axiom™



The 30 Year Horizon

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New Foreword

On October 1, 2001 Axiom was withdrawn from the market and ended life as a commercial product. On September 3, 2002 Axiom was released under the Modified BSD license, including this document. On August 27, 2003 Axiom was released as free and open source software available for download from the Free Software Foundation's website, Savannah.

Work on Axiom has had the generous support of the Center for Algorithms and Interactive Scientific Computation (CAISS) at City College of New York. Special thanks go to Dr. Gilbert Baumslag for his support of the long term goal.

The online version of this documentation is roughly 1000 pages. In order to make printed versions we've broken it up into three volumes. The first volume is tutorial in nature. The second volume is for programmers. The third volume is reference material. We've also added a fourth volume for developers. All of these changes represent an experiment in print-on-demand delivery of documentation. Time will tell whether the experiment succeeded.

Axiom has been in existence for over thirty years. It is estimated to contain about three hundred man-years of research and has, as of September 3, 2003, 143 people listed in the credits. All of these people have contributed directly or indirectly to making Axiom available. Axiom is being passed to the next generation. I'm looking forward to future milestones.

With that in mind I've introduced the theme of the "30 year horizon". We must invent the tools that support the Computational Mathematician working 30 years from now. How will research be done when every bit of mathematical knowledge is online and instantly available? What happens when we scale Axiom by a factor of 100, giving us 1.1 million domains? How can we integrate theory with code? How will we integrate theorems and proofs of the mathematics with space-time complexity proofs and running code? What visualization tools are needed? How do we support the conceptual structures and semantics of mathematics in effective ways? How do we support results from the sciences? How do we teach the next generation to be effective Computational Mathematicians?

The "30 year horizon" is much nearer than it appears.

Tim Daly
CAISS, City College of New York
November 10, 2003 ((iHy))

Chapter 1

Numerical Analysis [4]

We can describe each number as x^* which has a machine-representable form which differs from the number x it is intended to represent. Quoting Householder we get:

$$x^* = \pm(x_1\beta^{-1} + x_2\beta^{-2} + \cdots + x_\lambda\beta^\lambda)\beta^\sigma$$

where β is the base, usually 2 or 10, λ is a positive integer, and σ is any integer, possibly zero. It may be that λ is fixed throughout the course of the computation, or it may vary, but in any case it is limited by practical considerations. Such a number will be called a representation. It may be that x^* is obtained by "rounding off" a number whose true value is x (for example, $x = 1/3$, $x^* = 0.33$), or that x^* is the result of measuring physically a quantity whose true value is x, or that x^* is the result of a computation intended to give an approximation to the quantity x.

Suppose one is interested in performing an operations ω upon a pair of numbers x and y. That is to say, $x\omega y$ may represent a product of x and y, a quotient of x by y, the yth power of x, ... In the numerical computation, however, one has only x^* and y^* upon which to operate, not x and y (or at least these are the quantitites upon which one does, in fact operate). Not only this, but often one does not even perform the strict operation ω, but rather a pseudo operation ω^*, which yields a rounded-off product, quotient, power, etc. Hence, instead of obtaining the desired result $x\omega y$, one obtains a result $x^*\omega^* y^*$.

The error in the result is therefore

$$x\omega y - x^*\omega^* y^* = (x\omega y - x^*\omega y^*) + (x^*\omega y^* - x^*\omega^* y^*)$$

Since x^* and y^* are numbers, the operation ω can be applied to them, and $x^*\omega y^*$ is well defined, except for special cases as when ω represents division and $y^* = 0$. But the expression in the first parenthesees on the right represents propagated error, and that in the second parentheses represents generated error, or round-off. Hence the total error in the result is the sum of the error propagated by the operation and that generated by the operation.

Householder notes that, given two operations ω and ϕ, it may be true that the operations are associative, e.g:

$$(x^*\omega y^*)\phi z^* = x^*\omega(y^*\phi z^*)$$

but if we expand these in terms of the above definitions of propogation and generation error we get two different expressions:

$$\begin{aligned}(x^*\omega y^*)\phi z^* - (x^*\omega^* y^*)\phi^* z^* &= [(x^*\omega y^*)\phi z^* - (x^*\omega^* y^*)\phi z^*] \\ &+ [(x^*\omega^* y^*)\phi z^* - (x^*\omega^* y^*)\phi^* z^*]\end{aligned}$$

$$\begin{aligned}x^*\omega(y^*\phi z^*) - x^*\omega^*(y^*\phi^* z^*) &= [x^*\omega(y^*\phi z^*) - x^*\omega(y^*\phi^* z^*)] \\ &+ [x^*\omega(y^*\phi^* z^*) - x^*\omega^*(y^*\phi^* z^*)]\end{aligned}$$

These are not always equal which implies that the strictly machine operations are not necessarily commutative.

Householder distinguishes a third class of error (besides propagation and generative) called residual errors. This occurs because some functions are approximated by infinite series. The finite computation of the series forces the truncation of the remaining terms causing these residual errors.

We will try to perform an analysis of each of the routines in this library for the given inputs to try to see the propagation errors and generation errors they introduce. Every effort will be made to minimize these errors. In particular, we will appeal to the machine generated code to see what approximations actually occur.

Chapter 2

Chapter Overview

Each routine in the Basic Linear Algebra Subroutine set (BLAS) has a prefix where:

- C - Complex
- D - Double Precision
- S - Real
- Z - Complex*16

Routines in level 2 and level 3 of BLAS use the prefix for type:

- GE - general
- GB - general band
- SY - symmetric
- HE - hermitian
- TR - triangular
- SB - symmetric band
- HB - hermetian band
- TB - triangular band
- SP - Sum packed
- HP - hermitian packed
- TP - triangular packed

For level 2 and level 3 BLAS options the options argument is CHARACTER*1 and may be passed as character strings. They mean:

- TRANx
  - **N**o transpose
  - **T**ranspose
  - **C**onjugate transpose (X, X^T, X^H)
- UPLO
  - **U**pper triangular
  - **L**ower triangular
- DIAG
  - **N**on-unit triangular
  - **U**nit triangular
- SIDE
  - **L**eft - A or op(A) on the left
  - **R**ight - A or op(A) on the right

For real matrices, TRANSx=T and TRANSx=C have the same meaning. For Hermitian matrices, TRANSx=T is not allowed. For complex symmetric matrices, TRANSx=H is not allowed.

There were 38 BLAS Level 1 routines defined in [**?**]. They are

- Dot product SDSDOT, DSDOT, DQ-IDOT DQ-ADOT C-UDOT C-CDOT DDOT SDOT
- Constant times a vector plus a vector CAXPY DAXPY SAXPY
- Set up Givens rotation DROTG SROTG
- Apply rotation DROT SROT
- Set up modified Givens rotation DROTMG SROTMG
- Apply modified rotation DROTM SROTM
- Copy x into y CCOPY DCOPY SCOPY
- Sway x and y CSWAP DSWAP SSWAP
- 2-norm (Euclidean length) SCNRM2 DNRM2 SNRM2
- Sum of absolute values SCASUM DASUM SASUM

- Constant times a vector CSSCAL CSCAL DSCAL SSCAL
- Index of maximum element ICAMAX IDAMAX ISAMAX

where

- I Integer
- S Single Precision
- D Double Precision
- C Single Precision Complex
- Q extended precision
- Z COMPLEX*16

Vector arguments are permitted to have a storage spacing between elements. This spacing is specified by an increment parameter. For example, suppose a vector x having components x_i, $i = 1, ldots, N$ is stored in a DOUBLE PRECISION array DX() with increment parameter INCX. If $INCX \geq 0$ then x_i is stored in $DX(1 + (i-1) * INCX)$. If $INCX < 0$ then x_i is stored in $DX(1 + (N-1) * |INCX|)$.

Chapter 3

Algebra Cover Code

3.1 package BLAS1 BlasLevelOne

— BlasLevelOne.input —

```
)set break resume
)sys rm -f BlasLevelOne.output
)spool BlasLevelOne.output
)set message test on
)set message auto off
)clear all

--S 1 of 208
t1:Complex DoubleFloat := complex(1.0,0)
--R
--R
--R   (1)  1.
--R                                                    Type: Complex(DoubleFloat)
--E 1

--S 2 of 208
dcabs1(t1)
--R
--R
--R   (2)  1.
--R                                                          Type: DoubleFloat
--E 2

--S 3 of 208
t2:Complex DoubleFloat := complex(1.0,1.0)
--R
--R
```

```
--R   (3)  1. + %i
--R                                                    Type: Complex(DoubleFloat)
--E 3

--S 4 of 208
dcabs1(t2)
--R
--R
--R   (4)  2.
--R                                                             Type: DoubleFloat
--E 4

--S 5 of 208
t3:Complex DoubleFloat := complex(1.0,-1.0)
--R
--R
--R   (5)  1. - %i
--R                                                    Type: Complex(DoubleFloat)
--E 5

--S 6 of 208
dcabs1(t3)
--R
--R
--R   (6)  2.
--R                                                             Type: DoubleFloat
--E 6

--S 7 of 208
t4:Complex DoubleFloat := complex(-1.0,-1.0)
--R
--R
--R   (7)  - 1. - %i
--R                                                    Type: Complex(DoubleFloat)
--E 7

--S 8 of 208
dcabs1(t4)
--R
--R
--R   (8)  2.
--R                                                             Type: DoubleFloat
--E 8

--S 9 of 208
t5:Complex DoubleFloat := complex(-2.0,-2.0)
--R
--R
--R   (9)  - 2. - 2. %i
--R                                                    Type: Complex(DoubleFloat)
```

```
--E 9

--S 10 of 208
dcabs1(t5)
--R
--R
--R   (10)  4.
--R                                                    Type: DoubleFloat
--E 10

)clear all

--S 11 of 208
a:PRIMARR(DFLOAT):=[ [1.0,2.0,3.0,4,0,5,0,6,0] ]
--R
--R   (1)  [1.,2.,3.,4.,0.,5.,0.,6.,0.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 11

--S 12 of 208
dasum(3,a,-1) -- 0.0   neg incx
--R
--R   (2)  0.
--R                                                    Type: DoubleFloat
--E 12

--S 13 of 208
dasum(3,a,0) --  0.0   zero incx
--R
--R   (3)  0.
--R                                                    Type: DoubleFloat
--E 13

--S 14 of 208
dasum(-1,a,1) -- 0.0   neg elements
--R
--R   (4)  0.
--R                                                    Type: DoubleFloat
--E 14

--S 15 of 208
dasum(0,a,1) --  0.0   no elements
--R
--R   (5)  0.
--R                                                    Type: DoubleFloat
--E 15

--S 16 of 208
dasum(1,a,1) --  1.0   1.0
--R
```

```
--R   (6)  1.
--R                                                    Type: DoubleFloat
--E 16

--S 17 of 208
dasum(2,a,1) --  3.0   1.0+2.0
--R
--R   (7)  3.
--R                                                    Type: DoubleFloat
--E 17

--S 18 of 208
dasum(3,a,1) --  6.0   1.0+2.0+3.0
--R
--R   (8)  6.
--R                                                    Type: DoubleFloat
--E 18

--S 19 of 208
dasum(4,a,1) -- 10.0   1.0+2.0+3.0+4.0
--R
--R   (9)  10.
--R                                                    Type: DoubleFloat
--E 19

--S 20 of 208
dasum(5,a,1) -- 15.0   1.0+2.0+3.0+4.0+5.0
--R
--R   (10)  10.
--R                                                    Type: DoubleFloat
--E 20

--S 21 of 208
dasum(6,a,1) -- 21.0   1.0+2.0+3.0+4.0+5.0+6.0
--R
--R   (11)  15.
--R                                                    Type: DoubleFloat
--E 21

--S 22 of 208
dasum(7,a,1) -- 21.0   1.0+2.0+3.0+4.0+5.0+6.0
--R
--R   (12)  15.
--R                                                    Type: DoubleFloat
--E 22

--S 23 of 208
dasum(1,a,2) --  1.0   1.0
--R
--R   (13)  1.
```

```
--R                                                    Type: DoubleFloat
--E 23

--S 24 of 208
dasum(2,a,2) --  4.0   1.0+3.0
--R
--R   (14)  4.
--R                                                    Type: DoubleFloat
--E 24

--S 25 of 208
dasum(3,a,2) --  9.0   1.0+3.0+5.0
--R
--R   (15)  4.
--R                                                    Type: DoubleFloat
--E 25

--S 26 of 208
dasum(4,a,2) --  9.0   1.0+3.0+5.0
--R
--R   (16)  4.
--R                                                    Type: DoubleFloat
--E 26

--S 27 of 208
dasum(1,a,3) --  1.0   1.0
--R
--R   (17)  1.
--R                                                    Type: DoubleFloat
--E 27

--S 28 of 208
dasum(2,a,3) --  5.0   1.0+4.0
--R
--R   (18)  5.
--R                                                    Type: DoubleFloat
--E 28

--S 29 of 208
dasum(3,a,3) --  5.0   1.0+4.0
--R
--R   (19)  5.
--R                                                    Type: DoubleFloat
--E 29

--S 30 of 208
dasum(1,a,4) --  1.0   1.0
--R
--R   (20)  1.
--R                                                    Type: DoubleFloat
```

```
--E 30

--S 31 of 208
dasum(2,a,4) --  6.0   1.0+5.0
--R
--R   (21)  1.
--R                                                    Type: DoubleFloat
--E 31

--S 32 of 208
dasum(3,a,4) --  6.0   1.0+5.0
--R
--R   (22)  1.
--R                                                    Type: DoubleFloat
--E 32

--S 33 of 208
dasum(1,a,5) --  1.0   1.0
--R
--R   (23)  1.
--R                                                    Type: DoubleFloat
--E 33

--S 34 of 208
dasum(2,a,5) --  7.0   1.0+6.0
--R
--R   (24)  6.
--R                                                    Type: DoubleFloat
--E 34

--S 35 of 208
dasum(3,a,5) --  7.0   1.0+6.0
--R
--R   (25)  6.
--R                                                    Type: DoubleFloat
--E 35

--S 36 of 208
dasum(1,a,6) --  1.0   1.0
--R
--R   (26)  1.
--R                                                    Type: DoubleFloat
--E 36

--S 37 of 208
dasum(2,a,6) --  1.0   1.0
--R
--R   (27)  1.
--R                                                    Type: DoubleFloat
--E 37
```

```
--S 38 of 208
dasum(1,a,7) --  1.0   1.0
--R
--R   (28)  1.
--R                                                        Type: DoubleFloat
--E 38

)clear all

--S 39 of 208
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (1)  [1.,2.,3.,4.,5.,6.,7.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 39

--S 40 of 208
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (2)  [1.,2.,3.,4.,5.,6.,7.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 40

--S 41 of 208
daxpy(3,2.0,a,1,b,1)
--R
--R
--R   (3)  [3.,6.,9.,4.,5.,6.,7.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 41

--S 42 of 208
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (4)  [1.,2.,3.,4.,5.,6.,7.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 42

--S 43 of 208
daxpy(7,2.0,a,1,b,1)
--R
--R
--R   (5)  [3.,6.,9.,12.,15.,18.,21.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 43
```

```
--S 44 of 208
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (6)  [1.,2.,3.,4.,5.,6.,7.]
--R                                              Type: PrimitiveArray(DoubleFloat)
--E 44
```

———-

Note that Axiom properly handles array indexes that are out of bounds. The BLAS daxpy routine cannot check this condition.

— **BlasLevelOne.input** —

```
--S 45 of 208
daxpy(8,2.0,a,1,b,1)
--R
--R
--R   (7)  [1.,2.,3.,4.,5.,6.,7.]
--R                                              Type: PrimitiveArray(DoubleFloat)
--E 45

--S 46 of 208
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (8)  [1.,2.,3.,4.,5.,6.,7.]
--R                                              Type: PrimitiveArray(DoubleFloat)
--E 46

--S 47 of 208
daxpy(3,2.0,a,3,b,3)
--R
--R
--R   (9)  [3.,2.,3.,12.,5.,6.,21.]
--R                                              Type: PrimitiveArray(DoubleFloat)
--E 47

--S 48 of 208
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (10)  [1.,2.,3.,4.,5.,6.,7.]
--R                                              Type: PrimitiveArray(DoubleFloat)
--E 48

--S 49 of 208
daxpy(4,2.0,a,2,b,2)
--R
```

```
--R
--R   (11)  [3.,2.,9.,4.,15.,6.,21.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 49

--S 50 of 208
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (12)  [1.,2.,3.,4.,5.,6.,7.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 50

--S 51 of 208
daxpy(5,2.0,a,2,b,2)
--R
--R
--R   (13)  [1.,2.,3.,4.,5.,6.,7.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 51

--S 52 of 208
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (14)  [1.,2.,3.,4.,5.,6.,7.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 52

--S 53 of 208
daxpy(3,2.0,a,2,b,2)
--R
--R
--R   (15)  [3.,2.,9.,4.,15.,6.,7.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 53

--S 54 of 208
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (16)  [1.,2.,3.,4.,5.,6.,7.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 54

--S 55 of 208
daxpy(3,-2.0,a,2,b,2)
--R
--R
--R   (17)  [- 1.,2.,- 3.,4.,- 5.,6.,7.]
```

```
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 55

--S 56 of 208
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0] ]
--R
--R
--R   (18)  [1.,2.,3.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 56

--S 57 of 208
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0] ]
--R
--R
--R   (19)  [1.,2.,3.,4.,5.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 57

--S 58 of 208
daxpy(3,-2.0,a,1,b,2)
--R
--R
--R   (20)  [- 1.,2.,- 1.,4.,- 1.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 58

--S 59 of 208
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (21)  [1.,2.,3.,4.,5.,6.,7.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 59

--S 60 of 208
daxpy(3,0.0,a,1,b,2)
--R
--R
--R   (22)  [1.,2.,3.,4.,5.,6.,7.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 60

)clear all

--S 61 of 208
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (1)  [1.,2.,3.,4.,5.,6.,7.]
```

```
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 61

--S 62 of 208
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R   (2)  [0.,0.,0.,0.,0.,0.,0.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 62

--S 63 of 208
dcopy(3,a,1,b,1)
--R
--R
--R   (3)  [1.,2.,3.,0.,0.,0.,0.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 63

--S 64 of 208
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R   (4)  [0.,0.,0.,0.,0.,0.,0.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 64

--S 65 of 208
dcopy(7,a,1,b,1)
--R
--R
--R   (5)  [1.,2.,3.,4.,5.,6.,7.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 65

--S 66 of 208
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R   (6)  [0.,0.,0.,0.,0.,0.,0.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 66

--S 67 of 208
dcopy(8,a,1,b,1)
--R
--R
--R   (7)  [0.,0.,0.,0.,0.,0.,0.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 67
```

```
--S 68 of 208
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R   (8)  [0.,0.,0.,0.,0.,0.,0.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 68

--S 69 of 208
dcopy(3,a,3,b,3)
--R
--R
--R   (9)  [1.,0.,0.,4.,0.,0.,7.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 69

--S 70 of 208
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R   (10)  [0.,0.,0.,0.,0.,0.,0.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 70

--S 71 of 208
dcopy(4,a,2,b,2)
--R
--R
--R   (11)  [1.,0.,3.,0.,5.,0.,7.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 71

--S 72 of 208
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R   (12)  [0.,0.,0.,0.,0.,0.,0.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 72

--S 73 of 208
dcopy(5,a,2,b,2)
--R
--R
--R   (13)  [0.,0.,0.,0.,0.,0.,0.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 73

--S 74 of 208
```

```
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R   (14)  [0.,0.,0.,0.,0.,0.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 74

--S 75 of 208
dcopy(3,a,2,b,2)
--R
--R
--R   (15)  [1.,0.,3.,0.,5.,0.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 75

--S 76 of 208
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0] ]
--R
--R
--R   (16)  [1.,2.,3.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 76

--S 77 of 208
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0] ]
--R
--R
--R   (17)  [1.,2.,3.,4.,5.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 77

--S 78 of 208
dcopy(3,a,1,b,1)
--R
--R
--R   (18)  [1.,2.,3.,4.,5.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 78

--S 79 of 208
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0] ]
--R
--R
--R   (19)  [1.,2.,3.,4.,5.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 79

--S 80 of 208
dcopy(3,a,1,b,2)
--R
```

```
--R
--R   (20)  [1.,2.,2.,4.,3.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 80

--S 81 of 208
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0] ]
--R
--R
--R   (21)  [1.,2.,3.,4.,5.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 81

--S 82 of 208
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0] ]
--R
--R
--R   (22)  [1.,2.,3.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 82

--S 83 of 208
dcopy(5,a,1,b,1)
--R
--R
--R   (23)  [1.,2.,3.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 83

)clear all

--S 84 of 208
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0] ]
--R
--R   (1)  [1.,2.,3.,4.,5.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 84

--S 85 of 208
b:PRIMARR(DFLOAT):=[ [ 5.0, 6.0, 7.0, 8.0, 9.0] ]
--R
--R   (2)  [5.,6.,7.,8.,9.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 85

--S 86 of 208
ddot(0,a,1,b,1)
--R
--R   (3)  0.
--R                                                        Type: DoubleFloat
```

```
--E 86

--S 87 of 208
ddot(3,a,1,b,1)
--R
--R   (4)  38.
--R                                                    Type: DoubleFloat
--E 87

--S 88 of 208
ddot(3,a,1,b,2)
--R
--R   (5)  46.
--R                                                    Type: DoubleFloat
--E 88

--S 89 of 208
ddot(3,a,2,b,1)
--R
--R   (6)  58.
--R                                                    Type: DoubleFloat
--E 89

--S 90 of 208
ddot(3,a,1,b,-2)
--R
--R   (7)  38.
--R                                                    Type: DoubleFloat
--E 90

--S 91 of 208
ddot(3,a,-2,b,1)
--R
--R   (8)  50.
--R                                                    Type: DoubleFloat
--E 91

--S 92 of 208
ddot(3,a,-2,b,-2)
--R
--R   (9)  71.
--R                                                    Type: DoubleFloat
--E 92

)clear all

--S 93 of 208
a:PRIMARR(DFLOAT):=[ [ 3.0, -4.0, 5.0, -7.0, 9.0] ]
--R
--R   (1)  [3.,- 4.,5.,- 7.,9.]
```

```
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 93

--S 94 of 208
dnrm2(3,a,1)
--R
--R   (2)  7.0710678118654755
--R                                                                Type: DoubleFloat
--E 94

--S 95 of 208
dnrm2(5,a,1)
--R
--R   (3)  13.416407864998739
--R                                                                Type: DoubleFloat
--E 95

--S 96 of 208
dnrm2(3,a,2)
--R
--R   (4)  10.723805294763608
--R                                                                Type: DoubleFloat
--E 96

)clear all
--S 97 of 208
a:MATRIX(DFLOAT):=[[6,5,0],[5,1,4],[0,4,3]]
--R
--R        +6.  5.  0.+
--R        |          |
--R   (1)  |5.  1.  4.|
--R        |          |
--R        +0.  4.  3.+
--R                                                 Type: Matrix(DoubleFloat)
--E 97

--S 98 of 208
t1:=drotg(elt(a,1,1),elt(a,1,2),0.0,0.0)
--R
--R   (2)
--R   [7.810249675906654, 0.64018439966447993, 0.76822127959737585,
--R    0.64018439966447993]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 98

--S 99 of 208
g1:MATRIX(DFLOAT):=[[elt(t1,2), elt(t1,3),0.0],_
                    [-elt(t1,3),elt(t1,2),0.0],_
                    [0.0,       0.0,      1.0]]
--R
```

```
--R
--R        + 0.76822127959737585   0.64018439966447993  0.+
--R        |                                             |
--R   (3)  |- 0.64018439966447993  0.76822127959737585  0.|
--R        |                                             |
--R        +         0.                    0.           1.+
--R                                                 Type: Matrix(DoubleFloat)
--E 99

--S 100 of 208
t2:=g1*a
--R
--R        +   7.810249675906654       4.4812907976513596   2.5607375986579197+
--R        |                                                                   |
--R   (4)  |- 4.4408920985006262E-16  - 2.4327007187250236  3.0728851183895034|
--R        |                                                                   |
--R        +           0.                      4.                   3.        +
--R                                                 Type: Matrix(DoubleFloat)
--E 100

--S 101 of 208
t3:=drotg(elt(t2,2,2),elt(a,3,2),0.0,0.0)
--R
--R   (5)
--R   [4.6816698716254272, - 1.924474241977076, - 0.51962243930719854,
--R    0.85439599751428896]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 101

--S 102 of 208
g2:MATRIX(DFLOAT):=[[1.0, 0.0,      0.0],_
                    [0.0, elt(t3,2),elt(t3,3)],_
                    [0.0,-elt(t3,3),elt(t3,2)]]
--R
--R
--R        +1.           0.                     0.          +
--R        |                                                |
--R   (6)  |0.  - 0.51962243930719854   0.85439599751428896 |
--R        |                                                |
--R        +0.  - 0.85439599751428896  - 0.51962243930719854+
--R                                                 Type: Matrix(DoubleFloat)
--E 102

--S 103 of 208
g2*g1*a
--R
--R        +   7.810249675906654      4.4812907976513596   2.5607375986579197 +
--R        |                                                                  |
--R   (7)  | 2.2204460492503131E-16   4.6816698716254272  0.96644793161452336 |
--R        |                                                                  |
```

```
--R        +- 4.4408920985006262E-16          0.          - 4.1843280638948093+
--R                                                      Type: Matrix(DoubleFloat)
--E 103

--S 104 of 208
q:=transpose(g1)*transpose(g2)
--R
--R        +0.76822127959737585   0.33265417936007158    0.54697098874441952 +
--R        |                                                                  |
--R   (8)  |0.64018439966447993  - 0.39918501523208583  - 0.65636518649330344|
--R        |                                                                  |
--R        +        0.            0.85439599751428896   - 0.51962243930719854+
--R                                                      Type: Matrix(DoubleFloat)
--E 104

)clear all

--S 105 of 208
dx:PRIMARR(DFLOAT):=[[6,0, 1.0, 4.0, -1.0, -1.0]]
--R
--R   (1)  [6.,0.,1.,4.,- 1.,- 1.]
--R                                              Type: PrimitiveArray(DoubleFloat)
--E 105

--S 106 of 208
dy:PRIMARR(DFLOAT):=[[5.0, 1.0, -4.0, 4.0, -4.0]]
--R
--R   (2)  [5.,1.,- 4.,4.,- 4.]
--R                                              Type: PrimitiveArray(DoubleFloat)
--E 106

--S 107 of 208
drot(5,dx,1,dy,1,0.707106781,0.707106781) -- rotate by 45 degrees
--R
--R   (3)
--R   [
--R     [7.778174591, 0.70710678100000002, - 2.1213203429999998,
--R      5.6568542480000001, - 3.5355339050000003, - 1.]
--R     ,
--R
--R     [- 0.70710678100000002, 0.70710678100000002, - 3.5355339050000003, 0.,
--R      - 2.1213203429999998]
--R     ]
--R                                        Type: List(PrimitiveArray(DoubleFloat))
--E 107

--S 108 of 208
[dx,dy] -- note that the input arguments, dx and dy were modified
--R
--R   (4)
```

```
--R   [
--R     [7.778174591, 0.70710678100000002, - 2.1213203429999998,
--R      5.6568542480000001, - 3.5355339050000003, - 1.]
--R     ,
--R
--R     [- 0.70710678100000002, 0.70710678100000002, - 3.5355339050000003, 0.,
--R      - 2.1213203429999998]
--R     ]
--R                                    Type: List(PrimitiveArray(DoubleFloat))
--E 108

--S 109 of 208
drot(5,dx,1,dy,1,0.707106781,-0.707106781) -- rotate by -45 degrees
--R
--R   (5)
--R   [
--R     [5.9999999968341839, 7.8496237287950521E-17, 0.99999999947236384,
--R      3.9999999978894558, - 0.99999999947236451, - 1.]
--R     ,
--R
--R     [4.9999999973618188, 0.99999999947236384, - 3.9999999978894558,
--R      3.9999999978894554, - 3.9999999978894554]
--R     ]
--R                                    Type: List(PrimitiveArray(DoubleFloat))
--E 109

--S 110 of 208
[dx,dy] -- note that the input arguments, dx and dy were modified
--R
--R   (6)
--R   [
--R     [5.9999999968341839, 7.8496237287950521E-17, 0.99999999947236384,
--R      3.9999999978894558, - 0.99999999947236451, - 1.]
--R     ,
--R
--R     [4.9999999973618188, 0.99999999947236384, - 3.9999999978894558,
--R      3.9999999978894554, - 3.9999999978894554]
--R     ]
--R                                    Type: List(PrimitiveArray(DoubleFloat))
--E 110

--S 111 of 208
dx:PRIMARR(DFLOAT):=[[6,0, 1.0, 4.0, -1.0, -1.0]]
--R
--R   (7)  [6.,0.,1.,4.,- 1.,- 1.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 111

--S 112 of 208
dy:PRIMARR(DFLOAT):=[[5.0, 1.0, -4.0, 4.0, -4.0]]
```

```
--R
--R   (8)  [5.,1.,- 4.,4.,- 4.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 112

--S 113 of 208
drot(5,dx,1,dy,1,0.707106781,0.707106781) -- rotate by 45 degrees
--R
--R   (9)
--R   [
--R     [7.778174591, 0.70710678100000002, - 2.1213203429999998,
--R      5.6568542480000001, - 3.5355339050000003, - 1.]
--R     ,
--R
--R     [- 0.70710678100000002, 0.70710678100000002, - 3.5355339050000003, 0.,
--R      - 2.1213203429999998]
--R     ]
--R                                        Type: List(PrimitiveArray(DoubleFloat))
--E 113

--S 114 of 208
drot(5,dx,1,dy,1,0.707106781,0.707106781) -- rotate to 90 degrees
--R
--R   (10)
--R   [
--R     [4.9999999973618197, 0.99999999947236395, - 3.9999999978894558,
--R      3.9999999978894558, - 3.9999999978894558, - 1.]
--R     ,
--R
--R     [- 5.9999999968341839, 0., - 0.99999999947236429, - 3.9999999978894558,
--R      0.99999999947236429]
--R     ]
--R                                        Type: List(PrimitiveArray(DoubleFloat))
--E 114

--S 115 of 208
drot(5,dx,1,dy,1,0.707106781,0.707106781) -- rotate to 135 degrees
--R
--R   (11)
--R   [
--R     [- 0.70710678062690524, 0.70710678062690502, - 3.535533903134525, 0.,
--R      - 2.1213203418807147, - 1.]
--R     ,
--R
--R     [- 7.7781745868959549, - 0.70710678062690502, 2.1213203418807147,
--R      - 5.6568542450152401, 3.535533903134525]
--R     ]
--R                                        Type: List(PrimitiveArray(DoubleFloat))
--E 115
```

```
--S 116 of 208
drot(5,dx,1,dy,1,0.707106781,0.707106781) -- rotate to 180 degrees
--R
--R   (12)
--R   [
--R     [- 5.9999999936683679, 0., - 0.99999999894472813, - 3.9999999957789121,
--R      0.99999999894472813, - 1.]
--R     ,
--R
--R     [- 4.9999999947236393, - 0.99999999894472802, 3.9999999957789116,
--R      - 3.9999999957789121, 3.9999999957789116]
--R     ]
--R                                      Type: List(PrimitiveArray(DoubleFloat))
--E 116

--S 117 of 208
drot(5,dx,1,dy,1,0.707106781,0.707106781) -- rotate to 225 degrees
--R
--R   (13)
--R   [
--R     [- 7.7781745827919098, - 0.70710678025381002, 2.1213203407614296,
--R      - 5.6568542420304802, 3.5355339012690501, - 1.]
--R     ,
--R
--R     [0.70710678025381046, - 0.70710678025381002, 3.5355339012690501, 0.,
--R      2.1213203407614296]
--R     ]
--R                                      Type: List(PrimitiveArray(DoubleFloat))
--E 117

--S 118 of 208
drot(5,dx,1,dy,1,0.707106781,0.707106781) -- rotate to 270 degrees
--R
--R   (14)
--R   [
--R     [- 4.999999992085459, - 0.99999999841709197, 3.9999999936683674,
--R      - 3.9999999936683679, 3.9999999936683674, - 1.]
--R     ,
--R
--R     [5.9999999905025518, 0., 0.99999999841709231, 3.9999999936683679,
--R      - 0.99999999841709231]
--R     ]
--R                                      Type: List(PrimitiveArray(DoubleFloat))
--E 118

--S 119 of 208
drot(5,dx,1,dy,1,0.707106781,0.707106781) -- rotate to 315 degrees
--R
--R   (15)
--R   [
```

```
--R     [0.70710677988071569, - 0.70710677988071502, 3.5355338994035752, 0.,
--R      2.1213203396421445, - 1.]
--R     ,
--R
--R     [7.7781745786878647, 0.70710677988071502, - 2.1213203396421445,
--R      5.6568542390457202, - 3.5355338994035752]
--R     ]
--R                                        Type: List(PrimitiveArray(DoubleFloat))
--E 119

--S 120 of 208
drot(5,dx,1,dy,1,0.707106781,0.707106781) -- rotate to 360 degrees
--R
--R   (16)
--R   [
--R     [5.9999999873367358, 0., 0.99999999788945637, 3.9999999915578237,
--R      - 0.99999999788945637, - 1.]
--R     ,
--R
--R     [4.9999999894472786, 0.99999999788945593, - 3.9999999915578233,
--R      3.9999999915578237, - 3.9999999915578233]
--R     ]
--R                                        Type: List(PrimitiveArray(DoubleFloat))
--E 120

--S 121 of 208
[dx,dy] -- note that the input arguments, dx and dy were modified
--R
--R   (17)
--R   [
--R     [5.9999999873367358, 0., 0.99999999788945637, 3.9999999915578237,
--R      - 0.99999999788945637, - 1.]
--R     ,
--R
--R     [4.9999999894472786, 0.99999999788945593, - 3.9999999915578233,
--R      3.9999999915578237, - 3.9999999915578233]
--R     ]
--R                                        Type: List(PrimitiveArray(DoubleFloat))
--E 121

)clear all
--S 122 of 208
dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0, 5.0, 6.0]]
--R
--R   (1)  [1.,2.,3.,4.,5.,6.]
--R                                             Type: PrimitiveArray(DoubleFloat)
--E 122

--S 123 of 208
dscal(6,2.0,dx,1)
```

```
--R
--R   (2)  [2.,4.,6.,8.,10.,12.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 123

--S 124 of 208
dx
--R
--R   (3)  [2.,4.,6.,8.,10.,12.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 124

--S 125 of 208
dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0, 5.0, 6.0]]
--R
--R   (4)  [1.,2.,3.,4.,5.,6.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 125

--S 126 of 208
dscal(3,0.5,dx,1)
--R
--R   (5)  [0.5,1.,1.5,4.,5.,6.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 126

--S 127 of 208
dx
--R
--R   (6)  [0.5,1.,1.5,4.,5.,6.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 127

)clear all

--S 128 of 208
dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0,  5.0]]
--R
--R   (1)  [1.,2.,3.,4.,5.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 128

--S 129 of 208
dy:PRIMARR(DFLOAT):=[[9.0, 8.0, 7.0, 6.0, -5.0]]
--R
--R   (2)  [9.,8.,7.,6.,- 5.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 129

--S 130 of 208
```

```
dswap(5,dx,1,dy,1)
--R
--R   (3)  [[9.,8.,7.,6.,- 5.],[1.,2.,3.,4.,5.]]
--R                                    Type: List(PrimitiveArray(DoubleFloat))
--E 130

--S 131 of 208
dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0,  5.0]]
--R
--R   (4)  [1.,2.,3.,4.,5.]
--R                                        Type: PrimitiveArray(DoubleFloat)
--E 131

--S 132 of 208
dy:PRIMARR(DFLOAT):=[[9.0, 8.0, 7.0, 6.0, -5.0]]
--R
--R   (5)  [9.,8.,7.,6.,- 5.]
--R                                        Type: PrimitiveArray(DoubleFloat)
--E 132

--S 133 of 208
dswap(3,dx,2,dy,2)
--R
--R   (6)  [[9.,2.,7.,4.,- 5.],[1.,8.,3.,6.,5.]]
--R                                    Type: List(PrimitiveArray(DoubleFloat))
--E 133

--S 134 of 208
dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0,  5.0]]
--R
--R   (7)  [1.,2.,3.,4.,5.]
--R                                        Type: PrimitiveArray(DoubleFloat)
--E 134

--S 135 of 208
dy:PRIMARR(DFLOAT):=[[9.0, 8.0, 7.0, 6.0, -5.0]]
--R
--R   (8)  [9.,8.,7.,6.,- 5.]
--R                                        Type: PrimitiveArray(DoubleFloat)
--E 135

--S 136 of 208
dswap(5,dx,1,dy,-1)
--R
--R   (9)  [[9.,8.,7.,6.,- 5.],[1.,2.,3.,4.,5.]]
--R                                    Type: List(PrimitiveArray(DoubleFloat))
--E 136

)clear all
```

```
--S 137 of 208
d:PRIMARR(COMPLEX(DFLOAT)):=[[1.0+2.0*%i,-3.0+4.0*%i,5.0-6.0*%i]]
--R
--R   (1)  [1. + 2. %i,- 3. + 4. %i,5. - 6. %i]
--R                                  Type: PrimitiveArray(Complex(DoubleFloat))
--E 137

--S 138 of 208
dzasum(3,d,1) -- 21.0
--R
--R   (2)  21.
--R                                                        Type: DoubleFloat
--E 138

--S 139 of 208
dzasum(3,d,2) -- 14.0
--R
--R   (3)  14.
--R                                                        Type: DoubleFloat
--E 139

--S 140 of 208
dzasum(-3,d,1) -- 0.0
--R
--R   (4)  0.
--R                                                        Type: DoubleFloat
--E 140

)clear all

--S 141 of 208
a:PRIMARR(COMPLEX(DFLOAT)):=_
  [[3.+4.*%i, -4.+5.*%i, 5.+6.*%i, 7.-8.*%i, -9.-2.*%i]]
--R
--R   (1)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                  Type: PrimitiveArray(Complex(DoubleFloat))
--E 141

--S 142 of 208
dznrm2(5,a,1) -- should be 18.028
--R
--R   (2)  18.027756377319946
--R                                                        Type: DoubleFloat
--E 142

--S 143 of 208
dznrm2(3,a,2) -- should be 13.077
--R
--R   (3)  13.076696830622021
--R                                                        Type: DoubleFloat
```

```
--E 143

--S 144 of 208
dznrm2(3,a,1) -- should be 11.269
--R
--R   (4)  11.269427669584644
--R                                                          Type: DoubleFloat
--E 144

--S 145 of 208
dznrm2(3,a,-1) -- should be 0.0
--R
--R   (5)  0.
--R                                                          Type: DoubleFloat
--E 145

--S 146 of 208
dznrm2(-3,a,-1) -- should be 0.0
--R
--R   (6)  0.
--R                                                          Type: DoubleFloat
--E 146

--S 147 of 208
dznrm2(1,a,1) -- should be 5.0
--R
--R   (7)  5.
--R                                                          Type: DoubleFloat
--E 147

--S 148 of 208
dznrm2(1,a,2) -- should be 5.0
--R
--R   (8)  5.
--R                                                          Type: DoubleFloat
--E 148

)clear all

--S 149 of 208
a:PRIMARR(COMPLEX(FLOAT))
--R                                                                  Type: Void
--E 149

--S 150 of 208
a:=[[3.+4.*%i,-4.+5.*%i,5.+6.*%i,7.-8.*%i,-9.-2.*%i]]
--R
--R   (2)  [3.0 + 4.0 %i,- 4.0 + 5.0 %i,5.0 + 6.0 %i,7.0 - 8.0 %i,- 9.0 - 2.0 %i]
--R                                        Type: PrimitiveArray(Complex(Float))
--E 150
```

```
--S 151 of 208
icamax(5,a,1)  -- should be 3
--R
--R   (3)  3
--R                                                    Type: PositiveInteger
--E 151

--S 152 of 208
icamax(0,a,1)  -- should be -1
--R
--R   (4)  - 1
--R                                                            Type: Integer
--E 152

--S 153 of 208
icamax(5,a,-1) -- should be -1
--R
--R   (5)  - 1
--R                                                            Type: Integer
--E 153

--S 154 of 208
icamax(3,a,1)  -- should be 2
--R
--R   (6)  2
--R                                                    Type: PositiveInteger
--E 155

--S 155 of 208
icamax(3,a,2)  -- should be 1
--R
--R   (7)  1
--R                                                    Type: PositiveInteger
--E 155

)clear all

--S 156 of 208
a:PRIMARR(DFLOAT):=[[3.0, 4.0, -3.0, 5.0, -1.0]]
--R
--R   (1)  [3.,4.,- 3.,5.,- 1.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 156

--S 157 of 208
idamax(5,a,1)  -- should be 3
--R
--R   (2)  3
--R                                                    Type: PositiveInteger
```

```
--E 157

--S 158 of 208
idamax(3,a,1)  -- should be 1
--R
--R   (3)  1
--R                                                    Type: PositiveInteger
--E 158

--S 159 of 208
idamax(0,a,1)  -- should be -1
--R
--R   (4)  - 1
--R                                                            Type: Integer
--E 159

--S 160 of 208
idamax(-5,a,1) -- should be -1
--R
--R   (5)  - 1
--R                                                            Type: Integer
--E 160

--S 161 of 208
idamax(5,a,-1) -- should be -1
--R
--R   (6)  - 1
--R                                                            Type: Integer
--E 161

--S 162 of 208
idamax(5,a,2)  -- should be 0
--R
--R   (7)  0
--R                                                 Type: NonNegativeInteger
--E 162

--S 163 of 208
idamax(1,a,0)  -- should be -1
--R
--R   (8)  - 1
--R                                                            Type: Integer
--E 163

--S 164 of 208
idamax(1,a,-1) -- should be -1
--R
--R   (9)  - 1
--R                                                            Type: Integer
--E 164
```

```
--S 165 of 208
a:PRIMARR(DFLOAT):=[[3.0, 4.0, -3.0, -5.0, -1.0]]
--R
--R   (10)  [3.,4.,- 3.,- 5.,- 1.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 165

--S 166 of 208
idamax(5,a,1)  -- should be 3
--R
--R   (11)  3
--R                                                   Type: PositiveInteger
--E 166

)clear all

--S 167 of 208
a:PRIMARR(FLOAT):=[[3.0, 4.0, -3.0, 5.0, -1.0]]
--R
--R
--R   (1)  [3.0,4.0,- 3.0,5.0,- 1.0]
--R                                               Type: PrimitiveArray(Float)
--E 167

--S 168 of 208
isamax(5,a,1)  -- should be 3
--R
--R   (2)  3
--R                                                   Type: PositiveInteger
--E 168

--S 169 of 208
isamax(3,a,1)  -- should be 1
--R
--R   (3)  1
--R                                                   Type: PositiveInteger
--E 169

--S 170 of 208
isamax(0,a,1)  -- should be -1
--R
--R   (4)  - 1
--R                                                          Type: Integer
--E 170

--S 171 of 208
isamax(-5,a,1) -- should be -1
--R
--R   (5)  - 1
```

```
--R                                                                Type: Integer
--E 171

--S 172 of 208
isamax(5,a,-1) -- should be -1
--R
--R   (6)  - 1
--R                                                                Type: Integer
--E 172

--S 173 of 208
isamax(5,a,2)  -- should be 0
--R
--R   (7)  0
--R                                                  Type: NonNegativeInteger
--E 173

--S 174 of 208
isamax(1,a,0)  -- should be -1
--R
--R   (8)  - 1
--R                                                                Type: Integer
--E 174

--S 175 of 208
isamax(1,a,-1) -- should be -1
--R
--R   (9)  - 1
--R                                                                Type: Integer
--E 175

--S 176 of 208
a:PRIMARR(FLOAT):=[[3.0, 4.0, -3.0, -5.0, -1.0]]
--R
--R
--R   (10)  [3.0,4.0,- 3.0,- 5.0,- 1.0]
--R                                              Type: PrimitiveArray(Float)
--E 176

--S 177 of 208
isamax(5,a,1)  -- should be 3
--R
--R   (11)  3
--R                                                   Type: PositiveInteger
--E 177

)clear all

--S 178 of 208
a:PRIMARR(COMPLEX(DFLOAT)):=[[3.+4.*%i,-4.+5.*%i,5.+6.*%i,7.-8.*%i,-9.-2.*%i]]
```

```
--R
--R   (1)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                  Type: PrimitiveArray(Complex(DoubleFloat))
--E 178

--S 179 of 208
izamax(5,a,1)  -- should be 3
--R
--R   (2)  3
--R                                                        Type: PositiveInteger
--E 179

--S 180 of 208
izamax(0,a,1)  -- should be -1
--R
--R   (3)  - 1
--R                                                               Type: Integer
--E 180

--S 181 of 208
izamax(5,a,-1) -- should be -1
--R
--R   (4)  - 1
--R                                                               Type: Integer
--E 181

--S 182 of 208
izamax(3,a,1)  -- should be 2
--R
--R   (5)  2
--R                                                        Type: PositiveInteger
--E 182

--S 183 of 208
izamax(3,a,2)  -- should be 1
--R
--R   (6)  1
--R                                                        Type: PositiveInteger
--E 183

)clear all

--S 184 of 208
a:PRIMARR(COMPLEX(DFLOAT)):=_
     [[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (1)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                  Type: PrimitiveArray(Complex(DoubleFloat))
--E 184
```

```
--S 185 of 208
b:PRIMARR(COMPLEX(DFLOAT)):=_
     [[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (2)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray(Complex(DoubleFloat))
--E 185

--S 186 of 208
zaxpy(3,2.0,a,1,b,1)
--R
--R   (3)  [9. + 12. %i,- 12. + 15. %i,15. + 18. %i,7. - 8. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray(Complex(DoubleFloat))
--E 186

--S 187 of 208
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (4)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray(Complex(DoubleFloat))
--E 187

--S 188 of 208
zaxpy(5,2.0,a,1,b,1)
--R
--R   (5)  [9. + 12. %i,- 12. + 15. %i,15. + 18. %i,21. - 24. %i,- 27. - 6. %i]
--R                                    Type: PrimitiveArray(Complex(DoubleFloat))
--E 188

--S 189 of 208
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (6)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray(Complex(DoubleFloat))
--E 189

--S 190 of 208
zaxpy(3,2.0,a,3,b,3)
--R
--R   (7)  [9. + 12. %i,- 4. + 5. %i,5. + 6. %i,21. - 24. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray(Complex(DoubleFloat))
--E 190

--S 191 of 208
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (8)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray(Complex(DoubleFloat))
--E 191
```

```
--S 192 of 208
zaxpy(4,2.0,a,2,b,2)
--R
--R   (9)  [9. + 12. %i,- 4. + 5. %i,15. + 18. %i,7. - 8. %i,- 27. - 6. %i]
--R                                   Type: PrimitiveArray(Complex(DoubleFloat))
--E 192

--S 193 of 208
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (10)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                   Type: PrimitiveArray(Complex(DoubleFloat))
--E 193

--S 194 of 208
zaxpy(3,2.0,a,2,b,2)
--R
--R   (11)  [9. + 12. %i,- 4. + 5. %i,15. + 18. %i,7. - 8. %i,- 27. - 6. %i]
--R                                   Type: PrimitiveArray(Complex(DoubleFloat))
--E 194

--S 195 of 208
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (12)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                   Type: PrimitiveArray(Complex(DoubleFloat))
--E 195

--S 196 of 208
zaxpy(3,-2.0,a,1,b,2)
--R
--R   (13)  [- 3. - 4. %i,- 4. + 5. %i,13. - 4. %i,7. - 8. %i,- 19. - 14. %i]
--R                                   Type: PrimitiveArray(Complex(DoubleFloat))
--E 196

--S 197 of 208
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (14)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                   Type: PrimitiveArray(Complex(DoubleFloat))
--E 197

--S 198 of 208
zaxpy(3,2.0,a,1,b,2)
--R
--R   (15)  [9. + 12. %i,- 4. + 5. %i,- 3. + 16. %i,7. - 8. %i,1. + 10. %i]
--R                                   Type: PrimitiveArray(Complex(DoubleFloat))
--E 198

--S 199 of 208
```

```
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (16)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray(Complex(DoubleFloat))
--E 199

--S 200 of 208
zaxpy(-3,2.0,a,1,b,2)
--R
--R   (17)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray(Complex(DoubleFloat))
--E 200

--S 201 of 208
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (18)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray(Complex(DoubleFloat))
--E 201

--S 202 of 208
zaxpy(3,2.0,a,-1,b,2)
--R
--R   (19)  [13. + 16. %i,- 4. + 5. %i,- 3. + 16. %i,7. - 8. %i,- 3. + 6. %i]
--R                                    Type: PrimitiveArray(Complex(DoubleFloat))
--E 202

--S 203 of 208
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (20)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray(Complex(DoubleFloat))
--E 203

--S 204 of 208
zaxpy(3,2.0,a,1,b,-2)
--R
--R   (21)  [13. + 16. %i,- 4. + 5. %i,- 3. + 16. %i,7. - 8. %i,- 3. + 6. %i]
--R                                    Type: PrimitiveArray(Complex(DoubleFloat))
--E 204

--S 205 of 208
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (22)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray(Complex(DoubleFloat))
--E 205

--S 206 of 208
zaxpy(3,2.0,a,-1,b,-2)
```

```
--R
--R   (23)  [9. + 12. %i,- 4. + 5. %i,- 3. + 16. %i,7. - 8. %i,1. + 10. %i]
--R                                   Type: PrimitiveArray(Complex(DoubleFloat))
--E 206

--S 207 of 208
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (24)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                   Type: PrimitiveArray(Complex(DoubleFloat))
--E 207

--S 208 of 208
zaxpy(3,0.0,a,1,b,1)
--R
--R   (25)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                   Type: PrimitiveArray(Complex(DoubleFloat))
--E 208

)spool
)lisp (bye)
```

———-

— BlasLevelOne.help —

```
========================================================================
BlasLevelOne examples
========================================================================

The dcabs1 routine computes the sum of the absolute value of the
real and imaginary parts of a complex number.

t1:Complex DoubleFloat := complex(1.0,0)
   1.

dcabs1(t1)
   1.

t2:Complex DoubleFloat := complex(1.0,1.0)
   1. + %i

dcabs1(t2)
   2.

t3:Complex DoubleFloat := complex(1.0,-1.0)
   1. - %i

dcabs1(t3)
```

```
   2.

t4:Complex DoubleFloat := complex(-1.0,-1.0)
   - 1. - %i

dcabs1(t4)
   2.

t5:Complex DoubleFloat := complex(-2.0,-2.0)
   - 2. - 2. %i

dcabs1(t5)
   4.

See Also:
o )show BlasLevelOne
```

———-

3.1.1 BlasLevelOne (BLAS1)

— package BLAS1 BlasLevelOne —

```
)abbrev package BLAS1 BlasLevelOne
++ Author: Timothy Daly
++ Date Created: 2010
++ Date March 24, 2010
++ Description:
++ This package provides an interface to the Blas library (level 1)
BlasLevelOne() : Exports == Implementation where

  SI   ==> SingleInteger
  INT  ==> Integer
  DF   ==> DoubleFloat
  SX   ==> PrimitiveArray(Float)
  DX   ==> PrimitiveArray(DoubleFloat)
  CDF  ==> Complex(DoubleFloat)
  LDX  ==> List(PrimitiveArray(DoubleFloat))
  PCDF ==> PrimitiveArray(Complex(DoubleFloat))
  PCF  ==> PrimitiveArray(Complex(Float))

  Exports == with

    dcabs1: CDF -> DF
      ++ dcabs1(z) computes (+ (abs (realpart z)) (abs (imagpart z)))
```

```
    ++
    ++X t1:Complex DoubleFloat := complex(1.0,0)
    ++X dcabs1(t1)

  dasum: (SI, DX, SI) -> DF
    ++ dasum(n,array,incx) computes the sum of n elements in array
    ++ using a stride of incx
    ++
    ++X dx:PRIMARR(DFLOAT):=[ [1.0,2.0,3.0,4.0,5.0,6.0] ]
    ++X dasum(6,dx,1)
    ++X dasum(3,dx,2)

  daxpy: (SI, DF, DX, SI, DX, SI) -> DX
    ++ daxpy(n,da,x,incx,y,incy) computes a y = a*x + y
    ++ for each of the chosen elements of the vectors x and y
    ++ and a constant multiplier a
    ++ Note that the vector y is modified with the results.
    ++
    ++X x:PRIMARR(DFLOAT):=[ [1.0,2.0,3.0,4.0,5.0,6.0] ]
    ++X y:PRIMARR(DFLOAT):=[ [1.0,2.0,3.0,4.0,5.0,6.0] ]
    ++X daxpy(6,2.0,x,1,y,1)
    ++X y
    ++X m:PRIMARR(DFLOAT):=[ [1.0,2.0,3.0] ]
    ++X n:PRIMARR(DFLOAT):=[ [1.0,2.0,3.0,4.0,5.0,6.0] ]
    ++X daxpy(3,-2.0,m,1,n,2)
    ++X n

  dcopy: (SI, DX, SI, DX, SI) -> DX
    ++ dcopy(n,x,incx,y,incy) copies y from x
    ++ for each of the chosen elements of the vectors x and y
    ++ Note that the vector y is modified with the results.
    ++
    ++X x:PRIMARR(DFLOAT):=[ [1.0,2.0,3.0,4.0,5.0,6.0] ]
    ++X y:PRIMARR(DFLOAT):=[ [0.0,0.0,0.0,0.0,0.0,0.0] ]
    ++X dcopy(6,x,1,y,1)
    ++X y
    ++X m:PRIMARR(DFLOAT):=[ [1.0,2.0,3.0] ]
    ++X n:PRIMARR(DFLOAT):=[ [0.0,0.0,0.0,0.0,0.0,0.0] ]
    ++X dcopy(3,m,1,n,2)
    ++X n

  ddot: (SI, DX, SI, DX, SI) -> DF
    ++ ddot(n,x,incx,y,incy) computes the vector dot product
    ++ of elements from the vector x and the vector y
    ++ If the indicies are negative the elements are taken
    ++ relative to the far end of the vector.
    ++
    ++X x:PRIMARR(DFLOAT):=[ [1.0,2.0,3.0,4.0,5.0] ]
    ++X y:PRIMARR(DFLOAT):=[ [5.0,6.0,7.0,8.0,9.0] ]
    ++X ddot(0,a,1,b,1) -- handle 0 elements ==> 0
```

```
  ++X ddot(3,a,1,b,1) -- (1,2,3) * (5,6,7) ==> 38.0
  ++X ddot(3,a,1,b,2) -- increment = 2 in b (1,2,3) * (5,7,9) ==> 46.0
  ++X ddot(3,a,2,b,1) -- increment = 2 in a (1,3,5) * (5,6,7) ==> 58.0
  ++X ddot(3,a,1,b,-2) -- increment = -2 in b (1,2,3) * (9,7,5) ==> 38.0
  ++X ddot(2,a,-2,b,1) -- increment = -2 in a (5,3,1) * (5,6,7) ==> 50.0
  ++X ddot(3,a,-2,b,-2) -- (5,3,1) * (9,7,5) ==> 71.0

dnrm2: (SI, DX, SI) -> DF
  ++ dnrm2 takes the norm of the vector, ||x||
  ++
  ++X a:PRIMARR(DFLOAT):=[ [3.0, -4.0, 5.0, -7.0, 9.0] ]
  ++X dnrm2(3,a,1) -- 7.0710678118654755 = sqrt(3.0^2 + -4.0^2 + 5.0^2)
  ++X dnrm2(5,a,1) -- 13.416407864998739 = sqrt(180.0)
  ++X dnrm2(3,a,2) -- 10.72380529476361  = sqrt(115.0)

drotg: (DF, DF, DF, DF) -> DX
  ++ drotg computes a 2D plane Givens rotation spanned by two
  ++ coordinate axes.
  ++
  ++X a:MATRIX(DFLOAT):=[[6,5,0],[5,1,4],[0,4,3]]
  ++X drotg(elt(a,1,1),elt(a,1,2),0.0D0,0.0D0)

drot: (SI, DX, SI, DX, SI, DF, DF) -> LDX
  ++ drot computes a 2D plane Givens rotation spanned by two
  ++ coordinate axes. It modifies the arrays in place.
  ++ The call drot(n,dx,incx,dy,incy,c,s) has the dx array which
  ++ contains the y axis locations and dy which contains the
  ++ y axis locations. They are rotated in parallel where
  ++ c is the cosine of the angle and s is the sine of the angle and
  ++ c^2+s^2 = 1
  ++
  ++X dx:PRIMARR(DFLOAT):=[[6,0, 1.0, 4.0, -1.0, -1.0]]
  ++X dy:PRIMARR(DFLOAT):=[[5.0, 1.0, -4.0, 4.0, -4.0]]
  ++X drot(5,dx,1,dy,1,0.707106781,0.707106781) -- rotate by 45 degrees
  ++X dx -- dx has been modified
  ++X dy -- dy has been modified
  ++X drot(5,dx,1,dy,1,0.707106781,-0.707106781) -- rotate by -45 degrees
  ++X dx -- dx has been modified
  ++X dy -- dy has been modified

dscal: (SI, DF, DX, SI) -> DX
  ++ dscal scales each element of the vector by the scalar so
  ++ dscal(n,da,dx,incx) = da*dx for n elements, incremented by incx
  ++ Note that the dx array is modified in place.
  ++
  ++X dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0, 5.0, 6.0]]
  ++X dscal(6,2.0,dx,1)
  ++X dx
  ++X dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0, 5.0, 6.0]]
  ++X dscal(3,0.5,dx,1)
```

```
  ++X dx

dswap: (SI, DX, SI, DX, SI) -> LDX
  ++ dswap swaps elements from the first vector with the second
  ++ Note that the arrays are modified in place.
  ++
  ++X dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0, 5.0, 6.0]]
  ++X dy:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0, 5.0, 6.0]]
  ++X dswap(5,dx,1,dy,1)
  ++X dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0, 5.0, 6.0]]
  ++X dy:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0, 5.0, 6.0]]
  ++X dswap(3,dx,2,dy,2)
  ++X dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0, 5.0, 6.0]]
  ++X dy:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0, 5.0, 6.0]]
  ++X dswap(5,dx,1,dy,-1)

dzasum: (SI, PCDF, SI) -> DF
  ++ dzasum takes the sum over all of the array where each
  ++ element of the array sum is the sum of the absolute
  ++ value of the real part and the absolute value of the
  ++ imaginary part of each array element:
  ++   for i in array do sum = sum + (real(a(i)) + imag(a(i)))
  ++
  ++X d:PRIMARR(COMPLEX(DFLOAT)):=[[1.0+2.0*%i,-3.0+4.0*%i,5.0-6.0*%i]]
  ++X dzasum(3,d,1) -- 21.0
  ++X dzasum(3,d,2) -- 14.0
  ++X dzasum(-3,d,1) -- 0.0

dznrm2: (SI, PCDF, SI) -> DF
  ++ dznrm2 returns the norm of a complex vector. It computes
  ++ sqrt(sum(v*conjugate(v)))
  ++
  ++X a:PRIMARR(COMPLEX(DFLOAT))
  ++X a:=[[3.+4.*%i,-4.+5.*%i,5.+6.*%i,7.-8.*%i,-9.-2.*%i]]
  ++X dznrm2(5,a,1)   -- should be 18.028
  ++X dznrm2(3,a,2)   -- should be 13.077
  ++X dznrm2(3,a,1)   -- should be 11.269
  ++X dznrm2(3,a,-1)  -- should be 0.0
  ++X dznrm2(-3,a,-1) -- should be 0.0
  ++X dznrm2(1,a,1)   -- should be 5.0
  ++X dznrm2(1,a,2)   -- should be 5.0

icamax: (INT, PCF, INT) -> INT
  ++ icamax computes the largest absolute value of the elements
  ++ of the array and returns the index of the first instance
  ++ of the maximum
  ++
  ++X a:PRIMARR(COMPLEX(FLOAT))
  ++X a:=[[3.+4.*%i,-4.+5.*%i,5.+6.*%i,7.-8.*%i,-9.-2.*%i]]
  ++X icamax(5,a,1)  -- should be 3
```

```
  ++X icamax(0,a,1)  -- should be -1
  ++X icamax(5,a,-1) -- should be -1
  ++X icamax(3,a,1)  -- should be 2
  ++X icamax(3,a,2)  -- should be 1

idamax: (INT, DX, INT) -> INT
  ++ idamax computes the largest absolute value of the elements
  ++ of the array and returns the index of the first instance
  ++ of the maximum.
  ++
  ++X a:PRIMARR(DFLOAT):=[[3.0, 4.0, -3.0, 5.0, -1.0]]
  ++X idamax(5,a,1)  -- should be 3
  ++X idamax(3,a,1)  -- should be 1
  ++X idamax(0,a,1)  -- should be -1
  ++X idamax(-5,a,1) -- should be -1
  ++X idamax(5,a,-1) -- should be -1
  ++X idamax(5,a,2)  -- should be 0
  ++X idamax(1,a,0)  -- should be -1
  ++X idamax(1,a,-1) -- should be -1
  ++X a:PRIMARR(DFLOAT):=[[3.0, 4.0, -3.0, -5.0, -1.0]]
  ++X idamax(5,a,1)  -- should be 3

isamax: (INT, SX, INT) -> INT
  ++ isamax computes the largest absolute value of the elements
  ++ of the array and returns the index of the first instance
  ++ of the maximum.
  ++
  ++X a:PRIMARR(FLOAT):=[[3.0, 4.0, -3.0, 5.0, -1.0]]
  ++X isamax(5,a,1)  -- should be 3
  ++X isamax(3,a,1)  -- should be 1
  ++X isamax(0,a,1)  -- should be -1
  ++X isamax(-5,a,1) -- should be -1
  ++X isamax(5,a,-1) -- should be -1
  ++X isamax(5,a,2)  -- should be 0
  ++X isamax(1,a,0)  -- should be -1
  ++X isamax(1,a,-1) -- should be -1
  ++X a:PRIMARR(FLOAT):=[[3.0, 4.0, -3.0, -5.0, -1.0]]
  ++X isamax(5,a,1)  -- should be 3

izamax: (SI, PCDF, SI) -> INT
  ++ izamax computes the largest absolute value of the elements
  ++ of the array and returns the index of the first instance
  ++ of the maximum.
  ++
  ++X a:PRIMARR(COMPLEX(DFLOAT))
  ++X a:=[[3.+4.*%i,-4.+5.*%i,5.+6.*%i,7.-8.*%i,-9.-2.*%i]]
  ++X izamax(5,a,1)  -- should be 3
  ++X izamax(0,a,1)  -- should be -1
  ++X izamax(5,a,-1) -- should be -1
  ++X izamax(3,a,1)  -- should be 2
```

```
    ++X izamax(3,a,2)  -- should be 1

  zaxpy: (SI, CDF, PCDF, SI, PCDF, SI) -> PCDF
    ++ zaxpy(n,da,x,incx,y,incy) computes a y = a*x + y
    ++ for each of the chosen elements of the vectors x and y
    ++ and a constant multiplier a
    ++ Note that the vector y is modified with the results.
    ++
    ++X a:PRIMARR(COMPLEX(DFLOAT))
    ++X a:=[[3.+4.*%i, -4.+5.*%i, 5.+6.*%i, 7.-8.*%i, -9.-2.*%i]]
    ++X b:PRIMARR(COMPLEX(DFLOAT))
    ++X b:=[[3.+4.*%i, -4.+5.*%i, 5.+6.*%i, 7.-8.*%i, -9.-2.*%i]]
    ++X zaxpy(3,2.0,a,1,b,1)
    ++X b:=[[3.+4.*%i, -4.+5.*%i, 5.+6.*%i, 7.-8.*%i, -9.-2.*%i]]
    ++X zaxpy(5,2.0,a,1,b,1)
    ++X b:=[[3.+4.*%i, -4.+5.*%i, 5.+6.*%i, 7.-8.*%i, -9.-2.*%i]]
    ++X zaxpy(3,2.0,a,3,b,3)
    ++X b:=[[3.+4.*%i, -4.+5.*%i, 5.+6.*%i, 7.-8.*%i, -9.-2.*%i]]
    ++X zaxpy(4,2.0,a,2,b,2)

Implementation  == add

    dcabs1(z:CDF):DF ==
      DCABS1(COMPLEX(real(z),imag(z))$Lisp)$Lisp
    dasum(n:SI,dx:DX,incx:SI):DF ==
      DASUM(n,dx,incx)$Lisp
    daxpy(n:SI,da:DF,dx:DX,incx:SI,dy:DX,incy:SI):DX ==
      DAXPY(n,da,dx,incx,dy,incy)$Lisp
    dcopy(n:SI,dx:DX,incx:SI,dy:DX,incy:SI):DX ==
      DCOPY(n,dx,incx,dy,incy)$Lisp
    ddot(n:SI,dx:DX,incx:SI,dy:DX,incy:SI):DF ==
      DDOT(n,dx,incx,dy,incy)$Lisp
    dnrm2(n:SI,dx:DX,incx:SI):DF ==
      DNRM2(n,dx,incx)$Lisp
    drotg(a:DF,b:DF,c:DF,s:DF):DX ==
      DROTG(a,b,c,s)$Lisp
    drot(n:SI,dx:DX,incx:SI,dy:DX,incy:SI,c:DF,s:DF):LDX ==
      DROT(n,dx,incx,dy,incy,c,s)$Lisp
    dscal(n:SI,da:DF,dx:DX,incx:SI):DX ==
      DSCAL(n,da,dx,incx)$Lisp
    dswap(n:SI,dx:DX,incx:SI,dy:DX,incy:SI):LDX ==
      DSWAP(n,dx,incx,dy,incx)$Lisp
    dzasum(n:SI,dz:PCDF,incx:SI):DF ==
      DZASUMSPAD(n,dz,incx)$Lisp
    dznrm2(n:SI,dz:PCDF,incx:SI):DF ==
      DZNRM2SPAD(n,dz,incx)$Lisp
    icamax(n:INT,dz:PCF,incx:INT):INT ==
      ICAMAXSPAD(n,dz,incx)$Lisp
    idamax(n:INT,dz:DX,incx:INT):INT ==
      IDAMAX(n,dz,incx)$Lisp
```

```
      isamax(n:INT,dz:SX,incx:INT):INT ==
        ISAMAXSPAD(n,dz,incx)$Lisp
      izamax(n:SI,dz:PCDF,incx:SI):INT ==
        IZAMAXSPAD(n,dz,incx)$Lisp
      zaxpy(n:SI,da:CDF,dx:PCDF,incx:SI,dy:PCDF,incy:SI):PCDF ==
        ZAXPYSPAD(n,da,dx,incx,dy,incy)$Lisp
```

———-

— BLAS1.dotabb —

```
"BLAS1" [color="#444488",href="bookvol10.5.pdf#nameddest=BLAS1"]
"FIELD" [color="#4488FF",href="bookvol10.2.pdf#nameddest=FIELD"]
"RADCAT" [color="#4488FF",href="bookvol10.2.pdf#nameddest=RADCAT"]
"BLAS1" -> "FIELD"
"BLAS1" -> "RADCAT"
```

———-

3.2 dcabs1 BLAS

— dcabs1.input —

```
)set break resume
)sys rm -f dcabs1.output
)spool dcabs1.output
)set message test on
)set message auto off
)clear all

--S 1 of 10
t1:Complex DoubleFloat := complex(1.0,0)
--R
--R
--R   (1)  1.
--R                                                    Type: Complex(DoubleFloat)
--E 1

--S 2 of 10
dcabs1(t1)
--R
--R
--R   (2)  1.
```

```
--R                                                          Type: DoubleFloat
--E 2

--S 3 of 10
t2:Complex DoubleFloat := complex(1.0,1.0)
--R
--R
--R   (3)  1. + %i
--R                                                 Type: Complex(DoubleFloat)
--E 3

--S 4 of 10
dcabs1(t2)
--R
--R
--R   (4)  2.
--R                                                          Type: DoubleFloat
--E 4

--S 5 of 10
t3:Complex DoubleFloat := complex(1.0,-1.0)
--R
--R
--R   (5)  1. - %i
--R                                                 Type: Complex(DoubleFloat)
--E 5

--S 6 of 10
dcabs1(t3)
--R
--R
--R   (6)  2.
--R                                                          Type: DoubleFloat
--E 6

--S 7 of 10
t4:Complex DoubleFloat := complex(-1.0,-1.0)
--R
--R
--R   (7)  - 1. - %i
--R                                                 Type: Complex(DoubleFloat)
--E 7

--S 8 of 10
dcabs1(t4)
--R
--R
--R   (8)  2.
--R                                                          Type: DoubleFloat
--E 8
```

```
--S 9 of 10
t5:Complex DoubleFloat := complex(-2.0,-2.0)
--R
--R
--R   (9)  - 2. - 2. %i
--R                                                    Type: Complex(DoubleFloat)
--E 9

--S 10 of 10
dcabs1(t5)
--R
--R
--R   (10)  4.
--R                                                          Type: DoubleFloat
--E 10

)spool
)lisp (bye)
```

———-

— dcabs1.help —

```
==========================================================================
dcabs1 examples
==========================================================================

The dcabs1 routine computes the sum of the absolute value of the
real and imaginary parts of a complex number.

t1:Complex DoubleFloat := complex(1.0,0)
   1.

dcabs1(t1)
   1.

t2:Complex DoubleFloat := complex(1.0,1.0)
   1. + %i

dcabs1(t2)
   2.

t3:Complex DoubleFloat := complex(1.0,-1.0)
   1. - %i

dcabs1(t3)
   2.
```

```
t4:Complex DoubleFloat := complex(-1.0,-1.0)
   - 1. - %i

dcabs1(t4)
   2.

t5:Complex DoubleFloat := complex(-2.0,-2.0)
   - 2. - 2. %i

dcabs1(t5)
   4.

=======================================================================
Man Page Details
=======================================================================

The argument is:
\begin{itemize}
\item z - Complex DoubleFloat
\end{itemize}

The result is
\begin{itemize}
\item (+ (abs (realpart z)) (abs (imagpart z)))
\end{itemize}

See Also:
o )show BlasLevelOne
o )display operations dcabs1
o )help dcabs1
```

———-

Axiom represents the type Complex(DoubleFloat) as a pair whose car is the real part and whose cdr is the imaginary part. This fact is used in this implementation.

This should really be a macro.

— **dcabs1.f** —

```
      double precision function dcabs1(z)
C ORIGINAL:
c      double complex z,zz
c      double precision t(2)
c      equivalence (zz,t(1))
c      zz = z
c     dcabs1 = dabs(t(1)) + dabs(t(2))
c NEW
      double complex z
      dcabs1 = dabs(dble(z)) + dabs(dimag(z))
```

```
      return
      end

\end{verbatim}

\begin{chunk}{dcabs1 example}
       program dcabs1EX
*      Tim Daly April 23, 2012
*      unit tests for BLAS dcabs1
       double complex a,b,c,d
       a=COMPLEX(2.1,2.1)
       b=(3.1D2,4.1D3)
       c=a+b
       d=dcabs1(c)
       write(6,100)a
 100   format("        a=(",f10.3,",",f10.3,")")
       write(6,200)b
 200   format("        b=(",f10.3,",",f10.3,")")
       write(6,300)c
 300   format("      a+b=(",f10.3,",",f10.3,")")
       write(6,400)d
 400   format("dcabs1(c)=(",f10.3,",",f10.3,")")
       stop
       end
```

———-

```
gcc -o dcabs1EX dcabs1EX.f -lgfortran dcabs1.o && ./dcabs1EX

        a=(     2.100,     2.100)
        b=(   310.000,  4100.000)
      a+b=(   312.100,  4102.100)
dcabs1(c)=(  4414.200,     0.000)
```

— BLAS 1 dcabs1 —

```
(declaim (ftype (function (cons) double-float) dcabs1))
(defun dcabs1 (z)
 ; Tim Daly April 23, 2012
 "Complex(DoubleFloat) z is a pair where (realpart . imaginarypart)
  so the spad caller needs to construct a lisp complex number.
  The result is a DoubleFloat (+ (abs (realpart z)) (abs (imagpart z)))"
 (the double-float
  (+ (the double-float (abs (the double-float (realpart z))))
     (the double-float (abs (the double-float (imagpart z)))))))
```

———-

— BLAS 1 dcabs1 test —

```
(dcabs1 #C(312.100 4102.100))
```

————-

3.3 lsame BLAS

The `lsame` function returns t if `ca` and
cb represent the same letter regardless of case.

This has been replaced everywhere with common lisp's char-equal function which compares characters ignoring case. The type (simple-array character (*)) has been replaced everywhere which character.

— lsame.f —

```
      LOGICAL          FUNCTION LSAME( CA, CB )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     September 30, 1994
*
*     .. Scalar Arguments ..
      CHARACTER          CA, CB
*     ..
*
*  Purpose
*  =======
*
*  LSAME returns .TRUE. if CA is the same letter as CB regardless of
*  case.
*
*  Arguments
*  =========
*
*  CA      (input) CHARACTER*1
*  CB      (input) CHARACTER*1
*          CA and CB specify the single characters to be compared.
*
* =====================================================================
*
*     .. Intrinsic Functions ..
      INTRINSIC          ICHAR
*     ..
```

```
*     .. Local Scalars ..
      INTEGER            INTA, INTB, ZCODE
*     ..
*     .. Executable Statements ..
*
*     Test if the characters are equal
*
      LSAME = CA.EQ.CB
      IF( LSAME )
     $   RETURN
*
*     Now test for equivalence if both characters are alphabetic.
*
      ZCODE = ICHAR( 'Z' )
*
*     Use 'Z' rather than 'A' so that ASCII can be detected on Prime
*     machines, on which ICHAR returns a value with bit 8 set.
*     ICHAR('A') on Prime machines returns 193 which is the same as
*     ICHAR('A') on an EBCDIC machine.
*
      INTA = ICHAR( CA )
      INTB = ICHAR( CB )
*
      IF( ZCODE.EQ.90 .OR. ZCODE.EQ.122 ) THEN
*
*        ASCII is assumed - ZCODE is the ASCII code of either lower or
*        upper case 'Z'.
*
         IF( INTA.GE.97 .AND. INTA.LE.122 ) INTA = INTA - 32
         IF( INTB.GE.97 .AND. INTB.LE.122 ) INTB = INTB - 32
*
      ELSE IF( ZCODE.EQ.233 .OR. ZCODE.EQ.169 ) THEN
*
*        EBCDIC is assumed - ZCODE is the EBCDIC code of either lower or
*        upper case 'Z'.
*
         IF( INTA.GE.129 .AND. INTA.LE.137 .OR.
     $       INTA.GE.145 .AND. INTA.LE.153 .OR.
     $       INTA.GE.162 .AND. INTA.LE.169 ) INTA = INTA + 64
         IF( INTB.GE.129 .AND. INTB.LE.137 .OR.
     $       INTB.GE.145 .AND. INTB.LE.153 .OR.
     $       INTB.GE.162 .AND. INTB.LE.169 ) INTB = INTB + 64
*
      ELSE IF( ZCODE.EQ.218 .OR. ZCODE.EQ.250 ) THEN
*
*        ASCII is assumed, on Prime machines - ZCODE is the ASCII code
*        plus 128 of either lower or upper case 'Z'.
*
         IF( INTA.GE.225 .AND. INTA.LE.250 ) INTA = INTA - 32
         IF( INTB.GE.225 .AND. INTB.LE.250 ) INTB = INTB - 32
```

```
      END IF
      LSAME = INTA.EQ.INTB
*
*     RETURN
*
*     End of LSAME
*
      END

\end{verbatim}


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
\section{xerbla BLAS}
%\pagehead{xerbla}{xerbla}
%\pagepic{ps/v104algebraicfunction.ps}{AF}{1.00}

The {\tt xerbla} routine is an error handler.
It is called if an input parameter has an invalid value.

This function has been rewritten everywhere to use the common lisp error
function.

\begin{chunk}{xerbla.f}
      SUBROUTINE XERBLA( SRNAME, INFO )
*
*  -- LAPACK auxiliary routine (preliminary version) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     February 29, 1992
*
*     .. Scalar Arguments ..
      CHARACTER*6        SRNAME
      INTEGER            INFO
*     ..
*
*  Purpose
*  =======
*
*  XERBLA  is an error handler for the LAPACK routines.
*  It is called by an LAPACK routine if an input parameter has an
*  invalid value.  A message is printed and execution stops.
*
*  Installers may consider modifying the STOP statement in order to
*  call system-specific exception-handling facilities.
*
*  Arguments
*  =========
*
*  SRNAME  (input) CHARACTER*6
```

```
*          The name of the routine which called XERBLA.
*
*  INFO    (input) INTEGER
*          The position of the invalid parameter in the parameter list
*          of the calling routine.
*
*
      WRITE( *, FMT = 9999 )SRNAME, INFO
*
*
* commented out by RLT
*      STOP
*
 9999 FORMAT( ' ** On entry to ', A6, ' parameter number ', I2, ' had ',
     $      'an illegal value' )
*
*     End of XERBLA
*
      END

\end{verbatim}

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
\chapter{BLAS Level 1}
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
\section{dasum BLAS}
%\pagehead{dasum}{dasum}
%\pagepic{ps/v104algebraicfunction.ps}{AF}{1.00}

\begin{chunk}{dasum.input}
)set break resume
)sys rm -f dasum.output
)spool dasum.output
)set message test on
)set message auto off
)clear all

--S 1 of 28
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0] ]
--R
--R
--R   (1)  [1.,2.,3.,4.,5.,6.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 1

--S 2 of 28
dasum(3,a,-1) -- 0.0   neg incx
--R
--R
--R   (2)  0.
```

```
--R                                                    Type: DoubleFloat
--E 2

--S 3 of 28
dasum(3,a,0) --  0.0   zero incx
--R
--R
--R   (3)  0.
--R                                                    Type: DoubleFloat
--E 3

--S 4 of 28
dasum(-1,a,1) -- 0.0   neg elements
--R
--R
--R   (4)  0.
--R                                                    Type: DoubleFloat
--E 4

--S 5 of 28
dasum(0,a,1) --  0.0   no elements
--R
--R
--R   (5)  0.
--R                                                    Type: DoubleFloat
--E 5

--S 6 of 28
dasum(1,a,1) --  1.0   1.0
--R
--R
--R   (6)  1.
--R                                                    Type: DoubleFloat
--E 6

--S 7 of 28
dasum(2,a,1) --  3.0   1.0+2.0
--R
--R
--R   (7)  3.
--R                                                    Type: DoubleFloat
--E 7

--S 8 of 28
dasum(3,a,1) --  6.0   1.0+2.0+3.0
--R
--R
--R   (8)  6.
--R                                                    Type: DoubleFloat
--E 8
```

```
--S 9 of 28
dasum(4,a,1) -- 10.0   1.0+2.0+3.0+4.0
--R
--R
--R   (9)  10.
--R                                                        Type: DoubleFloat
--E 9

--S 10 of 28
dasum(5,a,1) -- 15.0   1.0+2.0+3.0+4.0+5.0
--R
--R
--R   (10)  15.
--R                                                        Type: DoubleFloat
--E 10

--S 11 of 28
dasum(6,a,1) -- 21.0   1.0+2.0+3.0+4.0+5.0+6.0
--R
--R
--R   (11)  21.
--R                                                        Type: DoubleFloat
--E 11

--S 12 of 28
dasum(7,a,1) -- 21.0   1.0+2.0+3.0+4.0+5.0+6.0
--R
--R
--R   (12)  21.
--R                                                        Type: DoubleFloat
--E 12

--S 13 of 28
dasum(1,a,2) --  1.0   1.0
--R
--R
--R   (13)  1.
--R                                                        Type: DoubleFloat
--E 13

--S 14 of 28
dasum(2,a,2) --  4.0   1.0+3.0
--R
--R
--R   (14)  4.
--R                                                        Type: DoubleFloat
--E 14

--S 15 of 28
```

```
dasum(3,a,2) --  9.0   1.0+3.0+5.0
--R
--R
--R   (15)  9.
--R                                                    Type: DoubleFloat
--E 15

--S 16 of 28
dasum(4,a,2) --  9.0   1.0+3.0+5.0
--R
--R
--R   (16)  9.
--R                                                    Type: DoubleFloat
--E 16

--S 17 of 28
dasum(1,a,3) --  1.0   1.0
--R
--R
--R   (17)  1.
--R                                                    Type: DoubleFloat
--E 17

--S 18 of 28
dasum(2,a,3) --  5.0   1.0+4.0
--R
--R
--R   (18)  5.
--R                                                    Type: DoubleFloat
--E 18

--S 19 of 28
dasum(3,a,3) --  5.0   1.0+4.0
--R
--R
--R   (19)  5.
--R                                                    Type: DoubleFloat
--E 19

--S 20 of 28
dasum(1,a,4) --  1.0   1.0
--R
--R
--R   (20)  1.
--R                                                    Type: DoubleFloat
--E 20

--S 21 of 28
dasum(2,a,4) --  6.0   1.0+5.0
--R
```

```
--R
--R   (21)  6.
--R                                                    Type: DoubleFloat
--E 21

--S 22 of 28
dasum(3,a,4) --  6.0   1.0+5.0
--R
--R
--R   (22)  6.
--R                                                    Type: DoubleFloat
--E 22

--S 23 of 28
dasum(1,a,5) --  1.0   1.0
--R
--R
--R   (23)  1.
--R                                                    Type: DoubleFloat
--E 23

--S 24 of 28
dasum(2,a,5) --  7.0   1.0+6.0
--R
--R
--R   (24)  7.
--R                                                    Type: DoubleFloat
--E 24

--S 25 of 28
dasum(3,a,5) --  7.0   1.0+6.0
--R
--R
--R   (25)  7.
--R                                                    Type: DoubleFloat
--E 25

--S 26 of 28
dasum(1,a,6) --  1.0   1.0
--R
--R
--R   (26)  1.
--R                                                    Type: DoubleFloat
--E 26

--S 27 of 28
dasum(2,a,6) --  1.0   1.0
--R
--R
--R   (27)  1.
```

```
--R                                                        Type: DoubleFloat
--E 27

--S 28 of 28
dasum(1,a,7) --  1.0   1.0
--R
--R
--R   (28)  1.
--R                                                        Type: DoubleFloat
--E 28

)spool
)lisp (bye)
```

———-

— dasum.help —

```
========================================================================
dasum examples
========================================================================

a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0] ]
    [1.,2.,3.,4.,5.,6.]

dasum(3,a,-1) -- 0.0   neg incx
    0.

dasum(3,a,0) --  0.0   zero incx
    0.

dasum(-1,a,1) -- 0.0   neg elements
    0.

dasum(0,a,1) --  0.0   no elements
    0.

dasum(1,a,1) --  1.0   1.0
    1.

dasum(2,a,1) --  3.0   1.0+2.0
    3.

dasum(3,a,1) --  6.0   1.0+2.0+3.0
    6.

dasum(4,a,1) -- 10.0   1.0+2.0+3.0+4.0
   10.
```

```
dasum(5,a,1) -- 15.0   1.0+2.0+3.0+4.0+5.0
   15.

dasum(6,a,1) -- 21.0   1.0+2.0+3.0+4.0+5.0+6.0
   21.

dasum(7,a,1) -- 21.0   1.0+2.0+3.0+4.0+5.0+6.0
   21.

dasum(1,a,2) --  1.0   1.0
    1.

dasum(2,a,2) --  4.0   1.0+3.0
    4.

dasum(3,a,2) --  9.0   1.0+3.0+5.0
    9.

dasum(4,a,2) --  9.0   1.0+3.0+5.0
    9.

dasum(1,a,3) --  1.0   1.0
    1.

dasum(2,a,3) --  5.0   1.0+4.0
    5.

dasum(3,a,3) --  5.0   1.0+4.0
    5.

dasum(1,a,4) --  1.0   1.0
    1.

dasum(2,a,4) --  6.0   1.0+5.0
    6.

dasum(3,a,4) --  6.0   1.0+5.0
    6.

dasum(1,a,5) --  1.0   1.0
    1.

dasum(2,a,5) --  7.0   1.0+6.0
    7.

dasum(3,a,5) --  7.0   1.0+6.0
    7.

dasum(1,a,6) --  1.0   1.0
    1.
```

```
dasum(2,a,6) --  1.0   1.0
    1.

dasum(1,a,7) --  1.0   1.0
    1.

========================================================================
Man Page Details
========================================================================

Computes doublefloat $asum \leftarrow ||re(x)||_1 + ||im(x)||_1$

Arguments are:
\begin{itemize}
\item n - fixnum
\item dx - array doublefloat
\item incx - fixnum
\end{itemize}

Return values are:
\begin{itemize}
\item 1 nil
\item 2 nil
\item 3 nil
\end{itemize}

NAME
       DASUM  -  BLAS level one, sums the absolute values of the elements of a
       double precision vector

SYNOPSIS
       DOUBLE PRECISION FUNCTION DASUM ( n, x, incx )
           INTEGER                      n, incx
           DOUBLE PRECISION             x

AXIOM SIGNATURE:
       SI  ==> SingleInteger
       DF  ==> DoubleFloat
       DX  ==> PrimitiveArray(DoubleFloat)

       dasum: (SI, DX, SI) -> DF

DESCRIPTION
       This routine performs the following vector operation:

                          n
                 DASUM <-- Sum abs(x(i))
                          i=1
```

```
ARGUMENTS
       n       INTEGER. (input)
               Number of vector elements to be summed.
               if n <= 0, the result will be 0.0
               if n > length(x) then the whole array is summed.

       x       DOUBLE PRECISION. (input)
               Array of dimension (n-1) * abs(incx)+ 1.
               Vector that contains elements to be summed.

       incx    INTEGER. (input)
               Increment between elements of x.
               If incx <= 0, the results will be 0.0

RESULT:
       DASUM   DOUBLE PRECISION. (output)
               Sum of the absolute values of the elements of the vector x.
               If n <= 0, DASUM is set to 0.0

NOTES:
       Axiom uses 0-based arrays. Fortran uses 1-based arrays.

       if the index of the array exceeds the length of x
       then no additional elements are added. Thus,
       if x = #(1.0 2.0 3.0 4.0 5.0 6.0)
       then
        (dasum 3 a -1) =  0.0 ; neg incx
        (dasum 3 a 0)  =  0.0 ; zero incx
        (dasum -1 a 1) =  0.0 ; neg elements
        (dasum 0 a 1)  =  0.0 ; no elements
        (dasum 1 a 1)  =  1.0 ; 1.0
        (dasum 2 a 1)  =  3.0 ; 1.0+2.0
        (dasum 3 a 1)  =  6.0 ; 1.0+2.0+3.0
        (dasum 4 a 1)  = 10.0 ; 1.0+2.0+3.0+4.0
        (dasum 5 a 1)  = 15.0 ; 1.0+2.0+3.0+4.0+5.0
        (dasum 6 a 1)  = 21.0 ; 1.0+2.0+3.0+4.0+5.0+6.0
        (dasum 7 a 1)  = 21.0 ; 1.0+2.0+3.0+4.0+5.0+6.0
        (dasum 1 a 2)  =  1.0 ; 1.0
        (dasum 2 a 2)  =  4.0 ; 1.0+3.0
        (dasum 3 a 2)  =  9.0 ; 1.0+3.0+5.0
        (dasum 4 a 2)  =  9.0 ; 1.0+3.0+5.0
        (dasum 1 a 3)  =  1.0 ; 1.0
        (dasum 2 a 3)  =  5.0 ; 1.0+4.0
        (dasum 3 a 3)  =  5.0 ; 1.0+4.0
        (dasum 1 a 4)  =  1.0 ; 1.0
        (dasum 2 a 4)  =  6.0 ; 1.0+5.0
        (dasum 3 a 4)  =  6.0 ; 1.0+5.0
        (dasum 1 a 5)  =  1.0 ; 1.0
        (dasum 2 a 5)  =  7.0 ; 1.0+6.0
        (dasum 3 a 5)  =  7.0 ; 1.0+6.0
```

```
        (dasum 1 a 6)  =  1.0 ; 1.0
        (dasum 2 a 6)  =  1.0 ; 1.0
        (dasum 1 a 7)  =  1.0 ; 1.0
```

———-

— dasum.f —

```
      double precision function dasum(n,dx,incx)
c
c     takes the sum of the absolute values.
c     jack dongarra, linpack, 3/11/78.
c     modified 3/93 to return if incx .le. 0.
c     modified 12/3/93, array(1) declarations changed to array(*)
c
      double precision dx(*),dtemp
      integer i,incx,m,mp1,n,nincx
c
      dasum = 0.0d0
      dtemp = 0.0d0
      if( n.le.0 .or. incx.le.0 )return
      if(incx.eq.1)go to 20
c
c        code for increment not equal to 1
c
      nincx = n*incx
      do 10 i = 1,nincx,incx
        dtemp = dtemp + dabs(dx(i))
   10 continue
      dasum = dtemp
      return
c
c        code for increment equal to 1
c
c
c        clean-up loop
c
   20 m = mod(n,6)
      if( m .eq. 0 ) go to 40
      do 30 i = 1,m
        dtemp = dtemp + dabs(dx(i))
   30 continue
      if( n .lt. 6 ) go to 60
   40 mp1 = m + 1
      do 50 i = mp1,n,6
        dtemp = dtemp + dabs(dx(i)) + dabs(dx(i + 1)) + dabs(dx(i + 2))
     *  + dabs(dx(i + 3)) + dabs(dx(i + 4)) + dabs(dx(i + 5))
   50 continue
```

```
   60 dasum = dtemp
      return
      end
```

———-

— dasum example —

```
      program dasumEX
*     Tim Daly April 24, 2012
*     unit tests for BLAS dasum
      double precision a(6)
      double precision b
      a = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0, 5.0D0, 6.0D0 /)
      write(6,100)a(1),a(2),a(3)
 100  format("a(1)=",f6.3," a(2)=",f6.3," a(3)=",f6.3)
      write(6,200)a(4),a(5),a(6)
 200  format("a(4)=",f6.3," a(5)=",f6.3," a(6)=",f6.3)
      d=dasum(3,a,-1)
      write(6,300)d
 300  format("d=",f6.3," should be 0.0, negative index")
      d=dasum(3,a,0)
      write(6,301)d
 301  format("d=",f6.3," should be 0.0, zero increment")
      d=dasum(-11,a,1)
      write(6,302)d
 302  format("d=",f6.3," should be 0.0, negative elements")
      d=dasum(0,a,1)
      write(6,303)d
 303  format("d=",f6.3," should be 0.0, no elements")
      d=dasum(1,a,1)
      write(6,304)d
 304  format("d=",f6.3," should be 1.0")
      d=dasum(2,a,1)
      write(6,305)d
 305  format("d=",f6.3," should be 3.0 = 1.0+2.0")
      d=dasum(3,a,1)
      write(6,306)d
 306  format("d=",f6.3," should be 6.0 = 1.0+2.0+3.0")
      d=dasum(4,a,1)
      write(6,307)d
 307  format("d=",f6.3," should be 10.0 = 1.0+2.0+3.0+4.0")
      d=dasum(5,a,1)
      write(6,308)d
 308  format("d=",f6.3," should be 15.0 = 1.0+2.0+3.0+4.0+5.0")
      d=dasum(6,a,1)
      write(6,309)d
 309  format("d=",f6.3," should be 21.0 = 1.0+2.0+3.0+4.0+5.0+6.0")
```

```
      d=dasum(7,a,1)
      write(6,310)d
 310  format("d=",f6.3," should be 21.0 = 1.0+2.0+3.0+4.0+5.0+6.0")
      d=dasum(1,a,2)
      write(6,311)d
 311  format("d=",f6.3," should be 1.0 = 1.0")
      d=dasum(2,a,2)
      write(6,312)d
 312  format("d=",f6.3," should be 4.0 = 1.0+3.0")
      d=dasum(3,a,2)
      write(6,313)d
 313  format("d=",f6.3," should be 9.0 = 1.0+3.0+5.0")
      d=dasum(4,a,2)
      write(6,314)d
 314  format("d=",f6.3," should be 9.0 = 1.0+3.0+5.0")
      d=dasum(1,a,3)
      write(6,315)d
 315  format("d=",f6.3," should be 1.0 = 1.0")
      d=dasum(2,a,3)
      write(6,316)d
 316  format("d=",f6.3," should be 5.0 = 1.0+4.0")
      d=dasum(3,a,3)
      write(6,317)d
 317  format("d=",f6.3," should be 5.0 = 1.0+4.0")
      d=dasum(1,a,4)
      write(6,318)d
 318  format("d=",f6.3," should be 1.0 = 1.0")
      d=dasum(2,a,4)
      write(6,319)d
 319  format("d=",f6.3," should be 6.0 = 1.0+5.0")
      d=dasum(3,a,4)
      write(6,320)d
 320  format("d=",f6.3," should be 6.0 = 1.0+5.0")
      d=dasum(1,a,5)
      write(6,321)d
 321  format("d=",f6.3," should be 1.0 = 1.0")
      d=dasum(2,a,5)
      write(6,322)d
 322  format("d=",f6.3," should be 7.0 = 1.0+6.0")
      d=dasum(3,a,5)
      write(6,323)d
 323  format("d=",f6.3," should be 7.0 = 1.0+6.0")
      d=dasum(1,a,6)
      write(6,324)d
 324  format("d=",f6.3," should be 1.0 = 1.0")
      d=dasum(2,a,6)
      write(6,325)d
 325  format("d=",f6.3," should be 1.0 = 1.0")
      d=dasum(1,a,7)
      write(6,326)d
```

```
 326   format("d=",f6.3," should be 1.0 = 1.0")
       stop
       end
```

```
gcc -o dasumEX dasumEX.f -lgfortran dasum.o && ./dasumEX

a(1)= 1.000 a(2)= 2.000 a(3)= 3.000
a(4)= 4.000 a(5)= 5.000 a(6)= 6.000
d= 0.000 should be 0.0, negative index
d= 0.000 should be 0.0, zero increment
d= 0.000 should be 0.0, negative elements
d= 0.000 should be 0.0, no elements
d= 1.000 should be 1.0
d= 3.000 should be 3.0 = 1.0+2.0
d= 6.000 should be 6.0 = 1.0+2.0+3.0
d=10.000 should be 10.0 = 1.0+2.0+3.0+4.0
d=15.000 should be 15.0 = 1.0+2.0+3.0+4.0+5.0
d=21.000 should be 21.0 = 1.0+2.0+3.0+4.0+5.0+6.0
d=21.000 should be 21.0 = 1.0+2.0+3.0+4.0+5.0+6.0
d= 1.000 should be 1.0 = 1.0
d= 4.000 should be 4.0 = 1.0+3.0
d= 9.000 should be 9.0 = 1.0+3.0+5.0
d= 9.000 should be 9.0 = 1.0+3.0+5.0
d= 1.000 should be 1.0 = 1.0
d= 5.000 should be 5.0 = 1.0+4.0
d= 5.000 should be 5.0 = 1.0+4.0
d= 1.000 should be 1.0 = 1.0
d= 6.000 should be 6.0 = 1.0+5.0
d= 6.000 should be 6.0 = 1.0+5.0
d= 1.000 should be 1.0 = 1.0
d= 7.000 should be 7.0 = 1.0+6.0
d= 7.000 should be 7.0 = 1.0+6.0
d= 1.000 should be 1.0 = 1.0
d= 1.000 should be 1.0 = 1.0
d= 1.000 should be 1.0 = 1.0
```

— BLAS 1 dasum —

```
(declaim (ftype (function (fixnum (simple-array double-float (*)) fixnum)
                          double-float) dasum))
(defun dasum (n dx incx)
 ; Tim Daly April 24, 2012
 (declare (type (simple-array double-float (*)) dx) (type fixnum incx n))
 (let ((dasum 0.0) (maxlen (length dx)))
```

```
  (declare (type (double-float) dasum) (type fixnum maxlen))
  (when (> incx 0)
   (when (> n maxlen) (setq n maxlen))
   (unless (<= n 0)
     (do ((i 0 (1+ i)) (j 0 (+ j incx)))
         ((or (>= i n) (>= j maxlen)))
      (setq dasum
       (the double-float
        (+ (the double-float dasum)
         (the double-float (abs (the double-float (svref dx j))))))))))
   dasum))
```

———-

3.4 daxpy BLAS

— daxpy.input —

```
)set break resume
)sys rm -f daxpy.output
)spool daxpy.output
)set message test on
)set message auto off
)clear all

--S 1 of 22
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (1)  [1.,2.,3.,4.,5.,6.,7.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 1

--S 2 of 22
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (2)  [1.,2.,3.,4.,5.,6.,7.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 2

--S 3 of 22
daxpy(3,2.0,a,1,b,1)
--R
--R
--R   (3)  [3.,6.,9.,4.,5.,6.,7.]
```

```
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 3

--S 4 of 22
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (4)  [1.,2.,3.,4.,5.,6.,7.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 4

--S 5 of 22
daxpy(7,2.0,a,1,b,1)
--R
--R
--R   (5)  [3.,6.,9.,12.,15.,18.,21.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 5

--S 6 of 22
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (6)  [1.,2.,3.,4.,5.,6.,7.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 6
```

———-

Note that Axiom properly handles array indexes that are out of bounds. The BLAS daxpy routine cannot check this condition.

— **daxpy.input** —

```
--S 7 of 22
daxpy(8,2.0,a,1,b,1)
--R
--R
--R   (7)  [1.,2.,3.,4.,5.,6.,7.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 7

--S 8 of 22
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (8)  [1.,2.,3.,4.,5.,6.,7.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 8
```

```
--S 9 of 22
daxpy(3,2.0,a,3,b,3)
--R
--R
--R   (9)  [3.,2.,3.,12.,5.,6.,21.]
--R                                              Type: PrimitiveArray(DoubleFloat)
--E 9

--S 10 of 22
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (10)  [1.,2.,3.,4.,5.,6.,7.]
--R                                              Type: PrimitiveArray(DoubleFloat)
--E 10

--S 11 of 22
daxpy(4,2.0,a,2,b,2)
--R
--R
--R   (11)  [3.,2.,9.,4.,15.,6.,21.]
--R                                              Type: PrimitiveArray(DoubleFloat)
--E 11

--S 12 of 22
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (12)  [1.,2.,3.,4.,5.,6.,7.]
--R                                              Type: PrimitiveArray(DoubleFloat)
--E 12

--S 13 of 22
daxpy(5,2.0,a,2,b,2)
--R
--R
--R   (13)  [1.,2.,3.,4.,5.,6.,7.]
--R                                              Type: PrimitiveArray(DoubleFloat)
--E 13

--S 14 of 22
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (14)  [1.,2.,3.,4.,5.,6.,7.]
--R                                              Type: PrimitiveArray(DoubleFloat)
--E 14

--S 15 of 22
daxpy(3,2.0,a,2,b,2)
```

```
--R
--R
--R   (15)  [3.,2.,9.,4.,15.,6.,7.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 15

--S 16 of 22
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (16)  [1.,2.,3.,4.,5.,6.,7.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 16

--S 17 of 22
daxpy(3,-2.0,a,2,b,2)
--R
--R
--R   (17)  [- 1.,2.,- 3.,4.,- 5.,6.,7.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 17

--S 18 of 22
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0] ]
--R
--R
--R   (18)  [1.,2.,3.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 18

--S 19 of 22
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0] ]
--R
--R
--R   (19)  [1.,2.,3.,4.,5.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 19

--S 20 of 22
daxpy(3,-2.0,a,1,b,2)
--R
--R
--R   (20)  [- 1.,2.,- 1.,4.,- 1.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 20

--S 21 of 22
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
```

```
--R   (21)  [1.,2.,3.,4.,5.,6.,7.]
--R                                              Type: PrimitiveArray(DoubleFloat)
--E 21

--S 22 of 22
daxpy(3,0.0,a,1,b,2)
--R
--R
--R   (22)  [1.,2.,3.,4.,5.,6.,7.]
--R                                              Type: PrimitiveArray(DoubleFloat)
--E 22

)spool
)lisp (bye)
```

———-

— daxpy.help —

```
========================================================================
daxpy examples
========================================================================

For each of the following examples we assume that we have preset
the variables to the following values. Note that the daxpy function
will modify the second array. Each example assumes we have reset
the variables to these values.

a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]

then we compute the sum of the first 3 elements of each vector
and we show the steps of the computation with trailing comments.
The comments show which elements are changed and what the computation is.

daxpy(3,2.0,a,1,b,1) ==> [3.,6.,9.,4.,5.,6.,7.]
  dy(0)[3.0] = dy(0)[1.0] + ( da[2.0] * dx(0)[1.0] )
  dy(1)[6.0] = dy(1)[2.0] + ( da[2.0] * dx(1)[2.0] )
  dy(2)[9.0] = dy(2)[3.0] + ( da[2.0] * dx(2)[3.0] )

or we compute the first 7 elements of each vector

daxpy(7,2.0,a,1,b,1) ==> [3.,6.,9.,12.,15.,18.,21.]
  dy(0) [3.0] = dy(0)[1.0] + ( da[2.0] * dx(0)[1.0] )
  dy(1) [6.0] = dy(1)[2.0] + ( da[2.0] * dx(1)[2.0] )
  dy(2) [9.0] = dy(2)[3.0] + ( da[2.0] * dx(2)[3.0] )
  dy(3)[12.0] = dy(3)[4.0] + ( da[2.0] * dx(3)[4.0] )
  dy(4)[15.0] = dy(4)[5.0] + ( da[2.0] * dx(4)[5.0] )
  dy(5)[18.0] = dy(5)[6.0] + ( da[2.0] * dx(5)[6.0] )
```

```
  dy(6)[21.0] = dy(6)[7.0] + ( da[2.0] * dx(6)[7.0] )

or we compute the first 8 elements, which fails due to the fact that
the vectors are not long enough.

daxpy(8,2.0,a,1,b,1) ==> [1.,2.,3.,4.,5.,6.,7.]

or we compute the 3 elements, taking every 3rd element, giving the
index of 0, 3, 6

daxpy(3,2.0,a,3,b,3) ==> [3.,2.,3.,12.,5.,6.,21.]
  dy(0) [3.0] = dy(0)[1.0] + ( da[2.0] * dx(0)[1.0] )
  dy(3)[12.0] = dy(3)[4.0] + ( da[2.0] * dx(3)[4.0] )
  dy(6)[21.0] = dy(6)[7.0] + ( da[2.0] * dx(6)[7.0] )

or we compute 4 elements, taking every 2nd element, giving the
index of 0, 2, 4, 6

daxpy(4,2.0,a,2,b,2) ==> [3.,2.,9.,4.,15.,6.,21.]
  dy(0) [3.0] = dy(0)[1.0] + ( da[2.0] * dx(0)[1.0] )
  dy(2) [9.0] = dy(2)[3.0] + ( da[2.0] * dx(2)[3.0] )
  dy(4)[15.0] = dy(4)[5.0] + ( da[2.0] * dx(4)[5.0] )
  dy(6)[21.0] = dy(6)[7.0] + ( da[2.0] * dx(6)[7.0] )

or we compute 5 elements, taking every 2nd element, which fails
due to vector length

daxpy(5,2.0,a,2,b,2) ==> [1.,2.,3.,4.,5.,6.,7.]

or we compute 3 elements, taking every 2nd value, giving the
index of 0, 2, 4

daxpy(3,2.0,a,2,b,2) ==> [3.,2.,9.,4.,15.,6.,7.]
  dy(0) [3.0] = dy(0)[1.0] + ( da[2.0] * dx(0)[1.0] )
  dy(2) [9.0] = dy(2)[3.0] + ( da[2.0] * dx(2)[3.0] )
  dy(4)[15.0] = dy(4)[5.0] + ( da[2.0] * dx(4)[5.0] )

or we compute 3 elements, taking every 2nd value, giving the
index of 0, 2, 4 but with a negative multiplier

daxpy(3,-2.0,a,2,b,2) ==> [- 1.,2.,- 3.,4.,- 5.,6.,7.]
  dy(0)[-1.0] = dy(0)[1.0] + ( da[-2.0] * dx(0)[1.0] )
  dy(2)[-3.0] = dy(2)[3.0] + ( da[-2.0] * dx(2)[3.0] )
  dy(4)[-5.0] = dy(4)[5.0] + ( da[-2.0] * dx(4)[5.0] )

or we change the lengths of the input vectors, making them unequal.
So for the next two examples we assume the arrays look like:

a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0] ]
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0] ]
```

```
We compute 3 elements, with a negative multiplier, and different increments
using an index for the 'a' array having values 0, 1, 2
using an index for the 'b' array having values 0, 2, 3

daxpy(3,-2.0,a,1,b,2) ==> [- 1.,2.,- 1.,4.,- 1.]
  dy(0)[-1.0] = dy(0)[1.0] + ( da[-2.0] * dx(0)[1.0] )
  dy(2)[-1.0] = dy(2)[3.0] + ( da[-2.0] * dx(1)[2.0] )
  dy(4)[-1.0] = dy(4)[5.0] + ( da[-2.0] * dx(2)[3.0] )

or we compute 3 elements with a multiplier of 0.0 which fails

daxpy(3,0.0,a,1,b,2) ==> [1.,2.,3.,4.,5.,6.,7.]

======================================================================
Man Page Details
======================================================================

NAME
       DAXPY - BLAS level one axpy subroutine

SYNOPSIS
       SUBROUTINE DAXPY    ( n, alpha, x, incx, y, incy )

           INTEGER           n, incx, incy

           DOUBLE PRECISION  alpha, x, y


DESCRIPTION
       DAXPY  adds  a  scalar multiple of a double precision vector to another
       double precision vector.

       DAXPY computes a constant alpha times a vector x plus a vector y.   The
       result overwrites the initial values of vector y.

       This routine performs the following vector operation:

            y  <--  alpha*x + y

       incx and incy specify the increment between two consecutive
       elements of respectively vector x and y.

ARGUMENTS
       n       INTEGER. (input)
               Number  of  elements in the vectors.  If n <= 0, these routines
               return without any computation.

       alpha   DOUBLE PRECISION. (input)
               If alpha = 0 this routine returns without any computation.
```

```
       x       DOUBLE PRECISION, (input)
               Array of dimension (n-1) * |incx| + 1.  Contains the vector  to
               be scaled before summation.

       incx    INTEGER. (input)
               Increment between elements of x.
               If incx = 0, the results will be unpredictable.

       y       DOUBLE PRECISION, (input and output)
               array of dimension (n-1) * |incy| + 1.
               Before calling the routine, y contains the vector to be summed.
               After the routine ends, y contains the result of the summation.

       incy    INTEGER. (input)
               Increment between elements of y.
               If incy = 0, the results will be unpredictable.

RETURN VALUES
       When  n <= 0, double precision alpha = 0., this routine returns immedi-
       ately with no change in its arguments.
```

———-

— **daxpy.f** —

```
      subroutine daxpy(n,da,dx,incx,dy,incy)
c
c     constant times a vector plus a vector.
c     uses unrolled loops for increments equal to one.
c     jack dongarra, linpack, 3/11/78.
c     modified 12/3/93, array(1) declarations changed to array(*)
c
      double precision dx(*),dy(*),da
      integer i,incx,incy,ix,iy,m,mp1,n
c
      if(n.le.0)return
      if (da .eq. 0.0d0) return
      if(incx.eq.1.and.incy.eq.1)go to 20
c
c        code for unequal increments or equal increments
c          not equal to 1
c
      ix = 1
      iy = 1
      if(incx.lt.0)ix = (-n+1)*incx + 1
      if(incy.lt.0)iy = (-n+1)*incy + 1
      do 10 i = 1,n
```

```
        dy(iy) = dy(iy) + da*dx(ix)
        ix = ix + incx
        iy = iy + incy
   10 continue
      return
c
c        code for both increments equal to 1
c
c
c        clean-up loop
c
   20 m = mod(n,4)
      if( m .eq. 0 ) go to 40
      do 30 i = 1,m
        dy(i) = dy(i) + da*dx(i)
   30 continue
      if( n .lt. 4 ) return
   40 mp1 = m + 1
      do 50 i = mp1,n,4
        dy(i) = dy(i) + da*dx(i)
        dy(i + 1) = dy(i + 1) + da*dx(i + 1)
        dy(i + 2) = dy(i + 2) + da*dx(i + 2)
        dy(i + 3) = dy(i + 3) + da*dx(i + 3)
   50 continue
      return
      end
```

———-

Compile with

```
gcc -c daxpy.f
gcc -o daxpyEx daxpyEX.f -lgfortran daxpy.o
```

— daxpy example —

```
       program daxpyEX
*      Tim Daly April 24, 2012
*      unit tests for BLAS daxpy (a*x+y)
       double precision a(7)
       double precision b(7)
       double precision c(7)
       a = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0, 5.0D0, 6.0D0, 7.0D0 /)
       b = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0, 5.0D0, 6.0D0, 7.0D0 /)
       write(6,100)a(1),a(2),a(3)
 100   format("a(1)=",f6.3," a(2)=",f6.3," a(3)=",f6.3)
       write(6,101)a(4),a(5),a(6)
 101   format("a(4)=",f6.3," a(5)=",f6.3," a(6)=",f6.3)
```

```
      write(6,102)b(1),b(2),b(3)
 102  format("b(1)=",f6.3," b(2)=",f6.3," b(3)=",f6.3)
      write(6,103)b(4),b(5),b(6)
 103  format("b(4)=",f6.3," b(5)=",f6.3," b(6)=",f6.3)

      call daxpy(3,2.0d0,a,1,b,1)
      write(6,200)
 200  format(/,"t200 is (/ 3.0, 6.0, 9.0, 4.0, 5.0, 6.0, 7.0 /)")
      write(6,201)b(1),b(2),b(3)
 201  format("b(1)=",f6.3," b(2)=",f6.3," b(3)=",f6.3)
      write(6,202)b(4),b(5),b(6),b(7)
 202  format("b(4)=",f6.3," b(5)=",f6.3," b(6)=",f6.3," b(7)=",f6.3)

      write(6,300)
 300  format(/,"t300 is (/ 3.0, 6.0, 9.0, 12.0, 15.0, 18.0, 21.0 /)")
      b = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0, 5.0D0, 6.0D0, 7.0D0 /)
      call daxpy(7,2.0d0,a,1,b,1)
      write(6,201)b(1),b(2),b(3)
      write(6,202)b(4),b(5),b(6),b(7)

      write(6,302)
 302  format(/,"t302 is (/ 3.0, 2.0, 3.0, 12.0, 5.0, 6.0, 21.0 /)")
      b = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0, 5.0D0, 6.0D0, 7.0D0 /)
      call daxpy(3,2.0d0,a,3,b,3)
      write(6,201)b(1),b(2),b(3)
      write(6,202)b(4),b(5),b(6),b(7)

      write(6,303)
 303  format(/,"t303 is (/ 3.0, 2.0, 9.0, 4.0, 15.0, 6.0, 21.0 /)")
      b = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0, 5.0D0, 6.0D0, 7.0D0 /)
      call daxpy(4,2.0d0,a,2,b,2)
      write(6,201)b(1),b(2),b(3)
      write(6,202)b(4),b(5),b(6),b(7)

      write(6,305)
 305  format(/,"t305 is (/  3.0, 2.0, 9.0, 4.0, 15.0, 6.0, 7.0 /)")
      b = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0, 5.0D0, 6.0D0, 7.0D0 /)
      call daxpy(3,2.0d0,a,2,b,2)
      write(6,201)b(1),b(2),b(3)
      write(6,202)b(4),b(5),b(6),b(7)

      write(6,306)
 306  format(/,"t306 is (/ -1.0, 2.0, -1.0, 4.0, -1.0, 6.0, 7.0 /)")
      b = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0, 5.0D0, 6.0D0, 7.0D0 /)
      call daxpy(3,-2.0d0,a,1,b,2)
      write(6,201)b(1),b(2),b(3)
      write(6,202)b(4),b(5),b(6),b(7)

      write(6,307)
 307  format(/,"t307 is (/ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0 /)")
```

```
      b = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0, 5.0D0, 6.0D0, 7.0D0 /)
      call daxpy(3,0.0d0,a,1,b,2)
      write(6,201)b(1),b(2),b(3)
      write(6,202)b(4),b(5),b(6),b(7)
      stop
      end
```

———-

```
gcc -o daxpyEX daxpyEX.f -lgfortran daxpy.o && ./daxpyEX

a(1)= 1.000 a(2)= 2.000 a(3)= 3.000
a(4)= 4.000 a(5)= 5.000 a(6)= 6.000
b(1)= 1.000 b(2)= 2.000 b(3)= 3.000
b(4)= 4.000 b(5)= 5.000 b(6)= 6.000

t200 is (/ 3.0, 6.0, 9.0, 4.0, 5.0, 6.0, 7.0 /)
b(1)= 3.000 b(2)= 6.000 b(3)= 9.000
b(4)= 4.000 b(5)= 5.000 b(6)= 6.000 b(7)= 7.000

t300 is (/ 3.0, 6.0, 9.0, 12.0, 15.0, 18.0, 21.0 /)
b(1)= 3.000 b(2)= 6.000 b(3)= 9.000
b(4)=12.000 b(5)=15.000 b(6)=18.000 b(7)=21.000

t302 is (/ 3.0, 2.0, 3.0, 12.0, 5.0, 6.0, 21.0 /)
b(1)= 3.000 b(2)= 2.000 b(3)= 3.000
b(4)=12.000 b(5)= 5.000 b(6)= 6.000 b(7)=21.000

t303 is (/ 3.0, 2.0, 9.0, 4.0, 15.0, 6.0, 21.0 /)
b(1)= 3.000 b(2)= 2.000 b(3)= 9.000
b(4)= 4.000 b(5)=15.000 b(6)= 6.000 b(7)=21.000

t305 is (/  3.0, 2.0, 9.0, 4.0, 15.0, 6.0, 7.0 /)
b(1)= 3.000 b(2)= 2.000 b(3)= 9.000
b(4)= 4.000 b(5)=15.000 b(6)= 6.000 b(7)= 7.000

t306 is (/ -1.0, 2.0, -1.0, 4.0, -1.0, 6.0, 7.0 /)
b(1)=-1.000 b(2)= 2.000 b(3)=-1.000
b(4)= 4.000 b(5)=-1.000 b(6)= 6.000 b(7)= 7.000

t307 is (/ 2.0, 2.0, 7.0, 4.0, 11.0, 6.0, 7.0 /)
b(1)= 3.000 b(2)= 2.000 b(3)= 7.000
b(4)= 4.000 b(5)=11.000 b(6)= 6.000 b(7)= 7.000
```

— BLAS 1 daxpy —

```
(declaim (ftype (function (fixnum double-float
```

```
                                  (simple-array double-float (*)) fixnum
                                  (simple-array double-float (*)) fixnum)
                (simple-array double-float (*))) daxpy))
(defun daxpy (n da dx incx dy incy)
 ; Tim Daly April 24, 2012
 (declare (type (simple-array double-float) dx dy)
          (type double-float da) (type fixnum incy incx n))
  (let ((maxx (length dx)) (maxy (length dy)))
   (declare (type fixnum maxx maxy))
   (when (and (> n 0) (/= da 0.0)
              (> incx 0) (< (* (1- n) incx) maxx)
              (> incy 0) (< (* (1- n) incy) maxy))
    (if (and (= incx 1) (= incy 1))
     (dotimes (i n)
       (setf (the double-float (svref dy i))
        (+ (the double-float (svref dy i))
           (* (the double-float da)
              (the double-float (svref dx i))))))
     ; non-unit increments
     (let ((ix 0) (iy 0))
      (declare (type fixnum ix iy))
      (when (< incx 0) (setq ix (* (1+ (- n)) incx)))
      (when (< incy 0) (setq iy (* (1+ (- n)) incy)))
      (dotimes (i n)
        (setf (the double-float (svref dy iy))
         (+ (the double-float (svref dy iy))
            (* (the double-float da)
               (the double-float (svref dx ix)))))
        (setq ix (+ ix incx))
        (setq iy (+ iy incy)))))))
   dy)
```

———-

— BLAS 1 daxpy lisp test —

```
(setq a (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0 6.0d0 7.0d0))
(setq b (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0 6.0d0 7.0d0))
(daxpy 3 2.0d0 a 1 b 1)
(setq b (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0 6.0d0 7.0d0))
(daxpy 7 2.0d0 a 1 b 1)
(setq b (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0 6.0d0 7.0d0))
(daxpy 8 2.0d0 a 1 b 1)
(setq b (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0 6.0d0 7.0d0))
(daxpy 3 2.0d0 a 3 b 3)
(setq b (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0 6.0d0 7.0d0))
(daxpy 4 2.0d0 a 2 b 2)
(setq b (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0 6.0d0 7.0d0))
```

```
(daxpy 5 2.0d0 a 2 b 2)
(setq b (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0 6.0d0 7.0d0))
(daxpy 3 2.0d0 a 2 b 2)
(setq b (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0 6.0d0 7.0d0))
(daxpy 3 -2.0d0 a 2 b 2)
(setq a (vector 1.0d0 2.0d0 3.0d0))
(setq b (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0))
(daxpy 3 -2.0d0 a 1 b 2)
(setq b (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0 6.0d0 7.0d0))
(daxpy 3 0.0d0 a 1 b 2)
```

———-

3.5 dcopy BLAS

— dcopy.input —

```
)set break resume
)sys rm -f dcopy.output
)spool dcopy.output
)set message test on
)set message auto off
)clear all

--S 1 of 23
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]
--R
--R
--R   (1)  [1.,2.,3.,4.,5.,6.,7.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 1

--S 2 of 23
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R   (2)  [0.,0.,0.,0.,0.,0.,0.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 2

--S 3 of 23
dcopy(3,a,1,b,1)
--R
--R
--R   (3)  [1.,2.,3.,0.,0.,0.,0.]
--R                                          Type: PrimitiveArray(DoubleFloat)
```

```
--E 3

--S 4 of 23
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R   (4)  [0.,0.,0.,0.,0.,0.,0.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 4

--S 5 of 23
dcopy(7,a,1,b,1)
--R
--R
--R   (5)  [1.,2.,3.,4.,5.,6.,7.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 5

--S 6 of 23
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R   (6)  [0.,0.,0.,0.,0.,0.,0.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 6

--S 7 of 23
dcopy(8,a,1,b,1)
--R
--R
--R   (7)  [0.,0.,0.,0.,0.,0.,0.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 7

--S 8 of 23
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R   (8)  [0.,0.,0.,0.,0.,0.,0.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 8

--S 9 of 23
dcopy(3,a,3,b,3)
--R
--R
--R   (9)  [1.,0.,0.,4.,0.,0.,7.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 9
```

```
--S 10 of 23
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R   (10)  [0.,0.,0.,0.,0.,0.,0.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 10

--S 11 of 23
dcopy(4,a,2,b,2)
--R
--R
--R   (11)  [1.,0.,3.,0.,5.,0.,7.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 11

--S 12 of 23
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R   (12)  [0.,0.,0.,0.,0.,0.,0.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 12

--S 13 of 23
dcopy(5,a,2,b,2)
--R
--R
--R   (13)  [0.,0.,0.,0.,0.,0.,0.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 13

--S 14 of 23
b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]
--R
--R
--R   (14)  [0.,0.,0.,0.,0.,0.,0.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 14

--S 15 of 23
dcopy(3,a,2,b,2)
--R
--R
--R   (15)  [1.,0.,3.,0.,5.,0.,0.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 15

--S 16 of 23
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0] ]
```

```
--R
--R
--R   (16)  [1.,2.,3.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 16

--S 17 of 23
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0] ]
--R
--R
--R   (17)  [1.,2.,3.,4.,5.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 17

--S 18 of 23
dcopy(3,a,1,b,1)
--R
--R
--R   (18)  [1.,2.,3.,4.,5.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 18

--S 19 of 23
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0] ]
--R
--R
--R   (19)  [1.,2.,3.,4.,5.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 19

--S 20 of 23
dcopy(3,a,1,b,2)
--R
--R
--R   (20)  [1.,2.,2.,4.,3.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 20

--S 21 of 23
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0] ]
--R
--R
--R   (21)  [1.,2.,3.,4.,5.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 21

--S 22 of 23
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0] ]
--R
--R
```

```
--R   (22)  [1.,2.,3.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 22

--S 23 of 23
dcopy(5,a,1,b,1)
--R
--R
--R   (23)  [1.,2.,3.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 23

)spool
)lisp (bye)
```

———-

— dcopy.help —

```
========================================================================
dcopy examples
========================================================================

Assume we have two arrays which we initialize to these values:
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0] ]

b:PRIMARR(DFLOAT):=[ [ 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0] ]

Note that after each call to dcopy the b array is modified.
The changed value is shown. We reset it after each bcopy but we
do not show that here.

dcopy(3,a,1,b,1) ==> [1.,2.,3.,0.,0.,0.,0.]

dcopy(7,a,1,b,1) ==> [1.,2.,3.,4.,5.,6.,7.]

dcopy(8,a,1,b,1) ==> [0.,0.,0.,0.,0.,0.,0.]

dcopy(3,a,3,b,3) ==> [1.,0.,0.,4.,0.,0.,7.]

dcopy(4,a,2,b,2) ==> [1.,0.,3.,0.,5.,0.,7.]

dcopy(5,a,2,b,2) ==> [0.,0.,0.,0.,0.,0.,0.]

dcopy(3,a,2,b,2) ==> [1.,0.,3.,0.,5.,0.,0.]

The arrays can be of different lengths:

a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0] ]
```

```
b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0] ]

dcopy(3,a,1,b,1) ==>  [1.,2.,3.,4.,5.]

dcopy(3,a,1,b,2) ==>  [1.,2.,2.,4.,3.]

a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0] ]

b:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0] ]

dcopy(5,a,1,b,1) ==> [1.,2.,3.]

========================================================================
Man Page Details
========================================================================

NAME
       DCOPY  -  BLAS level one, copies a double precision vector into another
       double precision vector

SYNOPSIS
       SUBROUTINE DCOPY    ( n, x, incx, y, incy )

           INTEGER           n, incx, incy

           DOUBLE PRECISION  x, y


DESCRIPTION
       DCOPY copies a double precision vector into  another  double  precision
       vector.  DCOPY copies a vector x, whose length is n to a vector y. incx
       and incy specify the increment  between  two  consecutive  elements  of
       respectively vector x and y.

       This routine performs the following vector operation:

            y  <--  x

       where x and y are double precision vectors.

ARGUMENTS
       n       INTEGER. (input)
               Number of vector elements to be copied.
               If n <= 0, this routine returns without computation.

       x       DOUBLE PRECISION, (input)
               Vector from which to copy.

       incx    INTEGER. (input)
```

```
               Increment between elements of x.
               If incx = 0, the y vector is unchanged

       y       DOUBLE PRECISION, (output)
               array of dimension (n-1) * |incy| + 1, result vector.

       incy    INTEGER. (input)
               Increment between elements of y.
               If incy = 0, the y vector is unchanged
```

— dcopy.f —

```
      subroutine  dcopy(n,dx,incx,dy,incy)
c
c     copies a vector, x, to a vector, y.
c     uses unrolled loops for increments equal to one.
c     jack dongarra, linpack, 3/11/78.
c     modified 12/3/93, array(1) declarations changed to array(*)
c
      double precision dx(*),dy(*)
      integer i,incx,incy,ix,iy,m,mp1,n
c
      if(n.le.0)return
      if(incx.eq.1.and.incy.eq.1)go to 20
c
c        code for unequal increments or equal increments
c          not equal to 1
c
      ix = 1
      iy = 1
      if(incx.lt.0)ix = (-n+1)*incx + 1
      if(incy.lt.0)iy = (-n+1)*incy + 1
      do 10 i = 1,n
        dy(iy) = dx(ix)
        ix = ix + incx
        iy = iy + incy
   10 continue
      return
c
c        code for both increments equal to 1
c
c
c        clean-up loop
c
   20 m = mod(n,7)
      if( m .eq. 0 ) go to 40
```

```
      do 30 i = 1,m
        dy(i) = dx(i)
   30 continue
      if( n .lt. 7 ) return
   40 mp1 = m + 1
      do 50 i = mp1,n,7
        dy(i) = dx(i)
        dy(i + 1) = dx(i + 1)
        dy(i + 2) = dx(i + 2)
        dy(i + 3) = dx(i + 3)
        dy(i + 4) = dx(i + 4)
        dy(i + 5) = dx(i + 5)
        dy(i + 6) = dx(i + 6)
   50 continue
      return
      end
```

———-

Compile with

```
gcc -c dcopy.f
gcc -o dcopyEx dcopyEX.f -lgfortran dcopy.o
```

— dcopy example —

```
       program dcopyEX
*      Tim Daly April 27, 2012
*      unit tests for BLAS dcopy
       double precision a(7)
       double precision b(7)
       a = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0, 5.0D0, 6.0D0, 7.0D0 /)
       b = (/ 0.0D0, 0.0D0, 0.0D0, 0.0D0, 0.0D0, 0.0D0, 0.0D0 /)
       write(6,100)a(1),a(2),a(3)
 100   format("a(1)=",f6.3," a(2)=",f6.3," a(3)=",f6.3)
       write(6,101)a(4),a(5),a(6)
 101   format("a(4)=",f6.3," a(5)=",f6.3," a(6)=",f6.3)
       write(6,102)b(1),b(2),b(3)
 102   format("b(1)=",f6.3," b(2)=",f6.3," b(3)=",f6.3)
       write(6,103)b(4),b(5),b(6)
 103   format("b(4)=",f6.3," b(5)=",f6.3," b(6)=",f6.3)

       call dcopy(3,a,1,b,1)
       write(6,200)
 200   format(/,"t200 is (/ 1.0 2.0 3.0 0.0 0.0 0.0 0.0 /)")
       write(6,201)b(1),b(2),b(3)
 201   format("b(1)=",f6.3," b(2)=",f6.3," b(3)=",f6.3)
       write(6,202)b(4),b(5),b(6),b(7)
```

```
 202   format("b(4)=",f6.3," b(5)=",f6.3," b(6)=",f6.3," b(7)=",f6.3)

       write(6,300)
 300   format(/,"t300 is (/ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0 /)")
       b = (/ 0.0D0, 0.0D0, 0.0D0, 0.0D0, 0.0D0, 0.0D0, 0.0D0 /)
       call dcopy(7,a,1,b,1)
       write(6,201)b(1),b(2),b(3)
       write(6,202)b(4),b(5),b(6),b(7)

       write(6,302)
 302   format(/,"t302 is (/ 1.0, 0.0, 0.0, 4.0, 0.0, 0.0, 7.0 /)")
       b = (/ 0.0D0, 0.0D0, 0.0D0, 0.0D0, 0.0D0, 0.0D0, 0.0D0 /)
       call dcopy(3,a,3,b,3)
       write(6,201)b(1),b(2),b(3)
       write(6,202)b(4),b(5),b(6),b(7)

       write(6,303)
 303   format(/,"t303 is (/ 1.0, 0.0, 3.0, 0.0, 5.0, 0.0, 7.0 /)")
       b = (/ 0.0D0, 0.0D0, 0.0D0, 0.0D0, 0.0D0, 0.0D0, 0.0D0 /)
       call dcopy(4,a,2,b,2)
       write(6,201)b(1),b(2),b(3)
       write(6,202)b(4),b(5),b(6),b(7)

       write(6,305)
 305   format(/,"t305 is (/ 1.0, 2.0, 3.0, 4.0, 5.0, 0.0, 0.0 /)")
       a = (/ 1.0D0, 2.0D0, 3.0D0, 0.0D0, 0.0D0, 0.0D0, 0.0D0 /)
       b = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0, 5.0D0, 0.0D0, 0.0D0 /)
       call dcopy(3,a,1,b,1)
       write(6,201)b(1),b(2),b(3)
       write(6,202)b(4),b(5),b(6),b(7)

       write(6,306)
 306   format(/,"t306 is (/ 1.0, 2.0, 2.0, 4.0, 3.0, 0.0, 0.0 /)")
       a = (/ 1.0D0, 2.0D0, 3.0D0, 0.0D0, 0.0D0, 0.0D0, 0.0D0 /)
       b = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0, 5.0D0, 0.0D0, 0.0D0 /)
       call dcopy(3,a,1,b,2)
       write(6,201)b(1),b(2),b(3)
       write(6,202)b(4),b(5),b(6),b(7)

       stop
       end
```

```
gcc -o dcopyEX dcopyEX.f -lgfortran dcopy.o && ./dcopyEX

a(1)= 1.000 a(2)= 2.000 a(3)= 3.000
a(4)= 4.000 a(5)= 5.000 a(6)= 6.000
b(1)= 0.000 b(2)= 0.000 b(3)= 0.000
b(4)= 0.000 b(5)= 0.000 b(6)= 0.000
```

```
t200 is (/ 1.0 2.0 3.0 0.0 0.0 0.0 0.0 /)
b(1)= 1.000 b(2)= 2.000 b(3)= 3.000
b(4)= 0.000 b(5)= 0.000 b(6)= 0.000 b(7)= 0.000

t300 is (/ 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0 /)
b(1)= 1.000 b(2)= 2.000 b(3)= 3.000
b(4)= 4.000 b(5)= 5.000 b(6)= 6.000 b(7)= 7.000

t302 is (/ 1.0, 0.0, 0.0, 4.0, 0.0, 0.0, 7.0 /)
b(1)= 1.000 b(2)= 0.000 b(3)= 0.000
b(4)= 4.000 b(5)= 0.000 b(6)= 0.000 b(7)= 7.000

t303 is (/ 1.0, 0.0, 3.0, 0.0, 5.0, 0.0, 7.0 /)
b(1)= 1.000 b(2)= 0.000 b(3)= 3.000
b(4)= 0.000 b(5)= 5.000 b(6)= 0.000 b(7)= 7.000

t305 is (/ 1.0, 2.0, 3.0, 4.0, 5.0, 0.0, 0.0 /)
b(1)= 1.000 b(2)= 2.000 b(3)= 3.000
b(4)= 4.000 b(5)= 5.000 b(6)= 0.000 b(7)= 0.000

t306 is (/ 1.0, 2.0, 2.0, 4.0, 3.0, 0.0, 0.0 /)
b(1)= 1.000 b(2)= 2.000 b(3)= 2.000
b(4)= 4.000 b(5)= 3.000 b(6)= 0.000 b(7)= 0.000
```

— BLAS 1 dcopy —

```
(declaim (ftype (function (fixnum (simple-array double-float (*)) fixnum
                                  (simple-array double-float (*)) fixnum)
                 (simple-array double-float (*))) dcopy))
(defun dcopy (n dx incx dy incy)
 ; Tim Daly April 27, 2012
 (declare (type (simple-array double-float) dy dx)
          (type fixnum incy incx n))
  (let ((maxx (length dx)) (maxy (length dy)))
   (declare (type fixnum maxx maxy))
   (when (and (> n 0)
              (> incx 0) (< (* (1- n) incx) maxx)
              (> incy 0) (< (* (1- n) incy) maxy))
    (if (and (= incx 1) (= incy 1))
     ; unit increments
     (dotimes (i n)
       (setf (the double-float (svref dy i)) (the double-float (svref dx i))))
     ; non-unit increments
     (let ((ix 0) (iy 0))
      (declare (type fixnum ix iy))
      (when (< incx 0) (setq ix (* (1+ (- n)) incx)))
      (when (< incy 0) (setq ix (* (1+ (- n)) incy)))
```

```
      (dotimes (i n)
       (setf (the double-float (svref dy iy)) (the double-float (svref dx ix)))
       (setq ix (+ ix incx))
       (setq iy (+ iy incy)))))))
   dy)
```

———-

— BLAS 1 dcopy lisp test —

```
(setq a (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0 6.0d0 7.0d0))
(setq b (vector 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0))
(dcopy 3 a 1 b 1)
(setq b (vector 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0))
(dcopy 7 a 1 b 1)
(setq b (vector 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0))
(dcopy 8 a 1 b 1)
(setq b (vector 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0))
(dcopy 3 a 3 b 3)
(setq b (vector 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0))
(dcopy 4 a 2 b 2)
(setq b (vector 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0))
(dcopy 5 a 2 b 2)
(setq b (vector 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0 0.0d0))
(dcopy 3 a 2 b 2)
(setq a (vector 1.0d0 2.0d0 3.0d0))
(setq b (vector 0.0d0 0.0d0 3.0d0 4.0d0 5.0d0))
(dcopy 3 a 1 b 1)
b
(setq b (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0))
(dcopy 3 a 1 b 2)
(setq a (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0))
(setq b (vector 1.0d0 2.0d0 3.0d0))
(dcopy 5 a 1 b 1)
```

———-

3.6 ddot BLAS

— ddot.input —

```
)set break resume
)sys rm -f ddot.output
)spool ddot.output
)set message test on
```

```
)set message auto off
)clear all

--S 1 of 9
a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0] ]
--R
--R   (1)  [1.,2.,3.,4.,5.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 1

--S 2 of 9
b:PRIMARR(DFLOAT):=[ [ 5.0, 6.0, 7.0, 8.0, 9.0] ]
--R
--R   (2)  [5.,6.,7.,8.,9.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 2

--S 3 of 9
ddot(0,a,1,b,1)
--R
--R   (3)  0.
--R                                                          Type: DoubleFloat
--E 3

--S 4 of 9
ddot(3,a,1,b,1)
--R
--R   (4)  38.
--R                                                          Type: DoubleFloat
--E 4

--S 5 of 9
ddot(3,a,1,b,2)
--R
--R   (5)  46.
--R                                                          Type: DoubleFloat
--E 5

--S 6 of 9
ddot(3,a,2,b,1)
--R
--R   (6)  58.
--R                                                          Type: DoubleFloat
--E 6

--S 7 of 9
ddot(3,a,1,b,-2)
--R
--R   (7)  38.
--R                                                          Type: DoubleFloat
```

```
--E 7

--S 8 of 9
ddot(3,a,-2,b,1)
--R
--R   (8)  50.
--R                                                    Type: DoubleFloat
--E 8

--S 9 of 9
ddot(3,a,-2,b,-2)
--R
--R   (9)  71.
--R                                                    Type: DoubleFloat
--E 9


)spool
)lisp (bye)
```

———-

— ddot.help —

```
========================================================================
ddot examples
========================================================================

a:PRIMARR(DFLOAT):=[ [ 1.0, 2.0, 3.0, 4.0, 5.0] ]

  [1.,2.,3.,4.,5.]

b:PRIMARR(DFLOAT):=[ [ 5.0, 6.0, 7.0, 8.0, 9.0] ]

  [5.,6.,7.,8.,9.]

ddot(0,a,1,b,1)

  0.

ddot(3,a,1,b,1)

 38. ( = 1.0*5.0 + 2.0*6.0 + 3.0*7.0 )

ddot(3,a,1,b,2)

 46. ( = 1.0*5.0 + 2.0*7.0 + 3.0*9.0 )

ddot(3,a,2,b,1)
```

```
 58. ( = 1.0*5.0 + 3.0*6.0 + 5.0*7.0 )

ddot(3,a,1,b,-2)

 38. ( = 1.0*9.0 + 2.0*7.0 + 3.0*5.0 )

ddot(3,a,-2,b,1)

 50. ( = 5.0*5.0 + 3.0*6.0 + 1.0*7.0 )

ddot(3,a,-2,b,-2)

 71. ( = 5.0*9.0 + 3.0*7.0 + 1.0*5.0 )

=====================================================================
Man Page Details
=====================================================================

NAME
       DDOT  -  BLAS  level one, computes a dot product (inner product) of two
       double precision vectors

SYNOPSIS
       DOUBLE PRECISION FUNCTION DDOT ( n, x, incx, y, incy )

           INTEGER                     n, incx, incy

           DOUBLE PRECISION            x, y


DESCRIPTION
       DDOT computes a dot product of two double precision vectors  (1  double
       precision inner product).
         2

       This routine performs the following vector operation:

                                                 n
               DDOT  <--  (transpose of x) * y  =  Sum  x(i)*y(i)
                                                 i=1
       where x and y are double precision vectors.

       If n <= 0, DDOT is set to 0.

ARGUMENTS
       n       INTEGER. (input)
               Number of elements in each vector.

       x       DOUBLE PRECISION. (input)
```

```
               Array of dimension (n-1) * |incx| + 1.
               Array x contains the first vector operand.

       incx    INTEGER. (input)
               Increment between elements of x.
               If incx = 0, the results will be unpredictable.

       y       DOUBLE PRECISION, (input)
               Array of dimension (n-1) * |incy| + 1.
               Array y contains the second vector operand.

       incy    INTEGER. (input)
               Increment between elements of y.  If incy = 0, the results will
               be unpredictable.

RETURN VALUES
       DDOT    DOUBLE PRECISION. Result (dot product). (output)

NOTES
       When  working  backward  (incx < 0 or incy < 0), each routine starts at
       the end of the vector and moves backward, as follows:

            x(1-incx * (n-1)), x(1-incx * (n-2)), ..., x(1)

            y(1-incy * (n-1)), y(1-incy * (n-2)), ..., y(1)
```

———-

— ddot.f —

```
      double precision function ddot(n,dx,incx,dy,incy)
c
c     forms the dot product of two vectors.
c     uses unrolled loops for increments equal to one.
c     jack dongarra, linpack, 3/11/78.
c     modified 12/3/93, array(1) declarations changed to array(*)
c
      double precision dx(*),dy(*),dtemp
      integer i,incx,incy,ix,iy,m,mp1,n
c
      ddot = 0.0d0
      dtemp = 0.0d0
      if(n.le.0)return
      if(incx.eq.1.and.incy.eq.1)go to 20
c
c        code for unequal increments or equal increments
c          not equal to 1
c
```

```
      ix = 1
      iy = 1
      if(incx.lt.0)ix = (-n+1)*incx + 1
      if(incy.lt.0)iy = (-n+1)*incy + 1
      do 10 i = 1,n
        dtemp = dtemp + dx(ix)*dy(iy)
        ix = ix + incx
        iy = iy + incy
   10 continue
      ddot = dtemp
      return
c
c        code for both increments equal to 1
c
c
c        clean-up loop
c
   20 m = mod(n,5)
      if( m .eq. 0 ) go to 40
      do 30 i = 1,m
        dtemp = dtemp + dx(i)*dy(i)
   30 continue
      if( n .lt. 5 ) go to 60
   40 mp1 = m + 1
      do 50 i = mp1,n,5
        dtemp = dtemp + dx(i)*dy(i) + dx(i + 1)*dy(i + 1) +
     *   dx(i + 2)*dy(i + 2) + dx(i + 3)*dy(i + 3) + dx(i + 4)*dy(i + 4)
   50 continue
   60 ddot = dtemp
      return
      end
```

———-

Compile with

```
gcc -c ddot.f
gcc -o ddotEx ddotEX.f -lgfortran ddot.o
```

— ddot example —

```
       program ddotEX
*      Tim Daly April 27, 2012
*      unit tests for BLAS ddot
       double precision a(5)
       double precision b(5)
       double precision c
       a = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0, 5.0D0 /)
```

```
       b = (/ 5.0D0, 6.0D0, 7.0D0, 8.0D0, 9.0D0 /)
       write(6,100)a(1),a(2),a(3),a(4),a(5)
 100   format("a=(/",f6.3," ",f6.3," ",f6.3," ",f6.3," ",f6.3,"/)")
       write(6,101)b(1),b(2),b(3),b(4),b(5)
 101   format("b=(/",f6.3," ",f6.3," ",f6.3," ",f6.3," ",f6.3,"/)")

* handle 0 elements
       c=ddot(0,a,1,b,1)
       write(6,200)c
 200   format(/,"t200 is 0.0",/,"c=",f6.3)

* handle (1,2,3) * (5,6,7)
       c=ddot(3,a,1,b,1)
       write(6,201)c
 201   format(/,"t201 is 38.0",/,"c=",f6.3)

* handle increment = 2 in b (1,2,3) * (5,7,9)
       c=ddot(3,a,1,b,2)
       write(6,202)c
 202   format(/,"t202 is 46.0",/,"c=",f6.3)

* handle increment = 2 in a (1,3,5) * (5,6,7)
       c=ddot(3,a,2,b,1)
       write(6,203)c
 203   format(/,"t203 is 58.0",/,"c=",f6.3)

* handle increment = -2 in b (1,2,3) * (9,7,5)
       c=ddot(3,a,1,b,-2)
       write(6,204)c
 204   format(/,"t204 is 38.0",/,"c=",f6.3)

* handle increment = -2 in a (5,3,1) * (5,6,7)
       c=ddot(3,a,-2,b,1)
       write(6,205)c
 205   format(/,"t205 is 50.0",/,"c=",f6.3)

* handle increment = -2 in a and b(5,3,1) * (9,7,5)
       c=ddot(3,a,-2,b,-2)
       write(6,206)c
 206   format(/,"t206 is 71.0",/,"c=",f6.3)

       stop
       end
```

```
a=(/ 1.000  2.000  3.000  4.000  5.000/)
a=(/ 5.000  6.000  7.000  8.000  9.000/)

t200 is 0.0
```

```
c= 0.000

t201 is 28.0
c=38.000

t202 is 46.0
c=46.000

t203 is 58.0
c=58.000

t204 is 38.0
c=38.000

t205 is 50.0
c=50.000

t206 is 71.0
c=71.000
```

— BLAS 1 ddot —

```
(declaim (ftype (function (fixnum (simple-array double-float (*)) fixnum
                                  (simple-array double-float (*)) fixnum)
                 double-float) ddot))
(defun ddot (n dx incx dy incy)
 ; Tim Daly April 27, 2012
 (declare (optimize (speed 3) (safety 0))
          (type (simple-array double-float (*)) dx dy)
          (type fixnum incy incx n))
 (let ((ix 0) (iy 0) (ddot 0.0d0))
 (declare (type (double-float) ddot) (type fixnum iy ix))
  (when (> n 0)
   (when (< incx 0)
     (setf ix (the fixnum (*
                  (the fixnum (- 1 (the fixnum n)))
                  (the fixnum incx)))))
   (when (< incy 0)
     (setf iy (the fixnum (*
                  (the fixnum (- 1 (the fixnum n)))
                  (the fixnum incy)))))
   (do ((i 0 (1+ i)) (x ix (+ x incx)) (y iy (+ y incy)))
       ((= i n))
     (setf ddot
        (the double-float (+ ddot
          (the double-float (* (aref dx x) (aref dy y))))))))
   ddot))
```

— BLAS 1 dcopy lisp test —

```
(setq a (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0))
(setq b (vector 5.0d0 6.0d0 7.0d0 8.0d0 9.0d0))
(= 0.0d0 (ddot 0 a 1 b 1))
(= 38.0d0 (ddot 3 a 1 b 1))
(= 46.0d0 (ddot 3 a 1 b 2))
(= 58.0d0 (ddot 3 a 2 b 1))
(= 38.0d0 (ddot 3 a 1 b -2))
(= 50.0d0 (ddot 3 a -2 b 1))
(= 71.0d0 (ddot 3 a -2 b -2))
```

————-

3.7 dnrm2 BLAS

— dnrm2.input —

```
)set break resume
)sys rm -f dnrm2.output
)spool dnrm2.output
)set message test on
)set message auto off
)clear all

--S 1 of 4
a:PRIMARR(DFLOAT):=[ [ 3.0, -4.0, 5.0, -7.0, 9.0] ]
--R
--R   (1)  [3.,- 4.,5.,- 7.,9.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 1

--S 2 of 4
dnrm2(3,a,1)
--R
--R   (2)  7.0710678118654755
--R                                                          Type: DoubleFloat
--E 2

--S 3 of 4
dnrm2(5,a,1)
--R
--R   (3)  13.416407864998739
--R                                                          Type: DoubleFloat
--E 3
```

```
--S 4 of 4
dnrm2(3,a,2)
--R
--R   (4)  10.72380529476361
--R                                                          Type: DoubleFloat
--E 4

)spool
)lisp (bye)
```

———-

— dnrm2.help —

```
==========================================================================
dnrm2 examples
==========================================================================

DNRM2 is a BLAS level one which computes the Euclidean norm of a vector.

Given the vector [ 3.0, -4.0, 5.0, -7.0, 9.0 ]

dnrm2(3,a,1)
   = sqrt(3.0^2 + -4.0^2 + 5.0^2)
   = sqrt(50.0)
   = 7.0710678118654755

dnrm2(5,a,1)
   = sqrt(3.0^2 + -4.0^2 + 5.0^2 + -7.0^2 + 9.0^2)
   = sqrt(180.0)
   = 13.416407864998739

dnrm2(3,a,2)
   = sqrt(3.0^2 + 5.0^2 + 9.0^2)
   = sqrt(115.0)
   = 10.72380529476361

==========================================================================
Man Page Details
==========================================================================

NAME
       DNRM2 - BLAS level one, computes the Euclidean norm of a vector

SYNOPSIS
       DOUBLE PRECISION FUNCTION DNRM2 ( n, x, incx )

           INTEGER                      n, incx
```

```
          DOUBLE PRECISION             x


DESCRIPTION
       DNRM2  computes the Euclidean (L2) norm of a double precision real vec-
       tor, as follows:

               DNRM2 <-- ||x||
                                2

       where x is a double precision real vector.

ARGUMENTS
       n       INTEGER. (input)
               Number of elements in the operand vector.

       x       DOUBLE PRECISION. (input)
               Array of dimension (n-1) * |incx| + 1.
               Array x contains the operand vector.

       incx    INTEGER. (input)
               Increment between elements of x.
               If incx = 0, the results will be unpredictable.

RETURN VALUES
       DNRM2   DOUBLE PRECISION. Result (Euclidean norm). (output)
               If n <= 0, DNRM2 is set to 0d0.

NOTES
       When working backward (incx < 0), each routine starts at the end of the
       vector and moves backward, as follows:

            x(1-incx * (n-1)), x(1-incx * (n-2)), ..., x(1)
```

———-

— dnrm2.f —

```
      DOUBLE PRECISION FUNCTION DNRM2 ( N, X, INCX )
*     .. Scalar Arguments ..
      INTEGER                          INCX, N
*     .. Array Arguments ..
      DOUBLE PRECISION                 X( * )
*     ..
*
*  DNRM2 returns the euclidean norm of a vector via the function
*  name, so that
*
```

```
*     DNRM2 := sqrt( x'*x )
*
*
*
*  -- This version written on 25-October-1982.
*     Modified on 14-October-1993 to inline the call to DLASSQ.
*     Sven Hammarling, Nag Ltd.
*
*
*     .. Parameters ..
      DOUBLE PRECISION      ONE         , ZERO
      PARAMETER           ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     .. Local Scalars ..
      INTEGER               IX
      DOUBLE PRECISION      ABSXI, NORM, SCALE, SSQ
*     .. Intrinsic Functions ..
      INTRINSIC             ABS, SQRT
*     ..
*     .. Executable Statements ..
      IF( N.LT.1 .OR. INCX.LT.1 )THEN
         NORM  = ZERO
      ELSE IF( N.EQ.1 )THEN
         NORM  = ABS( X( 1 ) )
      ELSE
         SCALE = ZERO
         SSQ   = ONE
*        The following loop is equivalent to this call to the LAPACK
*        auxiliary routine:
*        CALL DLASSQ( N, X, INCX, SCALE, SSQ )
*
         DO 10, IX = 1, 1 + ( N - 1 )*INCX, INCX
            IF( X( IX ).NE.ZERO )THEN
               ABSXI = ABS( X( IX ) )
               IF( SCALE.LT.ABSXI )THEN
                  SSQ   = ONE   + SSQ*( SCALE/ABSXI )**2
                  SCALE = ABSXI
               ELSE
                  SSQ   = SSQ   +     ( ABSXI/SCALE )**2
               END IF
            END IF
   10    CONTINUE
         NORM  = SCALE * SQRT( SSQ )
      END IF
*
      DNRM2 = NORM
      RETURN
*
*     End of DNRM2.
*
      END
```

———-

Compile with

```
gcc -c dnrm2.f
gcc -o dnrm2Ex dnrm2EX.f -lgfortran dnrm2.o
```

— dnrm2 example —

```
       program dnrm2EX
*      Tim Daly April 28, 2012
*      unit tests for BLAS dnrm2
       double precision a(5)
       double precision c
       a = (/ 3.0D0, -4.0D0, 5.0D0, -7.0D0, 9.0D0/)
       write(6,100)a(1),a(2),a(3)
 100   format("a=(/",f6.3," ",f6.3," ",f6.3"/)")

       c=dnrm2(3,a,1)
       write(6,200)c
 200   format(/,"t200 is sqrt(50.0)=7.071",/,"c=",f6.3)

       c=dnrm2(5,a,1)
       write(6,201)c
 201   format(/,"t201 is sqrt(180.0)=13.416",/,"c=",f6.3)

       c=dnrm2(3,a,2)
       write(6,202)c
 202   format(/,"t202 is sqrt(115.0)=10.724",/,"c=",f9.3)

       stop
       end
```

———-

```
gcc -o dnrm2EX dnrm2EX.f -lgfortran dnrm2.o && ./dnrm2EX
a=(/ 3.000 -4.000  5.000/)

t200 is sqrt(50.0)=7.071
c= 7.071

t201 is sqrt(180.0)=13.416
c=13.416

t202 is sqrt(115.0)=10.724
c=   10.724
```

— BLAS 1 dnrm2 —

```
(declaim (ftype (function (fixnum (simple-array double-float (*)) fixnum)
                 double-float) dnrm2))
(defun dnrm2 (n x incx)
 ; Tim Daly April 28, 2012
 (declare (type (simple-array double-float (*)) x) (type fixnum incx n))
 (let ((absxi 0.0d0) (norm 0.0d0) (scale 0.0d0) (ssq 0.0d0)
       (limit 0) (t1 0.0D0))
  (declare (type fixnum limit) (type double-float absxi norm scale ssq t1))
  (cond
   ((or (< n 1) (< incx 1)) (setf norm 0.0d0))
   ((= n 1)                 (setf norm (abs (aref x 0))))
   (t
    (setf limit (min (* (- n 1) incx) (1- (length x))))
    (do ((ix 0 (+ ix incx)))
        ((> ix limit) nil)
      (unless (= 0.0d0 (the double-float (aref x ix)))
       (setf absxi (the double-float (abs (the double-float (aref x ix)))))
       (cond
         ((< scale absxi)
           (setf t1 (the double-float
                      (/ (the double-float scale) (the double-float absxi))))
           (setf ssq
            (the double-float
             (+ 1.0d0
              (the double-float
               (* (the double-float ssq)
                  (the double-float
                   (* (the double-float t1) (the double-float t1))))))))
           (setf scale absxi))
         (t
           (setf t1 (the double-float
                      (/ (the double-float absxi) (the double-float scale))))
           (setf ssq
            (the double-float
             (+ (the double-float ssq)
                (the double-float
                 (* (the double-float t1) (the double-float t1)))))))))))
    (setf norm (the double-float (* scale (the double-float (sqrt ssq)))))))
   norm))
```

———-

— BLAS 1 dnrm2 lisp test —

```
(setq a (vector 3.0D0 -4.0D0 5.0D0 -7.0D0 9.0D0))
```

```
; sqrt(50.0)  = 7.0710678118654755
(dnrm2 3 a 1)
; sqrt(180.0) = 13.416407864998739
(dnrm2 5 a 1)
; sqrt(115.0) = 10.72380529476361
(dnrm2 3 a 2)
```

3.8 drotg BLAS

— drotg.input —

```
)set break resume
)sys rm -f drotg.output
)spool drotg.output
)set message test on
)set message auto off
)clear all

--S 1 of 8
a:MATRIX(DFLOAT):=[[6,5,0],[5,1,4],[0,4,3]]
--R
--R        +6.  5.  0.+
--R        |          |
--R   (1)  |5.  1.  4.|
--R        |          |
--R        +0.  4.  3.+
--R                                                  Type: Matrix(DoubleFloat)
--E 1

--S 2 of 8
t1:=drotg(elt(a,1,1),elt(a,1,2),0.0,0.0)
--R
--R   (2)
--R   [7.810249675906654, 0.64018439966447993, 0.76822127959737585,
--R    0.64018439966447993]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 2

--S 3 of 8
g1:MATRIX(DFLOAT):=[[elt(t1,2), elt(t1,3),0.0],_
                    [-elt(t1,3),elt(t1,2),0.0],_
                    [0.0,       0.0,      1.0]]
--R
--R
--R        + 0.76822127959737585   0.64018439966447993  0.+
```

```
--R        |                                                 |
--R   (3)  |- 0.64018439966447993  0.76822127959737585  0.|
--R        |                                                 |
--R        +         0.                    0.           1.+
--R                                                  Type: Matrix(DoubleFloat)
--E 3

--S 4 of 8
t2:=g1*a
--R
--R        +   7.810249675906654       4.4812907976513596   2.5607375986579197+
--R        |                                                                   |
--R   (4)  |- 4.4408920985006262E-16  - 2.4327007187250236  3.0728851183895034|
--R        |                                                                   |
--R        +           0.                      4.                   3.        +
--R                                                  Type: Matrix(DoubleFloat)
--E 4

--S 5 of 8
t3:=drotg(elt(t2,2,2),elt(a,3,2),0.0,0.0)
--R
--R   (5)
--R   [4.6816698716254272, - 1.924474241977076, - 0.51962243930719854,
--R    0.85439599751428896]
--R                                           Type: PrimitiveArray(DoubleFloat)
--E 5

--S 6 of 8
g2:MATRIX(DFLOAT):=[[1.0, 0.0,      0.0],_
                    [0.0, elt(t3,2),elt(t3,3)],_
                    [0.0,-elt(t3,3),elt(t3,2)]]
--R
--R
--R        +1.           0.                    0.          +
--R        |                                               |
--R   (6)  |0.  - 0.51962243930719854   0.85439599751428896 |
--R        |                                               |
--R        +0.  - 0.85439599751428896  - 0.51962243930719854+
--R                                                  Type: Matrix(DoubleFloat)
--E 6

--S 7 of 8
g2*g1*a
--R
--R        +   7.810249675906654      4.4812907976513596   2.5607375986579197 +
--R        |                                                                  |
--R   (7)  | 2.2204460492503131E-16   4.6816698716254272  0.96644793161452336 |
--R        |                                                                  |
--R        +- 4.4408920985006262E-16          0.          - 4.1843280638948093+
--R                                                  Type: Matrix(DoubleFloat)
```

```
--E 7

--S 8 of 8
q:=transpose(g1)*transpose(g2)
--R
--R        +0.76822127959737585   0.33265417936007158    0.54697098874441952 +
--R        |                                                                  |
--R   (8)  |0.64018439966447993  - 0.39918501523208583  - 0.65636518649330344|
--R        |                                                                  |
--R        +        0.            0.85439599751428896   - 0.51962243930719854+
--R                                                    Type: Matrix(DoubleFloat)
--E 8

)spool
)lisp (bye)
```

———-

— drotg.help —

```
========================================================================
drotg examples
========================================================================

A Givens rotation is a rotation in the plane spanned by two
coordinate axes, named after Wallace Givens. [REF-Wiki3]

A Givens rotation is represented by a matrix of the form

              +-                          -+
              | 1  ...  0  ...  0  ...  0 |
              | .   .   .   .   .   .   . |
              | .    .  .    .  .    .  . |
              | 0  ...  c  ... -s  ...  0 |
              | .   .   .   .   .   .   . |
G(i,j,theta) = | .    .  .    .  .    .  . |
              | 0  ...  s  ...  c  ...  0 |
              | .   .   .   .   .   .   . |
              | .    .  .    .  .    .  . |
              | 0  ...  0  ...  0  ...  1 |
              +-                          -+

where c = cos(theta) and s = sin(theta) appear at the intersections
of the ith, jth rows and columns. The non-zero elements of a Givens
matrix are given by:
```

```
g   = 1 for k != i,j
 kk
g   = c
 ii
g   = c              (sign of sine switches for j>i)
 jj
g   = -s
 ji
g   = s  for i > j
 ij
```

The product G(i,j,theta)*x represents the counterclockwise rotation
of the vector in the (i,j) plane of theta radians.

The main use of Givens rotations in numerical linear algebra is to
introduce zeros in vectors or matrices. This effect can be employed
for computing the QR decomposition of a matrix. One advantage over
the Householder tranformations is that they can easily be parallelized,
and another is that often for very sparse matrices they have a lower
operation count.

When a Givens rotation matrix, G(i,k,theta) multiplies another
matrix A from the left, GA, only rows i and j of A are affected.
Thus we restrict attention to the following problem. Given a and b,
find c=cos(theta) and s=sin(theta) such that

```
+-     -+ +- -+   +- -+
| c  -s | | a |   | r |
|       | |   | = |   |
| s   c | | b |   | 0 |
+-     -+ +- -+   +- -+
```

The solution is

```
r = sqrt(a^2+b^2)
c = a/r
s = -b/r
```

However, the computation for r may overflow or underflow. An alternative
formulation avoiding this problem [REF-GC96, p5.1.8] is implemented as the
hypot function in many programming languages.

As Anderson [REF-And00] discovered in improving LAPACK, a previously
overlooked numerical consideration is continuity. To achieve this
we require r to be positive.

```
   if (b = 0) then { c = copysign(1,a); s=0; r=abs(a) }
   else if (a = 0) then { c = 0; s = copysign(1,b); r = abs(b) }
   else if (abs(b) > abs(a)) then
     t = a/b
```

```
     u = copysign(sqrt(1+t*t),b)
     s = 1/u
     c = s*t
     r = b*u
   else
     t = b/a
     u = copysign(sqrt(1+t*t),a)
     c = 1/u
     s = c*t
     r = a*u

copysign can be implemented as x*sgn(y) using the sign function.

======================================================================
Man Page Details
======================================================================

NAME
       DGROTG - BLAS level one rotation subroutines

SYNOPSIS
       SUBROUTINE DROTG    ( a, b, c, s )

           DOUBLE PRECISION  a, b, c, s


DESCRIPTION
       DROTG  computes  the  elements  of  a Givens plane rotation matrix such
       that:

             _      _     _   _    _   _
             | c  s |     | a |    | r |
             |-s  c | *   | b | =  | 0 |
             -      -     -   -    -   -

       where  r = +- sqrt ( a**2 + b**2 )  and c**2 + s**2 =1.

       The Givens plane rotation can be used to introduce zero elements into
       a matrix selectively.



ARGUMENTS
       a       (input and output) DOUBLE PRECISION

               First vector component.  On input, the first component  of  the
               vector to be rotated.  On output, a is overwritten by r, the
               first component of the vector in the rotated coordinate  system
               where:
```

```
            r = sign(sqrt(a**2 + b**2),a), if |a| > |b|

            r = sign(sqrt(a**2 + b**2),b), if |a| <= |b|

      b     (input and output) DOUBLE PRECISION
            Second vector component.

            On input, the second component of the vector to be rotated.  On
            output, b contains z, where:

                z=s    if  |a| >  |b|
                z=1/c  if  |a| <= |b|  and  c != 0  and r != 0
                z=1    if  |a| <= |b|  and  c  = 0  and r != 0
                z=0    if  r = 0

      c     (output) DOUBLE PRECISION
            Cosine of the angle of rotation:

                 c = a/r  if  r != 0
                 c = 1    if  r  = 0

      s     (output) DOUBLE PRECISION
            Sine of the angle of rotation:

                 s = b/r  if  r != 0
                 s = 0    if  r  = 0


NOTE
      The value of z, returned in b by DROTG, gives a compact  representation
      of  the rotation matrix, which can be used later to reconstruct c and s
      as in the following example:

           IF (B .EQ. 1. ) THEN
               C = 0.
               S = 1.
           ELSEIF( ABS( B) .LT. 1) THEN
               C = SQRT( 1. - B * B)
               S = B
           ELSE
               C = 1. / B
               S = SQRT( 1 - C * C)
           ENDIF
```

Double precision. Computes plane rotation. Arguments are:

- da - double-float

- db - double-float
- c - double-float
- s - double-float

Returns multiple values where:

- 1 da - double-float
- 2 db - double-float
- 3 c - double-float
- 4 s - double-float

— drotg.f —

```
      subroutine drotg(da,db,c,s)
c
c     construct givens plane rotation.
c     jack dongarra, linpack, 3/11/78.
c
      double precision da,db,c,s,roe,scale,r,z
c
      roe = db
      if( dabs(da) .gt. dabs(db) ) roe = da
      scale = dabs(da) + dabs(db)
      if( scale .ne. 0.0d0 ) go to 10
         c = 1.0d0
         s = 0.0d0
         r = 0.0d0
         z = 0.0d0
         go to 20
   10 r = scale*dsqrt((da/scale)**2 + (db/scale)**2)
      r = dsign(1.0d0,roe)*r
      c = da/r
      s = db/r
      z = 1.0d0
      if( dabs(da) .gt. dabs(db) ) z = s
      if( dabs(db) .ge. dabs(da) .and. c .ne. 0.0d0 ) z = 1.0d0/c
   20 da = r
      db = z
      return
      end
```

————-

— drotg example —

```
      program drotgEX
*     Tim Daly May 2, 2012
*     unit tests for BLAS drotg
      double precision a11,a12,a13,a21,a22,a23,a31,a32,a33
      double precision b11,b12,b13,b21,b22,b23,b31,b32,b33
      double precision c11,c12,c13,c21,c22,c23,c31,c32,c33
      double precision d11,d12,d13,d21,d22,d23,d31,d32,d33
      double precision e11,e12,e13,e21,e22,e23,e31,e32,e33
      double precision f11,f12,f13,f21,f22,f23,f31,f32,f33
      double precision a,b,c,s
      a11=6.0d0
      a12=5.0d0
      a13=0.0d0
      a21=5.0d0
      a22=1.0d0
      a23=4.0d0
      a31=0.0d0
      a32=4.0d0
      a33=3.0d0
      write(6,10)
      write(6,20)
      write(6,30)a11,a12,a13
      write(6,30)a21,a22,a23
      write(6,30)a31,a32,a33
      write(6,20)
 10   format("A=");
 20   format("  +-                      -+")
 30   format("  | ",f6.3," ",f6.3," ",f6.3,"  |")

      a=a11
      b=a21
      c=0.0d0
      s=0.0d0
      write(6,100)a,b,c,s
 100  format(/,"a=",f6.3," b=",f6.3," c=",f6.3," s=",f6.3);

      call drotg(a,b,c,s)
      write(6,100)a,b,c,s

      b11=c
      b12=s
      b13=0.0d0
      b21=-s
      b22=c
      b23=0.0d0
      b31=0.0d0
      b32=0.0d0
      b33=1.0d0
      write(6,11)
 11   format(/,"G1=")
```

```
      write(6,20)
      write(6,30)b11,b12,b13
      write(6,30)b21,b22,b23
      write(6,30)b31,b32,b33
      write(6,20)

      c11=b11*a11+b12*a21+b13*a31
      c21=b21*a11+b22*a21+b23*a31
      c31=b31*a11+b32*a21+b33*a31
      c12=b11*a12+b12*a22+b13*a32
      c22=b21*a12+b22*a22+b23*a32
      c32=b31*a12+b32*a22+b33*a32
      c13=b11*a13+b12*a23+b13*a33
      c23=b21*a13+b22*a23+b23*a33
      c33=b31*a13+b32*a23+b33*a33
      write(6,12)
12    format(/,"G1*A=")
      write(6,20)
      write(6,30)c11,c12,c13
      write(6,30)c21,c22,c23
      write(6,30)c31,c32,c33
      write(6,20)

      a=c22
      b=c32
      c=0.0d0
      s=0.0d0
      write(6,100)a,b,c,s

      call drotg(a,b,c,s)
      write(6,100)a,b,c,s

      d11=1.0d0
      d12=0.0d0
      d13=0.0d0
      d21=0.0d0
      d22=c
      d23=s
      d31=0.0d0
      d32=-s
      d33=c
      write(6,13)
13    format(/,"G2=")
      write(6,20)
      write(6,30)d11,d12,d13
      write(6,30)d21,d22,d23
      write(6,30)d31,d32,d33
      write(6,20)

      e11=d11*c11+d12*c21+d13*c31
```

```
      e21=d21*c11+d22*c21+d23*c31
      e31=d31*c11+d32*c21+d33*c31
      e12=d11*c12+d12*c22+d13*c32
      e22=d21*c12+d22*c22+d23*c32
      e32=d31*c12+d32*c22+d33*c32
      e13=d11*c13+d12*c23+d13*c33
      e23=d21*c13+d22*c23+d23*c33
      e33=d31*c13+d32*c23+d33*c33
      write(6,14)
 14   format(/,"G2*G1*A=")
      write(6,20)
      write(6,30)e11,e12,e13
      write(6,30)e21,e22,e23
      write(6,30)e31,e32,e33
      write(6,20)

      f11=b31*d13 + b21*d12 + b11*d11
      f12=b31*d23 + b21*d22 + b11*d21
      f13=b31*d33 + b21*d32 + b11*d31
      f21=b32*d13 + b22*d12 + b12*d11
      f22=b32*d23 + b22*d22 + b12*d21
      f23=b32*d33 + b22*d32 + b12*d31
      f31=b33*d13 + b23*d12 + b13*d11
      f32=b33*d23 + b23*d22 + b13*d21
      f33=b33*d33 + b23*d32 + b13*d31
      write(6,15)
 15   format(/,"Q=transpose(G1)*transpose(G2)")
      write(6,20)
      write(6,30)f11,f12,f13
      write(6,30)f21,f22,f23
      write(6,30)f31,f32,f33
      write(6,20)

      stop
      end
```

```
gcc -o drotgEX drotgEX.f -lgfortran drotg.o && ./drotgEX

A=
  +-                     -+
  |  6.000  5.000  0.000  |
  |  5.000  1.000  4.000  |
  |  0.000  4.000  3.000  |
  +-                     -+

a= 6.000 b= 5.000 c= 0.000 s= 0.000

a= 7.810 b= 0.640 c= 0.768 s= 0.640
```

```
G1=
  +-                     -+
  |  0.768  0.640  0.000  |
  | -0.640  0.768  0.000  |
  |  0.000  0.000  1.000  |
  +-                     -+

G1*A=
  +-                     -+
  |  7.810  4.481  2.561  |
  | -0.000 -2.433  3.073  |
  |  0.000  4.000  3.000  |
  +-                     -+

a=-2.433 b= 4.000 c= 0.000 s= 0.000

a= 4.682 b=-1.924 c=-0.520 s= 0.854

G2=
  +-                     -+
  |  1.000  0.000  0.000  |
  |  0.000 -0.520  0.854  |
  |  0.000 -0.854 -0.520  |
  +-                     -+

G2*G1*A=
  +-                     -+
  |  7.810  4.481  2.561  |
  |  0.000  4.682  0.966  |
  |  0.000  0.000 -4.184  |
  +-                     -+

Q=transpose(G1)*transpose(G2)
  +-                     -+
  |  0.768  0.333  0.547  |
  |  0.640 -0.399 -0.656  |
  |  0.000  0.854 -0.520  |
  +-                     -+
```

— BLAS 1 drotg —

```
(defun drotg (da db c s)
 ; Tim Daly May 2, 2012
 (declare (type (double-float) s c db da))
 (let ((roe 0.0d0) (scale 0.0d0) (r 0.0d0) (z 0.0d0))
  (declare (type (double-float) z r scale roe))
   (setf roe db)
```

```
   (when (> (the double-float (abs da)) (the double-float (abs db)))
    (setf roe da))
   (setf scale (+ (the double-float (abs da)) (the double-float (abs db))))
   (if (/= scale 0.0d0)
    (progn
     (setf r
      (the double-float (*
        scale
        (the double-float (sqrt
         (the double-float (+
          (the double-float (*
           (the double-float (/ da scale))
           (the double-float (/ da scale))))
          (the double-float (*
           (the double-float (/ db scale))
           (the double-float (/ db scale))))))))))
     (setf r (* (float-sign roe 1.0d0) r))
     (setf c (the double-float (/ da r)))
     (setf s (the double-float (/ db r)))
     (setf z 1.0d0)
     (when (> (the double-float (abs da)) (the double-float (abs db)))
       (setf z s))
     (if (and (>= (the double-float (abs db)) (the double-float (abs da)))
              (/= c 0.0))
       (setf z (the double-float (/ 1.0d0 c))))
     (make-array 4 :initial-contents (list r z c s)))
    (make-array 4 :initial-contents (list 0.0d0 0.0d0 1.0d0 0.0d0)))))
```

— BLAS 1 drotg lisp test —

```
(load "drotg.lisp")
(defun m (m i j) (svref (svref m (1- i)) (1- j)))
(defun matprint (mat)
  (format t "+-                        -+~%")
  (format t "|  ~6,3f ~6,3f ~6,3f  |~%" (m mat 1 1) (m mat 1 2) (m mat 1 3))
  (format t "|  ~6,3f ~6,3f ~6,3f  |~%" (m mat 2 1) (m mat 2 2) (m mat 2 3))
  (format t "|  ~6,3f ~6,3f ~6,3f  |~%" (m mat 3 1) (m mat 3 2) (m mat 3 3))
  (format t "+-                        -+~%"))
(defun matmult (a b)
 (vector
  (vector (+ (* (m a 1 1) (m b 1 1))
             (* (m a 1 2) (m b 2 1))
             (* (m a 1 3) (m b 3 1)))
          (+ (* (m a 1 1) (m b 1 2))
             (* (m a 1 2) (m b 2 2))
             (* (m a 1 3) (m b 3 2)))
```

```
          (+ (* (m a 1 1) (m b 1 3))
             (* (m a 1 2) (m b 2 3))
             (* (m a 1 3) (m b 3 3))))
  (vector (+ (* (m a 2 1) (m b 1 1))
             (* (m a 2 2) (m b 2 1))
             (* (m a 2 3) (m b 3 1)))
          (+ (* (m a 2 1) (m b 1 2))
             (* (m a 2 2) (m b 2 2))
             (* (m a 2 3) (m b 3 2)))
          (+ (* (m a 2 1) (m b 1 3))
             (* (m a 2 2) (m b 2 3))
             (* (m a 2 3) (m b 3 3))))
  (vector (+ (* (m a 3 1) (m b 1 1))
             (* (m a 3 2) (m b 2 1))
             (* (m a 3 3) (m b 3 1)))
          (+ (* (m a 3 1) (m b 1 2))
             (* (m a 3 2) (m b 2 2))
             (* (m a 3 3) (m b 3 2)))
          (+ (* (m a 3 1) (m b 1 3))
             (* (m a 3 2) (m b 2 3))
             (* (m a 3 3) (m b 3 3))))))
(defun transpose (mat)
 (vector (vector (m mat 1 1) (m mat 1 2) (m mat 1 3))
         (vector (m mat 2 1) (m mat 2 2) (m mat 2 3))
         (vector (m mat 3 1) (m mat 3 2) (m mat 3 3))))
(setq a #(#(6.0d0 5.0d0 0.0d0)
          #(5.0d0 1.0d0 4.0d0)
          #(0.0d0 4.0d0 3.0d0)))
(multiple-value-setq (x y c s) (drotg (m a 1 1) (m a 2 1) 0.0d0 0.0d0))
(list x y c s)
(setq g1 (vector (vector c         s 0.0d0)
                 (vector (- s)     c 0.0d0)
                 (vector 0.0d0 0.0d0 1.0d0)))
(matprint (setq g1a (matmult g1 a)))
(multiple-value-setq (xx yy cc ss) (drotg (m g1a 2 2) (m g1a 3 2) 0.0d0 0.0d0))
(list xx yy cc ss)
(matprint (setq g2 (vector (vector 1.0d0 0.0d0 0.0d0) (vector 0.0d0 cc ss) (vector 0.0d0 (- ss) cc))))
(matprint (setq g2 (matmult g1 a)))
```

———-

3.9 drot BLAS

— drot.input —

```
)set break resume
```

```
)sys rm -f drot.output
)spool drot.output
)set message test on
)set message auto off
)clear all

--S 1 of 17
dx:PRIMARR(DFLOAT):=[[6,0, 1.0, 4.0, -1.0, -1.0]]
--R
--R   (1)  [6.,0.,1.,4.,- 1.,- 1.]
--R                                              Type: PrimitiveArray(DoubleFloat)
--E 1

--S 2 of 17
dy:PRIMARR(DFLOAT):=[[5.0, 1.0, -4.0, 4.0, -4.0]]
--R
--R   (2)  [5.,1.,- 4.,4.,- 4.]
--R                                              Type: PrimitiveArray(DoubleFloat)
--E 2

--S 3 of 17
drot(5,dx,1,dy,1,0.707106781,0.707106781) -- rotate by 45 degrees
--R
--R   (3)
--R   [
--R     [7.778174591, 0.70710678100000002, - 2.1213203429999998,
--R      5.6568542480000001, - 3.5355339050000003, - 1.]
--R     ,
--R
--R     [- 0.70710678100000002, 0.70710678100000002, - 3.5355339050000003, 0.,
--R      - 2.1213203429999998]
--R     ]
--R                                        Type: List(PrimitiveArray(DoubleFloat))
--E 3

--S 4 of 17
[dx,dy] -- note that the input arguments, dx and dy were modified
--R
--R   (4)
--R   [
--R     [7.778174591, 0.70710678100000002, - 2.1213203429999998,
--R      5.6568542480000001, - 3.5355339050000003, - 1.]
--R     ,
--R
--R     [- 0.70710678100000002, 0.70710678100000002, - 3.5355339050000003, 0.,
--R      - 2.1213203429999998]
--R     ]
--R                                        Type: List(PrimitiveArray(DoubleFloat))
--E 4
```

```
--S 5 of 17
drot(5,dx,1,dy,1,0.707106781,-0.707106781) -- rotate by -45 degrees
--R
--R   (5)
--R   [
--R     [5.9999999968341839, 7.8496237287950521E-17, 0.99999999947236384,
--R      3.9999999978894558, - 0.99999999947236451, - 1.]
--R     ,
--R
--R     [4.9999999973618188, 0.99999999947236384, - 3.9999999978894558,
--R      3.9999999978894554, - 3.9999999978894554]
--R     ]
--R                                      Type: List(PrimitiveArray(DoubleFloat))
--E 5

--S 6 of 17
[dx,dy] -- note that the input arguments, dx and dy were modified
--R
--R   (6)
--R   [
--R     [5.9999999968341839, 7.8496237287950521E-17, 0.99999999947236384,
--R      3.9999999978894558, - 0.99999999947236451, - 1.]
--R     ,
--R
--R     [4.9999999973618188, 0.99999999947236384, - 3.9999999978894558,
--R      3.9999999978894554, - 3.9999999978894554]
--R     ]
--R                                      Type: List(PrimitiveArray(DoubleFloat))
--E 6

--S 7 of 17
dx:PRIMARR(DFLOAT):=[[6,0, 1.0, 4.0, -1.0, -1.0]]
--R
--R   (7)  [6.,0.,1.,4.,- 1.,- 1.]
--R                                            Type: PrimitiveArray(DoubleFloat)
--E 7

--S 8 of 17
dy:PRIMARR(DFLOAT):=[[5.0, 1.0, -4.0, 4.0, -4.0]]
--R
--R   (8)  [5.,1.,- 4.,4.,- 4.]
--R                                            Type: PrimitiveArray(DoubleFloat)
--E 8

--S 9 of 17
drot(5,dx,1,dy,1,0.707106781,0.707106781) -- rotate by 45 degrees
--R
--R   (9)
--R   [
--R     [7.778174591, 0.70710678100000002, - 2.1213203429999998,
```

```
--R      5.6568542480000001, - 3.5355339050000003, - 1.]
--R     ,
--R
--R     [- 0.70710678100000002, 0.70710678100000002, - 3.5355339050000003, 0.,
--R      - 2.1213203429999998]
--R     ]
--R                                        Type: List(PrimitiveArray(DoubleFloat))
--E 9

--S 10 of 17
drot(5,dx,1,dy,1,0.707106781,0.707106781) -- rotate to 90 degrees
--R
--R   (10)
--R   [
--R     [4.9999999973618197, 0.99999999947236395, - 3.9999999978894558,
--R      3.9999999978894558, - 3.9999999978894558, - 1.]
--R     ,
--R
--R     [- 5.9999999968341839, 0., - 0.99999999947236429, - 3.9999999978894558,
--R      0.99999999947236429]
--R     ]
--R                                        Type: List(PrimitiveArray(DoubleFloat))
--E 10

--S 11 of 17
drot(5,dx,1,dy,1,0.707106781,0.707106781) -- rotate to 135 degrees
--R
--R   (11)
--R   [
--R     [- 0.70710678062690524, 0.70710678062690502, - 3.535533903134525, 0.,
--R      - 2.1213203418807147, - 1.]
--R     ,
--R
--R     [- 7.7781745868959549, - 0.70710678062690502, 2.1213203418807147,
--R      - 5.6568542450152401, 3.535533903134525]
--R     ]
--R                                        Type: List(PrimitiveArray(DoubleFloat))
--E 11

--S 12 of 17
drot(5,dx,1,dy,1,0.707106781,0.707106781) -- rotate to 180 degrees
--R
--R   (12)
--R   [
--R     [- 5.9999999936683679, 0., - 0.99999999894472813, - 3.9999999957789121,
--R      0.99999999894472813, - 1.]
--R     ,
--R
--R     [- 4.9999999947236393, - 0.99999999894472802, 3.9999999957789116,
--R      - 3.9999999957789121, 3.9999999957789116]
```

```
--R     ]
--R                                        Type: List(PrimitiveArray(DoubleFloat))
--E 12

--S 13 of 17
drot(5,dx,1,dy,1,0.707106781,0.707106781) -- rotate to 225 degrees
--R
--R   (13)
--R   [
--R     [- 7.7781745827919098, - 0.70710678025381002, 2.1213203407614296,
--R      - 5.6568542420304802, 3.5355339012690501, - 1.]
--R     ,
--R
--R     [0.70710678025381046, - 0.70710678025381002, 3.5355339012690501, 0.,
--R      2.1213203407614296]
--R     ]
--R                                        Type: List(PrimitiveArray(DoubleFloat))
--E 13

--S 14 of 17
drot(5,dx,1,dy,1,0.707106781,0.707106781) -- rotate to 270 degrees
--R
--R   (14)
--R   [
--R     [- 4.999999992085459, - 0.99999999841709197, 3.9999999936683674,
--R      - 3.9999999936683679, 3.9999999936683674, - 1.]
--R     ,
--R
--R     [5.9999999905025518, 0., 0.99999999841709231, 3.9999999936683679,
--R      - 0.99999999841709231]
--R     ]
--R                                        Type: List(PrimitiveArray(DoubleFloat))
--E 14

--S 15 of 17
drot(5,dx,1,dy,1,0.707106781,0.707106781) -- rotate to 315 degrees
--R
--R   (15)
--R   [
--R     [0.70710677988071569, - 0.70710677988071502, 3.5355338994035752, 0.,
--R      2.1213203396421445, - 1.]
--R     ,
--R
--R     [7.7781745786878647, 0.70710677988071502, - 2.1213203396421445,
--R      5.6568542390457202, - 3.5355338994035752]
--R     ]
--R                                        Type: List(PrimitiveArray(DoubleFloat))
--E 15

--S 16 of 17
```

```
drot(5,dx,1,dy,1,0.707106781,0.707106781) -- rotate to 360 degrees
--R
--R   (16)
--R   [
--R     [5.9999999873367358, 0., 0.99999999788945637, 3.9999999915578237,
--R      - 0.99999999788945637, - 1.]
--R     ,
--R
--R     [4.9999999894472786, 0.99999999788945593, - 3.9999999915578233,
--R      3.9999999915578237, - 3.9999999915578233]
--R     ]
--R                                        Type: List(PrimitiveArray(DoubleFloat))
--E 16

--S 17 of 17
[dx,dy] -- note that the input arguments, dx and dy were modified
--R
--R   (17)
--R   [
--R     [5.9999999873367358, 0., 0.99999999788945637, 3.9999999915578237,
--R      - 0.99999999788945637, - 1.]
--R     ,
--R
--R     [4.9999999894472786, 0.99999999788945593, - 3.9999999915578233,
--R      3.9999999915578237, - 3.9999999915578233]
--R     ]
--R                                        Type: List(PrimitiveArray(DoubleFloat))
--E 17

)spool
)lisp (bye)
```

———-

— drot.help —

```
========================================================================
drot examples
========================================================================

We set up two arrays of doublefloats, dx and dy

dx:PRIMARR(DFLOAT):=[[6,0, 1.0, 4.0, -1.0, -1.0]]

     [6.,0.,1.,4.,- 1.,- 1.]

dy:PRIMARR(DFLOAT):=[[5.0, 1.0, -4.0, 4.0, -4.0]]

     [5.,1.,- 4.,4.,- 4.]
```

```
We rotate them by 45 degrees where
   cos(45) = 0.707106781
   sin(45) = 0.707106781

drot(5,dx,1,dy,1,0.707106781,0.707106781) -- rotate by 45 degrees

   [ [7.778174591, 0.70710678100000002, - 2.1213203429999998,
      5.6568542480000001, - 3.5355339050000003, - 1.],

     [- 0.70710678100000002, 0.70710678100000002, - 3.5355339050000003, 0.,
      - 2.1213203429999998] ]

NOTE that the input arguments, dx and dy were modified, per BLAS spec.

[dx,dy]

   [ [7.778174591, 0.70710678100000002, - 2.1213203429999998,
      5.6568542480000001, - 3.5355339050000003, - 1.],

     [- 0.70710678100000002, 0.70710678100000002, - 3.5355339050000003, 0.,
      - 2.1213203429999998] ]

We rotate them by -45 degrees where
   cos(-45) =  0.707106781
   sin(-45) = -0.707106781

drot(5,dx,1,dy,1,0.707106781,-0.707106781) -- rotate by -45 degrees

   [ [5.9999999968341839, 7.8496237287950521E-17, 0.99999999947236384,
      3.9999999978894558, - 0.99999999947236451, - 1.],

     [4.9999999973618188, 0.99999999947236384, - 3.9999999978894558,
      3.9999999978894554, - 3.9999999978894554] ]


======================================================================
Man Page Details
======================================================================

NAME
       DROT - BLAS level one, plane rotation subroutines

SYNOPSIS
       SUBROUTINE DROT    ( n, x, incx, y, incy, c, s )

           INTEGER          n, incx, incy

           DOUBLE PRECISION x, y, c, s
```

```
DESCRIPTION
       DROT   applies  a  plane  rotation matrix to a real sequence of ordered
       pairs:

            (x , y ), for all i = 1, 2, ..., n.
              i   i

ARGUMENTS
       n       INTEGER. (input)
               Number of ordered pairs (planar points in DROT) to be  rotated.
               If n <= 0, this routine returns without computation.

       x       DOUBLE PRECISION, (input and output)
               Array  of dimension (n-1) * |incx| + 1.  On input, array x con-
               tains the x-coordinate of each planar point to be rotated.   On
               output,  array x contains the x-coordinate of each rotated pla-
               nar point.

       incx    INTEGER. (input)
               Increment between elements of x.  If incx = 0, the results will
               be unpredictable.

       y       DOUBLE PRECISION, (input and output)
               array of dimension (n-1) * |incy| + 1.
               On  input,  array  y  contains  the y-coordinate of each planar
               point to be rotated.  On output, array y contains the y-coordi-
               nate of each rotated planar point.

       incy    INTEGER. (input)
               Increment between elements of y.  If incy = 0, the results will
               be unpredictable.

       c       DOUBLE PRECISION, Cosine of the angle of rotation.
               (input)

       s       DOUBLE PRECISION, Sine of the angle of rotation. (input)

NOTES
       This routine applies the following plane rotation to each pair
       of elements (x , y):
                              i   i
            _      _       _      _     _      _
           | x(i) |  <--  | c  s |  .  | x(i) |
           | y(i) |       |-s  c |     | y(i) |
           -      -       -      -     -      -

            for i = 1,...,n
                                        2    2
       If coefficients c and s satisfy c  + s  = 1.0, the rotation matrix
```

```
       is orthogonal, and the transformation is called a Givens plane
       rotation. If c = 1 and s = 0, DROT returns without modifying any
       input parameters.

       To calculate the Givens coefficients c and s from a two-element
       vector to determine the angle of rotation, use SROTG(3S).

       When working backward (incx < 0 or incy < 0), each routine starts
       at the end of the vector and moves backward, as follows:

            x(1-incx * (n-1)), x(1-incx * (n-2)), ..., x(1)

            y(1-incy * (n-1)), y(1-incy * (n-2)), ..., y(1)
```

———-

— **drot.f** —

```
      subroutine  drot (n,dx,incx,dy,incy,c,s)
c
c     applies a plane rotation.
c     jack dongarra, linpack, 3/11/78.
c     modified 12/3/93, array(1) declarations changed to array(*)
c
      double precision dx(*),dy(*),dtemp,c,s
      integer i,incx,incy,ix,iy,n
c
      if(n.le.0)return
      if(incx.eq.1.and.incy.eq.1)go to 20
c
c       code for unequal increments or equal increments not equal
c         to 1
c
      ix = 1
      iy = 1
      if(incx.lt.0)ix = (-n+1)*incx + 1
      if(incy.lt.0)iy = (-n+1)*incy + 1
      do 10 i = 1,n
        dtemp = c*dx(ix) + s*dy(iy)
        dy(iy) = c*dy(iy) - s*dx(ix)
        dx(ix) = dtemp
        ix = ix + incx
        iy = iy + incy
   10 continue
      return
c
c       code for both increments equal to 1
c
```

```
   20 do 30 i = 1,n
        dtemp = c*dx(i) + s*dy(i)
        dy(i) = c*dy(i) - s*dx(i)
        dx(i) = dtemp
   30 continue
      return
      end
```

— drotg example —

```
       program drotEX
*      Tim Daly May 4, 2012
*      unit tests for BLAS drot
       double precision dx(5),dy(5)
       double precision c,s

       write(6,1)
 1     format(/,"rotate by 45, -45")
       dx= (/ 6.0d0, 1.0d0,  4.0d0, 1.0d0, -1.0d0 /)
       dy= (/ 5.0d0, 1.0d0, -4.0d0, 4.0d0, -4.0d0 /)
       write(6,10)dx(1),dy(1)
 10    format(/,"dx(1)=",f6.3," dy(1)=",f6.3)
       write(6,20)dx(2),dy(2)
 20    format("dx(2)=",f6.3," dy(2)=",f6.3)
       write(6,30)dx(3),dy(3)
 30    format("dx(3)=",f6.3," dy(2)=",f6.3)
       write(6,40)dx(4),dy(4)
 40    format("dx(4)=",f6.3," dy(4)=",f6.3)
       write(6,50)dx(5),dy(5)
 50    format("dx(5)=",f6.3," dy(5)=",f6.3)
       call drot(5,dx,1,dy,1,0.707106781d0,0.707106781d0)
       write(6,10)dx(1),dy(1)
       write(6,20)dx(2),dy(2)
       write(6,30)dx(3),dy(3)
       write(6,40)dx(4),dy(4)
       write(6,50)dx(5),dy(5)
       call drot(5,dx,1,dy,1,0.707106781d0,-0.707106781d0)
       write(6,10)dx(1),dy(1)
       write(6,20)dx(2),dy(2)
       write(6,30)dx(3),dy(3)
       write(6,40)dx(4),dy(4)
       write(6,50)dx(5),dy(5)

       write(6,2)
 2     format(/,"rotate by 45, -45, only some members")
       dx= (/ 6.0d0, 1.0d0,  4.0d0, 1.0d0, -1.0d0 /)
```

```
      dy= (/ 5.0d0, 1.0d0, -4.0d0, 4.0d0, -4.0d0 /)
      write(6,10)dx(1),dy(1)
      write(6,20)dx(2),dy(2)
      write(6,30)dx(3),dy(3)
      write(6,40)dx(4),dy(4)
      write(6,50)dx(5),dy(5)
      call drot(3,dx,2,dy,2,0.707106781d0,0.707106781d0)
      write(6,10)dx(1),dy(1)
      write(6,20)dx(2),dy(2)
      write(6,30)dx(3),dy(3)
      write(6,40)dx(4),dy(4)
      write(6,50)dx(5),dy(5)
      call drot(3,dx,2,dy,2,0.707106781d0,-0.707106781d0)
      write(6,10)dx(1),dy(1)
      write(6,20)dx(2),dy(2)
      write(6,30)dx(3),dy(3)
      write(6,40)dx(4),dy(4)
      write(6,50)dx(5),dy(5)

      write(6,3)
3     format(/,"rotate by 360")
      dx= (/ 6.0d0, 1.0d0,  4.0d0, 1.0d0, -1.0d0 /)
      dy= (/ 5.0d0, 1.0d0, -4.0d0, 4.0d0, -4.0d0 /)
      write(6,10)dx(1),dy(1)
      write(6,20)dx(2),dy(2)
      write(6,30)dx(3),dy(3)
      write(6,40)dx(4),dy(4)
      write(6,50)dx(5),dy(5)
      call drot(5,dx,1,dy,1,0.707106781d0,0.707106781d0)
      write(6,10)dx(1),dy(1)
      write(6,20)dx(2),dy(2)
      write(6,30)dx(3),dy(3)
      write(6,40)dx(4),dy(4)
      write(6,50)dx(5),dy(5)
      call drot(5,dx,1,dy,1,0.707106781d0,0.707106781d0)
      write(6,10)dx(1),dy(1)
      write(6,20)dx(2),dy(2)
      write(6,30)dx(3),dy(3)
      write(6,40)dx(4),dy(4)
      write(6,50)dx(5),dy(5)
      call drot(5,dx,1,dy,1,0.707106781d0,0.707106781d0)
      write(6,10)dx(1),dy(1)
      write(6,20)dx(2),dy(2)
      write(6,30)dx(3),dy(3)
      write(6,40)dx(4),dy(4)
      write(6,50)dx(5),dy(5)
      call drot(5,dx,1,dy,1,0.707106781d0,0.707106781d0)
      write(6,10)dx(1),dy(1)
      write(6,20)dx(2),dy(2)
      write(6,30)dx(3),dy(3)
```

```
      write(6,40)dx(4),dy(4)
      write(6,50)dx(5),dy(5)
      call drot(5,dx,1,dy,1,0.707106781d0,0.707106781d0)
      write(6,10)dx(1),dy(1)
      write(6,20)dx(2),dy(2)
      write(6,30)dx(3),dy(3)
      write(6,40)dx(4),dy(4)
      write(6,50)dx(5),dy(5)
      call drot(5,dx,1,dy,1,0.707106781d0,0.707106781d0)
      write(6,10)dx(1),dy(1)
      write(6,20)dx(2),dy(2)
      write(6,30)dx(3),dy(3)
      write(6,40)dx(4),dy(4)
      write(6,50)dx(5),dy(5)
      call drot(5,dx,1,dy,1,0.707106781d0,0.707106781d0)
      write(6,10)dx(1),dy(1)
      write(6,20)dx(2),dy(2)
      write(6,30)dx(3),dy(3)
      write(6,40)dx(4),dy(4)
      write(6,50)dx(5),dy(5)
      call drot(5,dx,1,dy,1,0.707106781d0,0.707106781d0)
      write(6,10)dx(1),dy(1)
      write(6,20)dx(2),dy(2)
      write(6,30)dx(3),dy(3)
      write(6,40)dx(4),dy(4)
      write(6,50)dx(5),dy(5)

      write(6,4)
 4    format(/,"rotate by 45, from end")
      dx= (/ 6.0d0, 1.0d0,  4.0d0, 1.0d0, -1.0d0 /)
      dy= (/ 5.0d0, 1.0d0, -4.0d0, 4.0d0, -4.0d0 /)
      write(6,10)dx(1),dy(1)
      write(6,20)dx(2),dy(2)
      write(6,30)dx(3),dy(3)
      write(6,40)dx(4),dy(4)
      write(6,50)dx(5),dy(5)
      call drot(2,dx,-1,dy,-1,0.707106781d0,0.707106781d0)
      write(6,10)dx(1),dy(1)
      write(6,20)dx(2),dy(2)
      write(6,30)dx(3),dy(3)
      write(6,40)dx(4),dy(4)
      write(6,50)dx(5),dy(5)
      stop
      end
```

```
gcc -o drotEX drotEX.f -lgfortran drot.o && ./drotEX

rotate by 45, -45
```

```
dx(1)= 6.000 dy(1)= 5.000
dx(2)= 1.000 dy(2)= 1.000
dx(3)= 4.000 dy(2)=-4.000
dx(4)=-1.000 dy(4)= 4.000
dx(5)=-1.000 dy(5)=-4.000

dx(1)= 7.778 dy(1)=-0.707
dx(2)= 1.414 dy(2)= 0.000
dx(3)= 0.000 dy(2)=-5.657
dx(4)= 2.121 dy(4)= 3.536
dx(5)=-3.536 dy(5)=-2.121

dx(1)= 6.000 dy(1)= 5.000
dx(2)= 1.000 dy(2)= 1.000
dx(3)= 4.000 dy(2)=-4.000
dx(4)=-1.000 dy(4)= 4.000
dx(5)=-1.000 dy(5)=-4.000

rotate by 45, -45, only some members

dx(1)= 6.000 dy(1)= 5.000
dx(2)= 1.000 dy(2)= 1.000
dx(3)= 4.000 dy(2)=-4.000
dx(4)=-1.000 dy(4)= 4.000
dx(5)=-1.000 dy(5)=-4.000

dx(1)= 7.778 dy(1)=-0.707
dx(2)= 1.000 dy(2)= 1.000
dx(3)= 0.000 dy(2)=-5.657
dx(4)=-1.000 dy(4)= 4.000
dx(5)=-3.536 dy(5)=-2.121

dx(1)= 6.000 dy(1)= 5.000
dx(2)= 1.000 dy(2)= 1.000
dx(3)= 4.000 dy(2)=-4.000
dx(4)=-1.000 dy(4)= 4.000
dx(5)=-1.000 dy(5)=-4.000

rotate by 360

dx(1)= 6.000 dy(1)= 5.000
dx(2)= 1.000 dy(2)= 1.000
dx(3)= 4.000 dy(2)=-4.000
dx(4)=-1.000 dy(4)= 4.000
dx(5)=-1.000 dy(5)=-4.000

dx(1)= 7.778 dy(1)=-0.707
dx(2)= 1.414 dy(2)= 0.000
dx(3)= 0.000 dy(2)=-5.657
```

```
dx(4)= 2.121 dy(4)= 3.536
dx(5)=-3.536 dy(5)=-2.121

dx(1)= 5.000 dy(1)=-6.000
dx(2)= 1.000 dy(2)=-1.000
dx(3)=-4.000 dy(2)=-4.000
dx(4)= 4.000 dy(4)= 1.000
dx(5)=-4.000 dy(5)= 1.000

dx(1)=-0.707 dy(1)=-7.778
dx(2)= 0.000 dy(2)=-1.414
dx(3)=-5.657 dy(2)= 0.000
dx(4)= 3.536 dy(4)=-2.121
dx(5)=-2.121 dy(5)= 3.536

dx(1)=-6.000 dy(1)=-5.000
dx(2)=-1.000 dy(2)=-1.000
dx(3)=-4.000 dy(2)= 4.000
dx(4)= 1.000 dy(4)=-4.000
dx(5)= 1.000 dy(5)= 4.000

dx(1)=-7.778 dy(1)= 0.707
dx(2)=-1.414 dy(2)= 0.000
dx(3)= 0.000 dy(2)= 5.657
dx(4)=-2.121 dy(4)=-3.536
dx(5)= 3.536 dy(5)= 2.121

dx(1)=-5.000 dy(1)= 6.000
dx(2)=-1.000 dy(2)= 1.000
dx(3)= 4.000 dy(2)= 4.000
dx(4)=-4.000 dy(4)=-1.000
dx(5)= 4.000 dy(5)=-1.000

dx(1)= 0.707 dy(1)= 7.778
dx(2)= 0.000 dy(2)= 1.414
dx(3)= 5.657 dy(2)= 0.000
dx(4)=-3.536 dy(4)= 2.121
dx(5)= 2.121 dy(5)=-3.536

dx(1)= 6.000 dy(1)= 5.000
dx(2)= 1.000 dy(2)= 1.000
dx(3)= 4.000 dy(2)=-4.000
dx(4)=-1.000 dy(4)= 4.000
dx(5)=-1.000 dy(5)=-4.000

rotate by 45, from end

dx(1)= 6.000 dy(1)= 5.000
dx(2)= 1.000 dy(2)= 1.000
dx(3)= 4.000 dy(2)=-4.000
```

```
dx(4)=-1.000 dy(4)= 4.000
dx(5)=-1.000 dy(5)=-4.000

dx(1)= 7.778 dy(1)=-0.707
dx(2)= 1.414 dy(2)= 0.000
dx(3)= 4.000 dy(2)=-4.000
dx(4)=-1.000 dy(4)= 4.000
dx(5)=-1.000 dy(5)=-4.000
```

— BLAS 1 drot —

```
(defun drot (n dx incx dy incy c s)
; Tim Daly May 4, 2012
 (declare (type (double-float) c s)
          (type (simple-array double-float (*)) dx dy)
          (type fixnum incy incx n))
 (let ((dtemp 0.0d0) (ix 0) (iy 0))
  (declare (type (double-float) dtemp) (type fixnum iy ix))
  (when (> n 0)
    (if (< incx 0)
     (setf ix (the fixnum (* (the fixnum (1+ (the fixnum (- n)))) incx))))
    (if (< incy 0)
     (setf iy (the fixnum (* (the fixnum (1+ (the fixnum (- n)))) incy))))
    (dotimes (i n)
     (setf dtemp (the double-float
      (+ (the double-float (* c (the double-float (svref dx ix))))
         (the double-float (* s (the double-float (svref dy iy)))))))
     (setf (the double-float (svref dy iy)) (the double-float
      (- (* c (the double-float (svref dy iy)))
         (* s (the double-float (svref dx ix))))))
     (setf (the double-float (svref dx ix)) (the double-float dtemp))
     (setf ix (the fixnum (+ ix incx)))
     (setf iy (the fixnum (+ iy incy)))))
  (list dx dy)))
```

———-

— BLAS 1 drot lisp test —

```
(load "drot.lisp")
; rotate by 45, -45
(setq dx (vector 6.0d0 1.0d0 4.0d0 -1.0d0 -1.0d0))
; #(6.0 1.0 4.0 -1.0 -1.0)

(setq dy (vector 5.0d0 1.0d0 -4.0d0 4.0d0 -4.0d0))
```

```
; #(5.0 1.0 -4.0 4.0 -4.0)

(drot 5 dx 1 dy 1 0.707106781d0 0.707106781d0)
; (#(7.778174591 1.414213562 0.0 2.1213203429999998 -3.5355339050000003)
;  #(-0.70710678099999935 0.0 -5.6568542480000001 3.5355339050000003
;   -2.1213203429999998))

(drot 5 dx 1 dy 1 0.707106781d0 -0.707106781d0)
; (#(5.9999999968341831 0.99999999947236395 3.9999999978894558
;    -0.99999999947236451 -0.99999999947236451)
;  #(4.9999999973618197 0.99999999947236395 -3.9999999978894558
;    3.9999999978894563 -3.9999999978894563))

; rotate by 45, -45, only some members

(setq dx (vector 6.0d0 1.0d0 4.0d0 -1.0d0 -1.0d0))
; #(6.0 1.0 4.0 -1.0 -1.0)

(setq dy (vector 5.0d0 1.0d0 -4.0d0 4.0d0 -4.0d0))
; #(5.0 1.0 -4.0 4.0 -4.0)

(drot 3 dx 2 dy 2 0.707106781d0 0.707106781d0)
; (#(7.778174591 1.0 0.0 -1.0 -3.5355339050000003)
;  #(-0.70710678099999935 1.0 -5.6568542480000001 4.0 -2.1213203429999998))

(drot 3 dx 2 dy 2 0.707106781d0 -0.707106781d0)
; (#(5.9999999968341831 1.0 3.9999999978894558 -1.0 -0.99999999947236451)
;  #(4.9999999973618197 1.0 -3.9999999978894558 4.0 -3.9999999978894563))

; rotate by 360

(setq dx (vector 6.0d0 1.0d0 4.0d0 -1.0d0 -1.0d0))
; #(6.0 1.0 4.0 -1.0 -1.0)

(setq dy (vector 5.0d0 1.0d0 -4.0d0 4.0d0 -4.0d0))
; #(5.0 1.0 -4.0 4.0 -4.0)

(drot 5 dx 1 dy 1 0.707106781d0 0.707106781d0)
; (#(7.778174591 1.414213562 0.0 2.1213203429999998 -3.5355339050000003)
;  #(-0.70710678099999935 0.0 -5.6568542480000001 3.5355339050000003
;    -2.1213203429999998))

(drot 5 dx 1 dy 1 0.707106781d0 0.707106781d0)
; (#(4.9999999973618197 0.99999999947236395 -3.9999999978894558
;    3.9999999978894563 -3.9999999978894563)
;  #(-5.9999999968341831 -0.99999999947236395 -3.9999999978894558
;    0.99999999947236451 0.99999999947236451))

(drot 5 dx 1 dy 1 0.707106781d0 0.707106781d0)
; (#(-0.70710678062690446 0.0 -5.6568542450152401 3.5355339031345254
```

```
;    -2.1213203418807147)
;  #(-7.778174586895954 -1.41421356125381 0.0 -2.1213203418807147
;    3.5355339031345254))

(drot 5 dx 1 dy 1 0.707106781d0 0.707106781d0)
; (#(-5.9999999936683661 -0.99999999894472802 -3.9999999957789121
;    0.99999999894472835 0.99999999894472835)
;  #(-4.9999999947236393 -0.99999999894472802 3.9999999957789121
;    -3.9999999957789116 3.9999999957789116))

(drot 5 dx 1 dy 1 0.707106781d0 0.707106781d0)
; (#(-7.7781745827919089 -1.41421356050762 0.0 -2.1213203407614296
;    3.5355339012690505)
;  #(0.70710678025380957 0.0 5.6568542420304802 -3.5355339012690505
;    2.1213203407614296))

(drot 5 dx 1 dy 1 0.707106781d0 0.707106781d0)
; (#(-4.999999992085459 -0.99999999841709197 3.9999999936683679
;    -3.9999999936683679 3.9999999936683679)
;  #(5.999999990502551 0.99999999841709197 3.9999999936683679
;   -0.99999999841709286 -0.99999999841709286))

(drot 5 dx 1 dy 1 0.707106781d0 0.707106781d0)
; (#(0.70710677988071557 0.0 5.6568542390457202 -3.5355338994035757
;    2.1213203396421445)
;  #(7.7781745786878638 1.41421355976143 0.0 2.1213203396421445
;    -3.5355338994035757))

(drot 5 dx 1 dy 1 0.707106781d0 0.707106781d0)
; (#(5.9999999873367349 0.99999999788945593 3.9999999915578237
;    -0.9999999978894567 -0.9999999978894567)
;  #(4.9999999894472777 0.99999999788945593 -3.9999999915578237
;    3.9999999915578237 -3.9999999915578237))

; rotate by 45, -45 from end

(setq dx (vector 6.0d0 1.0d0 4.0d0 -1.0d0 -1.0d0))
; #(6.0 1.0 4.0 -1.0 -1.0)

(setq dy (vector 5.0d0 1.0d0 -4.0d0 4.0d0 -4.0d0))
; #(5.0 1.0 -4.0 4.0 -4.0)

(drot 2 dx -1 dy -1 0.707106781d0 0.707106781d0)
; (#(7.778174591 1.414213562 4.0 -1.0 -1.0)
;  #(-0.70710678099999935 0.0 -4.0 4.0 -4.0))
```

———-

3.10 dscal BLAS

— dscal.input —

```
)set break resume
)sys rm -f dscal.output
)spool dscal.output
)set message test on
)set message auto off
)clear all

--S 1 of 6
dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0, 5.0, 6.0]]
--R
--R   (1)  [1.,2.,3.,4.,5.,6.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 1

--S 2 of 6
dscal(6,2.0,dx,1)
--R
--R   (2)  [2.,4.,6.,8.,10.,12.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 2

--S 3 of 6
dx
--R
--R   (3)  [2.,4.,6.,8.,10.,12.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 3

--S 4 of 6
dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0, 5.0, 6.0]]
--R
--R   (4)  [1.,2.,3.,4.,5.,6.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 4

--S 5 of 6
dscal(3,0.5,dx,1)
--R
--R   (5)  [0.5,1.,1.5,4.,5.,6.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 5

--S 6 of 6
dx
```

```
--R
--R   (6)  [0.5,1.,1.5,4.,5.,6.]
--R                                                Type: PrimitiveArray(DoubleFloat)
--E 6


)spool
)lisp (bye)
```

———-

— dscal.help —

```
========================================================================
dscal examples
========================================================================

Given an initial array

dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0, 5.0, 6.0]]

   [1.,2.,3.,4.,5.,6.]

scale each element by 2.0

dscal(6,2.0,dx,1)

   [2.,4.,6.,8.,10.,12.]

Note that this changes the initial array in place.

dx

   [2.,4.,6.,8.,10.,12.]

Given the initial array

dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0, 5.0, 6.0]]

   [1.,2.,3.,4.,5.,6.]

scale each element by 0.5

dscal(6,0.5,dx,1)

    [0.5,1.,1.5,2.,2.5,3.]

Given the initial array
```

```
dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0, 5.0, 6.0]]

   [1.,2.,3.,4.,5.,6.]

scale the first three elements by 0.5

dscal(3,0.5,dx,1)

   [0.5,1.,1.5,4.,5.,6.]

Given the initial array

dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0, 5.0, 6.0]]

   [1.,2.,3.,4.,5.,6.]

dscal will do nothing with a negative count

dscal(-3,0.5,dx,1)

   [1.,2.,3.,4.,5.,6.]

Given the initial array

dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0, 5.0, 6.0]]

   [1.,2.,3.,4.,5.,6.]

dscal will do nothing with a negative increment

dscal(3,0.5,dx,-1)

   [1.,2.,3.,4.,5.,6.]


======================================================================
Man Page Details
======================================================================

NAME
       DSCAL - BLAS level one, scales a double precision vector

SYNOPSIS
       SUBROUTINE DSCAL    ( n, alpha, x, incx )

           INTEGER           n, incx

           DOUBLE PRECISION  alpha, x
```

```
DESCRIPTION
       DSCAL  scales a double precision vector with a double precision scalar.
       DSCAL scales the vector x of length n and increment incx  by  the  con-
       stant a.

       This routine performs the following vector operation:

                 x <-- alpha x

       where alpha is a double precisoin scalar, and x is a double precision
       vector.

ARGUMENTS
       n       INTEGER. (input)
               Number of elements in the vector.
               If n <= 0, this routine returns without computation.

       alpha   DOUBLE PRECISION scalar alpha. (input)

       x       DOUBLE PRECISION, (input and output)
               Array of dimension (n-1) * |incx| + 1. Vector to be scaled.

       incx    INTEGER. (input)
               Increment between elements of x.
               If incx = 0, the results will be unpredictable.
```

———-

— dscal.f —

```
      subroutine  dscal(n,da,dx,incx)
c
c     scales a vector by a constant.
c     uses unrolled loops for increment equal to one.
c     jack dongarra, linpack, 3/11/78.
c     modified 3/93 to return if incx .le. 0.
c     modified 12/3/93, array(1) declarations changed to array(*)
c
      double precision da,dx(*)
      integer i,incx,m,mp1,n,nincx
c
      if( n.le.0 .or. incx.le.0 )return
      if(incx.eq.1)go to 20
c
c        code for increment not equal to 1
c
      nincx = n*incx
      do 10 i = 1,nincx,incx
```

```
        dx(i) = da*dx(i)
   10 continue
      return
c
c        code for increment equal to 1
c
c
c        clean-up loop
c
   20 m = mod(n,5)
      if( m .eq. 0 ) go to 40
      do 30 i = 1,m
        dx(i) = da*dx(i)
   30 continue
      if( n .lt. 5 ) return
   40 mp1 = m + 1
      do 50 i = mp1,n,5
        dx(i) = da*dx(i)
        dx(i + 1) = da*dx(i + 1)
        dx(i + 2) = da*dx(i + 2)
        dx(i + 3) = da*dx(i + 3)
        dx(i + 4) = da*dx(i + 4)
   50 continue
      return
      end
```

———-

— drotg example —

```
       program dscalEX
*      Tim Daly May 6, 2012
*      unit tests for BLAS dscal
       double precision a(6)
       double precision b
       a = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0, 5.0D0, 6.0D0 /)

       write(6,10)
 10    format(/,"the initial array")
       write(6,100)a(1),a(2),a(3)
 100   format("a(1)=",f6.3," a(2)=",f6.3," a(3)=",f6.3)
       write(6,200)a(4),a(5),a(6)
 200   format("a(4)=",f6.3," a(5)=",f6.3," a(6)=",f6.3)

       write(6,11)
 11    format(/,"scale whole array by 2.0")
       call dscal(6,2.0d0,a,1)
       write(6,100)a(1),a(2),a(3)
```

```
      write(6,200)a(4),a(5),a(6)

      write(6,12)
 12   format(/,"scale whole array by 0.5")
      a = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0, 5.0D0, 6.0D0 /)
      call dscal(6,0.5d0,a,1)
      write(6,100)a(1),a(2),a(3)
      write(6,200)a(4),a(5),a(6)

      write(6,13)
 13   format(/,"scale 3 elements by 0.5")
      a = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0, 5.0D0, 6.0D0 /)
      call dscal(3,0.5d0,a,1)
      write(6,100)a(1),a(2),a(3)
      write(6,200)a(4),a(5),a(6)

      write(6,14)
 14   format(/,"do nothing. negative length")
      a = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0, 5.0D0, 6.0D0 /)
      call dscal(-3,0.5d0,a,1)
      write(6,100)a(1),a(2),a(3)
      write(6,200)a(4),a(5),a(6)

      write(6,15)
 15   format(/,"scale 3 elements by -0.5, from end (does nothing)")
      a = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0, 5.0D0, 6.0D0 /)
      call dscal(3,0.5d0,a,-1)
      write(6,100)a(1),a(2),a(3)
      write(6,200)a(4),a(5),a(6)

      stop
      end
```

```
gcc -o dscalEX dscalEX.f -lgfortran dscal.o && ./dscalEX

the initial array
a(1)= 1.000 a(2)= 2.000 a(3)= 3.000
a(4)= 4.000 a(5)= 5.000 a(6)= 6.000

scale whole array by 2.0
a(1)= 2.000 a(2)= 4.000 a(3)= 6.000
a(4)= 8.000 a(5)=10.000 a(6)=12.000

scale whole array by 0.5
a(1)= 0.500 a(2)= 1.000 a(3)= 1.500
a(4)= 2.000 a(5)= 2.500 a(6)= 3.000
```

```
scale 3 elements by 0.5
a(1)= 0.500 a(2)= 1.000 a(3)= 1.500
a(4)= 4.000 a(5)= 5.000 a(6)= 6.000

do nothing. negative length
a(1)= 1.000 a(2)= 2.000 a(3)= 3.000
a(4)= 4.000 a(5)= 5.000 a(6)= 6.000

scale 3 elements by -0.5, from end (does nothing)
a(1)= 1.000 a(2)= 2.000 a(3)= 3.000
a(4)= 4.000 a(5)= 5.000 a(6)= 6.000
```

— BLAS 1 dscal —

```
(defun dscal (n da dx incx)
; Tim Daly May 6, 2012
  (declare (type (simple-array double-float (*)) dx)
           (type (double-float) da)
           (type fixnum n incx))
 (let ((i 0) (limit (length dx)))
 (declare (type fixnum limit i))
  (when (and (> n 0) (> incx 0))
   (do ((i 0 (the fixnum (+ i incx))))
       ((or (>= i n) (>= i limit)))
    (setf (svref dx i)
     (the double-float (* da (the double-float (svref dx i)))))))
  dx))
```

———-

— BLAS 1 dscal lisp test —

```
(load "dscal.lisp")
(setq a (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0 6.0d0))
; #(1.0 2.0 3.0 4.0 5.0 6.0)
(dscal 6 2.0d0 a 1)
; #(2.0 4.0 6.0 8.0 10.0 12.0)

(setq a (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0 6.0d0))
; #(1.0 2.0 3.0 4.0 5.0 6.0)
(dscal 6 0.5d0 a 1)
; #(0.5 1.0 1.5 2.0 2.5 3.0)

(setq a (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0 6.0d0))
; #(1.0 2.0 3.0 4.0 5.0 6.0)
(dscal 3 0.5d0 a 1)
```

```
; #(0.5 1.0 1.5 4.0 5.0 6.0)

(setq a (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0 6.0d0))
; #(1.0 2.0 3.0 4.0 5.0 6.0)
(dscal -3 0.5d0 a 1)
; #(1.0 2.0 3.0 4.0 5.0 6.0)

(setq a (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0 6.0d0))
; #(1.0 2.0 3.0 4.0 5.0 6.0)
(dscal 3 0.5d0 a -1)
; #(1.0 2.0 3.0 4.0 5.0 6.0)
```

———-

3.11 dswap BLAS

— dswap.input —

```
)set break resume
)sys rm -f dswap.output
)spool dswap.output
)set message test on
)set message auto off
)clear all

--S 1 of 9
dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0,  5.0]]
--R
--R   (1)  [1.,2.,3.,4.,5.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 1

--S 2 of 9
dy:PRIMARR(DFLOAT):=[[9.0, 8.0, 7.0, 6.0, -5.0]]
--R
--R   (2)  [9.,8.,7.,6.,- 5.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 2

--S 3 of 9
dswap(5,dx,1,dy,1)
--R
--R   (3)  [[9.,8.,7.,6.,- 5.],[1.,2.,3.,4.,5.]]
--R                                    Type: List(PrimitiveArray(DoubleFloat))
--E 3
```

```
--S 4 of 9
dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0,  5.0]]
--R
--R   (4)  [1.,2.,3.,4.,5.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 4

--S 5 of 9
dy:PRIMARR(DFLOAT):=[[9.0, 8.0, 7.0, 6.0, -5.0]]
--R
--R   (5)  [9.,8.,7.,6.,- 5.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 5

--S 6 of 9
dswap(3,dx,2,dy,2)
--R
--R   (6)  [[9.,2.,7.,4.,- 5.],[1.,8.,3.,6.,5.]]
--R                                    Type: List(PrimitiveArray(DoubleFloat))
--E 6

--S 7 of 9
dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0,  5.0]]
--R
--R   (7)  [1.,2.,3.,4.,5.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 7

--S 8 of 9
dy:PRIMARR(DFLOAT):=[[9.0, 8.0, 7.0, 6.0, -5.0]]
--R
--R   (8)  [9.,8.,7.,6.,- 5.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 8

--S 9 of 9
dswap(5,dx,1,dy,-1)
--R
--R   (9)  [[9.,8.,7.,6.,- 5.],[1.,2.,3.,4.,5.]]
--R                                    Type: List(PrimitiveArray(DoubleFloat))
--E 9

)spool
)lisp (bye)
```

———-

— dswap.help —

```
=====================================================================
dswap examples
=====================================================================

dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0,  5.0]]

  [1.,2.,3.,4.,5.]

dy:PRIMARR(DFLOAT):=[[9.0, 8.0, 7.0, 6.0, -5.0]]

  [9.,8.,7.,6.,- 5.]

dswap(5,dx,1,dy,1)

  [[9.,8.,7.,6.,- 5.],[1.,2.,3.,4.,5.]]

dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0,  5.0]]

  [1.,2.,3.,4.,5.]

dy:PRIMARR(DFLOAT):=[[9.0, 8.0, 7.0, 6.0, -5.0]]

  [9.,8.,7.,6.,- 5.]

dswap(3,dx,2,dy,2)

  [[9.,2.,7.,4.,- 5.],[1.,8.,3.,6.,5.]]

dx:PRIMARR(DFLOAT):=[[1.0, 2.0, 3.0, 4.0,  5.0]]

  [1.,2.,3.,4.,5.]

dy:PRIMARR(DFLOAT):=[[9.0, 8.0, 7.0, 6.0, -5.0]]

  [9.,8.,7.,6.,- 5.]

dswap(5,dx,1,dy,-1)

 [[9.,8.,7.,6.,- 5.],[1.,2.,3.,4.,5.]]


=====================================================================
Man Page Details
=====================================================================

NAME
       DSWAP - BLAS level one, Swaps two double precision vectors

SYNOPSIS
       SUBROUTINE DSWAP    ( n, x, incx, y, incy )
```

```
      INTEGER           n, incx, incy

      DOUBLE PRECISION  x, y


DESCRIPTION
       DSWAP  swaps  two double precision vectors, it interchanges n values of
       vector x and vector y.  incx and incy specify the increment between two
       consecutive elements of respectively vector x and y.


       This routine performs the following vector operation:

            x <-> y

        where x and y are double precision vectors.

ARGUMENTS
       n       INTEGER. (input)
               Number of vector elements to be swapped.
               If n <= 0, this routine returns without computation.

       x       DOUBLE PRECISION, (input and output)
               Array of dimension (n-1) * |incx| + 1.

       incx    INTEGER. (input)
               Increment between elements of x.
               If incx = 0, the results will be unpredictable.

       y       DOUBLE PRECISION, (input and output)
               array of dimension (n-1) * |incy| + 1. Vector to be swapped.

       incy    INTEGER. (input)
               Increment between elements of y.  If incy = 0, the results will
               be unpredictable.

NOTES
       When  working  backward  (incx < 0 or incy < 0), each routine starts at
       the end of the vector and moves backward, as follows:

            x(1-incx * (n-1)), x(1-incx * (n-2)), ..., x(1)

            y(1-incy * (n-1)), y(1-incy * (n-2)), ..., y(1)
```

— dswap.f —

```
      subroutine  dswap (n,dx,incx,dy,incy)
c
c     interchanges two vectors.
c     uses unrolled loops for increments equal one.
c     jack dongarra, linpack, 3/11/78.
c     modified 12/3/93, array(1) declarations changed to array(*)
c
      double precision dx(*),dy(*),dtemp
      integer i,incx,incy,ix,iy,m,mp1,n
c
      if(n.le.0)return
      if(incx.eq.1.and.incy.eq.1)go to 20
c
c       code for unequal increments or equal increments not equal
c         to 1
c
      ix = 1
      iy = 1
      if(incx.lt.0)ix = (-n+1)*incx + 1
      if(incy.lt.0)iy = (-n+1)*incy + 1
      do 10 i = 1,n
        dtemp = dx(ix)
        dx(ix) = dy(iy)
        dy(iy) = dtemp
        ix = ix + incx
        iy = iy + incy
   10 continue
      return
c
c       code for both increments equal to 1
c
c
c       clean-up loop
c
   20 m = mod(n,3)
      if( m .eq. 0 ) go to 40
      do 30 i = 1,m
        dtemp = dx(i)
        dx(i) = dy(i)
        dy(i) = dtemp
   30 continue
      if( n .lt. 3 ) return
   40 mp1 = m + 1
      do 50 i = mp1,n,3
        dtemp = dx(i)
        dx(i) = dy(i)
        dy(i) = dtemp
        dtemp = dx(i + 1)
        dx(i + 1) = dy(i + 1)
        dy(i + 1) = dtemp
```

```
        dtemp = dx(i + 2)
        dx(i + 2) = dy(i + 2)
        dy(i + 2) = dtemp
   50 continue
      return
      end
```

———-

There appears to be a bit of confusion using negative increments. The fortran code does not work as I would have guessed. I don't understand what it was intended to do.

— dswap example —

```
       program dswapEX
*      Tim Daly May 6, 2012
*      unit tests for BLAS dswap
       double precision a(5)
       double precision b(5)
       a = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0,  5.0D0/)
       b = (/ 9.0D0, 8.0D0, 7.0D0, 6.0D0, -5.0D0/)

       write(6,10)
 10    format(/,"before:")
       write(6,100)a(1),a(2),a(3),a(4),a(5)
 100   format("dx=(/",f6.3,", ",f6.3,", ",f6.3,", ",f6.3,", ",f6.3,"/)")
       write(6,101)b(1),b(2),b(3),b(4),b(5)
 101   format("dy=(/",f6.3,", ",f6.3,", ",f6.3,", ",f6.3,", ",f6.3,"/)")
       write(6,11)
 11    format(/,"swap all elements from dx to dy");
       call dswap(5,a,1,b,1)
       write(6,100)a(1),a(2),a(3),a(4),a(5)
       write(6,101)b(1),b(2),b(3),b(4),b(5)

       write(6,10)
       a = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0,  5.0D0/)
       b = (/ 9.0D0, 8.0D0, 7.0D0, 6.0D0, -5.0D0/)
       write(6,100)a(1),a(2),a(3),a(4),a(5)
       write(6,101)b(1),b(2),b(3),b(4),b(5)
       write(6,20)
 20    format(/,"swap every other element from dx to dy");
       a = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0,  5.0D0/)
       b = (/ 9.0D0, 8.0D0, 7.0D0, 6.0D0, -5.0D0/)
       call dswap(3,a,2,b,2)
       write(6,100)a(1),a(2),a(3),a(4),a(5)
       write(6,101)b(1),b(2),b(3),b(4),b(5)

       write(6,10)
```

```
      a = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0,  5.0D0/)
      b = (/ 9.0D0, 8.0D0, 7.0D0, 6.0D0, -5.0D0/)
      write(6,100)a(1),a(2),a(3),a(4),a(5)
      write(6,101)b(1),b(2),b(3),b(4),b(5)
      write(6,22)
 22   format(/,"swap and reverse elements dx to dy");
      a = (/ 1.0D0, 2.0D0, 3.0D0, 4.0D0,  5.0D0/)
      b = (/ 9.0D0, 8.0D0, 7.0D0, 6.0D0, -5.0D0/)
      call dswap(5,a,1,b,-1)
      write(6,100)a(1),a(2),a(3),a(4),a(5)
      write(6,101)b(1),b(2),b(3),b(4),b(5)

      stop
      end
```

```
gcc -o dswapEX dswapEX.f -lgfortran dswap.o && ./dswapEX

before:
dx=(/ 1.000,  2.000,  3.000,  4.000,  5.000/)
dy=(/ 9.000,  8.000,  7.000,  6.000, -5.000/)

swap all elements from dx to dy
dx=(/ 9.000,  8.000,  7.000,  6.000, -5.000/)
dy=(/ 1.000,  2.000,  3.000,  4.000,  5.000/)

before:
dx=(/ 1.000,  2.000,  3.000,  4.000,  5.000/)
dy=(/ 9.000,  8.000,  7.000,  6.000, -5.000/)

swap every other element from dx to dy
dx=(/ 9.000,  2.000,  7.000,  4.000, -5.000/)
dy=(/ 1.000,  8.000,  3.000,  6.000,  5.000/)

before:
dx=(/ 1.000,  2.000,  3.000,  4.000,  5.000/)
dy=(/ 9.000,  8.000,  7.000,  6.000, -5.000/)

swap and reverse elements dx to dy
dx=(/-5.000,  6.000,  7.000,  8.000,  9.000/)
dy=(/ 5.000,  4.000,  3.000,  2.000,  1.000/)
```

— BLAS 1 dswap —

```
(defun dswap (n dx incx dy incy)
; Tim Daly May 6, 2012
```

```
(declare (type (simple-array double-float (*)) dy dx)
         (type fixnum incy incx n))
(let ((ix 0) (iy 0) (limitx (length dx)) (limity (length dy))
      (dtemp 0.0d0))
(declare (type (double-float) dtemp) (type fixnum ix iy limitx limity))
 (when (> n 0)
  (when (< incx 0)
   (setf ix (the fixnum (* (the fixnum (1+ (the fixnum (- n)))) incx))))
  (when (< incy 0)
   (setf iy (the fixnum (* (the fixnum (1+ (the fixnum (- n)))) incy))))
  (do ((i 0 (1+ i)))
      ((or (>= i n) (>= i limitx) (>= i limity)))
    (setf dtemp (svref dx ix))
    (setf (svref dx ix) (svref dy iy))
    (setf (svref dy iy) dtemp)
    (setf ix (the fixnum (+ ix incx)))
    (setf iy (the fixnum (+ iy incy)))))
 (list dx dy)))
```

———-

— BLAS 1 dswap lisp test —

```
(load "dswap.lisp")
(setq a (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0))
; #(1.0 2.0 3.0 4.0 5.0)
(setq b (vector 9.0d0 8.0d0 7.0d0 6.0d0 -5.0d0))
; #(9.0 8.0 7.0 6.0 -5.0)
(dswap 5 a 1 b 1)
; (#(9.0 8.0 7.0 6.0 -5.0) #(1.0 2.0 3.0 4.0 5.0))
(setq a (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0))
; #(1.0 2.0 3.0 4.0 5.0)
(setq b (vector 9.0d0 8.0d0 7.0d0 6.0d0 -5.0d0))
; #(9.0 8.0 7.0 6.0 -5.0)
(dswap 3 a 2 b 2)
; (#(9.0 2.0 7.0 4.0 -5.0) #(1.0 8.0 3.0 6.0 5.0))
(setq a (vector 1.0d0 2.0d0 3.0d0 4.0d0 5.0d0))
; #(1.0 2.0 3.0 4.0 5.0)
(setq b (vector 9.0d0 8.0d0 7.0d0 6.0d0 -5.0d0))
; #(9.0 8.0 7.0 6.0 -5.0)
(dswap 5 a 1 b -1)
; (#(-5.0 6.0 7.0 8.0 9.0) #(5.0 4.0 3.0 2.0 1.0))
```

———-

3.12 dzasum BLAS

— dzasum.input —

```
)set break resume
)sys rm -f dzasum.output
)spool dzasum.output
)set message test on
)set message auto off
)clear all

--S 1 of 4
d:PRIMARR(COMPLEX(DFLOAT)):=[[1.0+2.0*%i,-3.0+4.0*%i,5.0-6.0*%i]]
--R
--R   (1)  [1. + 2. %i,- 3. + 4. %i,5. - 6. %i]
--R                                  Type: PrimitiveArray(Complex(DoubleFloat))
--E 1

--S 2 of 4
dzasum(3,d,1) -- 21.0
--R
--R   (2)  21.
--R                                                        Type: DoubleFloat
--E 2

--S 3 of 4
dzasum(3,d,2) -- 14.0
--R
--R   (3)  14.
--R                                                        Type: DoubleFloat
--E 3

--S 4 of 4
dzasum(-3,d,1) -- 0.0
--R
--R   (4)  0.
--R                                                        Type: DoubleFloat
--E 4

)spool
)lisp (bye)
```

————-

— dzasum.help —

```
=====================================================================
dzasum examples
```

```
=====================================================================

d:PRIMARR(COMPLEX(DFLOAT)):=[[1.0+2.0*%i,-3.0+4.0*%i,5.0-6.0*%i]]

  [1. + 2. %i,- 3. + 4. %i,5. - 6. %i]

dzasum(3,d,1)

  21.  = (1+2) + (abs(-3)+4) + (5+abs(-6))

dzasum(3,d,2)

  14.  = (1+2) + (5+abs(-6))

dzasum(-3,d,1)

  0.   -- never execute for negative arguments

=====================================================================
Man Page Details
=====================================================================

NAME
       DZASUM - BLAS level one, sums the absolute values of the real and imag-
       inary parts of the elements of a double complex vector

SYNOPSIS
       DOUBLE PRECISION FUNCTION DZASUM ( n, x, incx )

           INTEGER                     n, incx

           DOUBLE COMPLEX              x


DESCRIPTION
       This routine performs the following vector operation:

                          n
               DZASUM <-- Sum abs( real(x(i)) ) + abs( aimag(x(i)) )
                          i=1

ARGUMENTS
       n       INTEGER. (input)
               Number of vector elements to be summed.

       x       DOUBLE COMPLEX. (input)
               Array of dimension (n-1) * abs(incx) + 1.
               Vector that contains elements to be summed.

       incx    INTEGER. (input)
```

```
              Increment between elements of x.
              If incx = 0, the results will be unpredictable.

RETURN VALUES
       DZASUM  DOUBLE PRECISION. (output)
              Sum of the absolute values of the real and imaginary  parts  of
              the elements of the vector x.
              If n <= 0, DZASUM is set to 0.

NOTES
       When working backward (incx < 0), each routine starts at the end of the
       vector and moves backward, as follows:

            x(1-incx * (n-1)), x(1-incx * (n-2)), ..., x(1)
```

———-

Computes (complex double-float) $asum \leftarrow ||re(x)||_1 + ||im(x)||_1$

— **dzasum.f** —

```
      double precision function dzasum(n,zx,incx)
c
c     takes the sum of the absolute values.
c     jack dongarra, 3/11/78.
c     modified 3/93 to return if incx .le. 0.
c     modified 12/3/93, array(1) declarations changed to array(*)
c
      double complex zx(*)
      double precision stemp,dcabs1
      integer i,incx,ix,n
c
      dzasum = 0.0d0
      stemp = 0.0d0
      if( n.le.0 .or. incx.le.0 )return
      if(incx.eq.1)go to 20
c
c        code for increment not equal to 1
c
      ix = 1
      do 10 i = 1,n
        stemp = stemp + dcabs1(zx(ix))
        ix = ix + incx
   10 continue
      dzasum = stemp
      return
c
c        code for increment equal to 1
```

```
c
   20 do 30 i = 1,n
        stemp = stemp + dcabs1(zx(i))
   30 continue
      dzasum = stemp
      return
      end
```

— dzasum example —

```
      program dzasumEX
*     Tim Daly May 7, 2012
*     unit tests for BLAS dzasum
      double complex a(3)
      double precision b
      a = (/ (1.0D0,2.0D0), (-3.0D0,4.0D0), (5.0D0,-6.0D0)/)

      write(6,10)
 10   format(/,"before:")
      write(6,100)dble(a(1)),dimag(a(1))
 100  format("a(1)=C(",f6.3," ",f6.3,")")
      write(6,101)dble(a(2)),dimag(a(2))
 101  format("a(2)=C(",f6.3," ",f6.3,")")
      write(6,102)dble(a(3)),dimag(a(3))
 102  format("a(3)=C(",f6.3," ",f6.3,")")

      b=dzasum(3,a,1)
      write(6,11)
 11   format(/,"should be 21:")
      write(6,200)b
 200  format("b=",f6.3)

      b=dzasum(3,a,2)
      write(6,12)
 12   format(/,"should be 14:")
      write(6,200)b

      b=dzasum(-3,a,1)
      write(6,13)
 13   format(/,"should be 0:")
      write(6,200)b

      stop
      end
```

```
gcc -o dzasumEX dzasumEX.f -lgfortran dzasum.o dcabs1.o && ./dzasumEX

before:
a(1)=C( 1.000  2.000)
a(2)=C(-3.000  4.000)
a(3)=C( 5.000 -6.000)

should be 21:
b=21.000

should be 14:
b=14.000

should be 0:
b= 0.000
```

Spad represents complex numbers as a pair where the car is the real part and the cons is the imaginary part. BLAS wants a complex number in fortran format. So we have a design choice to make. Either we could write all of the BLAS code using Spad internal representation or we could follow the BLAS code standard. I've decided to follow the BLAS code standard so we need to create thunks to do the data translation.

— BLAS 1 dzasum —

```
(defun dzasumSpad (n zx incx)
; Tim Daly May 7, 2012
 (let (result vec)
  (dotimes (i (length zx))
   (push (complex (car (svref zx i)) (cdr (svref zx i))) result))
  (setq vec (make-array (length result) :initial-contents (nreverse result)))
  (dzasum n vec incx)))

(defun dzasum (n zx incx)
; Tim Daly May 7, 2012
 (declare (type (simple-array (complex double-float) (*)) zx)
          (type fixnum incx n))
 (let ((ix 0) (stemp 0.0d0) (dzasum 0.0d0) (limit (length zx)))
      (declare (type (double-float) dzasum stemp)
               (type fixnum ix limit))
  (when (and (> n 0) (> incx 0))
   (do ((i 0 (1+ i)))
       ((or (>= i n) (>= ix limit)) nil)
    (setf dzasum (+ dzasum (the double-float (dcabs1 (svref zx ix)))))
    (setf ix (+ ix incx))))
  dzasum))
```

———-

— BLAS 1 dzasum lisp test —

```
(load "dzasum.lisp")
(load "dcabs1.lisp")
(setq a (vector #C(1.0d0 2.0d0) #C(-3.0d0 4.0d0) #C(5.0d0 -6.0d0)))
; #(#C(1.0 2.0) #C(-3.0 4.0) #C(5.0 -6.0))
(dzasum 3 a 1)
; 21.0
(dzasum 3 a 2)
; 14.0
(dzasum -3 a 1)
; 0.0
```

———-

3.13 dznrm2 BLAS

— dznrm2.input —

```
)set break resume
)sys rm -f dznrm2.output
)spool dznrm2.output
)set message test on
)set message auto off
)clear all

--S 1 of 8
a:PRIMARR(COMPLEX(DFLOAT)):=_
  [[3.+4.*%i, -4.+5.*%i, 5.+6.*%i, 7.-8.*%i, -9.-2.*%i]]
--R
--R   (1)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray(Complex(DoubleFloat))
--E 1

--S 2 of 8
dznrm2(5,a,1) -- should be 18.028
--R
--R   (2)  18.027756377319946
--R                                                          Type: DoubleFloat
--E 2

--S 3 of 8
dznrm2(3,a,2) -- should be 13.077
--R
--R   (3)  13.076696830622021
--R                                                          Type: DoubleFloat
```

```
--E 3

--S 4 of 8
dznrm2(3,a,1) -- should be 11.269
--R
--R   (4)  11.269427669584644
--R                                                    Type: DoubleFloat
--E 4

--S 5 of 8
dznrm2(3,a,-1) -- should be 0.0
--R
--R   (5)  0.
--R                                                    Type: DoubleFloat
--E 5

--S 6 of 8
dznrm2(-3,a,-1) -- should be 0.0
--R
--R   (6)  0.
--R                                                    Type: DoubleFloat
--E 6

--S 7 of 8
dznrm2(1,a,1) -- should be 5.0
--R
--R   (7)  5.
--R                                                    Type: DoubleFloat
--E 7

--S 8 of 8
dznrm2(1,a,2) -- should be 5.0
--R
--R   (8)  5.
--R                                                    Type: DoubleFloat
--E 8

)spool
)lisp (bye)
```

———-

— dznrm2.help —

```
=====================================================================
dznrm2 examples
=====================================================================

dznrm2 computes the complex norm of the input vector.
```

```
For each element it computes the sum
    a.i*conjugate(a.i)
for all i. Then it returns the square root of the final sum.

If the count or increment are negative, the result is 0.0


a:PRIMARR(COMPLEX(DFLOAT)):=_
  [[3.+4.*%i, -4.+5.*%i, 5.+6.*%i, 7.-8.*%i, -9.-2.*%i]]

  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]

dznrm2(5,a,1)

  18.027756377319946

dznrm2(3,a,2)

  13.076696830622021

dznrm2(3,a,1)

  11.269427669584644

dznrm2(3,a,-1)

  0.

dznrm2(-3,a,-1)

  0.

dznrm2(1,a,1)

  5.

dznrm2(1,a,2)
  5.

========================================================================
Man Page Details
========================================================================

NAME
       DZNRM2 - BLAS level one, computes the Euclidean norm of a vector

SYNOPSIS
       DOUBLE PRECISION FUNCTION DZNRM2 ( n, x, incx )

           INTEGER                       n, incx
```

```
           DOUBLE COMPLEX                 x


DESCRIPTION
       DZNRM2  computes  the Euclidean (L2) norm of a double precision complex
       vector:

               DZNRM2 <-- ||x||
                               2

       where x is a double precision complex vector.


ARGUMENTS
       n       INTEGER (input)
               Number of elements in the operand vector.

       x       DOUBLE COMPLEX (input)
               Array of dimension (n-1) * |incx| + 1.
               Array x contains the operand vector.

       incx    INTEGER (input)
               Increment between elements of x.
               If incx = 0, the results will be unpredictable.

RETURN VALUES
       DZNRM2  DOUBLE PRECISION Result (Euclidean norm). (output)
               If n <= 0, DZNRM2 is set to 0d0.

NOTES
       When  working backward (incx < 0), DZNRM2 starts at the end of the vec-
       tor and moves backward, as follows:

               x(1-incx * (n-1)), x(1-incx * (n-2)), ..., x(1)
```

———-

— dznrm2.f —

```
      DOUBLE PRECISION FUNCTION DZNRM2( N, X, INCX )
*     .. Scalar Arguments ..
      INTEGER                          INCX, N
*     .. Array Arguments ..
      COMPLEX*16                       X( * )
*     ..
*
*  DZNRM2 returns the euclidean norm of a vector via the function
```

```
*  name, so that
*
*     DZNRM2 := sqrt( conjg( x' )*x )
*
*
*
*  -- This version written on 25-October-1982.
*     Modified on 14-October-1993 to inline the call to ZLASSQ.
*     Sven Hammarling, Nag Ltd.
*
*
*     .. Parameters ..
      DOUBLE PRECISION      ONE         , ZERO
      PARAMETER           ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     .. Local Scalars ..
      INTEGER               IX
      DOUBLE PRECISION      NORM, SCALE, SSQ, TEMP
*     .. Intrinsic Functions ..
      INTRINSIC             ABS, DIMAG, DBLE, SQRT
*     ..
*     .. Executable Statements ..
      IF( N.LT.1 .OR. INCX.LT.1 )THEN
         NORM  = ZERO
      ELSE
         SCALE = ZERO
         SSQ   = ONE
*        The following loop is equivalent to this call to the LAPACK
*        auxiliary routine:
*        CALL ZLASSQ( N, X, INCX, SCALE, SSQ )
*
         DO 10, IX = 1, 1 + ( N - 1 )*INCX, INCX
            IF( DBLE( X( IX ) ).NE.ZERO )THEN
               TEMP = ABS( DBLE( X( IX ) ) )
               IF( SCALE.LT.TEMP )THEN
                  SSQ   = ONE   + SSQ*( SCALE/TEMP )**2
                  SCALE = TEMP
               ELSE
                  SSQ   = SSQ   +     ( TEMP/SCALE )**2
               END IF
            END IF
            IF( DIMAG( X( IX ) ).NE.ZERO )THEN
               TEMP = ABS( DIMAG( X( IX ) ) )
               IF( SCALE.LT.TEMP )THEN
                  SSQ   = ONE   + SSQ*( SCALE/TEMP )**2
                  SCALE = TEMP
               ELSE
                  SSQ   = SSQ   +     ( TEMP/SCALE )**2
               END IF
            END IF
   10    CONTINUE
```

```
         NORM  = SCALE * SQRT( SSQ )
      END IF
*
      DZNRM2 = NORM
      RETURN
*
*     End of DZNRM2.
*
      END
```

———-

— **dznrm2 example** —

```
       program dznrm2EX
*      Tim Daly May 8, 2012
*      unit tests for BLAS dznrm2
       complex*16 a(5)
       double precision c
       a(1) = ( 3.0D0, 4.0D0)
       a(2) = (-4.0D0, 5.0D0)
       a(3) = ( 5.0D0, 6.0D0)
       a(4) = ( 7.0D0,-8.0D0)
       a(5) = (-9.0D0,-2.0D0)
       write(6,100)a(1),a(2),a(3),a(4),a(5)
 100   format("a=(/ (",f6.3,f6.3,"),(",f6.3,f6.3"),(",f6.3,f6.3"),",/,
     C        "     (",f6.3,f6.3,"),(",f6.3,f6.3") /)")
       c=dznrm2(5,a,1)
       write(6,200)c
 200   format("should be 18.028",/,"c=",f6.3)
       c=dznrm2(3,a,2)
       write(6,201)c
 201   format("should be 13.077",/,"c=",f6.3)
       c=dznrm2(3,a,1)
       write(6,202)c
 202   format("should be 11.269",/,"c=",f6.3)
       c=dznrm2(3,a,-1)
       write(6,203)c
 203   format("should be 0.000",/,"c=",f6.3)
       c=dznrm2(-3,a,-1)
       write(6,204)c
 204   format("should be 0.000",/,"c=",f6.3)
       c=dznrm2(1,a,1)
       write(6,205)c
 205   format("should be 5.000",/,"c=",f6.3)
       c=dznrm2(1,a,2)
       write(6,206)c
 206   format("should be 5.000",/,"c=",f6.3)
```

```
       stop
       end
```

```
gcc -o dznrm2EX dznrm2EX.f -lgfortran dznrm2.o && ./dznrm2EX
a=(/ ( 3.000 4.000),(-4.000 5.000),( 5.000 6.000),
     ( 7.000-8.000),(-9.000-2.000) /)
should be 18.028
c=18.028
should be 13.077
c=13.077
should be 11.269
c=11.269
should be 0.000
c= 0.000
should be 0.000
c= 0.000
should be 5.000
c= 5.000
should be 5.000
c= 5.000
```

Spad represents complex numbers as a pair where the car is the real part and the cons is the imaginary part. BLAS wants a complex number in fortran format. So we have a design choice to make. Either we could write all of the BLAS code using Spad internal representation or we could follow the BLAS code standard. I've decided to follow the BLAS code standard so we need to create thunks to do the data translation.

NOTE: The Axiom internal representation of PRIMARR(COMPLEX(FLOAT)) is an array where each array element AE is

```
AE = (cons (cons (therealpart 0)) (cons (theimagpart 0)))
```

so we need (caar AE) and (cadr AE) to get the real and imag parts.

— BLAS 1 dznrm2 —

```
(defun dznrm2Spad (n zx incx)
; Tim Daly May 8, 2012
 (let (result vec)
  (dotimes (i (length zx))
   (push (complex (car (svref zx i)) (cdr (svref zx i))) result))
  (setq vec (make-array (length result) :initial-contents (nreverse result)))
  (dznrm2 n vec incx)))

(defun dznrm2 (n x incx)
; Tim Daly May 8, 2012
```

```
(declare (type (simple-array (complex double-float) (*)) x)
         (type fixnum incx n))
(let ((scale 0.0d0) (ssq 0.0d0) (temp 0.0d0)
      (dznrm2 0.0d0) (limitx (min (* n incx) (length x))))
 (declare (type fixnum limitx) (type (double-float) scale ssq temp dznrm2))
 (when (and (>= n 1) (>= incx 1))
  (do ((ix 0 (the fixnum (+ ix incx))))
      ((>= ix limitx))
   (when (/= (the double-float (realpart
               (the (complex double-float) (svref x ix))))
             0.0d0)
     (setf temp
      (the double-float (abs
       (the double-float (realpart
        (the (complex double-float) (svref x ix)))))))
     (cond
      ((< scale temp)
        (setf ssq (+ 1.0d0
                     (the double-float (*
                       ssq
                       (the double-float (*
                        (the double-float (/ scale temp))
                        (the double-float (/ scale temp))))))))
        (setf scale temp))
       (t
        (setf ssq (+ ssq (*
                           (the double-float (/ temp scale))
                           (the double-float (/ temp scale)))))))
     (when (/= (the double-float (imagpart
                (the (complex double-float) (svref x ix)))) 0.0d0)
       (setf temp
        (the double-float (abs
         (the double-float (imagpart
          (the (complex double-float) (svref x ix)))))))
       (cond
        ((< scale temp)
          (setf ssq (+ 1.0d0 (* ssq (*
                                      (the double-float (/ scale temp))
                                      (the double-float (/ scale temp))))))
          (setf scale temp))
         (t
          (setf ssq (+ ssq (*
                             (the double-float (/ temp scale))
                             (the double-float (/ temp scale))))))))))
   (setf dznrm2 (the double-float (* scale (the double-float (sqrt ssq))))))
 dznrm2))
```

———-

— BLAS 1 dznrm2 lisp test —

```
(load "dznrm2.lisp")
(setq a (vector #C(3.0d0 4.0d0) #C(-4.0d0 5.0d0) #C(5.0d0 6.0d0)
                #C(7.0d0 -8.0d0) #C(-9.0d0 -2.0d0)))
; #(#C(3.0 4.0) #C(-4.0 5.0) #C(5.0 6.0) #C(7.0 -8.0) #C(-9.0 -2.0))
(dznrm2 5 a 1)
; 18.027756377319946
(dznrm2 3 a 2)
; 13.076696830622023
(dznrm2 3 a 1)
; 11.269427669584648
(dznrm2 3 a -1)
; 0.0
(dznrm2 -3 a -1)
; 0.0
(dznrm2 1 a 1)
; 5.0
(dznrm2 1 a 2)
; 5.0
```

———-

3.14 icamax BLAS

— icamax.input —

```
)set break resume
)sys rm -f icamax.output
)spool icamax.output
)set message test on
)set message auto off
)clear all

--S 1 of 7
a:PRIMARR(COMPLEX(FLOAT))
--R                                                                Type: Void
--E 1

--S 2 of 7
a:=[[3.+4.*%i,-4.+5.*%i,5.+6.*%i,7.-8.*%i,-9.-2.*%i]]
--R
--R   (9)  [3.0 + 4.0 %i,- 4.0 + 5.0 %i,5.0 + 6.0 %i,7.0 - 8.0 %i,- 9.0 - 2.0 %i]
--R                                        Type: PrimitiveArray(Complex(Float))
--E 2
```

```
--S 3 of 7
icamax(5,a,1)  -- should be 3
--R
--R   (10)  3
--R                                                    Type: PositiveInteger
--E 3

--S 4 of 7
icamax(0,a,1)  -- should be -1
--R
--R   (11)  - 1
--R                                                           Type: Integer
--E 4

--S 5 of 7
icamax(5,a,-1) -- should be -1
--R
--R   (12)  - 1
--R                                                           Type: Integer
--E 5

--S 6 of 7
icamax(3,a,1)  -- should be 2
--R
--R   (13)  2
--R                                                    Type: PositiveInteger
--E 6

--S 7 of 7
icamax(3,a,2)  -- should be 1
--R
--R   (14)  1
--R                                                    Type: PositiveInteger
--E 7

)spool
)lisp (bye)
```

———-

— icamax.help —

```
=====================================================================
icamax examples
=====================================================================

a:PRIMARR(COMPLEX(FLOAT))

a:=[[3.+4.*%i,-4.+5.*%i,5.+6.*%i,7.-8.*%i,-9.-2.*%i]]
```

```
  [3.0 + 4.0 %i,- 4.0 + 5.0 %i,5.0 + 6.0 %i,7.0 - 8.0 %i,- 9.0 - 2.0 %i]

Note that Axiom arrays are 0-based

icamax(5,a,1)  -- should be 3

  3

If the arguments are not valid, return an invalid array index

The count must be greater than 0.

icamax(0,a,1)  -- should be -1

  - 1

The increment must be positive

icamax(5,a,-1) -- should be -1

  - 1

icamax(3,a,1)  -- should be 2

  2

icamax(3,a,2)  -- should be 1

  1

========================================================================
Man Page Details
========================================================================

NAME
       ICAMAX - BLAS level one, maximum index function

SYNOPSIS
       INTEGER FUNCTION ICAMAX ( n, x, incx )

           INTEGER              n, incx

           COMPLEX              x


DESCRIPTION
       ICAMAX  searches a complex vector for the first occurrence of the maxi-
       mum absolute value.
```

```
       ICAMAX determines the first index i such that

       |Real(x )|+ |Imag(x ) | = MAX(|Real(x )| + | Imag(x )|): j = 1, ..., n
              i           i                 j             j
               where x  is an element of a complex vector.
                      j

ARGUMENTS
       n       INTEGER. (input)
               Number of elements to process in the vector to be searched.  If
               n <= 0, these routines return 0.

       x       COMPLEX. (input)
               Array of dimension (n-1) * |incx| + 1.
               Array x contains the vector to be searched.

       incx    INTEGER. (input)
               Increment between elements of x.

RETURN VALUES
       ICAMAX  INTEGER. (output)
               Return  the first index of the maximum absolute value of vector
               x.  The vector x has length n and increment incx.

NOTES
       When working backward (incx < 0), each routine starts at the end of the
       vector and moves backward, as follows:

            x(1-incx * (n-1)), x(1-incx * (n-2)), ..., x(1)

       The largest absolute value is:

            ABS (x(1+(index-1) * incx)) when incx > 0

            ABS (x(1+(n-index) * |incx|)) when incx < 0


            _______-
```

— icamax.f —

```
      integer function icamax(n,cx,incx)
c
c     finds the index of element having max. absolute value.
c     jack dongarra, linpack, 3/11/78.
c     modified 3/93 to return if incx .le. 0.
c     modified 12/3/93, array(1) declarations changed to array(*)
c
      complex cx(*)
```

```
      real smax
      integer i,incx,ix,n
      complex zdum
      real cabs1
      cabs1(zdum) = abs(real(zdum)) + abs(aimag(zdum))
c
      icamax = 0
      if( n.lt.1 .or. incx.le.0 ) return
      icamax = 1
      if(n.eq.1)return
      if(incx.eq.1)go to 20
c
c        code for increment not equal to 1
c
      ix = 1
      smax = cabs1(cx(1))
      ix = ix + incx
      do 10 i = 2,n
         if(cabs1(cx(ix)).le.smax) go to 5
         icamax = i
         smax = cabs1(cx(ix))
    5    ix = ix + incx
   10 continue
      return
c
c        code for increment equal to 1
c
   20 smax = cabs1(cx(1))
      do 30 i = 2,n
         if(cabs1(cx(i)).le.smax) go to 30
         icamax = i
         smax = cabs1(cx(i))
   30 continue
      return
      end
```

———-

— icamax example —

```
       program icamaxEX
*      Tim Daly May 17, 2012
*      unit tests for BLAS icamax
       complex a(5)
       integer n
       a(1) = ( 1.0, 2.0)
       a(2) = (-2.0, 2.0)
       a(3) = ( 2.0,-1.0)
```

```
      a(4) = ( 2.0,-3.0)
      a(5) = (-1.0,-0.0)
      write(6,100)a(1),a(2),a(3),a(4),a(5)
 100  format("a=(/ (",f6.3,f6.3,"),(",f6.3,f6.3"),(",f6.3,f6.3"),",/,
     C        "     (",f6.3,f6.3,"),(",f6.3,f6.3") /)")
      n=icamax(5,a,1)
      write(6,200)n
 200  format("should be 4",/,"n=",i3)
      n=icamax(3,a,1)
      write(6,201)n
 201  format("should be 2",/,"n=",i3)
      n=icamax(0,a,1)
      write(6,202)n
 202  format("should be 0",/,"n=",i3)
      n=icamax(-5,a,1)
      write(6,203)n
 203  format("should be 0",/,"n=",i3)
      n=icamax(5,a,-1)
      write(6,204)n
 204  format("should be 0",/,"n=",i3)
      n=icamax(5,a,2)
      write(6,205)n
 205  format("should be 1",/,"n=",i3)
      n=icamax(1,a,0)
      write(6,206)n
 206  format("should be 0",/,"n=",i3)
      n=icamax(1,a,-1)
      write(6,207)n
 207  format("should be 0",/,"n=",i3)
      n=icamax(1,a,5)
      write(6,208)n
 208  format("should be 1",/,"n=",i3)
      a(1) = ( 1.0, 2.0)
      a(2) = (-2.0, 2.0)
      a(3) = ( 2.0,-1.0)
      a(4) = (-2.0,-3.0)
      a(5) = (-1.0,-0.0)
      write(6,100)a(1),a(2),a(3),a(4),a(5)
      n=icamax(5,a,1)
      write(6,209)n
 209  format("should be 4",/,"n=",i3)
      stop
      end
```

```
gcc -o icamaxEX icamaxEX.f -lgfortran icamax.o && ./icamaxEX
a=(/ ( 1.000 2.000),(-2.000 2.000),( 2.000-1.000),
     ( 2.000-3.000),(-1.000-0.000) /)
should be 4
```

```
n=  4
should be 2
n=  2
should be 0
n=  0
should be 0
n=  0
should be 0
n=  0
should be 1
n=  1
should be 0
n=  0
should be 0
n=  0
should be 1
n=  1
a=(/ ( 1.000 2.000),(-2.000 2.000),( 2.000-1.000),
     (-2.000-3.000),(-1.000-0.000) /)
should be 4
n=  4
```

Spad represents complex numbers as a pair where the car is the real part and the cons is the imaginary part. BLAS wants a complex number in fortran format. So we have a design choice to make. Either we could write all of the BLAS code using Spad internal representation or we could follow the BLAS code standard. I've decided to follow the BLAS code standard so we need to create thunks to do the data translation.

NOTE: The Axiom internal representation of PRIMARR(COMPLEX(FLOAT)) is an array where each array element AE is

```
AE = (cons (cons (therealpart 0)) (cons (theimagpart 0)))
```

so we need (caar AE) and (cadr AE) to get the real and imag parts.

NOTE: Array indexing in Axiom is 0-based but Fortran is 1-based so the results are displaced by 1.

— BLAS 1 icamax —

```
(defun icamaxSpad (n zx incx)
; Tim Daly May 13, 2012
 (let (result vec)
  (dotimes (i (length zx))
   (push (complex
          (coerce (caar (svref zx i)) 'single-float)
          (coerce (cadr (svref zx i))'single-float)) result))
  (setq vec (make-array (length result) :initial-contents (nreverse result)
                        :element-type '(complex single-float)))
```

```
  (icamax n vec incx)))

(defun icamax (n cx incx)
 (declare (type (simple-array (complex single-float) (*)) cx)
          (type fixnum incx n))
 (labels (
  (cabs1 (zdum)
   (the single-float
    (+ (the single-float (abs (the single-float (realpart zdum))))
       (the single-float (abs (the single-float (imagpart zdum))))))))
 (declare (ftype (function (complex single-float) single-float) cabs1))
 (let ((ix 0) (smax 0.0f0) (icamax -1) (limit (length cx)))
  (declare (type (single-float) smax) (type fixnum icamax ix limit))
  (when (and (>= n 1) (> incx 0))
   (setq icamax 0)
   (setf smax (the single-float (cabs1 (svref cx 0))))
   (setf ix (the fixnum (+ ix incx)))
   (do ((i 1 (+ i 1)))
       ((or (>= ix limit) (>= i n)))
     (when (> (cabs1 (the (complex single-float) (svref cx ix)))
              smax)
      (setf icamax i)
      (setf smax (cabs1 (svref cx ix))))
     (setf ix (the fixnum (+ ix incx)))))
  icamax)))
```

———-

— BLAS 1 icamax lisp test —

```
(load "icamax.lisp")
(setq a
 (vector #C(1.0 2.0) #C(-2.0 2.0) #C(2.0 -1.0) #C(2.0 -3.0) #C(-1.0 -0.0)))
; #(#C(1.0 2.0) #C(-2.0 2.0) #C(2.0 -1.0) #C(2.0 -3.0) #C(-1.0 0.0))
(icamax 5 a 1)
; 3
(icamax 3 a 1)
; 1
(icamax 0 a 1)
; -1
(icamax -5 a 1)
; -1
(icamax 5 a -1)
; -1
(icamax 5 a 2)
; 0
(icamax 1 a 0)
; -1
```

```
(icamax 1 a -1)
; -1
(icamax 1 a 5)
; 0
(setq a
  (vector #C(1.0 2.0) #C(-2.0 2.0) #C(2.0 -1.0) #C(-2.0 -3.0) #C(-1.0 -0.0)))
; #(#C(1.0 2.0) #C(-2.0 2.0) #C(2.0 -1.0) #C(-2.0 -3.0) #C(-1.0 0.0))
(icamax 5 a 1)
; 3
```

———-

3.15 idamax BLAS

— idamax.input —

```
)set break resume
)sys rm -f idamax.output
)spool idamax.output
)set message test on
)set message auto off
)clear all

--S 1 of 11
a:PRIMARR(DFLOAT):=[[3.0, 4.0, -3.0, 5.0, -1.0]]
--R
--R   (1)  [3.,4.,- 3.,5.,- 1.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 1

--S 2 of 11
idamax(5,a,1)  -- should be 3
--R
--R   (2)  3
--R                                                    Type: PositiveInteger
--E 2

--S 3 of 11
idamax(3,a,1)  -- should be 1
--R
--R   (3)  1
--R                                                    Type: PositiveInteger
--E 3

--S 4 of 11
idamax(0,a,1)  -- should be -1
```

```
--R
--R   (4)  - 1
--R                                                          Type: Integer
--E 4

--S 5 of 11
idamax(-5,a,1) -- should be -1
--R
--R   (5)  - 1
--R                                                          Type: Integer
--E 5

--S 6 of 11
idamax(5,a,-1) -- should be -1
--R
--R   (6)  - 1
--R                                                          Type: Integer
--E 6

--S 7 of 11
idamax(5,a,2)  -- should be 0
--R
--R   (7)  0
--R                                                 Type: NonNegativeInteger
--E 7

--S 8 of 11
idamax(1,a,0)  -- should be -1
--R
--R   (8)  - 1
--R                                                          Type: Integer
--E 8

--S 9 of 11
idamax(1,a,-1) -- should be -1
--R
--R   (9)  - 1
--R                                                          Type: Integer
--E 9

--S 10 of 11
a:PRIMARR(DFLOAT):=[[3.0, 4.0, -3.0, -5.0, -1.0]]
--R
--R   (10)  [3.,4.,- 3.,- 5.,- 1.]
--R                                        Type: PrimitiveArray(DoubleFloat)
--E 10

--S 11 of 11
idamax(5,a,1)  -- should be 3
--R
```

```
--R   (11)  3
--R                                                    Type: PositiveInteger
--E 11

)spool
)lisp (bye)
```

———-

— idamax.help —

```
=======================================================================
idamax examples
=======================================================================

a:PRIMARR(DFLOAT):=[[3.0, 4.0, -3.0, 5.0, -1.0]]

  [3.,4.,- 3.,5.,- 1.]

Note that Axiom arrays are 0-based.

idamax(5,a,1)  -- should be 3

  3

idamax(3,a,1)  -- should be 1

  1

The count and increment must both be positive numbers

idamax(0,a,1)  -- should be -1

  - 1

idamax(-5,a,1) -- should be -1

  - 1

idamax(5,a,-1) -- should be -1

  - 1

idamax(5,a,2)  -- should be 0

  0

idamax(1,a,0)  -- should be -1
```

```
  - 1

idamax(1,a,-1) -- should be -1

  - 1

The comparison for maximum uses the absolute value

a:PRIMARR(DFLOAT):=[[3.0, 4.0, -3.0, -5.0, -1.0]]

  [3.,4.,- 3.,- 5.,- 1.]

idamax(5,a,1)  -- should be 3

  3

========================================================================
Man Page Details
========================================================================

NAME
       IDAMAX - BLAS level one, maximum index function

SYNOPSIS
       INTEGER FUNCTION IDAMAX ( n, x, incx )

           INTEGER               n, incx

           DOUBLE PRECISION      x


DESCRIPTION
       IDAMAX  searches  a double precision vector for the first occurrence of
       the the maximum absolute value. The vector x has length n and increment
       incx.

ARGUMENTS
       n       INTEGER. (input)
               Number of elements to process in the vector to be searched.  If
               n <= 0, these routines return 0.

       x       DOUBLE PRECISION. (input)
               Array of dimension (n-1) * |incx| + 1.
               Array x contains the vector to be searched.

       incx    INTEGER. (input)
               Increment between elements of x.

RETURN VALUES
       IDAMAX  INTEGER. (output)
```

```
              Return the first index of the maximum absolute value of  vector
              x.  The vector x has length n and increment incx.

NOTES
       When working backward (incx < 0), each routine starts at the end of the
       vector and moves backward, as follows:

            x(1-incx * (n-1)), x(1-incx * (n-2)), ..., x(1)

       The largest absolute value is:

            ABS (x(1+(index-1) * incx)) when incx > 0

            ABS (x(1+(n-index) * |incx|)) when incx < 0
```

———-

— idamax.f —

```
      integer function idamax(n,dx,incx)
c
c     finds the index of element having max. absolute value.
c     jack dongarra, linpack, 3/11/78.
c     modified 3/93 to return if incx .le. 0.
c     modified 12/3/93, array(1) declarations changed to array(*)
c
      double precision dx(*),dmax
      integer i,incx,ix,n
c
      idamax = 0
      if( n.lt.1 .or. incx.le.0 ) return
      idamax = 1
      if(n.eq.1)return
      if(incx.eq.1)go to 20
c
c        code for increment not equal to 1
c
      ix = 1
      dmax = dabs(dx(1))
      ix = ix + incx
      do 10 i = 2,n
         if(dabs(dx(ix)).le.dmax) go to 5
         idamax = i
         dmax = dabs(dx(ix))
    5    ix = ix + incx
   10 continue
      return
c
```

```
c        code for increment equal to 1
c
   20 dmax = dabs(dx(1))
      do 30 i = 2,n
         if(dabs(dx(i)).le.dmax) go to 30
         idamax = i
         dmax = dabs(dx(i))
   30 continue
      return
      end
```

———-

— idamaxEX example —

```
       program idamaxEX
*      Tim Daly May 16, 2012
*      unit tests for BLAS idamax
       double precision a(5)
       integer n
       a = (/ 3.0, 4.0, -3.0, 5.0, -1.0 /)
       write(6,100)a(1),a(2),a(3),a(4),a(5)
 100   format("a=(/ (/",f6.3," ",f6.3," ",f6.3," ",f6.3," ",f6.3," /)")
       n=idamax(5,a,1)
       write(6,200)n
 200   format("should be 4",/,"n=",i3)
       n=idamax(3,a,1)
       write(6,201)n
 201   format("should be 2",/,"n=",i3)
       n=idamax(0,a,1)
       write(6,202)n
 202   format("should be 0",/,"n=",i3)
       n=idamax(-5,a,1)
       write(6,203)n
 203   format("should be 0",/,"n=",i3)
       n=idamax(5,a,-1)
       write(6,204)n
 204   format("should be 0",/,"n=",i3)
       n=idamax(5,a,2)
       write(6,205)n
 205   format("should be 1",/,"n=",i3)
       n=idamax(1,a,0)
       write(6,206)n
 206   format("should be 0",/,"n=",i3)
       n=idamax(1,a,-1)
       write(6,207)n
 207   format("should be 0",/,"n=",i3)
       n=idamax(1,a,5)
```

```
      write(6,208)n
 208  format("should be 1",/,"n=",i3)
      a = (/ 3.0, 4.0, -3.0, -5.0, -1.0 /)
      write(6,100)a(1),a(2),a(3),a(4),a(5)
      n=idamax(5,a,1)
      write(6,209)n
 209  format("should be 4",/,"n=",i3)
      stop
      end
```

———-

```
gcc -o idamaxEX idamaxEX.f -lgfortran idamax.o && ./idamaxEX
a=(/ (/ 3.000  4.000 -3.000  5.000 -1.000 /)
should be 4
n=  4
should be 2
n=  2
should be 0
n=  0
should be 0
n=  0
should be 0
n=  0
should be 1
n=  1
should be 0
n=  0
should be 0
n=  0
should be 1
n=  1
a=(/ (/ 3.000  4.000 -3.000 -5.000 -1.000 /)
should be 4
n=  4
```

— BLAS 1 idamax —

```
(defun idamax (n dx incx)
 (declare (type (simple-array double-float (*)) dx)
          (type fixnum incx n))
 (let ((ix 0) (dmax 0.0) (idamax -1) (limit (length dx)))
  (declare (type (double-float) dmax) (type fixnum idamax ix limit))
  (when (and (>= n 1) (> incx 0))
   (setq idamax 0)
   (setf dmax (the double-float (abs (the double-float (svref dx 0)))))
   (setf ix (the fixnum (+ ix incx)))
   (do ((i 1 (+ i 1)))
```

```
       ((or (>= ix limit) (>= i n)))
    (when (> (the double-float (abs (the double-float (svref dx ix)))) dmax)
     (setf idamax i)
     (setf dmax (the double-float (abs (the double-float (svref dx ix))))))
    (setf ix (the fixnum (+ ix incx)))))
 idamax))
```

———-

— **BLAS 1 idamax lisp test** —

```
(load "idamax.lisp")
(setq a (vector 3.0d0 4.0d0 -3.0d0 5.0d0 -1.0d0))
; #(3.0 4.0 -3.0 5.0 -1.0)
(idamax 5 a 1)
; 3
(idamax 3 a 1)
; 1
(idamax 0 a 1)
; -1
(idamax -5 a 1)
; -1
(idamax 5 a -1)
; -1
(idamax 5 a 2)
; 0
(idamax 1 a 0)
; -1
(idamax 1 a -1)
; -1
(idamax 1 a 5)
; 0
(setq a (vector 3.0d0 4.0d0 -3.0d0 -5.0d0 -1.0d0))
; #(3.0 4.0 -3.0 -5.0 -1.0)
(idamax 5 a 1)
; 3
```

———-

3.16 isamax BLAS

— **isamax.input** —

```
)set break resume
)sys rm -f isamax.output
```

```
)spool isamax.output
)set message test on
)set message auto off
)clear all

--S 1 of 11
a:PRIMARR(FLOAT):=[[3.0, 4.0, -3.0, 5.0, -1.0]]
--R
--R   (1)  [3.,4.,- 3.,5.,- 1.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 1

--S 2 of 11
isamax(5,a,1)  -- should be 3
--R
--R   (2)  3
--R                                                    Type: PositiveInteger
--E 2

--S 3 of 11
isamax(3,a,1)  -- should be 1
--R
--R   (3)  1
--R                                                    Type: PositiveInteger
--E 3

--S 4 of 11
isamax(0,a,1)  -- should be -1
--R
--R   (4)  - 1
--R                                                           Type: Integer
--E 4

--S 5 of 11
isamax(-5,a,1) -- should be -1
--R
--R   (5)  - 1
--R                                                           Type: Integer
--E 5

--S 6 of 11
isamax(5,a,-1) -- should be -1
--R
--R   (6)  - 1
--R                                                           Type: Integer
--E 6

--S 7 of 11
isamax(5,a,2)  -- should be 0
--R
```

```
--R   (7)  0
--R                                                    Type: NonNegativeInteger
--E 7

--S 8 of 11
isamax(1,a,0)  -- should be -1
--R
--R   (8)  - 1
--R                                                                Type: Integer
--E 8

--S 9 of 11
isamax(1,a,-1) -- should be -1
--R
--R   (9)  - 1
--R                                                                Type: Integer
--E 9

--S 10 of 11
a:PRIMARR(FLOAT):=[[3.0, 4.0, -3.0, -5.0, -1.0]]
--R
--R   (10)  [3.,4.,- 3.,- 5.,- 1.]
--R                                          Type: PrimitiveArray(DoubleFloat)
--E 10

--S 11 of 11
isamax(5,a,1)  -- should be 3
--R
--R   (11)  3
--R                                                     Type: PositiveInteger
--E 11

)spool
)lisp (bye)
```

———-

— isamax.help —

```
=====================================================================
isamax examples
=====================================================================

a:PRIMARR(FLOAT):=[[3.0, 4.0, -3.0, 5.0, -1.0]]

  [3.,4.,- 3.,5.,- 1.]

Note that Axiom arrays are 0-based.
```

```
isamax(5,a,1)  -- should be 3

  3

isamax(3,a,1)  -- should be 1

  1

The count and increment must both be positive numbers

isamax(0,a,1)  -- should be -1

  - 1

isamax(-5,a,1) -- should be -1

  - 1

isamax(5,a,-1) -- should be -1

  - 1

isamax(5,a,2)  -- should be 0

  0

isamax(1,a,0)  -- should be -1

  - 1

isamax(1,a,-1) -- should be -1

  - 1

The comparison for maximum uses the absolute value

a:PRIMARR(FLOAT):=[[3.0, 4.0, -3.0, -5.0, -1.0]]

  [3.,4.,- 3.,- 5.,- 1.]

isamax(5,a,1)  -- should be 3

  3

========================================================================
Man Page Details
========================================================================

NAME
       ISAMAX - BLAS level one, maximum index function
```

```
SYNOPSIS
       INTEGER FUNCTION ISAMAX ( n, x, incx )

           INTEGER               n, incx

           REAL                  x


DESCRIPTION
       ISAMAX searches a real vector for the first occurrence of the the maxi-
       mum absolute value. The vector x has length n and increment incx.

       ISAMAX returns the first index i such that
               |x | = MAX |x | : j = 1, ..., n
                 i          j
       where x  is an element of a real vector.
              j

ARGUMENTS
       n       INTEGER. (input)
               Number of elements to process in the vector to be searched.  If
               n <= 0, these routines return 0.

       x       REAL. (input)
               Array of dimension (n-1) * |incx| + 1.
               Array x contains the vector to be searched.

       incx    INTEGER. (input)
               Increment between elements of x.

RETURN VALUES
       ISAMAX  INTEGER. (output)
               Return  the first index of the maximum absolute value of vector
               x.  The vector x has length n and increment incx.

NOTES
       When working backward (incx < 0), each routine starts at the end of the
       vector and moves backward, as follows:

            x(1-incx * (n-1)), x(1-incx * (n-2)), ..., x(1)

       The largest absolute value is:

            ABS (x(1+(index-1) * incx)) when incx > 0

            ABS (x(1+(n-index) * |incx|)) when incx < 0


            _______-
```

— **isamax.f** —

```
      integer function isamax(n,sx,incx)
c
c     finds the index of element having max. absolute value.
c     jack dongarra, linpack, 3/11/78.
c     modified 3/93 to return if incx .le. 0.
c     modified 12/3/93, array(1) declarations changed to array(*)
c
      real sx(*),smax
      integer i,incx,ix,n
c
      isamax = 0
      if( n.lt.1 .or. incx.le.0 ) return
      isamax = 1
      if(n.eq.1)return
      if(incx.eq.1)go to 20
c
c        code for increment not equal to 1
c
      ix = 1
      smax = abs(sx(1))
      ix = ix + incx
      do 10 i = 2,n
         if(abs(sx(ix)).le.smax) go to 5
         isamax = i
         smax = abs(sx(ix))
    5    ix = ix + incx
   10 continue
      return
c
c        code for increment equal to 1
c
   20 smax = abs(sx(1))
      do 30 i = 2,n
         if(abs(sx(i)).le.smax) go to 30
         isamax = i
         smax = abs(sx(i))
   30 continue
      return
      end
```

————-

— **isamaxEX example** —

```
       program isamaxEX
```

```
*       Tim Daly May 19, 2012
*       unit tests for BLAS isamax
        real a(5)
        integer n
        a = (/ 3.0, 4.0, -3.0, 5.0, -1.0 /)
        write(6,100)a(1),a(2),a(3),a(4),a(5)
 100    format("a=(/ (/",f6.3," ",f6.3," ",f6.3," ",f6.3," ",f6.3," /)")
        n=isamax(5,a,1)
        write(6,200)n
 200    format("should be 4",/,"n=",i3)
        n=isamax(3,a,1)
        write(6,201)n
 201    format("should be 2",/,"n=",i3)
        n=isamax(0,a,1)
        write(6,202)n
 202    format("should be 0",/,"n=",i3)
        n=isamax(-5,a,1)
        write(6,203)n
 203    format("should be 0",/,"n=",i3)
        n=isamax(5,a,-1)
        write(6,204)n
 204    format("should be 0",/,"n=",i3)
        n=isamax(5,a,2)
        write(6,205)n
 205    format("should be 1",/,"n=",i3)
        n=isamax(1,a,0)
        write(6,206)n
 206    format("should be 0",/,"n=",i3)
        n=isamax(1,a,-1)
        write(6,207)n
 207    format("should be 0",/,"n=",i3)
        n=isamax(1,a,5)
        write(6,208)n
 208    format("should be 1",/,"n=",i3)
        a = (/ 3.0, 4.0, -3.0, -5.0, -1.0 /)
        write(6,100)a(1),a(2),a(3),a(4),a(5)
        n=isamax(5,a,1)
        write(6,209)n
 209    format("should be 4",/,"n=",i3)
        stop
        end
```

```
gcc -o isamaxEX isamaxEX.f -lgfortran isamax.o && ./isamaxEX
a=(/ (/ 3.000  4.000 -3.000  5.000 -1.000 /)
should be 4
n=  4
should be 2
n=  2
```

```
should be 0
n=  0
should be 0
n=  0
should be 0
n=  0
should be 1
n=  1
should be 0
n=  0
should be 0
n=  0
should be 1
n=  1
a=(/ (/ 3.000  4.000 -3.000 -5.000 -1.000 /)
should be 4
n=  4
```

Spad represents complex numbers as a pair where the car is the real part and the cons is the imaginary part. BLAS wants a complex number in fortran format. So we have a design choice to make. Either we could write all of the BLAS code using Spad internal representation or we could follow the BLAS code standard. I've decided to follow the BLAS code standard so we need to create thunks to do the data translation.

— BLAS 1 isamax —

```
(defun isamaxSpad (n zx incx)
; Tim Daly May 19, 2012
 (let (result vec)
  (dotimes (i (length zx)) (push (float (car (svref zx i))) result))
  (setq vec (make-array (length result) :initial-contents (nreverse result)
                        :element-type 'single-float))
  (isamax n vec incx)))

(defun isamax (n dx incx)
; Tim Daly May 19, 2012
 (declare (type (simple-array single-float (*)) dx)
          (type fixnum incx n))
 (let ((ix 0) (dmax 0.0) (isamax -1) (limit (length dx)))
  (declare (type (single-float) dmax) (type fixnum isamax ix limit))
  (when (and (>= n 1) (> incx 0))
   (setq isamax 0)
   (setf dmax (the single-float (abs (the single-float (aref dx 0)))))
   (setf ix (the fixnum (+ ix incx)))
   (do ((i 1 (+ i 1)))
       ((or (>= ix limit) (>= i n)))
    (when (> (the single-float (abs (the single-float (aref dx ix)))) dmax)
     (setf isamax i)
     (setf dmax (the single-float (abs (the single-float (aref dx ix))))))
```

```
    (setf ix (the fixnum (+ ix incx)))))
 isamax))
```

———-

— **BLAS 1 isamax lisp test** —

```
(load "isamax.lisp")
(setq a (vector 3.0 4.0 -3.0 5.0 -1.0))
; #(3.0 4.0 -3.0 5.0 -1.0)
(isamax 5 a 1)
; 3
(isamax 3 a 1)
; 1
(isamax 0 a 1)
; -1
(isamax -5 a 1)
; -1
(isamax 5 a -1)
; -1
(isamax 5 a 2)
; 0
(isamax 1 a 0)
; -1
(isamax 1 a -1)
; -1
(isamax 1 a 5)
; 0
(setq a (vector 3.0 4.0 -3.0 -5.0 -1.0))
; #(3.0 4.0 -3.0 -5.0 -1.0)
(isamax 5 a 1)
; 3
```

———-

3.17 izamax BLAS

— **izamax.input** —

```
)set break resume
)sys rm -f izamax.output
)spool izamax.output
)set message test on
)set message auto off
)clear all
```

```
--S 1 of 6
a:PRIMARR(COMPLEX(DFLOAT)):=[[3.+4.*%i,-4.+5.*%i,5.+6.*%i,7.-8.*%i,-9.-2.*%i]]
--R
--R   (1)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                  Type: PrimitiveArray(Complex(DoubleFloat))
--E 1

--S 2 of 6
izamax(5,a,1)  -- should be 3
--R
--R   (2)  3
--R                                                        Type: PositiveInteger
--E 2

--S 3 of 6
izamax(0,a,1)  -- should be -1
--R
--R   (3)  - 1
--R                                                              Type: Integer
--E 3

--S 4 of 6
izamax(5,a,-1) -- should be -1
--R
--R   (4)  - 1
--R                                                              Type: Integer
--E 4

--S 5 of 6
izamax(3,a,1)  -- should be 2
--R
--R   (5)  2
--R                                                        Type: PositiveInteger
--E 5

--S 6 of 6
izamax(3,a,2)  -- should be 1
--R
--R   (6)  1
--R                                                        Type: PositiveInteger
--E 6

)spool
)lisp (bye)
```

———-

— izamax.help —

```
=====================================================================
izamax examples
=====================================================================

a:PRIMARR(COMPLEX(DFLOAT)):=[[3.+4.*%i,-4.+5.*%i,5.+6.*%i,7.-8.*%i,-9.-2.*%i]]

  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]

izamax(5,a,1)

  3

izamax(0,a,1)

  - 1

izamax(5,a,-1)

  - 1

izamax(3,a,1)

  2

izamax(3,a,2)

  1

=====================================================================
Man Page Details
=====================================================================

NAME
       IZAMAX - BLAS level one, maximum index function

SYNOPSIS
       INTEGER FUNCTION IZAMAX ( n, x, incx )

           INTEGER              n, incx

           DOUBLE COMPLEX       x


DESCRIPTION
       IZAMAX searches a double complex vector for the first occurrence of the
       maximum absolute value.

       IZAMAX determines the first index i such that

       |Real(x )|+ |Imag(x ) | = MAX(|Real(x )| + | Imag(x )|): j = 1, ..., n
```

```
             i          i                j            j
              where x  is an element of a double complex vector.
                     j

ARGUMENTS
       n       INTEGER. (input)
               Number of elements to process in the vector to be searched.  If
               n <= 0, these routines return 0.

       x       DOUBLE COMPLEX. (input)
               Array of dimension (n-1) * |incx| + 1.
               Array x contains the vector to be searched.

       incx    INTEGER. (input)
               Increment between elements of x.

RETURN VALUES
       IZAMAX  INTEGER. (output)
               Return  the first index of the maximum absolute value of vector
               x.  The vector x has length n and increment incx.

NOTES
       When working backward (incx < 0), each routine starts at the end of the
       vector and moves backward, as follows:

            x(1-incx * (n-1)), x(1-incx * (n-2)), ..., x(1)

       The largest absolute value is:

            ABS (x(1+(index-1) * incx)) when incx > 0

            ABS (x(1+(n-index) * |incx|)) when incx < 0
```

———-

— **izamax.f** —

```
      integer function izamax(n,zx,incx)
c
c     finds the index of element having max. absolute value.
c     jack dongarra, 1/15/85.
c     modified 3/93 to return if incx .le. 0.
c     modified 12/3/93, array(1) declarations changed to array(*)
c
      double complex zx(*)
      double precision smax
      integer i,incx,ix,n
      double precision dcabs1
```

```
c
      izamax = 0
      if( n.lt.1 .or. incx.le.0 )return
      izamax = 1
      if(n.eq.1)return
      if(incx.eq.1)go to 20
c
c        code for increment not equal to 1
c
      ix = 1
      smax = dcabs1(zx(1))
      ix = ix + incx
      do 10 i = 2,n
         if(dcabs1(zx(ix)).le.smax) go to 5
         izamax = i
         smax = dcabs1(zx(ix))
    5    ix = ix + incx
   10 continue
      return
c
c        code for increment equal to 1
c
   20 smax = dcabs1(zx(1))
      do 30 i = 2,n
         if(dcabs1(zx(i)).le.smax) go to 30
         izamax = i
         smax = dcabs1(zx(i))
   30 continue
      return
      end
```

———-

— izamaxEX example —

```
       program izamaxEX
*      Tim Daly May 20, 2012
*      unit tests for BLAS izamax
       double complex a(5)
       integer n
       a = (/ (1.0D0,2.0D0), (-3.0D0,4.0D0), (5.0D0,-6.0D0),
     C        (0.0D0,8.0D0), (0.0D0,-8.0D0) /)
       write(6,100)dble(a(1)),dimag(a(1))
 100   format("a(1)=C(",f6.3," ",f6.3,")")
       write(6,101)dble(a(2)),dimag(a(2))
 101   format("a(2)=C(",f6.3," ",f6.3,")")
       write(6,102)dble(a(3)),dimag(a(3))
 102   format("a(3)=C(",f6.3," ",f6.3,")")
```

```
      write(6,103)dble(a(4)),dimag(a(4))
 103  format("a(4)=C(",f6.3," ",f6.3,")")
      write(6,104)dble(a(5)),dimag(a(5))
 104  format("a(5)=C(",f6.3," ",f6.3,")")
      n=izamax(5,a,1)
      write(6,200)n
 200  format("should be 3",/,"n=",i3)
      n=izamax(3,a,1)
      write(6,201)n
 201  format("should be 3",/,"n=",i3)
      n=izamax(0,a,1)
      write(6,202)n
 202  format("should be 0",/,"n=",i3)
      n=izamax(-5,a,1)
      write(6,203)n
 203  format("should be 0",/,"n=",i3)
      n=izamax(5,a,-1)
      write(6,204)n
 204  format("should be 0",/,"n=",i3)
      n=izamax(5,a,2)
      write(6,205)n
 205  format("should be 2",/,"n=",i3)
      n=izamax(1,a,0)
      write(6,206)n
 206  format("should be 0",/,"n=",i3)
      n=izamax(1,a,-1)
      write(6,207)n
 207  format("should be 0",/,"n=",i3)
      n=izamax(1,a,5)
      write(6,208)n
 208  format("should be 1",/,"n=",i3)
      stop
      end
```

```
gcc -o izamaxEX izamaxEX.f -lgfortran izamax.o dcabs1.o && ./izamaxEX
a(1)=C( 1.000  2.000)
a(2)=C(-3.000  4.000)
a(3)=C( 5.000 -6.000)
a(4)=C( 0.000  8.000)
a(5)=C( 0.000 -8.000)
should be 3
n=  3
should be 3
n=  3
should be 0
n=  0
should be 0
n=  0
```

```
should be 0
n=  0
should be 2
n=  2
should be 0
n=  0
should be 0
n=  0
should be 1
n=  1
```

Spad represents complex numbers as a pair where the car is the real part and the cons is the imaginary part. BLAS wants a complex number in fortran format. So we have a design choice to make. Either we could write all of the BLAS code using Spad internal representation or we could follow the BLAS code standard. I've decided to follow the BLAS code standard so we need to create thunks to do the data translation.

NOTE: The Axiom internal representation of PRIMARR(COMPLEX(DFLOAT)) is an array where each array element AE is

```
AE = (cons (therealpart 0)) (cons (theimagpart 0))
```

so we need (car AE) and (cdr AE) to get the real and imag parts.

NOTE: Array indexing in Axiom is 0-based but Fortran is 1-based so the results are displaced by 1.

— BLAS 1 izamax —

```
(defun izamaxSpad (n zx incx)
; Tim Daly May 20, 2012
 (let (result vec)
  (dotimes (i (length zx))
   (push (complex (car (svref zx i)) (cdr (svref zx i))) result))
  (setq vec (make-array (length result) :initial-contents (nreverse result)))
  (izamax n vec incx)))

(defun izamax (n zx incx)
; Tim Daly May 20, 2012
 (declare (type (simple-array (complex double-float) (*)) zx)
          (type fixnum incx n))
 (let ((ix 0) (zmax 0.0d0) (izamax -1) (limit (length zx)))
  (declare (type (double-float) zmax) (type fixnum izamax ix limit))
  (when (and (>= n 1) (> incx 0))
   (setf izamax 0)
   (setf zmax (the double-float
                (dcabs1 (the (complex double-float) (svref zx 0)))))
   (setf ix (+ ix incx))
   (do ((i 1 (+ i 1)))
```

```
      ((or (>= ix limit) (>= i n)))
    (when (> (the double-float
                (dcabs1 (the (complex double-float) (svref zx ix))))
             zmax)
      (setf izamax i)
      (setf zmax (the double-float
                   (dcabs1 (the (complex double-float) (svref zx ix))))))
    (setf ix (the fixnum (+ ix incx)))))
 izamax))
```

———-

— BLAS 1 izamax lisp test —

```
(load "dcabs1.lisp")
(load "izamax.lisp")
(setq a (vector #C(1.0d0 2.0d0) #C(-3.0d0 4.0d0) #C(5.0d0 -6.0d0)
                #C(0.0d0 8.0d0) #C(0.0d0 -8.0d0)))
; #(#C(1.0 2.0) #C(-3.0 4.0) #C(5.0 -6.0) #C(0.0 8.0) #C(0.0 -8.0))
(izamax 5 a 1)
; 2
(izamax 3 a 1)
; 2
(izamax 0 a 1)
; -1
(izamax -5 a 1)
; -1
(izamax 5 a -1)
; -1
(izamax 5 a 2)
; 1
(izamax 1 a 0)
; -1
(izamax 1 a -1)
; -1
(izamax 1 a 5)
; 0
```

———-

3.18 zaxpy BLAS

— zaxpy.input —

```
)set break resume
)sys rm -f zaxpy.output
)spool zaxpy.output
)set message test on
)set message auto off
)clear all

--S 1 of 25
a:PRIMARR(COMPLEX(DFLOAT)):=_
     [[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (1)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                     Type: PrimitiveArray Complex DoubleFloat
--E 1

--S 2 of 25
b:PRIMARR(COMPLEX(DFLOAT)):=_
     [[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (2)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                     Type: PrimitiveArray Complex DoubleFloat
--E 2

--S 3 of 25
zaxpy(3,2.0,a,1,b,1)
--R
--R   (3)  [9. + 12. %i,- 12. + 15. %i,15. + 18. %i,7. - 8. %i,- 9. - 2. %i]
--R                                     Type: PrimitiveArray Complex DoubleFloat
--E 3

--S 4 of 25
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (4)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                     Type: PrimitiveArray Complex DoubleFloat
--E 4

--S 5 of 25
zaxpy(5,2.0,a,1,b,1)
--R
--R   (5)  [9. + 12. %i,- 12. + 15. %i,15. + 18. %i,21. - 24. %i,- 27. - 6. %i]
--R                                     Type: PrimitiveArray Complex DoubleFloat
--E 5

--S 6 of 25
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (6)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                     Type: PrimitiveArray Complex DoubleFloat
--E 6
```

```
--S 7 of 25
zaxpy(3,2.0,a,3,b,3)
--R
--R   (7)  [9. + 12. %i,- 4. + 5. %i,5. + 6. %i,21. - 24. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray Complex DoubleFloat
--E 7

--S 8 of 25
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (8)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray Complex DoubleFloat
--E 8

--S 9 of 25
zaxpy(4,2.0,a,2,b,2)
--R
--R   (9)  [9. + 12. %i,- 4. + 5. %i,15. + 18. %i,7. - 8. %i,- 27. - 6. %i]
--R                                    Type: PrimitiveArray Complex DoubleFloat
--E 9

--S 10 of 25
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (10)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray Complex DoubleFloat
--E 10

--S 11 of 25
zaxpy(3,2.0,a,2,b,2)
--R
--R   (11)  [9. + 12. %i,- 4. + 5. %i,15. + 18. %i,7. - 8. %i,- 27. - 6. %i]
--R                                    Type: PrimitiveArray Complex DoubleFloat
--E 11

--S 12 of 25
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (12)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray Complex DoubleFloat
--E 12

--S 13 of 25
zaxpy(3,-2.0,a,1,b,2)
--R
--R   (13)  [- 3. - 4. %i,- 4. + 5. %i,13. - 4. %i,7. - 8. %i,- 19. - 14. %i]
--R                                    Type: PrimitiveArray Complex DoubleFloat
--E 13
```

```
--S 14 of 25
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (14)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray Complex DoubleFloat
--E 14

--S 15 of 25
zaxpy(3,2.0,a,1,b,2)
--R
--R   (15)  [9. + 12. %i,- 4. + 5. %i,- 3. + 16. %i,7. - 8. %i,1. + 10. %i]
--R                                    Type: PrimitiveArray Complex DoubleFloat
--E 15

--S 16 of 25
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (16)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray Complex DoubleFloat
--E 16

--S 17 of 25
zaxpy(-3,2.0,a,1,b,2)
--R
--R   (17)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray Complex DoubleFloat
--E 17

--S 18 of 25
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (18)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray Complex DoubleFloat
--E 18

--S 19 of 25
zaxpy(3,2.0,a,-1,b,2)
--R
--R   (19)  [13. + 16. %i,- 4. + 5. %i,- 3. + 16. %i,7. - 8. %i,- 3. + 6. %i]
--R                                    Type: PrimitiveArray Complex DoubleFloat
--E 19

--S 20 of 25
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (20)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                    Type: PrimitiveArray Complex DoubleFloat
--E 20

--S 21 of 25
```

```
zaxpy(3,2.0,a,1,b,-2)
--R
--R   (21)  [13. + 16. %i,- 4. + 5. %i,- 3. + 16. %i,7. - 8. %i,- 3. + 6. %i]
--R                                     Type: PrimitiveArray Complex DoubleFloat
--E 21

--S 22 of 25
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (22)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                     Type: PrimitiveArray Complex DoubleFloat
--E 22

--S 23 of 25
zaxpy(3,2.0,a,-1,b,-2)
--R
--R   (23)  [9. + 12. %i,- 4. + 5. %i,- 3. + 16. %i,7. - 8. %i,1. + 10. %i]
--R                                     Type: PrimitiveArray Complex DoubleFloat
--E 23

--S 24 of 25
b:=[[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
--R
--R   (24)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                     Type: PrimitiveArray Complex DoubleFloat
--E 24

--S 25 of 25
zaxpy(3,0.0,a,1,b,1)
--R
--R   (25)  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
--R                                     Type: PrimitiveArray Complex DoubleFloat
--E 25

)spool
)lisp (bye)
```

———-

— zaxpy.help —

```
========================================================================
zaxpy examples
========================================================================

a:PRIMARR(COMPLEX(DFLOAT)):=_
     [[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]
  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]
```

```
b:PRIMARR(COMPLEX(DFLOAT)):=_
     [[3.0+4.0*%i, -4.0+5.0*%i, 5.0+6.0*%i, 7.0-8.0*%i, -9.0-2.0*%i]]

  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]

zaxpy(3,2.0,a,1,b,1)

  [9. + 12. %i,- 12. + 15. %i,15. + 18. %i,7. - 8. %i,- 9. - 2. %i]

NOTE: We reset b to the above value before every execution

zaxpy(5,2.0,a,1,b,1)

  [9. + 12. %i,- 12. + 15. %i,15. + 18. %i,21. - 24. %i,- 27. - 6. %i]

zaxpy(3,2.0,a,3,b,3)

  [9. + 12. %i,- 4. + 5. %i,5. + 6. %i,21. - 24. %i,- 9. - 2. %i]

zaxpy(4,2.0,a,2,b,2)

  [9. + 12. %i,- 4. + 5. %i,15. + 18. %i,7. - 8. %i,- 27. - 6. %i]

zaxpy(3,2.0,a,2,b,2)

  [9. + 12. %i,- 4. + 5. %i,15. + 18. %i,7. - 8. %i,- 27. - 6. %i]

zaxpy(3,-2.0,a,1,b,2)

  [- 3. - 4. %i,- 4. + 5. %i,13. - 4. %i,7. - 8. %i,- 19. - 14. %i]

zaxpy(3,2.0,a,1,b,2)

  [9. + 12. %i,- 4. + 5. %i,- 3. + 16. %i,7. - 8. %i,1. + 10. %i]

zaxpy(-3,2.0,a,1,b,2)

  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]

zaxpy(3,2.0,a,-1,b,2)

  [13. + 16. %i,- 4. + 5. %i,- 3. + 16. %i,7. - 8. %i,- 3. + 6. %i]

zaxpy(3,2.0,a,1,b,-2)

  [13. + 16. %i,- 4. + 5. %i,- 3. + 16. %i,7. - 8. %i,- 3. + 6. %i]

zaxpy(3,2.0,a,-1,b,-2)

  [9. + 12. %i,- 4. + 5. %i,- 3. + 16. %i,7. - 8. %i,1. + 10. %i]
```

```
zaxpy(3,0.0,a,1,b,1)

  [3. + 4. %i,- 4. + 5. %i,5. + 6. %i,7. - 8. %i,- 9. - 2. %i]

======================================================================
Man Page Details
======================================================================

NAME
       ZAXPY - BLAS level one axpy subroutine

SYNOPSIS
       SUBROUTINE ZAXPY    ( n, alpha, x, incx, y, incy )

           INTEGER           n, incx, incy

           DOUBLE COMPLEX    alpha, x, y


DESCRIPTION
       ZAXPY adds a scalar multiple of a double complex vector to another dou-
       ble complex vector.

       ZAXPY computes a constant alpha times a vector x plus a vector y.   The
       result overwrites the initial values of vector y.

       This routine performs the following vector operation:

            y  <--  alpha*x + y

       incx and incy specify the increment between two consecutive
       elements of respectively vector x and y.

ARGUMENTS
       n       INTEGER. (input)
               Number  of  elements in the vectors.  If n <= 0, these routines
               return without any computation.

       alpha   DOUBLE COMPLEX. (input)
               If alpha = 0 this routine returns without any computation.

       x       DOUBLE COMPLEX. (input)
               Array of dimension (n-1) * |incx| + 1.  Contains the vector  to
               be scaled before summation.

       incx    INTEGER. (input)
               Increment between elements of x.
               If incx = 0, the results will be unpredictable.
```

```
       y       DOUBLE COMPLEX. (input and output)
               array of dimension (n-1) * |incy| + 1.
               Before calling the routine, y contains the vector to be summed.
               After the routine ends, y contains the result of the summation.

       incy    INTEGER. (input)
               Increment between elements of y.
               If incy = 0, the results will be unpredictable.

NOTES
       This  routine  is  Level  1  Basic  Linear Algebra Subprograms (Level 1
       BLAS).

       When working backward (incx < 0 or incy < 0), each  routine  starts  at
       the end of the vector and moves backward, as follows:

            x(1-incx * (n-1)), x(1-incx * (n-2)), ..., x(1)

            y(1-incy * (n-1)), y(1-incy * (n-2)), ..., y(1)

RETURN VALUES
       When  n  <=  0, double complex alpha = 0 = 0.+0.i, this routine returns
       immediately with no change in its arguments.
```

———-

Computes (complex double-float) $y \leftarrow \alpha x + y$

Arguments are:

- n - fixnum
- da - (complex double-float)
- dx - array (complex double-float)
- incx - fixnum
- dy - array (complex double-float)
- incy - fixnum

— **zaxpy.f** —

```
      subroutine zaxpy(n,za,zx,incx,zy,incy)
c
c     constant times a vector plus a vector.
c     jack dongarra, 3/11/78.
c     modified 12/3/93, array(1) declarations changed to array(*)
```

```
c
      double complex zx(*),zy(*),za
      integer i,incx,incy,ix,iy,n
      double precision dcabs1
      if(n.le.0)return
      if (dcabs1(za) .eq. 0.0d0) return
      if (incx.eq.1.and.incy.eq.1)go to 20
c
c        code for unequal increments or equal increments
c          not equal to 1
c
      ix = 1
      iy = 1
      if(incx.lt.0)ix = (-n+1)*incx + 1
      if(incy.lt.0)iy = (-n+1)*incy + 1
      do 10 i = 1,n
        zy(iy) = zy(iy) + za*zx(ix)
        ix = ix + incx
        iy = iy + incy
   10 continue
      return
c
c        code for both increments equal to 1
c
   20 do 30 i = 1,n
        zy(i) = zy(i) + za*zx(i)
   30 continue
      return
      end
```

———-

— zaxpyEX example —

```
       program zaxpyEX
*      Tim Daly May 20, 2012
*      unit tests for BLAS zaxpy (a*x+y)
       double complex a(5)
       double complex b(5)
       double complex c(5)
       a(1) = ( 3.0D0, 4.0D0)
       a(2) = (-4.0D0, 5.0D0)
       a(3) = ( 5.0D0, 6.0D0)
       a(4) = ( 7.0D0,-8.0D0)
       a(5) = (-9.0D0,-2.0D0)
       b(1) = ( 3.0D0, 4.0D0)
       b(2) = (-4.0D0, 5.0D0)
       b(3) = ( 5.0D0, 6.0D0)
```

```
      b(4) = ( 7.0D0,-8.0D0)
      b(5) = (-9.0D0,-2.0D0)
      write(6,100)a(1),a(2),a(3),a(4),a(5)
100   format("a(1)=(",f7.2,",",f7.2,")",/
     C        "a(2)=(",f7.2,",",f7.2,")",/
     C        "a(3)=(",f7.2,",",f7.2,")",/
     C        "a(4)=(",f7.2,",",f7.2,")",/
     C        "a(5)=(",f7.2,",",f7.2,")")
      write(6,101)b(1),b(2),b(3),b(4),b(5)
101   format(/,"b(1)=(",f7.2,",",f7.2,")",/
     C        "b(2)=(",f7.2,",",f7.2,")",/
     C        "b(3)=(",f7.2,",",f7.2,")",/
     C        "b(4)=(",f7.2,",",f7.2,")",/
     C        "b(5)=(",f7.2,",",f7.2,")")

      call zaxpy(3,2.0d0,a,1,b,1)
      write(6,200)
200   format(/,"t200 is (9.00,12.00), (-12.00,15.00), (15.00,18.00) ",/,
     C          "        (7.00,-8.00), (-9.00,-2.00)")
      write(6,101)b(1),b(2),b(3),b(4),b(5)

      b(1) = ( 3.0D0, 4.0D0)
      b(2) = (-4.0D0, 5.0D0)
      b(3) = ( 5.0D0, 6.0D0)
      b(4) = ( 7.0D0,-8.0D0)
      b(5) = (-9.0D0,-2.0D0)
      call zaxpy(5,2.0d0,a,1,b,1)
      write(6,300)
300   format(/,"t300 is (9.00,12.00), (-12.00,15.00), (15.00,18.00) ",/,
     C          "        (21.00,-24.00), (-27.00,-6.00)")
      write(6,101)b(1),b(2),b(3),b(4),b(5)

      b(1) = ( 3.0D0, 4.0D0)
      b(2) = (-4.0D0, 5.0D0)
      b(3) = ( 5.0D0, 6.0D0)
      b(4) = ( 7.0D0,-8.0D0)
      b(5) = (-9.0D0,-2.0D0)
      call zaxpy(3,2.0d0,a,3,b,3)
      write(6,301)
301   format(/,"t301 is (9.00,12.00), (-4.00,5.00), (5.00,6.00) ",/,
     C          "        (21.00,-24.00), (-9.00,-2.00)")
      write(6,101)b(1),b(2),b(3),b(4),b(5)

      b(1) = ( 3.0D0, 4.0D0)
      b(2) = (-4.0D0, 5.0D0)
      b(3) = ( 5.0D0, 6.0D0)
      b(4) = ( 7.0D0,-8.0D0)
      b(5) = (-9.0D0,-2.0D0)
      call zaxpy(4,2.0d0,a,2,b,2)
      write(6,302)
```

```
302   format(/,"t302 is (9.00,12.00), (-4.00,5.00), (15.00,18.00) ",/,
     C          "        (7.00,-8.00), ( -27.00,  -6.00)")
      write(6,101)b(1),b(2),b(3),b(4),b(5)

      b(1) = ( 3.0D0, 4.0D0)
      b(2) = (-4.0D0, 5.0D0)
      b(3) = ( 5.0D0, 6.0D0)
      b(4) = ( 7.0D0,-8.0D0)
      b(5) = (-9.0D0,-2.0D0)
      call zaxpy(3,2.0d0,a,2,b,2)
      write(6,303)
303   format(/,"t303 is (9.00,12.00), (-4.00,5.00), (15.00,18.00) ",/,
     C          "        (7.00,-8.00), ( -27.00,  -6.00)")
      write(6,101)b(1),b(2),b(3),b(4),b(5)

      b(1) = ( 3.0D0, 4.0D0)
      b(2) = (-4.0D0, 5.0D0)
      b(3) = ( 5.0D0, 6.0D0)
      b(4) = ( 7.0D0,-8.0D0)
      b(5) = (-9.0D0,-2.0D0)
      call zaxpy(3,-2.0d0,a,1,b,2)
      write(6,304)
304   format(/,"t304 is (-3.00,-4.00), (-4.00,5.00), (13.00,-4.00) ",/,
     C          "        (7.00,-8.00), (-19.00,-14.00)")
      write(6,101)b(1),b(2),b(3),b(4),b(5)

      b(1) = ( 3.0D0, 4.0D0)
      b(2) = (-4.0D0, 5.0D0)
      b(3) = ( 5.0D0, 6.0D0)
      b(4) = ( 7.0D0,-8.0D0)
      b(5) = (-9.0D0,-2.0D0)
      call zaxpy(3,2.0d0,a,1,b,2)
      write(6,305)
305   format(/,"t305 is (9.00,12.00), (-4.00,5.00), (-3.00,16.00) ",/,
     C          "        (7.00,-8.00), (1.00,10.00)")
      write(6,101)b(1),b(2),b(3),b(4),b(5)

      b(1) = ( 3.0D0, 4.0D0)
      b(2) = (-4.0D0, 5.0D0)
      b(3) = ( 5.0D0, 6.0D0)
      b(4) = ( 7.0D0,-8.0D0)
      b(5) = (-9.0D0,-2.0D0)
      call zaxpy(-3,2.0d0,a,1,b,2)
      write(6,306)
306   format(/,"t306 is (3.00,4.00), (-4.00,5.00), (5.00,6.00) ",/,
     C          "        (7.00,-8.00), (-9.00,-2.00)")
      write(6,101)b(1),b(2),b(3),b(4),b(5)

      b(1) = ( 3.0D0, 4.0D0)
      b(2) = (-4.0D0, 5.0D0)
```

```
      b(3) = ( 5.0D0, 6.0D0)
      b(4) = ( 7.0D0,-8.0D0)
      b(5) = (-9.0D0,-2.0D0)
      call zaxpy(3,2.0d0,a,-1,b,2)
      write(6,307)
 307  format(/,"t307 is (13.00,16.00), (-4.00,5.00), (-3.00,16.00) ",/,
     C          "        (7.00,-8.00), (-3.00,6.00)")
      write(6,101)b(1),b(2),b(3),b(4),b(5)

      b(1) = ( 3.0D0, 4.0D0)
      b(2) = (-4.0D0, 5.0D0)
      b(3) = ( 5.0D0, 6.0D0)
      b(4) = ( 7.0D0,-8.0D0)
      b(5) = (-9.0D0,-2.0D0)
      call zaxpy(3,2.0d0,a,1,b,-2)
      write(6,308)
 308  format(/,"t308 is (13.00,16.00), (-4.00,5.00), (-3.00,16.00) ",/,
     C          "        (7.00,-8.00), (-3.00,6.00)")
      write(6,101)b(1),b(2),b(3),b(4),b(5)

      b(1) = ( 3.0D0, 4.0D0)
      b(2) = (-4.0D0, 5.0D0)
      b(3) = ( 5.0D0, 6.0D0)
      b(4) = ( 7.0D0,-8.0D0)
      b(5) = (-9.0D0,-2.0D0)
      call zaxpy(3,2.0d0,a,-1,b,-2)
      write(6,309)
 309  format(/,"t309 is (9.00,12.00), (-4.00,5.00), (-3.00,16.00) ",/,
     C          "        (7.00,-8.00), (1.00,10.00)")
      write(6,101)b(1),b(2),b(3),b(4),b(5)

      b(1) = ( 3.0D0, 4.0D0)
      b(2) = (-4.0D0, 5.0D0)
      b(3) = ( 5.0D0, 6.0D0)
      b(4) = ( 7.0D0,-8.0D0)
      b(5) = (-9.0D0,-2.0D0)
      call zaxpy(3,0.0d0,a,1,b,1)
      write(6,310)
 310  format(/,"t310 is (3.00,4.00), (-4.00,5.00), (5.00,6.00) ",/,
     C          "        (7.00,-8.00), (-9.00,-2.00)")
      write(6,101)b(1),b(2),b(3),b(4),b(5)

      stop
      end
```

```
gcc -o zaxpyEX zaxpyEX.f -lgfortran zaxpy.o dcabs1.o && ./zaxpyEX
a(1)=(   3.00,   4.00)
a(2)=(  -4.00,   5.00)
```

```
a(3)=(   5.00,   6.00)
a(4)=(   7.00,  -8.00)
a(5)=(  -9.00,  -2.00)

b(1)=(   3.00,   4.00)
b(2)=(  -4.00,   5.00)
b(3)=(   5.00,   6.00)
b(4)=(   7.00,  -8.00)
b(5)=(  -9.00,  -2.00)

t200 is (9.00,12.00), (-12.00,15.00), (15.00,18.00)
        (7.00,-8.00), (-9.00,-2.00)

b(1)=(   9.00,  12.00)
b(2)=( -12.00,  15.00)
b(3)=(  15.00,  18.00)
b(4)=(   7.00,  -8.00)
b(5)=(  -9.00,  -2.00)

t300 is (9.00,12.00), (-12.00,15.00), (15.00,18.00)
        (21.00,-24.00), (-27.00,-6.00)

b(1)=(   9.00,  12.00)
b(2)=( -12.00,  15.00)
b(3)=(  15.00,  18.00)
b(4)=(  21.00, -24.00)
b(5)=( -27.00,  -6.00)

t301 is (9.00,12.00), (-4.00,5.00), (5.00,6.00)
        (21.00,-24.00), (-9.00,-2.00)

b(1)=(   9.00,  12.00)
b(2)=(  -4.00,   5.00)
b(3)=(   5.00,   6.00)
b(4)=(  21.00, -24.00)
b(5)=(  -9.00,  -2.00)

t302 is (9.00,12.00), (-4.00,5.00), (15.00,18.00)
        (7.00,-8.00), ( -27.00,  -6.00)

b(1)=(   9.00,  12.00)
b(2)=(  -4.00,   5.00)
b(3)=(  15.00,  18.00)
b(4)=(   7.00,  -8.00)
b(5)=( -27.00,  -6.00)

t303 is (9.00,12.00), (-4.00,5.00), (15.00,18.00)
        (7.00,-8.00), ( -27.00,  -6.00)

b(1)=(   9.00,  12.00)
```

```
b(2)=(  -4.00,   5.00)
b(3)=(  15.00,  18.00)
b(4)=(   7.00,  -8.00)
b(5)=( -27.00,  -6.00)

t304 is (-3.00,-4.00), (-4.00,5.00), (13.00,-4.00)
        (7.00,-8.00), (-19.00,-14.00)

b(1)=(  -3.00,  -4.00)
b(2)=(  -4.00,   5.00)
b(3)=(  13.00,  -4.00)
b(4)=(   7.00,  -8.00)
b(5)=( -19.00, -14.00)

t305 is (9.00,12.00), (-4.00,5.00), (-3.00,16.00)
        (7.00,-8.00), (1.00,10.00)

b(1)=(   9.00,  12.00)
b(2)=(  -4.00,   5.00)
b(3)=(  -3.00,  16.00)
b(4)=(   7.00,  -8.00)
b(5)=(   1.00,  10.00)

t306 is (3.00,4.00), (-4.00,5.00), (5.00,6.00)
        (7.00,-8.00), (-9.00,-2.00)

b(1)=(   3.00,   4.00)
b(2)=(  -4.00,   5.00)
b(3)=(   5.00,   6.00)
b(4)=(   7.00,  -8.00)
b(5)=(  -9.00,  -2.00)

t307 is (13.00,16.00), (-4.00,5.00), (-3.00,16.00)
        (7.00,-8.00), (-3.00,6.00)

b(1)=(  13.00,  16.00)
b(2)=(  -4.00,   5.00)
b(3)=(  -3.00,  16.00)
b(4)=(   7.00,  -8.00)
b(5)=(  -3.00,   6.00)

t308 is (13.00,16.00), (-4.00,5.00), (-3.00,16.00)
        (7.00,-8.00), (-3.00,6.00)

b(1)=(  13.00,  16.00)
b(2)=(  -4.00,   5.00)
b(3)=(  -3.00,  16.00)
b(4)=(   7.00,  -8.00)
b(5)=(  -3.00,   6.00)
```

```
t309 is (9.00,12.00), (-4.00,5.00), (-3.00,16.00)
        (7.00,-8.00), (1.00,10.00)

b(1)=(   9.00,  12.00)
b(2)=(  -4.00,   5.00)
b(3)=(  -3.00,  16.00)
b(4)=(   7.00,  -8.00)
b(5)=(   1.00,  10.00)

t310 is (3.00,4.00), (-4.00,5.00), (5.00,6.00)
        (7.00,-8.00), (-9.00,-2.00)

b(1)=(   3.00,   4.00)
b(2)=(  -4.00,   5.00)
b(3)=(   5.00,   6.00)
b(4)=(   7.00,  -8.00)
b(5)=(  -9.00,  -2.00)
```

Axiom delivers PRIMARR(COMPLEX(DFLOAT)) as a list of pairs. We create a thunk function zaxpySpad which creates an array of complex double-float objects required by zaxpy.

The zaxpy function is defined to modify the second array. So the thunk function has to setf this information back into the original array.

The zaxpySpad function could be more efficient if it only copied elements that were modified. This was not done because of the overhead of figuring out which elements this could be under all possible arguments.

— BLAS 1 zaxpy —

```
(defun zaxpySpad (n za zx incx zy incy)
; Tim Daly May 23, 2012
 (let (result vecx vecy tx ty)
  (dotimes (i (length zx))
   (push (complex (car (svref zx i)) (cdr (svref zx i))) tx))
  (setq vecx (make-array (length tx) :initial-contents (nreverse tx)))
  (dotimes (i (length zy))
   (push (complex (car (svref zy i)) (cdr (svref zy i))) ty))
  (setq vecy (make-array (length ty) :initial-contents (nreverse ty)))
  (zaxpy n (complex (car za) (cdr za)) vecx incx vecy incy)
  (dotimes (i (length vecx))
   (setf (svref zy i)
     (cons (realpart (svref vecy i)) (imagpart (svref vecy i)))))
 zy))

(defun zaxpy (n za zx incx zy incy)
; Tim Daly May 23, 2012
 (declare (type (simple-array (complex double-float) (*)) zy zx)
          (type (complex double-float) za)
          (type fixnum incy incx n))
```

```
 (let ((ix 0) (iy 0) (limitx (length zx)) (limity (length zy)))
  (declare (type fixnum iy ix limitx limity))
  (when (and (> n 0) (/= (dcabs1 za) 0.0))
   (when (< incx 0)
    (setf ix (the fixnum (* (the fixnum (1+ (the fixnum (- n)))) incx))))
   (when (< incy 0)
    (setf iy (the fixnum (* (the fixnum (1+ (the fixnum (- n)))) incy))))
   (do ((i 0 (1+ i)))
       ((or (>= i n) (< ix 0) (< iy 0) (>= ix limitx) (>= iy limity)))
    (setf (the (complex double-float) (svref zy iy))
      (+ (the (complex double-float) (svref zy iy))
         (the (complex double-float)
           (* za (the (complex double-float) (svref zx ix))))))
    (setf ix (+ ix incx))
    (setf iy (+ iy incy))))))
```

———-

— BLAS 1 izamax lisp test —

```
(load "zaxpy.lisp")
(load "dcabs1.lisp")
(setq zx (vector (cons 3.0d0 4.0d0) (cons -4.0d0 5.0d0) (cons 5.0d0 6.0d0)
                 (cons 7.0d0 -8.0d0) (cons -9.0d0 -2.0d0)))
; #((3.0 . 4.0) (-4.0 . 5.0) (5.0 . 6.0) (7.0 . -8.0) (-9.0 . -2.0))
(setq zy (vector (cons 3.0d0 4.0d0) (cons -4.0d0 5.0d0) (cons 5.0d0 6.0d0)
                 (cons 7.0d0 -8.0d0) (cons -9.0d0 -2.0d0)))
; #((3.0 . 4.0) (-4.0 . 5.0) (5.0 . 6.0) (7.0 . -8.0) (-9.0 . -2.0))
(zaxpyspad 3 2.0d0 zx 1 zy 1) ; t200
; #((9.0 . 12.0) (-12.0 . 15.0) (15.0 . 18.0) (7.0 . -8.0) (-9.0 . -2.0))
(setq zy (vector (cons 3.0d0 4.0d0) (cons -4.0d0 5.0d0) (cons 5.0d0 6.0d0)
                 (cons 7.0d0 -8.0d0) (cons -9.0d0 -2.0d0)))
; #((3.0 . 4.0) (-4.0 . 5.0) (5.0 . 6.0) (7.0 . -8.0) (-9.0 . -2.0))
(zaxpyspad 5 2.0d0 zx 1 zy 1) ; t300
; #((9.0 . 12.0) (-12.0 . 15.0) (15.0 . 18.0) (21.0 . -24.0) (-27.0 . -6.0))
(setq zy (vector (cons 3.0d0 4.0d0) (cons -4.0d0 5.0d0) (cons 5.0d0 6.0d0)
                 (cons 7.0d0 -8.0d0) (cons -9.0d0 -2.0d0)))
; #((3.0 . 4.0) (-4.0 . 5.0) (5.0 . 6.0) (7.0 . -8.0) (-9.0 . -2.0))
(zaxpyspad 3 2.0d0 zx 3 zy 3) ; t301
; #((9.0 . 12.0) (-4.0 . 5.0) (5.0 . 6.0) (21.0 . -24.0) (-9.0 . -2.0))
(setq zy (vector (cons 3.0d0 4.0d0) (cons -4.0d0 5.0d0) (cons 5.0d0 6.0d0)
                 (cons 7.0d0 -8.0d0) (cons -9.0d0 -2.0d0)))
; #((3.0 . 4.0) (-4.0 . 5.0) (5.0 . 6.0) (7.0 . -8.0) (-9.0 . -2.0))
(zaxpyspad 4 2.0d0 zx 2 zy 2) ; t302
; #((9.0 . 12.0) (-4.0 . 5.0) (15.0 . 18.0) (7.0 . -8.0) (-27.0 . -6.0))
(setq zy (vector (cons 3.0d0 4.0d0) (cons -4.0d0 5.0d0) (cons 5.0d0 6.0d0)
                 (cons 7.0d0 -8.0d0) (cons -9.0d0 -2.0d0)))
; #((3.0 . 4.0) (-4.0 . 5.0) (5.0 . 6.0) (7.0 . -8.0) (-9.0 . -2.0))
```

```
(zaxpyspad 3 2.0d0 zx 2 zy 2) ; t303
; #((9.0 . 12.0) (-4.0 . 5.0) (15.0 . 18.0) (7.0 . -8.0) (-27.0 . -6.0))
(setq zy (vector (cons 3.0d0 4.0d0) (cons -4.0d0 5.0d0) (cons 5.0d0 6.0d0)
                 (cons 7.0d0 -8.0d0) (cons -9.0d0 -2.0d0)))
; #((3.0 . 4.0) (-4.0 . 5.0) (5.0 . 6.0) (7.0 . -8.0) (-9.0 . -2.0))
(zaxpyspad 3 -2.0d0 zx 1 zy 2) ; t304
; #((-3.0 . -4.0) (-4.0 . 5.0) (13.0 . -4.0) (7.0 . -8.0) (-19.0 . -14.0))
(setq zy (vector (cons 3.0d0 4.0d0) (cons -4.0d0 5.0d0) (cons 5.0d0 6.0d0)
                 (cons 7.0d0 -8.0d0) (cons -9.0d0 -2.0d0)))
; #((3.0 . 4.0) (-4.0 . 5.0) (5.0 . 6.0) (7.0 . -8.0) (-9.0 . -2.0))
(zaxpyspad 3 2.0d0 zx 1 zy 2) ; t305
; #((9.0 . 12.0) (-4.0 . 5.0) (-3.0 . 16.0) (7.0 . -8.0) (1.0 . 10.0))
(setq zy (vector (cons 3.0d0 4.0d0) (cons -4.0d0 5.0d0) (cons 5.0d0 6.0d0)
                 (cons 7.0d0 -8.0d0) (cons -9.0d0 -2.0d0)))
; #((3.0 . 4.0) (-4.0 . 5.0) (5.0 . 6.0) (7.0 . -8.0) (-9.0 . -2.0))
(zaxpyspad -3 2.0d0 zx 1 zy 2) ; t306
; #((3.0 . 4.0) (-4.0 . 5.0) (5.0 . 6.0) (7.0 . -8.0) (-9.0 . -2.0))
(setq zy (vector (cons 3.0d0 4.0d0) (cons -4.0d0 5.0d0) (cons 5.0d0 6.0d0)
                 (cons 7.0d0 -8.0d0) (cons -9.0d0 -2.0d0)))
; #((3.0 . 4.0) (-4.0 . 5.0) (5.0 . 6.0) (7.0 . -8.0) (-9.0 . -2.0))
(zaxpyspad 3 2.0d0 zx -1 zy 2) ; t307
; #((13.0 . 16.0) (-4.0 . 5.0) (-3.0 . 16.0) (7.0 . -8.0) (-3.0 . 6.0))
(setq zy (vector (cons 3.0d0 4.0d0) (cons -4.0d0 5.0d0) (cons 5.0d0 6.0d0)
                 (cons 7.0d0 -8.0d0) (cons -9.0d0 -2.0d0)))
; #((3.0 . 4.0) (-4.0 . 5.0) (5.0 . 6.0) (7.0 . -8.0) (-9.0 . -2.0))
(zaxpyspad 3 2.0d0 zx 1 zy -2) ; t308
; #((13.0 . 16.0) (-4.0 . 5.0) (-3.0 . 16.0) (7.0 . -8.0) (-3.0 . 6.0))
(setq zy (vector (cons 3.0d0 4.0d0) (cons -4.0d0 5.0d0) (cons 5.0d0 6.0d0)
                 (cons 7.0d0 -8.0d0) (cons -9.0d0 -2.0d0)))
; #((3.0 . 4.0) (-4.0 . 5.0) (5.0 . 6.0) (7.0 . -8.0) (-9.0 . -2.0))
(zaxpyspad 3 2.0d0 zx -1 zy -2) ; t309
; #((9.0 . 12.0) (-4.0 . 5.0) (-3.0 . 16.0) (7.0 . -8.0) (1.0 . 10.0))
(setq zy (vector (cons 3.0d0 4.0d0) (cons -4.0d0 5.0d0) (cons 5.0d0 6.0d0)
                 (cons 7.0d0 -8.0d0) (cons -9.0d0 -2.0d0)))
; #((3.0 . 4.0) (-4.0 . 5.0) (5.0 . 6.0) (7.0 . -8.0) (-9.0 . -2.0))
(zaxpyspad 3 0.0d0 zx 1 zy 1) ; t310
; #((3.0 . 4.0) (-4.0 . 5.0) (5.0 . 6.0) (7.0 . -8.0) (-9.0 . -2.0))
```

———-

3.19 zcopy BLAS

— zcopy.input —

```
)set break resume
)sys rm -f zcopy.output
```

```
)spool zcopy.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zcopy.help** —

```
==========================================================================
zcopy examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

NAME
       ZCOPY  -  BLAS  level  one, copies a double complex vector into another
       double complex vector

SYNOPSIS
       SUBROUTINE ZCOPY    ( n, x, incx, y, incy )

           INTEGER           n, incx, incy

           DOUBLE COMPLEX    x, y


DESCRIPTION
       ZCOPY copies a double complex vector into another double  complex  vec-
       tor.   ZCOPY  copies  a vector x, whose length is n to a vector y. incx
       and incy specify the increment  between  two  consecutive  elements  of
       respectively vector x and y.

       This routine performs the following vector operation:

            y  <--  x

       where x and y are double complex vectors.

ARGUMENTS
       n       INTEGER. (input)
               Number of vector elements to be copied.
               If n <= 0, this routine returns without computation.
```

```
       x       DOUBLE COMPLEX, (input)
               Vector from which to copy.

       incx    INTEGER. (input)
               Increment between elements of x.
               If incx = 0, the results will be unpredictable.

       y       DOUBLE COMPLEX, (output)
               array of dimension (n-1) * |incy| + 1, result vector.

       incy    INTEGER. (input)
               Increment between elements of y.  If incy = 0, the results will
               be unpredictable.

NOTES
       When  working  backward  (incx < 0 or incy < 0), each routine starts at
       the end of the vector and moves backward, as follows:

            x(1-incx * (n-1)), x(1-incx * (n-2)), ..., x(1)

            y(1-incy * (n-1)), y(1-incy * (n-2)), ..., y(1)
```

— zcopy.f —

```
      subroutine  zcopy(n,zx,incx,zy,incy)
c
c     copies a vector, x, to a vector, y.
c     jack dongarra, linpack, 4/11/78.
c     modified 12/3/93, array(1) declarations changed to array(*)
c
      double complex zx(*),zy(*)
      integer i,incx,incy,ix,iy,n
c
      if(n.le.0)return
      if(incx.eq.1.and.incy.eq.1)go to 20
c
c        code for unequal increments or equal increments
c          not equal to 1
c
      ix = 1
      iy = 1
      if(incx.lt.0)ix = (-n+1)*incx + 1
      if(incy.lt.0)iy = (-n+1)*incy + 1
      do 10 i = 1,n
        zy(iy) = zx(ix)
        ix = ix + incx
```

```
        iy = iy + incy
   10 continue
      return
c
c        code for both increments equal to 1
c
   20 do 30 i = 1,n
        zy(i) = zx(i)
   30 continue
      return
      end
```

———-

— BLAS 1 zcopy —

```
(defun zcopy (n zx incx zy incy)
  (declare (type (simple-array (complex double-float) (*)) zy zx)
           (type fixnum incy incx n))
  (f2cl-lib:with-multi-array-data
      ((zx (complex double-float) zx-%data% zx-%offset%)
       (zy (complex double-float) zy-%data% zy-%offset%))
    (prog ((i 0) (ix 0) (iy 0))
      (declare (type fixnum iy ix i))
      (if (<= n 0) (go end_label))
      (if (and (= incx 1) (= incy 1)) (go label20))
      (setf ix 1)
      (setf iy 1)
      (if (< incx 0)
          (setf ix
                (f2cl-lib:int-add
                 (f2cl-lib:int-mul (the fixnum (1- n)) incx)
                 1)))
      (if (< incy 0)
          (setf iy
                (f2cl-lib:int-add
                 (f2cl-lib:int-mul (the fixnum (1- n)) incy)
                 1)))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i n) nil)
        (tagbody
          (setf (f2cl-lib:fref zy-%data% (iy) ((1 *)) zy-%offset%)
                (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%))
          (setf ix (f2cl-lib:int-add ix incx))
          (setf iy (f2cl-lib:int-add iy incy))))
      (go end_label)
 label20
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
```

```
                  ((> i n) nil)
        (tagbody
          (setf (f2cl-lib:fref zy-%data% (i) ((1 *)) zy-%offset%)
                (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%))))
 end_label
      (return (values nil nil nil nil nil)))))
```

———-

3.20 zdotc BLAS

— **zdotc.input** —

```
)set break resume
)sys rm -f zdotc.output
)spool zdotc.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zdotc.help** —

```
=====================================================================
zdotc examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       ZDOTC  - BLAS level one, computes the hermitian dot product of vector x
       and vector y.

SYNOPSIS
       DOUBLE COMPLEX FUNCTION ZDOTC ( n, x, incx, y, incy )

           INTEGER                     n, incx, incy

           COMPLEX*16                  x, y
```

```
DESCRIPTION
       ZDOTC computes a dot product of the conjugate of a complex  vector  and
       another     complex     vector     (l     complex    inner    product).
       2

       ZDOTC computes a dot product of the conjugate of a complex  vector  and
       another     complex     vector     (l     complex    inner    product).
       2

       This routine performs the following vector operation:

            ZDOTC  <--  (conjugate transpose of x) * y
                            n
                        =  Sum  (complex conjugate of x(i))*y(i)
                           i=1
                                                H
       where x and y are complex vectors, and x is the conjugate
       transpose of x.

       If n <= 0, ZDOTC is set to 0.

ARGUMENTS
       n       INTEGER. (input)
               Number of elements in each vector.

       x       COMPLEX*16. (input)
               Array of dimension (n-1) * |incx| + 1.
               Array x contains the first vector operand.

       incx    INTEGER. (input)
               Increment between elements of x.
               If incx = 0, the results will be unpredictable.

       y       COMPLEX*16. (input)
               Array of dimension (n-1) * |incy| + 1.
               Array y contains the second vector operand.

       incy    INTEGER. (input)
               Increment between elements of y.
               If incy = 0, the results will be unpredictable.

RETURN VALUES
       ZDOTC    DOUBLE COMPLEX. Result (dot product). (output)

NOTES
       When  working  backward  (incx < 0 or incy < 0), each routine starts at
       the end of the vector and moves backward, as follows:
```

```
           x(1-incx * (n-1)), x(1-incx * (n-2)), ..., x(1)

           y(1-incy * (n-1)), y(1-incy * (n-2)), ..., y(1)
```

— zdotc.f —

```
      double complex function zdotc(n,zx,incx,zy,incy)
c
c     forms the dot product of a vector.
c     jack dongarra, 3/11/78.
c     modified 12/3/93, array(1) declarations changed to array(*)
c
      double complex zx(*),zy(*),ztemp
      integer i,incx,incy,ix,iy,n
      ztemp = (0.0d0,0.0d0)
      zdotc = (0.0d0,0.0d0)
      if(n.le.0)return
      if(incx.eq.1.and.incy.eq.1)go to 20
c
c        code for unequal increments or equal increments
c          not equal to 1
c
      ix = 1
      iy = 1
      if(incx.lt.0)ix = (-n+1)*incx + 1
      if(incy.lt.0)iy = (-n+1)*incy + 1
      do 10 i = 1,n
        ztemp = ztemp + dconjg(zx(ix))*zy(iy)
        ix = ix + incx
        iy = iy + incy
   10 continue
      zdotc = ztemp
      return
c
c        code for both increments equal to 1
c
   20 do 30 i = 1,n
        ztemp = ztemp + dconjg(zx(i))*zy(i)
   30 continue
      zdotc = ztemp
      return
      end
```

— BLAS 1 zdotc —

```
(defun zdotc (n zx incx zy incy)
  (declare (type (simple-array (complex double-float) (*)) zy zx)
           (type fixnum incy incx n))
  (f2cl-lib:with-multi-array-data
      ((zx (complex double-float) zx-%data% zx-%offset%)
       (zy (complex double-float) zy-%data% zy-%offset%))
    (prog ((i 0) (ix 0) (iy 0) (ztemp #C(0.0 0.0)) (zdotc #C(0.0 0.0)))
      (declare (type (complex double-float) zdotc ztemp)
               (type fixnum iy ix i))
      (setf ztemp (complex 0.0 0.0))
      (setf zdotc (complex 0.0 0.0))
      (if (<= n 0) (go end_label))
      (if (and (= incx 1) (= incy 1)) (go label20))
      (setf ix 1)
      (setf iy 1)
      (if (< incx 0)
          (setf ix
                (f2cl-lib:int-add
                 (f2cl-lib:int-mul (the fixnum (1- n)) incx)
                 1)))
      (if (< incy 0)
          (setf iy
                (f2cl-lib:int-add
                 (f2cl-lib:int-mul (the fixnum (1- n)) incy)
                 1)))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i n) nil)
        (tagbody
          (setf ztemp
                (+ ztemp
                   (*
                    (f2cl-lib:dconjg
                     (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%))
                    (f2cl-lib:fref zy-%data% (iy) ((1 *)) zy-%offset%))))
          (setf ix (f2cl-lib:int-add ix incx))
          (setf iy (f2cl-lib:int-add iy incy))))
      (setf zdotc ztemp)
      (go end_label)
 label20
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i n) nil)
        (tagbody
          (setf ztemp
                (+ ztemp
                   (*
                    (f2cl-lib:dconjg
                     (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%))
```

```
                    (f2cl-lib:fref zy-%data% (i) ((1 *)) zy-%offset%))))))
      (setf zdotc ztemp)
 end_label
      (return (values zdotc nil nil nil nil nil)))))
```

———-

3.21 zdotu BLAS

— **zdotu.input** —

```
)set break resume
)sys rm -f zdotu.output
)spool zdotu.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zdotu.help** —

```
========================================================================
zdotu examples
========================================================================

========================================================================
Man Page Details
========================================================================

NAME
       ZDOTU - BLAS level one, computes computes a dot product (inner product)
       of two complex vectors

SYNOPSIS
       DOUBLE COMPLEX FUNCTION ZDOTU ( n, x, incx, y, incy )

           INTEGER                     n, incx, incy

           COMPLEX*16                  x, y
```

```
DESCRIPTION
       ZDOTU computes a dot product of two complex vectors.

       This routine performs the following vector operation:

                                                    n
               ZDOTU  <--  (transpose of x) * y  =  Sum  x(i)*y(i)
                                                   i=1
                                        T
       where x and y are real vectors, and x is the transpose of
       x.

       If n <= 0, ZDOTU is set to 0.

ARGUMENTS
       n       INTEGER. (input)
               Number of elements in each vector.

       x       COMPLEX*16. (input)
               Array of dimension (n-1) * |incx| + 1.
               Array x contains the first vector operand.

       incx    INTEGER. (input)
               Increment between elements of x.
               If incx = 0, the results will be unpredictable.

       y       COMPLEX*16. (input)
               Array of dimension (n-1) * |incy| + 1.
               Array y contains the second vector operand.

       incy    INTEGER. (input)
               Increment between elements of y.
               If incy = 0, the results will be unpredictable.

RETURN VALUES
       ZDOTU   DOUBLE COMPLEX. Result (dot product). (output)

NOTES
       When  working  backward  (incx < 0 or incy < 0), each routine starts at
       the end of the vector and moves backward, as follows:

            x(1-incx * (n-1)), x(1-incx * (n-2)), ..., x(1)

            y(1-incy * (n-1)), y(1-incy * (n-2)), ..., y(1)
```

———-

— **zdotu.f** —

```
      double complex function zdotu(n,zx,incx,zy,incy)
c
c     forms the dot product of two vectors.
c     jack dongarra, 3/11/78.
c     modified 12/3/93, array(1) declarations changed to array(*)
c
      double complex zx(*),zy(*),ztemp
      integer i,incx,incy,ix,iy,n
      ztemp = (0.0d0,0.0d0)
      zdotu = (0.0d0,0.0d0)
      if(n.le.0)return
      if(incx.eq.1.and.incy.eq.1)go to 20
c
c        code for unequal increments or equal increments
c          not equal to 1
c
      ix = 1
      iy = 1
      if(incx.lt.0)ix = (-n+1)*incx + 1
      if(incy.lt.0)iy = (-n+1)*incy + 1
      do 10 i = 1,n
        ztemp = ztemp + zx(ix)*zy(iy)
        ix = ix + incx
        iy = iy + incy
   10 continue
      zdotu = ztemp
      return
c
c        code for both increments equal to 1
c
   20 do 30 i = 1,n
        ztemp = ztemp + zx(i)*zy(i)
   30 continue
      zdotu = ztemp
      return
      end
```

———-

— BLAS 1 zdotu —

```
(defun zdotu (n zx incx zy incy)
  (declare (type (simple-array (complex double-float) (*)) zy zx)
           (type fixnum incy incx n))
  (f2cl-lib:with-multi-array-data
      ((zx (complex double-float) zx-%data% zx-%offset%)
       (zy (complex double-float) zy-%data% zy-%offset%))
    (prog ((i 0) (ix 0) (iy 0) (ztemp #C(0.0 0.0)) (zdotu #C(0.0 0.0)))
```

```
      (declare (type (complex double-float) zdotu ztemp)
               (type fixnum iy ix i))
      (setf ztemp (complex 0.0 0.0))
      (setf zdotu (complex 0.0 0.0))
      (if (<= n 0) (go end_label))
      (if (and (= incx 1) (= incy 1)) (go label20))
      (setf ix 1)
      (setf iy 1)
      (if (< incx 0)
          (setf ix
                  (f2cl-lib:int-add
                   (f2cl-lib:int-mul (the fixnum (1- n)) incx)
                   1)))
      (if (< incy 0)
          (setf iy
                  (f2cl-lib:int-add
                   (f2cl-lib:int-mul (the fixnum (1- n)) incy)
                   1)))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i n) nil)
        (tagbody
          (setf ztemp
                  (+ ztemp
                     (* (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%)
                        (f2cl-lib:fref zy-%data% (iy) ((1 *)) zy-%offset%))))
          (setf ix (f2cl-lib:int-add ix incx))
          (setf iy (f2cl-lib:int-add iy incy))))
      (setf zdotu ztemp)
      (go end_label)
 label20
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i n) nil)
        (tagbody
          (setf ztemp
                  (+ ztemp
                     (* (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%)
                        (f2cl-lib:fref zy-%data% (i) ((1 *)) zy-%offset%))))))
      (setf zdotu ztemp)
 end_label
      (return (values zdotu nil nil nil nil nil)))))
```

———-

3.22 zdscal BLAS

— **zdscal.input** —

```
)set break resume
)sys rm -f zdscal.output
)spool zdscal.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— zdscal.help —

```
==========================================================================
zdscal examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

NAME
       ZDSCAL - BLAS level one, Scales a double complex vector

SYNOPSIS
       SUBROUTINE ZDSCAL    ( n, alpha, x, incx )

           INTEGER            n, incx

           DOUBLE COMPLEX     x

           DOUBLE PRECISION   alpha


DESCRIPTION
       ZDSCAL  scales  a double complex vector with a double precision scalar.
       ZDSCAL scales the vector x of length n and increment incx by  the  con-
       stant alpha.

       This routine performs the following vector operation:

                 x <-- alpha x

       where alpha is a double precision scalar, and x is a double complex
       vector.

ARGUMENTS
       n       INTEGER. (input)
```

```
              Number of elements in the vector.
              If n <= 0, this routine returns without computation.

       alpha  DOUBLE PRECISION. (input)
              Value used to scale vector

       x      DOUBLE COMPLEX. (input and output)
              Array  of dimension (n-1) * abs(incx) + 1. Vector to be scaled.

       incx   INTEGER. (input)
              Increment between elements of x.
              If incx = 0, the results will be unpredictable.

NOTES
       When  working  backward  (incx < 0 or incy < 0), each routine starts at
       the end of the vector and moves backward, as follows:

            x(1-incx * (n-1)), x(1-incx * (n-2)), ..., x(1)
```

———-

— zdscal.f —

```
      subroutine  zdscal(n,da,zx,incx)
c
c     scales a vector by a constant.
c     jack dongarra, 3/11/78.
c     modified 3/93 to return if incx .le. 0.
c     modified 12/3/93, array(1) declarations changed to array(*)
c
      double complex zx(*)
      double precision da
      integer i,incx,ix,n
c
      if( n.le.0 .or. incx.le.0 )return
      if(incx.eq.1)go to 20
c
c        code for increment not equal to 1
c
      ix = 1
      do 10 i = 1,n
        zx(ix) = dcmplx(da,0.0d0)*zx(ix)
        ix = ix + incx
   10 continue
      return
c
c        code for increment equal to 1
c
```

```
   20 do 30 i = 1,n
        zx(i) = dcmplx(da,0.0d0)*zx(i)
   30 continue
      return
      end
```

———-

— BLAS 1 zdscal —

```
(defun zdscal (n da zx incx)
  (declare (type (simple-array (complex double-float) (*)) zx)
           (type (double-float) da)
           (type fixnum incx n))
  (f2cl-lib:with-multi-array-data
      ((zx (complex double-float) zx-%data% zx-%offset%))
    (prog ((i 0) (ix 0))
      (declare (type fixnum ix i))
      (if (or (<= n 0) (<= incx 0)) (go end_label))
      (if (= incx 1) (go label20))
      (setf ix 1)
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i n) nil)
        (tagbody
          (setf (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%)
                  (* (coerce (complex da 0.0) '(complex doublefloat))
                     (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%)))
          (setf ix (f2cl-lib:int-add ix incx))))
      (go end_label)
 label20
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i n) nil)
        (tagbody
          (setf (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%)
                  (* (coerce (complex da 0.0) '(complex double-float))
                     (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%)))))
 end_label
      (return (values nil nil nil nil)))))
```

———-

3.23 zrotg BLAS

— zrotg.input —

```
)set break resume
)sys rm -f zrotg.output
)spool zrotg.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zrotg.help** —

```
=====================================================================
zrotg examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       ZROTG - Extensions to BLAS level one rotation subroutines


SYNOPSIS
           SUBROUTINE ZROTG ( a, b, c, s )

           DOUBLE COMPLEX
                       a, b, s

           DOUBLE PRECISION
                       c

DESCRIPTION
       ZROTG  computes  the  elements  of  a Givens plane rotation matrix such
       that:

            _             _    _   _    _   _
           |      c    s  |    | a |    | r |
           |-congj(s)  c  | *  | b | =  | 0 |
           -              -    -   -    -   -

       where r = (a / sqrt(conjg(a)*a)) * sqrt ( conjg(a)*a + conjg(b)*b ) ,
       and the notation conjg(z) represents the complex conjugate of z.

       The Givens plane rotation can be used to introduce zero elements into
       a matrix selectively.
```

```
ARGUMENTS
       a       (input and output) DOUBLE COMPLEX

               First vector component.

               On input, the first component of the vector to be rotated.  On
               output,  a is overwritten by the unique complex number r, whose
               size in the complex plane is the Euclidean norm of the  complex
               vector  (a,b),  and whose direction in the complex plane is the
               same as that of the original complex element a.

                   if |a| != 0
                   r = a / |a| * sqrt( conjg(a)*a + conjg(b)*b )

                   if |a| = 0
                   r = b

       b       (input) DOUBLE COMPLEX

               Second vector component.

               The second component of the vector to be rotated.



       c       (output) DOUBLE PRECISION

               Cosine of the angle of rotation.

                   if |a| != 0
                   c = |a| /  sqrt( conjg(a)*a + conjg(b)*b )

                   if |a| = 0
                   c = 0

       s       (output) DOUBLE COMPLEX
               Sine of the angle of rotation.

                   if |a| != 0
                   c=a/|a|*conjg(b)/sqrt(conjg(a)*a+conjg(b)*b)

                   if |a| = 0
                   s = ( 1.0 , 0.0 )
```

(Complex Double-Float). Computes plane rotation. Arguments are:

- da - (complex double-float)
- db - (complex double-float)
- c - double-float
- s - (complex double-float)

Returns multiple values where:

- 1 da - ca
- 2 db - nil
- 3 c - c
- 4 s - s

— zrotg.f —

```
   subroutine zrotg(ca,cb,c,s)
   double complex ca,cb,s
   double precision c
   double precision norm,scale
   double complex alpha
   if (cdabs(ca) .ne. 0.0d0) go to 10
      c = 0.0d0
      s = (1.0d0,0.0d0)
      ca = cb
      go to 20
10 continue
      scale = cdabs(ca) + cdabs(cb)
      norm = scale*dsqrt((cdabs(ca/dcmplx(scale,0.0d0)))**2 +
  *                     (cdabs(cb/dcmplx(scale,0.0d0)))**2)
      alpha = ca /cdabs(ca)
      c = cdabs(ca) / norm
      s = alpha * dconjg(cb) / norm
      ca = alpha * norm
20 continue
   return
   end
```

———-

— BLAS 1 zrotg —

```
(defun zrotg (ca cb c s)
  (declare (type (double-float) c) (type (complex double-float) s cb ca))
  (prog ((alpha #C(0.0 0.0)) (norm 0.0) (scale 0.0))
    (declare (type (double-float) scale norm)
             (type (complex double-float) alpha))
    (if (/= (f2cl-lib:cdabs ca) 0.0) (go label10))
    (setf c 0.0)
    (setf s (complex 1.0 0.0))
    (setf ca cb)
 (go label20)
 label10
    (setf scale
            (coerce (+ (f2cl-lib:cdabs ca) (f2cl-lib:cdabs cb)) 'double-float))
    (setf norm
            (* scale
               (f2cl-lib:dsqrt
                (+ (expt (f2cl-lib:cdabs (/ ca
                     (coerce (complex scale 0.0) '(complex double-float)))) 2)
                   (expt (f2cl-lib:cdabs (/ cb
                    (coerce (complex scale 0.0) '(complex double-float))))
                     2)))))
    (setf alpha (/ ca (f2cl-lib:cdabs ca)))
    (setf c (/ (f2cl-lib:cdabs ca) norm))
    (setf s (/ (* alpha (f2cl-lib:dconjg cb)) norm))
    (setf ca (* alpha norm))
 label20
    (return (values ca nil c s))))
```

———-

3.24 zscal BLAS

— **zscal.input** —

```
)set break resume
)sys rm -f zscal.output
)spool zscal.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— zscal.help —

```
======================================================================
zscal examples
======================================================================

======================================================================
Man Page Details
======================================================================

NAME
       ZSCAL - BLAS level one, Scales a double complex vector

SYNOPSIS
       SUBROUTINE ZSCAL    ( n, alpha, x, incx )

           INTEGER            n, incx

           DOUBLE COMPLEX     x, alpha


DESCRIPTION
       ZSCAL  scales  a  double  complex  vector with a double complex scalar.
       ZSCAL scales the vector x of length n and increment incx  by  the  con-
       stant alpha.

       This routine performs the following vector operation:

                 x <-- alpha x

       where alpha is a double complex scalar, and x is a double complex
       vector.

ARGUMENTS
       n       INTEGER. (input)
               Number of elements in the vector.
               If n <= 0, this routine returns without computation.

       alpha   DOUBLE COMPLEX. (input)
               Value used to scale vector

       x       DOUBLE COMPLEX. (input and output)
               Array  of dimension (n-1) * abs(incx) + 1. Vector to be scaled.

       incx    INTEGER. (input)
               Increment between elements of x.
               If incx = 0, the results will be unpredictable.

NOTES
```

```
       When  working  backward  (incx < 0 or incy < 0), each routine starts at
       the end of the vector and moves backward, as follows:

            x(1-incx * (n-1)), x(1-incx * (n-2)), ..., x(1)
```

— zscal.f —

```
      subroutine  zscal(n,za,zx,incx)
c
c     scales a vector by a constant.
c     jack dongarra, 3/11/78.
c     modified 3/93 to return if incx .le. 0.
c     modified 12/3/93, array(1) declarations changed to array(*)
c
      double complex za,zx(*)
      integer i,incx,ix,n
c
      if( n.le.0 .or. incx.le.0 )return
      if(incx.eq.1)go to 20
c
c        code for increment not equal to 1
c
      ix = 1
      do 10 i = 1,n
        zx(ix) = za*zx(ix)
        ix = ix + incx
   10 continue
      return
c
c        code for increment equal to 1
c
   20 do 30 i = 1,n
        zx(i) = za*zx(i)
   30 continue
      return
      end
```

— BLAS 1 zscal —

```
(defun zscal (n za zx incx)
  (declare (type (simple-array (complex double-float) (*)) zx)
           (type (complex double-float) za)
```

```
          (type fixnum incx n))
  (f2cl-lib:with-multi-array-data
      ((zx (complex double-float) zx-%data% zx-%offset%))
    (prog ((i 0) (ix 0))
      (declare (type fixnum ix i))
      (if (or (<= n 0) (<= incx 0)) (go end_label))
      (if (= incx 1) (go label20))
      (setf ix 1)
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i n) nil)
        (tagbody
          (setf (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%)
                  (* za (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%)))
          (setf ix (f2cl-lib:int-add ix incx))))
      (go end_label)
 label20
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i n) nil)
        (tagbody
          (setf (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%)
                  (* za (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%)))))
 end_label
      (return (values nil nil nil nil)))))
```

———-

3.25 zswap BLAS

— **zswap.input** —

```
)set break resume
)sys rm -f zswap.output
)spool zswap.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zswap.help** —

```
==========================================================================
```

```
zswap examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       ZSWAP - BLAS level one, Swaps two double complex vectors

SYNOPSIS
       SUBROUTINE ZSWAP    ( n, x, incx, y, incy )

           INTEGER           n, incx, incy

           DOUBLE COMPLEX    x, y


DESCRIPTION
       ZSWAP  swaps  two  double  complex vectors, it interchanges n values of
       vector x and vector y.  incx and incy specify the increment between two
       consecutive elements of respectively vector x and y.


       This routine performs the following vector operation:

                 x <-> y

            where x and y are double complex vectors.

ARGUMENTS
       n       INTEGER. (input)
               Number of vector elements to be swapped.
               If n <= 0, this routine returns without computation.

       x       DOUBLE COMPLEX, (input and output)
               Array of dimension (n-1) * |incx| + 1.

       incx    INTEGER. (input)
               Increment between elements of x.
               If incx = 0, the results will be unpredictable.

       y       DOUBLE COMPLEX, (input and output)
               array of dimension (n-1) * |incy| + 1. Vector to be swapped.

       incy    INTEGER. (input)
               Increment between elements of y.  If incy = 0, the results will
               be unpredictable.

NOTES
```

When working backward (incx < 0 or incy < 0), each routine starts at the end of the vector and moves backward, as follows:

x(1-incx * (n-1)), x(1-incx * (n-2)), ..., x(1)

y(1-incy * (n-1)), y(1-incy * (n-2)), ..., y(1)

———-

— **zswap.f** —

```
      subroutine  zswap (n,zx,incx,zy,incy)
c
c     interchanges two vectors.
c     jack dongarra, 3/11/78.
c     modified 12/3/93, array(1) declarations changed to array(*)
c
      double complex zx(*),zy(*),ztemp
      integer i,incx,incy,ix,iy,n
c
      if(n.le.0)return
      if(incx.eq.1.and.incy.eq.1)go to 20
c
c       code for unequal increments or equal increments not equal
c         to 1
c
      ix = 1
      iy = 1
      if(incx.lt.0)ix = (-n+1)*incx + 1
      if(incy.lt.0)iy = (-n+1)*incy + 1
      do 10 i = 1,n
        ztemp = zx(ix)
        zx(ix) = zy(iy)
        zy(iy) = ztemp
        ix = ix + incx
        iy = iy + incy
   10 continue
      return
c
c       code for both increments equal to 1
   20 do 30 i = 1,n
        ztemp = zx(i)
        zx(i) = zy(i)
        zy(i) = ztemp
   30 continue
      return
      end
```

———-

— BLAS 1 zswap —

```
(defun zswap (n zx incx zy incy)
  (declare (type (simple-array (complex double-float) (*)) zy zx)
           (type fixnum incy incx n))
  (f2cl-lib:with-multi-array-data
      ((zx (complex double-float) zx-%data% zx-%offset%)
       (zy (complex double-float) zy-%data% zy-%offset%))
    (prog ((i 0) (ix 0) (iy 0) (ztemp #C(0.0 0.0)))
      (declare (type (complex double-float) ztemp)
               (type fixnum iy ix i))
      (if (<= n 0) (go end_label))
      (if (and (= incx 1) (= incy 1)) (go label20))
      (setf ix 1)
      (setf iy 1)
      (if (< incx 0)
          (setf ix
                  (f2cl-lib:int-add
                   (f2cl-lib:int-mul (the fixnum (1- n)) incx)
                   1)))
      (if (< incy 0)
          (setf iy
                  (f2cl-lib:int-add
                   (f2cl-lib:int-mul (the fixnum (1- n)) incy)
                   1)))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i n) nil)
        (tagbody
          (setf ztemp (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%))
          (setf (f2cl-lib:fref zx-%data% (ix) ((1 *)) zx-%offset%)
                  (f2cl-lib:fref zy-%data% (iy) ((1 *)) zy-%offset%))
          (setf (f2cl-lib:fref zy-%data% (iy) ((1 *)) zy-%offset%) ztemp)
          (setf ix (f2cl-lib:int-add ix incx))
          (setf iy (f2cl-lib:int-add iy incy))))
      (go end_label)
 label20
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i n) nil)
        (tagbody
          (setf ztemp (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%))
          (setf (f2cl-lib:fref zx-%data% (i) ((1 *)) zx-%offset%)
                  (f2cl-lib:fref zy-%data% (i) ((1 *)) zy-%offset%))
          (setf (f2cl-lib:fref zy-%data% (i) ((1 *)) zy-%offset%) ztemp)))
 end_label
      (return (values nil nil nil nil nil)))))
```

Chapter 4

BLAS Level 2

4.1 dgbmv BLAS

— **dgbmv.input** —

```
)set break resume
)sys rm -f dgbmv.output
)spool dgbmv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

————-

— **dgbmv.help** —

```
========================================================================
dgbmv examples
========================================================================

========================================================================
Man Page Details
========================================================================

 NAME
      DGBMV - perform one of the matrix-vector operations   y :=
      alpha*A*x + beta*y, or y := alpha*A'*x + beta*y,
```

```
SYNOPSIS
     SUBROUTINE DGBMV ( TRANS, M, N, KL, KU, ALPHA, A, LDA, X,
                        INCX, BETA, Y, INCY )

         DOUBLE       PRECISION ALPHA, BETA

         INTEGER      INCX, INCY, KL, KU, LDA, M, N

         CHARACTER*1  TRANS

         DOUBLE       PRECISION A( LDA, * ), X( * ), Y( * )

PURPOSE
     DGBMV  performs one of the matrix-vector operations

     where alpha and beta are scalars, x and y are vectors and A
     is an m by n band matrix, with kl sub-diagonals and ku
     super-diagonals.

PARAMETERS
     TRANS  - CHARACTER*1.
            On entry, TRANS specifies the operation to be per-
            formed as follows:

            TRANS = 'N' or 'n'   y := alpha*A*x + beta*y.

            TRANS = 'T' or 't'   y := alpha*A'*x + beta*y.

            TRANS = 'C' or 'c'   y := alpha*A'*x + beta*y.

            Unchanged on exit.

     M      - INTEGER.
            On entry, M specifies the number of rows of the
            matrix A.  M must be at least zero.  Unchanged on
            exit.

     N      - INTEGER.
            On entry, N specifies the number of columns of the
            matrix A.  N must be at least zero.  Unchanged on
            exit.

     KL     - INTEGER.
            On entry, KL specifies the number of sub-diagonals of
            the matrix A. KL must satisfy  0 .le. KL.  Unchanged
            on exit.

     KU     - INTEGER.
            On entry, KU specifies the number of super-diagonals
            of the matrix A. KU must satisfy  0 .le. KU.
```

```
       Unchanged on exit.

ALPHA  - DOUBLE PRECISION.
       On entry, ALPHA specifies the scalar alpha.
       Unchanged on exit.

A      - DOUBLE PRECISION array of DIMENSION ( LDA, n ).
       Before entry, the leading ( kl + ku + 1 ) by n part
       of the array A must contain the matrix of coeffi-
       cients, supplied column by column, with the leading
       diagonal of the matrix in row ( ku + 1 ) of the
       array, the first super-diagonal starting at position
       2 in row ku, the first sub-diagonal starting at posi-
       tion 1 in row ( ku + 2 ), and so on.  Elements in the
       array A that do not correspond to elements in the
       band matrix (such as the top left ku by ku triangle)
       are not referenced.  The following program segment
       will transfer a band matrix from conventional full
       matrix storage to band storage:

       DO 20, J = 1, N K = KU + 1 - J DO 10, I = MAX( 1, J -
       KU ), MIN( M, J + KL ) A( K + I, J ) = matrix( I, J )
       10    CONTINUE 20 CONTINUE

       Unchanged on exit.

LDA    - INTEGER.
       On entry, LDA specifies the first dimension of A as
       declared in the calling (sub) program. LDA must be at
       least ( kl + ku + 1 ).  Unchanged on exit.

X      - DOUBLE PRECISION array of DIMENSION at least
       ( 1 + ( n - 1 )*abs( INCX ) ) when TRANS = 'N' or 'n'
       and at least ( 1 + ( m - 1 )*abs( INCX ) ) otherwise.
       Before entry, the incremented array X must contain
       the vector x.  Unchanged on exit.

INCX   - INTEGER.
       On entry, INCX specifies the increment for the ele-
       ments of X. INCX must not be zero.  Unchanged on
       exit.

BETA   - DOUBLE PRECISION.
       On entry, BETA specifies the scalar beta. When BETA
       is supplied as zero then Y need not be set on input.
       Unchanged on exit.

Y      - DOUBLE PRECISION array of DIMENSION at least
       ( 1 + ( m - 1 )*abs( INCY ) ) when TRANS = 'N' or 'n'
```

```
            and at least ( 1 + ( n - 1 )*abs( INCY ) ) otherwise.
            Before entry, the incremented array Y must contain
            the vector y. On exit, Y is overwritten by the
            updated vector y.

      INCY   - INTEGER.
            On entry, INCY specifies the increment for the ele-
            ments of Y. INCY must not be zero.  Unchanged on
            exit.
```

— dgbmv.f —

```
      SUBROUTINE DGBMV ( TRANS, M, N, KL, KU, ALPHA, A, LDA, X, INCX,
     $                   BETA, Y, INCY )
*     .. Scalar Arguments ..
      DOUBLE PRECISION   ALPHA, BETA
      INTEGER            INCX, INCY, KL, KU, LDA, M, N
      CHARACTER*1        TRANS
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), X( * ), Y( * )
*     ..
*
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE         , ZERO
      PARAMETER        ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     .. Local Scalars ..
      DOUBLE PRECISION   TEMP
      INTEGER            I, INFO, IX, IY, J, JX, JY, K, KUP1, KX, KY,
     $                   LENX, LENY
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
```

```
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( TRANS, 'N' ).AND.
     $         .NOT.LSAME( TRANS, 'T' ).AND.
     $         .NOT.LSAME( TRANS, 'C' )      )THEN
         INFO = 1
      ELSE IF( M.LT.0 )THEN
         INFO = 2
      ELSE IF( N.LT.0 )THEN
         INFO = 3
      ELSE IF( KL.LT.0 )THEN
         INFO = 4
      ELSE IF( KU.LT.0 )THEN
         INFO = 5
      ELSE IF( LDA.LT.( KL + KU + 1 ) )THEN
         INFO = 8
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 10
      ELSE IF( INCY.EQ.0 )THEN
         INFO = 13
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DGBMV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( M.EQ.0 ).OR.( N.EQ.0 ).OR.
     $    ( ( ALPHA.EQ.ZERO ).AND.( BETA.EQ.ONE ) ) )
     $   RETURN
*
*     Set  LENX  and  LENY, the lengths of the vectors x and y, and set
*     up the start points in  X  and  Y.
*
      IF( LSAME( TRANS, 'N' ) )THEN
         LENX = N
         LENY = M
      ELSE
         LENX = M
         LENY = N
      END IF
      IF( INCX.GT.0 )THEN
         KX = 1
      ELSE
         KX = 1 - ( LENX - 1 )*INCX
      END IF
```

```
      IF( INCY.GT.0 )THEN
         KY = 1
      ELSE
         KY = 1 - ( LENY - 1 )*INCY
      END IF
*
*     Start the operations. In this version the elements of A are
*     accessed sequentially with one pass through the band part of A.
*
*     First form  y := beta*y.
*
      IF( BETA.NE.ONE )THEN
         IF( INCY.EQ.1 )THEN
            IF( BETA.EQ.ZERO )THEN
               DO 10, I = 1, LENY
                  Y( I ) = ZERO
   10          CONTINUE
            ELSE
               DO 20, I = 1, LENY
                  Y( I ) = BETA*Y( I )
   20          CONTINUE
            END IF
         ELSE
            IY = KY
            IF( BETA.EQ.ZERO )THEN
               DO 30, I = 1, LENY
                  Y( IY ) = ZERO
                  IY      = IY   + INCY
   30          CONTINUE
            ELSE
               DO 40, I = 1, LENY
                  Y( IY ) = BETA*Y( IY )
                  IY      = IY           + INCY
   40          CONTINUE
            END IF
         END IF
      END IF
      IF( ALPHA.EQ.ZERO )
     $   RETURN
      KUP1 = KU + 1
      IF( LSAME( TRANS, 'N' ) )THEN
*
*        Form  y := alpha*A*x + y.
*
         JX = KX
         IF( INCY.EQ.1 )THEN
            DO 60, J = 1, N
               IF( X( JX ).NE.ZERO )THEN
                  TEMP = ALPHA*X( JX )
                  K    = KUP1 - J
```

```
                  DO 50, I = MAX( 1, J - KU ), MIN( M, J + KL )
                     Y( I ) = Y( I ) + TEMP*A( K + I, J )
   50             CONTINUE
               END IF
               JX = JX + INCX
   60       CONTINUE
         ELSE
            DO 80, J = 1, N
               IF( X( JX ).NE.ZERO )THEN
                  TEMP = ALPHA*X( JX )
                  IY   = KY
                  K    = KUP1 - J
                  DO 70, I = MAX( 1, J - KU ), MIN( M, J + KL )
                     Y( IY ) = Y( IY ) + TEMP*A( K + I, J )
                     IY      = IY      + INCY
   70             CONTINUE
               END IF
               JX = JX + INCX
               IF( J.GT.KU )
     $            KY = KY + INCY
   80       CONTINUE
         END IF
      ELSE
*
*        Form  y := alpha*A'*x + y.
*
         JY = KY
         IF( INCX.EQ.1 )THEN
            DO 100, J = 1, N
               TEMP = ZERO
               K    = KUP1 - J
               DO 90, I = MAX( 1, J - KU ), MIN( M, J + KL )
                  TEMP = TEMP + A( K + I, J )*X( I )
   90          CONTINUE
               Y( JY ) = Y( JY ) + ALPHA*TEMP
               JY      = JY      + INCY
  100       CONTINUE
         ELSE
            DO 120, J = 1, N
               TEMP = ZERO
               IX   = KX
               K    = KUP1 - J
               DO 110, I = MAX( 1, J - KU ), MIN( M, J + KL )
                  TEMP = TEMP + A( K + I, J )*X( IX )
                  IX   = IX   + INCX
  110          CONTINUE
               Y( JY ) = Y( JY ) + ALPHA*TEMP
               JY      = JY      + INCY
               IF( J.GT.KU )
     $            KX = KX + INCX
```

```
  120       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of DGBMV .
*
      END
```

———-

— BLAS 2 dgbmv —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dgbmv (trans m n kl ku alpha a lda x incx beta y incy)
    (declare (type (simple-array double-float (*)) y x a)
             (type (double-float) beta alpha)
             (type fixnum incy incx lda ku kl n m)
             (type character trans))
    (f2cl-lib:with-multi-array-data
        ((trans character trans-%data% trans-%offset%)
         (a double-float a-%data% a-%offset%)
         (x double-float x-%data% x-%offset%)
         (y double-float y-%data% y-%offset%))
      (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (k 0) (kup1 0)
             (kx 0) (ky 0) (lenx 0) (leny 0) (temp 0.0))
        (declare (type fixnum i info ix iy j jx jy k kup1 kx ky
                                          lenx leny)
                 (type (double-float) temp))
        (setf info 0)
        (cond
          ((and (not (char-equal trans #\N))
                (not (char-equal trans #\T))
                (not (char-equal trans #\C)))
           (setf info 1))
          ((< m 0)
           (setf info 2))
          ((< n 0)
           (setf info 3))
          ((< kl 0)
           (setf info 4))
          ((< ku 0)
           (setf info 5))
          ((< lda (f2cl-lib:int-add kl ku 1))
           (setf info 8))
```

```
          ((= incx 0)
           (setf info 10))
          ((= incy 0)
           (setf info 13)))
        (cond
          ((/= info 0)
            (error
              " ** On entry to ~a parameter number ~a had an illegal value~%"
              "DGBMV" info)
           (go end_label)))
        (if (or (= m 0) (= n 0) (and (= alpha zero) (= beta one)))
            (go end_label))
        (cond
          ((char-equal trans #\N)
           (setf lenx n)
           (setf leny m))
          (t
           (setf lenx m)
           (setf leny n)))
        (cond
          ((> incx 0)
           (setf kx 1))
          (t
           (setf kx
                   (the fixnum (- 1
                                  (f2cl-lib:int-mul
                                   (the fixnum (1- lenx))
                                   incx))))))
        (cond
          ((> incy 0)
           (setf ky 1))
          (t
           (setf ky
                   (the fixnum (- 1
                                  (f2cl-lib:int-mul
                                   (the fixnum (1- leny))
                                   incy)))
)))
        (cond
          ((/= beta one)
           (cond
             ((= incy 1)
              (cond
                ((= beta zero)
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                               ((> i leny) nil)
                   (tagbody
                     (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                             zero))))
                (t
```

```
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          ((> i leny) nil)
              (tagbody
                (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                        (* beta
                           (f2cl-lib:fref y-%data%
                                          (i)
                                          ((1 *))
                                          y-%offset%))))))))
       (t
        (setf iy ky)
        (cond
          ((= beta zero)
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i leny) nil)
             (tagbody
               (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                       zero)
               (setf iy (f2cl-lib:int-add iy incy)))))
          (t
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i leny) nil)
             (tagbody
               (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                       (* beta
                          (f2cl-lib:fref y-%data%
                                         (iy)
                                         ((1 *))
                                         y-%offset%)))
               (setf iy (f2cl-lib:int-add iy incy))))))))))
(if (= alpha zero) (go end_label))
(setf kup1 (f2cl-lib:int-add ku 1))
(cond
  ((char-equal trans #\N)
   (setf jx kx)
   (cond
     ((= incy 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (cond
            ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
             (setf temp
                     (* alpha
                        (f2cl-lib:fref x-%data%
                                       (jx)
                                       ((1 *))
                                       x-%offset%)))
             (setf k (f2cl-lib:int-sub kup1 j))
             (f2cl-lib:fdo (i
```

```
                              (max (the fixnum 1)
                                   (the fixnum
                                        (f2cl-lib:int-add j
                                                          (f2cl-lib:int-sub
                                                           ku))))
                              (f2cl-lib:int-add i 1))
                             ((> i
                                 (min (the fixnum m)
                                      (the fixnum
                                           (f2cl-lib:int-add j kl))))
                              nil)
                    (tagbody
                      (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                            (+
                             (f2cl-lib:fref y-%data%
                                            (i)
                                            ((1 *))
                                            y-%offset%)
                             (* temp
                                (f2cl-lib:fref a-%data%
                                               ((f2cl-lib:int-add k i) j)
                                               ((1 lda) (1 *))
                                               a-%offset%)))))))
          (setf jx (f2cl-lib:int-add jx incx)))))
      (t
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (cond
             ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
              (setf temp
                      (* alpha
                         (f2cl-lib:fref x-%data%
                                        (jx)
                                        ((1 *))
                                        x-%offset%)))
              (setf iy ky)
              (setf k (f2cl-lib:int-sub kup1 j))
              (f2cl-lib:fdo (i
                             (max (the fixnum 1)
                                  (the fixnum
                                       (f2cl-lib:int-add j
                                                         (f2cl-lib:int-sub
                                                          ku))))
                             (f2cl-lib:int-add i 1))
                            ((> i
                                (min (the fixnum m)
                                     (the fixnum
                                          (f2cl-lib:int-add j kl))))
                             nil)
```

```
                (tagbody
                  (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                          (+
                           (f2cl-lib:fref y-%data%
                                          (iy)
                                          ((1 *))
                                          y-%offset%)
                           (* temp
                              (f2cl-lib:fref a-%data%
                                             ((f2cl-lib:int-add k i) j)
                                             ((1 lda) (1 *))
                                             a-%offset%))))
                  (setf iy (f2cl-lib:int-add iy incy))))))
          (setf jx (f2cl-lib:int-add jx incx))
          (if (> j ku) (setf ky (f2cl-lib:int-add ky incy))))))))
(t
 (setf jy ky)
 (cond
   ((= incx 1)
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j n) nil)
      (tagbody
        (setf temp zero)
        (setf k (f2cl-lib:int-sub kup1 j))
        (f2cl-lib:fdo (i
                       (max (the fixnum 1)
                            (the fixnum
                                 (f2cl-lib:int-add j
                                                   (f2cl-lib:int-sub
                                                    ku))))
                       (f2cl-lib:int-add i 1))
                      ((> i
                          (min (the fixnum m)
                               (the fixnum
                                    (f2cl-lib:int-add j kl))))
                       nil)
          (tagbody
            (setf temp
                    (+ temp
                       (*
                        (f2cl-lib:fref a-%data%
                                       ((f2cl-lib:int-add k i) j)
                                       ((1 lda) (1 *))
                                       a-%offset%)
                        (f2cl-lib:fref x-%data%
                                       (i)
                                       ((1 *))
                                       x-%offset%))))))
        (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
```

```
                        (* alpha temp)))
                (setf jy (f2cl-lib:int-add jy incy)))))
           (t
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
              (tagbody
                (setf temp zero)
                (setf ix kx)
                (setf k (f2cl-lib:int-sub kup1 j))
                (f2cl-lib:fdo (i
                               (max (the fixnum 1)
                                    (the fixnum
                                         (f2cl-lib:int-add j
                                                           (f2cl-lib:int-sub
                                                            ku))))
                               (f2cl-lib:int-add i 1))
                              ((> i
                                  (min (the fixnum m)
                                       (the fixnum
                                            (f2cl-lib:int-add j kl))))
                               nil)
                  (tagbody
                    (setf temp
                            (+ temp
                               (*
                                (f2cl-lib:fref a-%data%
                                               ((f2cl-lib:int-add k i) j)
                                               ((1 lda) (1 *))
                                               a-%offset%)
                                (f2cl-lib:fref x-%data%
                                               (ix)
                                               ((1 *))
                                               x-%offset%))))
                    (setf ix (f2cl-lib:int-add ix incx))))
                (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                        (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                           (* alpha temp)))
                (setf jy (f2cl-lib:int-add jy incy))
                (if (> j ku) (setf kx (f2cl-lib:int-add kx incx)))))))))
end_label
       (return
        (values nil nil nil nil nil nil nil nil nil nil nil nil nil))))))
```

4.2 dgemv BLAS

— dgemv.input —

```
)set break resume
)sys rm -f dgemv.output
)spool dgemv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dgemv.help —

```
========================================================================
dgemv examples
========================================================================

========================================================================
Man Page Details
========================================================================

 NAME
      DGEMV - perform one of the matrix-vector operations   y :=
      alpha*A*x + beta*y, or y := alpha*A'*x + beta*y,

 SYNOPSIS
      SUBROUTINE DGEMV ( TRANS, M, N, ALPHA, A, LDA, X, INCX,
                         BETA, Y, INCY )

          DOUBLE       PRECISION ALPHA, BETA

          INTEGER      INCX, INCY, LDA, M, N

          CHARACTER*1  TRANS

          DOUBLE       PRECISION A( LDA, * ), X( * ), Y( * )

 PURPOSE
      DGEMV  performs one of the matrix-vector operations

      where alpha and beta are scalars, x and y are vectors and A
      is an m by n matrix.
```

```
PARAMETERS
     TRANS  - CHARACTER*1.
            On entry, TRANS specifies the operation to be per-
            formed as follows:

            TRANS = 'N' or 'n'   y := alpha*A*x + beta*y.

            TRANS = 'T' or 't'   y := alpha*A'*x + beta*y.

            TRANS = 'C' or 'c'   y := alpha*A'*x + beta*y.

            Unchanged on exit.

     M      - INTEGER.
            On entry, M specifies the number of rows of the
            matrix A.  M must be at least zero.  Unchanged on
            exit.

     N      - INTEGER.
            On entry, N specifies the number of columns of the
            matrix A.  N must be at least zero.  Unchanged on
            exit.

     ALPHA  - DOUBLE PRECISION.
            On entry, ALPHA specifies the scalar alpha.
            Unchanged on exit.

     A      - DOUBLE PRECISION array of DIMENSION ( LDA, n ).
            Before entry, the leading m by n part of the array A

            must contain the matrix of coefficients.  Unchanged
            on exit.

     LDA    - INTEGER.
            On entry, LDA specifies the first dimension of A as
            declared in the calling (sub) program. LDA must be at
            least max( 1, m ).  Unchanged on exit.

     X      - DOUBLE PRECISION array of DIMENSION at least
            ( 1 + ( n - 1 )*abs( INCX ) ) when TRANS = 'N' or 'n'
            and at least ( 1 + ( m - 1 )*abs( INCX ) ) otherwise.
            Before entry, the incremented array X must contain
            the vector x.  Unchanged on exit.

     INCX   - INTEGER.
            On entry, INCX specifies the increment for the ele-
            ments of X. INCX must not be zero.  Unchanged on
            exit.

     BETA   - DOUBLE PRECISION.
```

```
            On entry, BETA specifies the scalar beta. When BETA
            is supplied as zero then Y need not be set on input.
            Unchanged on exit.

      Y     - DOUBLE PRECISION array of DIMENSION at least
            ( 1 + ( m - 1 )*abs( INCY ) ) when TRANS = 'N' or 'n'
            and at least ( 1 + ( n - 1 )*abs( INCY ) ) otherwise.
            Before entry with BETA non-zero, the incremented
            array Y must contain the vector y. On exit, Y is
            overwritten by the updated vector y.

      INCY  - INTEGER.
            On entry, INCY specifies the increment for the ele-
            ments of Y. INCY must not be zero.  Unchanged on
            exit.
```

— dgemv.f —

```
      SUBROUTINE DGEMV ( TRANS, M, N, ALPHA, A, LDA, X, INCX,
     $                   BETA, Y, INCY )
*     .. Scalar Arguments ..
      DOUBLE PRECISION   ALPHA, BETA
      INTEGER            INCX, INCY, LDA, M, N
      CHARACTER*1        TRANS
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), X( * ), Y( * )
*     ..
*
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE         , ZERO
      PARAMETER        ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     .. Local Scalars ..
      DOUBLE PRECISION   TEMP
      INTEGER            I, INFO, IX, IY, J, JX, JY, KX, KY, LENX, LENY
*     .. External Functions ..
      LOGICAL            LSAME
```

```
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( TRANS, 'N' ).AND.
     $         .NOT.LSAME( TRANS, 'T' ).AND.
     $         .NOT.LSAME( TRANS, 'C' )      )THEN
         INFO = 1
      ELSE IF( M.LT.0 )THEN
         INFO = 2
      ELSE IF( N.LT.0 )THEN
         INFO = 3
      ELSE IF( LDA.LT.MAX( 1, M ) )THEN
         INFO = 6
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 8
      ELSE IF( INCY.EQ.0 )THEN
         INFO = 11
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DGEMV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( M.EQ.0 ).OR.( N.EQ.0 ).OR.
     $    ( ( ALPHA.EQ.ZERO ).AND.( BETA.EQ.ONE ) ) )
     $   RETURN
*
*     Set  LENX  and  LENY, the lengths of the vectors x and y, and set
*     up the start points in  X  and  Y.
*
      IF( LSAME( TRANS, 'N' ) )THEN
         LENX = N
         LENY = M
      ELSE
         LENX = M
         LENY = N
      END IF
      IF( INCX.GT.0 )THEN
         KX = 1
      ELSE
```

```
         KX = 1 - ( LENX - 1 )*INCX
      END IF
      IF( INCY.GT.0 )THEN
         KY = 1
      ELSE
         KY = 1 - ( LENY - 1 )*INCY
      END IF
*
*     Start the operations. In this version the elements of A are
*     accessed sequentially with one pass through A.
*
*     First form  y := beta*y.
*
      IF( BETA.NE.ONE )THEN
         IF( INCY.EQ.1 )THEN
            IF( BETA.EQ.ZERO )THEN
               DO 10, I = 1, LENY
                  Y( I ) = ZERO
   10          CONTINUE
            ELSE
               DO 20, I = 1, LENY
                  Y( I ) = BETA*Y( I )
   20          CONTINUE
            END IF
         ELSE
            IY = KY
            IF( BETA.EQ.ZERO )THEN
               DO 30, I = 1, LENY
                  Y( IY ) = ZERO
                  IY      = IY   + INCY
   30          CONTINUE
            ELSE
               DO 40, I = 1, LENY
                  Y( IY ) = BETA*Y( IY )
                  IY      = IY           + INCY
   40          CONTINUE
            END IF
         END IF
      END IF
      IF( ALPHA.EQ.ZERO )
     $   RETURN
      IF( LSAME( TRANS, 'N' ) )THEN
*
*        Form  y := alpha*A*x + y.
*
         JX = KX
         IF( INCY.EQ.1 )THEN
            DO 60, J = 1, N
               IF( X( JX ).NE.ZERO )THEN
                  TEMP = ALPHA*X( JX )
```

```
                  DO 50, I = 1, M
                     Y( I ) = Y( I ) + TEMP*A( I, J )
   50             CONTINUE
               END IF
               JX = JX + INCX
   60       CONTINUE
         ELSE
            DO 80, J = 1, N
               IF( X( JX ).NE.ZERO )THEN
                  TEMP = ALPHA*X( JX )
                  IY   = KY
                  DO 70, I = 1, M
                     Y( IY ) = Y( IY ) + TEMP*A( I, J )
                     IY      = IY      + INCY
   70             CONTINUE
               END IF
               JX = JX + INCX
   80       CONTINUE
         END IF
      ELSE
*
*        Form  y := alpha*A'*x + y.
*
         JY = KY
         IF( INCX.EQ.1 )THEN
            DO 100, J = 1, N
               TEMP = ZERO
               DO 90, I = 1, M
                  TEMP = TEMP + A( I, J )*X( I )
   90          CONTINUE
               Y( JY ) = Y( JY ) + ALPHA*TEMP
               JY      = JY      + INCY
  100       CONTINUE
         ELSE
            DO 120, J = 1, N
               TEMP = ZERO
               IX   = KX
               DO 110, I = 1, M
                  TEMP = TEMP + A( I, J )*X( IX )
                  IX   = IX   + INCX
  110          CONTINUE
               Y( JY ) = Y( JY ) + ALPHA*TEMP
               JY      = JY      + INCY
  120       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of DGEMV .
```

```
*
      END
```

———-

— BLAS 2 dgemv —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dgemv (trans m n alpha a lda x incx beta y incy)
    (declare (type (simple-array double-float (*)) y x a)
             (type (double-float) beta alpha)
             (type fixnum incy incx lda n m)
             (type character trans))
    (f2cl-lib:with-multi-array-data
        ((trans character trans-%data% trans-%offset%)
         (a double-float a-%data% a-%offset%)
         (x double-float x-%data% x-%offset%)
         (y double-float y-%data% y-%offset%))
      (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (kx 0) (ky 0)
             (lenx 0) (leny 0) (temp 0.0))
        (declare (type fixnum i info ix iy j jx jy kx ky lenx
                                        leny)
                 (type (double-float) temp))
        (setf info 0)
        (cond
          ((and (not (char-equal trans #\N))
                (not (char-equal trans #\T))
                (not (char-equal trans #\C)))
           (setf info 1))
          ((< m 0)
           (setf info 2))
          ((< n 0)
           (setf info 3))
          ((< lda (max (the fixnum 1) (the fixnum m)))
           (setf info 6))
          ((= incx 0)
           (setf info 8))
          ((= incy 0)
           (setf info 11)))
        (cond
          ((/= info 0)
           (error
             " ** On entry to ~a parameter number ~a had an illegal value~%"
             "DGEMV" info)
           (go end_label)))
        (if (or (= m 0) (= n 0) (and (= alpha zero) (= beta one)))
```

```
    (go end_label))
(cond
  ((char-equal trans #\N)
   (setf lenx n)
   (setf leny m))
  (t
   (setf lenx m)
   (setf leny n)))
(cond
  ((> incx 0)
   (setf kx 1))
  (t
   (setf kx
         (f2cl-lib:int-sub 1
                           (f2cl-lib:int-mul
                            (f2cl-lib:int-sub lenx 1)
                            incx)))))
(cond
  ((> incy 0)
   (setf ky 1))
  (t
   (setf ky
         (f2cl-lib:int-sub 1
                           (f2cl-lib:int-mul
                            (f2cl-lib:int-sub leny 1)
                            incy)))))
(cond
  ((/= beta one)
   (cond
     ((= incy 1)
      (cond
        ((= beta zero)
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i leny) nil)
           (tagbody
             (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                     zero))))
        (t
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i leny) nil)
           (tagbody
             (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                     (* beta
                        (f2cl-lib:fref y-%data%
                                       (i)
                                       ((1 *))
                                       y-%offset%)))))))))
     (t
      (setf iy ky)
      (cond
```

```
          ((= beta zero)
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i leny) nil)
             (tagbody
               (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                       zero)
               (setf iy (f2cl-lib:int-add iy incy)))))
          (t
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i leny) nil)
             (tagbody
               (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                       (* beta
                          (f2cl-lib:fref y-%data%
                                         (iy)
                                         ((1 *))
                                         y-%offset%)))
               (setf iy (f2cl-lib:int-add iy incy))))))))))
(if (= alpha zero) (go end_label))
(cond
  ((char-equal trans #\N)
   (setf jx kx)
   (cond
     ((= incy 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (cond
            ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
             (setf temp
                     (* alpha
                        (f2cl-lib:fref x-%data%
                                       (jx)
                                       ((1 *))
                                       x-%offset%)))
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i m) nil)
               (tagbody
                 (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                         (+
                          (f2cl-lib:fref y-%data%
                                         (i)
                                         ((1 *))
                                         y-%offset%)
                          (* temp
                             (f2cl-lib:fref a-%data%
                                            (i j)
                                            ((1 lda) (1 *))
                                            a-%offset%))))))))
          (setf jx (f2cl-lib:int-add jx incx)))))
```

```
      (t
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (cond
             ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
              (setf temp
                      (* alpha
                         (f2cl-lib:fref x-%data%
                                        (jx)
                                        ((1 *))
                                        x-%offset%)))
              (setf iy ky)
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                            ((> i m) nil)
                (tagbody
                  (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                          (+
                           (f2cl-lib:fref y-%data%
                                          (iy)
                                          ((1 *))
                                          y-%offset%)
                           (* temp
                              (f2cl-lib:fref a-%data%
                                             (i j)
                                             ((1 lda) (1 *))
                                             a-%offset%))))
                  (setf iy (f2cl-lib:int-add iy incy))))))
           (setf jx (f2cl-lib:int-add jx incx)))))))
    (t
     (setf jy ky)
     (cond
       ((= incx 1)
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                      ((> j n) nil)
          (tagbody
            (setf temp zero)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          ((> i m) nil)
              (tagbody
                (setf temp
                        (+ temp
                           (*
                            (f2cl-lib:fref a-%data%
                                           (i j)
                                           ((1 lda) (1 *))
                                           a-%offset%)
                            (f2cl-lib:fref x-%data%
                                           (i)
                                           ((1 *))
```

```
                                          x-%offset%))))))
                (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                        (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                           (* alpha temp)))
                (setf jy (f2cl-lib:int-add jy incy)))))
            (t
             (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                           ((> j n) nil)
               (tagbody
                 (setf temp zero)
                 (setf ix kx)
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                               ((> i m) nil)
                   (tagbody
                     (setf temp
                             (+ temp
                                (*
                                 (f2cl-lib:fref a-%data%
                                                (i j)
                                                ((1 lda) (1 *))
                                                a-%offset%)
                                 (f2cl-lib:fref x-%data%
                                                (ix)
                                                ((1 *))
                                                x-%offset%))))
                     (setf ix (f2cl-lib:int-add ix incx))))
                 (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                         (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                            (* alpha temp)))
                 (setf jy (f2cl-lib:int-add jy incy)))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil nil nil))))))
```

———-

4.3 dger BLAS

— **dger.input** —

```
)set break resume
)sys rm -f dger.output
)spool dger.output
)set message test on
)set message auto off
)clear all
```

```
)spool
)lisp (bye)
```

———-

— dger.help —

```
==========================================================================
dger examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      DGER - perform the rank 1 operation   A := alpha*x*y' + A,

 SYNOPSIS
      SUBROUTINE DGER ( M, N, ALPHA, X, INCX, Y, INCY, A, LDA )

          DOUBLE      PRECISION ALPHA

          INTEGER     INCX, INCY, LDA, M, N

          DOUBLE      PRECISION A( LDA, * ), X( * ), Y( * )

 PURPOSE
      DGER   performs the rank 1 operation

      where alpha is a scalar, x is an m element vector, y is an n
      element vector and A is an m by n matrix.

 PARAMETERS
      M      - INTEGER.
               On entry, M specifies the number of rows of the
               matrix A.  M must be at least zero.  Unchanged on
               exit.

      N      - INTEGER.
               On entry, N specifies the number of columns of the
               matrix A.  N must be at least zero.  Unchanged on
               exit.

      ALPHA  - DOUBLE PRECISION.
               On entry, ALPHA specifies the scalar alpha.
               Unchanged on exit.

      X      - DOUBLE PRECISION array of dimension at least
```

```
*           ( 1 + ( m - 1 )*abs( INCX ) ).  Before entry, the
*           incremented array X must contain the m element vector
*           x.  Unchanged on exit.
*
*     INCX   - INTEGER.
*           On entry, INCX specifies the increment for the ele-
*           ments of X. INCX must not be zero.  Unchanged on
*           exit.
*
*     Y      - DOUBLE PRECISION array of dimension at least
*           ( 1 + ( n - 1 )*abs( INCY ) ).  Before entry, the
*           incremented array Y must contain the n element vector
*           y.  Unchanged on exit.
*
*     INCY   - INTEGER.
*           On entry, INCY specifies the increment for the ele-
*           ments of Y. INCY must not be zero.  Unchanged on
*
*           exit.
*
*     A      - DOUBLE PRECISION array of DIMENSION ( LDA, n ).
*           Before entry, the leading m by n part of the array A
*           must contain the matrix of coefficients. On exit, A
*           is overwritten by the updated matrix.
*
*     LDA    - INTEGER.
*           On entry, LDA specifies the first dimension of A as
*           declared in the calling (sub) program. LDA must be at
*           least max( 1, m ).  Unchanged on exit.
```

— dger.f —

```
      SUBROUTINE DGER  ( M, N, ALPHA, X, INCX, Y, INCY, A, LDA )
*     .. Scalar Arguments ..
      DOUBLE PRECISION   ALPHA
      INTEGER            INCX, INCY, LDA, M, N
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), X( * ), Y( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
```

```
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER        ( ZERO = 0.0D+0 )
*     .. Local Scalars ..
      DOUBLE PRECISION   TEMP
      INTEGER            I, INFO, IX, J, JY, KX
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( M.LT.0 )THEN
         INFO = 1
      ELSE IF( N.LT.0 )THEN
         INFO = 2
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 5
      ELSE IF( INCY.EQ.0 )THEN
         INFO = 7
      ELSE IF( LDA.LT.MAX( 1, M ) )THEN
         INFO = 9
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DGER  ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( M.EQ.0 ).OR.( N.EQ.0 ).OR.( ALPHA.EQ.ZERO ) )
     $   RETURN
*
*     Start the operations. In this version the elements of A are
*     accessed sequentially with one pass through A.
*
      IF( INCY.GT.0 )THEN
         JY = 1
      ELSE
         JY = 1 - ( N - 1 )*INCY
      END IF
      IF( INCX.EQ.1 )THEN
         DO 20, J = 1, N
```

```
            IF( Y( JY ).NE.ZERO )THEN
               TEMP = ALPHA*Y( JY )
               DO 10, I = 1, M
                  A( I, J ) = A( I, J ) + X( I )*TEMP
   10          CONTINUE
            END IF
            JY = JY + INCY
   20    CONTINUE
      ELSE
         IF( INCX.GT.0 )THEN
            KX = 1
         ELSE
            KX = 1 - ( M - 1 )*INCX
         END IF
         DO 40, J = 1, N
            IF( Y( JY ).NE.ZERO )THEN
               TEMP = ALPHA*Y( JY )
               IX   = KX
               DO 30, I = 1, M
                  A( I, J ) = A( I, J ) + X( IX )*TEMP
                  IX        = IX        + INCX
   30          CONTINUE
            END IF
            JY = JY + INCY
   40    CONTINUE
      END IF
*
      RETURN
*
*     End of DGER  .
*
      END
```

———-

— BLAS 2 dger —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dger (m n alpha x incx y incy a lda)
    (declare (type (simple-array double-float (*)) a y x)
             (type (double-float) alpha)
             (type fixnum lda incy incx n m))
    (f2cl-lib:with-multi-array-data
        ((x double-float x-%data% x-%offset%)
         (y double-float y-%data% y-%offset%)
         (a double-float a-%data% a-%offset%))
      (prog ((i 0) (info 0) (ix 0) (j 0) (jy 0) (kx 0) (temp 0.0))
```

```
(declare (type fixnum i info ix j jy kx)
         (type (double-float) temp))
(setf info 0)
(cond
  ((< m 0)
   (setf info 1))
  ((< n 0)
   (setf info 2))
  ((= incx 0)
   (setf info 5))
  ((= incy 0)
   (setf info 7))
  ((< lda (max (the fixnum 1) (the fixnum m)))
   (setf info 9)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DYER" info)
   (go end_label)))
(if (or (= m 0) (= n 0) (= alpha zero)) (go end_label))
(cond
  ((> incy 0)
   (setf jy 1))
  (t
   (setf jy
           (f2cl-lib:int-sub 1
                             (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                               incy)))))
(cond
  ((= incx 1)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
     (tagbody
       (cond
         ((/= (f2cl-lib:fref y (jy) ((1 *))) zero)
          (setf temp
                  (* alpha
                     (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)))
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref a-%data%
                                   (i j)
                                   ((1 lda) (1 *))
                                   a-%offset%)
                    (+
                     (f2cl-lib:fref a-%data%
                                    (i j)
                                    ((1 lda) (1 *))
```

```
                                        a-%offset%)
                              (*
                               (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%)
                               temp)))))))
            (setf jy (f2cl-lib:int-add jy incy)))))
          (t
           (cond
             ((> incx 0)
              (setf kx 1))
             (t
              (setf kx
                      (f2cl-lib:int-sub 1
                                        (f2cl-lib:int-mul
                                         (f2cl-lib:int-sub m 1)
                                         incx)))))
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (cond
                 ((/= (f2cl-lib:fref y (jy) ((1 *))) zero)
                  (setf temp
                          (* alpha
                             (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)))
                  (setf ix kx)
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                ((> i m) nil)
                    (tagbody
                      (setf (f2cl-lib:fref a-%data%
                                           (i j)
                                           ((1 lda) (1 *))
                                           a-%offset%)
                                    (+
                                     (f2cl-lib:fref a-%data%
                                                    (i j)
                                                    ((1 lda) (1 *))
                                                    a-%offset%)
                                     (*
                                      (f2cl-lib:fref x-%data%
                                                     (ix)
                                                     ((1 *))
                                                     x-%offset%)
                                      temp)))
                            (setf ix (f2cl-lib:int-add ix incx))))))
                 (setf jy (f2cl-lib:int-add jy incy))))))
end_label
       (return (values nil nil nil nil nil nil nil nil nil)))))
```

4.4 dsbmv BLAS

— dsbmv.input —

```
)set break resume
)sys rm -f dsbmv.output
)spool dsbmv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

————-

— dsbmv.help —

```
==========================================================================
dsbmv examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      DSBMV - perform the matrix-vector operation   y := alpha*A*x
      + beta*y,

 SYNOPSIS
      SUBROUTINE DSBMV ( UPLO, N, K, ALPHA, A, LDA, X, INCX, BETA,
                         Y, INCY )

          DOUBLE       PRECISION ALPHA, BETA

          INTEGER      INCX, INCY, K, LDA, N

          CHARACTER*1  UPLO

          DOUBLE       PRECISION A( LDA, * ), X( * ), Y( * )

 PURPOSE
      DSBMV  performs the matrix-vector  operation

      where alpha and beta are scalars, x and y are n element vec-
      tors and A is an n by n symmetric band matrix, with k
      super-diagonals.
```

```
PARAMETERS
     UPLO   - CHARACTER*1.
            On entry, UPLO specifies whether the upper or lower
            triangular part of the band matrix A is being sup-
            plied as follows:

            UPLO = 'U' or 'u'   The upper triangular part of A is
            being supplied.

            UPLO = 'L' or 'l'   The lower triangular part of A is
            being supplied.

            Unchanged on exit.

     N      - INTEGER.
            On entry, N specifies the order of the matrix A.  N
            must be at least zero.  Unchanged on exit.

     K      - INTEGER.
            On entry, K specifies the number of super-diagonals
            of the matrix A. K must satisfy  0 .le. K.  Unchanged
            on exit.

     ALPHA  - DOUBLE PRECISION.
            On entry, ALPHA specifies the scalar alpha.
            Unchanged on exit.

     A      - DOUBLE PRECISION array of DIMENSION ( LDA, n ).

            Before entry with UPLO = 'U' or 'u', the leading ( k
            + 1 ) by n part of the array A must contain the upper
            triangular band part of the symmetric matrix, sup-
            plied column by column, with the leading diagonal of
            the matrix in row ( k + 1 ) of the array, the first
            super-diagonal starting at position 2 in row k, and
            so on. The top left k by k triangle of the array A is
            not referenced.  The following program segment will
            transfer the upper triangular part of a symmetric
            band matrix from conventional full matrix storage to
            band storage:

            DO 20, J = 1, N M = K + 1 - J DO 10, I = MAX( 1, J -
            K ), J A( M + I, J ) = matrix( I, J ) 10    CONTINUE
            20 CONTINUE

            Before entry with UPLO = 'L' or 'l', the leading ( k
            + 1 ) by n part of the array A must contain the lower
            triangular band part of the symmetric matrix, sup-
            plied column by column, with the leading diagonal of
```

```
        the matrix in row 1 of the array, the first sub-
        diagonal starting at position 1 in row 2, and so on.
        The bottom right k by k triangle of the array A is
        not referenced.  The following program segment will
        transfer the lower triangular part of a symmetric
        band matrix from conventional full matrix storage to
        band storage:

        DO 20, J = 1, N M = 1 - J DO 10, I = J, MIN( N, J + K
        ) A( M + I, J ) = matrix( I, J ) 10    CONTINUE 20
        CONTINUE

        Unchanged on exit.

LDA     - INTEGER.
        On entry, LDA specifies the first dimension of A as
        declared in the calling (sub) program. LDA must be at
        least ( k + 1 ).  Unchanged on exit.

X       - DOUBLE PRECISION array of DIMENSION at least
        ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
        incremented array X must contain the vector x.
        Unchanged on exit.

INCX    - INTEGER.
        On entry, INCX specifies the increment for the ele-
        ments of X. INCX must not be zero.  Unchanged on
        exit.

BETA    - DOUBLE PRECISION.
        On entry, BETA specifies the scalar beta.  Unchanged
        on exit.

Y       - DOUBLE PRECISION array of DIMENSION at least
        ( 1 + ( n - 1 )*abs( INCY ) ).  Before entry, the
        incremented array Y must contain the vector y. On
        exit, Y is overwritten by the updated vector y.

INCY    - INTEGER.
        On entry, INCY specifies the increment for the ele-
        ments of Y. INCY must not be zero.  Unchanged on
        exit.
```

———-

— dsbmv.f —

```
SUBROUTINE DSBMV ( UPLO, N, K, ALPHA, A, LDA, X, INCX,
```

```
     $                   BETA, Y, INCY )
*     .. Scalar Arguments ..
      DOUBLE PRECISION   ALPHA, BETA
      INTEGER            INCX, INCY, K, LDA, N
      CHARACTER*1        UPLO
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), X( * ), Y( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE         , ZERO
      PARAMETER        ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     .. Local Scalars ..
      DOUBLE PRECISION   TEMP1, TEMP2
      INTEGER            I, INFO, IX, IY, J, JX, JY, KPLUS1, KX, KY, L
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO, 'U' ).AND.
     $         .NOT.LSAME( UPLO, 'L' )      )THEN
         INFO = 1
      ELSE IF( N.LT.0 )THEN
         INFO = 2
      ELSE IF( K.LT.0 )THEN
         INFO = 3
      ELSE IF( LDA.LT.( K + 1 ) )THEN
         INFO = 6
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 8
      ELSE IF( INCY.EQ.0 )THEN
         INFO = 11
```

```
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DSBMV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( N.EQ.0 ).OR.( ( ALPHA.EQ.ZERO ).AND.( BETA.EQ.ONE ) ) )
     $   RETURN
*
*     Set up the start points in  X  and  Y.
*
      IF( INCX.GT.0 )THEN
         KX = 1
      ELSE
         KX = 1 - ( N - 1 )*INCX
      END IF
      IF( INCY.GT.0 )THEN
         KY = 1
      ELSE
         KY = 1 - ( N - 1 )*INCY
      END IF
*
*     Start the operations. In this version the elements of the array A
*     are accessed sequentially with one pass through A.
*
*     First form  y := beta*y.
*
      IF( BETA.NE.ONE )THEN
         IF( INCY.EQ.1 )THEN
            IF( BETA.EQ.ZERO )THEN
               DO 10, I = 1, N
                  Y( I ) = ZERO
   10          CONTINUE
            ELSE
               DO 20, I = 1, N
                  Y( I ) = BETA*Y( I )
   20          CONTINUE
            END IF
         ELSE
            IY = KY
            IF( BETA.EQ.ZERO )THEN
               DO 30, I = 1, N
                  Y( IY ) = ZERO
                  IY      = IY   + INCY
   30          CONTINUE
            ELSE
               DO 40, I = 1, N
                  Y( IY ) = BETA*Y( IY )
```

```
                IY      = IY           + INCY
   40         CONTINUE
            END IF
         END IF
      END IF
      IF( ALPHA.EQ.ZERO )
     $   RETURN
      IF( LSAME( UPLO, 'U' ) )THEN
*
*        Form  y  when upper triangle of A is stored.
*
         KPLUS1 = K + 1
         IF( ( INCX.EQ.1 ).AND.( INCY.EQ.1 ) )THEN
            DO 60, J = 1, N
               TEMP1 = ALPHA*X( J )
               TEMP2 = ZERO
               L     = KPLUS1 - J
               DO 50, I = MAX( 1, J - K ), J - 1
                  Y( I ) = Y( I ) + TEMP1*A( L + I, J )
                  TEMP2  = TEMP2  + A( L + I, J )*X( I )
   50          CONTINUE
               Y( J ) = Y( J ) + TEMP1*A( KPLUS1, J ) + ALPHA*TEMP2
   60       CONTINUE
         ELSE
            JX = KX
            JY = KY
            DO 80, J = 1, N
               TEMP1 = ALPHA*X( JX )
               TEMP2 = ZERO
               IX    = KX
               IY    = KY
               L     = KPLUS1 - J
               DO 70, I = MAX( 1, J - K ), J - 1
                  Y( IY ) = Y( IY ) + TEMP1*A( L + I, J )
                  TEMP2   = TEMP2   + A( L + I, J )*X( IX )
                  IX      = IX      + INCX
                  IY      = IY      + INCY
   70          CONTINUE
               Y( JY ) = Y( JY ) + TEMP1*A( KPLUS1, J ) + ALPHA*TEMP2
               JX      = JX      + INCX
               JY      = JY      + INCY
               IF( J.GT.K )THEN
                  KX = KX + INCX
                  KY = KY + INCY
               END IF
   80       CONTINUE
         END IF
      ELSE
*
*        Form  y  when lower triangle of A is stored.
```

```
*
         IF( ( INCX.EQ.1 ).AND.( INCY.EQ.1 ) )THEN
            DO 100, J = 1, N
               TEMP1  = ALPHA*X( J )
               TEMP2  = ZERO
               Y( J ) = Y( J )       + TEMP1*A( 1, J )
               L      = 1            - J
               DO 90, I = J + 1, MIN( N, J + K )
                  Y( I ) = Y( I ) + TEMP1*A( L + I, J )
                  TEMP2  = TEMP2  + A( L + I, J )*X( I )
   90          CONTINUE
               Y( J ) = Y( J ) + ALPHA*TEMP2
  100       CONTINUE
         ELSE
            JX = KX
            JY = KY
            DO 120, J = 1, N
               TEMP1   = ALPHA*X( JX )
               TEMP2   = ZERO
               Y( JY ) = Y( JY )       + TEMP1*A( 1, J )
               L       = 1             - J
               IX      = JX
               IY      = JY
               DO 110, I = J + 1, MIN( N, J + K )
                  IX      = IX      + INCX
                  IY      = IY      + INCY
                  Y( IY ) = Y( IY ) + TEMP1*A( L + I, J )
                  TEMP2   = TEMP2   + A( L + I, J )*X( IX )
  110          CONTINUE
               Y( JY ) = Y( JY ) + ALPHA*TEMP2
               JX      = JX      + INCX
               JY      = JY      + INCY
  120       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of DSBMV .
*
      END
```

———-

— BLAS 2 dsbmv —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
```

```
         (type (double-float 0.0 0.0) zero))
 (defun dsbmv (uplo n k alpha a lda x incx beta y incy)
   (declare (type (simple-array double-float (*)) y x a)
            (type (double-float) beta alpha)
            (type fixnum incy incx lda k n)
            (type character uplo))
   (f2cl-lib:with-multi-array-data
       ((uplo character uplo-%data% uplo-%offset%)
        (a double-float a-%data% a-%offset%)
        (x double-float x-%data% x-%offset%)
        (y double-float y-%data% y-%offset%))
     (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (kplus1 0) (kx 0)
            (ky 0) (l 0) (temp1 0.0) (temp2 0.0))
       (declare (type fixnum i info ix iy j jx jy kplus1 kx ky l)
                (type (double-float) temp1 temp2))
       (setf info 0)
       (cond
         ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
          (setf info 1))
         ((< n 0)
          (setf info 2))
         ((< k 0)
          (setf info 3))
         ((< lda (f2cl-lib:int-add k 1))
          (setf info 6))
         ((= incx 0)
          (setf info 8))
         ((= incy 0)
          (setf info 11)))
       (cond
         ((/= info 0)
          (error
           " ** On entry to ~a parameter number ~a had an illegal value~%"
           "DSBMV" info)
          (go end_label)))
       (if (or (= n 0) (and (= alpha zero) (= beta one))) (go end_label))
       (cond
         ((> incx 0)
          (setf kx 1))
         (t
          (setf kx
                  (f2cl-lib:int-sub 1
                                    (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                      incx)))))
       (cond
         ((> incy 0)
          (setf ky 1))
         (t
          (setf ky
                  (f2cl-lib:int-sub 1
```

```
                              (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                incy)))))
        (cond
          ((/= beta one)
           (cond
             ((= incy 1)
              (cond
                ((= beta zero)
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                               ((> i n) nil)
                   (tagbody
                     (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                             zero))))
                (t
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                               ((> i n) nil)
                   (tagbody
                     (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                             (* beta
                                (f2cl-lib:fref y-%data%
                                               (i)
                                               ((1 *))
                                               y-%offset%)))))))))
             (t
              (setf iy ky)
              (cond
                ((= beta zero)
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                               ((> i n) nil)
                   (tagbody
                     (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                             zero)
                     (setf iy (f2cl-lib:int-add iy incy)))))
                (t
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                               ((> i n) nil)
                   (tagbody
                     (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                             (* beta
                                (f2cl-lib:fref y-%data%
                                               (iy)
                                               ((1 *))
                                               y-%offset%)))
                     (setf iy (f2cl-lib:int-add iy incy)))))))))
        (if (= alpha zero) (go end_label))
        (cond
          ((char-equal uplo #\U)
           (setf kplus1 (f2cl-lib:int-add k 1))
           (cond
             ((and (= incx 1) (= incy 1))
```

```
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j n) nil)
  (tagbody
    (setf temp1
          (* alpha
             (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
    (setf temp2 zero)
    (setf l (f2cl-lib:int-sub kplus1 j))
    (f2cl-lib:fdo (i
                   (max (the fixnum 1)
                        (the fixnum
                             (f2cl-lib:int-add j
                                               (f2cl-lib:int-sub
                                                k))))
                   (f2cl-lib:int-add i 1))
                  ((> i
                      (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                   nil)
      (tagbody
        (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
              (+
               (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
               (* temp1
                  (f2cl-lib:fref a-%data%
                                 ((f2cl-lib:int-add l i) j)
                                 ((1 lda) (1 *))
                                 a-%offset%))))
        (setf temp2
              (+ temp2
                 (*
                  (f2cl-lib:fref a-%data%
                                 ((f2cl-lib:int-add l i) j)
                                 ((1 lda) (1 *))
                                 a-%offset%)
                  (f2cl-lib:fref x-%data%
                                 (i)
                                 ((1 *))
                                 x-%offset%))))))
    (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
          (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
             (* temp1
                (f2cl-lib:fref a-%data%
                               (kplus1 j)
                               ((1 lda) (1 *))
                               a-%offset%))
             (* alpha temp2))))))
(t
 (setf jx kx)
 (setf jy ky)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
```

```
           ((> j n) nil)
(tagbody
  (setf temp1
        (* alpha
           (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
  (setf temp2 zero)
  (setf ix kx)
  (setf iy ky)
  (setf l (f2cl-lib:int-sub kplus1 j))
  (f2cl-lib:fdo (i
                 (max (the fixnum 1)
                      (the fixnum
                           (f2cl-lib:int-add j
                                             (f2cl-lib:int-sub
                                              k))))
                 (f2cl-lib:int-add i 1))
                ((> i
                    (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                 nil)
    (tagbody
      (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
            (+
             (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
             (* temp1
                (f2cl-lib:fref a-%data%
                               ((f2cl-lib:int-add l i) j)
                               ((1 lda) (1 *))
                               a-%offset%))))
      (setf temp2
            (+ temp2
               (*
                (f2cl-lib:fref a-%data%
                               ((f2cl-lib:int-add l i) j)
                               ((1 lda) (1 *))
                               a-%offset%)
                (f2cl-lib:fref x-%data%
                               (ix)
                               ((1 *))
                               x-%offset%))))
      (setf ix (f2cl-lib:int-add ix incx))
      (setf iy (f2cl-lib:int-add iy incy))))
  (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
        (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
           (* temp1
              (f2cl-lib:fref a-%data%
                             (kplus1 j)
                             ((1 lda) (1 *))
                             a-%offset%))
           (* alpha temp2)))
  (setf jx (f2cl-lib:int-add jx incx))
```

```
          (setf jy (f2cl-lib:int-add jy incy))
          (cond
            ((> j k)
             (setf kx (f2cl-lib:int-add kx incx))
             (setf ky (f2cl-lib:int-add ky incy)))))))))
        (t
         (cond
           ((and (= incx 1) (= incy 1))
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
              (tagbody
                (setf temp1
                        (* alpha
                           (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
                (setf temp2 zero)
                (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                        (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                           (* temp1
                              (f2cl-lib:fref a-%data%
                                             (1 j)
                                             ((1 lda) (1 *))
                                             a-%offset%))))
                (setf l (f2cl-lib:int-sub 1 j))
                (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                 (f2cl-lib:int-add i 1))
                              ((> i
                                  (min (the fixnum n)
                                       (the fixnum
                                            (f2cl-lib:int-add j k))))
                               nil)
                  (tagbody
                    (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                            (+
                             (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                             (* temp1
                                (f2cl-lib:fref a-%data%
                                               ((f2cl-lib:int-add l i) j)
                                               ((1 lda) (1 *))
                                               a-%offset%))))
                    (setf temp2
                            (+ temp2
                               (*
                                (f2cl-lib:fref a-%data%
                                               ((f2cl-lib:int-add l i) j)
                                               ((1 lda) (1 *))
                                               a-%offset%)
                                (f2cl-lib:fref x-%data%
                                               (i)
                                               ((1 *))
                                               x-%offset%))))))))
```

```
      (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
              (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                 (* alpha temp2))))))
  (t
   (setf jx kx)
   (setf jy ky)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
     (tagbody
       (setf temp1
               (* alpha
                  (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
       (setf temp2 zero)
       (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
               (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                  (* temp1
                     (f2cl-lib:fref a-%data%
                                    (1 j)
                                    ((1 lda) (1 *))
                                    a-%offset%))))
       (setf l (f2cl-lib:int-sub 1 j))
       (setf ix jx)
       (setf iy jy)
       (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                        (f2cl-lib:int-add i 1))
                     ((> i
                         (min (the fixnum n)
                              (the fixnum
                                   (f2cl-lib:int-add j k))))
                      nil)
         (tagbody
           (setf ix (f2cl-lib:int-add ix incx))
           (setf iy (f2cl-lib:int-add iy incy))
           (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                   (+
                    (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                    (* temp1
                       (f2cl-lib:fref a-%data%
                                      ((f2cl-lib:int-add l i) j)
                                      ((1 lda) (1 *))
                                      a-%offset%))))
           (setf temp2
                   (+ temp2
                      (*
                       (f2cl-lib:fref a-%data%
                                      ((f2cl-lib:int-add l i) j)
                                      ((1 lda) (1 *))
                                      a-%offset%)
                       (f2cl-lib:fref x-%data%
                                      (ix)
```

```
                                                ((1 *))
                                                x-%offset%))))))
                    (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                            (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                               (* alpha temp2)))
                    (setf jx (f2cl-lib:int-add jx incx))
                    (setf jy (f2cl-lib:int-add jy incy))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil nil nil))))))
```

———-

4.5 dspmv BLAS

— dspmv.input —

```
)set break resume
)sys rm -f dspmv.output
)spool dspmv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dspmv.help —

```
========================================================================
dspmv examples
========================================================================

========================================================================
Man Page Details
========================================================================

 NAME
      DSPMV - perform the matrix-vector operation   y := alpha*A*x
      + beta*y,

 SYNOPSIS
      SUBROUTINE DSPMV ( UPLO, N, ALPHA, AP, X, INCX, BETA, Y,
                         INCY )
```

```
          DOUBLE       PRECISION ALPHA, BETA

          INTEGER      INCX, INCY, N

          CHARACTER*1  UPLO

          DOUBLE       PRECISION AP( * ), X( * ), Y( * )

PURPOSE
     DSPMV  performs the matrix-vector operation

     where alpha and beta are scalars, x and y are n element vec-
     tors and A is an n by n symmetric matrix, supplied in packed
     form.

PARAMETERS
     UPLO   - CHARACTER*1.
            On entry, UPLO specifies whether the upper or lower
            triangular part of the matrix A is supplied in the
            packed array AP as follows:

            UPLO = 'U' or 'u'   The upper triangular part of A is
            supplied in AP.

            UPLO = 'L' or 'l'   The lower triangular part of A is
            supplied in AP.

            Unchanged on exit.

     N      - INTEGER.
            On entry, N specifies the order of the matrix A.  N
            must be at least zero.  Unchanged on exit.

     ALPHA  - DOUBLE PRECISION.
            On entry, ALPHA specifies the scalar alpha.
            Unchanged on exit.

     AP     - DOUBLE PRECISION array of DIMENSION at least
            ( ( n*( n + 1 ) )/2 ).  Before entry with UPLO = 'U'
            or 'u', the array AP must contain the upper triangu-
            lar part of the symmetric matrix packed sequentially,
            column by column, so that AP( 1 ) contains a( 1, 1 ),
            AP( 2 ) and AP( 3 ) contain a( 1, 2 ) and a( 2, 2 )

            respectively, and so on.  Before entry with UPLO =
            'L' or 'l', the array AP must contain the lower tri-
            angular part of the symmetric matrix packed sequen-
            tially, column by column, so that AP( 1 ) contains a(
            1, 1 ), AP( 2 ) and AP( 3 ) contain a( 2, 1 ) and a(
```

```
            3, 1 ) respectively, and so on.  Unchanged on exit.

      X     - DOUBLE PRECISION array of dimension at least
            ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
            incremented array X must contain the n element vector
            x.  Unchanged on exit.

      INCX  - INTEGER.
            On entry, INCX specifies the increment for the ele-
            ments of X. INCX must not be zero.  Unchanged on
            exit.

      BETA  - DOUBLE PRECISION.
            On entry, BETA specifies the scalar beta. When BETA
            is supplied as zero then Y need not be set on input.
            Unchanged on exit.

      Y     - DOUBLE PRECISION array of dimension at least
            ( 1 + ( n - 1 )*abs( INCY ) ).  Before entry, the
            incremented array Y must contain the n element vector
            y. On exit, Y is overwritten by the updated vector y.

      INCY  - INTEGER.
            On entry, INCY specifies the increment for the ele-
            ments of Y. INCY must not be zero.  Unchanged on
            exit.
```

———-

— dspmv.f —

```
      SUBROUTINE DSPMV ( UPLO, N, ALPHA, AP, X, INCX, BETA, Y, INCY )
*     .. Scalar Arguments ..
      DOUBLE PRECISION   ALPHA, BETA
      INTEGER            INCX, INCY, N
      CHARACTER*1        UPLO
*     .. Array Arguments ..
      DOUBLE PRECISION   AP( * ), X( * ), Y( * )
*     ..
*

*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
```

```
*
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE         , ZERO
      PARAMETER        ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     .. Local Scalars ..
      DOUBLE PRECISION   TEMP1, TEMP2
      INTEGER            I, INFO, IX, IY, J, JX, JY, K, KK, KX, KY
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO, 'U' ).AND.
     $         .NOT.LSAME( UPLO, 'L' )      )THEN
         INFO = 1
      ELSE IF( N.LT.0 )THEN
         INFO = 2
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 6
      ELSE IF( INCY.EQ.0 )THEN
         INFO = 9
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DSPMV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( N.EQ.0 ).OR.( ( ALPHA.EQ.ZERO ).AND.( BETA.EQ.ONE ) ) )
     $   RETURN
*
*     Set up the start points in  X  and  Y.
*
      IF( INCX.GT.0 )THEN
         KX = 1
      ELSE
         KX = 1 - ( N - 1 )*INCX
      END IF
      IF( INCY.GT.0 )THEN
         KY = 1
      ELSE
         KY = 1 - ( N - 1 )*INCY
```

```
      END IF
*
*     Start the operations. In this version the elements of the array AP
*     are accessed sequentially with one pass through AP.
*
*     First form  y := beta*y.
*
      IF( BETA.NE.ONE )THEN
         IF( INCY.EQ.1 )THEN
            IF( BETA.EQ.ZERO )THEN
               DO 10, I = 1, N
                  Y( I ) = ZERO
   10          CONTINUE
            ELSE
               DO 20, I = 1, N
                  Y( I ) = BETA*Y( I )
   20          CONTINUE
            END IF
         ELSE
            IY = KY
            IF( BETA.EQ.ZERO )THEN
               DO 30, I = 1, N
                  Y( IY ) = ZERO
                  IY      = IY   + INCY
   30          CONTINUE
            ELSE
               DO 40, I = 1, N
                  Y( IY ) = BETA*Y( IY )
                  IY      = IY           + INCY
   40          CONTINUE
            END IF
         END IF
      END IF
      IF( ALPHA.EQ.ZERO )
     $   RETURN
      KK = 1
      IF( LSAME( UPLO, 'U' ) )THEN
*
*        Form  y  when AP contains the upper triangle.
*
         IF( ( INCX.EQ.1 ).AND.( INCY.EQ.1 ) )THEN
            DO 60, J = 1, N
               TEMP1 = ALPHA*X( J )
               TEMP2 = ZERO
               K     = KK
               DO 50, I = 1, J - 1
                  Y( I ) = Y( I ) + TEMP1*AP( K )
                  TEMP2  = TEMP2  + AP( K )*X( I )
                  K      = K      + 1
   50          CONTINUE
```

```
               Y( J ) = Y( J ) + TEMP1*AP( KK + J - 1 ) + ALPHA*TEMP2
               KK     = KK     + J
   60       CONTINUE
         ELSE
            JX = KX
            JY = KY
            DO 80, J = 1, N
               TEMP1 = ALPHA*X( JX )
               TEMP2 = ZERO
               IX    = KX
               IY    = KY
               DO 70, K = KK, KK + J - 2
                  Y( IY ) = Y( IY ) + TEMP1*AP( K )
                  TEMP2   = TEMP2   + AP( K )*X( IX )
                  IX      = IX      + INCX
                  IY      = IY      + INCY
   70          CONTINUE
               Y( JY ) = Y( JY ) + TEMP1*AP( KK + J - 1 ) + ALPHA*TEMP2
               JX      = JX      + INCX
               JY      = JY      + INCY
               KK      = KK      + J
   80       CONTINUE
         END IF
      ELSE
*
*        Form  y  when AP contains the lower triangle.
*
         IF( ( INCX.EQ.1 ).AND.( INCY.EQ.1 ) )THEN
            DO 100, J = 1, N
               TEMP1  = ALPHA*X( J )
               TEMP2  = ZERO
               Y( J ) = Y( J )       + TEMP1*AP( KK )
               K      = KK           + 1
               DO 90, I = J + 1, N
                  Y( I ) = Y( I ) + TEMP1*AP( K )
                  TEMP2  = TEMP2  + AP( K )*X( I )
                  K      = K      + 1
   90          CONTINUE
               Y( J ) = Y( J ) + ALPHA*TEMP2
               KK     = KK     + ( N - J + 1 )
  100       CONTINUE
         ELSE
            JX = KX
            JY = KY
            DO 120, J = 1, N
               TEMP1   = ALPHA*X( JX )
               TEMP2   = ZERO
               Y( JY ) = Y( JY )       + TEMP1*AP( KK )
               IX      = JX
               IY      = JY
```

```
              DO 110, K = KK + 1, KK + N - J
                 IX      = IX      + INCX
                 IY      = IY      + INCY
                 Y( IY ) = Y( IY ) + TEMP1*AP( K )
                 TEMP2   = TEMP2   + AP( K )*X( IX )
  110         CONTINUE
              Y( JY ) = Y( JY ) + ALPHA*TEMP2
              JX      = JX      + INCX
              JY      = JY      + INCY
              KK      = KK      + ( N - J + 1 )
  120       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of DSPMV .
*
      END
```

———-

— BLAS 2 dspmv —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dspmv (uplo n alpha ap x incx beta y incy)
    (declare (type (simple-array double-float (*)) y x ap)
             (type (double-float) beta alpha)
             (type fixnum incy incx n)
             (type character uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (ap double-float ap-%data% ap-%offset%)
         (x double-float x-%data% x-%offset%)
         (y double-float y-%data% y-%offset%))
      (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (k 0) (kk 0)
             (kx 0) (ky 0) (temp1 0.0) (temp2 0.0))
        (declare (type fixnum i info ix iy j jx jy k kk kx ky)
                 (type (double-float) temp1 temp2))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
          ((< n 0)
           (setf info 2))
          ((= incx 0)
```

```
   (setf info 6))
  ((= incy 0)
   (setf info 9)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DSPMV" info)
   (go end_label)))
(if (or (= n 0) (and (= alpha zero) (= beta one))) (go end_label))
(cond
  ((> incx 0)
   (setf kx 1))
  (t
   (setf kx
           (f2cl-lib:int-sub 1
                             (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                               incx)))))
(cond
  ((> incy 0)
   (setf ky 1))
  (t
   (setf ky
           (f2cl-lib:int-sub 1
                             (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                               incy)))))
(cond
  ((/= beta one)
   (cond
     ((= incy 1)
      (cond
        ((= beta zero)
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i n) nil)
           (tagbody
             (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                     zero))))
        (t
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i n) nil)
           (tagbody
             (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                     (* beta
                        (f2cl-lib:fref y-%data%
                                       (i)
                                       ((1 *))
                                       y-%offset%)))))))))
     (t
      (setf iy ky)
      (cond
```

```
          ((= beta zero)
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i n) nil)
             (tagbody
               (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                       zero)
               (setf iy (f2cl-lib:int-add iy incy)))))
          (t
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i n) nil)
             (tagbody
               (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                       (* beta
                          (f2cl-lib:fref y-%data%
                                         (iy)
                                         ((1 *))
                                         y-%offset%)))
               (setf iy (f2cl-lib:int-add iy incy))))))))))
(if (= alpha zero) (go end_label))
(setf kk 1)
(cond
  ((char-equal uplo #\U)
   (cond
     ((and (= incx 1) (= incy 1))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (setf temp1
                  (* alpha
                     (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
          (setf temp2 zero)
          (setf k kk)
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i
                            (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                         nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                      (+
                       (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                       (* temp1
                          (f2cl-lib:fref ap-%data%
                                         (k)
                                         ((1 *))
                                         ap-%offset%))))
              (setf temp2
                      (+ temp2
                         (*
                          (f2cl-lib:fref ap-%data%
                                         (k)
```

```
                                    ((1 *))
                                    ap-%offset%)
                        (f2cl-lib:fref x-%data%
                                    (i)
                                    ((1 *))
                                    x-%offset%))))
            (setf k (f2cl-lib:int-add k 1))))
        (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
              (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                 (* temp1
                    (f2cl-lib:fref ap-%data%
                                   ((f2cl-lib:int-sub
                                     (f2cl-lib:int-add kk j)
                                     1))
                                   ((1 *))
                                   ap-%offset%))
                 (* alpha temp2)))
        (setf kk (f2cl-lib:int-add kk j)))))
  (t
   (setf jx kx)
   (setf jy ky)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
     (tagbody
       (setf temp1
             (* alpha
                (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
       (setf temp2 zero)
       (setf ix kx)
       (setf iy ky)
       (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
                     ((> k
                         (f2cl-lib:int-add kk
                                           j
                                           (f2cl-lib:int-sub 2)))
                      nil)
         (tagbody
           (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                 (+
                  (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                  (* temp1
                     (f2cl-lib:fref ap-%data%
                                    (k)
                                    ((1 *))
                                    ap-%offset%))))
           (setf temp2
                 (+ temp2
                    (*
                     (f2cl-lib:fref ap-%data%
                                    (k)
```

```
                                        ((1 *))
                                        ap-%offset%)
                                (f2cl-lib:fref x-%data%
                                        (ix)
                                        ((1 *))
                                        x-%offset%))))
                    (setf ix (f2cl-lib:int-add ix incx))
                    (setf iy (f2cl-lib:int-add iy incy))))
                (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                        (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                           (* temp1
                              (f2cl-lib:fref ap-%data%
                                             ((f2cl-lib:int-sub
                                               (f2cl-lib:int-add kk j)
                                               1))
                                             ((1 *))
                                             ap-%offset%))
                           (* alpha temp2)))
                (setf jx (f2cl-lib:int-add jx incx))
                (setf jy (f2cl-lib:int-add jy incy))
                (setf kk (f2cl-lib:int-add kk j)))))))
        (t
         (cond
           ((and (= incx 1) (= incy 1))
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
              (tagbody
                (setf temp1
                        (* alpha
                           (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
                (setf temp2 zero)
                (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                        (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                           (* temp1
                              (f2cl-lib:fref ap-%data%
                                             (kk)
                                             ((1 *))
                                             ap-%offset%))))
                (setf k (f2cl-lib:int-add kk 1))
                (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                 (f2cl-lib:int-add i 1))
                              ((> i n) nil)
                  (tagbody
                    (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                            (+
                             (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                             (* temp1
                                (f2cl-lib:fref ap-%data%
                                               (k)
                                               ((1 *))
```

```
                                        ap-%offset%))))
            (setf temp2
                    (+ temp2
                       (*
                        (f2cl-lib:fref ap-%data%
                                       (k)
                                       ((1 *))
                                       ap-%offset%)
                        (f2cl-lib:fref x-%data%
                                       (i)
                                       ((1 *))
                                       x-%offset%))))
            (setf k (f2cl-lib:int-add k 1))))
        (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                   (* alpha temp2)))
        (setf kk
                (f2cl-lib:int-add kk
                                  (f2cl-lib:int-add
                                   (f2cl-lib:int-sub n j)
                                   1))))))
    (t
     (setf jx kx)
     (setf jy ky)
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   ((> j n) nil)
       (tagbody
         (setf temp1
                 (* alpha
                    (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
         (setf temp2 zero)
         (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                 (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                    (* temp1
                       (f2cl-lib:fref ap-%data%
                                      (kk)
                                      ((1 *))
                                      ap-%offset%))))
         (setf ix jx)
         (setf iy jy)
         (f2cl-lib:fdo (k (f2cl-lib:int-add kk 1)
                          (f2cl-lib:int-add k 1))
                       ((> k
                           (f2cl-lib:int-add kk
                                             n
                                             (f2cl-lib:int-sub j)))
                        nil)
           (tagbody
             (setf ix (f2cl-lib:int-add ix incx))
             (setf iy (f2cl-lib:int-add iy incy))
```

```
                    (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                            (+
                             (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                             (* temp1
                                (f2cl-lib:fref ap-%data%
                                               (k)
                                               ((1 *))
                                               ap-%offset%))))
                    (setf temp2
                            (+ temp2
                               (*
                                (f2cl-lib:fref ap-%data%
                                               (k)
                                               ((1 *))
                                               ap-%offset%)
                                (f2cl-lib:fref x-%data%
                                               (ix)
                                               ((1 *))
                                               x-%offset%))))))
                (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                        (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                           (* alpha temp2)))
                (setf jx (f2cl-lib:int-add jx incx))
                (setf jy (f2cl-lib:int-add jy incy))
                (setf kk
                        (f2cl-lib:int-add kk
                                          (f2cl-lib:int-add
                                           (f2cl-lib:int-sub n j)
                                           1)))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil))))))
```

———-

4.6 dspr2 BLAS

— dspr2.input —

```
)set break resume
)sys rm -f dspr2.output
)spool dspr2.output
)set message test on
)set message auto off
)clear all

)spool
```

```
)lisp (bye)
```

———-

— dspr2.help —

```
==========================================================================
dspr2 examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      DSPR2 - perform the symmetric rank 2 operation   A :=
      alpha*x*y' + alpha*y*x' + A,

 SYNOPSIS
      SUBROUTINE DSPR2 ( UPLO, N, ALPHA, X, INCX, Y, INCY, AP )

          DOUBLE       PRECISION ALPHA

          INTEGER      INCX, INCY, N

          CHARACTER*1  UPLO

          DOUBLE       PRECISION AP( * ), X( * ), Y( * )

 PURPOSE
      DSPR2  performs the symmetric rank 2 operation

      where alpha is a scalar, x and y are n element vectors and A
      is an n by n symmetric matrix, supplied in packed form.

 PARAMETERS
      UPLO   - CHARACTER*1.
               On entry, UPLO specifies whether the upper or lower
               triangular part of the matrix A is supplied in the
               packed array AP as follows:

               UPLO = 'U' or 'u'   The upper triangular part of A is
               supplied in AP.

               UPLO = 'L' or 'l'   The lower triangular part of A is
               supplied in AP.

               Unchanged on exit.
```

```
N      - INTEGER.
       On entry, N specifies the order of the matrix A.  N
       must be at least zero.  Unchanged on exit.

ALPHA  - DOUBLE PRECISION.
       On entry, ALPHA specifies the scalar alpha.
       Unchanged on exit.

X      - DOUBLE PRECISION array of dimension at least
       ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
       incremented array X must contain the n element vector
       x.  Unchanged on exit.

INCX   - INTEGER.
       On entry, INCX specifies the increment for the ele-
       ments of X. INCX must not be zero.  Unchanged on

       exit.

Y      - DOUBLE PRECISION array of dimension at least
       ( 1 + ( n - 1 )*abs( INCY ) ).  Before entry, the
       incremented array Y must contain the n element vector
       y.  Unchanged on exit.

INCY   - INTEGER.
       On entry, INCY specifies the increment for the ele-
       ments of Y. INCY must not be zero.  Unchanged on
       exit.

AP     - DOUBLE PRECISION array of DIMENSION at least
       ( ( n*( n + 1 ) )/2 ).  Before entry with  UPLO = 'U'
       or 'u', the array AP must contain the upper triangu-
       lar part of the symmetric matrix packed sequentially,
       column by column, so that AP( 1 ) contains a( 1, 1 ),
       AP( 2 ) and AP( 3 ) contain a( 1, 2 ) and a( 2, 2 )
       respectively, and so on. On exit, the array AP is
       overwritten by the upper triangular part of the
       updated matrix.  Before entry with UPLO = 'L' or 'l',
       the array AP must contain the lower triangular part
       of the symmetric matrix packed sequentially, column
       by column, so that AP( 1 ) contains a( 1, 1 ), AP( 2
       ) and AP( 3 ) contain a( 2, 1 ) and a( 3, 1 ) respec-
       tively, and so on. On exit, the array AP is overwrit-
       ten by the lower triangular part of the updated
       matrix.
```

— dspr2.f —

```
      SUBROUTINE DSPR2 ( UPLO, N, ALPHA, X, INCX, Y, INCY, AP )
*     .. Scalar Arguments ..
      DOUBLE PRECISION   ALPHA
      INTEGER            INCX, INCY, N
      CHARACTER*1        UPLO
*     .. Array Arguments ..
      DOUBLE PRECISION   AP( * ), X( * ), Y( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER        ( ZERO = 0.0D+0 )
*     .. Local Scalars ..
      DOUBLE PRECISION   TEMP1, TEMP2
      INTEGER            I, INFO, IX, IY, J, JX, JY, K, KK, KX, KY
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO, 'U' ).AND.
     $         .NOT.LSAME( UPLO, 'L' )      )THEN
         INFO = 1
      ELSE IF( N.LT.0 )THEN
         INFO = 2
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 5
      ELSE IF( INCY.EQ.0 )THEN
         INFO = 7
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DSPR2 ', INFO )
         RETURN
```

```
      END IF
*
*     Quick return if possible.
*
      IF( ( N.EQ.0 ).OR.( ALPHA.EQ.ZERO ) )
     $   RETURN
*
*     Set up the start points in X and Y if the increments are not both
*     unity.
*
      IF( ( INCX.NE.1 ).OR.( INCY.NE.1 ) )THEN
         IF( INCX.GT.0 )THEN
            KX = 1
         ELSE
            KX = 1 - ( N - 1 )*INCX
         END IF
         IF( INCY.GT.0 )THEN
            KY = 1
         ELSE
            KY = 1 - ( N - 1 )*INCY
         END IF
         JX = KX
         JY = KY
      END IF
*
*     Start the operations. In this version the elements of the array AP
*     are accessed sequentially with one pass through AP.
*
      KK = 1
      IF( LSAME( UPLO, 'U' ) )THEN
*
*        Form  A  when upper triangle is stored in AP.
*
         IF( ( INCX.EQ.1 ).AND.( INCY.EQ.1 ) )THEN
            DO 20, J = 1, N
               IF( ( X( J ).NE.ZERO ).OR.( Y( J ).NE.ZERO ) )THEN
                  TEMP1 = ALPHA*Y( J )
                  TEMP2 = ALPHA*X( J )
                  K     = KK
                  DO 10, I = 1, J
                     AP( K ) = AP( K ) + X( I )*TEMP1 + Y( I )*TEMP2
                     K       = K       + 1
   10             CONTINUE
               END IF
               KK = KK + J
   20       CONTINUE
         ELSE
            DO 40, J = 1, N
               IF( ( X( JX ).NE.ZERO ).OR.( Y( JY ).NE.ZERO ) )THEN
                  TEMP1 = ALPHA*Y( JY )
```

```
                  TEMP2 = ALPHA*X( JX )
                  IX    = KX
                  IY    = KY
                  DO 30, K = KK, KK + J - 1
                     AP( K ) = AP( K ) + X( IX )*TEMP1 + Y( IY )*TEMP2
                     IX      = IX      + INCX
                     IY      = IY      + INCY
   30             CONTINUE
               END IF
               JX = JX + INCX
               JY = JY + INCY
               KK = KK + J
   40       CONTINUE
         END IF
      ELSE
*
*        Form  A  when lower triangle is stored in AP.
*
         IF( ( INCX.EQ.1 ).AND.( INCY.EQ.1 ) )THEN
            DO 60, J = 1, N
               IF( ( X( J ).NE.ZERO ).OR.( Y( J ).NE.ZERO ) )THEN
                  TEMP1 = ALPHA*Y( J )
                  TEMP2 = ALPHA*X( J )
                  K     = KK
                  DO 50, I = J, N
                     AP( K ) = AP( K ) + X( I )*TEMP1 + Y( I )*TEMP2
                     K       = K       + 1
   50             CONTINUE
               END IF
               KK = KK + N - J + 1
   60       CONTINUE
         ELSE
            DO 80, J = 1, N
               IF( ( X( JX ).NE.ZERO ).OR.( Y( JY ).NE.ZERO ) )THEN
                  TEMP1 = ALPHA*Y( JY )
                  TEMP2 = ALPHA*X( JX )
                  IX    = JX
                  IY    = JY
                  DO 70, K = KK, KK + N - J
                     AP( K ) = AP( K ) + X( IX )*TEMP1 + Y( IY )*TEMP2
                     IX      = IX      + INCX
                     IY      = IY      + INCY
   70             CONTINUE
               END IF
               JX = JX + INCX
               JY = JY + INCY
               KK = KK + N - J + 1
   80       CONTINUE
         END IF
      END IF
```

```
*
      RETURN
*
*     End of DSPR2 .
*
      END
```

———-

— BLAS 2 dspr2 —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dspr2 (uplo n alpha x incx y incy ap)
    (declare (type (simple-array double-float (*)) ap y x)
             (type (double-float) alpha)
             (type fixnum incy incx n)
             (type character uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (x double-float x-%data% x-%offset%)
         (y double-float y-%data% y-%offset%)
         (ap double-float ap-%data% ap-%offset%))
      (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (k 0) (kk 0)
             (kx 0) (ky 0) (temp1 0.0) (temp2 0.0))
        (declare (type fixnum i info ix iy j jx jy k kk kx ky)
                 (type (double-float) temp1 temp2))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
          ((< n 0)
           (setf info 2))
          ((= incx 0)
           (setf info 5))
          ((= incy 0)
           (setf info 7)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DSPR2" info)
           (go end_label)))
        (if (or (= n 0) (= alpha zero)) (go end_label))
        (cond
          ((or (/= incx 1) (/= incy 1))
           (cond
             ((> incx 0)
```

```
          (setf kx 1))
         (t
          (setf kx
                  (f2cl-lib:int-sub 1
                                    (f2cl-lib:int-mul
                                     (f2cl-lib:int-sub n 1)
                                     incx)))))
      (cond
        ((> incy 0)
         (setf ky 1))
        (t
         (setf ky
                  (f2cl-lib:int-sub 1
                                    (f2cl-lib:int-mul
                                     (f2cl-lib:int-sub n 1)
                                     incy)))))
      (setf jx kx)
      (setf jy ky)))
   (setf kk 1)
   (cond
     ((char-equal uplo #\U)
      (cond
        ((and (= incx 1) (= incy 1))
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (cond
               ((or (/= (f2cl-lib:fref x (j) ((1 *))) zero)
                    (/= (f2cl-lib:fref y (j) ((1 *))) zero))
                (setf temp1
                        (* alpha
                           (f2cl-lib:fref y-%data%
                                          (j)
                                          ((1 *))
                                          y-%offset%)))
                (setf temp2
                        (* alpha
                           (f2cl-lib:fref x-%data%
                                          (j)
                                          ((1 *))
                                          x-%offset%)))
                (setf k kk)
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                              ((> i j) nil)
                  (tagbody
                    (setf (f2cl-lib:fref ap-%data%
                                         (k)
                                         ((1 *))
                                         ap-%offset%)
                          (+
```

```
                        (f2cl-lib:fref ap-%data%
                                       (k)
                                       ((1 *))
                                       ap-%offset%)
                        (*
                         (f2cl-lib:fref x-%data%
                                        (i)
                                        ((1 *))
                                        x-%offset%)
                         temp1)
                        (*
                         (f2cl-lib:fref y-%data%
                                        (i)
                                        ((1 *))
                                        y-%offset%)
                         temp2)))
              (setf k (f2cl-lib:int-add k 1))))))
      (setf kk (f2cl-lib:int-add kk j)))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (cond
       ((or (/= (f2cl-lib:fref x (jx) ((1 *))) zero)
            (/= (f2cl-lib:fref y (jy) ((1 *))) zero))
        (setf temp1
                (* alpha
                   (f2cl-lib:fref y-%data%
                                  (jy)
                                  ((1 *))
                                  y-%offset%)))
        (setf temp2
                (* alpha
                   (f2cl-lib:fref x-%data%
                                  (jx)
                                  ((1 *))
                                  x-%offset%)))
        (setf ix kx)
        (setf iy ky)
        (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
                      ((> k
                          (f2cl-lib:int-add kk
                                            j
                                            (f2cl-lib:int-sub 1)))
                       nil)
          (tagbody
            (setf (f2cl-lib:fref ap-%data%
                                 (k)
                                 ((1 *))
                                 ap-%offset%)
```

```
                          (+
                           (f2cl-lib:fref ap-%data%
                                          (k)
                                          ((1 *))
                                          ap-%offset%)
                           (*
                            (f2cl-lib:fref x-%data%
                                           (ix)
                                           ((1 *))
                                           x-%offset%)
                            temp1)
                           (*
                            (f2cl-lib:fref y-%data%
                                           (iy)
                                           ((1 *))
                                           y-%offset%)
                            temp2)))
                    (setf ix (f2cl-lib:int-add ix incx))
                    (setf iy (f2cl-lib:int-add iy incy))))))
              (setf jx (f2cl-lib:int-add jx incx))
              (setf jy (f2cl-lib:int-add jy incy))
              (setf kk (f2cl-lib:int-add kk j)))))))
      (t
       (cond
         ((and (= incx 1) (= incy 1))
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                        ((> j n) nil)
            (tagbody
              (cond
                ((or (/= (f2cl-lib:fref x (j) ((1 *))) zero)
                     (/= (f2cl-lib:fref y (j) ((1 *))) zero))
                 (setf temp1
                         (* alpha
                            (f2cl-lib:fref y-%data%
                                           (j)
                                           ((1 *))
                                           y-%offset%)))
                 (setf temp2
                         (* alpha
                            (f2cl-lib:fref x-%data%
                                           (j)
                                           ((1 *))
                                           x-%offset%)))
                 (setf k kk)
                 (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                               ((> i n) nil)
                   (tagbody
                     (setf (f2cl-lib:fref ap-%data%
                                          (k)
                                          ((1 *))
```

```
                                        ap-%offset%)
                                (+
                                 (f2cl-lib:fref ap-%data%
                                                (k)
                                                ((1 *))
                                                ap-%offset%)
                                 (*
                                  (f2cl-lib:fref x-%data%
                                                 (i)
                                                 ((1 *))
                                                 x-%offset%)
                                  temp1)
                                 (*
                                  (f2cl-lib:fref y-%data%
                                                 (i)
                                                 ((1 *))
                                                 y-%offset%)
                                  temp2)))
                        (setf k (f2cl-lib:int-add k 1))))))
             (setf kk
                     (f2cl-lib:int-add
                      (f2cl-lib:int-sub (f2cl-lib:int-add kk n) j)
                      1)))))
        (t
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (cond
               ((or (/= (f2cl-lib:fref x (jx) ((1 *))) zero)
                    (/= (f2cl-lib:fref y (jy) ((1 *))) zero))
                (setf temp1
                        (* alpha
                           (f2cl-lib:fref y-%data%
                                          (jy)
                                          ((1 *))
                                          y-%offset%)))
                (setf temp2
                        (* alpha
                           (f2cl-lib:fref x-%data%
                                          (jx)
                                          ((1 *))
                                          x-%offset%)))
                (setf ix jx)
                (setf iy jy)
                (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
                              ((> k
                                  (f2cl-lib:int-add kk
                                                    n
                                                    (f2cl-lib:int-sub j)))
                               nil)
```

```
                    (tagbody
                      (setf (f2cl-lib:fref ap-%data%
                                           (k)
                                           ((1 *))
                                           ap-%offset%)
                            (+
                             (f2cl-lib:fref ap-%data%
                                            (k)
                                            ((1 *))
                                            ap-%offset%)
                             (*
                              (f2cl-lib:fref x-%data%
                                             (ix)
                                             ((1 *))
                                             x-%offset%)
                              temp1)
                             (*
                              (f2cl-lib:fref y-%data%
                                             (iy)
                                             ((1 *))
                                             y-%offset%)
                              temp2)))
                      (setf ix (f2cl-lib:int-add ix incx))
                      (setf iy (f2cl-lib:int-add iy incy))))))
               (setf jx (f2cl-lib:int-add jx incx))
               (setf jy (f2cl-lib:int-add jy incy))
               (setf kk
                     (f2cl-lib:int-add
                      (f2cl-lib:int-sub (f2cl-lib:int-add kk n) j)
                      1))))))))
 end_label
       (return (values nil nil nil nil nil nil nil nil))))))
```

———-

4.7 dspr BLAS

— dspr.input —

```
)set break resume
)sys rm -f dspr.output
)spool dspr.output
)set message test on
)set message auto off
)clear all
```

```
)spool
)lisp (bye)
```

———-

— dspr.help —

```
========================================================================
dspr examples
========================================================================

========================================================================
Man Page Details
========================================================================

 NAME
      DSPR - perform the symmetric rank 1 operation   A :=
      alpha*x*x' + A,

 SYNOPSIS
      SUBROUTINE DSPR ( UPLO, N, ALPHA, X, INCX, AP )

          DOUBLE      PRECISION ALPHA

          INTEGER     INCX, N

          CHARACTER*1 UPLO

          DOUBLE      PRECISION AP( * ), X( * )

 PURPOSE
      DSPR    performs the symmetric rank 1 operation

      where alpha is a real scalar, x is an n element vector and A
      is an n by n symmetric matrix, supplied in packed form.

 PARAMETERS
      UPLO   - CHARACTER*1.
               On entry, UPLO specifies whether the upper or lower
               triangular part of the matrix A is supplied in the
               packed array AP as follows:

               UPLO = 'U' or 'u'   The upper triangular part of A is
               supplied in AP.

               UPLO = 'L' or 'l'   The lower triangular part of A is
               supplied in AP.

               Unchanged on exit.
```

```
      N      - INTEGER.
             On entry, N specifies the order of the matrix A.  N
             must be at least zero.  Unchanged on exit.

      ALPHA  - DOUBLE PRECISION.
             On entry, ALPHA specifies the scalar alpha.
             Unchanged on exit.

      X      - DOUBLE PRECISION array of dimension at least
             ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
             incremented array X must contain the n element vector
             x.  Unchanged on exit.

      INCX   - INTEGER.
             On entry, INCX specifies the increment for the ele-
             ments of X. INCX must not be zero.  Unchanged on

             exit.

      AP     - DOUBLE PRECISION array of DIMENSION at least
             ( ( n*( n + 1 ) )/2 ).  Before entry with  UPLO = 'U'
             or 'u', the array AP must contain the upper triangu-
             lar part of the symmetric matrix packed sequentially,
             column by column, so that AP( 1 ) contains a( 1, 1 ),
             AP( 2 ) and AP( 3 ) contain a( 1, 2 ) and a( 2, 2 )
             respectively, and so on. On exit, the array AP is
             overwritten by the upper triangular part of the
             updated matrix.  Before entry with UPLO = 'L' or 'l',
             the array AP must contain the lower triangular part
             of the symmetric matrix packed sequentially, column
             by column, so that AP( 1 ) contains a( 1, 1 ), AP( 2
             ) and AP( 3 ) contain a( 2, 1 ) and a( 3, 1 ) respec-
             tively, and so on. On exit, the array AP is overwrit-
             ten by the lower triangular part of the updated
             matrix.
```

———-

— dspr.f —

```
      SUBROUTINE DSPR  ( UPLO, N, ALPHA, X, INCX, AP )
*     .. Scalar Arguments ..
      DOUBLE PRECISION   ALPHA
      INTEGER            INCX, N
      CHARACTER*1        UPLO
*     .. Array Arguments ..
      DOUBLE PRECISION   AP( * ), X( * )
```

```
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER        ( ZERO = 0.0D+0 )
*     .. Local Scalars ..
      DOUBLE PRECISION   TEMP
      INTEGER            I, INFO, IX, J, JX, K, KK, KX
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO, 'U' ).AND.
     $         .NOT.LSAME( UPLO, 'L' )      )THEN
         INFO = 1
      ELSE IF( N.LT.0 )THEN
         INFO = 2
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 5
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DSPR  ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( N.EQ.0 ).OR.( ALPHA.EQ.ZERO ) )
     $   RETURN
*
*     Set the start point in X if the increment is not unity.
*
      IF( INCX.LE.0 )THEN
         KX = 1 - ( N - 1 )*INCX
```

```
      ELSE IF( INCX.NE.1 )THEN
         KX = 1
      END IF
*
*     Start the operations. In this version the elements of the array AP
*     are accessed sequentially with one pass through AP.
*
      KK = 1
      IF( LSAME( UPLO, 'U' ) )THEN
*
*        Form  A  when upper triangle is stored in AP.
*
         IF( INCX.EQ.1 )THEN
            DO 20, J = 1, N
               IF( X( J ).NE.ZERO )THEN
                  TEMP = ALPHA*X( J )
                  K    = KK
                  DO 10, I = 1, J
                     AP( K ) = AP( K ) + X( I )*TEMP
                     K       = K       + 1
   10             CONTINUE
               END IF
               KK = KK + J
   20       CONTINUE
         ELSE
            JX = KX
            DO 40, J = 1, N
               IF( X( JX ).NE.ZERO )THEN
                  TEMP = ALPHA*X( JX )
                  IX   = KX
                  DO 30, K = KK, KK + J - 1
                     AP( K ) = AP( K ) + X( IX )*TEMP
                     IX      = IX      + INCX
   30             CONTINUE
               END IF
               JX = JX + INCX
               KK = KK + J
   40       CONTINUE
         END IF
      ELSE
*
*        Form  A  when lower triangle is stored in AP.
*
         IF( INCX.EQ.1 )THEN
            DO 60, J = 1, N
               IF( X( J ).NE.ZERO )THEN
                  TEMP = ALPHA*X( J )
                  K    = KK
                  DO 50, I = J, N
                     AP( K ) = AP( K ) + X( I )*TEMP
```

```
                  K       = K       + 1
   50             CONTINUE
               END IF
               KK = KK + N - J + 1
   60       CONTINUE
         ELSE
            JX = KX
            DO 80, J = 1, N
               IF( X( JX ).NE.ZERO )THEN
                  TEMP = ALPHA*X( JX )
                  IX   = JX
                  DO 70, K = KK, KK + N - J
                     AP( K ) = AP( K ) + X( IX )*TEMP
                     IX      = IX      + INCX
   70             CONTINUE
               END IF
               JX = JX + INCX
               KK = KK + N - J + 1
   80       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of DSPR  .
*
      END
```

— BLAS 2 dspr —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dspr (uplo n alpha x incx ap)
    (declare (type (simple-array double-float (*)) ap x)
             (type (double-float) alpha)
             (type fixnum incx n)
             (type character uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (x double-float x-%data% x-%offset%)
         (ap double-float ap-%data% ap-%offset%))
      (prog ((i 0) (info 0) (ix 0) (j 0) (jx 0) (k 0) (kk 0) (kx 0) (temp 0.0))
        (declare (type fixnum i info ix j jx k kk kx)
                 (type (double-float) temp))
        (setf info 0)
        (cond
```

```
  ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
   (setf info 1))
  ((< n 0)
   (setf info 2))
  ((= incx 0)
   (setf info 5)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
     "DSPR" info)
   (go end_label)))
(if (or (= n 0) (= alpha zero)) (go end_label))
(cond
  ((<= incx 0)
   (setf kx
           (f2cl-lib:int-sub 1
                             (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                               incx))))
  ((/= incx 1)
   (setf kx 1)))
(setf kk 1)
(cond
  ((char-equal uplo #\U)
   (cond
     ((= incx 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (cond
            ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
             (setf temp
                     (* alpha
                        (f2cl-lib:fref x-%data%
                                       (j)
                                       ((1 *))
                                       x-%offset%)))
             (setf k kk)
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i j) nil)
               (tagbody
                 (setf (f2cl-lib:fref ap-%data%
                                      (k)
                                      ((1 *))
                                      ap-%offset%)
                       (+
                        (f2cl-lib:fref ap-%data%
                                       (k)
                                       ((1 *))
                                       ap-%offset%)
```

```
                              (*
                               (f2cl-lib:fref x-%data%
                                              (i)
                                              ((1 *))
                                              x-%offset%)
                               temp)))
                     (setf k (f2cl-lib:int-add k 1))))))
            (setf kk (f2cl-lib:int-add kk j)))))
       (t
        (setf jx kx)
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                      ((> j n) nil)
          (tagbody
            (cond
              ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
               (setf temp
                       (* alpha
                          (f2cl-lib:fref x-%data%
                                         (jx)
                                         ((1 *))
                                         x-%offset%)))
               (setf ix kx)
               (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
                             ((> k
                                 (f2cl-lib:int-add kk
                                                   j
                                                   (f2cl-lib:int-sub 1)))
                              nil)
                 (tagbody
                   (setf (f2cl-lib:fref ap-%data%
                                        (k)
                                        ((1 *))
                                        ap-%offset%)
                         (+
                          (f2cl-lib:fref ap-%data%
                                         (k)
                                         ((1 *))
                                         ap-%offset%)
                          (*
                           (f2cl-lib:fref x-%data%
                                          (ix)
                                          ((1 *))
                                          x-%offset%)
                           temp)))
                   (setf ix (f2cl-lib:int-add ix incx))))))
            (setf jx (f2cl-lib:int-add jx incx))
            (setf kk (f2cl-lib:int-add kk j)))))))
(t
 (cond
   ((= incx 1)
```

```
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (cond
       (((/= (f2cl-lib:fref x (j) ((1 *))) zero)
        (setf temp
                (* alpha
                   (f2cl-lib:fref x-%data%
                                  (j)
                                  ((1 *))
                                  x-%offset%)))
        (setf k kk)
        (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                      ((> i n) nil)
          (tagbody
            (setf (f2cl-lib:fref ap-%data%
                                 (k)
                                 ((1 *))
                                 ap-%offset%)
                  (+
                   (f2cl-lib:fref ap-%data%
                                  (k)
                                  ((1 *))
                                  ap-%offset%)
                   (*
                    (f2cl-lib:fref x-%data%
                                   (i)
                                   ((1 *))
                                   x-%offset%)
                    temp)))
            (setf k (f2cl-lib:int-add k 1))))))
     (setf kk
             (f2cl-lib:int-add
              (f2cl-lib:int-sub (f2cl-lib:int-add kk n) j)
              1)))))
(t
 (setf jx kx)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (cond
       (((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (setf temp
                (* alpha
                   (f2cl-lib:fref x-%data%
                                  (jx)
                                  ((1 *))
                                  x-%offset%)))
        (setf ix jx)
        (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
```

```
                                ((> k
                                    (f2cl-lib:int-add kk
                                                      n
                                                      (f2cl-lib:int-sub j)))
                                 nil)
                          (tagbody
                            (setf (f2cl-lib:fref ap-%data%
                                                 (k)
                                                 ((1 *))
                                                 ap-%offset%)
                                  (+
                                   (f2cl-lib:fref ap-%data%
                                                  (k)
                                                  ((1 *))
                                                  ap-%offset%)
                                   (*
                                    (f2cl-lib:fref x-%data%
                                                   (ix)
                                                   ((1 *))
                                                   x-%offset%)
                                    temp)))
                              (setf ix (f2cl-lib:int-add ix incx))))))
                    (setf jx (f2cl-lib:int-add jx incx))
                    (setf kk
                            (f2cl-lib:int-add
                             (f2cl-lib:int-sub (f2cl-lib:int-add kk n) j)
                             1))))))))
 end_label
        (return (values nil nil nil nil nil nil))))))
```

———-

4.8 dsymv BLAS

— dsymv.input —

```
)set break resume
)sys rm -f dsymv.output
)spool dsymv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dsymv.help —

```
=====================================================================
dsymv examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 NAME
      DSYMV - perform the matrix-vector operation   y := alpha*A*x
      + beta*y,

 SYNOPSIS
      SUBROUTINE DSYMV ( UPLO, N, ALPHA, A, LDA, X, INCX, BETA, Y,
                         INCY )

          DOUBLE       PRECISION ALPHA, BETA

          INTEGER      INCX, INCY, LDA, N

          CHARACTER*1  UPLO

          DOUBLE       PRECISION A( LDA, * ), X( * ), Y( * )

 PURPOSE
      DSYMV  performs the matrix-vector  operation

      where alpha and beta are scalars, x and y are n element vec-
      tors and A is an n by n symmetric matrix.

 PARAMETERS
      UPLO   - CHARACTER*1.
               On entry, UPLO specifies whether the upper or lower
               triangular part of the array A is to be referenced as
               follows:

               UPLO = 'U' or 'u'   Only the upper triangular part of
               A is to be referenced.

               UPLO = 'L' or 'l'   Only the lower triangular part of
               A is to be referenced.

               Unchanged on exit.

      N      - INTEGER.
```

```
         On entry, N specifies the order of the matrix A.  N
         must be at least zero.  Unchanged on exit.

ALPHA  - DOUBLE PRECISION.
         On entry, ALPHA specifies the scalar alpha.
         Unchanged on exit.

A      - DOUBLE PRECISION array of DIMENSION ( LDA, n ).
         Before entry with  UPLO = 'U' or 'u', the leading n
         by n upper triangular part of the array A must con-
         tain the upper triangular part of the symmetric
         matrix and the strictly lower triangular part of A is
         not referenced.  Before entry with UPLO = 'L' or 'l',
         the leading n by n lower triangular part of the array

         A must contain the lower triangular part of the sym-
         metric matrix and the strictly upper triangular part
         of A is not referenced.  Unchanged on exit.

LDA    - INTEGER.
         On entry, LDA specifies the first dimension of A as
         declared in the calling (sub) program. LDA must be at
         least max( 1, n ).  Unchanged on exit.

X      - DOUBLE PRECISION array of dimension at least
         ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
         incremented array X must contain the n element vector
         x.  Unchanged on exit.

INCX   - INTEGER.
         On entry, INCX specifies the increment for the ele-
         ments of X. INCX must not be zero.  Unchanged on
         exit.

BETA   - DOUBLE PRECISION.
         On entry, BETA specifies the scalar beta. When BETA
         is supplied as zero then Y need not be set on input.
         Unchanged on exit.

Y      - DOUBLE PRECISION array of dimension at least
         ( 1 + ( n - 1 )*abs( INCY ) ).  Before entry, the
         incremented array Y must contain the n element vector
         y. On exit, Y is overwritten by the updated vector y.

INCY   - INTEGER.
         On entry, INCY specifies the increment for the ele-
         ments of Y. INCY must not be zero.  Unchanged on
         exit.
```

———-

— dsymv.f —

```
      SUBROUTINE DSYMV ( UPLO, N, ALPHA, A, LDA, X, INCX,
     $                   BETA, Y, INCY )
*     .. Scalar Arguments ..
      DOUBLE PRECISION   ALPHA, BETA
      INTEGER            INCX, INCY, LDA, N
      CHARACTER*1        UPLO
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), X( * ), Y( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE         , ZERO
      PARAMETER        ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     .. Local Scalars ..
      DOUBLE PRECISION   TEMP1, TEMP2
      INTEGER            I, INFO, IX, IY, J, JX, JY, KX, KY
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO, 'U' ).AND.
     $         .NOT.LSAME( UPLO, 'L' )      )THEN
         INFO = 1
      ELSE IF( N.LT.0 )THEN
         INFO = 2
      ELSE IF( LDA.LT.MAX( 1, N ) )THEN
         INFO = 5
```

```
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 7
      ELSE IF( INCY.EQ.0 )THEN
         INFO = 10
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DSYMV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( N.EQ.0 ).OR.( ( ALPHA.EQ.ZERO ).AND.( BETA.EQ.ONE ) ) )
     $   RETURN
*
*     Set up the start points in  X  and  Y.
*
      IF( INCX.GT.0 )THEN
         KX = 1
      ELSE
         KX = 1 - ( N - 1 )*INCX
      END IF
      IF( INCY.GT.0 )THEN
         KY = 1
      ELSE
         KY = 1 - ( N - 1 )*INCY
      END IF
*
*     Start the operations. In this version the elements of A are
*     accessed sequentially with one pass through the triangular part
*     of A.
*
*     First form  y := beta*y.
*
      IF( BETA.NE.ONE )THEN
         IF( INCY.EQ.1 )THEN
            IF( BETA.EQ.ZERO )THEN
               DO 10, I = 1, N
                  Y( I ) = ZERO
   10          CONTINUE
            ELSE
               DO 20, I = 1, N
                  Y( I ) = BETA*Y( I )
   20          CONTINUE
            END IF
         ELSE
            IY = KY
            IF( BETA.EQ.ZERO )THEN
               DO 30, I = 1, N
                  Y( IY ) = ZERO
```

```
                  IY      = IY   + INCY
   30          CONTINUE
            ELSE
               DO 40, I = 1, N
                  Y( IY ) = BETA*Y( IY )
                  IY      = IY           + INCY
   40          CONTINUE
            END IF
         END IF
      END IF
      IF( ALPHA.EQ.ZERO )
     $   RETURN
      IF( LSAME( UPLO, 'U' ) )THEN
*
*        Form  y  when A is stored in upper triangle.
*
         IF( ( INCX.EQ.1 ).AND.( INCY.EQ.1 ) )THEN
            DO 60, J = 1, N
               TEMP1 = ALPHA*X( J )
               TEMP2 = ZERO
               DO 50, I = 1, J - 1
                  Y( I ) = Y( I ) + TEMP1*A( I, J )
                  TEMP2  = TEMP2  + A( I, J )*X( I )
   50          CONTINUE
               Y( J ) = Y( J ) + TEMP1*A( J, J ) + ALPHA*TEMP2
   60       CONTINUE
         ELSE
            JX = KX
            JY = KY
            DO 80, J = 1, N
               TEMP1 = ALPHA*X( JX )
               TEMP2 = ZERO
               IX    = KX
               IY    = KY
               DO 70, I = 1, J - 1
                  Y( IY ) = Y( IY ) + TEMP1*A( I, J )
                  TEMP2   = TEMP2   + A( I, J )*X( IX )
                  IX      = IX      + INCX
                  IY      = IY      + INCY
   70          CONTINUE
               Y( JY ) = Y( JY ) + TEMP1*A( J, J ) + ALPHA*TEMP2
               JX      = JX      + INCX
               JY      = JY      + INCY
   80       CONTINUE
         END IF
      ELSE
*
*        Form  y  when A is stored in lower triangle.
*
         IF( ( INCX.EQ.1 ).AND.( INCY.EQ.1 ) )THEN
```

```
            DO 100, J = 1, N
               TEMP1  = ALPHA*X( J )
               TEMP2  = ZERO
               Y( J ) = Y( J )       + TEMP1*A( J, J )
               DO 90, I = J + 1, N
                  Y( I ) = Y( I ) + TEMP1*A( I, J )
                  TEMP2  = TEMP2  + A( I, J )*X( I )
   90          CONTINUE
               Y( J ) = Y( J ) + ALPHA*TEMP2
  100       CONTINUE
         ELSE
            JX = KX
            JY = KY
            DO 120, J = 1, N
               TEMP1   = ALPHA*X( JX )
               TEMP2   = ZERO
               Y( JY ) = Y( JY )       + TEMP1*A( J, J )
               IX      = JX
               IY      = JY
               DO 110, I = J + 1, N
                  IX      = IX      + INCX
                  IY      = IY      + INCY
                  Y( IY ) = Y( IY ) + TEMP1*A( I, J )
                  TEMP2   = TEMP2   + A( I, J )*X( IX )
  110          CONTINUE
               Y( JY ) = Y( JY ) + ALPHA*TEMP2
               JX      = JX      + INCX
               JY      = JY      + INCY
  120       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of DSYMV .
*
      END
```

———-

— BLAS 2 dsymv —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dsymv (uplo n alpha a lda x incx beta y incy)
    (declare (type (simple-array double-float (*)) y x a)
             (type (double-float) beta alpha)
```

```
         (type fixnum incy incx lda n)
         (type character uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (a double-float a-%data% a-%offset%)
         (x double-float x-%data% x-%offset%)
         (y double-float y-%data% y-%offset%))
      (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (kx 0) (ky 0)
             (temp1 0.0) (temp2 0.0))
        (declare (type fixnum i info ix iy j jx jy kx ky)
                 (type (double-float) temp1 temp2))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
          ((< n 0)
           (setf info 2))
          ((< lda (max (the fixnum 1) (the fixnum n)))
           (setf info 5))
          ((= incx 0)
           (setf info 7))
          ((= incy 0)
           (setf info 10)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DSYMV" info)
           (go end_label)))
        (if (or (= n 0) (and (= alpha zero) (= beta one))) (go end_label))
        (cond
          ((> incx 0)
           (setf kx 1))
          (t
           (setf kx
                 (f2cl-lib:int-sub 1
                                   (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                     incx)))))
        (cond
          ((> incy 0)
           (setf ky 1))
          (t
           (setf ky
                 (f2cl-lib:int-sub 1
                                   (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                     incy)))))
        (cond
          ((/= beta one)
           (cond
             ((= incy 1)
```

```
       (cond
         ((= beta zero)
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                      zero))))
         (t
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                      (* beta
                         (f2cl-lib:fref y-%data%
                                        (i)
                                        ((1 *))
                                        y-%offset%)))))))))
      (t
       (setf iy ky)
       (cond
         ((= beta zero)
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                      zero)
              (setf iy (f2cl-lib:int-add iy incy)))))
         (t
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                      (* beta
                         (f2cl-lib:fref y-%data%
                                        (iy)
                                        ((1 *))
                                        y-%offset%)))
              (setf iy (f2cl-lib:int-add iy incy)))))))))
(if (= alpha zero) (go end_label))
(cond
  ((char-equal uplo #\U)
   (cond
     ((and (= incx 1) (= incy 1))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (setf temp1
                  (* alpha
                     (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
          (setf temp2 zero)
```

```
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i
                        (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                     nil)
        (tagbody
          (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                  (+
                   (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                   (* temp1
                      (f2cl-lib:fref a-%data%
                                     (i j)
                                     ((1 lda) (1 *))
                                     a-%offset%))))
          (setf temp2
                  (+ temp2
                     (*
                      (f2cl-lib:fref a-%data%
                                     (i j)
                                     ((1 lda) (1 *))
                                     a-%offset%)
                      (f2cl-lib:fref x-%data%
                                     (i)
                                     ((1 *))
                                     x-%offset%))))))
      (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
              (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                 (* temp1
                    (f2cl-lib:fref a-%data%
                                   (j j)
                                   ((1 lda) (1 *))
                                   a-%offset%))
                 (* alpha temp2))))))
  (t
   (setf jx kx)
   (setf jy ky)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
     (tagbody
       (setf temp1
               (* alpha
                  (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
       (setf temp2 zero)
       (setf ix kx)
       (setf iy ky)
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i
                         (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                      nil)
         (tagbody
           (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
```

```
                        (+
                         (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                         (* temp1
                            (f2cl-lib:fref a-%data%
                                           (i j)
                                           ((1 lda) (1 *))
                                           a-%offset%))))
                    (setf temp2
                            (+ temp2
                               (*
                                (f2cl-lib:fref a-%data%
                                               (i j)
                                               ((1 lda) (1 *))
                                               a-%offset%)
                                (f2cl-lib:fref x-%data%
                                               (ix)
                                               ((1 *))
                                               x-%offset%))))
                    (setf ix (f2cl-lib:int-add ix incx))
                    (setf iy (f2cl-lib:int-add iy incy))))
                (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                        (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                           (* temp1
                              (f2cl-lib:fref a-%data%
                                             (j j)
                                             ((1 lda) (1 *))
                                             a-%offset%))
                           (* alpha temp2)))
                (setf jx (f2cl-lib:int-add jx incx))
                (setf jy (f2cl-lib:int-add jy incy)))))))
        (t
         (cond
           ((and (= incx 1) (= incy 1))
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
              (tagbody
                (setf temp1
                        (* alpha
                           (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
                (setf temp2 zero)
                (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                        (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                           (* temp1
                              (f2cl-lib:fref a-%data%
                                             (j j)
                                             ((1 lda) (1 *))
                                             a-%offset%))))
                (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                 (f2cl-lib:int-add i 1))
                              ((> i n) nil)
```

```
          (tagbody
            (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                    (+
                     (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                     (* temp1
                        (f2cl-lib:fref a-%data%
                                       (i j)
                                       ((1 lda) (1 *))
                                       a-%offset%))))
            (setf temp2
                    (+ temp2
                       (*
                        (f2cl-lib:fref a-%data%
                                       (i j)
                                       ((1 lda) (1 *))
                                       a-%offset%)
                        (f2cl-lib:fref x-%data%
                                       (i)
                                       ((1 *))
                                       x-%offset%))))))
        (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                   (* alpha temp2))))))
    (t
     (setf jx kx)
     (setf jy ky)
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   ((> j n) nil)
       (tagbody
         (setf temp1
                 (* alpha
                    (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
         (setf temp2 zero)
         (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                 (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                    (* temp1
                       (f2cl-lib:fref a-%data%
                                      (j j)
                                      ((1 lda) (1 *))
                                      a-%offset%))))
         (setf ix jx)
         (setf iy jy)
         (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                          (f2cl-lib:int-add i 1))
                       ((> i n) nil)
           (tagbody
             (setf ix (f2cl-lib:int-add ix incx))
             (setf iy (f2cl-lib:int-add iy incy))
             (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                     (+
```

```
                              (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                              (* temp1
                                 (f2cl-lib:fref a-%data%
                                                (i j)
                                                ((1 lda) (1 *))
                                                a-%offset%))))
                        (setf temp2
                                (+ temp2
                                   (*
                                    (f2cl-lib:fref a-%data%
                                                   (i j)
                                                   ((1 lda) (1 *))
                                                   a-%offset%)
                                    (f2cl-lib:fref x-%data%
                                                   (ix)
                                                   ((1 *))
                                                   x-%offset%))))))
                    (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                            (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                               (* alpha temp2)))
                    (setf jx (f2cl-lib:int-add jx incx))
                    (setf jy (f2cl-lib:int-add jy incy))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil nil))))))
```

———-

4.9 dsyr2 BLAS

— **dsyr2.input** —

```
)set break resume
)sys rm -f dsyr2.output
)spool dsyr2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dsyr2.help** —

```
===========================================================================
```

```
dsyr2 examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 NAME
      DSYR2 - perform the symmetric rank 2 operation   A :=
      alpha*x*y' + alpha*y*x' + A,

 SYNOPSIS
      SUBROUTINE DSYR2 ( UPLO, N, ALPHA, X, INCX, Y, INCY, A, LDA
                       )

          DOUBLE       PRECISION ALPHA

          INTEGER      INCX, INCY, LDA, N

          CHARACTER*1  UPLO

          DOUBLE       PRECISION A( LDA, * ), X( * ), Y( * )

 PURPOSE
      DSYR2  performs the symmetric rank 2 operation

      where alpha is a scalar, x and y are n element vectors and A
      is an n by n symmetric matrix.

 PARAMETERS
      UPLO   - CHARACTER*1.
               On entry, UPLO specifies whether the upper or lower
               triangular part of the array A is to be referenced as
               follows:

               UPLO = 'U' or 'u'   Only the upper triangular part of
               A is to be referenced.

               UPLO = 'L' or 'l'   Only the lower triangular part of
               A is to be referenced.

               Unchanged on exit.

      N      - INTEGER.
               On entry, N specifies the order of the matrix A.  N
               must be at least zero.  Unchanged on exit.

      ALPHA  - DOUBLE PRECISION.
               On entry, ALPHA specifies the scalar alpha.
               Unchanged on exit.
```

```
*  X      - DOUBLE PRECISION array of dimension at least
*         ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
*         incremented array X must contain the n element vector
*         x.  Unchanged on exit.
*
*  INCX   - INTEGER.
*         On entry, INCX specifies the increment for the
*
*         elements of X. INCX must not be zero.  Unchanged on
*         exit.
*
*  Y      - DOUBLE PRECISION array of dimension at least
*         ( 1 + ( n - 1 )*abs( INCY ) ).  Before entry, the
*         incremented array Y must contain the n element vector
*         y.  Unchanged on exit.
*
*  INCY   - INTEGER.
*         On entry, INCY specifies the increment for the ele-
*         ments of Y. INCY must not be zero.  Unchanged on
*         exit.
*
*  A      - DOUBLE PRECISION array of DIMENSION ( LDA, n ).
*         Before entry with  UPLO = 'U' or 'u', the leading n
*         by n upper triangular part of the array A must con-
*         tain the upper triangular part of the symmetric
*         matrix and the strictly lower triangular part of A is
*         not referenced. On exit, the upper triangular part of
*         the array A is overwritten by the upper triangular
*         part of the updated matrix.  Before entry with UPLO =
*         'L' or 'l', the leading n by n lower triangular part
*         of the array A must contain the lower triangular part
*         of the symmetric matrix and the strictly upper tri-
*         angular part of A is not referenced. On exit, the
*         lower triangular part of the array A is overwritten
*         by the lower triangular part of the updated matrix.
*
*  LDA    - INTEGER.
*         On entry, LDA specifies the first dimension of A as
*         declared in the calling (sub) program. LDA must be at
*         least max( 1, n ).  Unchanged on exit.
*
*
*  -------
```

— dsyr2.f —

```
      SUBROUTINE DSYR2 ( UPLO, N, ALPHA, X, INCX, Y, INCY, A, LDA )
*     .. Scalar Arguments ..
```

```
      DOUBLE PRECISION   ALPHA
      INTEGER            INCX, INCY, LDA, N
      CHARACTER*1        UPLO
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), X( * ), Y( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER        ( ZERO = 0.0D+0 )
*     .. Local Scalars ..
      DOUBLE PRECISION   TEMP1, TEMP2
      INTEGER            I, INFO, IX, IY, J, JX, JY, KX, KY
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO, 'U' ).AND.
     $         .NOT.LSAME( UPLO, 'L' )      )THEN
         INFO = 1
      ELSE IF( N.LT.0 )THEN
         INFO = 2
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 5
      ELSE IF( INCY.EQ.0 )THEN
         INFO = 7
      ELSE IF( LDA.LT.MAX( 1, N ) )THEN
         INFO = 9
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DSYR2 ', INFO )
         RETURN
```

```
      END IF
*
*     Quick return if possible.
*
      IF( ( N.EQ.0 ).OR.( ALPHA.EQ.ZERO ) )
     $   RETURN
*
*     Set up the start points in X and Y if the increments are not both
*     unity.
*
      IF( ( INCX.NE.1 ).OR.( INCY.NE.1 ) )THEN
         IF( INCX.GT.0 )THEN
            KX = 1
         ELSE
            KX = 1 - ( N - 1 )*INCX
         END IF
         IF( INCY.GT.0 )THEN
            KY = 1
         ELSE
            KY = 1 - ( N - 1 )*INCY
         END IF
         JX = KX
         JY = KY
      END IF
*
*     Start the operations. In this version the elements of A are
*     accessed sequentially with one pass through the triangular part
*     of A.
*
      IF( LSAME( UPLO, 'U' ) )THEN
*
*        Form  A  when A is stored in the upper triangle.
*
         IF( ( INCX.EQ.1 ).AND.( INCY.EQ.1 ) )THEN
            DO 20, J = 1, N
               IF( ( X( J ).NE.ZERO ).OR.( Y( J ).NE.ZERO ) )THEN
                  TEMP1 = ALPHA*Y( J )
                  TEMP2 = ALPHA*X( J )
                  DO 10, I = 1, J
                     A( I, J ) = A( I, J ) + X( I )*TEMP1 + Y( I )*TEMP2
   10             CONTINUE
               END IF
   20       CONTINUE
         ELSE
            DO 40, J = 1, N
               IF( ( X( JX ).NE.ZERO ).OR.( Y( JY ).NE.ZERO ) )THEN
                  TEMP1 = ALPHA*Y( JY )
                  TEMP2 = ALPHA*X( JX )
                  IX    = KX
                  IY    = KY
```

```
                  DO 30, I = 1, J
                     A( I, J ) = A( I, J ) + X( IX )*TEMP1
     $                                      + Y( IY )*TEMP2
                     IX        = IX        + INCX
                     IY        = IY        + INCY
   30             CONTINUE
               END IF
               JX = JX + INCX
               JY = JY + INCY
   40       CONTINUE
         END IF
      ELSE
*
*        Form  A  when A is stored in the lower triangle.
*
         IF( ( INCX.EQ.1 ).AND.( INCY.EQ.1 ) )THEN
            DO 60, J = 1, N
               IF( ( X( J ).NE.ZERO ).OR.( Y( J ).NE.ZERO ) )THEN
                  TEMP1 = ALPHA*Y( J )
                  TEMP2 = ALPHA*X( J )
                  DO 50, I = J, N
                     A( I, J ) = A( I, J ) + X( I )*TEMP1 + Y( I )*TEMP2
   50             CONTINUE
               END IF
   60       CONTINUE
         ELSE
            DO 80, J = 1, N
               IF( ( X( JX ).NE.ZERO ).OR.( Y( JY ).NE.ZERO ) )THEN
                  TEMP1 = ALPHA*Y( JY )
                  TEMP2 = ALPHA*X( JX )
                  IX    = JX
                  IY    = JY
                  DO 70, I = J, N
                     A( I, J ) = A( I, J ) + X( IX )*TEMP1
     $                                      + Y( IY )*TEMP2
                     IX        = IX        + INCX
                     IY        = IY        + INCY
   70             CONTINUE
               END IF
               JX = JX + INCX
               JY = JY + INCY
   80       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of DSYR2 .
*
      END
```

———-

— BLAS 2 dsyr2 —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dsyr2 (uplo n alpha x incx y incy a lda)
    (declare (type (simple-array double-float (*)) a y x)
             (type (double-float) alpha)
             (type fixnum lda incy incx n)
             (type character uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (x double-float x-%data% x-%offset%)
         (y double-float y-%data% y-%offset%)
         (a double-float a-%data% a-%offset%))
      (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (kx 0) (ky 0)
             (temp1 0.0) (temp2 0.0))
        (declare (type fixnum i info ix iy j jx jy kx ky)
                 (type (double-float) temp1 temp2))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
          ((< n 0)
           (setf info 2))
          ((= incx 0)
           (setf info 5))
          ((= incy 0)
           (setf info 7))
          ((< lda (max (the fixnum 1) (the fixnum n)))
           (setf info 9)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DSYR2" info)
           (go end_label)))
        (if (or (= n 0) (= alpha zero)) (go end_label))
        (cond
          ((or (/= incx 1) (/= incy 1))
           (cond
             ((> incx 0)
              (setf kx 1))
             (t
              (setf kx
                      (f2cl-lib:int-sub 1
```

```
                                (f2cl-lib:int-mul
                                 (f2cl-lib:int-sub n 1)
                                 incx)))))
    (cond
      ((> incy 0)
       (setf ky 1))
      (t
       (setf ky
             (f2cl-lib:int-sub 1
                               (f2cl-lib:int-mul
                                (f2cl-lib:int-sub n 1)
                                incy)))))
    (setf jx kx)
    (setf jy ky)))
  (cond
    ((char-equal uplo #\U)
     (cond
       ((and (= incx 1) (= incy 1))
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                      ((> j n) nil)
          (tagbody
            (cond
              ((or (/= (f2cl-lib:fref x (j) ((1 *))) zero)
                   (/= (f2cl-lib:fref y (j) ((1 *))) zero))
               (setf temp1
                       (* alpha
                          (f2cl-lib:fref y-%data%
                                         (j)
                                         ((1 *))
                                         y-%offset%)))
               (setf temp2
                       (* alpha
                          (f2cl-lib:fref x-%data%
                                         (j)
                                         ((1 *))
                                         x-%offset%)))
               (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                             ((> i j) nil)
                 (tagbody
                   (setf (f2cl-lib:fref a-%data%
                                        (i j)
                                        ((1 lda) (1 *))
                                        a-%offset%)
                         (+
                          (f2cl-lib:fref a-%data%
                                         (i j)
                                         ((1 lda) (1 *))
                                         a-%offset%)
                          (*
                           (f2cl-lib:fref x-%data%
```

```
                                        (i)
                                        ((1 *))
                                        x-%offset%)
                         temp1)
                        (*
                         (f2cl-lib:fref y-%data%
                                        (i)
                                        ((1 *))
                                        y-%offset%)
                         temp2))))))))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (cond
       ((or (/= (f2cl-lib:fref x (jx) ((1 *))) zero)
            (/= (f2cl-lib:fref y (jy) ((1 *))) zero))
        (setf temp1
                (* alpha
                   (f2cl-lib:fref y-%data%
                                  (jy)
                                  ((1 *))
                                  y-%offset%)))
        (setf temp2
                (* alpha
                   (f2cl-lib:fref x-%data%
                                  (jx)
                                  ((1 *))
                                  x-%offset%)))
        (setf ix kx)
        (setf iy ky)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i j) nil)
          (tagbody
            (setf (f2cl-lib:fref a-%data%
                                 (i j)
                                 ((1 lda) (1 *))
                                 a-%offset%)
                  (+
                   (f2cl-lib:fref a-%data%
                                  (i j)
                                  ((1 lda) (1 *))
                                  a-%offset%)
                   (*
                    (f2cl-lib:fref x-%data%
                                   (ix)
                                   ((1 *))
                                   x-%offset%)
                    temp1)
                   (*
```

```
                              (f2cl-lib:fref y-%data%
                                             (iy)
                                             ((1 *))
                                             y-%offset%)
                              temp2)))
                    (setf ix (f2cl-lib:int-add ix incx))
                    (setf iy (f2cl-lib:int-add iy incy))))))
              (setf jx (f2cl-lib:int-add jx incx))
              (setf jy (f2cl-lib:int-add jy incy)))))))
     (t
      (cond
        ((and (= incx 1) (= incy 1))
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (cond
               ((or (/= (f2cl-lib:fref x (j) ((1 *))) zero)
                    (/= (f2cl-lib:fref y (j) ((1 *))) zero))
                (setf temp1
                        (* alpha
                           (f2cl-lib:fref y-%data%
                                          (j)
                                          ((1 *))
                                          y-%offset%)))
                (setf temp2
                        (* alpha
                           (f2cl-lib:fref x-%data%
                                          (j)
                                          ((1 *))
                                          x-%offset%)))
                (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                              ((> i n) nil)
                  (tagbody
                    (setf (f2cl-lib:fref a-%data%
                                         (i j)
                                         ((1 lda) (1 *))
                                         a-%offset%)
                            (+
                             (f2cl-lib:fref a-%data%
                                            (i j)
                                            ((1 lda) (1 *))
                                            a-%offset%)
                             (*
                              (f2cl-lib:fref x-%data%
                                             (i)
                                             ((1 *))
                                             x-%offset%)
                              temp1)
                             (*
                              (f2cl-lib:fref y-%data%
```

```
                                        (i)
                                        ((1 *))
                                        y-%offset%)
                          temp2)))))))))))
      (t
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (cond
             ((or (/= (f2cl-lib:fref x (jx) ((1 *))) zero)
                  (/= (f2cl-lib:fref y (jy) ((1 *))) zero))
              (setf temp1
                      (* alpha
                         (f2cl-lib:fref y-%data%
                                        (jy)
                                        ((1 *))
                                        y-%offset%)))
              (setf temp2
                      (* alpha
                         (f2cl-lib:fref x-%data%
                                        (jx)
                                        ((1 *))
                                        x-%offset%)))
              (setf ix jx)
              (setf iy jy)
              (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                            ((> i n) nil)
                (tagbody
                  (setf (f2cl-lib:fref a-%data%
                                       (i j)
                                       ((1 lda) (1 *))
                                       a-%offset%)
                        (+
                         (f2cl-lib:fref a-%data%
                                        (i j)
                                        ((1 lda) (1 *))
                                        a-%offset%)
                         (*
                          (f2cl-lib:fref x-%data%
                                         (ix)
                                         ((1 *))
                                         x-%offset%)
                          temp1)
                         (*
                          (f2cl-lib:fref y-%data%
                                         (iy)
                                         ((1 *))
                                         y-%offset%)
                          temp2)))
                  (setf ix (f2cl-lib:int-add ix incx))
```

```
                        (setf iy (f2cl-lib:int-add iy incy))))))
                 (setf jx (f2cl-lib:int-add jx incx))
                 (setf jy (f2cl-lib:int-add jy incy))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil))))))
```

———-

4.10 dsyr BLAS

— **dsyr.input** —

```
)set break resume
)sys rm -f dsyr.output
)spool dsyr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dsyr.help** —

```
==========================================================================
dsyr examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      DSYR - perform the symmetric rank 1 operation   A :=
      alpha*x*x' + A,

 SYNOPSIS
      SUBROUTINE DSYR ( UPLO, N, ALPHA, X, INCX, A, LDA )

          DOUBLE      PRECISION ALPHA

          INTEGER     INCX, LDA, N
```

```
          CHARACTER*1 UPLO

          DOUBLE      PRECISION A( LDA, * ), X( * )

PURPOSE
     DSYR   performs the symmetric rank 1 operation

     where alpha is a real scalar, x is an n element vector and A
     is an n by n symmetric matrix.

PARAMETERS
     UPLO   - CHARACTER*1.
            On entry, UPLO specifies whether the upper or lower
            triangular part of the array A is to be referenced as
            follows:

            UPLO = 'U' or 'u'   Only the upper triangular part of
            A is to be referenced.

            UPLO = 'L' or 'l'   Only the lower triangular part of
            A is to be referenced.

            Unchanged on exit.

     N      - INTEGER.
            On entry, N specifies the order of the matrix A.  N
            must be at least zero.  Unchanged on exit.

     ALPHA  - DOUBLE PRECISION.
            On entry, ALPHA specifies the scalar alpha.
            Unchanged on exit.

     X      - DOUBLE PRECISION array of dimension at least
            ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
            incremented array X must contain the n element vector
            x.  Unchanged on exit.

     INCX   - INTEGER.
            On entry, INCX specifies the increment for the ele-
            ments of X. INCX must not be zero.  Unchanged on

            exit.

     A      - DOUBLE PRECISION array of DIMENSION ( LDA, n ).
            Before entry with  UPLO = 'U' or 'u', the leading n
            by n upper triangular part of the array A must con-
            tain the upper triangular part of the symmetric
            matrix and the strictly lower triangular part of A is
            not referenced. On exit, the upper triangular part of
            the array A is overwritten by the upper triangular
```

```
             part of the updated matrix.  Before entry with UPLO =
             'L' or 'l', the leading n by n lower triangular part
             of the array A must contain the lower triangular part
             of the symmetric matrix and the strictly upper tri-
             angular part of A is not referenced. On exit, the
             lower triangular part of the array A is overwritten
             by the lower triangular part of the updated matrix.

      LDA    - INTEGER.
             On entry, LDA specifies the first dimension of A as
             declared in the calling (sub) program. LDA must be at
             least max( 1, n ).  Unchanged on exit.
```

———-

— dsyr.f —

```
      SUBROUTINE DSYR  ( UPLO, N, ALPHA, X, INCX, A, LDA )
*     .. Scalar Arguments ..
      DOUBLE PRECISION   ALPHA
      INTEGER            INCX, LDA, N
      CHARACTER*1        UPLO
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), X( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER        ( ZERO = 0.0D+0 )
*     .. Local Scalars ..
      DOUBLE PRECISION   TEMP
      INTEGER            I, INFO, IX, J, JX, KX
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
```

```
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO, 'U' ).AND.
     $         .NOT.LSAME( UPLO, 'L' )      )THEN
         INFO = 1
      ELSE IF( N.LT.0 )THEN
         INFO = 2
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 5
      ELSE IF( LDA.LT.MAX( 1, N ) )THEN
         INFO = 7
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DSYR  ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( N.EQ.0 ).OR.( ALPHA.EQ.ZERO ) )
     $   RETURN
*
*     Set the start point in X if the increment is not unity.
*
      IF( INCX.LE.0 )THEN
         KX = 1 - ( N - 1 )*INCX
      ELSE IF( INCX.NE.1 )THEN
         KX = 1
      END IF
*
*     Start the operations. In this version the elements of A are
*     accessed sequentially with one pass through the triangular part
*     of A.
*
      IF( LSAME( UPLO, 'U' ) )THEN
*
*        Form  A  when A is stored in upper triangle.
*
         IF( INCX.EQ.1 )THEN
            DO 20, J = 1, N
               IF( X( J ).NE.ZERO )THEN
                  TEMP = ALPHA*X( J )
                  DO 10, I = 1, J
                     A( I, J ) = A( I, J ) + X( I )*TEMP
   10             CONTINUE
               END IF
```

```
   20       CONTINUE
         ELSE
            JX = KX
            DO 40, J = 1, N
               IF( X( JX ).NE.ZERO )THEN
                  TEMP = ALPHA*X( JX )
                  IX   = KX
                  DO 30, I = 1, J
                     A( I, J ) = A( I, J ) + X( IX )*TEMP
                     IX        = IX        + INCX
   30             CONTINUE
               END IF
               JX = JX + INCX
   40       CONTINUE
         END IF
      ELSE
*
*        Form  A  when A is stored in lower triangle.
*
         IF( INCX.EQ.1 )THEN
            DO 60, J = 1, N
               IF( X( J ).NE.ZERO )THEN
                  TEMP = ALPHA*X( J )
                  DO 50, I = J, N
                     A( I, J ) = A( I, J ) + X( I )*TEMP
   50             CONTINUE
               END IF
   60       CONTINUE
         ELSE
            JX = KX
            DO 80, J = 1, N
               IF( X( JX ).NE.ZERO )THEN
                  TEMP = ALPHA*X( JX )
                  IX   = JX
                  DO 70, I = J, N
                     A( I, J ) = A( I, J ) + X( IX )*TEMP
                     IX        = IX        + INCX
   70             CONTINUE
               END IF
               JX = JX + INCX
   80       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of DSYR  .
*
      END
```

———-

— BLAS 2 dsyr —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dsyr (uplo n alpha x incx a lda)
    (declare (type (simple-array double-float (*)) a x)
             (type (double-float) alpha)
             (type fixnum lda incx n)
             (type character uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (x double-float x-%data% x-%offset%)
         (a double-float a-%data% a-%offset%))
      (prog ((i 0) (info 0) (ix 0) (j 0) (jx 0) (kx 0) (temp 0.0))
        (declare (type fixnum i info ix j jx kx)
                 (type (double-float) temp))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
          ((< n 0)
           (setf info 2))
          ((= incx 0)
           (setf info 5))
          ((< lda (max (the fixnum 1) (the fixnum n)))
           (setf info 7)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DSYR" info)
           (go end_label)))
        (if (or (= n 0) (= alpha zero)) (go end_label))
        (cond
          ((<= incx 0)
           (setf kx
                   (f2cl-lib:int-sub 1
                                     (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                       incx))))
          ((/= incx 1)
           (setf kx 1)))
        (cond
          ((char-equal uplo #\U)
           (cond
             ((= incx 1)
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
```

```
      (tagbody
        (cond
          (((/= (f2cl-lib:fref x (j) ((1 *))) zero)
           (setf temp
                   (* alpha
                      (f2cl-lib:fref x-%data%
                                     (j)
                                     ((1 *))
                                     x-%offset%)))
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i j) nil)
             (tagbody
               (setf (f2cl-lib:fref a-%data%
                                    (i j)
                                    ((1 lda) (1 *))
                                    a-%offset%)
                     (+
                      (f2cl-lib:fref a-%data%
                                     (i j)
                                     ((1 lda) (1 *))
                                     a-%offset%)
                      (*
                       (f2cl-lib:fref x-%data%
                                      (i)
                                      ((1 *))
                                      x-%offset%)
                       temp)))))))))
    (t
     (setf jx kx)
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   ((> j n) nil)
       (tagbody
         (cond
           (((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
            (setf temp
                    (* alpha
                       (f2cl-lib:fref x-%data%
                                      (jx)
                                      ((1 *))
                                      x-%offset%)))
            (setf ix kx)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          ((> i j) nil)
              (tagbody
                (setf (f2cl-lib:fref a-%data%
                                     (i j)
                                     ((1 lda) (1 *))
                                     a-%offset%)
                      (+
                       (f2cl-lib:fref a-%data%
```

```
                                        (i j)
                                        ((1 lda) (1 *))
                                        a-%offset%)
                              (*
                               (f2cl-lib:fref x-%data%
                                              (ix)
                                              ((1 *))
                                              x-%offset%)
                               temp)))
                    (setf ix (f2cl-lib:int-add ix incx))))))
             (setf jx (f2cl-lib:int-add jx incx)))))))
      (t
       (cond
         ((= incx 1)
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                        ((> j n) nil)
            (tagbody
              (cond
                ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                 (setf temp
                         (* alpha
                            (f2cl-lib:fref x-%data%
                                           (j)
                                           ((1 *))
                                           x-%offset%)))
                 (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                               ((> i n) nil)
                   (tagbody
                     (setf (f2cl-lib:fref a-%data%
                                          (i j)
                                          ((1 lda) (1 *))
                                          a-%offset%)
                               (+
                                (f2cl-lib:fref a-%data%
                                               (i j)
                                               ((1 lda) (1 *))
                                               a-%offset%)
                                (*
                                 (f2cl-lib:fref x-%data%
                                                (i)
                                                ((1 *))
                                                x-%offset%)
                                 temp)))))))))))
         (t
          (setf jx kx)
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                        ((> j n) nil)
            (tagbody
              (cond
                ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
```

```
                    (setf temp
                            (* alpha
                               (f2cl-lib:fref x-%data%
                                              (jx)
                                              ((1 *))
                                              x-%offset%)))
                    (setf ix jx)
                    (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                                  ((> i n) nil)
                      (tagbody
                        (setf (f2cl-lib:fref a-%data%
                                             (i j)
                                             ((1 lda) (1 *))
                                             a-%offset%)
                                      (+
                                       (f2cl-lib:fref a-%data%
                                                      (i j)
                                                      ((1 lda) (1 *))
                                                      a-%offset%)
                                       (*
                                        (f2cl-lib:fref x-%data%
                                                       (ix)
                                                       ((1 *))
                                                       x-%offset%)
                                        temp)))
                            (setf ix (f2cl-lib:int-add ix incx))))))
                  (setf jx (f2cl-lib:int-add jx incx))))))))
 end_label
        (return (values nil nil nil nil nil nil nil))))))
```

———-

4.11 dtbmv BLAS

— dtbmv.input —

```
)set break resume
)sys rm -f dtbmv.output
)spool dtbmv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dtbmv.help —

```
=====================================================================
dtbmv examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 NAME
      DTBMV - perform one of the matrix-vector operations   x :=
      A*x, or x := A'*x,

 SYNOPSIS
      SUBROUTINE DTBMV ( UPLO, TRANS, DIAG, N, K, A, LDA, X, INCX
                       )

          INTEGER      INCX, K, LDA, N

          CHARACTER*1  DIAG, TRANS, UPLO

          DOUBLE       PRECISION A( LDA, * ), X( * )

 PURPOSE
      DTBMV  performs one of the matrix-vector operations

      where x is an n element vector and  A is an n by n unit, or
      non-unit, upper or lower triangular band matrix, with ( k +
      1 ) diagonals.

 PARAMETERS
      UPLO   - CHARACTER*1.
               On entry, UPLO specifies whether the matrix is an
               upper or lower triangular matrix as follows:

               UPLO = 'U' or 'u'   A is an upper triangular matrix.

               UPLO = 'L' or 'l'   A is a lower triangular matrix.

               Unchanged on exit.

      TRANS  - CHARACTER*1.
               On entry, TRANS specifies the operation to be per-
               formed as follows:

               TRANS = 'N' or 'n'   x := A*x.
```

```
          TRANS = 'T' or 't'   x := A'*x.

          TRANS = 'C' or 'c'   x := A'*x.

          Unchanged on exit.

DIAG   - CHARACTER*1.
          On entry, DIAG specifies whether or not A is unit
          triangular as follows:

          DIAG = 'U' or 'u'   A is assumed to be unit triangu-
          lar.

          DIAG = 'N' or 'n'   A is not assumed to be unit tri-
          angular.

          Unchanged on exit.

N      - INTEGER.
          On entry, N specifies the order of the matrix A.  N
          must be at least zero.  Unchanged on exit.

K      - INTEGER.
          On entry with UPLO = 'U' or 'u', K specifies the
          number of super-diagonals of the matrix A.  On entry
          with UPLO = 'L' or 'l', K specifies the number of
          sub-diagonals of the matrix A.  K must satisfy  0
          .le. K.  Unchanged on exit.

A      - DOUBLE PRECISION array of DIMENSION ( LDA, n ).
          Before entry with UPLO = 'U' or 'u', the leading ( k
          + 1 ) by n part of the array A must contain the upper
          triangular band part of the matrix of coefficients,
          supplied column by column, with the leading diagonal
          of the matrix in row ( k + 1 ) of the array, the
          first super-diagonal starting at position 2 in row k,
          and so on. The top left k by k triangle of the array
          A is not referenced.  The following program segment
          will transfer an upper triangular band matrix from
          conventional full matrix storage to band storage:

          DO 20, J = 1, N M = K + 1 - J DO 10, I = MAX( 1, J -
          K ), J A( M + I, J ) = matrix( I, J ) 10    CONTINUE
          20 CONTINUE

          Before entry with UPLO = 'L' or 'l', the leading ( k
          + 1 ) by n part of the array A must contain the lower
          triangular band part of the matrix of coefficients,
          supplied column by column, with the leading diagonal
```

```
           of the matrix in row 1 of the array, the first sub-
           diagonal starting at position 1 in row 2, and so on.
           The bottom right k by k triangle of the array A is
           not referenced.  The following program segment will
           transfer a lower triangular band matrix from conven-
           tional full matrix storage to band storage:

           DO 20, J = 1, N M = 1 - J DO 10, I = J, MIN( N, J + K
           ) A( M + I, J ) = matrix( I, J ) 10    CONTINUE 20
           CONTINUE

           Note that when DIAG = 'U' or 'u' the elements of the
           array A corresponding to the diagonal elements of the
           matrix are not referenced, but are assumed to be
           unity.  Unchanged on exit.

     LDA   - INTEGER.
           On entry, LDA specifies the first dimension of A as
           declared in the calling (sub) program. LDA must be at
           least ( k + 1 ).  Unchanged on exit.

     X     - DOUBLE PRECISION array of dimension at least
           ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
           incremented array X must contain the n element vector
           x. On exit, X is overwritten with the transformed
           vector x.

     INCX  - INTEGER.
           On entry, INCX specifies the increment for the ele-
           ments of X. INCX must not be zero.  Unchanged on
           exit.
```

———-

— dtbmv.f —

```
     SUBROUTINE DTBMV ( UPLO, TRANS, DIAG, N, K, A, LDA, X, INCX )
*     .. Scalar Arguments ..
      INTEGER            INCX, K, LDA, N
      CHARACTER*1        DIAG, TRANS, UPLO
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), X( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
```

```
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER        ( ZERO = 0.0D+0 )
*     .. Local Scalars ..
      DOUBLE PRECISION   TEMP
      INTEGER            I, INFO, IX, J, JX, KPLUS1, KX, L
      LOGICAL            NOUNIT
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO , 'U' ).AND.
     $         .NOT.LSAME( UPLO , 'L' )      )THEN
         INFO = 1
      ELSE IF( .NOT.LSAME( TRANS, 'N' ).AND.
     $         .NOT.LSAME( TRANS, 'T' ).AND.
     $         .NOT.LSAME( TRANS, 'C' )      )THEN
         INFO = 2
      ELSE IF( .NOT.LSAME( DIAG , 'U' ).AND.
     $         .NOT.LSAME( DIAG , 'N' )      )THEN
         INFO = 3
      ELSE IF( N.LT.0 )THEN
         INFO = 4
      ELSE IF( K.LT.0 )THEN
         INFO = 5
      ELSE IF( LDA.LT.( K + 1 ) )THEN
         INFO = 7
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 9
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DTBMV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
```

```
*
      IF( N.EQ.0 )
     $   RETURN
*
      NOUNIT = LSAME( DIAG, 'N' )
*
*     Set up the start point in X if the increment is not unity. This
*     will be  ( N - 1 )*INCX   too small for descending loops.
*
      IF( INCX.LE.0 )THEN
         KX = 1 - ( N - 1 )*INCX
      ELSE IF( INCX.NE.1 )THEN
         KX = 1
      END IF
*
*     Start the operations. In this version the elements of A are
*     accessed sequentially with one pass through A.
*
      IF( LSAME( TRANS, 'N' ) )THEN
*
*         Form  x := A*x.
*
         IF( LSAME( UPLO, 'U' ) )THEN
            KPLUS1 = K + 1
            IF( INCX.EQ.1 )THEN
               DO 20, J = 1, N
                  IF( X( J ).NE.ZERO )THEN
                     TEMP = X( J )
                     L    = KPLUS1 - J
                     DO 10, I = MAX( 1, J - K ), J - 1
                        X( I ) = X( I ) + TEMP*A( L + I, J )
   10                CONTINUE
                     IF( NOUNIT )
     $                  X( J ) = X( J )*A( KPLUS1, J )
                  END IF
   20          CONTINUE
            ELSE
               JX = KX
               DO 40, J = 1, N
                  IF( X( JX ).NE.ZERO )THEN
                     TEMP = X( JX )
                     IX   = KX
                     L    = KPLUS1  - J
                     DO 30, I = MAX( 1, J - K ), J - 1
                        X( IX ) = X( IX ) + TEMP*A( L + I, J )
                        IX      = IX      + INCX
   30                CONTINUE
                     IF( NOUNIT )
     $                  X( JX ) = X( JX )*A( KPLUS1, J )
                  END IF
```

```
                  JX = JX + INCX
                  IF( J.GT.K )
     $               KX = KX + INCX
   40          CONTINUE
            END IF
         ELSE
            IF( INCX.EQ.1 )THEN
               DO 60, J = N, 1, -1
                  IF( X( J ).NE.ZERO )THEN
                     TEMP = X( J )
                     L    = 1      - J
                     DO 50, I = MIN( N, J + K ), J + 1, -1
                        X( I ) = X( I ) + TEMP*A( L + I, J )
   50                CONTINUE
                     IF( NOUNIT )
     $                  X( J ) = X( J )*A( 1, J )
                  END IF
   60          CONTINUE
            ELSE
               KX = KX + ( N - 1 )*INCX
               JX = KX
               DO 80, J = N, 1, -1
                  IF( X( JX ).NE.ZERO )THEN
                     TEMP = X( JX )
                     IX   = KX
                     L    = 1       - J
                     DO 70, I = MIN( N, J + K ), J + 1, -1
                        X( IX ) = X( IX ) + TEMP*A( L + I, J )
                        IX      = IX      - INCX
   70                CONTINUE
                     IF( NOUNIT )
     $                  X( JX ) = X( JX )*A( 1, J )
                  END IF
                  JX = JX - INCX
                  IF( ( N - J ).GE.K )
     $               KX = KX - INCX
   80          CONTINUE
            END IF
         END IF
      ELSE
*
*        Form  x := A'*x.
*
         IF( LSAME( UPLO, 'U' ) )THEN
            KPLUS1 = K + 1
            IF( INCX.EQ.1 )THEN
               DO 100, J = N, 1, -1
                  TEMP = X( J )
                  L    = KPLUS1 - J
                  IF( NOUNIT )
```

```
     $              TEMP = TEMP*A( KPLUS1, J )
                    DO 90, I = J - 1, MAX( 1, J - K ), -1
                       TEMP = TEMP + A( L + I, J )*X( I )
  90                CONTINUE
                    X( J ) = TEMP
 100             CONTINUE
              ELSE
                 KX = KX + ( N - 1 )*INCX
                 JX = KX
                 DO 120, J = N, 1, -1
                    TEMP = X( JX )
                    KX   = KX      - INCX
                    IX   = KX
                    L    = KPLUS1  - J
                    IF( NOUNIT )
     $                 TEMP = TEMP*A( KPLUS1, J )
                    DO 110, I = J - 1, MAX( 1, J - K ), -1
                       TEMP = TEMP + A( L + I, J )*X( IX )
                       IX   = IX   - INCX
 110                CONTINUE
                    X( JX ) = TEMP
                    JX      = JX   - INCX
 120             CONTINUE
              END IF
           ELSE
              IF( INCX.EQ.1 )THEN
                 DO 140, J = 1, N
                    TEMP = X( J )
                    L    = 1      - J
                    IF( NOUNIT )
     $                 TEMP = TEMP*A( 1, J )
                    DO 130, I = J + 1, MIN( N, J + K )
                       TEMP = TEMP + A( L + I, J )*X( I )
 130                CONTINUE
                    X( J ) = TEMP
 140             CONTINUE
              ELSE
                 JX = KX
                 DO 160, J = 1, N
                    TEMP = X( JX )
                    KX   = KX      + INCX
                    IX   = KX
                    L    = 1       - J
                    IF( NOUNIT )
     $                 TEMP = TEMP*A( 1, J )
                    DO 150, I = J + 1, MIN( N, J + K )
                       TEMP = TEMP + A( L + I, J )*X( IX )
                       IX   = IX   + INCX
 150                CONTINUE
                    X( JX ) = TEMP
```

```
                JX      = JX   + INCX
  160          CONTINUE
           END IF
         END IF
      END IF
*
      RETURN
*
*     End of DTBMV .
*
      END
```

———-

— BLAS 2 dtbmv —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dtbmv (uplo trans diag n k a lda x incx)
    (declare (type (simple-array double-float (*)) x a)
             (type fixnum incx lda k n)
             (type character diag trans uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (a double-float a-%data% a-%offset%)
         (x double-float x-%data% x-%offset%))
      (prog ((nounit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0) (kplus1 0) (kx 0)
             (l 0) (temp 0.0))
        (declare (type (member t nil) nounit)
                 (type fixnum i info ix j jx kplus1 kx l)
                 (type (double-float) temp))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
          ((and (not (char-equal trans #\N))
                (not (char-equal trans #\T))
                (not (char-equal trans #\C)))
           (setf info 2))
          ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
           (setf info 3))
          ((< n 0)
           (setf info 4))
          ((< k 0)
           (setf info 5))
          ((< lda (f2cl-lib:int-add k 1))
```

```
   (setf info 7))
  ((= incx 0)
   (setf info 9)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DTBMV" info)
   (go end_label)))
(if (= n 0) (go end_label))
(setf nounit (char-equal diag #\N))
(cond
  ((<= incx 0)
   (setf kx
         (f2cl-lib:int-sub 1
                           (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                             incx))))
  ((/= incx 1)
   (setf kx 1)))
(cond
  ((char-equal trans #\N)
   (cond
     ((char-equal uplo #\U)
      (setf kplus1 (f2cl-lib:int-add k 1))
      (cond
        ((= incx 1)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (cond
               ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                (setf temp
                        (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                (setf l (f2cl-lib:int-sub kplus1 j))
                (f2cl-lib:fdo (i
                               (max (the fixnum 1)
                                    (the fixnum
                                         (f2cl-lib:int-add j
                                                           (f2cl-lib:int-sub
                                                            k))))
                               (f2cl-lib:int-add i 1))
                              ((> i
                                  (f2cl-lib:int-add j
                                                    (f2cl-lib:int-sub
                                                     1)))
                               nil)
                  (tagbody
                    (setf (f2cl-lib:fref x-%data%
                                         (i)
                                         ((1 *))
```

```
                                    x-%offset%)
                            (+
                             (f2cl-lib:fref x-%data%
                                            (i)
                                            ((1 *))
                                            x-%offset%)
                             (* temp
                                (f2cl-lib:fref a-%data%
                                               ((f2cl-lib:int-add l i)
                                                j)
                                               ((1 lda) (1 *))
                                               a-%offset%))))))
                    (if nounit
                        (setf (f2cl-lib:fref x-%data%
                                             (j)
                                             ((1 *))
                                             x-%offset%)
                              (*
                               (f2cl-lib:fref x-%data%
                                              (j)
                                              ((1 *))
                                              x-%offset%)
                               (f2cl-lib:fref a-%data%
                                              (kplus1 j)
                                              ((1 lda) (1 *))
                                              a-%offset%)))))))))
          (t
           (setf jx kx)
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (cond
                 ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
                  (setf temp
                          (f2cl-lib:fref x-%data%
                                         (jx)
                                         ((1 *))
                                         x-%offset%))
                  (setf ix kx)
                  (setf l (f2cl-lib:int-sub kplus1 j))
                  (f2cl-lib:fdo (i
                                 (max (the fixnum 1)
                                      (the fixnum
                                           (f2cl-lib:int-add j
                                                             (f2cl-lib:int-sub
                                                              k))))
                                 (f2cl-lib:int-add i 1))
                                ((> i
                                    (f2cl-lib:int-add j
                                                      (f2cl-lib:int-sub
```

```
                                                  1)))
                                nil)
                          (tagbody
                            (setf (f2cl-lib:fref x-%data%
                                                 (ix)
                                                 ((1 *))
                                                 x-%offset%)
                                  (+
                                   (f2cl-lib:fref x-%data%
                                                  (ix)
                                                  ((1 *))
                                                  x-%offset%)
                                   (* temp
                                      (f2cl-lib:fref a-%data%
                                                     ((f2cl-lib:int-add l i)
                                                      j)
                                                     ((1 lda) (1 *))
                                                     a-%offset%))))
                            (setf ix (f2cl-lib:int-add ix incx))))
                        (if nounit
                            (setf (f2cl-lib:fref x-%data%
                                                 (jx)
                                                 ((1 *))
                                                 x-%offset%)
                                  (*
                                   (f2cl-lib:fref x-%data%
                                                  (jx)
                                                  ((1 *))
                                                  x-%offset%)
                                   (f2cl-lib:fref a-%data%
                                                  (kplus1 j)
                                                  ((1 lda) (1 *))
                                                  a-%offset%))))))
                  (setf jx (f2cl-lib:int-add jx incx))
                  (if (> j k) (setf kx (f2cl-lib:int-add kx incx))))))))
        (t
         (cond
           ((= incx 1)
            (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                          ((> j 1) nil)
              (tagbody
                (cond
                  ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                   (setf temp
                           (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                   (setf l (f2cl-lib:int-sub 1 j))
                   (f2cl-lib:fdo (i
                                  (min (the fixnum n)
                                       (the fixnum
                                            (f2cl-lib:int-add j k)))
```

```
                              (f2cl-lib:int-add i
                                               (f2cl-lib:int-sub 1)))
                             ((> i (f2cl-lib:int-add j 1)) nil)
                   (tagbody
                     (setf (f2cl-lib:fref x-%data%
                                          (i)
                                          ((1 *))
                                          x-%offset%)
                           (+
                            (f2cl-lib:fref x-%data%
                                           (i)
                                           ((1 *))
                                           x-%offset%)
                            (* temp
                               (f2cl-lib:fref a-%data%
                                              ((f2cl-lib:int-add l i)
                                               j)
                                              ((1 lda) (1 *))
                                              a-%offset%))))))
                 (if nounit
                     (setf (f2cl-lib:fref x-%data%
                                          (j)
                                          ((1 *))
                                          x-%offset%)
                           (*
                            (f2cl-lib:fref x-%data%
                                           (j)
                                           ((1 *))
                                           x-%offset%)
                            (f2cl-lib:fref a-%data%
                                           (1 j)
                                           ((1 lda) (1 *))
                                           a-%offset%)))))))))
        (t
         (setf kx
                 (f2cl-lib:int-add kx
                                   (f2cl-lib:int-mul
                                    (f2cl-lib:int-sub n 1)
                                    incx)))
         (setf jx kx)
         (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                       ((> j 1) nil)
           (tagbody
             (cond
               ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
                (setf temp
                        (f2cl-lib:fref x-%data%
                                       (jx)
                                       ((1 *))
                                       x-%offset%))
```

```
                    (setf ix kx)
                    (setf l (f2cl-lib:int-sub 1 j))
                    (f2cl-lib:fdo (i
                                   (min (the fixnum n)
                                        (the fixnum
                                             (f2cl-lib:int-add j k)))
                                   (f2cl-lib:int-add i
                                                     (f2cl-lib:int-sub 1)))
                                  ((> i (f2cl-lib:int-add j 1)) nil)
                      (tagbody
                        (setf (f2cl-lib:fref x-%data%
                                             (ix)
                                             ((1 *))
                                             x-%offset%)
                              (+
                               (f2cl-lib:fref x-%data%
                                              (ix)
                                              ((1 *))
                                              x-%offset%)
                               (* temp
                                  (f2cl-lib:fref a-%data%
                                                 ((f2cl-lib:int-add l i)
                                                  j)
                                                 ((1 lda) (1 *))
                                                 a-%offset%))))
                        (setf ix (f2cl-lib:int-sub ix incx))))
                    (if nounit
                        (setf (f2cl-lib:fref x-%data%
                                             (jx)
                                             ((1 *))
                                             x-%offset%)
                              (*
                               (f2cl-lib:fref x-%data%
                                              (jx)
                                              ((1 *))
                                              x-%offset%)
                               (f2cl-lib:fref a-%data%
                                              (1 j)
                                              ((1 lda) (1 *))
                                              a-%offset%))))))
                (setf jx (f2cl-lib:int-sub jx incx))
                (if (>= (f2cl-lib:int-sub n j) k)
                    (setf kx (f2cl-lib:int-sub kx incx)))))))))
          (t
           (cond
             ((char-equal uplo #\U)
              (setf kplus1 (f2cl-lib:int-add k 1))
              (cond
                ((= incx 1)
                 (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
```

```
                ((> j 1) nil)
      (tagbody
        (setf temp
                (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
        (setf l (f2cl-lib:int-sub kplus1 j))
        (if nounit
            (setf temp
                    (* temp
                       (f2cl-lib:fref a-%data%
                                      (kplus1 j)
                                      ((1 lda) (1 *))
                                      a-%offset%))))
        (f2cl-lib:fdo (i (f2cl-lib:int-add j (f2cl-lib:int-sub 1))
                       (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                      ((> i
                          (max (the fixnum 1)
                               (the fixnum
                                    (f2cl-lib:int-add j
                                                      (f2cl-lib:int-sub
                                                       k)))))
                       nil)
          (tagbody
            (setf temp
                    (+ temp
                       (*
                        (f2cl-lib:fref a-%data%
                                       ((f2cl-lib:int-add l i) j)
                                       ((1 lda) (1 *))
                                       a-%offset%)
                        (f2cl-lib:fref x-%data%
                                       (i)
                                       ((1 *))
                                       x-%offset%))))))
        (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
                temp))))
    (t
     (setf kx
             (f2cl-lib:int-add kx
                               (f2cl-lib:int-mul
                                (f2cl-lib:int-sub n 1)
                                incx)))
     (setf jx kx)
     (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                   ((> j 1) nil)
       (tagbody
         (setf temp
                 (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
         (setf kx (f2cl-lib:int-sub kx incx))
         (setf ix kx)
         (setf l (f2cl-lib:int-sub kplus1 j))
```

```
                (if nounit
                    (setf temp
                            (* temp
                               (f2cl-lib:fref a-%data%
                                              (kplus1 j)
                                              ((1 lda) (1 *))
                                              a-%offset%))))
                (f2cl-lib:fdo (i (f2cl-lib:int-add j (f2cl-lib:int-sub 1))
                               (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                              ((> i
                                  (max (the fixnum 1)
                                       (the fixnum
                                            (f2cl-lib:int-add j
                                                              (f2cl-lib:int-sub
                                                               k)))))
                               nil)
                  (tagbody
                    (setf temp
                            (+ temp
                               (*
                                (f2cl-lib:fref a-%data%
                                               ((f2cl-lib:int-add l i) j)
                                               ((1 lda) (1 *))
                                               a-%offset%)
                                (f2cl-lib:fref x-%data%
                                               (ix)
                                               ((1 *))
                                               x-%offset%))))
                    (setf ix (f2cl-lib:int-sub ix incx))))
                (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                        temp)
                (setf jx (f2cl-lib:int-sub jx incx)))))))
          (t
           (cond
             ((= incx 1)
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
                (tagbody
                  (setf temp
                          (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                  (setf l (f2cl-lib:int-sub 1 j))
                  (if nounit
                      (setf temp
                              (* temp
                                 (f2cl-lib:fref a-%data%
                                                (1 j)
                                                ((1 lda) (1 *))
                                                a-%offset%))))
                  (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                   (f2cl-lib:int-add i 1))
```

```
                      ((> i
                          (min (the fixnum n)
                               (the fixnum
                                    (f2cl-lib:int-add j k))))
                       nil)
             (tagbody
               (setf temp
                       (+ temp
                          (*
                           (f2cl-lib:fref a-%data%
                                          ((f2cl-lib:int-add l i) j)
                                          ((1 lda) (1 *))
                                          a-%offset%)
                           (f2cl-lib:fref x-%data%
                                          (i)
                                          ((1 *))
                                          x-%offset%))))))
           (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
                   temp))))
      (t
       (setf jx kx)
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (setf temp
                   (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
           (setf kx (f2cl-lib:int-add kx incx))
           (setf ix kx)
           (setf l (f2cl-lib:int-sub 1 j))
           (if nounit
               (setf temp
                       (* temp
                          (f2cl-lib:fref a-%data%
                                         (1 j)
                                         ((1 lda) (1 *))
                                         a-%offset%))))
           (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                            (f2cl-lib:int-add i 1))
                         ((> i
                             (min (the fixnum n)
                                  (the fixnum
                                       (f2cl-lib:int-add j k))))
                          nil)
             (tagbody
               (setf temp
                       (+ temp
                          (*
                           (f2cl-lib:fref a-%data%
                                          ((f2cl-lib:int-add l i) j)
                                          ((1 lda) (1 *))
```

```
                                                a-%offset%)
                                      (f2cl-lib:fref x-%data%
                                                     (ix)
                                                     ((1 *))
                                                     x-%offset%))))
                           (setf ix (f2cl-lib:int-add ix incx))))
                         (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                                 temp)
                         (setf jx (f2cl-lib:int-add jx incx)))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil))))))
```

———-

4.12 dtbsv BLAS

— **dtbsv.input** —

```
)set break resume
)sys rm -f dtbsv.output
)spool dtbsv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dtbsv.help** —

```
=======================================================================
dtbsv examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

 NAME
      DTBSV - solve one of the systems of equations   A*x = b, or
      A'*x = b,

 SYNOPSIS
```

```
     SUBROUTINE DTBSV ( UPLO, TRANS, DIAG, N, K, A, LDA, X, INCX
                      )

         INTEGER      INCX, K, LDA, N

         CHARACTER*1  DIAG, TRANS, UPLO

         DOUBLE       PRECISION A( LDA, * ), X( * )

PURPOSE
     DTBSV  solves one of the systems of equations

     where b and x are n element vectors and A is an n by n unit,
     or non-unit, upper or lower triangular band matrix, with ( k
     + 1 ) diagonals.

     No test for singularity or near-singularity is included in
     this routine. Such tests must be performed before calling
     this routine.

PARAMETERS
     UPLO   - CHARACTER*1.
            On entry, UPLO specifies whether the matrix is an
            upper or lower triangular matrix as follows:

            UPLO = 'U' or 'u'   A is an upper triangular matrix.

            UPLO = 'L' or 'l'   A is a lower triangular matrix.

            Unchanged on exit.

     TRANS  - CHARACTER*1.
            On entry, TRANS specifies the equations to be solved
            as follows:

            TRANS = 'N' or 'n'   A*x = b.

            TRANS = 'T' or 't'   A'*x = b.

            TRANS = 'C' or 'c'   A'*x = b.

            Unchanged on exit.

     DIAG   - CHARACTER*1.
            On entry, DIAG specifies whether or not A is unit
            triangular as follows:

            DIAG = 'U' or 'u'   A is assumed to be unit triangu-
            lar.
```

```
          DIAG = 'N' or 'n'   A is not assumed to be unit tri-
          angular.

          Unchanged on exit.

N         - INTEGER.
          On entry, N specifies the order of the matrix A.  N
          must be at least zero.  Unchanged on exit.

K         - INTEGER.
          On entry with UPLO = 'U' or 'u', K specifies the
          number of super-diagonals of the matrix A.  On entry
          with UPLO = 'L' or 'l', K specifies the number of
          sub-diagonals of the matrix A.  K must satisfy  0
          .le. K.  Unchanged on exit.

A         - DOUBLE PRECISION array of DIMENSION ( LDA, n ).
          Before entry with UPLO = 'U' or 'u', the leading ( k
          + 1 ) by n part of the array A must contain the upper
          triangular band part of the matrix of coefficients,
          supplied column by column, with the leading diagonal
          of the matrix in row ( k + 1 ) of the array, the
          first super-diagonal starting at position 2 in row k,
          and so on. The top left k by k triangle of the array
          A is not referenced.  The following program segment
          will transfer an upper triangular band matrix from
          conventional full matrix storage to band storage:

          DO 20, J = 1, N M = K + 1 - J DO 10, I = MAX( 1, J -
          K ), J A( M + I, J ) = matrix( I, J ) 10    CONTINUE
          20 CONTINUE

          Before entry with UPLO = 'L' or 'l', the leading ( k
          + 1 ) by n part of the array A must contain the lower
          triangular band part of the matrix of coefficients,
          supplied column by column, with the leading diagonal
          of the matrix in row 1 of the array, the first sub-
          diagonal starting at position 1 in row 2, and so on.
          The bottom right k by k triangle of the array A is
          not referenced.  The following program segment will
          transfer a lower triangular band matrix from conven-
          tional full matrix storage to band storage:

          DO 20, J = 1, N M = 1 - J DO 10, I = J, MIN( N, J + K
          ) A( M + I, J ) = matrix( I, J ) 10    CONTINUE 20
          CONTINUE

          Note that when DIAG = 'U' or 'u' the elements of the
          array A corresponding to the diagonal elements of the
```

```
            matrix are not referenced, but are assumed to be
            unity.  Unchanged on exit.

      LDA    - INTEGER.
            On entry, LDA specifies the first dimension of A as
            declared in the calling (sub) program. LDA must be at
            least ( k + 1 ).  Unchanged on exit.

      X      - DOUBLE PRECISION array of dimension at least
            ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
            incremented array X must contain the n element
            right-hand side vector b. On exit, X is overwritten
            with the solution vector x.

      INCX   - INTEGER.
            On entry, INCX specifies the increment for the ele-
            ments of X. INCX must not be zero.  Unchanged on
            exit.
```

———-

— dtbsv.f —

```
      SUBROUTINE DTBSV ( UPLO, TRANS, DIAG, N, K, A, LDA, X, INCX )
*     .. Scalar Arguments ..
      INTEGER            INCX, K, LDA, N
      CHARACTER*1        DIAG, TRANS, UPLO
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), X( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER        ( ZERO = 0.0D+0 )
*     .. Local Scalars ..
      DOUBLE PRECISION   TEMP
      INTEGER            I, INFO, IX, J, JX, KPLUS1, KX, L
      LOGICAL            NOUNIT
*     .. External Functions ..
```

```
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO , 'U' ).AND.
     $         .NOT.LSAME( UPLO , 'L' )      )THEN
         INFO = 1
      ELSE IF( .NOT.LSAME( TRANS, 'N' ).AND.
     $         .NOT.LSAME( TRANS, 'T' ).AND.
     $         .NOT.LSAME( TRANS, 'C' )      )THEN
         INFO = 2
      ELSE IF( .NOT.LSAME( DIAG , 'U' ).AND.
     $         .NOT.LSAME( DIAG , 'N' )      )THEN
         INFO = 3
      ELSE IF( N.LT.0 )THEN
         INFO = 4
      ELSE IF( K.LT.0 )THEN
         INFO = 5
      ELSE IF( LDA.LT.( K + 1 ) )THEN
         INFO = 7
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 9
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DTBSV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( N.EQ.0 )
     $   RETURN
*
      NOUNIT = LSAME( DIAG, 'N' )
*
*     Set up the start point in X if the increment is not unity. This
*     will be  ( N - 1 )*INCX  too small for descending loops.
*
      IF( INCX.LE.0 )THEN
         KX = 1 - ( N - 1 )*INCX
      ELSE IF( INCX.NE.1 )THEN
         KX = 1
```

```
      END IF
*
*     Start the operations. In this version the elements of A are
*     accessed by sequentially with one pass through A.
*
      IF( LSAME( TRANS, 'N' ) )THEN
*
*        Form  x := inv( A )*x.
*
         IF( LSAME( UPLO, 'U' ) )THEN
            KPLUS1 = K + 1
            IF( INCX.EQ.1 )THEN
               DO 20, J = N, 1, -1
                  IF( X( J ).NE.ZERO )THEN
                     L = KPLUS1 - J
                     IF( NOUNIT )
     $                  X( J ) = X( J )/A( KPLUS1, J )
                     TEMP = X( J )
                     DO 10, I = J - 1, MAX( 1, J - K ), -1
                        X( I ) = X( I ) - TEMP*A( L + I, J )
   10                CONTINUE
                  END IF
   20          CONTINUE
            ELSE
               KX = KX + ( N - 1 )*INCX
               JX = KX
               DO 40, J = N, 1, -1
                  KX = KX - INCX
                  IF( X( JX ).NE.ZERO )THEN
                     IX = KX
                     L  = KPLUS1 - J
                     IF( NOUNIT )
     $                  X( JX ) = X( JX )/A( KPLUS1, J )
                     TEMP = X( JX )
                     DO 30, I = J - 1, MAX( 1, J - K ), -1
                        X( IX ) = X( IX ) - TEMP*A( L + I, J )
                        IX      = IX      - INCX
   30                CONTINUE
                  END IF
                  JX = JX - INCX
   40          CONTINUE
            END IF
         ELSE
            IF( INCX.EQ.1 )THEN
               DO 60, J = 1, N
                  IF( X( J ).NE.ZERO )THEN
                     L = 1 - J
                     IF( NOUNIT )
     $                  X( J ) = X( J )/A( 1, J )
                     TEMP = X( J )
```

```
                  DO 50, I = J + 1, MIN( N, J + K )
                     X( I ) = X( I ) - TEMP*A( L + I, J )
   50             CONTINUE
                END IF
   60         CONTINUE
            ELSE
               JX = KX
               DO 80, J = 1, N
                  KX = KX + INCX
                  IF( X( JX ).NE.ZERO )THEN
                     IX = KX
                     L  = 1  - J
                     IF( NOUNIT )
     $                  X( JX ) = X( JX )/A( 1, J )
                     TEMP = X( JX )
                     DO 70, I = J + 1, MIN( N, J + K )
                        X( IX ) = X( IX ) - TEMP*A( L + I, J )
                        IX      = IX      + INCX
   70                CONTINUE
                  END IF
                  JX = JX + INCX
   80          CONTINUE
            END IF
         END IF
      ELSE
*
*        Form  x := inv( A')*x.
*
         IF( LSAME( UPLO, 'U' ) )THEN
            KPLUS1 = K + 1
            IF( INCX.EQ.1 )THEN
               DO 100, J = 1, N
                  TEMP = X( J )
                  L    = KPLUS1 - J
                  DO 90, I = MAX( 1, J - K ), J - 1
                     TEMP = TEMP - A( L + I, J )*X( I )
   90             CONTINUE
                  IF( NOUNIT )
     $               TEMP = TEMP/A( KPLUS1, J )
                  X( J ) = TEMP
  100          CONTINUE
            ELSE
               JX = KX
               DO 120, J = 1, N
                  TEMP = X( JX )
                  IX   = KX
                  L    = KPLUS1  - J
                  DO 110, I = MAX( 1, J - K ), J - 1
                     TEMP = TEMP - A( L + I, J )*X( IX )
                     IX   = IX   + INCX
```

```
  110             CONTINUE
                  IF( NOUNIT )
     $               TEMP = TEMP/A( KPLUS1, J )
                  X( JX ) = TEMP
                  JX      = JX   + INCX
                  IF( J.GT.K )
     $               KX = KX + INCX
  120          CONTINUE
            END IF
         ELSE
            IF( INCX.EQ.1 )THEN
               DO 140, J = N, 1, -1
                  TEMP = X( J )
                  L    = 1      - J
                  DO 130, I = MIN( N, J + K ), J + 1, -1
                     TEMP = TEMP - A( L + I, J )*X( I )
  130             CONTINUE
                  IF( NOUNIT )
     $               TEMP = TEMP/A( 1, J )
                  X( J ) = TEMP
  140          CONTINUE
            ELSE
               KX = KX + ( N - 1 )*INCX
               JX = KX
               DO 160, J = N, 1, -1
                  TEMP = X( JX )
                  IX   = KX
                  L    = 1       - J
                  DO 150, I = MIN( N, J + K ), J + 1, -1
                     TEMP = TEMP - A( L + I, J )*X( IX )
                     IX   = IX   - INCX
  150             CONTINUE
                  IF( NOUNIT )
     $               TEMP = TEMP/A( 1, J )
                  X( JX ) = TEMP
                  JX      = JX   - INCX
                  IF( ( N - J ).GE.K )
     $               KX = KX - INCX
  160          CONTINUE
            END IF
         END IF
      END IF
*
      RETURN
*
*     End of DTBSV .
*
      END
```

———-

— BLAS 2 dtbsv —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dtbsv (uplo trans diag n k a lda x incx)
    (declare (type (simple-array double-float (*)) x a)
             (type fixnum incx lda k n)
             (type character diag trans uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (a double-float a-%data% a-%offset%)
         (x double-float x-%data% x-%offset%))
      (prog ((nounit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0) (kplus1 0) (kx 0)
             (l 0) (temp 0.0))
        (declare (type (member t nil) nounit)
                 (type fixnum i info ix j jx kplus1 kx l)
                 (type (double-float) temp))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
          ((and (not (char-equal trans #\N))
                (not (char-equal trans #\T))
                (not (char-equal trans #\C)))
           (setf info 2))
          ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
           (setf info 3))
          ((< n 0)
           (setf info 4))
          ((< k 0)
           (setf info 5))
          ((< lda (f2cl-lib:int-add k 1))
           (setf info 7))
          ((= incx 0)
           (setf info 9)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DTBSV" info)
           (go end_label)))
        (if (= n 0) (go end_label))
        (setf nounit (char-equal diag #\N))
        (cond
          ((<= incx 0)
```

```
    (setf kx
            (f2cl-lib:int-sub 1
                              (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                incx))))
   ((/= incx 1)
    (setf kx 1)))
  (cond
   ((char-equal trans #\N)
    (cond
     ((char-equal uplo #\U)
      (setf kplus1 (f2cl-lib:int-add k 1))
      (cond
       ((= incx 1)
        (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                      ((> j 1) nil)
          (tagbody
            (cond
              ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
               (setf l (f2cl-lib:int-sub kplus1 j))
               (if nounit
                   (setf (f2cl-lib:fref x-%data%
                                        (j)
                                        ((1 *))
                                        x-%offset%)
                         (/
                          (f2cl-lib:fref x-%data%
                                         (j)
                                         ((1 *))
                                         x-%offset%)
                          (f2cl-lib:fref a-%data%
                                         (kplus1 j)
                                         ((1 lda) (1 *))
                                         a-%offset%))))
               (setf temp
                     (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
               (f2cl-lib:fdo (i
                              (f2cl-lib:int-add j
                                                (f2cl-lib:int-sub 1))
                              (f2cl-lib:int-add i
                                                (f2cl-lib:int-sub 1)))
                             ((> i
                                 (max (the fixnum 1)
                                      (the fixnum
                                           (f2cl-lib:int-add j
                                              (f2cl-lib:int-sub
                                                             k)))))
                              nil)
                 (tagbody
                   (setf (f2cl-lib:fref x-%data%
                                        (i)
```

```
                                    ((1 *))
                                    x-%offset%)
                            (-
                             (f2cl-lib:fref x-%data%
                                            (i)
                                            ((1 *))
                                            x-%offset%)
                             (* temp
                                (f2cl-lib:fref a-%data%
                                               ((f2cl-lib:int-add l i)
                                                j)
                                               ((1 lda) (1 *))
                                               a-%offset%)))))))))))
          (t
           (setf kx
                 (f2cl-lib:int-add kx
                                   (f2cl-lib:int-mul
                                    (f2cl-lib:int-sub n 1)
                                    incx)))
           (setf jx kx)
           (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                         ((> j 1) nil)
             (tagbody
               (setf kx (f2cl-lib:int-sub kx incx))
               (cond
                 ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
                  (setf ix kx)
                  (setf l (f2cl-lib:int-sub kplus1 j))
                  (if nounit
                      (setf (f2cl-lib:fref x-%data%
                                           (jx)
                                           ((1 *))
                                           x-%offset%)
                            (/
                             (f2cl-lib:fref x-%data%
                                            (jx)
                                            ((1 *))
                                            x-%offset%)
                             (f2cl-lib:fref a-%data%
                                            (kplus1 j)
                                            ((1 lda) (1 *))
                                            a-%offset%))))
                  (setf temp
                        (f2cl-lib:fref x-%data%
                                       (jx)
                                       ((1 *))
                                       x-%offset%))
                  (f2cl-lib:fdo (i
                                 (f2cl-lib:int-add j
                                                   (f2cl-lib:int-sub 1))
```

```
                                (f2cl-lib:int-add i
                                                  (f2cl-lib:int-sub 1)))
                               ((> i
                                   (max (the fixnum 1)
                                        (the fixnum
                                             (f2cl-lib:int-add j
                                              (f2cl-lib:int-sub
                                                               k)))))
                                nil)
                         (tagbody
                           (setf (f2cl-lib:fref x-%data%
                                                (ix)
                                                ((1 *))
                                                x-%offset%)
                                 (-
                                  (f2cl-lib:fref x-%data%
                                                 (ix)
                                                 ((1 *))
                                                 x-%offset%)
                                  (* temp
                                     (f2cl-lib:fref a-%data%
                                                    ((f2cl-lib:int-add l i)
                                                     j)
                                                    ((1 lda) (1 *))
                                                    a-%offset%))))
                           (setf ix (f2cl-lib:int-sub ix incx))))))
                  (setf jx (f2cl-lib:int-sub jx incx)))))))
        (t
         (cond
           ((= incx 1)
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
              (tagbody
                (cond
                  ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                   (setf l (f2cl-lib:int-sub 1 j))
                   (if nounit
                       (setf (f2cl-lib:fref x-%data%
                                            (j)
                                            ((1 *))
                                            x-%offset%)
                             (/
                              (f2cl-lib:fref x-%data%
                                             (j)
                                             ((1 *))
                                             x-%offset%)
                              (f2cl-lib:fref a-%data%
                                             (1 j)
                                             ((1 lda) (1 *))
                                             a-%offset%))))
```

```
            (setf temp
                    (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
            (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                             (f2cl-lib:int-add i 1))
                          ((> i
                              (min (the fixnum n)
                                   (the fixnum
                                        (f2cl-lib:int-add j k))))
                           nil)
              (tagbody
                (setf (f2cl-lib:fref x-%data%
                                     (i)
                                     ((1 *))
                                     x-%offset%)
                      (-
                       (f2cl-lib:fref x-%data%
                                      (i)
                                      ((1 *))
                                      x-%offset%)
                       (* temp
                          (f2cl-lib:fref a-%data%
                                         ((f2cl-lib:int-add l i)
                                          j)
                                         ((1 lda) (1 *))
                                         a-%offset%))))))))
          (t
           (setf jx kx)
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (setf kx (f2cl-lib:int-add kx incx))
               (cond
                 ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
                  (setf ix kx)
                  (setf l (f2cl-lib:int-sub 1 j))
                  (if nounit
                      (setf (f2cl-lib:fref x-%data%
                                           (jx)
                                           ((1 *))
                                           x-%offset%)
                            (/
                             (f2cl-lib:fref x-%data%
                                            (jx)
                                            ((1 *))
                                            x-%offset%)
                             (f2cl-lib:fref a-%data%
                                            (1 j)
                                            ((1 lda) (1 *))
                                            a-%offset%))))
                  (setf temp
```

```
                        (f2cl-lib:fref x-%data%
                                      (jx)
                                      ((1 *))
                                      x-%offset%))
                   (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                    (f2cl-lib:int-add i 1))
                                 ((> i
                                     (min (the fixnum n)
                                          (the fixnum
                                               (f2cl-lib:int-add j k))))
                                  nil)
                     (tagbody
                       (setf (f2cl-lib:fref x-%data%
                                            (ix)
                                            ((1 *))
                                            x-%offset%)
                             (-
                              (f2cl-lib:fref x-%data%
                                            (ix)
                                            ((1 *))
                                            x-%offset%)
                              (* temp
                                 (f2cl-lib:fref a-%data%
                                                ((f2cl-lib:int-add l i)
                                                 j)
                                                ((1 lda) (1 *))
                                                a-%offset%))))
                       (setf ix (f2cl-lib:int-add ix incx))))))
               (setf jx (f2cl-lib:int-add jx incx)))))))))
(t
 (cond
   ((char-equal uplo #\U)
    (setf kplus1 (f2cl-lib:int-add k 1))
    (cond
      ((= incx 1)
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (setf temp
                   (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
           (setf l (f2cl-lib:int-sub kplus1 j))
           (f2cl-lib:fdo (i
                          (max (the fixnum 1)
                               (the fixnum
                                    (f2cl-lib:int-add j
                                                      (f2cl-lib:int-sub
                                                       k))))
                          (f2cl-lib:int-add i 1))
                         ((> i
                             (f2cl-lib:int-add j
```

```
                                              (f2cl-lib:int-sub 1)))
                        nil)
          (tagbody
            (setf temp
                    (- temp
                       (*
                        (f2cl-lib:fref a-%data%
                                       ((f2cl-lib:int-add l i) j)
                                       ((1 lda) (1 *))
                                       a-%offset%)
                        (f2cl-lib:fref x-%data%
                                       (i)
                                       ((1 *))
                                       x-%offset%))))))
          (if nounit
              (setf temp
                      (/ temp
                         (f2cl-lib:fref a-%data%
                                        (kplus1 j)
                                        ((1 lda) (1 *))
                                        a-%offset%))))
          (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
                  temp))))
      (t
       (setf jx kx)
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (setf temp
                   (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
           (setf ix kx)
           (setf l (f2cl-lib:int-sub kplus1 j))
           (f2cl-lib:fdo (i
                          (max (the fixnum 1)
                               (the fixnum
                                    (f2cl-lib:int-add j
                                                      (f2cl-lib:int-sub
                                                       k))))
                          (f2cl-lib:int-add i 1))
                         ((> i
                             (f2cl-lib:int-add j
                                              (f2cl-lib:int-sub 1)))
                          nil)
             (tagbody
               (setf temp
                       (- temp
                          (*
                           (f2cl-lib:fref a-%data%
                                          ((f2cl-lib:int-add l i) j)
                                          ((1 lda) (1 *))
```

```
                                        a-%offset%)
                              (f2cl-lib:fref x-%data%
                                        (ix)
                                        ((1 *))
                                        x-%offset%))))
              (setf ix (f2cl-lib:int-add ix incx))))
          (if nounit
              (setf temp
                    (/ temp
                       (f2cl-lib:fref a-%data%
                                      (kplus1 j)
                                      ((1 lda) (1 *))
                                      a-%offset%))))
          (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                temp)
          (setf jx (f2cl-lib:int-add jx incx))
          (if (> j k) (setf kx (f2cl-lib:int-add kx incx))))))))
(t
 (cond
   ((= incx 1)
    (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                  ((> j 1) nil)
      (tagbody
        (setf temp
              (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
        (setf l (f2cl-lib:int-sub 1 j))
        (f2cl-lib:fdo (i
                       (min (the fixnum n)
                            (the fixnum
                                 (f2cl-lib:int-add j k)))
                       (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                      ((> i (f2cl-lib:int-add j 1)) nil)
          (tagbody
            (setf temp
                  (- temp
                     (*
                      (f2cl-lib:fref a-%data%
                                     ((f2cl-lib:int-add l i) j)
                                     ((1 lda) (1 *))
                                     a-%offset%)
                      (f2cl-lib:fref x-%data%
                                     (i)
                                     ((1 *))
                                     x-%offset%))))))
        (if nounit
            (setf temp
                  (/ temp
                     (f2cl-lib:fref a-%data%
                                    (1 j)
                                    ((1 lda) (1 *))
```

```
                                        a-%offset%))))
                    (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
                          temp))))
                (t
                 (setf kx
                       (f2cl-lib:int-add kx
                                         (f2cl-lib:int-mul
                                          (f2cl-lib:int-sub n 1)
                                          incx)))
                 (setf jx kx)
                 (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                               ((> j 1) nil)
                   (tagbody
                     (setf temp
                           (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
                     (setf ix kx)
                     (setf l (f2cl-lib:int-sub 1 j))
                     (f2cl-lib:fdo (i
                                    (min (the fixnum n)
                                         (the fixnum
                                              (f2cl-lib:int-add j k)))
                                    (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                                   ((> i (f2cl-lib:int-add j 1)) nil)
                       (tagbody
                         (setf temp
                                 (- temp
                                    (*
                                     (f2cl-lib:fref a-%data%
                                                    ((f2cl-lib:int-add l i) j)
                                                    ((1 lda) (1 *))
                                                    a-%offset%)
                                     (f2cl-lib:fref x-%data%
                                                    (ix)
                                                    ((1 *))
                                                    x-%offset%))))
                         (setf ix (f2cl-lib:int-sub ix incx))))
                     (if nounit
                         (setf temp
                                 (/ temp
                                    (f2cl-lib:fref a-%data%
                                                   (1 j)
                                                   ((1 lda) (1 *))
                                                   a-%offset%))))
                     (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                           temp)
                     (setf jx (f2cl-lib:int-sub jx incx))
                     (if (>= (f2cl-lib:int-sub n j) k)
                         (setf kx (f2cl-lib:int-sub kx incx)))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil))))))
```

———-

4.13 dtpmv BLAS

— **dtpmv.input** —

```
)set break resume
)sys rm -f dtpmv.output
)spool dtpmv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dtpmv.help** —

```
==========================================================================
dtpmv examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      DTPMV - perform one of the matrix-vector operations   x :=
      A*x, or x := A'*x,

 SYNOPSIS
      SUBROUTINE DTPMV ( UPLO, TRANS, DIAG, N, AP, X, INCX )

          INTEGER      INCX, N

          CHARACTER*1  DIAG, TRANS, UPLO

          DOUBLE       PRECISION AP( * ), X( * )

 PURPOSE
      DTPMV  performs one of the matrix-vector operations
```

```
     where x is an n element vector and  A is an n by n unit, or
     non-unit, upper or lower triangular matrix, supplied in
     packed form.

 PARAMETERS
      UPLO   - CHARACTER*1.
               On entry, UPLO specifies whether the matrix is an
               upper or lower triangular matrix as follows:

               UPLO = 'U' or 'u'   A is an upper triangular matrix.

               UPLO = 'L' or 'l'   A is a lower triangular matrix.

               Unchanged on exit.

      TRANS  - CHARACTER*1.
               On entry, TRANS specifies the operation to be per-
               formed as follows:

               TRANS = 'N' or 'n'   x := A*x.

               TRANS = 'T' or 't'   x := A'*x.

               TRANS = 'C' or 'c'   x := A'*x.

               Unchanged on exit.

      DIAG   - CHARACTER*1.
               On entry, DIAG specifies whether or not A is unit
               triangular as follows:

               DIAG = 'U' or 'u'   A is assumed to be unit triangu-
               lar.

               DIAG = 'N' or 'n'   A is not assumed to be unit

               triangular.

               Unchanged on exit.

      N      - INTEGER.
               On entry, N specifies the order of the matrix A.  N
               must be at least zero.  Unchanged on exit.

      AP     - DOUBLE PRECISION array of DIMENSION at least
               ( ( n*( n + 1 ) )/2 ).  Before entry with  UPLO = 'U'
               or 'u', the array AP must contain the upper triangu-
               lar matrix packed sequentially, column by column, so
               that AP( 1 ) contains a( 1, 1 ), AP( 2 ) and AP( 3 )
               contain a( 1, 2 ) and a( 2, 2 ) respectively, and so
```

```
            on.  Before entry with UPLO = 'L' or 'l', the array
            AP must contain the lower triangular matrix packed
            sequentially, column by column, so that AP( 1 ) con-
            tains a( 1, 1 ), AP( 2 ) and AP( 3 ) contain a( 2, 1
            ) and a( 3, 1 ) respectively, and so on.  Note that
            when  DIAG = 'U' or 'u', the diagonal elements of A
            are not referenced, but are assumed to be unity.
            Unchanged on exit.

      X     - DOUBLE PRECISION array of dimension at least
            ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
            incremented array X must contain the n element vector
            x. On exit, X is overwritten with the transformed
            vector x.

      INCX  - INTEGER.
            On entry, INCX specifies the increment for the ele-
            ments of X. INCX must not be zero.  Unchanged on
            exit.
```

———-

— dtpmv.f —

```
      SUBROUTINE DTPMV ( UPLO, TRANS, DIAG, N, AP, X, INCX )
*     .. Scalar Arguments ..
      INTEGER            INCX, N
      CHARACTER*1        DIAG, TRANS, UPLO
*     .. Array Arguments ..
      DOUBLE PRECISION   AP( * ), X( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER        ( ZERO = 0.0D+0 )
*     .. Local Scalars ..
      DOUBLE PRECISION   TEMP
      INTEGER            I, INFO, IX, J, JX, K, KK, KX
      LOGICAL            NOUNIT
```

```
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO , 'U' ).AND.
     $         .NOT.LSAME( UPLO , 'L' )      )THEN
         INFO = 1
      ELSE IF( .NOT.LSAME( TRANS, 'N' ).AND.
     $         .NOT.LSAME( TRANS, 'T' ).AND.
     $         .NOT.LSAME( TRANS, 'C' )      )THEN
         INFO = 2
      ELSE IF( .NOT.LSAME( DIAG , 'U' ).AND.
     $         .NOT.LSAME( DIAG , 'N' )      )THEN
         INFO = 3
      ELSE IF( N.LT.0 )THEN
         INFO = 4
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 7
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DTPMV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( N.EQ.0 )
     $   RETURN
*
      NOUNIT = LSAME( DIAG, 'N' )
*
*     Set up the start point in X if the increment is not unity. This
*     will be  ( N - 1 )*INCX  too small for descending loops.
*
      IF( INCX.LE.0 )THEN
         KX = 1 - ( N - 1 )*INCX
      ELSE IF( INCX.NE.1 )THEN
         KX = 1
      END IF
*
*     Start the operations. In this version the elements of AP are
*     accessed sequentially with one pass through AP.
*
```

```
      IF( LSAME( TRANS, 'N' ) )THEN
*
*        Form  x:= A*x.
*
         IF( LSAME( UPLO, 'U' ) )THEN
            KK =1
            IF( INCX.EQ.1 )THEN
               DO 20, J = 1, N
                  IF( X( J ).NE.ZERO )THEN
                     TEMP = X( J )
                     K    = KK
                     DO 10, I = 1, J - 1
                        X( I ) = X( I ) + TEMP*AP( K )
                        K      = K      + 1
   10                CONTINUE
                     IF( NOUNIT )
     $                  X( J ) = X( J )*AP( KK + J - 1 )
                  END IF
                  KK = KK + J
   20          CONTINUE
            ELSE
               JX = KX
               DO 40, J = 1, N
                  IF( X( JX ).NE.ZERO )THEN
                     TEMP = X( JX )
                     IX   = KX
                     DO 30, K = KK, KK + J - 2
                        X( IX ) = X( IX ) + TEMP*AP( K )
                        IX      = IX      + INCX
   30                CONTINUE
                     IF( NOUNIT )
     $                  X( JX ) = X( JX )*AP( KK + J - 1 )
                  END IF
                  JX = JX + INCX
                  KK = KK + J
   40          CONTINUE
            END IF
         ELSE
            KK = ( N*( N + 1 ) )/2
            IF( INCX.EQ.1 )THEN
               DO 60, J = N, 1, -1
                  IF( X( J ).NE.ZERO )THEN
                     TEMP = X( J )
                     K    = KK
                     DO 50, I = N, J + 1, -1
                        X( I ) = X( I ) + TEMP*AP( K )
                        K      = K      - 1
   50                CONTINUE
                     IF( NOUNIT )
     $                  X( J ) = X( J )*AP( KK - N + J )
```

```
               END IF
               KK = KK - ( N - J + 1 )
   60       CONTINUE
         ELSE
            KX = KX + ( N - 1 )*INCX
            JX = KX
            DO 80, J = N, 1, -1
               IF( X( JX ).NE.ZERO )THEN
                  TEMP = X( JX )
                  IX   = KX
                  DO 70, K = KK, KK - ( N - ( J + 1 ) ), -1
                     X( IX ) = X( IX ) + TEMP*AP( K )
                     IX      = IX      - INCX
   70                CONTINUE
                  IF( NOUNIT )
     $               X( JX ) = X( JX )*AP( KK - N + J )
               END IF
               JX = JX - INCX
               KK = KK - ( N - J + 1 )
   80       CONTINUE
         END IF
      END IF
   ELSE
*
*        Form  x := A'*x.
*
         IF( LSAME( UPLO, 'U' ) )THEN
            KK = ( N*( N + 1 ) )/2
            IF( INCX.EQ.1 )THEN
               DO 100, J = N, 1, -1
                  TEMP = X( J )
                  IF( NOUNIT )
     $               TEMP = TEMP*AP( KK )
                  K = KK - 1
                  DO 90, I = J - 1, 1, -1
                     TEMP = TEMP + AP( K )*X( I )
                     K    = K    - 1
   90             CONTINUE
                  X( J ) = TEMP
                  KK     = KK   - J
  100          CONTINUE
            ELSE
               JX = KX + ( N - 1 )*INCX
               DO 120, J = N, 1, -1
                  TEMP = X( JX )
                  IX   = JX
                  IF( NOUNIT )
     $               TEMP = TEMP*AP( KK )
                  DO 110, K = KK - 1, KK - J + 1, -1
                     IX   = IX   - INCX
```

```
                  TEMP = TEMP + AP( K )*X( IX )
  110             CONTINUE
                  X( JX ) = TEMP
                  JX      = JX   - INCX
                  KK      = KK   - J
  120          CONTINUE
            END IF
         ELSE
            KK = 1
            IF( INCX.EQ.1 )THEN
               DO 140, J = 1, N
                  TEMP = X( J )
                  IF( NOUNIT )
     $               TEMP = TEMP*AP( KK )
                  K = KK + 1
                  DO 130, I = J + 1, N
                     TEMP = TEMP + AP( K )*X( I )
                     K    = K    + 1
  130             CONTINUE
                  X( J ) = TEMP
                  KK     = KK   + ( N - J + 1 )
  140          CONTINUE
            ELSE
               JX = KX
               DO 160, J = 1, N
                  TEMP = X( JX )
                  IX   = JX
                  IF( NOUNIT )
     $               TEMP = TEMP*AP( KK )
                  DO 150, K = KK + 1, KK + N - J
                     IX   = IX   + INCX
                     TEMP = TEMP + AP( K )*X( IX )
  150             CONTINUE
                  X( JX ) = TEMP
                  JX      = JX   + INCX
                  KK      = KK   + ( N - J + 1 )
  160          CONTINUE
            END IF
         END IF
      END IF
*
      RETURN
*
*     End of DTPMV .
*
      END
```

— BLAS 2 dtpmv —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dtpmv (uplo trans diag n ap x incx)
    (declare (type (simple-array double-float (*)) x ap)
             (type fixnum incx n)
             (type character diag trans uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (ap double-float ap-%data% ap-%offset%)
         (x double-float x-%data% x-%offset%))
      (prog ((nounit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0) (k 0) (kk 0)
             (kx 0) (temp 0.0))
        (declare (type (member t nil) nounit)
                 (type fixnum i info ix j jx k kk kx)
                 (type (double-float) temp))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
          ((and (not (char-equal trans #\N))
                (not (char-equal trans #\T))
                (not (char-equal trans #\C)))
           (setf info 2))
          ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
           (setf info 3))
          ((< n 0)
           (setf info 4))
          ((= incx 0)
           (setf info 7)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DTPMV" info)
           (go end_label)))
        (if (= n 0) (go end_label))
        (setf nounit (char-equal diag #\N))
        (cond
          ((<= incx 0)
           (setf kx
                   (f2cl-lib:int-sub 1
                                     (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                       incx))))
          ((/= incx 1)
           (setf kx 1)))
```

```
(cond
  ((char-equal trans #\N)
   (cond
     ((char-equal uplo #\U)
      (setf kk 1)
      (cond
        ((= incx 1)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (cond
               ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                (setf temp
                        (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                (setf k kk)
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                              ((> i
                                  (f2cl-lib:int-add j
                                                    (f2cl-lib:int-sub
                                                     1)))
                               nil)
                  (tagbody
                    (setf (f2cl-lib:fref x-%data%
                                         (i)
                                         ((1 *))
                                         x-%offset%)
                          (+
                           (f2cl-lib:fref x-%data%
                                          (i)
                                          ((1 *))
                                          x-%offset%)
                           (* temp
                              (f2cl-lib:fref ap-%data%
                                             (k)
                                             ((1 *))
                                             ap-%offset%))))
                    (setf k (f2cl-lib:int-add k 1))))
                (if nounit
                    (setf (f2cl-lib:fref x-%data%
                                         (j)
                                         ((1 *))
                                         x-%offset%)
                          (*
                           (f2cl-lib:fref x-%data%
                                          (j)
                                          ((1 *))
                                          x-%offset%)
                           (f2cl-lib:fref ap-%data%
                                          ((f2cl-lib:int-sub
                                            (f2cl-lib:int-add kk j)
```

```
                                        1))
                                       ((1 *))
                                       ap-%offset%))))))
          (setf kk (f2cl-lib:int-add kk j)))))
      (t
       (setf jx kx)
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (cond
             ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
              (setf temp
                      (f2cl-lib:fref x-%data%
                                     (jx)
                                     ((1 *))
                                     x-%offset%))
              (setf ix kx)
              (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
                            ((> k
                                (f2cl-lib:int-add kk
                                                  j
                                                  (f2cl-lib:int-sub
                                                   2)))
                             nil)
                (tagbody
                  (setf (f2cl-lib:fref x-%data%
                                       (ix)
                                       ((1 *))
                                       x-%offset%)
                            (+
                             (f2cl-lib:fref x-%data%
                                            (ix)
                                            ((1 *))
                                            x-%offset%)
                             (* temp
                                (f2cl-lib:fref ap-%data%
                                               (k)
                                               ((1 *))
                                               ap-%offset%))))
                  (setf ix (f2cl-lib:int-add ix incx))))
              (if nounit
                  (setf (f2cl-lib:fref x-%data%
                                       (jx)
                                       ((1 *))
                                       x-%offset%)
                            (*
                             (f2cl-lib:fref x-%data%
                                            (jx)
                                            ((1 *))
                                            x-%offset%)
```

```
                          (f2cl-lib:fref ap-%data%
                                         ((f2cl-lib:int-sub
                                           (f2cl-lib:int-add kk j)
                                           1))
                                         ((1 *))
                                         ap-%offset%))))))
          (setf jx (f2cl-lib:int-add jx incx))
          (setf kk (f2cl-lib:int-add kk j)))))))
(t
 (setf kk (the fixnum (truncate (* n (+ n 1)) 2)))
 (cond
   ((= incx 1)
    (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                  ((> j 1) nil)
      (tagbody
        (cond
          ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
           (setf temp
                   (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
           (setf k kk)
           (f2cl-lib:fdo (i n
                          (f2cl-lib:int-add i
                                            (f2cl-lib:int-sub 1)))
                         ((> i (f2cl-lib:int-add j 1)) nil)
             (tagbody
               (setf (f2cl-lib:fref x-%data%
                                    (i)
                                    ((1 *))
                                    x-%offset%)
                     (+
                      (f2cl-lib:fref x-%data%
                                     (i)
                                     ((1 *))
                                     x-%offset%)
                      (* temp
                         (f2cl-lib:fref ap-%data%
                                        (k)
                                        ((1 *))
                                        ap-%offset%))))
               (setf k (f2cl-lib:int-sub k 1))))
           (if nounit
               (setf (f2cl-lib:fref x-%data%
                                    (j)
                                    ((1 *))
                                    x-%offset%)
                     (*
                      (f2cl-lib:fref x-%data%
                                     (j)
                                     ((1 *))
                                     x-%offset%)
```

```
                        (f2cl-lib:fref ap-%data%
                                       ((f2cl-lib:int-add
                                         (f2cl-lib:int-sub kk n)
                                         j))
                                       ((1 *))
                                       ap-%offset%))))))
          (setf kk
                (f2cl-lib:int-sub kk
                                  (f2cl-lib:int-add
                                   (f2cl-lib:int-sub n j)
                                   1))))))
     (t
      (setf kx
            (f2cl-lib:int-add kx
                              (f2cl-lib:int-mul
                               (f2cl-lib:int-sub n 1)
                               incx)))
      (setf jx kx)
      (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                    ((> j 1) nil)
        (tagbody
          (cond
            ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
             (setf temp
                   (f2cl-lib:fref x-%data%
                                  (jx)
                                  ((1 *))
                                  x-%offset%))
             (setf ix kx)
             (f2cl-lib:fdo (k kk
                            (f2cl-lib:int-add k
                                              (f2cl-lib:int-sub 1)))
                           ((> k
                               (f2cl-lib:int-add kk
                                                 (f2cl-lib:int-sub
                                                  (f2cl-lib:int-add
                                                   n
                                                   (f2cl-lib:int-sub
                                                    (f2cl-lib:int-add
                                                     j
                                                     1))))))
                            nil)
               (tagbody
                 (setf (f2cl-lib:fref x-%data%
                                      (ix)
                                      ((1 *))
                                      x-%offset%)
                       (+
                        (f2cl-lib:fref x-%data%
                                       (ix)
```

```
                                          ((1 *))
                                          x-%offset%)
                              (* temp
                                 (f2cl-lib:fref ap-%data%
                                                (k)
                                                ((1 *))
                                                ap-%offset%))))
                          (setf ix (f2cl-lib:int-sub ix incx))))
                     (if nounit
                         (setf (f2cl-lib:fref x-%data%
                                              (jx)
                                              ((1 *))
                                              x-%offset%)
                               (*
                                (f2cl-lib:fref x-%data%
                                               (jx)
                                               ((1 *))
                                               x-%offset%)
                                (f2cl-lib:fref ap-%data%
                                               ((f2cl-lib:int-add
                                                 (f2cl-lib:int-sub kk n)
                                                 j))
                                               ((1 *))
                                               ap-%offset%))))))
                (setf jx (f2cl-lib:int-sub jx incx))
                (setf kk
                       (f2cl-lib:int-sub kk
                                         (f2cl-lib:int-add
                                          (f2cl-lib:int-sub n j)
                                          1))))))))))
          (t
           (cond
             ((char-equal uplo #\U)
              (setf kk (the fixnum (truncate (* n (+ n 1)) 2)))
              (cond
                ((= incx 1)
                 (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                               ((> j 1) nil)
                   (tagbody
                     (setf temp
                             (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                     (if nounit
                         (setf temp
                                 (* temp
                                    (f2cl-lib:fref ap-%data%
                                                   (kk)
                                                   ((1 *))
                                                   ap-%offset%))))
                     (setf k (f2cl-lib:int-sub kk 1))
                     (f2cl-lib:fdo (i (f2cl-lib:int-add j (f2cl-lib:int-sub 1))
```

```
                    (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                   ((> i 1) nil)
         (tagbody
           (setf temp
                   (+ temp
                      (*
                       (f2cl-lib:fref ap-%data%
                                      (k)
                                      ((1 *))
                                      ap-%offset%)
                       (f2cl-lib:fref x-%data%
                                      (i)
                                      ((1 *))
                                      x-%offset%))))
           (setf k (f2cl-lib:int-sub k 1))))
       (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
             temp)
       (setf kk (f2cl-lib:int-sub kk j)))))
  (t
   (setf jx
         (f2cl-lib:int-add kx
                           (f2cl-lib:int-mul
                            (f2cl-lib:int-sub n 1)
                            incx)))
   (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                 ((> j 1) nil)
     (tagbody
       (setf temp
             (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
       (setf ix jx)
       (if nounit
           (setf temp
                   (* temp
                      (f2cl-lib:fref ap-%data%
                                     (kk)
                                     ((1 *))
                                     ap-%offset%))))
       (f2cl-lib:fdo (k
                      (f2cl-lib:int-add kk (f2cl-lib:int-sub 1))
                      (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
                     ((> k
                         (f2cl-lib:int-add kk
                                           (f2cl-lib:int-sub j)
                                           1))
                      nil)
         (tagbody
           (setf ix (f2cl-lib:int-sub ix incx))
           (setf temp
                   (+ temp
                      (*
```

```
                              (f2cl-lib:fref ap-%data%
                                             (k)
                                             ((1 *))
                                             ap-%offset%)
                              (f2cl-lib:fref x-%data%
                                             (ix)
                                             ((1 *))
                                             x-%offset%))))))
            (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                    temp)
            (setf jx (f2cl-lib:int-sub jx incx))
            (setf kk (f2cl-lib:int-sub kk j)))))))
    (t
     (setf kk 1)
     (cond
       ((= incx 1)
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                      ((> j n) nil)
          (tagbody
            (setf temp
                    (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
            (if nounit
                (setf temp
                        (* temp
                           (f2cl-lib:fref ap-%data%
                                          (kk)
                                          ((1 *))
                                          ap-%offset%))))
            (setf k (f2cl-lib:int-add kk 1))
            (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                             (f2cl-lib:int-add i 1))
                          ((> i n) nil)
              (tagbody
                (setf temp
                        (+ temp
                           (*
                            (f2cl-lib:fref ap-%data%
                                           (k)
                                           ((1 *))
                                           ap-%offset%)
                            (f2cl-lib:fref x-%data%
                                           (i)
                                           ((1 *))
                                           x-%offset%))))
                (setf k (f2cl-lib:int-add k 1))))
            (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
                    temp)
            (setf kk
                    (f2cl-lib:int-add kk
                                      (f2cl-lib:int-add
```

```
                                        (f2cl-lib:int-sub n j)
                                        1))))))
                (t
                 (setf jx kx)
                 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                               ((> j n) nil)
                   (tagbody
                     (setf temp
                             (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
                     (setf ix jx)
                     (if nounit
                         (setf temp
                                 (* temp
                                    (f2cl-lib:fref ap-%data%
                                                   (kk)
                                                   ((1 *))
                                                   ap-%offset%))))
                     (f2cl-lib:fdo (k (f2cl-lib:int-add kk 1)
                                    (f2cl-lib:int-add k 1))
                                   ((> k
                                       (f2cl-lib:int-add kk
                                                         n
                                                         (f2cl-lib:int-sub j)))
                                    nil)
                       (tagbody
                         (setf ix (f2cl-lib:int-add ix incx))
                         (setf temp
                                 (+ temp
                                    (*
                                     (f2cl-lib:fref ap-%data%
                                                    (k)
                                                    ((1 *))
                                                    ap-%offset%)
                                     (f2cl-lib:fref x-%data%
                                                    (ix)
                                                    ((1 *))
                                                    x-%offset%))))))
                     (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                             temp)
                     (setf jx (f2cl-lib:int-add jx incx))
                     (setf kk
                             (f2cl-lib:int-add kk
                                              (f2cl-lib:int-add
                                               (f2cl-lib:int-sub n j)
                                               1)))))))))
 end_label
        (return (values nil nil nil nil nil nil nil))))))
```

4.14 dtpsv BLAS

— **dtpsv.input** —

```
)set break resume
)sys rm -f dtpsv.output
)spool dtpsv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

————-

— **dtpsv.help** —

```
==========================================================================
dtpsv examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      DTPSV - solve one of the systems of equations   A*x = b, or
      A'*x = b,

 SYNOPSIS
      SUBROUTINE DTPSV ( UPLO, TRANS, DIAG, N, AP, X, INCX )

          INTEGER      INCX, N

          CHARACTER*1  DIAG, TRANS, UPLO

          DOUBLE       PRECISION AP( * ), X( * )

 PURPOSE
      DTPSV  solves one of the systems of equations

      where b and x are n element vectors and A is an n by n unit,
      or non-unit, upper or lower triangular matrix, supplied in
      packed form.

      No test for singularity or near-singularity is included in
      this routine. Such tests must be performed before calling
```

```
     this routine.

 PARAMETERS
     UPLO   - CHARACTER*1.
            On entry, UPLO specifies whether the matrix is an
            upper or lower triangular matrix as follows:

            UPLO = 'U' or 'u'   A is an upper triangular matrix.

            UPLO = 'L' or 'l'   A is a lower triangular matrix.

            Unchanged on exit.

     TRANS  - CHARACTER*1.
            On entry, TRANS specifies the equations to be solved
            as follows:

            TRANS = 'N' or 'n'   A*x = b.

            TRANS = 'T' or 't'   A'*x = b.

            TRANS = 'C' or 'c'   A'*x = b.

            Unchanged on exit.

     DIAG   - CHARACTER*1.
            On entry, DIAG specifies whether or not A is unit
            triangular as follows:

            DIAG = 'U' or 'u'   A is assumed to be unit triangu-
            lar.

            DIAG = 'N' or 'n'   A is not assumed to be unit tri-
            angular.

            Unchanged on exit.

     N      - INTEGER.
            On entry, N specifies the order of the matrix A.  N
            must be at least zero.  Unchanged on exit.

     AP     - DOUBLE PRECISION array of DIMENSION at least
            ( ( n*( n + 1 ) )/2 ).  Before entry with  UPLO = 'U'
            or 'u', the array AP must contain the upper triangu-
            lar matrix packed sequentially, column by column, so
            that AP( 1 ) contains a( 1, 1 ), AP( 2 ) and AP( 3 )
            contain a( 1, 2 ) and a( 2, 2 ) respectively, and so
            on.  Before entry with UPLO = 'L' or 'l', the array
            AP must contain the lower triangular matrix packed
            sequentially, column by column, so that AP( 1 ) con-
```

```
            tains a( 1, 1 ), AP( 2 ) and AP( 3 ) contain a( 2, 1
            ) and a( 3, 1 ) respectively, and so on.  Note that
            when  DIAG = 'U' or 'u', the diagonal elements of A
            are not referenced, but are assumed to be unity.
            Unchanged on exit.

      X     - DOUBLE PRECISION array of dimension at least
            ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
            incremented array X must contain the n element
            right-hand side vector b. On exit, X is overwritten
            with the solution vector x.

      INCX  - INTEGER.
            On entry, INCX specifies the increment for the ele-
            ments of X. INCX must not be zero.  Unchanged on
            exit.
```

— dtpsv.f —

```
      SUBROUTINE DTPSV ( UPLO, TRANS, DIAG, N, AP, X, INCX )
*     .. Scalar Arguments ..
      INTEGER            INCX, N
      CHARACTER*1        DIAG, TRANS, UPLO
*     .. Array Arguments ..
      DOUBLE PRECISION   AP( * ), X( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER        ( ZERO = 0.0D+0 )
*     .. Local Scalars ..
      DOUBLE PRECISION   TEMP
      INTEGER            I, INFO, IX, J, JX, K, KK, KX
      LOGICAL            NOUNIT
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
```

```
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO , 'U' ).AND.
     $         .NOT.LSAME( UPLO , 'L' )      )THEN
         INFO = 1
      ELSE IF( .NOT.LSAME( TRANS, 'N' ).AND.
     $         .NOT.LSAME( TRANS, 'T' ).AND.
     $         .NOT.LSAME( TRANS, 'C' )      )THEN
         INFO = 2
      ELSE IF( .NOT.LSAME( DIAG , 'U' ).AND.
     $         .NOT.LSAME( DIAG , 'N' )      )THEN
         INFO = 3
      ELSE IF( N.LT.0 )THEN
         INFO = 4
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 7
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DTPSV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( N.EQ.0 )
     $   RETURN
*
      NOUNIT = LSAME( DIAG, 'N' )
*
*     Set up the start point in X if the increment is not unity. This
*     will be  ( N - 1 )*INCX  too small for descending loops.
*
      IF( INCX.LE.0 )THEN
         KX = 1 - ( N - 1 )*INCX
      ELSE IF( INCX.NE.1 )THEN
         KX = 1
      END IF
*
*     Start the operations. In this version the elements of AP are
*     accessed sequentially with one pass through AP.
*
      IF( LSAME( TRANS, 'N' ) )THEN
*
*        Form  x := inv( A )*x.
```

```
*
         IF( LSAME( UPLO, 'U' ) )THEN
            KK = ( N*( N + 1 ) )/2
            IF( INCX.EQ.1 )THEN
               DO 20, J = N, 1, -1
                  IF( X( J ).NE.ZERO )THEN
                     IF( NOUNIT )
     $                  X( J ) = X( J )/AP( KK )
                     TEMP = X( J )
                     K    = KK     - 1
                     DO 10, I = J - 1, 1, -1
                        X( I ) = X( I ) - TEMP*AP( K )
                        K      = K      - 1
   10                CONTINUE
                  END IF
                  KK = KK - J
   20          CONTINUE
            ELSE
               JX = KX + ( N - 1 )*INCX
               DO 40, J = N, 1, -1
                  IF( X( JX ).NE.ZERO )THEN
                     IF( NOUNIT )
     $                  X( JX ) = X( JX )/AP( KK )
                     TEMP = X( JX )
                     IX   = JX
                     DO 30, K = KK - 1, KK - J + 1, -1
                        IX      = IX      - INCX
                        X( IX ) = X( IX ) - TEMP*AP( K )
   30                CONTINUE
                  END IF
                  JX = JX - INCX
                  KK = KK - J
   40          CONTINUE
            END IF
         ELSE
            KK = 1
            IF( INCX.EQ.1 )THEN
               DO 60, J = 1, N
                  IF( X( J ).NE.ZERO )THEN
                     IF( NOUNIT )
     $                  X( J ) = X( J )/AP( KK )
                     TEMP = X( J )
                     K    = KK     + 1
                     DO 50, I = J + 1, N
                        X( I ) = X( I ) - TEMP*AP( K )
                        K      = K      + 1
   50                CONTINUE
                  END IF
                  KK = KK + ( N - J + 1 )
   60          CONTINUE
```

```
            ELSE
               JX = KX
               DO 80, J = 1, N
                  IF( X( JX ).NE.ZERO )THEN
                     IF( NOUNIT )
     $                  X( JX ) = X( JX )/AP( KK )
                     TEMP = X( JX )
                     IX   = JX
                     DO 70, K = KK + 1, KK + N - J
                        IX      = IX      + INCX
                        X( IX ) = X( IX ) - TEMP*AP( K )
   70                CONTINUE
                  END IF
                  JX = JX + INCX
                  KK = KK + ( N - J + 1 )
   80          CONTINUE
            END IF
         END IF
      ELSE
*
*        Form  x := inv( A' )*x.
*
         IF( LSAME( UPLO, 'U' ) )THEN
            KK = 1
            IF( INCX.EQ.1 )THEN
               DO 100, J = 1, N
                  TEMP = X( J )
                  K    = KK
                  DO 90, I = 1, J - 1
                     TEMP = TEMP - AP( K )*X( I )
                     K    = K    + 1
   90             CONTINUE
                  IF( NOUNIT )
     $               TEMP = TEMP/AP( KK + J - 1 )
                  X( J ) = TEMP
                  KK     = KK   + J
  100          CONTINUE
            ELSE
               JX = KX
               DO 120, J = 1, N
                  TEMP = X( JX )
                  IX   = KX
                  DO 110, K = KK, KK + J - 2
                     TEMP = TEMP - AP( K )*X( IX )
                     IX   = IX   + INCX
  110             CONTINUE
                  IF( NOUNIT )
     $               TEMP = TEMP/AP( KK + J - 1 )
                  X( JX ) = TEMP
                  JX      = JX   + INCX
```

```
                  KK      = KK   + J
  120          CONTINUE
               END IF
            ELSE
               KK = ( N*( N + 1 ) )/2
               IF( INCX.EQ.1 )THEN
                  DO 140, J = N, 1, -1
                     TEMP = X( J )
                     K = KK
                     DO 130, I = N, J + 1, -1
                        TEMP = TEMP - AP( K )*X( I )
                        K    = K    - 1
  130                CONTINUE
                     IF( NOUNIT )
     $                  TEMP = TEMP/AP( KK - N + J )
                     X( J ) = TEMP
                     KK     = KK   - ( N - J + 1 )
  140             CONTINUE
               ELSE
                  KX = KX + ( N - 1 )*INCX
                  JX = KX
                  DO 160, J = N, 1, -1
                     TEMP = X( JX )
                     IX   = KX
                     DO 150, K = KK, KK - ( N - ( J + 1 ) ), -1
                        TEMP = TEMP - AP( K )*X( IX )
                        IX   = IX   - INCX
  150                CONTINUE
                     IF( NOUNIT )
     $                  TEMP = TEMP/AP( KK - N + J )
                     X( JX ) = TEMP
                     JX      = JX   - INCX
                     KK      = KK   - (N - J + 1 )
  160             CONTINUE
               END IF
            END IF
      END IF
*
      RETURN
*
*     End of DTPSV .
*
      END
```

———-

— BLAS 2 dtpsv —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dtpsv (uplo trans diag n ap x incx)
    (declare (type (simple-array double-float (*)) x ap)
             (type fixnum incx n)
             (type character diag trans uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (ap double-float ap-%data% ap-%offset%)
         (x double-float x-%data% x-%offset%))
      (prog ((nounit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0) (k 0) (kk 0)
             (kx 0) (temp 0.0))
        (declare (type (member t nil) nounit)
                 (type fixnum i info ix j jx k kk kx)
                 (type (double-float) temp))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
          ((and (not (char-equal trans #\N))
                (not (char-equal trans #\T))
                (not (char-equal trans #\C)))
           (setf info 2))
          ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
           (setf info 3))
          ((< n 0)
           (setf info 4))
          ((= incx 0)
           (setf info 7)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DTPSV" info)
           (go end_label)))
        (if (= n 0) (go end_label))
        (setf nounit (char-equal diag #\N))
        (cond
          ((<= incx 0)
           (setf kx
                   (f2cl-lib:int-sub 1
                                     (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                       incx))))
          ((/= incx 1)
           (setf kx 1)))
        (cond
          ((char-equal trans #\N)
           (cond
```

```
((char-equal uplo #\U)
 (setf kk (the fixnum (truncate (* n (+ n 1)) 2)))
 (cond
   ((= incx 1)
    (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                  ((> j 1) nil)
      (tagbody
        (cond
          ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
           (if nounit
               (setf (f2cl-lib:fref x-%data%
                                    (j)
                                    ((1 *))
                                    x-%offset%)
                     (/
                      (f2cl-lib:fref x-%data%
                                     (j)
                                     ((1 *))
                                     x-%offset%)
                      (f2cl-lib:fref ap-%data%
                                     (kk)
                                     ((1 *))
                                     ap-%offset%))))
           (setf temp
                   (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
           (setf k (f2cl-lib:int-sub kk 1))
           (f2cl-lib:fdo (i
                          (f2cl-lib:int-add j
                                            (f2cl-lib:int-sub 1))
                          (f2cl-lib:int-add i
                                            (f2cl-lib:int-sub 1)))
                         ((> i 1) nil)
             (tagbody
               (setf (f2cl-lib:fref x-%data%
                                    (i)
                                    ((1 *))
                                    x-%offset%)
                     (-
                      (f2cl-lib:fref x-%data%
                                     (i)
                                     ((1 *))
                                     x-%offset%)
                      (* temp
                         (f2cl-lib:fref ap-%data%
                                        (k)
                                        ((1 *))
                                        ap-%offset%))))
               (setf k (f2cl-lib:int-sub k 1))))))
       (setf kk (f2cl-lib:int-sub kk j)))))
   (t
```

```
(setf jx
       (f2cl-lib:int-add kx
                         (f2cl-lib:int-mul
                          (f2cl-lib:int-sub n 1)
                          incx)))
(f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
              ((> j 1) nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
       (if nounit
           (setf (f2cl-lib:fref x-%data%
                                (jx)
                                ((1 *))
                                x-%offset%)
                 (/
                  (f2cl-lib:fref x-%data%
                                 (jx)
                                 ((1 *))
                                 x-%offset%)
                  (f2cl-lib:fref ap-%data%
                                 (kk)
                                 ((1 *))
                                 ap-%offset%))))
       (setf temp
             (f2cl-lib:fref x-%data%
                            (jx)
                            ((1 *))
                            x-%offset%))
       (setf ix jx)
       (f2cl-lib:fdo (k
                      (f2cl-lib:int-add kk
                                        (f2cl-lib:int-sub 1))
                      (f2cl-lib:int-add k
                                        (f2cl-lib:int-sub 1)))
                     ((> k
                         (f2cl-lib:int-add kk
                                           (f2cl-lib:int-sub
                                            j)
                                           1))
                      nil)
         (tagbody
           (setf ix (f2cl-lib:int-sub ix incx))
           (setf (f2cl-lib:fref x-%data%
                                (ix)
                                ((1 *))
                                x-%offset%)
                 (-
                  (f2cl-lib:fref x-%data%
                                 (ix)
```

```
                                        ((1 *))
                                        x-%offset%)
                          (* temp
                             (f2cl-lib:fref ap-%data%
                                            (k)
                                            ((1 *))
                                            ap-%offset%))))))))
         (setf jx (f2cl-lib:int-sub jx incx))
         (setf kk (f2cl-lib:int-sub kk j)))))))
(t
 (setf kk 1)
 (cond
   ((= incx 1)
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j n) nil)
      (tagbody
        (cond
          ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
           (if nounit
               (setf (f2cl-lib:fref x-%data%
                                    (j)
                                    ((1 *))
                                    x-%offset%)
                     (/
                      (f2cl-lib:fref x-%data%
                                     (j)
                                     ((1 *))
                                     x-%offset%)
                      (f2cl-lib:fref ap-%data%
                                     (kk)
                                     ((1 *))
                                     ap-%offset%))))
           (setf temp
                   (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
           (setf k (f2cl-lib:int-add kk 1))
           (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                            (f2cl-lib:int-add i 1))
                         ((> i n) nil)
             (tagbody
               (setf (f2cl-lib:fref x-%data%
                                    (i)
                                    ((1 *))
                                    x-%offset%)
                     (-
                      (f2cl-lib:fref x-%data%
                                     (i)
                                     ((1 *))
                                     x-%offset%)
                      (* temp
                         (f2cl-lib:fref ap-%data%
```

```
                                          (k)
                                          ((1 *))
                                          ap-%offset%))))
                (setf k (f2cl-lib:int-add k 1))))))
        (setf kk
                (f2cl-lib:int-add kk
                                  (f2cl-lib:int-add
                                   (f2cl-lib:int-sub n j)
                                   1))))))
(t
 (setf jx kx)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (cond
       ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (if nounit
            (setf (f2cl-lib:fref x-%data%
                                 (jx)
                                 ((1 *))
                                 x-%offset%)
                  (/
                   (f2cl-lib:fref x-%data%
                                  (jx)
                                  ((1 *))
                                  x-%offset%)
                   (f2cl-lib:fref ap-%data%
                                  (kk)
                                  ((1 *))
                                  ap-%offset%))))
        (setf temp
                (f2cl-lib:fref x-%data%
                               (jx)
                               ((1 *))
                               x-%offset%))
        (setf ix jx)
        (f2cl-lib:fdo (k (f2cl-lib:int-add kk 1)
                         (f2cl-lib:int-add k 1))
                      ((> k
                          (f2cl-lib:int-add kk
                                            n
                                            (f2cl-lib:int-sub
                                             j)))
                       nil)
          (tagbody
            (setf ix (f2cl-lib:int-add ix incx))
            (setf (f2cl-lib:fref x-%data%
                                 (ix)
                                 ((1 *))
                                 x-%offset%)
```

```
                              (-
                               (f2cl-lib:fref x-%data%
                                             (ix)
                                             ((1 *))
                                             x-%offset%)
                               (* temp
                                  (f2cl-lib:fref ap-%data%
                                                 (k)
                                                 ((1 *))
                                                 ap-%offset%))))))))
                    (setf jx (f2cl-lib:int-add jx incx))
                    (setf kk
                            (f2cl-lib:int-add kk
                                              (f2cl-lib:int-add
                                               (f2cl-lib:int-sub n j)
                                               1)))))))))))
          (t
           (cond
             ((char-equal uplo #\U)
              (setf kk 1)
              (cond
                ((= incx 1)
                 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                               ((> j n) nil)
                   (tagbody
                     (setf temp
                             (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                     (setf k kk)
                     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                   ((> i
                                       (f2cl-lib:int-add j
                                                         (f2cl-lib:int-sub 1)))
                                    nil)
                       (tagbody
                         (setf temp
                                 (- temp
                                    (*
                                     (f2cl-lib:fref ap-%data%
                                                    (k)
                                                    ((1 *))
                                                    ap-%offset%)
                                     (f2cl-lib:fref x-%data%
                                                    (i)
                                                    ((1 *))
                                                    x-%offset%))))
                         (setf k (f2cl-lib:int-add k 1))))
                     (if nounit
                         (setf temp
                                 (/ temp
                                    (f2cl-lib:fref ap-%data%
```

```
                                        ((f2cl-lib:int-sub
                                          (f2cl-lib:int-add kk j)
                                          1))
                                        ((1 *))
                                        ap-%offset%))))
                    (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
                            temp)
                    (setf kk (f2cl-lib:int-add kk j)))))
                  (t
                   (setf jx kx)
                   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                                 ((> j n) nil)
                     (tagbody
                       (setf temp
                               (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
                       (setf ix kx)
                       (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
                                     ((> k
                                         (f2cl-lib:int-add kk
                                                           j
                                                           (f2cl-lib:int-sub 2)))
                                      nil)
                         (tagbody
                           (setf temp
                                   (- temp
                                      (*
                                       (f2cl-lib:fref ap-%data%
                                                      (k)
                                                      ((1 *))
                                                      ap-%offset%)
                                       (f2cl-lib:fref x-%data%
                                                      (ix)
                                                      ((1 *))
                                                      x-%offset%))))
                           (setf ix (f2cl-lib:int-add ix incx))))
                       (if nounit
                           (setf temp
                                   (/ temp
                                      (f2cl-lib:fref ap-%data%
                                                     ((f2cl-lib:int-sub
                                                       (f2cl-lib:int-add kk j)
                                                       1))
                                                     ((1 *))
                                                     ap-%offset%))))
                       (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                               temp)
                       (setf jx (f2cl-lib:int-add jx incx))
                       (setf kk (f2cl-lib:int-add kk j)))))))
             (t
              (setf kk (the fixnum (truncate (* n (+ n 1)) 2)))
```

```
(cond
  ((= incx 1)
   (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                 ((> j 1) nil)
     (tagbody
       (setf temp
               (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
       (setf k kk)
       (f2cl-lib:fdo (i n
                      (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                     ((> i (f2cl-lib:int-add j 1)) nil)
         (tagbody
           (setf temp
                   (- temp
                      (*
                       (f2cl-lib:fref ap-%data%
                                      (k)
                                      ((1 *))
                                      ap-%offset%)
                       (f2cl-lib:fref x-%data%
                                      (i)
                                      ((1 *))
                                      x-%offset%))))
           (setf k (f2cl-lib:int-sub k 1))))
       (if nounit
           (setf temp
                   (/ temp
                      (f2cl-lib:fref ap-%data%
                                     ((f2cl-lib:int-add
                                       (f2cl-lib:int-sub kk n)
                                       j))
                                     ((1 *))
                                     ap-%offset%))))
       (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
               temp)
       (setf kk
               (f2cl-lib:int-sub kk
                                 (f2cl-lib:int-add
                                  (f2cl-lib:int-sub n j)
                                  1))))))
  (t
   (setf kx
           (f2cl-lib:int-add kx
                             (f2cl-lib:int-mul
                              (f2cl-lib:int-sub n 1)
                              incx)))
   (setf jx kx)
   (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                 ((> j 1) nil)
     (tagbody
```

```
                    (setf temp
                          (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
                    (setf ix kx)
                    (f2cl-lib:fdo (k kk
                                   (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
                                  ((> k
                                      (f2cl-lib:int-add kk
                                        (f2cl-lib:int-sub
                                         (f2cl-lib:int-add n
                                          (f2cl-lib:int-sub
                                           (f2cl-lib:int-add
                                             j
                                             1))))))
                                   nil)
                      (tagbody
                        (setf temp
                                (- temp
                                   (*
                                    (f2cl-lib:fref ap-%data%
                                                   (k)
                                                   ((1 *))
                                                   ap-%offset%)
                                    (f2cl-lib:fref x-%data%
                                                   (ix)
                                                   ((1 *))
                                                   x-%offset%))))
                        (setf ix (f2cl-lib:int-sub ix incx))))
                    (if nounit
                        (setf temp
                                (/ temp
                                   (f2cl-lib:fref ap-%data%
                                                  ((f2cl-lib:int-add
                                                    (f2cl-lib:int-sub kk n)
                                                    j))
                                                  ((1 *))
                                                  ap-%offset%))))
                    (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                            temp)
                    (setf jx (f2cl-lib:int-sub jx incx))
                    (setf kk
                            (f2cl-lib:int-sub kk
                                              (f2cl-lib:int-add
                                               (f2cl-lib:int-sub n j)
                                               1))))))))))
 end_label
        (return (values nil nil nil nil nil nil nil))))))
```

4.15 dtrmv BLAS

— dtrmv.input —

```
)set break resume
)sys rm -f dtrmv.output
)spool dtrmv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

————-

— dtrmv.help —

```
==========================================================================
dtrmv examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      DTRMV - perform one of the matrix-vector operations   x :=
      A*x, or x := A'*x,

 SYNOPSIS
      SUBROUTINE DTRMV ( UPLO, TRANS, DIAG, N, A, LDA, X, INCX )

          INTEGER      INCX, LDA, N

          CHARACTER*1  DIAG, TRANS, UPLO

          DOUBLE       PRECISION A( LDA, * ), X( * )

 PURPOSE
      DTRMV  performs one of the matrix-vector operations

      where x is an n element vector and  A is an n by n unit, or
      non-unit, upper or lower triangular matrix.

 PARAMETERS
      UPLO   - CHARACTER*1.
               On entry, UPLO specifies whether the matrix is an
```

```
         upper or lower triangular matrix as follows:

         UPLO = 'U' or 'u'   A is an upper triangular matrix.

         UPLO = 'L' or 'l'   A is a lower triangular matrix.

         Unchanged on exit.

TRANS  - CHARACTER*1.
         On entry, TRANS specifies the operation to be per-
         formed as follows:

         TRANS = 'N' or 'n'   x := A*x.

         TRANS = 'T' or 't'   x := A'*x.

         TRANS = 'C' or 'c'   x := A'*x.

         Unchanged on exit.

DIAG   - CHARACTER*1.
         On entry, DIAG specifies whether or not A is unit
         triangular as follows:

         DIAG = 'U' or 'u'   A is assumed to be unit triangu-
         lar.

         DIAG = 'N' or 'n'   A is not assumed to be unit tri-
         angular.

         Unchanged on exit.

N      - INTEGER.
         On entry, N specifies the order of the matrix A.  N
         must be at least zero.  Unchanged on exit.

A      - DOUBLE PRECISION array of DIMENSION ( LDA, n ).
         Before entry with  UPLO = 'U' or 'u', the leading n
         by n upper triangular part of the array A must con-
         tain the upper triangular matrix and the strictly
         lower triangular part of A is not referenced.  Before
         entry with UPLO = 'L' or 'l', the leading n by n
         lower triangular part of the array A must contain the
         lower triangular matrix and the strictly upper tri-
         angular part of A is not referenced.  Note that when
         DIAG = 'U' or 'u', the diagonal elements of A are not
         referenced either, but are assumed to be unity.
         Unchanged on exit.

LDA    - INTEGER.
```

```
           On entry, LDA specifies the first dimension of A as
           declared in the calling (sub) program. LDA must be at
           least max( 1, n ).  Unchanged on exit.

     X     - DOUBLE PRECISION array of dimension at least
           ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
           incremented array X must contain the n element vector
           x. On exit, X is overwritten with the transformed
           vector x.

     INCX  - INTEGER.
           On entry, INCX specifies the increment for the ele-
           ments of X. INCX must not be zero.  Unchanged on
           exit.
```

———-

— dtrmv.f —

```
      SUBROUTINE DTRMV ( UPLO, TRANS, DIAG, N, A, LDA, X, INCX )
*     .. Scalar Arguments ..
      INTEGER            INCX, LDA, N
      CHARACTER*1        DIAG, TRANS, UPLO
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), X( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER        ( ZERO = 0.0D+0 )
*     .. Local Scalars ..
      DOUBLE PRECISION   TEMP
      INTEGER            I, INFO, IX, J, JX, KX
      LOGICAL            NOUNIT
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
```

```
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO , 'U' ).AND.
     $         .NOT.LSAME( UPLO , 'L' )      )THEN
         INFO = 1
      ELSE IF( .NOT.LSAME( TRANS, 'N' ).AND.
     $         .NOT.LSAME( TRANS, 'T' ).AND.
     $         .NOT.LSAME( TRANS, 'C' )      )THEN
         INFO = 2
      ELSE IF( .NOT.LSAME( DIAG , 'U' ).AND.
     $         .NOT.LSAME( DIAG , 'N' )      )THEN
         INFO = 3
      ELSE IF( N.LT.0 )THEN
         INFO = 4
      ELSE IF( LDA.LT.MAX( 1, N ) )THEN
         INFO = 6
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 8
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DTRMV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( N.EQ.0 )
     $   RETURN
*
      NOUNIT = LSAME( DIAG, 'N' )
*
*     Set up the start point in X if the increment is not unity. This
*     will be  ( N - 1 )*INCX  too small for descending loops.
*
      IF( INCX.LE.0 )THEN
         KX = 1 - ( N - 1 )*INCX
      ELSE IF( INCX.NE.1 )THEN
         KX = 1
      END IF
*
*     Start the operations. In this version the elements of A are
*     accessed sequentially with one pass through A.
*
      IF( LSAME( TRANS, 'N' ) )THEN
```

```
*
*        Form  x := A*x.
*
         IF( LSAME( UPLO, 'U' ) )THEN
            IF( INCX.EQ.1 )THEN
               DO 20, J = 1, N
                  IF( X( J ).NE.ZERO )THEN
                     TEMP = X( J )
                     DO 10, I = 1, J - 1
                        X( I ) = X( I ) + TEMP*A( I, J )
   10                CONTINUE
                     IF( NOUNIT )
     $                  X( J ) = X( J )*A( J, J )
                  END IF
   20          CONTINUE
            ELSE
               JX = KX
               DO 40, J = 1, N
                  IF( X( JX ).NE.ZERO )THEN
                     TEMP = X( JX )
                     IX   = KX
                     DO 30, I = 1, J - 1
                        X( IX ) = X( IX ) + TEMP*A( I, J )
                        IX      = IX      + INCX
   30                CONTINUE
                     IF( NOUNIT )
     $                  X( JX ) = X( JX )*A( J, J )
                  END IF
                  JX = JX + INCX
   40          CONTINUE
            END IF
         ELSE
            IF( INCX.EQ.1 )THEN
               DO 60, J = N, 1, -1
                  IF( X( J ).NE.ZERO )THEN
                     TEMP = X( J )
                     DO 50, I = N, J + 1, -1
                        X( I ) = X( I ) + TEMP*A( I, J )
   50                CONTINUE
                     IF( NOUNIT )
     $                  X( J ) = X( J )*A( J, J )
                  END IF
   60          CONTINUE
            ELSE
               KX = KX + ( N - 1 )*INCX
               JX = KX
               DO 80, J = N, 1, -1
                  IF( X( JX ).NE.ZERO )THEN
                     TEMP = X( JX )
                     IX   = KX
```

```
                  DO 70, I = N, J + 1, -1
                     X( IX ) = X( IX ) + TEMP*A( I, J )
                     IX      = IX      - INCX
   70             CONTINUE
                  IF( NOUNIT )
     $               X( JX ) = X( JX )*A( J, J )
                END IF
                JX = JX - INCX
   80         CONTINUE
           END IF
        END IF
     ELSE
*
*       Form  x := A'*x.
*
        IF( LSAME( UPLO, 'U' ) )THEN
           IF( INCX.EQ.1 )THEN
              DO 100, J = N, 1, -1
                 TEMP = X( J )
                 IF( NOUNIT )
     $              TEMP = TEMP*A( J, J )
                 DO 90, I = J - 1, 1, -1
                    TEMP = TEMP + A( I, J )*X( I )
   90            CONTINUE
                 X( J ) = TEMP
  100         CONTINUE
           ELSE
              JX = KX + ( N - 1 )*INCX
              DO 120, J = N, 1, -1
                 TEMP = X( JX )
                 IX   = JX
                 IF( NOUNIT )
     $              TEMP = TEMP*A( J, J )
                 DO 110, I = J - 1, 1, -1
                    IX   = IX   - INCX
                    TEMP = TEMP + A( I, J )*X( IX )
  110            CONTINUE
                 X( JX ) = TEMP
                 JX      = JX   - INCX
  120         CONTINUE
           END IF
        ELSE
           IF( INCX.EQ.1 )THEN
              DO 140, J = 1, N
                 TEMP = X( J )
                 IF( NOUNIT )
     $              TEMP = TEMP*A( J, J )
                 DO 130, I = J + 1, N
                    TEMP = TEMP + A( I, J )*X( I )
  130            CONTINUE
```

```
                  X( J ) = TEMP
  140          CONTINUE
               ELSE
                  JX = KX
                  DO 160, J = 1, N
                     TEMP = X( JX )
                     IX   = JX
                     IF( NOUNIT )
     $                  TEMP = TEMP*A( J, J )
                     DO 150, I = J + 1, N
                        IX   = IX   + INCX
                        TEMP = TEMP + A( I, J )*X( IX )
  150                CONTINUE
                     X( JX ) = TEMP
                     JX      = JX   + INCX
  160             CONTINUE
               END IF
            END IF
         END IF
*
         RETURN
*
*     End of DTRMV .
*
         END
```

———-

— BLAS 2 dtrmv —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dtrmv (uplo trans diag n a lda x incx)
    (declare (type (simple-array double-float (*)) x a)
             (type fixnum incx lda n)
             (type character diag trans uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (a double-float a-%data% a-%offset%)
         (x double-float x-%data% x-%offset%))
      (prog ((nounit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0) (kx 0) (temp 0.0))
        (declare (type (member t nil) nounit)
                 (type fixnum i info ix j jx kx)
                 (type (double-float) temp))
        (setf info 0)
        (cond
```

```
  ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
   (setf info 1))
  ((and (not (char-equal trans #\N))
        (not (char-equal trans #\T))
        (not (char-equal trans #\C)))
   (setf info 2))
  ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
   (setf info 3))
  ((< n 0)
   (setf info 4))
  ((< lda (max (the fixnum 1) (the fixnum n)))
   (setf info 6))
  ((= incx 0)
   (setf info 8)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DTRMV" info)
   (go end_label)))
(if (= n 0) (go end_label))
(setf nounit (char-equal diag #\N))
(cond
  ((<= incx 0)
   (setf kx
         (f2cl-lib:int-sub 1
                           (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                             incx))))
  ((/= incx 1)
   (setf kx 1)))
(cond
  ((char-equal trans #\N)
   (cond
     ((char-equal uplo #\U)
      (cond
        ((= incx 1)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (cond
               ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                (setf temp
                        (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                              ((> i
                                  (f2cl-lib:int-add j
                                                    (f2cl-lib:int-sub
                                                     1)))
                               nil)
                  (tagbody
```

```
                (setf (f2cl-lib:fref x-%data%
                                     (i)
                                     ((1 *))
                                     x-%offset%)
                      (+
                       (f2cl-lib:fref x-%data%
                                      (i)
                                      ((1 *))
                                      x-%offset%)
                       (* temp
                          (f2cl-lib:fref a-%data%
                                         (i j)
                                         ((1 lda) (1 *))
                                         a-%offset%))))))
        (if nounit
            (setf (f2cl-lib:fref x-%data%
                                 (j)
                                 ((1 *))
                                 x-%offset%)
                  (*
                   (f2cl-lib:fref x-%data%
                                  (j)
                                  ((1 *))
                                  x-%offset%)
                   (f2cl-lib:fref a-%data%
                                  (j j)
                                  ((1 lda) (1 *))
                                  a-%offset%)))))))))
(t
 (setf jx kx)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (cond
       ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (setf temp
                (f2cl-lib:fref x-%data%
                               (jx)
                               ((1 *))
                               x-%offset%))
        (setf ix kx)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i
                          (f2cl-lib:int-add j
                                            (f2cl-lib:int-sub
                                             1)))
                       nil)
          (tagbody
            (setf (f2cl-lib:fref x-%data%
                                 (ix)
```

```
                                        ((1 *))
                                        x-%offset%)
                                (+
                                 (f2cl-lib:fref x-%data%
                                                (ix)
                                                ((1 *))
                                                x-%offset%)
                                 (* temp
                                    (f2cl-lib:fref a-%data%
                                                   (i j)
                                                   ((1 lda) (1 *))
                                                   a-%offset%))))
                            (setf ix (f2cl-lib:int-add ix incx))))
                        (if nounit
                            (setf (f2cl-lib:fref x-%data%
                                                 (jx)
                                                 ((1 *))
                                                 x-%offset%)
                                  (*
                                   (f2cl-lib:fref x-%data%
                                                  (jx)
                                                  ((1 *))
                                                  x-%offset%)
                                   (f2cl-lib:fref a-%data%
                                                  (j j)
                                                  ((1 lda) (1 *))
                                                  a-%offset%))))))
                        (setf jx (f2cl-lib:int-add jx incx)))))))
        (t
         (cond
           ((= incx 1)
            (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                          ((> j 1) nil)
              (tagbody
                (cond
                  ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                   (setf temp
                           (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                   (f2cl-lib:fdo (i n
                                  (f2cl-lib:int-add i
                                                    (f2cl-lib:int-sub 1)))
                                 ((> i (f2cl-lib:int-add j 1)) nil)
                     (tagbody
                       (setf (f2cl-lib:fref x-%data%
                                            (i)
                                            ((1 *))
                                            x-%offset%)
                             (+
                              (f2cl-lib:fref x-%data%
                                             (i)
```

```
                                        ((1 *))
                                        x-%offset%)
                          (* temp
                             (f2cl-lib:fref a-%data%
                                            (i j)
                                            ((1 lda) (1 *))
                                            a-%offset%))))))
                 (if nounit
                     (setf (f2cl-lib:fref x-%data%
                                          (j)
                                          ((1 *))
                                          x-%offset%)
                           (*
                            (f2cl-lib:fref x-%data%
                                           (j)
                                           ((1 *))
                                           x-%offset%)
                            (f2cl-lib:fref a-%data%
                                           (j j)
                                           ((1 lda) (1 *))
                                           a-%offset%)))))))))
         (t
          (setf kx
                (f2cl-lib:int-add kx
                                  (f2cl-lib:int-mul
                                   (f2cl-lib:int-sub n 1)
                                   incx)))
          (setf jx kx)
          (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                        ((> j 1) nil)
            (tagbody
              (cond
                ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
                 (setf temp
                       (f2cl-lib:fref x-%data%
                                      (jx)
                                      ((1 *))
                                      x-%offset%))
                 (setf ix kx)
                 (f2cl-lib:fdo (i n
                                (f2cl-lib:int-add i
                                                  (f2cl-lib:int-sub 1)))
                               ((> i (f2cl-lib:int-add j 1)) nil)
                   (tagbody
                     (setf (f2cl-lib:fref x-%data%
                                          (ix)
                                          ((1 *))
                                          x-%offset%)
                           (+
                            (f2cl-lib:fref x-%data%
```

```
                                          (ix)
                                          ((1 *))
                                          x-%offset%)
                                  (* temp
                                     (f2cl-lib:fref a-%data%
                                                    (i j)
                                                    ((1 lda) (1 *))
                                                    a-%offset%))))
                          (setf ix (f2cl-lib:int-sub ix incx))))
                     (if nounit
                         (setf (f2cl-lib:fref x-%data%
                                              (jx)
                                              ((1 *))
                                              x-%offset%)
                               (*
                                (f2cl-lib:fref x-%data%
                                               (jx)
                                               ((1 *))
                                               x-%offset%)
                                (f2cl-lib:fref a-%data%
                                               (j j)
                                               ((1 lda) (1 *))
                                               a-%offset%))))))
                (setf jx (f2cl-lib:int-sub jx incx)))))))))
          (t
           (cond
             ((char-equal uplo #\U)
              (cond
                ((= incx 1)
                 (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                               ((> j 1) nil)
                   (tagbody
                     (setf temp
                             (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                     (if nounit
                         (setf temp
                                 (* temp
                                    (f2cl-lib:fref a-%data%
                                                   (j j)
                                                   ((1 lda) (1 *))
                                                   a-%offset%))))
                     (f2cl-lib:fdo (i (f2cl-lib:int-add j (f2cl-lib:int-sub 1))
                                    (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                                   ((> i 1) nil)
                       (tagbody
                         (setf temp
                                 (+ temp
                                    (*
                                     (f2cl-lib:fref a-%data%
                                                    (i j)
```

```
                                        ((1 lda) (1 *))
                                        a-%offset%)
                            (f2cl-lib:fref x-%data%
                                        (i)
                                        ((1 *))
                                        x-%offset%))))))
            (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
                    temp))))
       (t
        (setf jx
                (f2cl-lib:int-add kx
                                  (f2cl-lib:int-mul
                                   (f2cl-lib:int-sub n 1)
                                   incx)))
        (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                      ((> j 1) nil)
          (tagbody
            (setf temp
                    (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
            (setf ix jx)
            (if nounit
                (setf temp
                        (* temp
                           (f2cl-lib:fref a-%data%
                                          (j j)
                                          ((1 lda) (1 *))
                                          a-%offset%))))
            (f2cl-lib:fdo (i (f2cl-lib:int-add j (f2cl-lib:int-sub 1))
                           (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                          ((> i 1) nil)
              (tagbody
                (setf ix (f2cl-lib:int-sub ix incx))
                (setf temp
                        (+ temp
                           (*
                            (f2cl-lib:fref a-%data%
                                          (i j)
                                          ((1 lda) (1 *))
                                          a-%offset%)
                            (f2cl-lib:fref x-%data%
                                          (ix)
                                          ((1 *))
                                          x-%offset%))))))
            (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                    temp)
            (setf jx (f2cl-lib:int-sub jx incx)))))))
  (t
   (cond
     ((= incx 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
```

```
                ((> j n) nil)
      (tagbody
        (setf temp
              (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
        (if nounit
            (setf temp
                  (* temp
                     (f2cl-lib:fref a-%data%
                                    (j j)
                                    ((1 lda) (1 *))
                                    a-%offset%))))
        (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                       (f2cl-lib:int-add i 1))
                      ((> i n) nil)
          (tagbody
            (setf temp
                  (+ temp
                     (*
                      (f2cl-lib:fref a-%data%
                                     (i j)
                                     ((1 lda) (1 *))
                                     a-%offset%)
                      (f2cl-lib:fref x-%data%
                                     (i)
                                     ((1 *))
                                     x-%offset%))))))
        (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
              temp))))
    (t
     (setf jx kx)
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   ((> j n) nil)
       (tagbody
         (setf temp
               (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
         (setf ix jx)
         (if nounit
             (setf temp
                   (* temp
                      (f2cl-lib:fref a-%data%
                                     (j j)
                                     ((1 lda) (1 *))
                                     a-%offset%))))
         (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                        (f2cl-lib:int-add i 1))
                       ((> i n) nil)
           (tagbody
             (setf ix (f2cl-lib:int-add ix incx))
             (setf temp
                   (+ temp
```

```
                                    (*
                                     (f2cl-lib:fref a-%data%
                                                    (i j)
                                                    ((1 lda) (1 *))
                                                    a-%offset%)
                                     (f2cl-lib:fref x-%data%
                                                    (ix)
                                                    ((1 *))
                                                    x-%offset%))))))
                      (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                              temp)
                      (setf jx (f2cl-lib:int-add jx incx))))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil))))))
```

———-

4.16 dtrsv BLAS

— **dtrsv.input** —

```
)set break resume
)sys rm -f dtrsv.output
)spool dtrsv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dtrsv.help** —

```
=====================================================================
dtrsv examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 NAME
      DTRSV - solve one of the systems of equations   A*x = b, or
```

```
     A'*x = b,

SYNOPSIS
     SUBROUTINE DTRSV ( UPLO, TRANS, DIAG, N, A, LDA, X, INCX )

         INTEGER      INCX, LDA, N

         CHARACTER*1  DIAG, TRANS, UPLO

         DOUBLE       PRECISION A( LDA, * ), X( * )

PURPOSE
     DTRSV  solves one of the systems of equations

     where b and x are n element vectors and A is an n by n unit,
     or non-unit, upper or lower triangular matrix.

     No test for singularity or near-singularity is included in
     this routine. Such tests must be performed before calling
     this routine.

PARAMETERS
     UPLO   - CHARACTER*1.
            On entry, UPLO specifies whether the matrix is an
            upper or lower triangular matrix as follows:

            UPLO = 'U' or 'u'   A is an upper triangular matrix.

            UPLO = 'L' or 'l'   A is a lower triangular matrix.

            Unchanged on exit.

     TRANS  - CHARACTER*1.
            On entry, TRANS specifies the equations to be solved
            as follows:

            TRANS = 'N' or 'n'   A*x = b.

            TRANS = 'T' or 't'   A'*x = b.

            TRANS = 'C' or 'c'   A'*x = b.

            Unchanged on exit.

     DIAG   - CHARACTER*1.
            On entry, DIAG specifies whether or not A is unit
            triangular as follows:

            DIAG = 'U' or 'u'   A is assumed to be unit
```

```
              triangular.

              DIAG = 'N' or 'n'   A is not assumed to be unit tri-
              angular.

              Unchanged on exit.

      N       - INTEGER.
              On entry, N specifies the order of the matrix A.  N
              must be at least zero.  Unchanged on exit.

      A       - DOUBLE PRECISION array of DIMENSION ( LDA, n ).
              Before entry with  UPLO = 'U' or 'u', the leading n
              by n upper triangular part of the array A must con-
              tain the upper triangular matrix and the strictly
              lower triangular part of A is not referenced.  Before
              entry with UPLO = 'L' or 'l', the leading n by n
              lower triangular part of the array A must contain the
              lower triangular matrix and the strictly upper tri-
              angular part of A is not referenced.  Note that when
              DIAG = 'U' or 'u', the diagonal elements of A are not
              referenced either, but are assumed to be unity.
              Unchanged on exit.

      LDA     - INTEGER.
              On entry, LDA specifies the first dimension of A as
              declared in the calling (sub) program. LDA must be at
              least max( 1, n ).  Unchanged on exit.

      X       - DOUBLE PRECISION array of dimension at least
              ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
              incremented array X must contain the n element
              right-hand side vector b. On exit, X is overwritten
              with the solution vector x.

      INCX    - INTEGER.
              On entry, INCX specifies the increment for the ele-
              ments of X. INCX must not be zero.  Unchanged on
              exit.
```

———-

— dtrsv.f —

```
      SUBROUTINE DTRSV ( UPLO, TRANS, DIAG, N, A, LDA, X, INCX )
*     .. Scalar Arguments ..
      INTEGER            INCX, LDA, N
      CHARACTER*1        DIAG, TRANS, UPLO
```

```
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), X( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER        ( ZERO = 0.0D+0 )
*     .. Local Scalars ..
      DOUBLE PRECISION   TEMP
      INTEGER            I, INFO, IX, J, JX, KX
      LOGICAL            NOUNIT
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO , 'U' ).AND.
     $         .NOT.LSAME( UPLO , 'L' )      )THEN
         INFO = 1
      ELSE IF( .NOT.LSAME( TRANS, 'N' ).AND.
     $         .NOT.LSAME( TRANS, 'T' ).AND.
     $         .NOT.LSAME( TRANS, 'C' )      )THEN
         INFO = 2
      ELSE IF( .NOT.LSAME( DIAG , 'U' ).AND.
     $         .NOT.LSAME( DIAG , 'N' )      )THEN
         INFO = 3
      ELSE IF( N.LT.0 )THEN
         INFO = 4
      ELSE IF( LDA.LT.MAX( 1, N ) )THEN
         INFO = 6
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 8
      END IF
```

```
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DTRSV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( N.EQ.0 )
     $   RETURN
*
      NOUNIT = LSAME( DIAG, 'N' )
*
*     Set up the start point in X if the increment is not unity. This
*     will be  ( N - 1 )*INCX  too small for descending loops.
*
      IF( INCX.LE.0 )THEN
         KX = 1 - ( N - 1 )*INCX
      ELSE IF( INCX.NE.1 )THEN
         KX = 1
      END IF
*
*     Start the operations. In this version the elements of A are
*     accessed sequentially with one pass through A.
*
      IF( LSAME( TRANS, 'N' ) )THEN
*
*        Form  x := inv( A )*x.
*
         IF( LSAME( UPLO, 'U' ) )THEN
            IF( INCX.EQ.1 )THEN
               DO 20, J = N, 1, -1
                  IF( X( J ).NE.ZERO )THEN
                     IF( NOUNIT )
     $                  X( J ) = X( J )/A( J, J )
                     TEMP = X( J )
                     DO 10, I = J - 1, 1, -1
                        X( I ) = X( I ) - TEMP*A( I, J )
   10                CONTINUE
                  END IF
   20          CONTINUE
            ELSE
               JX = KX + ( N - 1 )*INCX
               DO 40, J = N, 1, -1
                  IF( X( JX ).NE.ZERO )THEN
                     IF( NOUNIT )
     $                  X( JX ) = X( JX )/A( J, J )
                     TEMP = X( JX )
                     IX   = JX
                     DO 30, I = J - 1, 1, -1
                        IX      = IX      - INCX
```

```
                     X( IX ) = X( IX ) - TEMP*A( I, J )
   30             CONTINUE
                  END IF
                  JX = JX - INCX
   40          CONTINUE
            END IF
         ELSE
            IF( INCX.EQ.1 )THEN
               DO 60, J = 1, N
                  IF( X( J ).NE.ZERO )THEN
                     IF( NOUNIT )
     $                  X( J ) = X( J )/A( J, J )
                     TEMP = X( J )
                     DO 50, I = J + 1, N
                        X( I ) = X( I ) - TEMP*A( I, J )
   50                CONTINUE
                  END IF
   60          CONTINUE
            ELSE
               JX = KX
               DO 80, J = 1, N
                  IF( X( JX ).NE.ZERO )THEN
                     IF( NOUNIT )
     $                  X( JX ) = X( JX )/A( J, J )
                     TEMP = X( JX )
                     IX   = JX
                     DO 70, I = J + 1, N
                        IX      = IX      + INCX
                        X( IX ) = X( IX ) - TEMP*A( I, J )
   70                CONTINUE
                  END IF
                  JX = JX + INCX
   80          CONTINUE
            END IF
         END IF
      ELSE
*
*        Form  x := inv( A' )*x.
*
         IF( LSAME( UPLO, 'U' ) )THEN
            IF( INCX.EQ.1 )THEN
               DO 100, J = 1, N
                  TEMP = X( J )
                  DO 90, I = 1, J - 1
                     TEMP = TEMP - A( I, J )*X( I )
   90             CONTINUE
                  IF( NOUNIT )
     $               TEMP = TEMP/A( J, J )
                  X( J ) = TEMP
  100          CONTINUE
```

```
            ELSE
               JX = KX
               DO 120, J = 1, N
                  TEMP = X( JX )
                  IX   = KX
                  DO 110, I = 1, J - 1
                     TEMP = TEMP - A( I, J )*X( IX )
                     IX   = IX   + INCX
  110             CONTINUE
                  IF( NOUNIT )
     $               TEMP = TEMP/A( J, J )
                  X( JX ) = TEMP
                  JX      = JX   + INCX
  120          CONTINUE
            END IF
         ELSE
            IF( INCX.EQ.1 )THEN
               DO 140, J = N, 1, -1
                  TEMP = X( J )
                  DO 130, I = N, J + 1, -1
                     TEMP = TEMP - A( I, J )*X( I )
  130             CONTINUE
                  IF( NOUNIT )
     $               TEMP = TEMP/A( J, J )
                  X( J ) = TEMP
  140          CONTINUE
            ELSE
               KX = KX + ( N - 1 )*INCX
               JX = KX
               DO 160, J = N, 1, -1
                  TEMP = X( JX )
                  IX   = KX
                  DO 150, I = N, J + 1, -1
                     TEMP = TEMP - A( I, J )*X( IX )
                     IX   = IX   - INCX
  150             CONTINUE
                  IF( NOUNIT )
     $               TEMP = TEMP/A( J, J )
                  X( JX ) = TEMP
                  JX      = JX   - INCX
  160          CONTINUE
            END IF
         END IF
      END IF
*
      RETURN
*
*     End of DTRSV .
*
      END
```

———-

— BLAS 2 dtrsv —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dtrsv (uplo trans diag n a lda x incx)
    (declare (type (simple-array double-float (*)) x a)
             (type fixnum incx lda n)
             (type character diag trans uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (a double-float a-%data% a-%offset%)
         (x double-float x-%data% x-%offset%))
      (prog ((nounit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0) (kx 0) (temp 0.0))
        (declare (type (member t nil) nounit)
                 (type fixnum i info ix j jx kx)
                 (type (double-float) temp))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
          ((and (not (char-equal trans #\N))
                (not (char-equal trans #\T))
                (not (char-equal trans #\C)))
           (setf info 2))
          ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
           (setf info 3))
          ((< n 0)
           (setf info 4))
          ((< lda (max (the fixnum 1) (the fixnum n)))
           (setf info 6))
          ((= incx 0)
           (setf info 8)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DTRSV" info)
           (go end_label)))
        (if (= n 0) (go end_label))
        (setf nounit (char-equal diag #\N))
        (cond
          ((<= incx 0)
           (setf kx
```

```
            (f2cl-lib:int-sub 1
                              (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                incx))))
    ((/= incx 1)
     (setf kx 1)))
  (cond
    ((char-equal trans #\N)
     (cond
       ((char-equal uplo #\U)
        (cond
          ((= incx 1)
           (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                         ((> j 1) nil)
             (tagbody
               (cond
                 ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                  (if nounit
                      (setf (f2cl-lib:fref x-%data%
                                           (j)
                                           ((1 *))
                                           x-%offset%)
                            (/
                             (f2cl-lib:fref x-%data%
                                            (j)
                                            ((1 *))
                                            x-%offset%)
                             (f2cl-lib:fref a-%data%
                                            (j j)
                                            ((1 lda) (1 *))
                                            a-%offset%))))
                  (setf temp
                          (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                  (f2cl-lib:fdo (i
                                 (f2cl-lib:int-add j
                                                   (f2cl-lib:int-sub 1))
                                 (f2cl-lib:int-add i
                                                   (f2cl-lib:int-sub 1)))
                                ((> i 1) nil)
                    (tagbody
                      (setf (f2cl-lib:fref x-%data%
                                           (i)
                                           ((1 *))
                                           x-%offset%)
                            (-
                             (f2cl-lib:fref x-%data%
                                            (i)
                                            ((1 *))
                                            x-%offset%)
                             (* temp
                                (f2cl-lib:fref a-%data%
```

```
                                        (i j)
                                        ((1 lda) (1 *))
                                        a-%offset%))))))))))))
                (t
                 (setf jx
                       (f2cl-lib:int-add kx
                                         (f2cl-lib:int-mul
                                          (f2cl-lib:int-sub n 1)
                                          incx)))
                 (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                               ((> j 1) nil)
                   (tagbody
                     (cond
                       ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
                        (if nounit
                            (setf (f2cl-lib:fref x-%data%
                                                 (jx)
                                                 ((1 *))
                                                 x-%offset%)
                                  (/
                                   (f2cl-lib:fref x-%data%
                                                  (jx)
                                                  ((1 *))
                                                  x-%offset%)
                                   (f2cl-lib:fref a-%data%
                                                  (j j)
                                                  ((1 lda) (1 *))
                                                  a-%offset%))))
                        (setf temp
                              (f2cl-lib:fref x-%data%
                                             (jx)
                                             ((1 *))
                                             x-%offset%))
                        (setf ix jx)
                        (f2cl-lib:fdo (i
                                       (f2cl-lib:int-add j
                                                         (f2cl-lib:int-sub 1))
                                       (f2cl-lib:int-add i
                                                         (f2cl-lib:int-sub 1)))
                                      ((> i 1) nil)
                          (tagbody
                            (setf ix (f2cl-lib:int-sub ix incx))
                            (setf (f2cl-lib:fref x-%data%
                                                 (ix)
                                                 ((1 *))
                                                 x-%offset%)
                                  (-
                                   (f2cl-lib:fref x-%data%
                                                  (ix)
                                                  ((1 *))
```

```
                                        x-%offset%)
                          (* temp
                             (f2cl-lib:fref a-%data%
                                            (i j)
                                            ((1 lda) (1 *))
                                            a-%offset%))))))))
        (setf jx (f2cl-lib:int-sub jx incx)))))))
(t
 (cond
   ((= incx 1)
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j n) nil)
      (tagbody
        (cond
          ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
           (if nounit
               (setf (f2cl-lib:fref x-%data%
                                    (j)
                                    ((1 *))
                                    x-%offset%)
                     (/
                      (f2cl-lib:fref x-%data%
                                     (j)
                                     ((1 *))
                                     x-%offset%)
                      (f2cl-lib:fref a-%data%
                                     (j j)
                                     ((1 lda) (1 *))
                                     a-%offset%))))
               (setf temp
                       (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
               (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                (f2cl-lib:int-add i 1))
                             ((> i n) nil)
                 (tagbody
                   (setf (f2cl-lib:fref x-%data%
                                        (i)
                                        ((1 *))
                                        x-%offset%)
                         (-
                          (f2cl-lib:fref x-%data%
                                         (i)
                                         ((1 *))
                                         x-%offset%)
                          (* temp
                             (f2cl-lib:fref a-%data%
                                            (i j)
                                            ((1 lda) (1 *))
                                            a-%offset%)))))))))))
   (t
```

```
              (setf jx kx)
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
                (tagbody
                  (cond
                    ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
                     (if nounit
                         (setf (f2cl-lib:fref x-%data%
                                              (jx)
                                              ((1 *))
                                              x-%offset%)
                               (/
                                (f2cl-lib:fref x-%data%
                                               (jx)
                                               ((1 *))
                                               x-%offset%)
                                (f2cl-lib:fref a-%data%
                                               (j j)
                                               ((1 lda) (1 *))
                                               a-%offset%))))
                         (setf temp
                                 (f2cl-lib:fref x-%data%
                                                (jx)
                                                ((1 *))
                                                x-%offset%))
                         (setf ix jx)
                         (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                          (f2cl-lib:int-add i 1))
                                       ((> i n) nil)
                           (tagbody
                             (setf ix (f2cl-lib:int-add ix incx))
                             (setf (f2cl-lib:fref x-%data%
                                                  (ix)
                                                  ((1 *))
                                                  x-%offset%)
                                   (-
                                    (f2cl-lib:fref x-%data%
                                                   (ix)
                                                   ((1 *))
                                                   x-%offset%)
                                    (* temp
                                       (f2cl-lib:fref a-%data%
                                                      (i j)
                                                      ((1 lda) (1 *))
                                                      a-%offset%)))))))))
                    (setf jx (f2cl-lib:int-add jx incx)))))))))
            (t
             (cond
               ((char-equal uplo #\U)
                (cond
```

```
((= incx 1)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (setf temp
             (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                   ((> i
                       (f2cl-lib:int-add j
                                         (f2cl-lib:int-sub 1)))
                    nil)
       (tagbody
         (setf temp
                 (- temp
                    (*
                     (f2cl-lib:fref a-%data%
                                    (i j)
                                    ((1 lda) (1 *))
                                    a-%offset%)
                     (f2cl-lib:fref x-%data%
                                    (i)
                                    ((1 *))
                                    x-%offset%))))))
     (if nounit
         (setf temp
                 (/ temp
                    (f2cl-lib:fref a-%data%
                                   (j j)
                                   ((1 lda) (1 *))
                                   a-%offset%))))
     (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
             temp))))
(t
 (setf jx kx)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (setf temp
             (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
     (setf ix kx)
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                   ((> i
                       (f2cl-lib:int-add j
                                         (f2cl-lib:int-sub 1)))
                    nil)
       (tagbody
         (setf temp
                 (- temp
                    (*
                     (f2cl-lib:fref a-%data%
```

```
                                          (i j)
                                          ((1 lda) (1 *))
                                          a-%offset%)
                                (f2cl-lib:fref x-%data%
                                          (ix)
                                          ((1 *))
                                          x-%offset%))))
                    (setf ix (f2cl-lib:int-add ix incx))))
                (if nounit
                    (setf temp
                            (/ temp
                               (f2cl-lib:fref a-%data%
                                          (j j)
                                          ((1 lda) (1 *))
                                          a-%offset%))))
                (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                        temp)
                (setf jx (f2cl-lib:int-add jx incx)))))))
        (t
         (cond
           ((= incx 1)
            (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                          ((> j 1) nil)
              (tagbody
                (setf temp
                        (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                (f2cl-lib:fdo (i n
                               (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                              ((> i (f2cl-lib:int-add j 1)) nil)
                  (tagbody
                    (setf temp
                            (- temp
                               (*
                                (f2cl-lib:fref a-%data%
                                          (i j)
                                          ((1 lda) (1 *))
                                          a-%offset%)
                                (f2cl-lib:fref x-%data%
                                          (i)
                                          ((1 *))
                                          x-%offset%))))))
                (if nounit
                    (setf temp
                            (/ temp
                               (f2cl-lib:fref a-%data%
                                          (j j)
                                          ((1 lda) (1 *))
                                          a-%offset%))))
                (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
                        temp))))
```

```
               (t
                (setf kx
                       (f2cl-lib:int-add kx
                                        (f2cl-lib:int-mul
                                         (f2cl-lib:int-sub n 1)
                                         incx)))
                (setf jx kx)
                (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                              ((> j 1) nil)
                  (tagbody
                    (setf temp
                            (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
                    (setf ix kx)
                    (f2cl-lib:fdo (i n
                                   (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                                  ((> i (f2cl-lib:int-add j 1)) nil)
                      (tagbody
                        (setf temp
                                (- temp
                                   (*
                                    (f2cl-lib:fref a-%data%
                                                   (i j)
                                                   ((1 lda) (1 *))
                                                   a-%offset%)
                                    (f2cl-lib:fref x-%data%
                                                   (ix)
                                                   ((1 *))
                                                   x-%offset%))))
                        (setf ix (f2cl-lib:int-sub ix incx))))
                    (if nounit
                        (setf temp
                                (/ temp
                                   (f2cl-lib:fref a-%data%
                                                  (j j)
                                                  ((1 lda) (1 *))
                                                  a-%offset%))))
                    (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                            temp)
                    (setf jx (f2cl-lib:int-sub jx incx))))))))
end_label
       (return (values nil nil nil nil nil nil nil nil))))))
```

4.17 zgbmv BLAS

— zgbmv.input —

```
)set break resume
)sys rm -f zgbmv.output
)spool zgbmv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— zgbmv.help —

```
========================================================================
zgbmv examples
========================================================================

========================================================================
Man Page Details
========================================================================

 NAME
      ZGBMV - perform one of the matrix-vector operations   y :=
      alpha*A*x + beta*y, or y := alpha*A'*x + beta*y, or   y :=
      alpha*conjg( A' )*x + beta*y,

 SYNOPSIS
      SUBROUTINE ZGBMV ( TRANS, M, N, KL, KU, ALPHA, A, LDA, X,
                         INCX, BETA, Y, INCY )

          COMPLEX*16   ALPHA, BETA

          INTEGER      INCX, INCY, KL, KU, LDA, M, N

          CHARACTER*1  TRANS

          COMPLEX*16   A( LDA, * ), X( * ), Y( * )

 PURPOSE
      ZGBMV  performs one of the matrix-vector operations

      where alpha and beta are scalars, x and y are vectors and A
      is an m by n band matrix, with kl sub-diagonals and ku
      super-diagonals.

 PARAMETERS
```

```
TRANS  - CHARACTER*1.
       On entry, TRANS specifies the operation to be per-
       formed as follows:

       TRANS = 'N' or 'n'   y := alpha*A*x + beta*y.

       TRANS = 'T' or 't'   y := alpha*A'*x + beta*y.

       TRANS = 'C' or 'c'   y := alpha*conjg( A' )*x +
       beta*y.

       Unchanged on exit.

M      - INTEGER.
       On entry, M specifies the number of rows of the
       matrix A.  M must be at least zero.  Unchanged on
       exit.

N      - INTEGER.
       On entry, N specifies the number of columns of the
       matrix A.  N must be at least zero.  Unchanged on
       exit.

KL     - INTEGER.
       On entry, KL specifies the number of sub-diagonals of
       the matrix A. KL must satisfy  0 .le. KL.  Unchanged

       on exit.

KU     - INTEGER.
       On entry, KU specifies the number of super-diagonals
       of the matrix A. KU must satisfy  0 .le. KU.
       Unchanged on exit.

ALPHA  - COMPLEX*16      .
       On entry, ALPHA specifies the scalar alpha.
       Unchanged on exit.

A      - COMPLEX*16       array of DIMENSION ( LDA, n ).
       Before entry, the leading ( kl + ku + 1 ) by n part
       of the array A must contain the matrix of coeffi-
       cients, supplied column by column, with the leading
       diagonal of the matrix in row ( ku + 1 ) of the
       array, the first super-diagonal starting at position
       2 in row ku, the first sub-diagonal starting at posi-
       tion 1 in row ( ku + 2 ), and so on.  Elements in the
       array A that do not correspond to elements in the
       band matrix (such as the top left ku by ku triangle)
       are not referenced.  The following program segment
       will transfer a band matrix from conventional full
```

```
            matrix storage to band storage:

            DO 20, J = 1, N K = KU + 1 - J DO 10, I = MAX( 1, J -
            KU ), MIN( M, J + KL ) A( K + I, J ) = matrix( I, J )
            10    CONTINUE 20 CONTINUE

            Unchanged on exit.

      LDA   - INTEGER.
            On entry, LDA specifies the first dimension of A as
            declared in the calling (sub) program. LDA must be at
            least ( kl + ku + 1 ).  Unchanged on exit.

      X     - COMPLEX*16       array of DIMENSION at least
            ( 1 + ( n - 1 )*abs( INCX ) ) when TRANS = 'N' or 'n'
            and at least ( 1 + ( m - 1 )*abs( INCX ) ) otherwise.
            Before entry, the incremented array X must contain
            the vector x.  Unchanged on exit.

      INCX  - INTEGER.
            On entry, INCX specifies the increment for the ele-
            ments of X. INCX must not be zero.  Unchanged on
            exit.

      BETA  - COMPLEX*16      .
            On entry, BETA specifies the scalar beta. When BETA
            is supplied as zero then Y need not be set on input.
            Unchanged on exit.

      Y     - COMPLEX*16       array of DIMENSION at least
            ( 1 + ( m - 1 )*abs( INCY ) ) when TRANS = 'N' or 'n'
            and at least ( 1 + ( n - 1 )*abs( INCY ) ) otherwise.
            Before entry, the incremented array Y must contain
            the vector y. On exit, Y is overwritten by the
            updated vector y.

      INCY  - INTEGER.
            On entry, INCY specifies the increment for the ele-
            ments of Y. INCY must not be zero.  Unchanged on
            exit.
```

———-

— zgbmv.f —

```
      SUBROUTINE ZGBMV ( TRANS, M, N, KL, KU, ALPHA, A, LDA, X, INCX,
     $                   BETA, Y, INCY )
*     .. Scalar Arguments ..
```

```
      COMPLEX*16         ALPHA, BETA
      INTEGER            INCX, INCY, KL, KU, LDA, M, N
      CHARACTER*1        TRANS
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), X( * ), Y( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      COMPLEX*16         ONE
      PARAMETER        ( ONE  = ( 1.0D+0, 0.0D+0 ) )
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     .. Local Scalars ..
      COMPLEX*16         TEMP
      INTEGER            I, INFO, IX, IY, J, JX, JY, K, KUP1, KX, KY,
     $                   LENX, LENY
      LOGICAL            NOCONJ
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG, MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( TRANS, 'N' ).AND.
     $         .NOT.LSAME( TRANS, 'T' ).AND.
     $         .NOT.LSAME( TRANS, 'C' )      )THEN
         INFO = 1
      ELSE IF( M.LT.0 )THEN
         INFO = 2
      ELSE IF( N.LT.0 )THEN
         INFO = 3
      ELSE IF( KL.LT.0 )THEN
         INFO = 4
      ELSE IF( KU.LT.0 )THEN
```

```
         INFO = 5
      ELSE IF( LDA.LT.( KL + KU + 1 ) )THEN
         INFO = 8
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 10
      ELSE IF( INCY.EQ.0 )THEN
         INFO = 13
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZGBMV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( M.EQ.0 ).OR.( N.EQ.0 ).OR.
     $    ( ( ALPHA.EQ.ZERO ).AND.( BETA.EQ.ONE ) ) )
     $   RETURN
*
      NOCONJ = LSAME( TRANS, 'T' )
*
*     Set  LENX  and  LENY, the lengths of the vectors x and y, and set
*     up the start points in  X  and  Y.
*
      IF( LSAME( TRANS, 'N' ) )THEN
         LENX = N
         LENY = M
      ELSE
         LENX = M
         LENY = N
      END IF
      IF( INCX.GT.0 )THEN
         KX = 1
      ELSE
         KX = 1 - ( LENX - 1 )*INCX
      END IF
      IF( INCY.GT.0 )THEN
         KY = 1
      ELSE
         KY = 1 - ( LENY - 1 )*INCY
      END IF
*
*     Start the operations. In this version the elements of A are
*     accessed sequentially with one pass through the band part of A.
*
*     First form  y := beta*y.
*
      IF( BETA.NE.ONE )THEN
         IF( INCY.EQ.1 )THEN
            IF( BETA.EQ.ZERO )THEN
```

```
               DO 10, I = 1, LENY
                  Y( I ) = ZERO
   10          CONTINUE
            ELSE
               DO 20, I = 1, LENY
                  Y( I ) = BETA*Y( I )
   20          CONTINUE
            END IF
         ELSE
            IY = KY
            IF( BETA.EQ.ZERO )THEN
               DO 30, I = 1, LENY
                  Y( IY ) = ZERO
                  IY      = IY   + INCY
   30          CONTINUE
            ELSE
               DO 40, I = 1, LENY
                  Y( IY ) = BETA*Y( IY )
                  IY      = IY           + INCY
   40          CONTINUE
            END IF
         END IF
      END IF
      IF( ALPHA.EQ.ZERO )
     $   RETURN
      KUP1 = KU + 1
      IF( LSAME( TRANS, 'N' ) )THEN
*
*        Form  y := alpha*A*x + y.
*
         JX = KX
         IF( INCY.EQ.1 )THEN
            DO 60, J = 1, N
               IF( X( JX ).NE.ZERO )THEN
                  TEMP = ALPHA*X( JX )
                  K    = KUP1 - J
                  DO 50, I = MAX( 1, J - KU ), MIN( M, J + KL )
                     Y( I ) = Y( I ) + TEMP*A( K + I, J )
   50             CONTINUE
               END IF
               JX = JX + INCX
   60       CONTINUE
         ELSE
            DO 80, J = 1, N
               IF( X( JX ).NE.ZERO )THEN
                  TEMP = ALPHA*X( JX )
                  IY   = KY
                  K    = KUP1 - J
                  DO 70, I = MAX( 1, J - KU ), MIN( M, J + KL )
                     Y( IY ) = Y( IY ) + TEMP*A( K + I, J )
```

```
                  IY      = IY      + INCY
   70             CONTINUE
               END IF
               JX = JX + INCX
               IF( J.GT.KU )
     $            KY = KY + INCY
   80       CONTINUE
         END IF
      ELSE
*
*        Form  y := alpha*A'*x + y  or  y := alpha*conjg( A' )*x + y.
*
         JY = KY
         IF( INCX.EQ.1 )THEN
            DO 110, J = 1, N
               TEMP = ZERO
               K    = KUP1 - J
               IF( NOCONJ )THEN
                  DO 90, I = MAX( 1, J - KU ), MIN( M, J + KL )
                     TEMP = TEMP + A( K + I, J )*X( I )
   90             CONTINUE
               ELSE
                  DO 100, I = MAX( 1, J - KU ), MIN( M, J + KL )
                     TEMP = TEMP + DCONJG( A( K + I, J ) )*X( I )
  100             CONTINUE
               END IF
               Y( JY ) = Y( JY ) + ALPHA*TEMP
               JY      = JY      + INCY
  110       CONTINUE
         ELSE
            DO 140, J = 1, N
               TEMP = ZERO
               IX   = KX
               K    = KUP1 - J
               IF( NOCONJ )THEN
                  DO 120, I = MAX( 1, J - KU ), MIN( M, J + KL )
                     TEMP = TEMP + A( K + I, J )*X( IX )
                     IX   = IX   + INCX
  120             CONTINUE
               ELSE
                  DO 130, I = MAX( 1, J - KU ), MIN( M, J + KL )
                     TEMP = TEMP + DCONJG( A( K + I, J ) )*X( IX )
                     IX   = IX   + INCX
  130             CONTINUE
               END IF
               Y( JY ) = Y( JY ) + ALPHA*TEMP
               JY      = JY      + INCY
               IF( J.GT.KU )
     $            KX = KX + INCX
  140       CONTINUE
```

```
         END IF
      END IF
*
      RETURN
*
*     End of ZGBMV .
*
      END
```

———-

— **BLAS 2 zgbmv** —

```
(let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
 (declare (type (complex double-float) one) (type (complex double-float) zero))
  (defun zgbmv (trans m n kl ku alpha a lda x incx beta y incy)
    (declare (type (simple-array (complex double-float) (*)) y x a)
             (type (complex double-float) beta alpha)
             (type fixnum incy incx lda ku kl n m)
             (type character trans))
    (f2cl-lib:with-multi-array-data
        ((trans character trans-%data% trans-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (x (complex double-float) x-%data% x-%offset%)
         (y (complex double-float) y-%data% y-%offset%))
      (prog ((noconj nil) (i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0)
             (k 0) (kup1 0) (kx 0) (ky 0) (lenx 0) (leny 0) (temp #C(0.0 0.0)))
        (declare (type (member t nil) noconj)
                 (type fixnum i info ix iy j jx jy k kup1 kx ky
                                        lenx leny)
                 (type (complex double-float) temp))
        (setf info 0)
        (cond
          ((and (not (char-equal trans #\N))
                (not (char-equal trans #\T))
                (not (char-equal trans #\C)))
           (setf info 1))
          ((< m 0)
           (setf info 2))
          ((< n 0)
           (setf info 3))
          ((< kl 0)
           (setf info 4))
          ((< ku 0)
           (setf info 5))
          ((< lda (f2cl-lib:int-add kl ku 1))
           (setf info 8))
          ((= incx 0)
```

```
   (setf info 10))
  ((= incy 0)
   (setf info 13)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "ZGBMV" info)
   (go end_label)))
(if (or (= m 0) (= n 0) (and (= alpha zero) (= beta one)))
    (go end_label))
(setf noconj (char-equal trans #\T))
(cond
  ((char-equal trans #\N)
   (setf lenx n)
   (setf leny m))
  (t
   (setf lenx m)
   (setf leny n)))
(cond
  ((> incx 0)
   (setf kx 1))
  (t
   (setf kx
         (f2cl-lib:int-sub 1
                           (f2cl-lib:int-mul
                            (f2cl-lib:int-sub lenx 1)
                            incx)))))
(cond
  ((> incy 0)
   (setf ky 1))
  (t
   (setf ky
         (f2cl-lib:int-sub 1
                           (f2cl-lib:int-mul
                            (f2cl-lib:int-sub leny 1)
                            incy)))))
(cond
  ((/= beta one)
   (cond
     ((= incy 1)
      (cond
        ((= beta zero)
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i leny) nil)
           (tagbody
             (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                     zero))))
        (t
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
```

```
                        ((> i leny) nil)
              (tagbody
                (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                        (* beta
                           (f2cl-lib:fref y-%data%
                                          (i)
                                          ((1 *))
                                          y-%offset%))))))))
       (t
        (setf iy ky)
        (cond
          ((= beta zero)
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i leny) nil)
             (tagbody
               (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                       zero)
               (setf iy (f2cl-lib:int-add iy incy)))))
          (t
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i leny) nil)
             (tagbody
               (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                       (* beta
                          (f2cl-lib:fref y-%data%
                                         (iy)
                                         ((1 *))
                                         y-%offset%)))
               (setf iy (f2cl-lib:int-add iy incy))))))))))
(if (= alpha zero) (go end_label))
(setf kup1 (f2cl-lib:int-add ku 1))
(cond
  ((char-equal trans #\N)
   (setf jx kx)
   (cond
     ((= incy 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   ((> j n) nil)
        (tagbody
          (cond
            ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
             (setf temp
                     (* alpha
                        (f2cl-lib:fref x-%data%
                                       (jx)
                                       ((1 *))
                                       x-%offset%)))
             (setf k (f2cl-lib:int-sub kup1 j))
             (f2cl-lib:fdo (i
                            (max (the fixnum 1)
```

```
                                    (the fixnum
                                         (f2cl-lib:int-add j
                                                           (f2cl-lib:int-sub
                                                            ku))))
                                (f2cl-lib:int-add i 1))
                               ((> i
                                   (min (the fixnum m)
                                        (the fixnum
                                             (f2cl-lib:int-add j kl))))
                                nil)
                    (tagbody
                      (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                            (+
                             (f2cl-lib:fref y-%data%
                                            (i)
                                            ((1 *))
                                            y-%offset%)
                             (* temp
                                (f2cl-lib:fref a-%data%
                                               ((f2cl-lib:int-add k i) j)
                                               ((1 lda) (1 *))
                                               a-%offset%))))))
                (setf jx (f2cl-lib:int-add jx incx)))))
           (t
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
              (tagbody
                (cond
                  ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
                   (setf temp
                           (* alpha
                              (f2cl-lib:fref x-%data%
                                             (jx)
                                             ((1 *))
                                             x-%offset%)))
                   (setf iy ky)
                   (setf k (f2cl-lib:int-sub kup1 j))
                   (f2cl-lib:fdo (i
                                  (max (the fixnum 1)
                                       (the fixnum
                                            (f2cl-lib:int-add j
                                                              (f2cl-lib:int-sub
                                                               ku))))
                                  (f2cl-lib:int-add i 1))
                                 ((> i
                                     (min (the fixnum m)
                                          (the fixnum
                                               (f2cl-lib:int-add j kl))))
                                  nil)
                     (tagbody
```

```
                    (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                            (+
                             (f2cl-lib:fref y-%data%
                                            (iy)
                                            ((1 *))
                                            y-%offset%)
                             (* temp
                                (f2cl-lib:fref a-%data%
                                               ((f2cl-lib:int-add k i) j)
                                               ((1 lda) (1 *))
                                               a-%offset%))))
                    (setf iy (f2cl-lib:int-add iy incy))))))
            (setf jx (f2cl-lib:int-add jx incx))
            (if (> j ku) (setf ky (f2cl-lib:int-add ky incy))))))))
    (t
     (setf jy ky)
     (cond
       ((= incx 1)
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                      ((> j n) nil)
          (tagbody
            (setf temp zero)
            (setf k (f2cl-lib:int-sub kup1 j))
            (cond
              (noconj
               (f2cl-lib:fdo (i
                              (max (the fixnum 1)
                                   (the fixnum
                                        (f2cl-lib:int-add j
                                                          (f2cl-lib:int-sub
                                                           ku))))
                              (f2cl-lib:int-add i 1))
                             ((> i
                                 (min (the fixnum m)
                                      (the fixnum
                                           (f2cl-lib:int-add j kl))))
                              nil)
                 (tagbody
                   (setf temp
                           (+ temp
                              (*
                               (f2cl-lib:fref a-%data%
                                              ((f2cl-lib:int-add k i) j)
                                              ((1 lda) (1 *))
                                              a-%offset%)
                               (f2cl-lib:fref x-%data%
                                              (i)
                                              ((1 *))
                                              x-%offset%)))))))
              (t
```

```
                (f2cl-lib:fdo (i
                               (max (the fixnum 1)
                                    (the fixnum
                                         (f2cl-lib:int-add j
                                                           (f2cl-lib:int-sub
                                                            ku))))
                               (f2cl-lib:int-add i 1))
                              ((> i
                                  (min (the fixnum m)
                                       (the fixnum
                                            (f2cl-lib:int-add j kl))))
                               nil)
                  (tagbody
                    (setf temp
                            (+ temp
                               (*
                                (f2cl-lib:dconjg
                                 (f2cl-lib:fref a-%data%
                                               ((f2cl-lib:int-add k i) j)
                                               ((1 lda) (1 *))
                                               a-%offset%))
                                (f2cl-lib:fref x-%data%
                                               (i)
                                               ((1 *))
                                               x-%offset%))))))))
             (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                   (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                      (* alpha temp)))
             (setf jy (f2cl-lib:int-add jy incy)))))
          (t
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (setf temp zero)
               (setf ix kx)
               (setf k (f2cl-lib:int-sub kup1 j))
               (cond
                 (noconj
                  (f2cl-lib:fdo (i
                                 (max (the fixnum 1)
                                      (the fixnum
                                           (f2cl-lib:int-add j
                                                             (f2cl-lib:int-sub
                                                              ku))))
                                 (f2cl-lib:int-add i 1))
                                ((> i
                                    (min (the fixnum m)
                                         (the fixnum
                                              (f2cl-lib:int-add j kl))))
                                 nil)
```

```
                    (tagbody
                      (setf temp
                              (+ temp
                                 (*
                                  (f2cl-lib:fref a-%data%
                                                 ((f2cl-lib:int-add k i) j)
                                                 ((1 lda) (1 *))
                                                 a-%offset%)
                                  (f2cl-lib:fref x-%data%
                                                 (ix)
                                                 ((1 *))
                                                 x-%offset%))))
                      (setf ix (f2cl-lib:int-add ix incx)))))
                  (t
                   (f2cl-lib:fdo (i
                                  (max (the fixnum 1)
                                       (the fixnum
                                            (f2cl-lib:int-add j
                                                              (f2cl-lib:int-sub
                                                               ku))))
                                  (f2cl-lib:int-add i 1))
                                 ((> i
                                     (min (the fixnum m)
                                          (the fixnum
                                               (f2cl-lib:int-add j kl))))
                                  nil)
                     (tagbody
                       (setf temp
                               (+ temp
                                  (*
                                   (f2cl-lib:dconjg
                                    (f2cl-lib:fref a-%data%
                                                   ((f2cl-lib:int-add k i) j)
                                                   ((1 lda) (1 *))
                                                   a-%offset%))
                                   (f2cl-lib:fref x-%data%
                                                  (ix)
                                                  ((1 *))
                                                  x-%offset%))))
                       (setf ix (f2cl-lib:int-add ix incx))))))
                 (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                         (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                            (* alpha temp)))
                 (setf jy (f2cl-lib:int-add jy incy))
                 (if (> j ku) (setf kx (f2cl-lib:int-add kx incx)))))))))
 end_label
        (return
         (values nil nil nil nil nil nil nil nil nil nil nil nil nil))))))
```

———-

4.18 zgemv BLAS

— **zgemv.input** —

```
)set break resume
)sys rm -f zgemv.output
)spool zgemv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zgemv.help** —

```
==========================================================================
zgemv examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      ZGEMV - perform one of the matrix-vector operations   y :=
      alpha*A*x + beta*y, or y := alpha*A'*x + beta*y, or   y :=
      alpha*conjg( A' )*x + beta*y,

 SYNOPSIS
      SUBROUTINE ZGEMV ( TRANS, M, N, ALPHA, A, LDA, X, INCX,
                         BETA, Y, INCY )

          COMPLEX*16   ALPHA, BETA

          INTEGER      INCX, INCY, LDA, M, N

          CHARACTER*1  TRANS

          COMPLEX*16   A( LDA, * ), X( * ), Y( * )

 PURPOSE
```

```
     ZGEMV  performs one of the matrix-vector operations

     where alpha and beta are scalars, x and y are vectors and A
     is an m by n matrix.

 PARAMETERS
     TRANS  - CHARACTER*1.
            On entry, TRANS specifies the operation to be per-
            formed as follows:

            TRANS = 'N' or 'n'   y := alpha*A*x + beta*y.

            TRANS = 'T' or 't'   y := alpha*A'*x + beta*y.

            TRANS = 'C' or 'c'   y := alpha*conjg( A' )*x +
            beta*y.

            Unchanged on exit.

     M      - INTEGER.
            On entry, M specifies the number of rows of the
            matrix A.  M must be at least zero.  Unchanged on
            exit.

     N      - INTEGER.
            On entry, N specifies the number of columns of the
            matrix A.  N must be at least zero.  Unchanged on
            exit.

     ALPHA  - COMPLEX*16      .
            On entry, ALPHA specifies the scalar alpha.
            Unchanged on exit.

     A      - COMPLEX*16       array of DIMENSION ( LDA, n ).
            Before entry, the leading m by n part of the array A
            must contain the matrix of coefficients.  Unchanged
            on exit.

     LDA    - INTEGER.
            On entry, LDA specifies the first dimension of A as
            declared in the calling (sub) program. LDA must be at
            least max( 1, m ).  Unchanged on exit.

     X      - COMPLEX*16       array of DIMENSION at least
            ( 1 + ( n - 1 )*abs( INCX ) ) when TRANS = 'N' or 'n'
            and at least ( 1 + ( m - 1 )*abs( INCX ) ) otherwise.
            Before entry, the incremented array X must contain
            the vector x.  Unchanged on exit.

     INCX   - INTEGER.
```

```
            On entry, INCX specifies the increment for the ele-
            ments of X. INCX must not be zero.  Unchanged on
            exit.

      BETA   - COMPLEX*16      .
            On entry, BETA specifies the scalar beta. When BETA
            is supplied as zero then Y need not be set on input.
            Unchanged on exit.

      Y      - COMPLEX*16       array of DIMENSION at least
            ( 1 + ( m - 1 )*abs( INCY ) ) when TRANS = 'N' or 'n'
            and at least ( 1 + ( n - 1 )*abs( INCY ) ) otherwise.
            Before entry with BETA non-zero, the incremented
            array Y must contain the vector y. On exit, Y is
            overwritten by the updated vector y.

      INCY   - INTEGER.
            On entry, INCY specifies the increment for the ele-
            ments of Y. INCY must not be zero.  Unchanged on
            exit.
```

———-

— zgemv.f —

```
      SUBROUTINE ZGEMV ( TRANS, M, N, ALPHA, A, LDA, X, INCX,
     $                   BETA, Y, INCY )
*     .. Scalar Arguments ..
      COMPLEX*16         ALPHA, BETA
      INTEGER            INCX, INCY, LDA, M, N
      CHARACTER*1        TRANS
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), X( * ), Y( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      COMPLEX*16         ONE
      PARAMETER        ( ONE  = ( 1.0D+0, 0.0D+0 ) )
      COMPLEX*16         ZERO
```

```
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     .. Local Scalars ..
      COMPLEX*16         TEMP
      INTEGER            I, INFO, IX, IY, J, JX, JY, KX, KY, LENX, LENY
      LOGICAL            NOCONJ
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG, MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( TRANS, 'N' ).AND.
     $         .NOT.LSAME( TRANS, 'T' ).AND.
     $         .NOT.LSAME( TRANS, 'C' )      )THEN
         INFO = 1
      ELSE IF( M.LT.0 )THEN
         INFO = 2
      ELSE IF( N.LT.0 )THEN
         INFO = 3
      ELSE IF( LDA.LT.MAX( 1, M ) )THEN
         INFO = 6
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 8
      ELSE IF( INCY.EQ.0 )THEN
         INFO = 11
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZGEMV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( M.EQ.0 ).OR.( N.EQ.0 ).OR.
     $    ( ( ALPHA.EQ.ZERO ).AND.( BETA.EQ.ONE ) ) )
     $   RETURN
*
      NOCONJ = LSAME( TRANS, 'T' )
*
*     Set  LENX  and  LENY, the lengths of the vectors x and y, and set
*     up the start points in  X  and  Y.
*
      IF( LSAME( TRANS, 'N' ) )THEN
```

```
         LENX = N
         LENY = M
      ELSE
         LENX = M
         LENY = N
      END IF
      IF( INCX.GT.0 )THEN
         KX = 1
      ELSE
         KX = 1 - ( LENX - 1 )*INCX
      END IF
      IF( INCY.GT.0 )THEN
         KY = 1
      ELSE
         KY = 1 - ( LENY - 1 )*INCY
      END IF
*
*     Start the operations. In this version the elements of A are
*     accessed sequentially with one pass through A.
*
*     First form  y := beta*y.
*
      IF( BETA.NE.ONE )THEN
         IF( INCY.EQ.1 )THEN
            IF( BETA.EQ.ZERO )THEN
               DO 10, I = 1, LENY
                  Y( I ) = ZERO
   10          CONTINUE
            ELSE
               DO 20, I = 1, LENY
                  Y( I ) = BETA*Y( I )
   20          CONTINUE
            END IF
         ELSE
            IY = KY
            IF( BETA.EQ.ZERO )THEN
               DO 30, I = 1, LENY
                  Y( IY ) = ZERO
                  IY      = IY   + INCY
   30          CONTINUE
            ELSE
               DO 40, I = 1, LENY
                  Y( IY ) = BETA*Y( IY )
                  IY      = IY           + INCY
   40          CONTINUE
            END IF
         END IF
      END IF
      IF( ALPHA.EQ.ZERO )
     $   RETURN
```

```
      IF( LSAME( TRANS, 'N' ) )THEN
*
*        Form  y := alpha*A*x + y.
*
         JX = KX
         IF( INCY.EQ.1 )THEN
            DO 60, J = 1, N
               IF( X( JX ).NE.ZERO )THEN
                  TEMP = ALPHA*X( JX )
                  DO 50, I = 1, M
                     Y( I ) = Y( I ) + TEMP*A( I, J )
   50             CONTINUE
               END IF
               JX = JX + INCX
   60       CONTINUE
         ELSE
            DO 80, J = 1, N
               IF( X( JX ).NE.ZERO )THEN
                  TEMP = ALPHA*X( JX )
                  IY   = KY
                  DO 70, I = 1, M
                     Y( IY ) = Y( IY ) + TEMP*A( I, J )
                     IY      = IY      + INCY
   70             CONTINUE
               END IF
               JX = JX + INCX
   80       CONTINUE
         END IF
      ELSE
*
*        Form  y := alpha*A'*x + y  or  y := alpha*conjg( A' )*x + y.
*
         JY = KY
         IF( INCX.EQ.1 )THEN
            DO 110, J = 1, N
               TEMP = ZERO
               IF( NOCONJ )THEN
                  DO 90, I = 1, M
                     TEMP = TEMP + A( I, J )*X( I )
   90             CONTINUE
               ELSE
                  DO 100, I = 1, M
                     TEMP = TEMP + DCONJG( A( I, J ) )*X( I )
  100             CONTINUE
               END IF
               Y( JY ) = Y( JY ) + ALPHA*TEMP
               JY      = JY      + INCY
  110       CONTINUE
         ELSE
            DO 140, J = 1, N
```

```
              TEMP = ZERO
              IX   = KX
              IF( NOCONJ )THEN
                 DO 120, I = 1, M
                    TEMP = TEMP + A( I, J )*X( IX )
                    IX   = IX   + INCX
  120            CONTINUE
              ELSE
                 DO 130, I = 1, M
                    TEMP = TEMP + DCONJG( A( I, J ) )*X( IX )
                    IX   = IX   + INCX
  130            CONTINUE
              END IF
              Y( JY ) = Y( JY ) + ALPHA*TEMP
              JY      = JY      + INCY
  140       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of ZGEMV .
*
      END
```

———-

— BLAS 2 zgemv —

```
(let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
 (declare (type (complex double-float) one) (type (complex double-float) zero))
  (defun zgemv (trans m n alpha a lda x incx beta y incy)
    (declare (type (simple-array (complex double-float) (*)) y x a)
             (type (complex double-float) beta alpha)
             (type fixnum incy incx lda n m)
             (type character trans))
    (f2cl-lib:with-multi-array-data
        ((trans character trans-%data% trans-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (x (complex double-float) x-%data% x-%offset%)
         (y (complex double-float) y-%data% y-%offset%))
      (prog ((noconj nil) (i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0)
             (kx 0) (ky 0) (lenx 0) (leny 0) (temp #C(0.0 0.0)))
        (declare (type (member t nil) noconj)
                 (type fixnum i info ix iy j jx jy kx ky lenx
                                          leny)
                 (type (complex double-float) temp))
        (setf info 0)
```

```
(cond
  ((and (not (char-equal trans #\N))
        (not (char-equal trans #\T))
        (not (char-equal trans #\C)))
   (setf info 1))
  ((< m 0)
   (setf info 2))
  ((< n 0)
   (setf info 3))
  ((< lda (max (the fixnum 1) (the fixnum m)))
   (setf info 6))
  ((= incx 0)
   (setf info 8))
  ((= incy 0)
   (setf info 11)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "ZGEMV" info)
   (go end_label)))
(if (or (= m 0) (= n 0) (and (= alpha zero) (= beta one)))
    (go end_label))
(setf noconj (char-equal trans #\T))
(cond
  ((char-equal trans #\N)
   (setf lenx n)
   (setf leny m))
  (t
   (setf lenx m)
   (setf leny n)))
(cond
  ((> incx 0)
   (setf kx 1))
  (t
   (setf kx
         (f2cl-lib:int-sub 1
                           (f2cl-lib:int-mul
                            (f2cl-lib:int-sub lenx 1)
                            incx)))))
(cond
  ((> incy 0)
   (setf ky 1))
  (t
   (setf ky
         (f2cl-lib:int-sub 1
                           (f2cl-lib:int-mul
                            (f2cl-lib:int-sub leny 1)
                            incy)))))
(cond
```

```
  ((/= beta one)
   (cond
     ((= incy 1)
      (cond
        ((= beta zero)
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i leny) nil)
           (tagbody
             (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                     zero))))
        (t
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i leny) nil)
           (tagbody
             (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                     (* beta
                        (f2cl-lib:fref y-%data%
                                       (i)
                                       ((1 *))
                                       y-%offset%)))))))))
     (t
      (setf iy ky)
      (cond
        ((= beta zero)
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i leny) nil)
           (tagbody
             (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                     zero)
             (setf iy (f2cl-lib:int-add iy incy)))))
        (t
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i leny) nil)
           (tagbody
             (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                     (* beta
                        (f2cl-lib:fref y-%data%
                                       (iy)
                                       ((1 *))
                                       y-%offset%)))
             (setf iy (f2cl-lib:int-add iy incy)))))))))
(if (= alpha zero) (go end_label))
(cond
  ((char-equal trans #\N)
   (setf jx kx)
   (cond
     ((= incy 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
```

```
      (cond
        ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
         (setf temp
                 (* alpha
                    (f2cl-lib:fref x-%data%
                                   (jx)
                                   ((1 *))
                                   x-%offset%)))
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i m) nil)
           (tagbody
             (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                     (+
                      (f2cl-lib:fref y-%data%
                                     (i)
                                     ((1 *))
                                     y-%offset%)
                      (* temp
                         (f2cl-lib:fref a-%data%
                                        (i j)
                                        ((1 lda) (1 *))
                                        a-%offset%))))))))
      (setf jx (f2cl-lib:int-add jx incx)))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (cond
       ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (setf temp
                (* alpha
                   (f2cl-lib:fref x-%data%
                                  (jx)
                                  ((1 *))
                                  x-%offset%)))
        (setf iy ky)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i m) nil)
          (tagbody
            (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                    (+
                     (f2cl-lib:fref y-%data%
                                    (iy)
                                    ((1 *))
                                    y-%offset%)
                     (* temp
                        (f2cl-lib:fref a-%data%
                                       (i j)
                                       ((1 lda) (1 *))
                                       a-%offset%))))
```

```
                (setf iy (f2cl-lib:int-add iy incy))))))
          (setf jx (f2cl-lib:int-add jx incx)))))))
(t
 (setf jy ky)
 (cond
   ((= incx 1)
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j n) nil)
      (tagbody
        (setf temp zero)
        (cond
          (noconj
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i m) nil)
             (tagbody
               (setf temp
                       (+ temp
                          (*
                           (f2cl-lib:fref a-%data%
                                          (i j)
                                          ((1 lda) (1 *))
                                          a-%offset%)
                           (f2cl-lib:fref x-%data%
                                          (i)
                                          ((1 *))
                                          x-%offset%)))))))
          (t
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i m) nil)
             (tagbody
               (setf temp
                       (+ temp
                          (*
                           (f2cl-lib:dconjg
                            (f2cl-lib:fref a-%data%
                                           (i j)
                                           ((1 lda) (1 *))
                                           a-%offset%))
                           (f2cl-lib:fref x-%data%
                                          (i)
                                          ((1 *))
                                          x-%offset%)))))))))
        (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                   (* alpha temp)))
        (setf jy (f2cl-lib:int-add jy incy)))))
   (t
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j n) nil)
      (tagbody
```

```
                (setf temp zero)
                (setf ix kx)
                (cond
                  (noconj
                   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                 ((> i m) nil)
                     (tagbody
                       (setf temp
                               (+ temp
                                  (*
                                   (f2cl-lib:fref a-%data%
                                                  (i j)
                                                  ((1 lda) (1 *))
                                                  a-%offset%)
                                   (f2cl-lib:fref x-%data%
                                                  (ix)
                                                  ((1 *))
                                                  x-%offset%))))
                       (setf ix (f2cl-lib:int-add ix incx)))))
                  (t
                   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                 ((> i m) nil)
                     (tagbody
                       (setf temp
                               (+ temp
                                  (*
                                   (f2cl-lib:dconjg
                                    (f2cl-lib:fref a-%data%
                                                   (i j)
                                                   ((1 lda) (1 *))
                                                   a-%offset%))
                                   (f2cl-lib:fref x-%data%
                                                  (ix)
                                                  ((1 *))
                                                  x-%offset%))))
                       (setf ix (f2cl-lib:int-add ix incx))))))
                (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                        (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                           (* alpha temp)))
                (setf jy (f2cl-lib:int-add jy incy))))))))
end_label
       (return (values nil nil nil nil nil nil nil nil nil nil nil))))))
```

4.19 zgerc BLAS

— zgerc.input —

```
)set break resume
)sys rm -f zgerc.output
)spool zgerc.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— zgerc.help —

```
==========================================================================
zgerc examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      ZGERC - perform the rank 1 operation   A := alpha*x*conjg(
      y' ) + A,

 SYNOPSIS
      SUBROUTINE ZGERC ( M, N, ALPHA, X, INCX, Y, INCY, A, LDA )

          COMPLEX*16   ALPHA

          INTEGER      INCX, INCY, LDA, M, N

          COMPLEX*16   A( LDA, * ), X( * ), Y( * )

 PURPOSE
      ZGERC  performs the rank 1 operation

      where alpha is a scalar, x is an m element vector, y is an n
      element vector and A is an m by n matrix.

 PARAMETERS
      M      - INTEGER.
               On entry, M specifies the number of rows of the
```

```
       matrix A.  M must be at least zero.  Unchanged on
       exit.

N      - INTEGER.
       On entry, N specifies the number of columns of the
       matrix A.  N must be at least zero.  Unchanged on
       exit.

ALPHA  - COMPLEX*16      .
       On entry, ALPHA specifies the scalar alpha.
       Unchanged on exit.

X      - COMPLEX*16       array of dimension at least
       ( 1 + ( m - 1 )*abs( INCX ) ).  Before entry, the
       incremented array X must contain the m element vector
       x.  Unchanged on exit.

INCX   - INTEGER.
       On entry, INCX specifies the increment for the ele-
       ments of X. INCX must not be zero.  Unchanged on
       exit.

Y      - COMPLEX*16       array of dimension at least
       ( 1 + ( n - 1 )*abs( INCY ) ).  Before entry, the
       incremented array Y must contain the n element vector
       y.  Unchanged on exit.

INCY   - INTEGER.
       On entry, INCY specifies the increment for the

       elements of Y. INCY must not be zero.  Unchanged on
       exit.

A      - COMPLEX*16       array of DIMENSION ( LDA, n ).
       Before entry, the leading m by n part of the array A
       must contain the matrix of coefficients. On exit, A
       is overwritten by the updated matrix.

LDA    - INTEGER.
       On entry, LDA specifies the first dimension of A as
       declared in the calling (sub) program. LDA must be at
       least max( 1, m ).  Unchanged on exit.
```

———-

— zgerc.f —

```
SUBROUTINE ZGERC ( M, N, ALPHA, X, INCX, Y, INCY, A, LDA )
```

```
*     .. Scalar Arguments ..
      COMPLEX*16         ALPHA
      INTEGER            INCX, INCY, LDA, M, N
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), X( * ), Y( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     .. Local Scalars ..
      COMPLEX*16         TEMP
      INTEGER            I, INFO, IX, J, JY, KX
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG, MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( M.LT.0 )THEN
         INFO = 1
      ELSE IF( N.LT.0 )THEN
         INFO = 2
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 5
      ELSE IF( INCY.EQ.0 )THEN
         INFO = 7
      ELSE IF( LDA.LT.MAX( 1, M ) )THEN
         INFO = 9
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZGERC ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
```

```
      IF( ( M.EQ.0 ).OR.( N.EQ.0 ).OR.( ALPHA.EQ.ZERO ) )
     $   RETURN
*
*     Start the operations. In this version the elements of A are
*     accessed sequentially with one pass through A.
*
      IF( INCY.GT.0 )THEN
         JY = 1
      ELSE
         JY = 1 - ( N - 1 )*INCY
      END IF
      IF( INCX.EQ.1 )THEN
         DO 20, J = 1, N
            IF( Y( JY ).NE.ZERO )THEN
               TEMP = ALPHA*DCONJG( Y( JY ) )
               DO 10, I = 1, M
                  A( I, J ) = A( I, J ) + X( I )*TEMP
   10          CONTINUE
            END IF
            JY = JY + INCY
   20    CONTINUE
      ELSE
         IF( INCX.GT.0 )THEN
            KX = 1
         ELSE
            KX = 1 - ( M - 1 )*INCX
         END IF
         DO 40, J = 1, N
            IF( Y( JY ).NE.ZERO )THEN
               TEMP = ALPHA*DCONJG( Y( JY ) )
               IX   = KX
               DO 30, I = 1, M
                  A( I, J ) = A( I, J ) + X( IX )*TEMP
                  IX        = IX        + INCX
   30          CONTINUE
            END IF
            JY = JY + INCY
   40    CONTINUE
      END IF
*
      RETURN
*
*     End of ZGERC .
*
      END
```

— BLAS 2 zgerc —

```
(let* ((zero (complex 0.0 0.0)))
  (declare (type (complex double-float) zero))
  (defun zgerc (m n alpha x incx y incy a lda)
    (declare (type (simple-array (complex double-float) (*)) a y x)
             (type (complex double-float) alpha)
             (type fixnum lda incy incx n m))
    (f2cl-lib:with-multi-array-data
        ((x (complex double-float) x-%data% x-%offset%)
         (y (complex double-float) y-%data% y-%offset%)
         (a (complex double-float) a-%data% a-%offset%))
      (prog ((i 0) (info 0) (ix 0) (j 0) (jy 0) (kx 0) (temp #C(0.0 0.0)))
        (declare (type fixnum i info ix j jy kx)
                 (type (complex double-float) temp))
        (setf info 0)
        (cond
          ((< m 0)
           (setf info 1))
          ((< n 0)
           (setf info 2))
          ((= incx 0)
           (setf info 5))
          ((= incy 0)
           (setf info 7))
          ((< lda (max (the fixnum 1) (the fixnum m)))
           (setf info 9)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "ZGERC" info)
           (go end_label)))
        (if (or (= m 0) (= n 0) (= alpha zero)) (go end_label))
        (cond
          ((> incy 0)
           (setf jy 1))
          (t
           (setf jy
                   (f2cl-lib:int-sub 1
                                     (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                       incy)))))
        (cond
          ((= incx 1)
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (cond
                 ((/= (f2cl-lib:fref y (jy) ((1 *))) zero)
                  (setf temp
```

```
                  (* alpha
                     (f2cl-lib:dconjg
                      (f2cl-lib:fref y-%data%
                                     (jy)
                                     ((1 *))
                                     y-%offset%))))
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref a-%data%
                                   (i j)
                                   ((1 lda) (1 *))
                                   a-%offset%)
                    (+
                     (f2cl-lib:fref a-%data%
                                    (i j)
                                    ((1 lda) (1 *))
                                    a-%offset%)
                     (*
                      (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%)
                      temp)))))))
      (setf jy (f2cl-lib:int-add jy incy)))))
(t
 (cond
   ((> incx 0)
    (setf kx 1))
   (t
    (setf kx
            (f2cl-lib:int-sub 1
                              (f2cl-lib:int-mul
                               (f2cl-lib:int-sub m 1)
                               incx)))))
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (cond
       ((/= (f2cl-lib:fref y (jy) ((1 *))) zero)
        (setf temp
                (* alpha
                   (f2cl-lib:dconjg
                    (f2cl-lib:fref y-%data%
                                   (jy)
                                   ((1 *))
                                   y-%offset%))))
        (setf ix kx)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i m) nil)
          (tagbody
            (setf (f2cl-lib:fref a-%data%
                                 (i j)
```

```
                                        ((1 lda) (1 *))
                                        a-%offset%)
                                (+
                                 (f2cl-lib:fref a-%data%
                                                (i j)
                                                ((1 lda) (1 *))
                                                a-%offset%)
                                 (*
                                  (f2cl-lib:fref x-%data%
                                                 (ix)
                                                 ((1 *))
                                                 x-%offset%)
                                  temp)))
                          (setf ix (f2cl-lib:int-add ix incx))))))
                  (setf jy (f2cl-lib:int-add jy incy))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil))))))
```

———-

4.20 zgeru BLAS

— **zgeru.input** —

```
)set break resume
)sys rm -f zgeru.output
)spool zgeru.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zgeru.help** —

```
===========================================================================
zgeru examples
===========================================================================

===========================================================================
Man Page Details
===========================================================================
```

```
NAME
     ZGERU - perform the rank 1 operation   A := alpha*x*y' + A,

SYNOPSIS
     SUBROUTINE ZGERU ( M, N, ALPHA, X, INCX, Y, INCY, A, LDA )

         COMPLEX*16   ALPHA

         INTEGER      INCX, INCY, LDA, M, N

         COMPLEX*16   A( LDA, * ), X( * ), Y( * )

PURPOSE
     ZGERU  performs the rank 1 operation

     where alpha is a scalar, x is an m element vector, y is an n
     element vector and A is an m by n matrix.

PARAMETERS
     M      - INTEGER.
              On entry, M specifies the number of rows of the
              matrix A.  M must be at least zero.  Unchanged on
              exit.

     N      - INTEGER.
              On entry, N specifies the number of columns of the
              matrix A.  N must be at least zero.  Unchanged on
              exit.

     ALPHA  - COMPLEX*16      .
              On entry, ALPHA specifies the scalar alpha.
              Unchanged on exit.

     X      - COMPLEX*16       array of dimension at least
              ( 1 + ( m - 1 )*abs( INCX ) ).  Before entry, the
              incremented array X must contain the m element vector
              x.  Unchanged on exit.

     INCX   - INTEGER.
              On entry, INCX specifies the increment for the ele-
              ments of X. INCX must not be zero.  Unchanged on
              exit.

     Y      - COMPLEX*16       array of dimension at least
              ( 1 + ( n - 1 )*abs( INCY ) ).  Before entry, the
              incremented array Y must contain the n element vector
              y.  Unchanged on exit.

     INCY   - INTEGER.
```

```
            On entry, INCY specifies the increment for the ele-
            ments of Y. INCY must not be zero.  Unchanged on

            exit.

      A     - COMPLEX*16       array of DIMENSION ( LDA, n ).
            Before entry, the leading m by n part of the array A
            must contain the matrix of coefficients. On exit, A
            is overwritten by the updated matrix.

      LDA   - INTEGER.
            On entry, LDA specifies the first dimension of A as
            declared in the calling (sub) program. LDA must be at
            least max( 1, m ).  Unchanged on exit.
```

— zgeru.f —

```
      SUBROUTINE ZGERU ( M, N, ALPHA, X, INCX, Y, INCY, A, LDA )
*     .. Scalar Arguments ..
      COMPLEX*16         ALPHA
      INTEGER            INCX, INCY, LDA, M, N
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), X( * ), Y( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     .. Local Scalars ..
      COMPLEX*16         TEMP
      INTEGER            I, INFO, IX, J, JY, KX
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     ..
*     .. Executable Statements ..
```

```
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( M.LT.0 )THEN
         INFO = 1
      ELSE IF( N.LT.0 )THEN
         INFO = 2
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 5
      ELSE IF( INCY.EQ.0 )THEN
         INFO = 7
      ELSE IF( LDA.LT.MAX( 1, M ) )THEN
         INFO = 9
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZGERU ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( M.EQ.0 ).OR.( N.EQ.0 ).OR.( ALPHA.EQ.ZERO ) )
     $   RETURN
*
*     Start the operations. In this version the elements of A are
*     accessed sequentially with one pass through A.
*
      IF( INCY.GT.0 )THEN
         JY = 1
      ELSE
         JY = 1 - ( N - 1 )*INCY
      END IF
      IF( INCX.EQ.1 )THEN
         DO 20, J = 1, N
            IF( Y( JY ).NE.ZERO )THEN
               TEMP = ALPHA*Y( JY )
               DO 10, I = 1, M
                  A( I, J ) = A( I, J ) + X( I )*TEMP
   10          CONTINUE
            END IF
            JY = JY + INCY
   20    CONTINUE
      ELSE
         IF( INCX.GT.0 )THEN
            KX = 1
         ELSE
            KX = 1 - ( M - 1 )*INCX
         END IF
         DO 40, J = 1, N
```

```
            IF( Y( JY ).NE.ZERO )THEN
               TEMP = ALPHA*Y( JY )
               IX   = KX
               DO 30, I = 1, M
                  A( I, J ) = A( I, J ) + X( IX )*TEMP
                  IX        = IX        + INCX
   30          CONTINUE
            END IF
            JY = JY + INCY
   40    CONTINUE
      END IF
*
      RETURN
*
*     End of ZGERU .
*
      END
```

— BLAS 2 zgeru —

```
(let* ((zero (complex 0.0 0.0)))
  (declare (type (complex double-float) zero))
  (defun zgeru (m n alpha x incx y incy a lda)
    (declare (type (simple-array (complex double-float) (*)) a y x)
             (type (complex double-float) alpha)
             (type fixnum lda incy incx n m))
    (f2cl-lib:with-multi-array-data
        ((x (complex double-float) x-%data% x-%offset%)
         (y (complex double-float) y-%data% y-%offset%)
         (a (complex double-float) a-%data% a-%offset%))
      (prog ((i 0) (info 0) (ix 0) (j 0) (jy 0) (kx 0) (temp #C(0.0 0.0)))
        (declare (type fixnum i info ix j jy kx)
                 (type (complex double-float) temp))
        (setf info 0)
        (cond
          ((< m 0)
           (setf info 1))
          ((< n 0)
           (setf info 2))
          ((= incx 0)
           (setf info 5))
          ((= incy 0)
           (setf info 7))
          ((< lda (max (the fixnum 1) (the fixnum m)))
           (setf info 9)))
        (cond
```

```
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "ZGERU" info)
   (go end_label)))
(if (or (= m 0) (= n 0) (= alpha zero)) (go end_label))
(cond
  ((> incy 0)
   (setf jy 1))
  (t
   (setf jy
         (f2cl-lib:int-sub 1
                           (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                             incy)))))
(cond
  ((= incx 1)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
     (tagbody
       (cond
         ((/= (f2cl-lib:fref y (jy) ((1 *))) zero)
          (setf temp
                  (* alpha
                     (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)))
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref a-%data%
                                   (i j)
                                   ((1 lda) (1 *))
                                   a-%offset%)
                    (+
                     (f2cl-lib:fref a-%data%
                                    (i j)
                                    ((1 lda) (1 *))
                                    a-%offset%)
                     (*
                      (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%)
                      temp)))))))
       (setf jy (f2cl-lib:int-add jy incy)))))
  (t
   (cond
     ((> incx 0)
      (setf kx 1))
     (t
      (setf kx
            (f2cl-lib:int-sub 1
                              (f2cl-lib:int-mul
                               (f2cl-lib:int-sub m 1)
                               incx)))))
```

```
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                        ((> j n) nil)
            (tagbody
              (cond
                ((/= (f2cl-lib:fref y (jy) ((1 *))) zero)
                 (setf temp
                         (* alpha
                            (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)))
                 (setf ix kx)
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                               ((> i m) nil)
                   (tagbody
                     (setf (f2cl-lib:fref a-%data%
                                          (i j)
                                          ((1 lda) (1 *))
                                          a-%offset%)
                             (+
                              (f2cl-lib:fref a-%data%
                                             (i j)
                                             ((1 lda) (1 *))
                                             a-%offset%)
                              (*
                               (f2cl-lib:fref x-%data%
                                              (ix)
                                              ((1 *))
                                              x-%offset%)
                               temp)))
                     (setf ix (f2cl-lib:int-add ix incx))))))
                (setf jy (f2cl-lib:int-add jy incy))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil))))))
```

———-

4.21 zhbmv BLAS

— **zhbmv.input** —

```
)set break resume
)sys rm -f zhbmv.output
)spool zhbmv.output
)set message test on
)set message auto off
)clear all

)spool
```

```
)lisp (bye)
```

———-

— zhbmv.help —

```
==========================================================================
zhbmv examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      ZHBMV - perform the matrix-vector operation   y := alpha*A*x
      + beta*y,

 SYNOPSIS
      SUBROUTINE ZHBMV ( UPLO, N, K, ALPHA, A, LDA, X, INCX, BETA,
                         Y, INCY )

          COMPLEX*16   ALPHA, BETA

          INTEGER      INCX, INCY, K, LDA, N

          CHARACTER*1  UPLO

          COMPLEX*16   A( LDA, * ), X( * ), Y( * )

 PURPOSE
      ZHBMV  performs the matrix-vector  operation

      where alpha and beta are scalars, x and y are n element vec-
      tors and A is an n by n hermitian band matrix, with k
      super-diagonals.

 PARAMETERS
      UPLO   - CHARACTER*1.
               On entry, UPLO specifies whether the upper or lower
               triangular part of the band matrix A is being sup-
               plied as follows:

               UPLO = 'U' or 'u'   The upper triangular part of A is
               being supplied.

               UPLO = 'L' or 'l'   The lower triangular part of A is
               being supplied.
```

```
        Unchanged on exit.

N       - INTEGER.
        On entry, N specifies the order of the matrix A.  N
        must be at least zero.  Unchanged on exit.

K       - INTEGER.
        On entry, K specifies the number of super-diagonals
        of the matrix A. K must satisfy  0 .le. K.  Unchanged
        on exit.

ALPHA   - COMPLEX*16      .
        On entry, ALPHA specifies the scalar alpha.
        Unchanged on exit.

A       - COMPLEX*16       array of DIMENSION ( LDA, n ).

        Before entry with UPLO = 'U' or 'u', the leading ( k
        + 1 ) by n part of the array A must contain the upper
        triangular band part of the hermitian matrix, sup-
        plied column by column, with the leading diagonal of
        the matrix in row ( k + 1 ) of the array, the first
        super-diagonal starting at position 2 in row k, and
        so on. The top left k by k triangle of the array A is
        not referenced.  The following program segment will
        transfer the upper triangular part of a hermitian
        band matrix from conventional full matrix storage to
        band storage:

        DO 20, J = 1, N M = K + 1 - J DO 10, I = MAX( 1, J -
        K ), J A( M + I, J ) = matrix( I, J ) 10    CONTINUE
        20 CONTINUE

        Before entry with UPLO = 'L' or 'l', the leading ( k
        + 1 ) by n part of the array A must contain the lower
        triangular band part of the hermitian matrix, sup-
        plied column by column, with the leading diagonal of
        the matrix in row 1 of the array, the first sub-
        diagonal starting at position 1 in row 2, and so on.
        The bottom right k by k triangle of the array A is
        not referenced.  The following program segment will
        transfer the lower triangular part of a hermitian
        band matrix from conventional full matrix storage to
        band storage:

        DO 20, J = 1, N M = 1 - J DO 10, I = J, MIN( N, J + K
        ) A( M + I, J ) = matrix( I, J ) 10    CONTINUE 20
        CONTINUE

        Note that the imaginary parts of the diagonal ele-
```

```
           ments need not be set and are assumed to be zero.
           Unchanged on exit.

     LDA   - INTEGER.
           On entry, LDA specifies the first dimension of A as
           declared in the calling (sub) program. LDA must be at
           least ( k + 1 ).  Unchanged on exit.

     X     - COMPLEX*16       array of DIMENSION at least
           ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
           incremented array X must contain the vector x.
           Unchanged on exit.

     INCX  - INTEGER.
           On entry, INCX specifies the increment for the ele-
           ments of X. INCX must not be zero.  Unchanged on
           exit.

     BETA  - COMPLEX*16      .

           On entry, BETA specifies the scalar beta.  Unchanged
           on exit.

     Y     - COMPLEX*16       array of DIMENSION at least
           ( 1 + ( n - 1 )*abs( INCY ) ).  Before entry, the
           incremented array Y must contain the vector y. On
           exit, Y is overwritten by the updated vector y.

     INCY  - INTEGER.
           On entry, INCY specifies the increment for the ele-
           ments of Y. INCY must not be zero.  Unchanged on
           exit.
```

———-

— zhbmv.f —

```
     SUBROUTINE ZHBMV ( UPLO, N, K, ALPHA, A, LDA, X, INCX,
    $                   BETA, Y, INCY )
*     .. Scalar Arguments ..
      COMPLEX*16         ALPHA, BETA
      INTEGER            INCX, INCY, K, LDA, N
      CHARACTER*1        UPLO
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), X( * ), Y( * )
*     ..
*
*  Level 2 Blas routine.
```

```
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      COMPLEX*16         ONE
      PARAMETER        ( ONE  = ( 1.0D+0, 0.0D+0 ) )
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     .. Local Scalars ..
      COMPLEX*16         TEMP1, TEMP2
      INTEGER            I, INFO, IX, IY, J, JX, JY, KPLUS1, KX, KY, L
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG, MAX, MIN, DBLE
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO, 'U' ).AND.
     $         .NOT.LSAME( UPLO, 'L' )      )THEN
         INFO = 1
      ELSE IF( N.LT.0 )THEN
         INFO = 2
      ELSE IF( K.LT.0 )THEN
         INFO = 3
      ELSE IF( LDA.LT.( K + 1 ) )THEN
         INFO = 6
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 8
      ELSE IF( INCY.EQ.0 )THEN
         INFO = 11
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZHBMV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
```

```
      IF( ( N.EQ.0 ).OR.( ( ALPHA.EQ.ZERO ).AND.( BETA.EQ.ONE ) ) )
     $   RETURN
*
*     Set up the start points in  X  and  Y.
*
      IF( INCX.GT.0 )THEN
         KX = 1
      ELSE
         KX = 1 - ( N - 1 )*INCX
      END IF
      IF( INCY.GT.0 )THEN
         KY = 1
      ELSE
         KY = 1 - ( N - 1 )*INCY
      END IF
*
*     Start the operations. In this version the elements of the array A
*     are accessed sequentially with one pass through A.
*
*     First form  y := beta*y.
*
      IF( BETA.NE.ONE )THEN
         IF( INCY.EQ.1 )THEN
            IF( BETA.EQ.ZERO )THEN
               DO 10, I = 1, N
                  Y( I ) = ZERO
   10          CONTINUE
            ELSE
               DO 20, I = 1, N
                  Y( I ) = BETA*Y( I )
   20          CONTINUE
            END IF
         ELSE
            IY = KY
            IF( BETA.EQ.ZERO )THEN
               DO 30, I = 1, N
                  Y( IY ) = ZERO
                  IY      = IY   + INCY
   30          CONTINUE
            ELSE
               DO 40, I = 1, N
                  Y( IY ) = BETA*Y( IY )
                  IY      = IY           + INCY
   40          CONTINUE
            END IF
         END IF
      END IF
      IF( ALPHA.EQ.ZERO )
     $   RETURN
      IF( LSAME( UPLO, 'U' ) )THEN
```

```
*
*        Form  y  when upper triangle of A is stored.
*
         KPLUS1 = K + 1
         IF( ( INCX.EQ.1 ).AND.( INCY.EQ.1 ) )THEN
            DO 60, J = 1, N
               TEMP1 = ALPHA*X( J )
               TEMP2 = ZERO
               L     = KPLUS1 - J
               DO 50, I = MAX( 1, J - K ), J - 1
                  Y( I ) = Y( I ) + TEMP1*A( L + I, J )
                  TEMP2  = TEMP2  + DCONJG( A( L + I, J ) )*X( I )
   50          CONTINUE
               Y( J ) = Y( J ) + TEMP1*DBLE( A( KPLUS1, J ) )
     $                         + ALPHA*TEMP2
   60       CONTINUE
         ELSE
            JX = KX
            JY = KY
            DO 80, J = 1, N
               TEMP1 = ALPHA*X( JX )
               TEMP2 = ZERO
               IX    = KX
               IY    = KY
               L     = KPLUS1 - J
               DO 70, I = MAX( 1, J - K ), J - 1
                  Y( IY ) = Y( IY ) + TEMP1*A( L + I, J )
                  TEMP2   = TEMP2   + DCONJG( A( L + I, J ) )*X( IX )
                  IX      = IX      + INCX
                  IY      = IY      + INCY
   70          CONTINUE
               Y( JY ) = Y( JY ) + TEMP1*DBLE( A( KPLUS1, J ) )
     $                           + ALPHA*TEMP2
               JX      = JX      + INCX
               JY      = JY      + INCY
               IF( J.GT.K )THEN
                  KX = KX + INCX
                  KY = KY + INCY
               END IF
   80       CONTINUE
         END IF
      ELSE
*
*        Form  y  when lower triangle of A is stored.
*
         IF( ( INCX.EQ.1 ).AND.( INCY.EQ.1 ) )THEN
            DO 100, J = 1, N
               TEMP1  = ALPHA*X( J )
               TEMP2  = ZERO
               Y( J ) = Y( J ) + TEMP1*DBLE( A( 1, J ) )
```

```
              L      = 1      - J
              DO 90, I = J + 1, MIN( N, J + K )
                 Y( I ) = Y( I ) + TEMP1*A( L + I, J )
                 TEMP2  = TEMP2  + DCONJG( A( L + I, J ) )*X( I )
   90         CONTINUE
              Y( J ) = Y( J ) + ALPHA*TEMP2
  100       CONTINUE
         ELSE
            JX = KX
            JY = KY
            DO 120, J = 1, N
               TEMP1   = ALPHA*X( JX )
               TEMP2   = ZERO
               Y( JY ) = Y( JY ) + TEMP1*DBLE( A( 1, J ) )
               L       = 1       - J
               IX      = JX
               IY      = JY
               DO 110, I = J + 1, MIN( N, J + K )
                  IX      = IX      + INCX
                  IY      = IY      + INCY
                  Y( IY ) = Y( IY ) + TEMP1*A( L + I, J )
                  TEMP2   = TEMP2   + DCONJG( A( L + I, J ) )*X( IX )
  110          CONTINUE
               Y( JY ) = Y( JY ) + ALPHA*TEMP2
               JX      = JX      + INCX
               JY      = JY      + INCY
  120       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of ZHBMV .
*
      END
```

———-

— BLAS 2 zhbmv —

```
(let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
 (declare (type (complex double-float) one) (type (complex double-float) zero))
  (defun zhbmv (uplo n k alpha a lda x incx beta y incy)
    (declare (type (simple-array (complex double-float) (*)) y x a)
             (type (complex double-float) beta alpha)
             (type fixnum incy incx lda k n)
             (type character uplo))
    (f2cl-lib:with-multi-array-data
```

```
  ((uplo character uplo-%data% uplo-%offset%)
   (a (complex double-float) a-%data% a-%offset%)
   (x (complex double-float) x-%data% x-%offset%)
   (y (complex double-float) y-%data% y-%offset%))
(prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (kplus1 0) (kx 0)
       (ky 0) (l 0) (temp1 #C(0.0 0.0)) (temp2 #C(0.0 0.0)))
  (declare (type fixnum i info ix iy j jx jy kplus1 kx ky l)
           (type (complex double-float) temp1 temp2))
  (setf info 0)
  (cond
    ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
     (setf info 1))
    ((< n 0)
     (setf info 2))
    ((< k 0)
     (setf info 3))
    ((< lda (f2cl-lib:int-add k 1))
     (setf info 6))
    ((= incx 0)
     (setf info 8))
    ((= incy 0)
     (setf info 11)))
  (cond
    ((/= info 0)
     (error
      " ** On entry to ~a parameter number ~a had an illegal value~%"
      "ZHBMV" info)
     (go end_label)))
  (if (or (= n 0) (and (= alpha zero) (= beta one))) (go end_label))
  (cond
    ((> incx 0)
     (setf kx 1))
    (t
     (setf kx
             (f2cl-lib:int-sub 1
                               (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                 incx)))))
  (cond
    ((> incy 0)
     (setf ky 1))
    (t
     (setf ky
             (f2cl-lib:int-sub 1
                               (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                 incy)))))
  (cond
    ((/= beta one)
     (cond
       ((= incy 1)
        (cond
```

```
          ((= beta zero)
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i n) nil)
             (tagbody
               (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                       zero))))
          (t
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i n) nil)
             (tagbody
               (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                       (* beta
                          (f2cl-lib:fref y-%data%
                                         (i)
                                         ((1 *))
                                         y-%offset%))))))))
      (t
       (setf iy ky)
       (cond
         ((= beta zero)
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                      zero)
              (setf iy (f2cl-lib:int-add iy incy)))))
         (t
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                      (* beta
                         (f2cl-lib:fref y-%data%
                                        (iy)
                                        ((1 *))
                                        y-%offset%)))
              (setf iy (f2cl-lib:int-add iy incy)))))))))
(if (= alpha zero) (go end_label))
(cond
  ((char-equal uplo #\U)
   (setf kplus1 (f2cl-lib:int-add k 1))
   (cond
     ((and (= incx 1) (= incy 1))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (setf temp1
                  (* alpha
                     (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
          (setf temp2 zero)
```

```
      (setf l (f2cl-lib:int-sub kplus1 j))
      (f2cl-lib:fdo (i
                     (max (the fixnum 1)
                          (the fixnum
                               (f2cl-lib:int-add j
                                                 (f2cl-lib:int-sub
                                                  k))))
                     (f2cl-lib:int-add i 1))
                    ((> i
                        (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                     nil)
        (tagbody
          (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                  (+
                   (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                   (* temp1
                      (f2cl-lib:fref a-%data%
                                     ((f2cl-lib:int-add l i) j)
                                     ((1 lda) (1 *))
                                     a-%offset%))))
          (setf temp2
                  (+ temp2
                     (*
                      (f2cl-lib:dconjg
                       (f2cl-lib:fref a-%data%
                                      ((f2cl-lib:int-add l i) j)
                                      ((1 lda) (1 *))
                                      a-%offset%))
                      (f2cl-lib:fref x-%data%
                                     (i)
                                     ((1 *))
                                     x-%offset%))))))
      (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
              (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                 (* temp1
                    (coerce (realpart
                             (f2cl-lib:fref a-%data%
                                            (kplus1 j)
                                            ((1 lda) (1 *))
                                            a-%offset%)) 'double-float))
                 (* alpha temp2))))))
(t
 (setf jx kx)
 (setf jy ky)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (setf temp1
             (* alpha
                (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
```

```
(setf temp2 zero)
(setf ix kx)
(setf iy ky)
(setf l (f2cl-lib:int-sub kplus1 j))
(f2cl-lib:fdo (i
               (max (the fixnum 1)
                    (the fixnum
                         (f2cl-lib:int-add j
                                           (f2cl-lib:int-sub
                                            k))))
               (f2cl-lib:int-add i 1))
              ((> i
                  (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
               nil)
  (tagbody
    (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
            (+
             (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
             (* temp1
                (f2cl-lib:fref a-%data%
                               ((f2cl-lib:int-add l i) j)
                               ((1 lda) (1 *))
                               a-%offset%))))
    (setf temp2
            (+ temp2
               (*
                (f2cl-lib:dconjg
                 (f2cl-lib:fref a-%data%
                                ((f2cl-lib:int-add l i) j)
                                ((1 lda) (1 *))
                                a-%offset%))
                (f2cl-lib:fref x-%data%
                               (ix)
                               ((1 *))
                               x-%offset%))))
    (setf ix (f2cl-lib:int-add ix incx))
    (setf iy (f2cl-lib:int-add iy incy))))
(setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
        (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
           (* temp1
              (coerce (realpart
               (f2cl-lib:fref a-%data%
                              (kplus1 j)
                              ((1 lda) (1 *))
                              a-%offset%)) 'double-float))
           (* alpha temp2)))
(setf jx (f2cl-lib:int-add jx incx))
(setf jy (f2cl-lib:int-add jy incy))
(cond
  ((> j k)
```

```
          (setf kx (f2cl-lib:int-add kx incx))
          (setf ky (f2cl-lib:int-add ky incy)))))))))
     (t
      (cond
        ((and (= incx 1) (= incy 1))
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (setf temp1
                     (* alpha
                        (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
             (setf temp2 zero)
             (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                     (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                        (* temp1
                           (coerce (realpart
                            (f2cl-lib:fref a-%data%
                                           (1 j)
                                           ((1 lda) (1 *))
                                           a-%offset%)) 'double-float))))
             (setf l (f2cl-lib:int-sub 1 j))
             (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                              (f2cl-lib:int-add i 1))
                           ((> i
                               (min (the fixnum n)
                                    (the fixnum
                                         (f2cl-lib:int-add j k))))
                            nil)
               (tagbody
                 (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                         (+
                          (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                          (* temp1
                             (f2cl-lib:fref a-%data%
                                            ((f2cl-lib:int-add l i) j)
                                            ((1 lda) (1 *))
                                            a-%offset%))))
                 (setf temp2
                         (+ temp2
                            (*
                             (f2cl-lib:dconjg
                              (f2cl-lib:fref a-%data%
                                             ((f2cl-lib:int-add l i) j)
                                             ((1 lda) (1 *))
                                             a-%offset%))
                             (f2cl-lib:fref x-%data%
                                            (i)
                                            ((1 *))
                                            x-%offset%))))))
             (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
```

```
              (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                 (* alpha temp2))))))
        (t
         (setf jx kx)
         (setf jy ky)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (setf temp1
                     (* alpha
                        (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
             (setf temp2 zero)
             (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                     (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                        (* temp1
                           (coerce (realpart
                            (f2cl-lib:fref a-%data%
                                           (1 j)
                                           ((1 lda) (1 *))
                                           a-%offset%)) 'double-float))))
             (setf l (f2cl-lib:int-sub 1 j))
             (setf ix jx)
             (setf iy jy)
             (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                              (f2cl-lib:int-add i 1))
                           ((> i
                               (min (the fixnum n)
                                    (the fixnum
                                         (f2cl-lib:int-add j k))))
                            nil)
               (tagbody
                 (setf ix (f2cl-lib:int-add ix incx))
                 (setf iy (f2cl-lib:int-add iy incy))
                 (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                         (+
                          (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                          (* temp1
                             (f2cl-lib:fref a-%data%
                                            ((f2cl-lib:int-add l i) j)
                                            ((1 lda) (1 *))
                                            a-%offset%))))
                 (setf temp2
                         (+ temp2
                            (*
                             (f2cl-lib:dconjg
                              (f2cl-lib:fref a-%data%
                                             ((f2cl-lib:int-add l i) j)
                                             ((1 lda) (1 *))
                                             a-%offset%))
                             (f2cl-lib:fref x-%data%
```

```
                                                (ix)
                                                ((1 *))
                                                x-%offset%))))))
                    (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                            (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                               (* alpha temp2)))
                    (setf jx (f2cl-lib:int-add jx incx))
                    (setf jy (f2cl-lib:int-add jy incy))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil nil nil))))))
```

———-

4.22 zhemv BLAS

— **zhemv.input** —

```
)set break resume
)sys rm -f zhemv.output
)spool zhemv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zhemv.help** —

```
=======================================================================
zhemv examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

 NAME
      ZHEMV - perform the matrix-vector operation   y := alpha*A*x
      + beta*y,

 SYNOPSIS
      SUBROUTINE ZHEMV ( UPLO, N, ALPHA, A, LDA, X, INCX, BETA, Y,
```

```
                    INCY )

          COMPLEX*16   ALPHA, BETA

          INTEGER      INCX, INCY, LDA, N

          CHARACTER*1  UPLO

          COMPLEX*16   A( LDA, * ), X( * ), Y( * )

PURPOSE
     ZHEMV  performs the matrix-vector  operation

     where alpha and beta are scalars, x and y are n element vec-
     tors and A is an n by n hermitian matrix.

PARAMETERS
     UPLO   - CHARACTER*1.
            On entry, UPLO specifies whether the upper or lower
            triangular part of the array A is to be referenced as
            follows:

            UPLO = 'U' or 'u'   Only the upper triangular part of
            A is to be referenced.

            UPLO = 'L' or 'l'   Only the lower triangular part of
            A is to be referenced.

            Unchanged on exit.

     N      - INTEGER.
            On entry, N specifies the order of the matrix A.  N
            must be at least zero.  Unchanged on exit.

     ALPHA  - COMPLEX*16      .
            On entry, ALPHA specifies the scalar alpha.
            Unchanged on exit.

     A      - COMPLEX*16       array of DIMENSION ( LDA, n ).
            Before entry with  UPLO = 'U' or 'u', the leading n
            by n upper triangular part of the array A must con-
            tain the upper triangular part of the hermitian
            matrix and the strictly lower triangular part of A is
            not referenced.  Before entry with UPLO = 'L' or 'l',
            the leading n by n lower triangular part of the array

            A must contain the lower triangular part of the her-
            mitian matrix and the strictly upper triangular part
            of A is not referenced.  Note that the imaginary
            parts of the diagonal elements need not be set and
```

```
*           are assumed to be zero.  Unchanged on exit.
*
*     LDA    - INTEGER.
*           On entry, LDA specifies the first dimension of A as
*           declared in the calling (sub) program. LDA must be at
*           least max( 1, n ).  Unchanged on exit.
*
*     X      - COMPLEX*16       array of dimension at least
*           ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
*           incremented array X must contain the n element vector
*           x.  Unchanged on exit.
*
*     INCX   - INTEGER.
*           On entry, INCX specifies the increment for the ele-
*           ments of X. INCX must not be zero.  Unchanged on
*           exit.
*
*     BETA   - COMPLEX*16      .
*           On entry, BETA specifies the scalar beta. When BETA
*           is supplied as zero then Y need not be set on input.
*           Unchanged on exit.
*
*     Y      - COMPLEX*16       array of dimension at least
*           ( 1 + ( n - 1 )*abs( INCY ) ).  Before entry, the
*           incremented array Y must contain the n element vector
*           y. On exit, Y is overwritten by the updated vector y.
*
*     INCY   - INTEGER.
*           On entry, INCY specifies the increment for the ele-
*           ments of Y. INCY must not be zero.  Unchanged on
*           exit.
*
*
*           ---------
```

— zhemv.f —

```
      SUBROUTINE ZHEMV ( UPLO, N, ALPHA, A, LDA, X, INCX,
     $                   BETA, Y, INCY )
*     .. Scalar Arguments ..
      COMPLEX*16         ALPHA, BETA
      INTEGER            INCX, INCY, LDA, N
      CHARACTER*1        UPLO
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), X( * ), Y( * )
*     ..
*
*  Level 2 Blas routine.
*
```

```
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      COMPLEX*16         ONE
      PARAMETER        ( ONE  = ( 1.0D+0, 0.0D+0 ) )
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     .. Local Scalars ..
      COMPLEX*16         TEMP1, TEMP2
      INTEGER            I, INFO, IX, IY, J, JX, JY, KX, KY
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG, MAX, DBLE
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO, 'U' ).AND.
     $         .NOT.LSAME( UPLO, 'L' )      )THEN
         INFO = 1
      ELSE IF( N.LT.0 )THEN
         INFO = 2
      ELSE IF( LDA.LT.MAX( 1, N ) )THEN
         INFO = 5
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 7
      ELSE IF( INCY.EQ.0 )THEN
         INFO = 10
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZHEMV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( N.EQ.0 ).OR.( ( ALPHA.EQ.ZERO ).AND.( BETA.EQ.ONE ) ) )
     $   RETURN
*
```

```
*     Set up the start points in  X  and  Y.
*
      IF( INCX.GT.0 )THEN
         KX = 1
      ELSE
         KX = 1 - ( N - 1 )*INCX
      END IF
      IF( INCY.GT.0 )THEN
         KY = 1
      ELSE
         KY = 1 - ( N - 1 )*INCY
      END IF
*
*     Start the operations. In this version the elements of A are
*     accessed sequentially with one pass through the triangular part
*     of A.
*
*     First form  y := beta*y.
*
      IF( BETA.NE.ONE )THEN
         IF( INCY.EQ.1 )THEN
            IF( BETA.EQ.ZERO )THEN
               DO 10, I = 1, N
                  Y( I ) = ZERO
   10          CONTINUE
            ELSE
               DO 20, I = 1, N
                  Y( I ) = BETA*Y( I )
   20          CONTINUE
            END IF
         ELSE
            IY = KY
            IF( BETA.EQ.ZERO )THEN
               DO 30, I = 1, N
                  Y( IY ) = ZERO
                  IY      = IY   + INCY
   30          CONTINUE
            ELSE
               DO 40, I = 1, N
                  Y( IY ) = BETA*Y( IY )
                  IY      = IY           + INCY
   40          CONTINUE
            END IF
         END IF
      END IF
      IF( ALPHA.EQ.ZERO )
     $   RETURN
      IF( LSAME( UPLO, 'U' ) )THEN
*
*        Form  y  when A is stored in upper triangle.
```

```
*
         IF( ( INCX.EQ.1 ).AND.( INCY.EQ.1 ) )THEN
            DO 60, J = 1, N
               TEMP1 = ALPHA*X( J )
               TEMP2 = ZERO
               DO 50, I = 1, J - 1
                  Y( I ) = Y( I ) + TEMP1*A( I, J )
                  TEMP2  = TEMP2  + DCONJG( A( I, J ) )*X( I )
   50          CONTINUE
               Y( J ) = Y( J ) + TEMP1*DBLE( A( J, J ) ) + ALPHA*TEMP2
   60       CONTINUE
         ELSE
            JX = KX
            JY = KY
            DO 80, J = 1, N
               TEMP1 = ALPHA*X( JX )
               TEMP2 = ZERO
               IX    = KX
               IY    = KY
               DO 70, I = 1, J - 1
                  Y( IY ) = Y( IY ) + TEMP1*A( I, J )
                  TEMP2   = TEMP2   + DCONJG( A( I, J ) )*X( IX )
                  IX      = IX      + INCX
                  IY      = IY      + INCY
   70          CONTINUE
               Y( JY ) = Y( JY ) + TEMP1*DBLE( A( J, J ) ) + ALPHA*TEMP2
               JX      = JX      + INCX
               JY      = JY      + INCY
   80       CONTINUE
         END IF
      ELSE
*
*        Form  y  when A is stored in lower triangle.
*
         IF( ( INCX.EQ.1 ).AND.( INCY.EQ.1 ) )THEN
            DO 100, J = 1, N
               TEMP1  = ALPHA*X( J )
               TEMP2  = ZERO
               Y( J ) = Y( J ) + TEMP1*DBLE( A( J, J ) )
               DO 90, I = J + 1, N
                  Y( I ) = Y( I ) + TEMP1*A( I, J )
                  TEMP2  = TEMP2  + DCONJG( A( I, J ) )*X( I )
   90          CONTINUE
               Y( J ) = Y( J ) + ALPHA*TEMP2
  100       CONTINUE
         ELSE
            JX = KX
            JY = KY
            DO 120, J = 1, N
               TEMP1   = ALPHA*X( JX )
```

```
               TEMP2   = ZERO
               Y( JY ) = Y( JY ) + TEMP1*DBLE( A( J, J ) )
               IX      = JX
               IY      = JY
               DO 110, I = J + 1, N
                  IX      = IX      + INCX
                  IY      = IY      + INCY
                  Y( IY ) = Y( IY ) + TEMP1*A( I, J )
                  TEMP2   = TEMP2   + DCONJG( A( I, J ) )*X( IX )
  110          CONTINUE
               Y( JY ) = Y( JY ) + ALPHA*TEMP2
               JX      = JX      + INCX
               JY      = JY      + INCY
  120       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of ZHEMV .
*
      END
```

———-

— BLAS 2 zhemv —

```
(let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
 (declare (type (complex double-float) one) (type (complex double-float) zero))
  (defun zhemv (uplo n alpha a lda x incx beta y incy)
    (declare (type (simple-array (complex double-float) (*)) y x a)
             (type (complex double-float) beta alpha)
             (type fixnum incy incx lda n)
             (type character uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (x (complex double-float) x-%data% x-%offset%)
         (y (complex double-float) y-%data% y-%offset%))
      (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (kx 0) (ky 0)
             (temp1 #C(0.0 0.0)) (temp2 #C(0.0 0.0)))
        (declare (type fixnum i info ix iy j jx jy kx ky)
                 (type (complex double-float) temp1 temp2))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
          ((< n 0)
```

```
   (setf info 2))
  ((< lda (max (the fixnum 1) (the fixnum n)))
   (setf info 5))
  ((= incx 0)
   (setf info 7))
  ((= incy 0)
   (setf info 10)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "ZHEMV" info)
   (go end_label)))
(if (or (= n 0) (and (= alpha zero) (= beta one))) (go end_label))
(cond
  ((> incx 0)
   (setf kx 1))
  (t
   (setf kx
           (f2cl-lib:int-sub 1
                             (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                               incx)))))
(cond
  ((> incy 0)
   (setf ky 1))
  (t
   (setf ky
           (f2cl-lib:int-sub 1
                             (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                               incy)))))
(cond
  ((/= beta one)
   (cond
     ((= incy 1)
      (cond
        ((= beta zero)
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i n) nil)
           (tagbody
             (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                     zero))))
        (t
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i n) nil)
           (tagbody
             (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                     (* beta
                        (f2cl-lib:fref y-%data%
                                       (i)
                                       ((1 *))
```

```
                                        y-%offset%))))))))
      (t
       (setf iy ky)
       (cond
         ((= beta zero)
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                      zero)
              (setf iy (f2cl-lib:int-add iy incy)))))
         (t
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                      (* beta
                         (f2cl-lib:fref y-%data%
                                        (iy)
                                        ((1 *))
                                        y-%offset%)))
              (setf iy (f2cl-lib:int-add iy incy))))))))))
(if (= alpha zero) (go end_label))
(cond
  ((char-equal uplo #\U)
   (cond
     ((and (= incx 1) (= incy 1))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (setf temp1
                  (* alpha
                     (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
          (setf temp2 zero)
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i
                            (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                         nil)
            (tagbody
              (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                      (+
                       (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                       (* temp1
                          (f2cl-lib:fref a-%data%
                                         (i j)
                                         ((1 lda) (1 *))
                                         a-%offset%))))
              (setf temp2
                      (+ temp2
                         (*
```

```
                        (f2cl-lib:dconjg
                         (f2cl-lib:fref a-%data%
                                        (i j)
                                        ((1 lda) (1 *))
                                        a-%offset%))
                        (f2cl-lib:fref x-%data%
                                       (i)
                                       ((1 *))
                                       x-%offset%))))))
      (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
              (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                 (* temp1
                    (coerce (realpart
                             (f2cl-lib:fref a-%data%
                                            (j j)
                                            ((1 lda) (1 *))
                                            a-%offset%)) 'double-float))
                 (* alpha temp2))))))
(t
 (setf jx kx)
 (setf jy ky)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (setf temp1
             (* alpha
                (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
     (setf temp2 zero)
     (setf ix kx)
     (setf iy ky)
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                   ((> i
                       (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                    nil)
       (tagbody
         (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                 (+
                  (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                  (* temp1
                     (f2cl-lib:fref a-%data%
                                    (i j)
                                    ((1 lda) (1 *))
                                    a-%offset%))))
         (setf temp2
                 (+ temp2
                    (*
                     (f2cl-lib:dconjg
                      (f2cl-lib:fref a-%data%
                                     (i j)
                                     ((1 lda) (1 *))
```

```
                                        a-%offset%))
                              (f2cl-lib:fref x-%data%
                                             (ix)
                                             ((1 *))
                                             x-%offset%))))
                    (setf ix (f2cl-lib:int-add ix incx))
                    (setf iy (f2cl-lib:int-add iy incy))))
                (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                        (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                           (* temp1
                              (coerce (realpart
                               (f2cl-lib:fref a-%data%
                                             (j j)
                                             ((1 lda) (1 *))
                                             a-%offset%)) 'double-float))
                           (* alpha temp2)))
                (setf jx (f2cl-lib:int-add jx incx))
                (setf jy (f2cl-lib:int-add jy incy)))))))
        (t
         (cond
           ((and (= incx 1) (= incy 1))
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
              (tagbody
                (setf temp1
                        (* alpha
                           (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
                (setf temp2 zero)
                (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                        (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                           (* temp1
                              (coerce (realpart
                               (f2cl-lib:fref a-%data%
                                             (j j)
                                             ((1 lda) (1 *))
                                             a-%offset%)) 'double-float))))
                (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                               (f2cl-lib:int-add i 1))
                              ((> i n) nil)
                  (tagbody
                    (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                            (+
                             (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                             (* temp1
                                (f2cl-lib:fref a-%data%
                                               (i j)
                                               ((1 lda) (1 *))
                                               a-%offset%))))
                    (setf temp2
                            (+ temp2
```

```
                    (*
                     (f2cl-lib:dconjg
                      (f2cl-lib:fref a-%data%
                                     (i j)
                                     ((1 lda) (1 *))
                                     a-%offset%))
                     (f2cl-lib:fref x-%data%
                                    (i)
                                    ((1 *))
                                    x-%offset%))))))
      (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
              (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                 (* alpha temp2))))))
(t
 (setf jx kx)
 (setf jy ky)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (setf temp1
             (* alpha
                (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
     (setf temp2 zero)
     (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
             (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                (* temp1
                   (coerce (realpart
                    (f2cl-lib:fref a-%data%
                                   (j j)
                                   ((1 lda) (1 *))
                                   a-%offset%)) 'double-float))))
     (setf ix jx)
     (setf iy jy)
     (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                      (f2cl-lib:int-add i 1))
                   ((> i n) nil)
       (tagbody
         (setf ix (f2cl-lib:int-add ix incx))
         (setf iy (f2cl-lib:int-add iy incy))
         (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                 (+
                  (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                  (* temp1
                     (f2cl-lib:fref a-%data%
                                    (i j)
                                    ((1 lda) (1 *))
                                    a-%offset%))))
         (setf temp2
                 (+ temp2
                    (*
```

```
                                    (f2cl-lib:dconjg
                                     (f2cl-lib:fref a-%data%
                                                    (i j)
                                                    ((1 lda) (1 *))
                                                    a-%offset%))
                                    (f2cl-lib:fref x-%data%
                                                   (ix)
                                                   ((1 *))
                                                   x-%offset%))))))
                  (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                          (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                             (* alpha temp2)))
                  (setf jx (f2cl-lib:int-add jx incx))
                  (setf jy (f2cl-lib:int-add jy incy))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil nil))))))
```

———-

4.23 zher2 BLAS

— **zher2.input** —

```
)set break resume
)sys rm -f zher2.output
)spool zher2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zher2.help** —

```
=====================================================================
zher2 examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================
```

```
NAME
     ZHER2 - perform the hermitian rank 2 operation   A :=
     alpha*x*conjg( y' ) + conjg( alpha )*y*conjg( x' ) + A,

SYNOPSIS
     SUBROUTINE ZHER2 ( UPLO, N, ALPHA, X, INCX, Y, INCY, A, LDA
                      )

         COMPLEX*16   ALPHA

         INTEGER      INCX, INCY, LDA, N

         CHARACTER*1  UPLO

         COMPLEX*16   A( LDA, * ), X( * ), Y( * )

PURPOSE
     ZHER2  performs the hermitian rank 2 operation

     where alpha is a scalar, x and y are n element vectors and A
     is an n by n hermitian matrix.

PARAMETERS
     UPLO   - CHARACTER*1.
            On entry, UPLO specifies whether the upper or lower
            triangular part of the array A is to be referenced as
            follows:

            UPLO = 'U' or 'u'   Only the upper triangular part of
            A is to be referenced.

            UPLO = 'L' or 'l'   Only the lower triangular part of
            A is to be referenced.

            Unchanged on exit.

     N      - INTEGER.
            On entry, N specifies the order of the matrix A.  N
            must be at least zero.  Unchanged on exit.

     ALPHA  - COMPLEX*16      .
            On entry, ALPHA specifies the scalar alpha.
            Unchanged on exit.

     X      - COMPLEX*16       array of dimension at least
            ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
            incremented array X must contain the n element vector
            x.  Unchanged on exit.

     INCX   - INTEGER.
```

```
          On entry, INCX specifies the increment for the

          elements of X. INCX must not be zero.  Unchanged on
          exit.

      Y       - COMPLEX*16       array of dimension at least
          ( 1 + ( n - 1 )*abs( INCY ) ).  Before entry, the
          incremented array Y must contain the n element vector
          y.  Unchanged on exit.

      INCY    - INTEGER.
          On entry, INCY specifies the increment for the ele-
          ments of Y. INCY must not be zero.  Unchanged on
          exit.

      A       - COMPLEX*16       array of DIMENSION ( LDA, n ).
          Before entry with  UPLO = 'U' or 'u', the leading n
          by n upper triangular part of the array A must con-
          tain the upper triangular part of the hermitian
          matrix and the strictly lower triangular part of A is
          not referenced. On exit, the upper triangular part of
          the array A is overwritten by the upper triangular
          part of the updated matrix.  Before entry with UPLO =
          'L' or 'l', the leading n by n lower triangular part
          of the array A must contain the lower triangular part
          of the hermitian matrix and the strictly upper tri-
          angular part of A is not referenced. On exit, the
          lower triangular part of the array A is overwritten
          by the lower triangular part of the updated matrix.
          Note that the imaginary parts of the diagonal ele-
          ments need not be set, they are assumed to be zero,
          and on exit they are set to zero.

      LDA     - INTEGER.
          On entry, LDA specifies the first dimension of A as
          declared in the calling (sub) program. LDA must be at
          least max( 1, n ).  Unchanged on exit.
```

— zher2.f —

```
      SUBROUTINE ZHER2 ( UPLO, N, ALPHA, X, INCX, Y, INCY, A, LDA )
*     .. Scalar Arguments ..
      COMPLEX*16         ALPHA
      INTEGER            INCX, INCY, LDA, N
      CHARACTER*1        UPLO
*     .. Array Arguments ..
```

```
      COMPLEX*16         A( LDA, * ), X( * ), Y( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     .. Local Scalars ..
      COMPLEX*16         TEMP1, TEMP2
      INTEGER            I, INFO, IX, IY, J, JX, JY, KX, KY
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG, MAX, DBLE
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO, 'U' ).AND.
     $         .NOT.LSAME( UPLO, 'L' )      )THEN
         INFO = 1
      ELSE IF( N.LT.0 )THEN
         INFO = 2
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 5
      ELSE IF( INCY.EQ.0 )THEN
         INFO = 7
      ELSE IF( LDA.LT.MAX( 1, N ) )THEN
         INFO = 9
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZHER2 ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
```

```
      IF( ( N.EQ.0 ).OR.( ALPHA.EQ.ZERO ) )
     $   RETURN
*
*     Set up the start points in X and Y if the increments are not both
*     unity.
*
      IF( ( INCX.NE.1 ).OR.( INCY.NE.1 ) )THEN
         IF( INCX.GT.0 )THEN
            KX = 1
         ELSE
            KX = 1 - ( N - 1 )*INCX
         END IF
         IF( INCY.GT.0 )THEN
            KY = 1
         ELSE
            KY = 1 - ( N - 1 )*INCY
         END IF
         JX = KX
         JY = KY
      END IF
*
*     Start the operations. In this version the elements of A are
*     accessed sequentially with one pass through the triangular part
*     of A.
*
      IF( LSAME( UPLO, 'U' ) )THEN
*
*        Form  A  when A is stored in the upper triangle.
*
         IF( ( INCX.EQ.1 ).AND.( INCY.EQ.1 ) )THEN
            DO 20, J = 1, N
               IF( ( X( J ).NE.ZERO ).OR.( Y( J ).NE.ZERO ) )THEN
                  TEMP1 = ALPHA*DCONJG( Y( J ) )
                  TEMP2 = DCONJG( ALPHA*X( J ) )
                  DO 10, I = 1, J - 1
                     A( I, J ) = A( I, J ) + X( I )*TEMP1 + Y( I )*TEMP2
   10             CONTINUE
                  A( J, J ) = DBLE( A( J, J ) ) +
     $                        DBLE( X( J )*TEMP1 + Y( J )*TEMP2 )
               ELSE
                  A( J, J ) = DBLE( A( J, J ) )
               END IF
   20       CONTINUE
         ELSE
            DO 40, J = 1, N
               IF( ( X( JX ).NE.ZERO ).OR.( Y( JY ).NE.ZERO ) )THEN
                  TEMP1 = ALPHA*DCONJG( Y( JY ) )
                  TEMP2 = DCONJG( ALPHA*X( JX ) )
                  IX    = KX
                  IY    = KY
```

```
                  DO 30, I = 1, J - 1
                     A( I, J ) = A( I, J ) + X( IX )*TEMP1
     $                                      + Y( IY )*TEMP2
                     IX        = IX        + INCX
                     IY        = IY        + INCY
   30                CONTINUE
                     A( J, J ) = DBLE( A( J, J ) ) +
     $                           DBLE( X( JX )*TEMP1 + Y( JY )*TEMP2 )
                  ELSE
                     A( J, J ) = DBLE( A( J, J ) )
                  END IF
                  JX = JX + INCX
                  JY = JY + INCY
   40          CONTINUE
            END IF
         ELSE
*
*           Form  A  when A is stored in the lower triangle.
*
            IF( ( INCX.EQ.1 ).AND.( INCY.EQ.1 ) )THEN
               DO 60, J = 1, N
                  IF( ( X( J ).NE.ZERO ).OR.( Y( J ).NE.ZERO ) )THEN
                     TEMP1     = ALPHA*DCONJG( Y( J ) )
                     TEMP2     = DCONJG( ALPHA*X( J ) )
                     A( J, J ) = DBLE( A( J, J ) ) +
     $                           DBLE( X( J )*TEMP1 + Y( J )*TEMP2 )
                     DO 50, I = J + 1, N
                        A( I, J ) = A( I, J ) + X( I )*TEMP1 + Y( I )*TEMP2
   50                CONTINUE
                  ELSE
                     A( J, J ) = DBLE( A( J, J ) )
                  END IF
   60          CONTINUE
            ELSE
               DO 80, J = 1, N
                  IF( ( X( JX ).NE.ZERO ).OR.( Y( JY ).NE.ZERO ) )THEN
                     TEMP1     = ALPHA*DCONJG( Y( JY ) )
                     TEMP2     = DCONJG( ALPHA*X( JX ) )
                     A( J, J ) = DBLE( A( J, J ) ) +
     $                           DBLE( X( JX )*TEMP1 + Y( JY )*TEMP2 )
                     IX        = JX
                     IY        = JY
                     DO 70, I = J + 1, N
                        IX        = IX        + INCX
                        IY        = IY        + INCY
                        A( I, J ) = A( I, J ) + X( IX )*TEMP1
     $                                        + Y( IY )*TEMP2
   70                CONTINUE
                  ELSE
                     A( J, J ) = DBLE( A( J, J ) )
```

```
              END IF
              JX = JX + INCX
              JY = JY + INCY
   80       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of ZHER2 .
*
      END
```

———-

— BLAS 2 zher2 —

```
(let* ((zero (complex 0.0 0.0)))
  (declare (type (complex double-float) zero))
  (defun zher2 (uplo n alpha x incx y incy a lda)
    (declare (type (simple-array (complex double-float) (*)) a y x)
             (type (complex double-float) alpha)
             (type fixnum lda incy incx n)
             (type character uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (x (complex double-float) x-%data% x-%offset%)
         (y (complex double-float) y-%data% y-%offset%)
         (a (complex double-float) a-%data% a-%offset%))
      (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (kx 0) (ky 0)
             (temp1 #C(0.0 0.0)) (temp2 #C(0.0 0.0)))
        (declare (type fixnum i info ix iy j jx jy kx ky)
                 (type (complex double-float) temp1 temp2))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
          ((< n 0)
           (setf info 2))
          ((= incx 0)
           (setf info 5))
          ((= incy 0)
           (setf info 7))
          ((< lda (max (the fixnum 1) (the fixnum n)))
           (setf info 9)))
        (cond
          ((/= info 0)
           (error
```

```
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "ZHER2" info)
   (go end_label)))
(if (or (= n 0) (= alpha zero)) (go end_label))
(cond
  ((or (/= incx 1) (/= incy 1))
   (cond
     ((> incx 0)
      (setf kx 1))
     (t
      (setf kx
              (f2cl-lib:int-sub 1
                                (f2cl-lib:int-mul
                                 (f2cl-lib:int-sub n 1)
                                 incx)))))
   (cond
     ((> incy 0)
      (setf ky 1))
     (t
      (setf ky
              (f2cl-lib:int-sub 1
                                (f2cl-lib:int-mul
                                 (f2cl-lib:int-sub n 1)
                                 incy)))))
   (setf jx kx)
   (setf jy ky)))
(cond
  ((char-equal uplo #\U)
   (cond
     ((and (= incx 1) (= incy 1))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (cond
            ((or (/= (f2cl-lib:fref x (j) ((1 *))) zero)
                 (/= (f2cl-lib:fref y (j) ((1 *))) zero))
             (setf temp1
                     (* alpha
                        (f2cl-lib:dconjg
                         (f2cl-lib:fref y-%data%
                                        (j)
                                        ((1 *))
                                        y-%offset%))))
             (setf temp2
                     (coerce
                      (f2cl-lib:dconjg
                       (* alpha
                          (f2cl-lib:fref x-%data%
                                         (j)
                                         ((1 *))
```

```
                                x-%offset%)))
            '(complex double-float)))
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i
                     (f2cl-lib:int-add j
                                       (f2cl-lib:int-sub 1)))
                  nil)
     (tagbody
       (setf (f2cl-lib:fref a-%data%
                            (i j)
                            ((1 lda) (1 *))
                            a-%offset%)
             (+
              (f2cl-lib:fref a-%data%
                             (i j)
                             ((1 lda) (1 *))
                             a-%offset%)
              (*
               (f2cl-lib:fref x-%data%
                              (i)
                              ((1 *))
                              x-%offset%)
               temp1)
              (*
               (f2cl-lib:fref y-%data%
                              (i)
                              ((1 *))
                              y-%offset%)
               temp2)))))
   (setf (f2cl-lib:fref a-%data%
                        (j j)
                        ((1 lda) (1 *))
                        a-%offset%)
         (coerce
          (+
           (coerce (realpart
            (f2cl-lib:fref a-%data%
                           (j j)
                           ((1 lda) (1 *))
                           a-%offset%)) 'double-float)
           (coerce (realpart
            (+
             (*
              (f2cl-lib:fref x-%data%
                             (j)
                             ((1 *))
                             x-%offset%)
              temp1)
             (*
              (f2cl-lib:fref y-%data%
```

```
                                        (j)
                                        ((1 *))
                                        y-%offset%)
                           temp2))) 'double-float))
                     '(complex double-float))))
             (t
              (setf (f2cl-lib:fref a-%data%
                                   (j j)
                                   ((1 lda) (1 *))
                                   a-%offset%)
                    (coerce
                     (coerce (realpart
                      (f2cl-lib:fref a-%data%
                                     (j j)
                                     ((1 lda) (1 *))
                                     a-%offset%)) 'double-float)
                     '(complex double-float))))))))
      (t
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (cond
             ((or (/= (f2cl-lib:fref x (jx) ((1 *))) zero)
                  (/= (f2cl-lib:fref y (jy) ((1 *))) zero))
              (setf temp1
                    (* alpha
                       (f2cl-lib:dconjg
                        (f2cl-lib:fref y-%data%
                                       (jy)
                                       ((1 *))
                                       y-%offset%))))
              (setf temp2
                    (coerce
                     (f2cl-lib:dconjg
                      (* alpha
                         (f2cl-lib:fref x-%data%
                                        (jx)
                                        ((1 *))
                                        x-%offset%)))
                     '(complex double-float)))
              (setf ix kx)
              (setf iy ky)
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                            ((> i
                                (f2cl-lib:int-add j
                                                  (f2cl-lib:int-sub 1)))
                             nil)
                (tagbody
                  (setf (f2cl-lib:fref a-%data%
                                       (i j)
```

```
                                    ((1 lda) (1 *))
                                    a-%offset%)
                                (+
                                 (f2cl-lib:fref a-%data%
                                                (i j)
                                                ((1 lda) (1 *))
                                                a-%offset%)
                                 (*
                                  (f2cl-lib:fref x-%data%
                                                 (ix)
                                                 ((1 *))
                                                 x-%offset%)
                                  temp1)
                                 (*
                                  (f2cl-lib:fref y-%data%
                                                 (iy)
                                                 ((1 *))
                                                 y-%offset%)
                                  temp2)))
                            (setf ix (f2cl-lib:int-add ix incx))
                            (setf iy (f2cl-lib:int-add iy incy))))
                         (setf (f2cl-lib:fref a-%data%
                                              (j j)
                                              ((1 lda) (1 *))
                                              a-%offset%)
                                (coerce
                                 (+
                                  (coerce (realpart
                                   (f2cl-lib:fref a-%data%
                                                  (j j)
                                                  ((1 lda) (1 *))
                                                  a-%offset%)) 'double-float)
                                  (coerce (realpart
                                   (+
                                    (*
                                     (f2cl-lib:fref x-%data%
                                                    (jx)
                                                    ((1 *))
                                                    x-%offset%)
                                     temp1)
                                    (*
                                     (f2cl-lib:fref y-%data%
                                                    (jy)
                                                    ((1 *))
                                                    y-%offset%)
                                     temp2))) 'double-float))
                                 '(complex double-float))))
                        (t
                         (setf (f2cl-lib:fref a-%data%
                                              (j j)
```

```
                                    ((1 lda) (1 *))
                                    a-%offset%)
                           (coerce
                            (coerce (realpart
                             (f2cl-lib:fref a-%data%
                                            (j j)
                                            ((1 lda) (1 *))
                                            a-%offset%)) 'double-float)
                            '(complex double-float)))))
                 (setf jx (f2cl-lib:int-add jx incx))
                 (setf jy (f2cl-lib:int-add jy incy)))))))
       (t
        (cond
          ((and (= incx 1) (= incy 1))
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (cond
                 ((or (/= (f2cl-lib:fref x (j) ((1 *))) zero)
                      (/= (f2cl-lib:fref y (j) ((1 *))) zero))
                  (setf temp1
                          (* alpha
                             (f2cl-lib:dconjg
                              (f2cl-lib:fref y-%data%
                                             (j)
                                             ((1 *))
                                             y-%offset%))))
                  (setf temp2
                          (coerce
                           (f2cl-lib:dconjg
                            (* alpha
                               (f2cl-lib:fref x-%data%
                                              (j)
                                              ((1 *))
                                              x-%offset%)))
                           '(complex double-float)))
                  (setf (f2cl-lib:fref a-%data%
                                       (j j)
                                       ((1 lda) (1 *))
                                       a-%offset%)
                          (coerce
                           (+
                            (coerce (realpart
                             (f2cl-lib:fref a-%data%
                                            (j j)
                                            ((1 lda) (1 *))
                                            a-%offset%)) 'double-float)
                            (coerce (realpart
                             (+
                              (*
```

```
                                (f2cl-lib:fref x-%data%
                                               (j)
                                               ((1 *))
                                               x-%offset%)
                                temp1)
                               (*
                                (f2cl-lib:fref y-%data%
                                               (j)
                                               ((1 *))
                                               y-%offset%)
                                temp2))) 'double-float))
                         '(complex double-float)))
                  (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                   (f2cl-lib:int-add i 1))
                                ((> i n) nil)
                    (tagbody
                      (setf (f2cl-lib:fref a-%data%
                                           (i j)
                                           ((1 lda) (1 *))
                                           a-%offset%)
                            (+
                             (f2cl-lib:fref a-%data%
                                            (i j)
                                            ((1 lda) (1 *))
                                            a-%offset%)
                             (*
                              (f2cl-lib:fref x-%data%
                                             (i)
                                             ((1 *))
                                             x-%offset%)
                              temp1)
                             (*
                              (f2cl-lib:fref y-%data%
                                             (i)
                                             ((1 *))
                                             y-%offset%)
                              temp2))))))
                 (t
                  (setf (f2cl-lib:fref a-%data%
                                       (j j)
                                       ((1 lda) (1 *))
                                       a-%offset%)
                        (coerce
                         (coerce (realpart
                          (f2cl-lib:fref a-%data%
                                         (j j)
                                         ((1 lda) (1 *))
                                         a-%offset%)) 'double-float)
                         '(complex double-float)))))))
           (t
```

```
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j n) nil)
  (tagbody
    (cond
      ((or (/= (f2cl-lib:fref x (jx) ((1 *))) zero)
           (/= (f2cl-lib:fref y (jy) ((1 *))) zero))
       (setf temp1
             (* alpha
                (f2cl-lib:dconjg
                 (f2cl-lib:fref y-%data%
                                (jy)
                                ((1 *))
                                y-%offset%))))
       (setf temp2
             (coerce
              (f2cl-lib:dconjg
               (* alpha
                  (f2cl-lib:fref x-%data%
                                 (jx)
                                 ((1 *))
                                 x-%offset%)))
              '(complex double-float)))
       (setf (f2cl-lib:fref a-%data%
                            (j j)
                            ((1 lda) (1 *))
                            a-%offset%)
             (coerce
              (+
               (coerce (realpart
                (f2cl-lib:fref a-%data%
                               (j j)
                               ((1 lda) (1 *))
                               a-%offset%)) 'double-float)
               (coerce (realpart
                (+
                 (*
                  (f2cl-lib:fref x-%data%
                                 (jx)
                                 ((1 *))
                                 x-%offset%)
                  temp1)
                 (*
                  (f2cl-lib:fref y-%data%
                                 (jy)
                                 ((1 *))
                                 y-%offset%)
                  temp2))) 'double-float))
              '(complex double-float)))
       (setf ix jx)
       (setf iy jy)
```

```
                    (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                   (f2cl-lib:int-add i 1))
                                  ((> i n) nil)
                      (tagbody
                        (setf ix (f2cl-lib:int-add ix incx))
                        (setf iy (f2cl-lib:int-add iy incy))
                        (setf (f2cl-lib:fref a-%data%
                                             (i j)
                                             ((1 lda) (1 *))
                                             a-%offset%)
                              (+
                               (f2cl-lib:fref a-%data%
                                              (i j)
                                              ((1 lda) (1 *))
                                              a-%offset%)
                               (*
                                (f2cl-lib:fref x-%data%
                                               (ix)
                                               ((1 *))
                                               x-%offset%)
                                temp1)
                               (*
                                (f2cl-lib:fref y-%data%
                                               (iy)
                                               ((1 *))
                                               y-%offset%)
                                temp2))))))
                     (t
                      (setf (f2cl-lib:fref a-%data%
                                           (j j)
                                           ((1 lda) (1 *))
                                           a-%offset%)
                            (coerce
                             (coerce (realpart
                              (f2cl-lib:fref a-%data%
                                             (j j)
                                             ((1 lda) (1 *))
                                             a-%offset%)) 'double-float)
                             '(complex double-float)))))
                    (setf jx (f2cl-lib:int-add jx incx))
                    (setf jy (f2cl-lib:int-add jy incy))))))))
end_label
       (return (values nil nil nil nil nil nil nil nil nil))))))
```

4.24 zher BLAS

— **zher.input** —

```
)set break resume
)sys rm -f zher.output
)spool zher.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

————-

— **zher.help** —

```
==========================================================================
zher examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      ZHER - perform the hermitian rank 1 operation   A :=
      alpha*x*conjg( x' ) + A,

 SYNOPSIS
      SUBROUTINE ZHER ( UPLO, N, ALPHA, X, INCX, A, LDA )

          DOUBLE      PRECISION ALPHA

          INTEGER     INCX, LDA, N

          CHARACTER*1 UPLO

          COMPLEX*16  A( LDA, * ), X( * )

 PURPOSE
      ZHER   performs the hermitian rank 1 operation

      where alpha is a real scalar, x is an n element vector and A
      is an n by n hermitian matrix.

 PARAMETERS
```

```
UPLO   - CHARACTER*1.
       On entry, UPLO specifies whether the upper or lower
       triangular part of the array A is to be referenced as
       follows:

       UPLO = 'U' or 'u'   Only the upper triangular part of
       A is to be referenced.

       UPLO = 'L' or 'l'   Only the lower triangular part of
       A is to be referenced.

       Unchanged on exit.

N      - INTEGER.
       On entry, N specifies the order of the matrix A.  N
       must be at least zero.  Unchanged on exit.

ALPHA  - DOUBLE PRECISION.
       On entry, ALPHA specifies the scalar alpha.
       Unchanged on exit.

X      - COMPLEX*16       array of dimension at least
       ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
       incremented array X must contain the n element vector
       x.  Unchanged on exit.

INCX   - INTEGER.
       On entry, INCX specifies the increment for the ele-
       ments of X. INCX must not be zero.  Unchanged on

       exit.

A      - COMPLEX*16       array of DIMENSION ( LDA, n ).
       Before entry with  UPLO = 'U' or 'u', the leading n
       by n upper triangular part of the array A must con-
       tain the upper triangular part of the hermitian
       matrix and the strictly lower triangular part of A is
       not referenced. On exit, the upper triangular part of
       the array A is overwritten by the upper triangular
       part of the updated matrix.  Before entry with UPLO =
       'L' or 'l', the leading n by n lower triangular part
       of the array A must contain the lower triangular part
       of the hermitian matrix and the strictly upper tri-
       angular part of A is not referenced. On exit, the
       lower triangular part of the array A is overwritten
       by the lower triangular part of the updated matrix.
       Note that the imaginary parts of the diagonal ele-
       ments need not be set, they are assumed to be zero,
       and on exit they are set to zero.
```

```
      LDA    - INTEGER.
             On entry, LDA specifies the first dimension of A as
             declared in the calling (sub) program. LDA must be at
             least max( 1, n ).  Unchanged on exit.
```

— zher.f —

```
      SUBROUTINE ZHER  ( UPLO, N, ALPHA, X, INCX, A, LDA )
*     .. Scalar Arguments ..
      DOUBLE PRECISION   ALPHA
      INTEGER            INCX, LDA, N
      CHARACTER*1        UPLO
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), X( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     .. Local Scalars ..
      COMPLEX*16         TEMP
      INTEGER            I, INFO, IX, J, JX, KX
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG, MAX, DBLE
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO, 'U' ).AND.
     $         .NOT.LSAME( UPLO, 'L' )      )THEN
```

```
         INFO = 1
      ELSE IF( N.LT.0 )THEN
         INFO = 2
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 5
      ELSE IF( LDA.LT.MAX( 1, N ) )THEN
         INFO = 7
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZHER  ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( N.EQ.0 ).OR.( ALPHA.EQ.DBLE( ZERO ) ) )
     $   RETURN
*
*     Set the start point in X if the increment is not unity.
*
      IF( INCX.LE.0 )THEN
         KX = 1 - ( N - 1 )*INCX
      ELSE IF( INCX.NE.1 )THEN
         KX = 1
      END IF
*
*     Start the operations. In this version the elements of A are
*     accessed sequentially with one pass through the triangular part
*     of A.
*
      IF( LSAME( UPLO, 'U' ) )THEN
*
*        Form  A  when A is stored in upper triangle.
*
         IF( INCX.EQ.1 )THEN
            DO 20, J = 1, N
               IF( X( J ).NE.ZERO )THEN
                  TEMP = ALPHA*DCONJG( X( J ) )
                  DO 10, I = 1, J - 1
                     A( I, J ) = A( I, J ) + X( I )*TEMP
   10             CONTINUE
                  A( J, J ) = DBLE( A( J, J ) ) + DBLE( X( J )*TEMP )
               ELSE
                  A( J, J ) = DBLE( A( J, J ) )
               END IF
   20       CONTINUE
         ELSE
            JX = KX
            DO 40, J = 1, N
               IF( X( JX ).NE.ZERO )THEN
```

```
                  TEMP = ALPHA*DCONJG( X( JX ) )
                  IX   = KX
                  DO 30, I = 1, J - 1
                     A( I, J ) = A( I, J ) + X( IX )*TEMP
                     IX        = IX        + INCX
   30             CONTINUE
                  A( J, J ) = DBLE( A( J, J ) ) + DBLE( X( JX )*TEMP )
               ELSE
                  A( J, J ) = DBLE( A( J, J ) )
               END IF
               JX = JX + INCX
   40       CONTINUE
         END IF
      ELSE
*
*        Form  A  when A is stored in lower triangle.
*
         IF( INCX.EQ.1 )THEN
            DO 60, J = 1, N
               IF( X( J ).NE.ZERO )THEN
                  TEMP      = ALPHA*DCONJG( X( J ) )
                  A( J, J ) = DBLE( A( J, J ) ) + DBLE( TEMP*X( J ) )
                  DO 50, I = J + 1, N
                     A( I, J ) = A( I, J ) + X( I )*TEMP
   50             CONTINUE
               ELSE
                  A( J, J ) = DBLE( A( J, J ) )
               END IF
   60       CONTINUE
         ELSE
            JX = KX
            DO 80, J = 1, N
               IF( X( JX ).NE.ZERO )THEN
                  TEMP      = ALPHA*DCONJG( X( JX ) )
                  A( J, J ) = DBLE( A( J, J ) ) + DBLE( TEMP*X( JX ) )
                  IX        = JX
                  DO 70, I = J + 1, N
                     IX        = IX        + INCX
                     A( I, J ) = A( I, J ) + X( IX )*TEMP
   70             CONTINUE
               ELSE
                  A( J, J ) = DBLE( A( J, J ) )
               END IF
               JX = JX + INCX
   80       CONTINUE
         END IF
      END IF
*
      RETURN
*
```

```
*     End of ZHER  .
*
      END
```

———-

— BLAS 2 zher —

```
(let* ((zero (complex 0.0 0.0)))
  (declare (type (complex double-float) zero))
  (defun zher (uplo n alpha x incx a lda)
    (declare (type (simple-array (complex double-float) (*)) a x)
             (type (double-float) alpha)
             (type fixnum lda incx n)
             (type character uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (x (complex double-float) x-%data% x-%offset%)
         (a (complex double-float) a-%data% a-%offset%))
      (prog ((i 0) (info 0) (ix 0) (j 0) (jx 0) (kx 0) (temp #C(0.0 0.0)))
        (declare (type fixnum i info ix j jx kx)
                 (type (complex double-float) temp))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
          ((< n 0)
           (setf info 2))
          ((= incx 0)
           (setf info 5))
          ((< lda (max (the fixnum 1) (the fixnum n)))
           (setf info 7)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "ZHER" info)
           (go end_label)))
        (if (or (= n 0) (= alpha (coerce (realpart zero) 'double-float)))
            (go end_label))
        (cond
          ((<= incx 0)
           (setf kx
                   (f2cl-lib:int-sub 1
                                     (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                       incx))))
          ((/= incx 1)
           (setf kx 1)))
```

```
(cond
  ((char-equal uplo #\U)
   (cond
     ((= incx 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (cond
            ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
             (setf temp
                     (coerce
                      (* alpha
                         (f2cl-lib:dconjg
                          (f2cl-lib:fref x-%data%
                                         (j)
                                         ((1 *))
                                         x-%offset%)))
                      '(complex double-float)))
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i
                               (f2cl-lib:int-add j
                                                 (f2cl-lib:int-sub 1)))
                            nil)
               (tagbody
                 (setf (f2cl-lib:fref a-%data%
                                      (i j)
                                      ((1 lda) (1 *))
                                      a-%offset%)
                       (+
                        (f2cl-lib:fref a-%data%
                                       (i j)
                                       ((1 lda) (1 *))
                                       a-%offset%)
                        (*
                         (f2cl-lib:fref x-%data%
                                        (i)
                                        ((1 *))
                                        x-%offset%)
                         temp)))))
             (setf (f2cl-lib:fref a-%data%
                                  (j j)
                                  ((1 lda) (1 *))
                                  a-%offset%)
                   (coerce
                    (+
                     (coerce (realpart
                      (f2cl-lib:fref a-%data%
                                     (j j)
                                     ((1 lda) (1 *))
                                     a-%offset%)) 'double-float)
```

```
                      (coerce (realpart
                       (*
                        (f2cl-lib:fref x-%data%
                                       (j)
                                       ((1 *))
                                       x-%offset%)
                        temp)) 'double-float))
                     '(complex double-float))))
             (t
              (setf (f2cl-lib:fref a-%data%
                                   (j j)
                                   ((1 lda) (1 *))
                                   a-%offset%)
                    (coerce
                     (coerce (realpart
                      (f2cl-lib:fref a-%data%
                                     (j j)
                                     ((1 lda) (1 *))
                                     a-%offset%)) 'double-float)
                     '(complex double-float))))))))
      (t
       (setf jx kx)
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (cond
             ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
              (setf temp
                    (coerce
                     (* alpha
                        (f2cl-lib:dconjg
                         (f2cl-lib:fref x-%data%
                                        (jx)
                                        ((1 *))
                                        x-%offset%)))
                     '(complex double-float)))
              (setf ix kx)
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                            ((> i
                                (f2cl-lib:int-add j
                                                  (f2cl-lib:int-sub 1)))
                             nil)
                (tagbody
                  (setf (f2cl-lib:fref a-%data%
                                       (i j)
                                       ((1 lda) (1 *))
                                       a-%offset%)
                        (+
                         (f2cl-lib:fref a-%data%
                                        (i j)
```

```
                                          ((1 lda) (1 *))
                                          a-%offset%)
                              (*
                               (f2cl-lib:fref x-%data%
                                              (ix)
                                              ((1 *))
                                              x-%offset%)
                               temp)))
                    (setf ix (f2cl-lib:int-add ix incx))))
                (setf (f2cl-lib:fref a-%data%
                                     (j j)
                                     ((1 lda) (1 *))
                                     a-%offset%)
                      (coerce
                       (+
                        (coerce (realpart
                         (f2cl-lib:fref a-%data%
                                        (j j)
                                        ((1 lda) (1 *))
                                        a-%offset%)) 'double-float)
                        (coerce (realpart
                         (*
                          (f2cl-lib:fref x-%data%
                                         (jx)
                                         ((1 *))
                                         x-%offset%)
                          temp)) 'double-float))
                       '(complex double-float))))
               (t
                (setf (f2cl-lib:fref a-%data%
                                     (j j)
                                     ((1 lda) (1 *))
                                     a-%offset%)
                      (coerce
                       (coerce (realpart
                        (f2cl-lib:fref a-%data%
                                       (j j)
                                       ((1 lda) (1 *))
                                       a-%offset%)) 'double-float)
                       '(complex double-float)))))
            (setf jx (f2cl-lib:int-add jx incx)))))))
(t
 (cond
   ((= incx 1)
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j n) nil)
      (tagbody
        (cond
          ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
           (setf temp
```

```
                (coerce
                 (* alpha
                    (f2cl-lib:dconjg
                     (f2cl-lib:fref x-%data%
                                    (j)
                                    ((1 *))
                                    x-%offset%)))
                 '(complex double-float)))
          (setf (f2cl-lib:fref a-%data%
                               (j j)
                               ((1 lda) (1 *))
                               a-%offset%)
                (coerce
                 (+
                  (coerce (realpart
                   (f2cl-lib:fref a-%data%
                                  (j j)
                                  ((1 lda) (1 *))
                                  a-%offset%)) 'double-float)
                  (coerce (realpart
                   (* temp
                      (f2cl-lib:fref x-%data%
                                     (j)
                                     ((1 *))
                                     x-%offset%))) 'double-float))
                 '(complex double-float)))
          (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                         (f2cl-lib:int-add i 1))
                        ((> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref a-%data%
                                   (i j)
                                   ((1 lda) (1 *))
                                   a-%offset%)
                    (+
                     (f2cl-lib:fref a-%data%
                                    (i j)
                                    ((1 lda) (1 *))
                                    a-%offset%)
                     (*
                      (f2cl-lib:fref x-%data%
                                     (i)
                                     ((1 *))
                                     x-%offset%)
                      temp))))))
        (t
         (setf (f2cl-lib:fref a-%data%
                              (j j)
                              ((1 lda) (1 *))
                              a-%offset%)
```

```
                (coerce
                 (coerce (realpart
                  (f2cl-lib:fref a-%data%
                                 (j j)
                                 ((1 lda) (1 *))
                                 a-%offset%)) 'double-float)
                 '(complex double-float))))))))
(t
 (setf jx kx)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (cond
       ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (setf temp
                (coerce
                 (* alpha
                    (f2cl-lib:dconjg
                     (f2cl-lib:fref x-%data%
                                    (jx)
                                    ((1 *))
                                    x-%offset%)))
                 '(complex double-float)))
        (setf (f2cl-lib:fref a-%data%
                             (j j)
                             ((1 lda) (1 *))
                             a-%offset%)
                (coerce
                 (+
                  (coerce (realpart
                   (f2cl-lib:fref a-%data%
                                  (j j)
                                  ((1 lda) (1 *))
                                  a-%offset%)) 'double-float)
                  (coerce (realpart
                   (* temp
                      (f2cl-lib:fref x-%data%
                                     (jx)
                                     ((1 *))
                                     x-%offset%))) 'double-float))
                 '(complex double-float)))
        (setf ix jx)
        (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                         (f2cl-lib:int-add i 1))
                      ((> i n) nil)
          (tagbody
            (setf ix (f2cl-lib:int-add ix incx))
            (setf (f2cl-lib:fref a-%data%
                                 (i j)
                                 ((1 lda) (1 *))
```

```
                                        a-%offset%)
                                (+
                                 (f2cl-lib:fref a-%data%
                                                (i j)
                                                ((1 lda) (1 *))
                                                a-%offset%)
                                 (*
                                  (f2cl-lib:fref x-%data%
                                                 (ix)
                                                 ((1 *))
                                                 x-%offset%)
                                  temp))))))
                        (t
                         (setf (f2cl-lib:fref a-%data%
                                              (j j)
                                              ((1 lda) (1 *))
                                              a-%offset%)
                               (coerce
                                (coerce (realpart
                                 (f2cl-lib:fref a-%data%
                                                (j j)
                                                ((1 lda) (1 *))
                                                a-%offset%)) 'double-float)
                                '(complex double-float)))))
                       (setf jx (f2cl-lib:int-add jx incx))))))))
 end_label
        (return (values nil nil nil nil nil nil nil))))))
```

———-

4.25 zhpmv BLAS

— **zhpmv.input** —

```
)set break resume
)sys rm -f zhpmv.output
)spool zhpmv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— zhpmv.help —

```
=====================================================================
zhpmv examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 NAME
      ZHPMV - perform the matrix-vector operation   y := alpha*A*x
      + beta*y,

 SYNOPSIS
      SUBROUTINE ZHPMV ( UPLO, N, ALPHA, AP, X, INCX, BETA, Y,
                         INCY )

          COMPLEX*16   ALPHA, BETA

          INTEGER      INCX, INCY, N

          CHARACTER*1  UPLO

          COMPLEX*16   AP( * ), X( * ), Y( * )

 PURPOSE
      ZHPMV  performs the matrix-vector operation

      where alpha and beta are scalars, x and y are n element vec-
      tors and A is an n by n hermitian matrix, supplied in packed
      form.

 PARAMETERS
      UPLO   - CHARACTER*1.
               On entry, UPLO specifies whether the upper or lower
               triangular part of the matrix A is supplied in the
               packed array AP as follows:

               UPLO = 'U' or 'u'   The upper triangular part of A is
               supplied in AP.

               UPLO = 'L' or 'l'   The lower triangular part of A is
               supplied in AP.

               Unchanged on exit.

      N      - INTEGER.
               On entry, N specifies the order of the matrix A.  N
```

```
       must be at least zero.  Unchanged on exit.

ALPHA  - COMPLEX*16      .
       On entry, ALPHA specifies the scalar alpha.
       Unchanged on exit.

AP     - COMPLEX*16       array of DIMENSION at least
       ( ( n*( n + 1 ) )/2 ).  Before entry with UPLO = 'U'
       or 'u', the array AP must contain the upper triangu-
       lar part of the hermitian matrix packed sequentially,
       column by column, so that AP( 1 ) contains a( 1, 1 ),
       AP( 2 ) and AP( 3 ) contain a( 1, 2 ) and a( 2, 2 )

       respectively, and so on.  Before entry with UPLO =
       'L' or 'l', the array AP must contain the lower tri-
       angular part of the hermitian matrix packed sequen-
       tially, column by column, so that AP( 1 ) contains a(
       1, 1 ), AP( 2 ) and AP( 3 ) contain a( 2, 1 ) and a(
       3, 1 ) respectively, and so on.  Note that the ima-
       ginary parts of the diagonal elements need not be set
       and are assumed to be zero.  Unchanged on exit.

X      - COMPLEX*16       array of dimension at least
       ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
       incremented array X must contain the n element vector
       x.  Unchanged on exit.

INCX   - INTEGER.
       On entry, INCX specifies the increment for the ele-
       ments of X. INCX must not be zero.  Unchanged on
       exit.

BETA   - COMPLEX*16      .
       On entry, BETA specifies the scalar beta. When BETA
       is supplied as zero then Y need not be set on input.
       Unchanged on exit.

Y      - COMPLEX*16       array of dimension at least
       ( 1 + ( n - 1 )*abs( INCY ) ).  Before entry, the
       incremented array Y must contain the n element vector
       y. On exit, Y is overwritten by the updated vector y.

INCY   - INTEGER.
       On entry, INCY specifies the increment for the ele-
       ments of Y. INCY must not be zero.  Unchanged on
       exit.
```

— zhpmv.f —

```
      SUBROUTINE ZHPMV ( UPLO, N, ALPHA, AP, X, INCX, BETA, Y, INCY )
*     .. Scalar Arguments ..
      COMPLEX*16         ALPHA, BETA
      INTEGER            INCX, INCY, N
      CHARACTER*1        UPLO
*     .. Array Arguments ..
      COMPLEX*16         AP( * ), X( * ), Y( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      COMPLEX*16         ONE
      PARAMETER        ( ONE  = ( 1.0D+0, 0.0D+0 ) )
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     .. Local Scalars ..
      COMPLEX*16         TEMP1, TEMP2
      INTEGER            I, INFO, IX, IY, J, JX, JY, K, KK, KX, KY
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG, DBLE
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO, 'U' ).AND.
     $         .NOT.LSAME( UPLO, 'L' )      )THEN
         INFO = 1
      ELSE IF( N.LT.0 )THEN
         INFO = 2
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 6
      ELSE IF( INCY.EQ.0 )THEN
```

```
         INFO = 9
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZHPMV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( N.EQ.0 ).OR.( ( ALPHA.EQ.ZERO ).AND.( BETA.EQ.ONE ) ) )
     $   RETURN
*
*     Set up the start points in  X  and  Y.
*
      IF( INCX.GT.0 )THEN
         KX = 1
      ELSE
         KX = 1 - ( N - 1 )*INCX
      END IF
      IF( INCY.GT.0 )THEN
         KY = 1
      ELSE
         KY = 1 - ( N - 1 )*INCY
      END IF
*
*     Start the operations. In this version the elements of the array AP
*     are accessed sequentially with one pass through AP.
*
*     First form  y := beta*y.
*
      IF( BETA.NE.ONE )THEN
         IF( INCY.EQ.1 )THEN
            IF( BETA.EQ.ZERO )THEN
               DO 10, I = 1, N
                  Y( I ) = ZERO
   10          CONTINUE
            ELSE
               DO 20, I = 1, N
                  Y( I ) = BETA*Y( I )
   20          CONTINUE
            END IF
         ELSE
            IY = KY
            IF( BETA.EQ.ZERO )THEN
               DO 30, I = 1, N
                  Y( IY ) = ZERO
                  IY      = IY   + INCY
   30          CONTINUE
            ELSE
               DO 40, I = 1, N
```

```
                  Y( IY ) = BETA*Y( IY )
                  IY      = IY           + INCY
   40          CONTINUE
            END IF
         END IF
      END IF
      IF( ALPHA.EQ.ZERO )
     $   RETURN
      KK = 1
      IF( LSAME( UPLO, 'U' ) )THEN
*
*        Form  y  when AP contains the upper triangle.
*
         IF( ( INCX.EQ.1 ).AND.( INCY.EQ.1 ) )THEN
            DO 60, J = 1, N
               TEMP1 = ALPHA*X( J )
               TEMP2 = ZERO
               K     = KK
               DO 50, I = 1, J - 1
                  Y( I ) = Y( I ) + TEMP1*AP( K )
                  TEMP2  = TEMP2  + DCONJG( AP( K ) )*X( I )
                  K      = K      + 1
   50          CONTINUE
               Y( J ) = Y( J ) + TEMP1*DBLE( AP( KK + J - 1 ) )
     $                         + ALPHA*TEMP2
               KK     = KK     + J
   60       CONTINUE
         ELSE
            JX = KX
            JY = KY
            DO 80, J = 1, N
               TEMP1 = ALPHA*X( JX )
               TEMP2 = ZERO
               IX    = KX
               IY    = KY
               DO 70, K = KK, KK + J - 2
                  Y( IY ) = Y( IY ) + TEMP1*AP( K )
                  TEMP2   = TEMP2   + DCONJG( AP( K ) )*X( IX )
                  IX      = IX      + INCX
                  IY      = IY      + INCY
   70          CONTINUE
               Y( JY ) = Y( JY ) + TEMP1*DBLE( AP( KK + J - 1 ) )
     $                           + ALPHA*TEMP2
               JX      = JX      + INCX
               JY      = JY      + INCY
               KK      = KK      + J
   80       CONTINUE
         END IF
      ELSE
*
```

```
*        Form  y  when AP contains the lower triangle.
*
         IF( ( INCX.EQ.1 ).AND.( INCY.EQ.1 ) )THEN
            DO 100, J = 1, N
               TEMP1  = ALPHA*X( J )
               TEMP2  = ZERO
               Y( J ) = Y( J ) + TEMP1*DBLE( AP( KK ) )
               K      = KK     + 1
               DO 90, I = J + 1, N
                  Y( I ) = Y( I ) + TEMP1*AP( K )
                  TEMP2  = TEMP2  + DCONJG( AP( K ) )*X( I )
                  K      = K      + 1
   90          CONTINUE
               Y( J ) = Y( J ) + ALPHA*TEMP2
               KK     = KK     + ( N - J + 1 )
  100       CONTINUE
         ELSE
            JX = KX
            JY = KY
            DO 120, J = 1, N
               TEMP1   = ALPHA*X( JX )
               TEMP2   = ZERO
               Y( JY ) = Y( JY ) + TEMP1*DBLE( AP( KK ) )
               IX      = JX
               IY      = JY
               DO 110, K = KK + 1, KK + N - J
                  IX      = IX      + INCX
                  IY      = IY      + INCY
                  Y( IY ) = Y( IY ) + TEMP1*AP( K )
                  TEMP2   = TEMP2   + DCONJG( AP( K ) )*X( IX )
  110          CONTINUE
               Y( JY ) = Y( JY ) + ALPHA*TEMP2
               JX      = JX      + INCX
               JY      = JY      + INCY
               KK      = KK      + ( N - J + 1 )
  120       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of ZHPMV .
*
      END
```

———-

— BLAS 2 zhpmv —

```
(let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
 (declare (type (complex double-float) one) (type (complex double-float) zero))
  (defun zhpmv (uplo n alpha ap x incx beta y incy)
    (declare (type (simple-array (complex double-float) (*)) y x ap)
             (type (complex double-float) beta alpha)
             (type fixnum incy incx n)
             (type character uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (ap (complex double-float) ap-%data% ap-%offset%)
         (x (complex double-float) x-%data% x-%offset%)
         (y (complex double-float) y-%data% y-%offset%))
      (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (k 0) (kk 0)
             (kx 0) (ky 0) (temp1 #C(0.0 0.0)) (temp2 #C(0.0 0.0)))
        (declare (type fixnum i info ix iy j jx jy k kk kx ky)
                 (type (complex double-float) temp1 temp2))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
          ((< n 0)
           (setf info 2))
          ((= incx 0)
           (setf info 6))
          ((= incy 0)
           (setf info 9)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "ZHPMV" info)
           (go end_label)))
        (if (or (= n 0) (and (= alpha zero) (= beta one))) (go end_label))
        (cond
          ((> incx 0)
           (setf kx 1))
          (t
           (setf kx
                 (f2cl-lib:int-sub 1
                                   (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                     incx)))))
        (cond
          ((> incy 0)
           (setf ky 1))
          (t
           (setf ky
                 (f2cl-lib:int-sub 1
                                   (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                     incy)))))
        (cond
```

```
  ((/= beta one)
   (cond
     ((= incy 1)
      (cond
        ((= beta zero)
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i n) nil)
           (tagbody
             (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                     zero))))
        (t
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i n) nil)
           (tagbody
             (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                     (* beta
                        (f2cl-lib:fref y-%data%
                                       (i)
                                       ((1 *))
                                       y-%offset%)))))))))
     (t
      (setf iy ky)
      (cond
        ((= beta zero)
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i n) nil)
           (tagbody
             (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                     zero)
             (setf iy (f2cl-lib:int-add iy incy)))))
        (t
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i n) nil)
           (tagbody
             (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                     (* beta
                        (f2cl-lib:fref y-%data%
                                       (iy)
                                       ((1 *))
                                       y-%offset%)))
             (setf iy (f2cl-lib:int-add iy incy)))))))))
(if (= alpha zero) (go end_label))
(setf kk 1)
(cond
  ((char-equal uplo #\U)
   (cond
     ((and (= incx 1) (= incy 1))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
```

```
      (setf temp1
            (* alpha
               (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
      (setf temp2 zero)
      (setf k kk)
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i
                        (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                     nil)
        (tagbody
          (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                (+
                 (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                 (* temp1
                    (f2cl-lib:fref ap-%data%
                                   (k)
                                   ((1 *))
                                   ap-%offset%))))
          (setf temp2
                (+ temp2
                   (*
                    (f2cl-lib:dconjg
                     (f2cl-lib:fref ap-%data%
                                    (k)
                                    ((1 *))
                                    ap-%offset%))
                    (f2cl-lib:fref x-%data%
                                   (i)
                                   ((1 *))
                                   x-%offset%))))
          (setf k (f2cl-lib:int-add k 1))))
      (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
            (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
               (* temp1
                  (coerce (realpart
                           (f2cl-lib:fref ap-%data%
                                          ((f2cl-lib:int-sub
                                            (f2cl-lib:int-add kk j)
                                            1))
                                          ((1 *))
                                          ap-%offset%)) 'double-float))
               (* alpha temp2)))
      (setf kk (f2cl-lib:int-add kk j)))))
  (t
   (setf jx kx)
   (setf jy ky)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
     (tagbody
       (setf temp1
```

```
                        (* alpha
                           (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
                    (setf temp2 zero)
                    (setf ix kx)
                    (setf iy ky)
                    (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
                                  ((> k
                                      (f2cl-lib:int-add kk
                                                        j
                                                        (f2cl-lib:int-sub 2)))
                                   nil)
                      (tagbody
                        (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                                (+
                                 (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                                 (* temp1
                                    (f2cl-lib:fref ap-%data%
                                                   (k)
                                                   ((1 *))
                                                   ap-%offset%))))
                        (setf temp2
                                (+ temp2
                                   (*
                                    (f2cl-lib:dconjg
                                     (f2cl-lib:fref ap-%data%
                                                    (k)
                                                    ((1 *))
                                                    ap-%offset%))
                                    (f2cl-lib:fref x-%data%
                                                   (ix)
                                                   ((1 *))
                                                   x-%offset%))))
                        (setf ix (f2cl-lib:int-add ix incx))
                        (setf iy (f2cl-lib:int-add iy incy))))
                    (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                            (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                               (* temp1
                                  (coerce (realpart
                                           (f2cl-lib:fref ap-%data%
                                                          ((f2cl-lib:int-sub
                                                            (f2cl-lib:int-add kk j)
                                                            1))
                                                          ((1 *))
                                                          ap-%offset%)) 'double-float))
                               (* alpha temp2)))
                    (setf jx (f2cl-lib:int-add jx incx))
                    (setf jy (f2cl-lib:int-add jy incy))
                    (setf kk (f2cl-lib:int-add kk j)))))))
            (t
             (cond
```

```
((and (= incx 1) (= incy 1))
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (setf temp1
             (* alpha
                (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)))
     (setf temp2 zero)
     (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
             (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                (* temp1
                   (coerce (realpart
                    (f2cl-lib:fref ap-%data%
                                   (kk)
                                   ((1 *))
                                   ap-%offset%)) 'double-float))))
     (setf k (f2cl-lib:int-add kk 1))
     (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                      (f2cl-lib:int-add i 1))
                   ((> i n) nil)
       (tagbody
         (setf (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                 (+
                  (f2cl-lib:fref y-%data% (i) ((1 *)) y-%offset%)
                  (* temp1
                     (f2cl-lib:fref ap-%data%
                                    (k)
                                    ((1 *))
                                    ap-%offset%))))
         (setf temp2
                 (+ temp2
                    (*
                     (f2cl-lib:dconjg
                      (f2cl-lib:fref ap-%data%
                                     (k)
                                     ((1 *))
                                     ap-%offset%))
                     (f2cl-lib:fref x-%data%
                                    (i)
                                    ((1 *))
                                    x-%offset%))))
         (setf k (f2cl-lib:int-add k 1))))
     (setf (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
             (+ (f2cl-lib:fref y-%data% (j) ((1 *)) y-%offset%)
                (* alpha temp2)))
     (setf kk
             (f2cl-lib:int-add kk
                               (f2cl-lib:int-add
                                (f2cl-lib:int-sub n j)
                                1))))))
```

```
(t
 (setf jx kx)
 (setf jy ky)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (setf temp1
             (* alpha
                (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)))
     (setf temp2 zero)
     (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
             (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                (* temp1
                   (coerce (realpart
                    (f2cl-lib:fref ap-%data%
                                   (kk)
                                   ((1 *))
                                   ap-%offset%)) 'double-float))))
     (setf ix jx)
     (setf iy jy)
     (f2cl-lib:fdo (k (f2cl-lib:int-add kk 1)
                      (f2cl-lib:int-add k 1))
                   ((> k
                       (f2cl-lib:int-add kk
                                         n
                                         (f2cl-lib:int-sub j)))
                    nil)
       (tagbody
         (setf ix (f2cl-lib:int-add ix incx))
         (setf iy (f2cl-lib:int-add iy incy))
         (setf (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                 (+
                  (f2cl-lib:fref y-%data% (iy) ((1 *)) y-%offset%)
                  (* temp1
                     (f2cl-lib:fref ap-%data%
                                    (k)
                                    ((1 *))
                                    ap-%offset%))))
         (setf temp2
                 (+ temp2
                    (*
                     (f2cl-lib:dconjg
                      (f2cl-lib:fref ap-%data%
                                     (k)
                                     ((1 *))
                                     ap-%offset%))
                     (f2cl-lib:fref x-%data%
                                    (ix)
                                    ((1 *))
                                    x-%offset%))))))))
```

```
                (setf (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                       (+ (f2cl-lib:fref y-%data% (jy) ((1 *)) y-%offset%)
                          (* alpha temp2)))
                (setf jx (f2cl-lib:int-add jx incx))
                (setf jy (f2cl-lib:int-add jy incy))
                (setf kk
                       (f2cl-lib:int-add kk
                                         (f2cl-lib:int-add
                                          (f2cl-lib:int-sub n j)
                                          1)))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil))))))
```

———-

4.26 zhpr2 BLAS

— **zhpr2.input** —

```
)set break resume
)sys rm -f zhpr2.output
)spool zhpr2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zhpr2.help** —

```
=====================================================================
zhpr2 examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 NAME
      ZHPR2 - perform the hermitian rank 2 operation   A :=
      alpha*x*conjg( y' ) + conjg( alpha )*y*conjg( x' ) + A,
```

```
SYNOPSIS
     SUBROUTINE ZHPR2 ( UPLO, N, ALPHA, X, INCX, Y, INCY, AP )

         COMPLEX*16   ALPHA

         INTEGER      INCX, INCY, N

         CHARACTER*1  UPLO

         COMPLEX*16   AP( * ), X( * ), Y( * )

PURPOSE
     ZHPR2  performs the hermitian rank 2 operation

     where alpha is a scalar, x and y are n element vectors and A
     is an n by n hermitian matrix, supplied in packed form.

PARAMETERS
     UPLO   - CHARACTER*1.
            On entry, UPLO specifies whether the upper or lower
            triangular part of the matrix A is supplied in the
            packed array AP as follows:

            UPLO = 'U' or 'u'   The upper triangular part of A is
            supplied in AP.

            UPLO = 'L' or 'l'   The lower triangular part of A is
            supplied in AP.

            Unchanged on exit.

     N      - INTEGER.
            On entry, N specifies the order of the matrix A.  N
            must be at least zero.  Unchanged on exit.

     ALPHA  - COMPLEX*16      .
            On entry, ALPHA specifies the scalar alpha.
            Unchanged on exit.

     X      - COMPLEX*16       array of dimension at least
            ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
            incremented array X must contain the n element vector
            x.  Unchanged on exit.

     INCX   - INTEGER.
            On entry, INCX specifies the increment for the ele-
            ments of X. INCX must not be zero.  Unchanged on

            exit.
```

```
      Y      - COMPLEX*16       array of dimension at least
             ( 1 + ( n - 1 )*abs( INCY ) ).  Before entry, the
             incremented array Y must contain the n element vector
             y.  Unchanged on exit.

      INCY   - INTEGER.
             On entry, INCY specifies the increment for the ele-
             ments of Y. INCY must not be zero.  Unchanged on
             exit.

      AP     - COMPLEX*16       array of DIMENSION at least
             ( ( n*( n + 1 ) )/2 ).  Before entry with  UPLO = 'U'
             or 'u', the array AP must contain the upper triangu-
             lar part of the hermitian matrix packed sequentially,
             column by column, so that AP( 1 ) contains a( 1, 1 ),
             AP( 2 ) and AP( 3 ) contain a( 1, 2 ) and a( 2, 2 )
             respectively, and so on. On exit, the array AP is
             overwritten by the upper triangular part of the
             updated matrix.  Before entry with UPLO = 'L' or 'l',
             the array AP must contain the lower triangular part
             of the hermitian matrix packed sequentially, column
             by column, so that AP( 1 ) contains a( 1, 1 ), AP( 2
             ) and AP( 3 ) contain a( 2, 1 ) and a( 3, 1 ) respec-
             tively, and so on. On exit, the array AP is overwrit-
             ten by the lower triangular part of the updated
             matrix.  Note that the imaginary parts of the diago-
             nal elements need not be set, they are assumed to be
             zero, and on exit they are set to zero.
```

— zhpr2.f —

```
      SUBROUTINE ZHPR2 ( UPLO, N, ALPHA, X, INCX, Y, INCY, AP )
*     .. Scalar Arguments ..
      COMPLEX*16         ALPHA
      INTEGER            INCX, INCY, N
      CHARACTER*1        UPLO
*     .. Array Arguments ..
      COMPLEX*16         AP( * ), X( * ), Y( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
```

```
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     .. Local Scalars ..
      COMPLEX*16         TEMP1, TEMP2
      INTEGER            I, INFO, IX, IY, J, JX, JY, K, KK, KX, KY
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG, DBLE
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO, 'U' ).AND.
     $         .NOT.LSAME( UPLO, 'L' )      )THEN
         INFO = 1
      ELSE IF( N.LT.0 )THEN
         INFO = 2
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 5
      ELSE IF( INCY.EQ.0 )THEN
         INFO = 7
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZHPR2 ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( N.EQ.0 ).OR.( ALPHA.EQ.ZERO ) )
     $   RETURN
*
*     Set up the start points in X and Y if the increments are not both
*     unity.
*
      IF( ( INCX.NE.1 ).OR.( INCY.NE.1 ) )THEN
         IF( INCX.GT.0 )THEN
            KX = 1
         ELSE
            KX = 1 - ( N - 1 )*INCX
```

```
         END IF
         IF( INCY.GT.0 )THEN
            KY = 1
         ELSE
            KY = 1 - ( N - 1 )*INCY
         END IF
         JX = KX
         JY = KY
      END IF
*
*     Start the operations. In this version the elements of the array AP
*     are accessed sequentially with one pass through AP.
*
      KK = 1
      IF( LSAME( UPLO, 'U' ) )THEN
*
*        Form  A  when upper triangle is stored in AP.
*
         IF( ( INCX.EQ.1 ).AND.( INCY.EQ.1 ) )THEN
            DO 20, J = 1, N
               IF( ( X( J ).NE.ZERO ).OR.( Y( J ).NE.ZERO ) )THEN
                  TEMP1 = ALPHA*DCONJG( Y( J ) )
                  TEMP2 = DCONJG( ALPHA*X( J ) )
                  K     = KK
                  DO 10, I = 1, J - 1
                     AP( K ) = AP( K ) + X( I )*TEMP1 + Y( I )*TEMP2
                     K       = K       + 1
   10             CONTINUE
                  AP( KK + J - 1 ) = DBLE( AP( KK + J - 1 ) ) +
     $                               DBLE( X( J )*TEMP1 + Y( J )*TEMP2 )
               ELSE
                  AP( KK + J - 1 ) = DBLE( AP( KK + J - 1 ) )
               END IF
               KK = KK + J
   20       CONTINUE
         ELSE
            DO 40, J = 1, N
               IF( ( X( JX ).NE.ZERO ).OR.( Y( JY ).NE.ZERO ) )THEN
                  TEMP1 = ALPHA*DCONJG( Y( JY ) )
                  TEMP2 = DCONJG( ALPHA*X( JX ) )
                  IX    = KX
                  IY    = KY
                  DO 30, K = KK, KK + J - 2
                     AP( K ) = AP( K ) + X( IX )*TEMP1 + Y( IY )*TEMP2
                     IX      = IX      + INCX
                     IY      = IY      + INCY
   30             CONTINUE
                  AP( KK + J - 1 ) = DBLE( AP( KK + J - 1 ) ) +
     $                               DBLE( X( JX )*TEMP1 +
     $                                     Y( JY )*TEMP2 )
```

```
               ELSE
                  AP( KK + J - 1 ) = DBLE( AP( KK + J - 1 ) )
               END IF
               JX = JX + INCX
               JY = JY + INCY
               KK = KK + J
   40       CONTINUE
         END IF
      ELSE
*
*        Form  A  when lower triangle is stored in AP.
*
         IF( ( INCX.EQ.1 ).AND.( INCY.EQ.1 ) )THEN
            DO 60, J = 1, N
               IF( ( X( J ).NE.ZERO ).OR.( Y( J ).NE.ZERO ) )THEN
                  TEMP1   = ALPHA*DCONJG( Y( J ) )
                  TEMP2   = DCONJG( ALPHA*X( J ) )
                  AP( KK ) = DBLE( AP( KK ) ) +
     $                       DBLE( X( J )*TEMP1 + Y( J )*TEMP2 )
                  K        = KK               + 1
                  DO 50, I = J + 1, N
                     AP( K ) = AP( K ) + X( I )*TEMP1 + Y( I )*TEMP2
                     K       = K       + 1
   50             CONTINUE
               ELSE
                  AP( KK ) = DBLE( AP( KK ) )
               END IF
               KK = KK + N - J + 1
   60       CONTINUE
         ELSE
            DO 80, J = 1, N
               IF( ( X( JX ).NE.ZERO ).OR.( Y( JY ).NE.ZERO ) )THEN
                  TEMP1    = ALPHA*DCONJG( Y( JY ) )
                  TEMP2    = DCONJG( ALPHA*X( JX ) )
                  AP( KK ) = DBLE( AP( KK ) ) +
     $                       DBLE( X( JX )*TEMP1 + Y( JY )*TEMP2 )
                  IX       = JX
                  IY       = JY
                  DO 70, K = KK + 1, KK + N - J
                     IX      = IX      + INCX
                     IY      = IY      + INCY
                     AP( K ) = AP( K ) + X( IX )*TEMP1 + Y( IY )*TEMP2
   70             CONTINUE
               ELSE
                  AP( KK ) = DBLE( AP( KK ) )
               END IF
               JX = JX + INCX
               JY = JY + INCY
               KK = KK + N - J + 1
   80       CONTINUE
```

```
         END IF
      END IF
*
      RETURN
*
*     End of ZHPR2 .
*
      END
```

———-

— BLAS 2 zhpr2 —

```
(let* ((zero (complex 0.0 0.0)))
  (declare (type (complex double-float) zero))
  (defun zhpr2 (uplo n alpha x incx y incy ap)
    (declare (type (simple-array (complex double-float) (*)) ap y x)
             (type (complex double-float) alpha)
             (type fixnum incy incx n)
             (type character uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (x (complex double-float) x-%data% x-%offset%)
         (y (complex double-float) y-%data% y-%offset%)
         (ap (complex double-float) ap-%data% ap-%offset%))
      (prog ((i 0) (info 0) (ix 0) (iy 0) (j 0) (jx 0) (jy 0) (k 0) (kk 0)
             (kx 0) (ky 0) (temp1 #C(0.0 0.0)) (temp2 #C(0.0 0.0)))
        (declare (type fixnum i info ix iy j jx jy k kk kx ky)
                 (type (complex double-float) temp1 temp2))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
          ((< n 0)
           (setf info 2))
          ((= incx 0)
           (setf info 5))
          ((= incy 0)
           (setf info 7)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "ZHPR2" info)
           (go end_label)))
        (if (or (= n 0) (= alpha zero)) (go end_label))
        (cond
          ((or (/= incx 1) (/= incy 1))
```

```
   (cond
     ((> incx 0)
      (setf kx 1))
     (t
      (setf kx
              (f2cl-lib:int-sub 1
                                (f2cl-lib:int-mul
                                 (f2cl-lib:int-sub n 1)
                                 incx)))))
   (cond
     ((> incy 0)
      (setf ky 1))
     (t
      (setf ky
              (f2cl-lib:int-sub 1
                                (f2cl-lib:int-mul
                                 (f2cl-lib:int-sub n 1)
                                 incy)))))
   (setf jx kx)
   (setf jy ky)))
(setf kk 1)
(cond
  ((char-equal uplo #\U)
   (cond
     ((and (= incx 1) (= incy 1))
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (cond
            ((or (/= (f2cl-lib:fref x (j) ((1 *))) zero)
                 (/= (f2cl-lib:fref y (j) ((1 *))) zero))
             (setf temp1
                     (* alpha
                        (f2cl-lib:dconjg
                         (f2cl-lib:fref y-%data%
                                        (j)
                                        ((1 *))
                                        y-%offset%))))
             (setf temp2
                     (coerce
                      (f2cl-lib:dconjg
                       (* alpha
                          (f2cl-lib:fref x-%data%
                                         (j)
                                         ((1 *))
                                         x-%offset%)))
                      '(complex double-float)))
             (setf k kk)
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i
```

```
                    (f2cl-lib:int-add j
                                     (f2cl-lib:int-sub 1)))
                nil)
          (tagbody
            (setf (f2cl-lib:fref ap-%data%
                                 (k)
                                 ((1 *))
                                 ap-%offset%)
                  (+
                   (f2cl-lib:fref ap-%data%
                                  (k)
                                  ((1 *))
                                  ap-%offset%)
                   (*
                    (f2cl-lib:fref x-%data%
                                   (i)
                                   ((1 *))
                                   x-%offset%)
                    temp1)
                   (*
                    (f2cl-lib:fref y-%data%
                                   (i)
                                   ((1 *))
                                   y-%offset%)
                    temp2)))
            (setf k (f2cl-lib:int-add k 1))))
        (setf (f2cl-lib:fref ap-%data%
                             ((f2cl-lib:int-sub
                               (f2cl-lib:int-add kk j)
                               1))
                             ((1 *))
                             ap-%offset%)
              (coerce
               (+
                (coerce (realpart
                 (f2cl-lib:fref ap-%data%
                                ((f2cl-lib:int-sub
                                  (f2cl-lib:int-add kk j)
                                  1))
                                ((1 *))
                                ap-%offset%)) 'double-float)
                (coerce (realpart
                 (+
                  (*
                   (f2cl-lib:fref x-%data%
                                  (j)
                                  ((1 *))
                                  x-%offset%)
                   temp1)
                  (*
```

```
                        (f2cl-lib:fref y-%data%
                                       (j)
                                       ((1 *))
                                       y-%offset%)
                        temp2))) 'double-float))
                  '(complex double-float))))
          (t
           (setf (f2cl-lib:fref ap-%data%
                                ((f2cl-lib:int-sub
                                  (f2cl-lib:int-add kk j)
                                  1))
                                ((1 *))
                                ap-%offset%)
                 (coerce
                  (coerce (realpart
                   (f2cl-lib:fref ap-%data%
                                  ((f2cl-lib:int-sub
                                    (f2cl-lib:int-add kk j)
                                    1))
                                  ((1 *))
                                  ap-%offset%)) 'double-float)
                  '(complex double-float)))))
      (setf kk (f2cl-lib:int-add kk j)))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (cond
       ((or (/= (f2cl-lib:fref x (jx) ((1 *))) zero)
            (/= (f2cl-lib:fref y (jy) ((1 *))) zero))
        (setf temp1
                (* alpha
                   (f2cl-lib:dconjg
                    (f2cl-lib:fref y-%data%
                                   (jy)
                                   ((1 *))
                                   y-%offset%))))
        (setf temp2
                (coerce
                 (f2cl-lib:dconjg
                  (* alpha
                     (f2cl-lib:fref x-%data%
                                    (jx)
                                    ((1 *))
                                    x-%offset%)))
                 '(complex double-float)))
        (setf ix kx)
        (setf iy ky)
        (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
                      ((> k
```

```
                    (f2cl-lib:int-add kk
                                      j
                                      (f2cl-lib:int-sub 2)))
                nil)
  (tagbody
    (setf (f2cl-lib:fref ap-%data%
                         (k)
                         ((1 *))
                         ap-%offset%)
          (+
           (f2cl-lib:fref ap-%data%
                          (k)
                          ((1 *))
                          ap-%offset%)
           (*
            (f2cl-lib:fref x-%data%
                           (ix)
                           ((1 *))
                           x-%offset%)
            temp1)
           (*
            (f2cl-lib:fref y-%data%
                           (iy)
                           ((1 *))
                           y-%offset%)
            temp2)))
    (setf ix (f2cl-lib:int-add ix incx))
    (setf iy (f2cl-lib:int-add iy incy))))
(setf (f2cl-lib:fref ap-%data%
                     ((f2cl-lib:int-sub
                       (f2cl-lib:int-add kk j)
                       1))
                     ((1 *))
                     ap-%offset%)
      (coerce
       (+
        (coerce (realpart
         (f2cl-lib:fref ap-%data%
                        ((f2cl-lib:int-sub
                          (f2cl-lib:int-add kk j)
                          1))
                        ((1 *))
                        ap-%offset%)) 'double-float)
        (coerce (realpart
         (+
          (*
           (f2cl-lib:fref x-%data%
                          (jx)
                          ((1 *))
                          x-%offset%)
```

```
                                temp1)
                               (*
                                (f2cl-lib:fref y-%data%
                                               (jy)
                                               ((1 *))
                                               y-%offset%)
                                temp2))) 'double-float))
                            '(complex double-float))))
                    (t
                     (setf (f2cl-lib:fref ap-%data%
                                          ((f2cl-lib:int-sub
                                            (f2cl-lib:int-add kk j)
                                            1))
                                          ((1 *))
                                          ap-%offset%)
                           (coerce
                            (coerce (realpart
                             (f2cl-lib:fref ap-%data%
                                            ((f2cl-lib:int-sub
                                              (f2cl-lib:int-add kk j)
                                              1))
                                            ((1 *))
                                            ap-%offset%)) 'double-float)
                            '(complex double-float)))))
                    (setf jx (f2cl-lib:int-add jx incx))
                    (setf jy (f2cl-lib:int-add jy incy))
                    (setf kk (f2cl-lib:int-add kk j)))))))
            (t
             (cond
               ((and (= incx 1) (= incy 1))
                (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                              ((> j n) nil)
                  (tagbody
                    (cond
                      ((or (/= (f2cl-lib:fref x (j) ((1 *))) zero)
                           (/= (f2cl-lib:fref y (j) ((1 *))) zero))
                       (setf temp1
                             (* alpha
                                (f2cl-lib:dconjg
                                 (f2cl-lib:fref y-%data%
                                                (j)
                                                ((1 *))
                                                y-%offset%))))
                       (setf temp2
                             (coerce
                              (f2cl-lib:dconjg
                               (* alpha
                                  (f2cl-lib:fref x-%data%
                                                 (j)
                                                 ((1 *))
```

```
                              x-%offset%)))
          '(complex double-float)))
(setf (f2cl-lib:fref ap-%data% (kk) ((1 *)) ap-%offset%)
        (coerce
         (+
          (coerce (realpart
           (f2cl-lib:fref ap-%data%
                          (kk)
                          ((1 *))
                          ap-%offset%)) 'double-float)
          (coerce (realpart
           (+
            (*
             (f2cl-lib:fref x-%data%
                            (j)
                            ((1 *))
                            x-%offset%)
             temp1)
            (*
             (f2cl-lib:fref y-%data%
                            (j)
                            ((1 *))
                            y-%offset%)
             temp2))) 'double-float))
          '(complex double-float)))
(setf k (f2cl-lib:int-add kk 1))
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                 (f2cl-lib:int-add i 1))
               ((> i n) nil)
  (tagbody
    (setf (f2cl-lib:fref ap-%data%
                         (k)
                         ((1 *))
                         ap-%offset%)
            (+
             (f2cl-lib:fref ap-%data%
                            (k)
                            ((1 *))
                            ap-%offset%)
             (*
              (f2cl-lib:fref x-%data%
                             (i)
                             ((1 *))
                             x-%offset%)
              temp1)
             (*
              (f2cl-lib:fref y-%data%
                             (i)
                             ((1 *))
                             y-%offset%)
```

```
                        temp2)))
                (setf k (f2cl-lib:int-add k 1)))))
          (t
           (setf (f2cl-lib:fref ap-%data% (kk) ((1 *)) ap-%offset%)
                 (coerce
                  (coerce (realpart
                   (f2cl-lib:fref ap-%data%
                                  (kk)
                                  ((1 *))
                                  ap-%offset%)) 'double-float)
                  '(complex double-float)))))
       (setf kk
             (f2cl-lib:int-add
              (f2cl-lib:int-sub (f2cl-lib:int-add kk n) j)
              1)))))
  (t
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
     (tagbody
       (cond
         ((or (/= (f2cl-lib:fref x (jx) ((1 *))) zero)
              (/= (f2cl-lib:fref y (jy) ((1 *))) zero))
          (setf temp1
                  (* alpha
                     (f2cl-lib:dconjg
                      (f2cl-lib:fref y-%data%
                                     (jy)
                                     ((1 *))
                                     y-%offset%))))
          (setf temp2
                  (coerce
                   (f2cl-lib:dconjg
                    (* alpha
                       (f2cl-lib:fref x-%data%
                                      (jx)
                                      ((1 *))
                                      x-%offset%)))
                   '(complex double-float)))
          (setf (f2cl-lib:fref ap-%data% (kk) ((1 *)) ap-%offset%)
                  (coerce
                   (+
                    (coerce (realpart
                     (f2cl-lib:fref ap-%data%
                                    (kk)
                                    ((1 *))
                                    ap-%offset%)) 'double-float)
                    (coerce (realpart
                     (+
                      (*
                       (f2cl-lib:fref x-%data%
```

```
                                (jx)
                                ((1 *))
                                x-%offset%)
                    temp1)
                   (*
                    (f2cl-lib:fref y-%data%
                                (jy)
                                ((1 *))
                                y-%offset%)
                    temp2))) 'double-float))
             '(complex double-float)))
 (setf ix jx)
 (setf iy jy)
 (f2cl-lib:fdo (k (f2cl-lib:int-add kk 1)
                  (f2cl-lib:int-add k 1))
                ((> k
                    (f2cl-lib:int-add kk
                                      n
                                      (f2cl-lib:int-sub j)))
                 nil)
   (tagbody
     (setf ix (f2cl-lib:int-add ix incx))
     (setf iy (f2cl-lib:int-add iy incy))
     (setf (f2cl-lib:fref ap-%data%
                          (k)
                          ((1 *))
                          ap-%offset%)
             (+
              (f2cl-lib:fref ap-%data%
                             (k)
                             ((1 *))
                             ap-%offset%)
              (*
               (f2cl-lib:fref x-%data%
                              (ix)
                              ((1 *))
                              x-%offset%)
               temp1)
              (*
               (f2cl-lib:fref y-%data%
                              (iy)
                              ((1 *))
                              y-%offset%)
               temp2))))))
(t
 (setf (f2cl-lib:fref ap-%data% (kk) ((1 *)) ap-%offset%)
         (coerce
          (coerce (realpart
           (f2cl-lib:fref ap-%data%
                          (kk)
```

```
                                          ((1 *))
                                          ap-%offset%)) 'double-float)
                             '(complex double-float)))))
                (setf jx (f2cl-lib:int-add jx incx))
                (setf jy (f2cl-lib:int-add jy incy))
                (setf kk
                       (f2cl-lib:int-add
                        (f2cl-lib:int-sub (f2cl-lib:int-add kk n) j)
                        1))))))))
 end_label
       (return (values nil nil nil nil nil nil nil nil))))))
```

———-

4.27 zhpr BLAS

— **zhpr.input** —

```
)set break resume
)sys rm -f zhpr.output
)spool zhpr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zhpr.help** —

```
=======================================================================
zhpr examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

 NAME
      ZHPR - perform the hermitian rank 1 operation   A :=
      alpha*x*conjg( x' ) + A,

 SYNOPSIS
```

```
      SUBROUTINE ZHPR ( UPLO, N, ALPHA, X, INCX, AP )

          DOUBLE      PRECISION ALPHA

          INTEGER     INCX, N

          CHARACTER*1 UPLO

          COMPLEX*16  AP( * ), X( * )

PURPOSE
     ZHPR    performs the hermitian rank 1 operation

     where alpha is a real scalar, x is an n element vector and A
     is an n by n hermitian matrix, supplied in packed form.

PARAMETERS
     UPLO   - CHARACTER*1.
            On entry, UPLO specifies whether the upper or lower
            triangular part of the matrix A is supplied in the
            packed array AP as follows:

            UPLO = 'U' or 'u'   The upper triangular part of A is
            supplied in AP.

            UPLO = 'L' or 'l'   The lower triangular part of A is
            supplied in AP.

            Unchanged on exit.

     N      - INTEGER.
            On entry, N specifies the order of the matrix A.  N
            must be at least zero.  Unchanged on exit.

     ALPHA  - DOUBLE PRECISION.
            On entry, ALPHA specifies the scalar alpha.
            Unchanged on exit.

     X      - COMPLEX*16       array of dimension at least
            ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
            incremented array X must contain the n element vector
            x.  Unchanged on exit.

     INCX   - INTEGER.
            On entry, INCX specifies the increment for the ele-
            ments of X. INCX must not be zero.  Unchanged on

            exit.

     AP     - COMPLEX*16       array of DIMENSION at least
```

```
           ( ( n*( n + 1 ) )/2 ).  Before entry with  UPLO = 'U'
           or 'u', the array AP must contain the upper triangu-
           lar part of the hermitian matrix packed sequentially,
           column by column, so that AP( 1 ) contains a( 1, 1 ),
           AP( 2 ) and AP( 3 ) contain a( 1, 2 ) and a( 2, 2 )
           respectively, and so on. On exit, the array AP is
           overwritten by the upper triangular part of the
           updated matrix.  Before entry with UPLO = 'L' or 'l',
           the array AP must contain the lower triangular part
           of the hermitian matrix packed sequentially, column
           by column, so that AP( 1 ) contains a( 1, 1 ), AP( 2
           ) and AP( 3 ) contain a( 2, 1 ) and a( 3, 1 ) respec-
           tively, and so on. On exit, the array AP is overwrit-
           ten by the lower triangular part of the updated
           matrix.  Note that the imaginary parts of the diago-
           nal elements need not be set, they are assumed to be
           zero, and on exit they are set to zero.
```

— zhpr.f —

```
      SUBROUTINE ZHPR  ( UPLO, N, ALPHA, X, INCX, AP )
*     .. Scalar Arguments ..
      DOUBLE PRECISION   ALPHA
      INTEGER            INCX, N
      CHARACTER*1        UPLO
*     .. Array Arguments ..
      COMPLEX*16         AP( * ), X( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     .. Local Scalars ..
      COMPLEX*16         TEMP
      INTEGER            I, INFO, IX, J, JX, K, KK, KX
*     .. External Functions ..
      LOGICAL            LSAME
```

```
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG, DBLE
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO, 'U' ).AND.
     $         .NOT.LSAME( UPLO, 'L' )      )THEN
         INFO = 1
      ELSE IF( N.LT.0 )THEN
         INFO = 2
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 5
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZHPR  ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( N.EQ.0 ).OR.( ALPHA.EQ.DBLE( ZERO ) ) )
     $   RETURN
*
*     Set the start point in X if the increment is not unity.
*
      IF( INCX.LE.0 )THEN
         KX = 1 - ( N - 1 )*INCX
      ELSE IF( INCX.NE.1 )THEN
         KX = 1
      END IF
*
*     Start the operations. In this version the elements of the array AP
*     are accessed sequentially with one pass through AP.
*
      KK = 1
      IF( LSAME( UPLO, 'U' ) )THEN
*
*        Form  A  when upper triangle is stored in AP.
*
         IF( INCX.EQ.1 )THEN
            DO 20, J = 1, N
               IF( X( J ).NE.ZERO )THEN
                  TEMP = ALPHA*DCONJG( X( J ) )
                  K    = KK
```

```
                  DO 10, I = 1, J - 1
                     AP( K ) = AP( K ) + X( I )*TEMP
                     K       = K       + 1
   10             CONTINUE
                  AP( KK + J - 1 ) = DBLE( AP( KK + J - 1 ) )
     $                             + DBLE( X( J )*TEMP )
               ELSE
                  AP( KK + J - 1 ) = DBLE( AP( KK + J - 1 ) )
               END IF
               KK = KK + J
   20       CONTINUE
         ELSE
            JX = KX
            DO 40, J = 1, N
               IF( X( JX ).NE.ZERO )THEN
                  TEMP = ALPHA*DCONJG( X( JX ) )
                  IX   = KX
                  DO 30, K = KK, KK + J - 2
                     AP( K ) = AP( K ) + X( IX )*TEMP
                     IX      = IX      + INCX
   30             CONTINUE
                  AP( KK + J - 1 ) = DBLE( AP( KK + J - 1 ) )
     $                             + DBLE( X( JX )*TEMP )
               ELSE
                  AP( KK + J - 1 ) = DBLE( AP( KK + J - 1 ) )
               END IF
               JX = JX + INCX
               KK = KK + J
   40       CONTINUE
         END IF
      ELSE
*
*        Form  A  when lower triangle is stored in AP.
*
         IF( INCX.EQ.1 )THEN
            DO 60, J = 1, N
               IF( X( J ).NE.ZERO )THEN
                  TEMP     = ALPHA*DCONJG( X( J ) )
                  AP( KK ) = DBLE( AP( KK ) ) + DBLE( TEMP*X( J ) )
                  K        = KK               + 1
                  DO 50, I = J + 1, N
                     AP( K ) = AP( K ) + X( I )*TEMP
                     K       = K       + 1
   50             CONTINUE
               ELSE
                  AP( KK ) = DBLE( AP( KK ) )
               END IF
               KK = KK + N - J + 1
   60       CONTINUE
         ELSE
```

```
            JX = KX
            DO 80, J = 1, N
               IF( X( JX ).NE.ZERO )THEN
                  TEMP    = ALPHA*DCONJG( X( JX ) )
                  AP( KK ) = DBLE( AP( KK ) ) + DBLE( TEMP*X( JX ) )
                  IX      = JX
                  DO 70, K = KK + 1, KK + N - J
                     IX      = IX      + INCX
                     AP( K ) = AP( K ) + X( IX )*TEMP
   70             CONTINUE
               ELSE
                  AP( KK ) = DBLE( AP( KK ) )
               END IF
               JX = JX + INCX
               KK = KK + N - J + 1
   80       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of ZHPR  .
*
      END
```

———-

— BLAS 2 zhpr —

```
(let* ((zero (complex 0.0 0.0)))
  (declare (type (complex double-float) zero))
  (defun zhpr (uplo n alpha x incx ap)
    (declare (type (simple-array (complex double-float) (*)) ap x)
             (type (double-float) alpha)
             (type fixnum incx n)
             (type character uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (x (complex double-float) x-%data% x-%offset%)
         (ap (complex double-float) ap-%data% ap-%offset%))
      (prog ((i 0) (info 0) (ix 0) (j 0) (jx 0) (k 0) (kk 0) (kx 0)
             (temp #C(0.0 0.0)))
        (declare (type fixnum i info ix j jx k kk kx)
                 (type (complex double-float) temp))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
```

```
  ((< n 0)
   (setf info 2))
  ((= incx 0)
   (setf info 5)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "ZHPR" info)
   (go end_label)))
(if (or (= n 0) (= alpha (coerce (realpart zero) 'double-float)))
   (go end_label))
(cond
  ((<= incx 0)
   (setf kx
         (f2cl-lib:int-sub 1
                           (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                             incx))))
  ((/= incx 1)
   (setf kx 1)))
(setf kk 1)
(cond
  ((char-equal uplo #\U)
   (cond
     ((= incx 1)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (cond
            (((/= (f2cl-lib:fref x (j) ((1 *))) zero)
             (setf temp
                     (coerce
                      (* alpha
                         (f2cl-lib:dconjg
                          (f2cl-lib:fref x-%data%
                                         (j)
                                         ((1 *))
                                         x-%offset%)))
                      '(complex double-float)))
             (setf k kk)
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i
                               (f2cl-lib:int-add j
                                                 (f2cl-lib:int-sub 1)))
                            nil)
               (tagbody
                 (setf (f2cl-lib:fref ap-%data%
                                      (k)
                                      ((1 *))
                                      ap-%offset%)
```

```
                  (+
                   (f2cl-lib:fref ap-%data%
                                  (k)
                                  ((1 *))
                                  ap-%offset%)
                   (*
                    (f2cl-lib:fref x-%data%
                                   (i)
                                   ((1 *))
                                   x-%offset%)
                    temp)))
              (setf k (f2cl-lib:int-add k 1))))
       (setf (f2cl-lib:fref ap-%data%
                            ((f2cl-lib:int-sub
                              (f2cl-lib:int-add kk j)
                              1))
                            ((1 *))
                            ap-%offset%)
             (coerce
              (+
               (coerce (realpart
                        (f2cl-lib:fref ap-%data%
                                       ((f2cl-lib:int-sub
                                         (f2cl-lib:int-add kk j)
                                         1))
                                       ((1 *))
                                       ap-%offset%)) 'double-float)
               (coerce (realpart
                        (*
                         (f2cl-lib:fref x-%data%
                                        (j)
                                        ((1 *))
                                        x-%offset%)
                         temp)) 'double-float))
              '(complex double-float))))
      (t
       (setf (f2cl-lib:fref ap-%data%
                            ((f2cl-lib:int-sub
                              (f2cl-lib:int-add kk j)
                              1))
                            ((1 *))
                            ap-%offset%)
             (coerce
              (coerce (realpart
                       (f2cl-lib:fref ap-%data%
                                      ((f2cl-lib:int-sub
                                        (f2cl-lib:int-add kk j)
                                        1))
                                      ((1 *))
                                      ap-%offset%)) 'double-float)
```

```
                  '(complex double-float)))))
      (setf kk (f2cl-lib:int-add kk j)))))
(t
 (setf jx kx)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (cond
       ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (setf temp
                (coerce
                 (* alpha
                    (f2cl-lib:dconjg
                     (f2cl-lib:fref x-%data%
                                    (jx)
                                    ((1 *))
                                    x-%offset%)))
                 '(complex double-float)))
        (setf ix kx)
        (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
                      ((> k
                          (f2cl-lib:int-add kk
                                            j
                                            (f2cl-lib:int-sub 2)))
                       nil)
          (tagbody
            (setf (f2cl-lib:fref ap-%data%
                                 (k)
                                 ((1 *))
                                 ap-%offset%)
                  (+
                   (f2cl-lib:fref ap-%data%
                                  (k)
                                  ((1 *))
                                  ap-%offset%)
                   (*
                    (f2cl-lib:fref x-%data%
                                   (ix)
                                   ((1 *))
                                   x-%offset%)
                    temp)))
            (setf ix (f2cl-lib:int-add ix incx))))
        (setf (f2cl-lib:fref ap-%data%
                             ((f2cl-lib:int-sub
                               (f2cl-lib:int-add kk j)
                               1))
                             ((1 *))
                             ap-%offset%)
              (coerce
               (+
```

```
                        (coerce (realpart
                         (f2cl-lib:fref ap-%data%
                                        ((f2cl-lib:int-sub
                                          (f2cl-lib:int-add kk j)
                                          1))
                                        ((1 *))
                                        ap-%offset%)) 'double-float)
                        (coerce (realpart
                         (*
                          (f2cl-lib:fref x-%data%
                                         (jx)
                                         ((1 *))
                                         x-%offset%)
                          temp)) 'double-float))
                       '(complex double-float))))
              (t
               (setf (f2cl-lib:fref ap-%data%
                                    ((f2cl-lib:int-sub
                                      (f2cl-lib:int-add kk j)
                                      1))
                                    ((1 *))
                                    ap-%offset%)
                     (coerce
                      (coerce (realpart
                       (f2cl-lib:fref ap-%data%
                                      ((f2cl-lib:int-sub
                                        (f2cl-lib:int-add kk j)
                                        1))
                                      ((1 *))
                                      ap-%offset%)) 'double-float)
                      '(complex double-float)))))
              (setf jx (f2cl-lib:int-add jx incx))
              (setf kk (f2cl-lib:int-add kk j)))))))
    (t
     (cond
       ((= incx 1)
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                      ((> j n) nil)
          (tagbody
            (cond
              ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
               (setf temp
                     (coerce
                      (* alpha
                         (f2cl-lib:dconjg
                          (f2cl-lib:fref x-%data%
                                         (j)
                                         ((1 *))
                                         x-%offset%)))
                      '(complex double-float)))
```

```
                  (setf (f2cl-lib:fref ap-%data% (kk) ((1 *)) ap-%offset%)
                          (coerce
                           (+
                            (coerce (realpart
                             (f2cl-lib:fref ap-%data%
                                            (kk)
                                            ((1 *))
                                            ap-%offset%)) 'double-float)
                            (coerce (realpart
                             (* temp
                                (f2cl-lib:fref x-%data%
                                               (j)
                                               ((1 *))
                                               x-%offset%))) 'double-float))
                           '(complex double-float)))
                  (setf k (f2cl-lib:int-add kk 1))
                  (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                 (f2cl-lib:int-add i 1))
                                ((> i n) nil)
                    (tagbody
                      (setf (f2cl-lib:fref ap-%data%
                                           (k)
                                           ((1 *))
                                           ap-%offset%)
                            (+
                             (f2cl-lib:fref ap-%data%
                                            (k)
                                            ((1 *))
                                            ap-%offset%)
                             (*
                              (f2cl-lib:fref x-%data%
                                             (i)
                                             ((1 *))
                                             x-%offset%)
                              temp)))
                      (setf k (f2cl-lib:int-add k 1)))))
                 (t
                  (setf (f2cl-lib:fref ap-%data% (kk) ((1 *)) ap-%offset%)
                          (coerce
                           (coerce (realpart
                            (f2cl-lib:fref ap-%data%
                                           (kk)
                                           ((1 *))
                                           ap-%offset%)) 'double-float)
                           '(complex double-float)))))
               (setf kk
                       (f2cl-lib:int-add
                        (f2cl-lib:int-sub (f2cl-lib:int-add kk n) j)
                        1)))))
          (t
```

```
(setf jx kx)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j n) nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
       (setf temp
              (coerce
               (* alpha
                  (f2cl-lib:dconjg
                   (f2cl-lib:fref x-%data%
                                  (jx)
                                  ((1 *))
                                  x-%offset%)))
               '(complex double-float)))
       (setf (f2cl-lib:fref ap-%data% (kk) ((1 *)) ap-%offset%)
              (coerce
               (+
                (coerce (realpart
                 (f2cl-lib:fref ap-%data%
                                (kk)
                                ((1 *))
                                ap-%offset%)) 'double-float)
                (coerce (realpart
                 (* temp
                    (f2cl-lib:fref x-%data%
                                   (jx)
                                   ((1 *))
                                   x-%offset%))) 'double-float))
               '(complex double-float)))
       (setf ix jx)
       (f2cl-lib:fdo (k (f2cl-lib:int-add kk 1)
                        (f2cl-lib:int-add k 1))
                     ((> k
                         (f2cl-lib:int-add kk
                                           n
                                           (f2cl-lib:int-sub j)))
                      nil)
         (tagbody
           (setf ix (f2cl-lib:int-add ix incx))
           (setf (f2cl-lib:fref ap-%data%
                                (k)
                                ((1 *))
                                ap-%offset%)
                 (+
                  (f2cl-lib:fref ap-%data%
                                 (k)
                                 ((1 *))
                                 ap-%offset%)
                  (*
```

```
                                (f2cl-lib:fref x-%data%
                                               (ix)
                                               ((1 *))
                                               x-%offset%)
                                temp))))))
                  (t
                   (setf (f2cl-lib:fref ap-%data% (kk) ((1 *)) ap-%offset%)
                           (coerce
                            (coerce (realpart
                             (f2cl-lib:fref ap-%data%
                                            (kk)
                                            ((1 *))
                                            ap-%offset%)) 'double-float)
                            '(complex double-float)))))
                 (setf jx (f2cl-lib:int-add jx incx))
                 (setf kk
                        (f2cl-lib:int-add
                         (f2cl-lib:int-sub (f2cl-lib:int-add kk n) j)
                         1))))))))
 end_label
        (return (values nil nil nil nil nil nil))))))
```

———-

4.28 ztbmv BLAS

— **ztbmv.input** —

```
)set break resume
)sys rm -f ztbmv.output
)spool ztbmv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **ztbmv.help** —

```
===========================================================================
ztbmv examples
===========================================================================
```

```
================================================================
Man Page Details
================================================================

 NAME
      ZTBMV - perform one of the matrix-vector operations   x :=
      A*x, or x := A'*x, or x := conjg( A' )*x,

 SYNOPSIS
      SUBROUTINE ZTBMV ( UPLO, TRANS, DIAG, N, K, A, LDA, X, INCX
                       )

          INTEGER      INCX, K, LDA, N

          CHARACTER*1  DIAG, TRANS, UPLO

          COMPLEX*16   A( LDA, * ), X( * )

 PURPOSE
      ZTBMV  performs one of the matrix-vector operations

      where x is an n element vector and  A is an n by n unit, or
      non-unit, upper or lower triangular band matrix, with ( k +
      1 ) diagonals.

 PARAMETERS
      UPLO   - CHARACTER*1.
               On entry, UPLO specifies whether the matrix is an
               upper or lower triangular matrix as follows:

               UPLO = 'U' or 'u'   A is an upper triangular matrix.

               UPLO = 'L' or 'l'   A is a lower triangular matrix.

               Unchanged on exit.

      TRANS  - CHARACTER*1.
               On entry, TRANS specifies the operation to be per-
               formed as follows:

               TRANS = 'N' or 'n'   x := A*x.

               TRANS = 'T' or 't'   x := A'*x.

               TRANS = 'C' or 'c'   x := conjg( A' )*x.

               Unchanged on exit.

      DIAG   - CHARACTER*1.
```

```
          On entry, DIAG specifies whether or not A is unit
          triangular as follows:

          DIAG = 'U' or 'u'   A is assumed to be unit triangu-
          lar.

          DIAG = 'N' or 'n'   A is not assumed to be unit tri-
          angular.

          Unchanged on exit.

N         - INTEGER.
          On entry, N specifies the order of the matrix A.  N
          must be at least zero.  Unchanged on exit.

K         - INTEGER.
          On entry with UPLO = 'U' or 'u', K specifies the
          number of super-diagonals of the matrix A.  On entry
          with UPLO = 'L' or 'l', K specifies the number of
          sub-diagonals of the matrix A.  K must satisfy  0
          .le. K.  Unchanged on exit.

A         - COMPLEX*16       array of DIMENSION ( LDA, n ).
          Before entry with UPLO = 'U' or 'u', the leading ( k
          + 1 ) by n part of the array A must contain the upper
          triangular band part of the matrix of coefficients,
          supplied column by column, with the leading diagonal
          of the matrix in row ( k + 1 ) of the array, the
          first super-diagonal starting at position 2 in row k,
          and so on. The top left k by k triangle of the array
          A is not referenced.  The following program segment
          will transfer an upper triangular band matrix from
          conventional full matrix storage to band storage:

          DO 20, J = 1, N M = K + 1 - J DO 10, I = MAX( 1, J -
          K ), J A( M + I, J ) = matrix( I, J ) 10    CONTINUE
          20 CONTINUE

          Before entry with UPLO = 'L' or 'l', the leading ( k
          + 1 ) by n part of the array A must contain the lower
          triangular band part of the matrix of coefficients,
          supplied column by column, with the leading diagonal
          of the matrix in row 1 of the array, the first sub-
          diagonal starting at position 1 in row 2, and so on.
          The bottom right k by k triangle of the array A is
          not referenced.  The following program segment will
          transfer a lower triangular band matrix from conven-
          tional full matrix storage to band storage:

          DO 20, J = 1, N M = 1 - J DO 10, I = J, MIN( N, J + K
```

```
            ) A( M + I, J ) = matrix( I, J ) 10    CONTINUE 20
            CONTINUE

            Note that when DIAG = 'U' or 'u' the elements of the
            array A corresponding to the diagonal elements of the
            matrix are not referenced, but are assumed to be
            unity.  Unchanged on exit.

      LDA   - INTEGER.
            On entry, LDA specifies the first dimension of A as
            declared in the calling (sub) program. LDA must be at
            least ( k + 1 ).  Unchanged on exit.

      X     - COMPLEX*16       array of dimension at least
            ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
            incremented array X must contain the n element vector
            x. On exit, X is overwritten with the transformed
            vector x.

      INCX  - INTEGER.
            On entry, INCX specifies the increment for the ele-
            ments of X. INCX must not be zero.  Unchanged on
            exit.
```

———-

— ztbmv.f —

```
      SUBROUTINE ZTBMV ( UPLO, TRANS, DIAG, N, K, A, LDA, X, INCX )
*     .. Scalar Arguments ..
      INTEGER            INCX, K, LDA, N
      CHARACTER*1        DIAG, TRANS, UPLO
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), X( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
```

```
*     .. Local Scalars ..
      COMPLEX*16         TEMP
      INTEGER            I, INFO, IX, J, JX, KPLUS1, KX, L
      LOGICAL            NOCONJ, NOUNIT
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG, MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO , 'U' ).AND.
     $         .NOT.LSAME( UPLO , 'L' )      )THEN
         INFO = 1
      ELSE IF( .NOT.LSAME( TRANS, 'N' ).AND.
     $         .NOT.LSAME( TRANS, 'T' ).AND.
     $         .NOT.LSAME( TRANS, 'C' )      )THEN
         INFO = 2
      ELSE IF( .NOT.LSAME( DIAG , 'U' ).AND.
     $         .NOT.LSAME( DIAG , 'N' )      )THEN
         INFO = 3
      ELSE IF( N.LT.0 )THEN
         INFO = 4
      ELSE IF( K.LT.0 )THEN
         INFO = 5
      ELSE IF( LDA.LT.( K + 1 ) )THEN
         INFO = 7
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 9
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZTBMV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( N.EQ.0 )
     $   RETURN
*
      NOCONJ = LSAME( TRANS, 'T' )
      NOUNIT = LSAME( DIAG , 'N' )
*
*     Set up the start point in X if the increment is not unity. This
```

```
*     will be  ( N - 1 )*INCX   too small for descending loops.
*
      IF( INCX.LE.0 )THEN
         KX = 1 - ( N - 1 )*INCX
      ELSE IF( INCX.NE.1 )THEN
         KX = 1
      END IF
*
*     Start the operations. In this version the elements of A are
*     accessed sequentially with one pass through A.
*
      IF( LSAME( TRANS, 'N' ) )THEN
*
*         Form  x := A*x.
*
         IF( LSAME( UPLO, 'U' ) )THEN
            KPLUS1 = K + 1
            IF( INCX.EQ.1 )THEN
               DO 20, J = 1, N
                  IF( X( J ).NE.ZERO )THEN
                     TEMP = X( J )
                     L    = KPLUS1 - J
                     DO 10, I = MAX( 1, J - K ), J - 1
                        X( I ) = X( I ) + TEMP*A( L + I, J )
   10                CONTINUE
                     IF( NOUNIT )
     $                  X( J ) = X( J )*A( KPLUS1, J )
                  END IF
   20          CONTINUE
            ELSE
               JX = KX
               DO 40, J = 1, N
                  IF( X( JX ).NE.ZERO )THEN
                     TEMP = X( JX )
                     IX   = KX
                     L    = KPLUS1  - J
                     DO 30, I = MAX( 1, J - K ), J - 1
                        X( IX ) = X( IX ) + TEMP*A( L + I, J )
                        IX      = IX      + INCX
   30                CONTINUE
                     IF( NOUNIT )
     $                  X( JX ) = X( JX )*A( KPLUS1, J )
                  END IF
                  JX = JX + INCX
                  IF( J.GT.K )
     $               KX = KX + INCX
   40          CONTINUE
            END IF
         ELSE
            IF( INCX.EQ.1 )THEN
```

```
               DO 60, J = N, 1, -1
                  IF( X( J ).NE.ZERO )THEN
                     TEMP = X( J )
                     L    = 1      - J
                     DO 50, I = MIN( N, J + K ), J + 1, -1
                        X( I ) = X( I ) + TEMP*A( L + I, J )
   50                CONTINUE
                     IF( NOUNIT )
     $                  X( J ) = X( J )*A( 1, J )
                  END IF
   60             CONTINUE
               ELSE
                  KX = KX + ( N - 1 )*INCX
                  JX = KX
                  DO 80, J = N, 1, -1
                     IF( X( JX ).NE.ZERO )THEN
                        TEMP = X( JX )
                        IX   = KX
                        L    = 1       - J
                        DO 70, I = MIN( N, J + K ), J + 1, -1
                           X( IX ) = X( IX ) + TEMP*A( L + I, J )
                           IX      = IX      - INCX
   70                   CONTINUE
                        IF( NOUNIT )
     $                     X( JX ) = X( JX )*A( 1, J )
                     END IF
                     JX = JX - INCX
                     IF( ( N - J ).GE.K )
     $                  KX = KX - INCX
   80             CONTINUE
               END IF
            END IF
         ELSE
*
*           Form  x := A'*x  or  x := conjg( A' )*x.
*
            IF( LSAME( UPLO, 'U' ) )THEN
               KPLUS1 = K + 1
               IF( INCX.EQ.1 )THEN
                  DO 110, J = N, 1, -1
                     TEMP = X( J )
                     L    = KPLUS1 - J
                     IF( NOCONJ )THEN
                        IF( NOUNIT )
     $                     TEMP = TEMP*A( KPLUS1, J )
                        DO 90, I = J - 1, MAX( 1, J - K ), -1
                           TEMP = TEMP + A( L + I, J )*X( I )
   90                   CONTINUE
                     ELSE
                        IF( NOUNIT )
```

```
     $                  TEMP = TEMP*DCONJG( A( KPLUS1, J ) )
                        DO 100, I = J - 1, MAX( 1, J - K ), -1
                           TEMP = TEMP + DCONJG( A( L + I, J ) )*X( I )
  100                   CONTINUE
                     END IF
                     X( J ) = TEMP
  110             CONTINUE
                ELSE
                   KX = KX + ( N - 1 )*INCX
                   JX = KX
                   DO 140, J = N, 1, -1
                      TEMP = X( JX )
                      KX   = KX      - INCX
                      IX   = KX
                      L    = KPLUS1  - J
                      IF( NOCONJ )THEN
                         IF( NOUNIT )
     $                      TEMP = TEMP*A( KPLUS1, J )
                         DO 120, I = J - 1, MAX( 1, J - K ), -1
                            TEMP = TEMP + A( L + I, J )*X( IX )
                            IX   = IX   - INCX
  120                   CONTINUE
                      ELSE
                         IF( NOUNIT )
     $                      TEMP = TEMP*DCONJG( A( KPLUS1, J ) )
                         DO 130, I = J - 1, MAX( 1, J - K ), -1
                            TEMP = TEMP + DCONJG( A( L + I, J ) )*X( IX )
                            IX   = IX   - INCX
  130                   CONTINUE
                      END IF
                      X( JX ) = TEMP
                      JX      = JX   - INCX
  140             CONTINUE
                END IF
             ELSE
                IF( INCX.EQ.1 )THEN
                   DO 170, J = 1, N
                      TEMP = X( J )
                      L    = 1      - J
                      IF( NOCONJ )THEN
                         IF( NOUNIT )
     $                      TEMP = TEMP*A( 1, J )
                         DO 150, I = J + 1, MIN( N, J + K )
                            TEMP = TEMP + A( L + I, J )*X( I )
  150                   CONTINUE
                      ELSE
                         IF( NOUNIT )
     $                      TEMP = TEMP*DCONJG( A( 1, J ) )
                         DO 160, I = J + 1, MIN( N, J + K )
                            TEMP = TEMP + DCONJG( A( L + I, J ) )*X( I )
```

```
  160               CONTINUE
                 END IF
                 X( J ) = TEMP
  170          CONTINUE
            ELSE
               JX = KX
               DO 200, J = 1, N
                  TEMP = X( JX )
                  KX   = KX      + INCX
                  IX   = KX
                  L    = 1       - J
                  IF( NOCONJ )THEN
                     IF( NOUNIT )
     $                  TEMP = TEMP*A( 1, J )
                     DO 180, I = J + 1, MIN( N, J + K )
                        TEMP = TEMP + A( L + I, J )*X( IX )
                        IX   = IX   + INCX
  180                CONTINUE
                  ELSE
                     IF( NOUNIT )
     $                  TEMP = TEMP*DCONJG( A( 1, J ) )
                     DO 190, I = J + 1, MIN( N, J + K )
                        TEMP = TEMP + DCONJG( A( L + I, J ) )*X( IX )
                        IX   = IX   + INCX
  190                CONTINUE
                  END IF
                  X( JX ) = TEMP
                  JX      = JX   + INCX
  200          CONTINUE
            END IF
         END IF
      END IF
*
      RETURN
*
*     End of ZTBMV .
*
      END
```

— BLAS 2 ztbmv —

```
(let* ((zero (complex 0.0 0.0)))
  (declare (type (complex double-float) zero))
  (defun ztbmv (uplo trans diag n k a lda x incx)
    (declare (type (simple-array (complex double-float) (*)) x a)
             (type fixnum incx lda k n)
```

```
         (type character diag trans uplo))
(f2cl-lib:with-multi-array-data
    ((uplo character uplo-%data% uplo-%offset%)
     (trans character trans-%data% trans-%offset%)
     (diag character diag-%data% diag-%offset%)
     (a (complex double-float) a-%data% a-%offset%)
     (x (complex double-float) x-%data% x-%offset%))
  (prog ((noconj nil) (nounit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0)
         (kplus1 0) (kx 0) (l 0) (temp #C(0.0 0.0)))
    (declare (type (member t nil) noconj nounit)
             (type fixnum i info ix j jx kplus1 kx l)
             (type (complex double-float) temp))
    (setf info 0)
    (cond
      ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
       (setf info 1))
      ((and (not (char-equal trans #\N))
            (not (char-equal trans #\T))
            (not (char-equal trans #\C)))
       (setf info 2))
      ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
       (setf info 3))
      ((< n 0)
       (setf info 4))
      ((< k 0)
       (setf info 5))
      ((< lda (f2cl-lib:int-add k 1))
       (setf info 7))
      ((= incx 0)
       (setf info 9)))
    (cond
      ((/= info 0)
       (error
        " ** On entry to ~a parameter number ~a had an illegal value~%"
        "ZTBMV" info)
       (go end_label)))
    (if (= n 0) (go end_label))
    (setf noconj (char-equal trans #\T))
    (setf nounit (char-equal diag #\N))
    (cond
      ((<= incx 0)
       (setf kx
             (f2cl-lib:int-sub 1
                               (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                 incx))))
      ((/= incx 1)
       (setf kx 1)))
    (cond
      ((char-equal trans #\N)
       (cond
```

```
((char-equal uplo #\U)
 (setf kplus1 (f2cl-lib:int-add k 1))
 (cond
   ((= incx 1)
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j n) nil)
      (tagbody
        (cond
          ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
           (setf temp
                   (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
           (setf l (f2cl-lib:int-sub kplus1 j))
           (f2cl-lib:fdo (i
                          (max (the fixnum 1)
                               (the fixnum
                                    (f2cl-lib:int-add j
                                                      (f2cl-lib:int-sub
                                                       k))))
                          (f2cl-lib:int-add i 1))
                         ((> i
                             (f2cl-lib:int-add j
                                               (f2cl-lib:int-sub
                                                1)))
                          nil)
             (tagbody
               (setf (f2cl-lib:fref x-%data%
                                    (i)
                                    ((1 *))
                                    x-%offset%)
                     (+
                      (f2cl-lib:fref x-%data%
                                     (i)
                                     ((1 *))
                                     x-%offset%)
                      (* temp
                         (f2cl-lib:fref a-%data%
                                        ((f2cl-lib:int-add l i)
                                         j)
                                        ((1 lda) (1 *))
                                        a-%offset%))))))
           (if nounit
               (setf (f2cl-lib:fref x-%data%
                                    (j)
                                    ((1 *))
                                    x-%offset%)
                     (*
                      (f2cl-lib:fref x-%data%
                                     (j)
                                     ((1 *))
                                     x-%offset%)
```

```
                      (f2cl-lib:fref a-%data%
                                     (kplus1 j)
                                     ((1 lda) (1 *))
                                     a-%offset%)))))))))
(t
 (setf jx kx)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (cond
       ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (setf temp
                (f2cl-lib:fref x-%data%
                               (jx)
                               ((1 *))
                               x-%offset%))
        (setf ix kx)
        (setf l (f2cl-lib:int-sub kplus1 j))
        (f2cl-lib:fdo (i
                       (max (the fixnum 1)
                            (the fixnum
                                 (f2cl-lib:int-add j
                                                   (f2cl-lib:int-sub
                                                    k))))
                       (f2cl-lib:int-add i 1))
                      ((> i
                          (f2cl-lib:int-add j
                                            (f2cl-lib:int-sub
                                             1)))
                       nil)
          (tagbody
            (setf (f2cl-lib:fref x-%data%
                                 (ix)
                                 ((1 *))
                                 x-%offset%)
                  (+
                   (f2cl-lib:fref x-%data%
                                  (ix)
                                  ((1 *))
                                  x-%offset%)
                   (* temp
                      (f2cl-lib:fref a-%data%
                                     ((f2cl-lib:int-add l i)
                                      j)
                                     ((1 lda) (1 *))
                                     a-%offset%))))
            (setf ix (f2cl-lib:int-add ix incx))))
        (if nounit
            (setf (f2cl-lib:fref x-%data%
                                 (jx)
```

```
                                        ((1 *))
                                        x-%offset%)
                                (*
                                 (f2cl-lib:fref x-%data%
                                                (jx)
                                                ((1 *))
                                                x-%offset%)
                                 (f2cl-lib:fref a-%data%
                                                (kplus1 j)
                                                ((1 lda) (1 *))
                                                a-%offset%))))))
                  (setf jx (f2cl-lib:int-add jx incx))
                  (if (> j k) (setf kx (f2cl-lib:int-add kx incx))))))))
              (t
               (cond
                 ((= incx 1)
                  (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                                ((> j 1) nil)
                    (tagbody
                      (cond
                        ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                         (setf temp
                                 (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                         (setf l (f2cl-lib:int-sub 1 j))
                         (f2cl-lib:fdo (i
                                        (min (the fixnum n)
                                             (the fixnum
                                                  (f2cl-lib:int-add j k)))
                                        (f2cl-lib:int-add i
                                                          (f2cl-lib:int-sub 1)))
                                       ((> i (f2cl-lib:int-add j 1)) nil)
                           (tagbody
                             (setf (f2cl-lib:fref x-%data%
                                                  (i)
                                                  ((1 *))
                                                  x-%offset%)
                                   (+
                                    (f2cl-lib:fref x-%data%
                                                   (i)
                                                   ((1 *))
                                                   x-%offset%)
                                    (* temp
                                       (f2cl-lib:fref a-%data%
                                                      ((f2cl-lib:int-add l i)
                                                       j)
                                                      ((1 lda) (1 *))
                                                      a-%offset%))))))
                         (if nounit
                             (setf (f2cl-lib:fref x-%data%
                                                  (j)
```

```
                                    ((1 *))
                                    x-%offset%)
                            (*
                             (f2cl-lib:fref x-%data%
                                            (j)
                                            ((1 *))
                                            x-%offset%)
                             (f2cl-lib:fref a-%data%
                                            (1 j)
                                            ((1 lda) (1 *))
                                            a-%offset%)))))))))
        (t
         (setf kx
                 (f2cl-lib:int-add kx
                                   (f2cl-lib:int-mul
                                    (f2cl-lib:int-sub n 1)
                                    incx)))
         (setf jx kx)
         (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                       ((> j 1) nil)
           (tagbody
             (cond
               ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
                (setf temp
                        (f2cl-lib:fref x-%data%
                                       (jx)
                                       ((1 *))
                                       x-%offset%))
                (setf ix kx)
                (setf l (f2cl-lib:int-sub 1 j))
                (f2cl-lib:fdo (i
                               (min (the fixnum n)
                                    (the fixnum
                                         (f2cl-lib:int-add j k)))
                               (f2cl-lib:int-add i
                                                 (f2cl-lib:int-sub 1)))
                              ((> i (f2cl-lib:int-add j 1)) nil)
                  (tagbody
                    (setf (f2cl-lib:fref x-%data%
                                         (ix)
                                         ((1 *))
                                         x-%offset%)
                              (+
                               (f2cl-lib:fref x-%data%
                                              (ix)
                                              ((1 *))
                                              x-%offset%)
                               (* temp
                                  (f2cl-lib:fref a-%data%
                                                 ((f2cl-lib:int-add l i)
```

```
                                                j)
                                               ((1 lda) (1 *))
                                               a-%offset%))))
                        (setf ix (f2cl-lib:int-sub ix incx))))
                    (if nounit
                        (setf (f2cl-lib:fref x-%data%
                                             (jx)
                                             ((1 *))
                                             x-%offset%)
                              (*
                               (f2cl-lib:fref x-%data%
                                              (jx)
                                              ((1 *))
                                              x-%offset%)
                               (f2cl-lib:fref a-%data%
                                              (1 j)
                                              ((1 lda) (1 *))
                                              a-%offset%))))))
                (setf jx (f2cl-lib:int-sub jx incx))
                (if (>= (f2cl-lib:int-sub n j) k)
                    (setf kx (f2cl-lib:int-sub kx incx)))))))))
      (t
       (cond
         ((char-equal uplo #\U)
          (setf kplus1 (f2cl-lib:int-add k 1))
          (cond
            ((= incx 1)
             (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                           ((> j 1) nil)
               (tagbody
                 (setf temp
                         (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                 (setf l (f2cl-lib:int-sub kplus1 j))
                 (cond
                   (noconj
                    (if nounit
                        (setf temp
                              (* temp
                                 (f2cl-lib:fref a-%data%
                                                (kplus1 j)
                                                ((1 lda) (1 *))
                                                a-%offset%))))
                    (f2cl-lib:fdo (i
                                   (f2cl-lib:int-add j
                                                     (f2cl-lib:int-sub 1))
                                   (f2cl-lib:int-add i
                                                     (f2cl-lib:int-sub 1)))
                                  ((> i
                                      (max (the fixnum 1)
                                           (the fixnum
```

```
                                    (f2cl-lib:int-add j
                                        (f2cl-lib:int-sub
                                                    k)))))
                    nil)
      (tagbody
        (setf temp
                (+ temp
                   (*
                    (f2cl-lib:fref a-%data%
                                   ((f2cl-lib:int-add l i)
                                    j)
                                   ((1 lda) (1 *))
                                   a-%offset%)
                    (f2cl-lib:fref x-%data%
                                   (i)
                                   ((1 *))
                                   x-%offset%)))))))
   (t
    (if nounit
        (setf temp
                (* temp
                   (f2cl-lib:dconjg
                    (f2cl-lib:fref a-%data%
                                   (kplus1 j)
                                   ((1 lda) (1 *))
                                   a-%offset%)))))
    (f2cl-lib:fdo (i
                   (f2cl-lib:int-add j
                                     (f2cl-lib:int-sub 1))
                   (f2cl-lib:int-add i
                                     (f2cl-lib:int-sub 1)))
                  ((> i
                      (max (the fixnum 1)
                           (the fixnum
                                (f2cl-lib:int-add j
                                    (f2cl-lib:int-sub
                                                k)))))
                   nil)
      (tagbody
        (setf temp
                (+ temp
                   (*
                    (f2cl-lib:dconjg
                     (f2cl-lib:fref a-%data%
                                    ((f2cl-lib:int-add l i)
                                     j)
                                    ((1 lda) (1 *))
                                    a-%offset%))
                    (f2cl-lib:fref x-%data%
                                   (i)
```

```
                                        ((1 *))
                                        x-%offset%))))))))
      (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
            temp))))
(t
 (setf kx
       (f2cl-lib:int-add kx
                         (f2cl-lib:int-mul
                          (f2cl-lib:int-sub n 1)
                          incx)))
 (setf jx kx)
 (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
               ((> j 1) nil)
   (tagbody
     (setf temp
           (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
     (setf kx (f2cl-lib:int-sub kx incx))
     (setf ix kx)
     (setf l (f2cl-lib:int-sub kplus1 j))
     (cond
       (noconj
        (if nounit
            (setf temp
                  (* temp
                     (f2cl-lib:fref a-%data%
                                    (kplus1 j)
                                    ((1 lda) (1 *))
                                    a-%offset%))))
        (f2cl-lib:fdo (i
                       (f2cl-lib:int-add j
                                         (f2cl-lib:int-sub 1))
                       (f2cl-lib:int-add i
                                         (f2cl-lib:int-sub 1)))
                      ((> i
                          (max (the fixnum 1)
                               (the fixnum
                                    (f2cl-lib:int-add j
                                           (f2cl-lib:int-sub
                                                      k)))))
                       nil)
          (tagbody
            (setf temp
                  (+ temp
                     (*
                      (f2cl-lib:fref a-%data%
                                     ((f2cl-lib:int-add l i)
                                      j)
                                     ((1 lda) (1 *))
                                     a-%offset%)
                      (f2cl-lib:fref x-%data%
```

```
                                        (ix)
                                        ((1 *))
                                        x-%offset%))))
                    (setf ix (f2cl-lib:int-sub ix incx)))))
                (t
                 (if nounit
                     (setf temp
                             (* temp
                                (f2cl-lib:dconjg
                                 (f2cl-lib:fref a-%data%
                                                (kplus1 j)
                                                ((1 lda) (1 *))
                                                a-%offset%)))))
                 (f2cl-lib:fdo (i
                                (f2cl-lib:int-add j
                                                  (f2cl-lib:int-sub 1))
                                (f2cl-lib:int-add i
                                                  (f2cl-lib:int-sub 1)))
                               ((> i
                                   (max (the fixnum 1)
                                        (the fixnum
                                             (f2cl-lib:int-add j
                                                  (f2cl-lib:int-sub
                                                               k)))))
                                nil)
                   (tagbody
                     (setf temp
                             (+ temp
                                (*
                                 (f2cl-lib:dconjg
                                  (f2cl-lib:fref a-%data%
                                                 ((f2cl-lib:int-add l i)
                                                  j)
                                                 ((1 lda) (1 *))
                                                 a-%offset%))
                                 (f2cl-lib:fref x-%data%
                                                (ix)
                                                ((1 *))
                                                x-%offset%))))
                     (setf ix (f2cl-lib:int-sub ix incx))))))
               (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                       temp)
               (setf jx (f2cl-lib:int-sub jx incx)))))))
        (t
         (cond
           ((= incx 1)
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
              (tagbody
                (setf temp
```

```
       (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
(setf l (f2cl-lib:int-sub 1 j))
(cond
  (noconj
   (if nounit
       (setf temp
               (* temp
                  (f2cl-lib:fref a-%data%
                                 (1 j)
                                 ((1 lda) (1 *))
                                 a-%offset%))))
   (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                  (f2cl-lib:int-add i 1))
                 ((> i
                     (min (the fixnum n)
                          (the fixnum
                               (f2cl-lib:int-add j k))))
                  nil)
     (tagbody
       (setf temp
               (+ temp
                  (*
                   (f2cl-lib:fref a-%data%
                                  ((f2cl-lib:int-add l i)
                                   j)
                                  ((1 lda) (1 *))
                                  a-%offset%)
                   (f2cl-lib:fref x-%data%
                                  (i)
                                  ((1 *))
                                  x-%offset%)))))))
  (t
   (if nounit
       (setf temp
               (* temp
                  (f2cl-lib:dconjg
                   (f2cl-lib:fref a-%data%
                                  (1 j)
                                  ((1 lda) (1 *))
                                  a-%offset%)))))
   (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                  (f2cl-lib:int-add i 1))
                 ((> i
                     (min (the fixnum n)
                          (the fixnum
                               (f2cl-lib:int-add j k))))
                  nil)
     (tagbody
       (setf temp
               (+ temp
```

```
                          (*
                           (f2cl-lib:dconjg
                            (f2cl-lib:fref a-%data%
                                           ((f2cl-lib:int-add l i)
                                            j)
                                           ((1 lda) (1 *))
                                           a-%offset%))
                           (f2cl-lib:fref x-%data%
                                          (i)
                                          ((1 *))
                                          x-%offset%))))))))
      (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
            temp))))
 (t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                ((> j n) nil)
    (tagbody
      (setf temp
            (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
      (setf kx (f2cl-lib:int-add kx incx))
      (setf ix kx)
      (setf l (f2cl-lib:int-sub 1 j))
      (cond
        (noconj
         (if nounit
             (setf temp
                   (* temp
                      (f2cl-lib:fref a-%data%
                                     (1 j)
                                     ((1 lda) (1 *))
                                     a-%offset%))))
         (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                          (f2cl-lib:int-add i 1))
                       ((> i
                           (min (the fixnum n)
                                (the fixnum
                                     (f2cl-lib:int-add j k))))
                        nil)
           (tagbody
             (setf temp
                   (+ temp
                      (*
                       (f2cl-lib:fref a-%data%
                                      ((f2cl-lib:int-add l i)
                                       j)
                                      ((1 lda) (1 *))
                                      a-%offset%)
                       (f2cl-lib:fref x-%data%
                                      (ix)
```

```
                                          ((1 *))
                                          x-%offset%))))
                        (setf ix (f2cl-lib:int-add ix incx)))))
                   (t
                    (if nounit
                        (setf temp
                                (* temp
                                   (f2cl-lib:dconjg
                                    (f2cl-lib:fref a-%data%
                                                   (1 j)
                                                   ((1 lda) (1 *))
                                                   a-%offset%)))))
                    (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                    (f2cl-lib:int-add i 1))
                                  ((> i
                                      (min (the fixnum n)
                                           (the fixnum
                                                (f2cl-lib:int-add j k))))
                                   nil)
                      (tagbody
                        (setf temp
                                (+ temp
                                   (*
                                    (f2cl-lib:dconjg
                                     (f2cl-lib:fref a-%data%
                                                    ((f2cl-lib:int-add l i)
                                                     j)
                                                    ((1 lda) (1 *))
                                                    a-%offset%))
                                    (f2cl-lib:fref x-%data%
                                                   (ix)
                                                   ((1 *))
                                                   x-%offset%))))
                        (setf ix (f2cl-lib:int-add ix incx))))))
                  (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                          temp)
                  (setf jx (f2cl-lib:int-add jx incx)))))))))
end_label
       (return (values nil nil nil nil nil nil nil nil nil))))))
```

———-

4.29 ztbsv BLAS

— ztbsv.input —

```
)set break resume
)sys rm -f ztbsv.output
)spool ztbsv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— ztbsv.help —

```
==========================================================================
ztbsv examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      ZTBSV - solve one of the systems of equations   A*x = b, or
      A'*x = b, or conjg( A' )*x = b,

 SYNOPSIS
      SUBROUTINE ZTBSV ( UPLO, TRANS, DIAG, N, K, A, LDA, X, INCX
                       )

          INTEGER      INCX, K, LDA, N

          CHARACTER*1  DIAG, TRANS, UPLO

          COMPLEX*16   A( LDA, * ), X( * )

 PURPOSE
      ZTBSV  solves one of the systems of equations

      where b and x are n element vectors and A is an n by n unit,
      or non-unit, upper or lower triangular band matrix, with ( k
      + 1 ) diagonals.

      No test for singularity or near-singularity is included in
      this routine. Such tests must be performed before calling
      this routine.

 PARAMETERS
      UPLO   - CHARACTER*1.
```

```
         On entry, UPLO specifies whether the matrix is an
         upper or lower triangular matrix as follows:

         UPLO = 'U' or 'u'   A is an upper triangular matrix.

         UPLO = 'L' or 'l'   A is a lower triangular matrix.

         Unchanged on exit.

TRANS  - CHARACTER*1.
         On entry, TRANS specifies the equations to be solved
         as follows:

         TRANS = 'N' or 'n'   A*x = b.

         TRANS = 'T' or 't'   A'*x = b.

         TRANS = 'C' or 'c'   conjg( A' )*x = b.

         Unchanged on exit.

DIAG   - CHARACTER*1.
         On entry, DIAG specifies whether or not A is unit
         triangular as follows:

         DIAG = 'U' or 'u'   A is assumed to be unit triangu-
         lar.

         DIAG = 'N' or 'n'   A is not assumed to be unit tri-
         angular.

         Unchanged on exit.

N      - INTEGER.
         On entry, N specifies the order of the matrix A.  N
         must be at least zero.  Unchanged on exit.

K      - INTEGER.
         On entry with UPLO = 'U' or 'u', K specifies the
         number of super-diagonals of the matrix A.  On entry
         with UPLO = 'L' or 'l', K specifies the number of
         sub-diagonals of the matrix A.  K must satisfy  0
         .le. K.  Unchanged on exit.

A      - COMPLEX*16       array of DIMENSION ( LDA, n ).
         Before entry with UPLO = 'U' or 'u', the leading ( k
         + 1 ) by n part of the array A must contain the upper
         triangular band part of the matrix of coefficients,
         supplied column by column, with the leading diagonal
         of the matrix in row ( k + 1 ) of the array, the
```

first super-diagonal starting at position 2 in row k, and so on. The top left k by k triangle of the array A is not referenced. The following program segment will transfer an upper triangular band matrix from conventional full matrix storage to band storage:

DO 20, J = 1, N M = K + 1 - J DO 10, I = MAX(1, J - K), J A(M + I, J) = matrix(I, J) 10 CONTINUE 20 CONTINUE

Before entry with UPLO = 'L' or 'l', the leading (k + 1) by n part of the array A must contain the lower triangular band part of the matrix of coefficients, supplied column by column, with the leading diagonal of the matrix in row 1 of the array, the first sub-diagonal starting at position 1 in row 2, and so on. The bottom right k by k triangle of the array A is not referenced. The following program segment will transfer a lower triangular band matrix from conventional full matrix storage to band storage:

DO 20, J = 1, N M = 1 - J DO 10, I = J, MIN(N, J + K) A(M + I, J) = matrix(I, J) 10 CONTINUE 20 CONTINUE

Note that when DIAG = 'U' or 'u' the elements of the array A corresponding to the diagonal elements of the

matrix are not referenced, but are assumed to be unity. Unchanged on exit.

LDA - INTEGER.
On entry, LDA specifies the first dimension of A as declared in the calling (sub) program. LDA must be at least (k + 1). Unchanged on exit.

X - COMPLEX*16 array of dimension at least (1 + (n - 1)*abs(INCX)). Before entry, the incremented array X must contain the n element right-hand side vector b. On exit, X is overwritten with the solution vector x.

INCX - INTEGER.
On entry, INCX specifies the increment for the elements of X. INCX must not be zero. Unchanged on exit.

— ztbsv.f —

```
      SUBROUTINE ZTBSV ( UPLO, TRANS, DIAG, N, K, A, LDA, X, INCX )
*     .. Scalar Arguments ..
      INTEGER            INCX, K, LDA, N
      CHARACTER*1        DIAG, TRANS, UPLO
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), X( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     .. Local Scalars ..
      COMPLEX*16         TEMP
      INTEGER            I, INFO, IX, J, JX, KPLUS1, KX, L
      LOGICAL            NOCONJ, NOUNIT
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG, MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO , 'U' ).AND.
     $         .NOT.LSAME( UPLO , 'L' )      )THEN
         INFO = 1
      ELSE IF( .NOT.LSAME( TRANS, 'N' ).AND.
     $         .NOT.LSAME( TRANS, 'T' ).AND.
     $         .NOT.LSAME( TRANS, 'C' )      )THEN
         INFO = 2
      ELSE IF( .NOT.LSAME( DIAG , 'U' ).AND.
     $         .NOT.LSAME( DIAG , 'N' )      )THEN
         INFO = 3
```

```
      ELSE IF( N.LT.0 )THEN
         INFO = 4
      ELSE IF( K.LT.0 )THEN
         INFO = 5
      ELSE IF( LDA.LT.( K + 1 ) )THEN
         INFO = 7
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 9
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZTBSV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( N.EQ.0 )
     $   RETURN
*
      NOCONJ = LSAME( TRANS, 'T' )
      NOUNIT = LSAME( DIAG , 'N' )
*
*     Set up the start point in X if the increment is not unity. This
*     will be  ( N - 1 )*INCX  too small for descending loops.
*
      IF( INCX.LE.0 )THEN
         KX = 1 - ( N - 1 )*INCX
      ELSE IF( INCX.NE.1 )THEN
         KX = 1
      END IF
*
*     Start the operations. In this version the elements of A are
*     accessed by sequentially with one pass through A.
*
      IF( LSAME( TRANS, 'N' ) )THEN
*
*        Form  x := inv( A )*x.
*
         IF( LSAME( UPLO, 'U' ) )THEN
            KPLUS1 = K + 1
            IF( INCX.EQ.1 )THEN
               DO 20, J = N, 1, -1
                  IF( X( J ).NE.ZERO )THEN
                     L = KPLUS1 - J
                     IF( NOUNIT )
     $                  X( J ) = X( J )/A( KPLUS1, J )
                     TEMP = X( J )
                     DO 10, I = J - 1, MAX( 1, J - K ), -1
                        X( I ) = X( I ) - TEMP*A( L + I, J )
   10                CONTINUE
```

```
               END IF
   20          CONTINUE
            ELSE
               KX = KX + ( N - 1 )*INCX
               JX = KX
               DO 40, J = N, 1, -1
                  KX = KX - INCX
                  IF( X( JX ).NE.ZERO )THEN
                     IX = KX
                     L  = KPLUS1 - J
                     IF( NOUNIT )
     $                  X( JX ) = X( JX )/A( KPLUS1, J )
                     TEMP = X( JX )
                     DO 30, I = J - 1, MAX( 1, J - K ), -1
                        X( IX ) = X( IX ) - TEMP*A( L + I, J )
                        IX      = IX      - INCX
   30                CONTINUE
                  END IF
                  JX = JX - INCX
   40          CONTINUE
            END IF
         ELSE
            IF( INCX.EQ.1 )THEN
               DO 60, J = 1, N
                  IF( X( J ).NE.ZERO )THEN
                     L = 1 - J
                     IF( NOUNIT )
     $                  X( J ) = X( J )/A( 1, J )
                     TEMP = X( J )
                     DO 50, I = J + 1, MIN( N, J + K )
                        X( I ) = X( I ) - TEMP*A( L + I, J )
   50                CONTINUE
                  END IF
   60          CONTINUE
            ELSE
               JX = KX
               DO 80, J = 1, N
                  KX = KX + INCX
                  IF( X( JX ).NE.ZERO )THEN
                     IX = KX
                     L  = 1  - J
                     IF( NOUNIT )
     $                  X( JX ) = X( JX )/A( 1, J )
                     TEMP = X( JX )
                     DO 70, I = J + 1, MIN( N, J + K )
                        X( IX ) = X( IX ) - TEMP*A( L + I, J )
                        IX      = IX      + INCX
   70                CONTINUE
                  END IF
                  JX = JX + INCX
```

```
   80          CONTINUE
            END IF
         END IF
      ELSE
*
*        Form  x := inv( A' )*x  or  x := inv( conjg( A') )*x.
*
         IF( LSAME( UPLO, 'U' ) )THEN
            KPLUS1 = K + 1
            IF( INCX.EQ.1 )THEN
               DO 110, J = 1, N
                  TEMP = X( J )
                  L    = KPLUS1 - J
                  IF( NOCONJ )THEN
                     DO 90, I = MAX( 1, J - K ), J - 1
                        TEMP = TEMP - A( L + I, J )*X( I )
   90                CONTINUE
                     IF( NOUNIT )
     $                  TEMP = TEMP/A( KPLUS1, J )
                  ELSE
                     DO 100, I = MAX( 1, J - K ), J - 1
                        TEMP = TEMP - DCONJG( A( L + I, J ) )*X( I )
  100                CONTINUE
                     IF( NOUNIT )
     $                  TEMP = TEMP/DCONJG( A( KPLUS1, J ) )
                  END IF
                  X( J ) = TEMP
  110          CONTINUE
            ELSE
               JX = KX
               DO 140, J = 1, N
                  TEMP = X( JX )
                  IX   = KX
                  L    = KPLUS1  - J
                  IF( NOCONJ )THEN
                     DO 120, I = MAX( 1, J - K ), J - 1
                        TEMP = TEMP - A( L + I, J )*X( IX )
                        IX   = IX   + INCX
  120                CONTINUE
                     IF( NOUNIT )
     $                  TEMP = TEMP/A( KPLUS1, J )
                  ELSE
                     DO 130, I = MAX( 1, J - K ), J - 1
                        TEMP = TEMP - DCONJG( A( L + I, J ) )*X( IX )
                        IX   = IX   + INCX
  130                CONTINUE
                     IF( NOUNIT )
     $                  TEMP = TEMP/DCONJG( A( KPLUS1, J ) )
                  END IF
                  X( JX ) = TEMP
```

```
               JX      = JX   + INCX
               IF( J.GT.K )
     $            KX = KX + INCX
  140       CONTINUE
            END IF
         ELSE
            IF( INCX.EQ.1 )THEN
               DO 170, J = N, 1, -1
                  TEMP = X( J )
                  L    = 1      - J
                  IF( NOCONJ )THEN
                     DO 150, I = MIN( N, J + K ), J + 1, -1
                        TEMP = TEMP - A( L + I, J )*X( I )
  150                CONTINUE
                     IF( NOUNIT )
     $                  TEMP = TEMP/A( 1, J )
                  ELSE
                     DO 160, I = MIN( N, J + K ), J + 1, -1
                        TEMP = TEMP - DCONJG( A( L + I, J ) )*X( I )
  160                CONTINUE
                     IF( NOUNIT )
     $                  TEMP = TEMP/DCONJG( A( 1, J ) )
                  END IF
                  X( J ) = TEMP
  170          CONTINUE
            ELSE
               KX = KX + ( N - 1 )*INCX
               JX = KX
               DO 200, J = N, 1, -1
                  TEMP = X( JX )
                  IX   = KX
                  L    = 1       - J
                  IF( NOCONJ )THEN
                     DO 180, I = MIN( N, J + K ), J + 1, -1
                        TEMP = TEMP - A( L + I, J )*X( IX )
                        IX   = IX   - INCX
  180                CONTINUE
                     IF( NOUNIT )
     $                  TEMP = TEMP/A( 1, J )
                  ELSE
                     DO 190, I = MIN( N, J + K ), J + 1, -1
                        TEMP = TEMP - DCONJG( A( L + I, J ) )*X( IX )
                        IX   = IX   - INCX
  190                CONTINUE
                     IF( NOUNIT )
     $                  TEMP = TEMP/DCONJG( A( 1, J ) )
                  END IF
                  X( JX ) = TEMP
                  JX      = JX   - INCX
                  IF( ( N - J ).GE.K )
```

```
     $              KX = KX - INCX
  200          CONTINUE
            END IF
          END IF
       END IF
*
       RETURN
*
*     End of ZTBSV .
*
       END
```

———-

— **BLAS 2 ztbsv** —

```
(let* ((zero (complex 0.0 0.0)))
  (declare (type (complex double-float) zero))
  (defun ztbsv (uplo trans diag n k a lda x incx)
    (declare (type (simple-array (complex double-float) (*)) x a)
             (type fixnum incx lda k n)
             (type character diag trans uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (x (complex double-float) x-%data% x-%offset%))
      (prog ((noconj nil) (nounit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0)
             (kplus1 0) (kx 0) (l 0) (temp #C(0.0 0.0)))
        (declare (type (member t nil) noconj nounit)
                 (type fixnum i info ix j jx kplus1 kx l)
                 (type (complex double-float) temp))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
          ((and (not (char-equal trans #\N))
                (not (char-equal trans #\T))
                (not (char-equal trans #\C)))
           (setf info 2))
          ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
           (setf info 3))
          ((< n 0)
           (setf info 4))
          ((< k 0)
           (setf info 5))
          ((< lda (f2cl-lib:int-add k 1))
```

```
   (setf info 7))
  ((= incx 0)
   (setf info 9)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "ZTBSV" info)
   (go end_label)))
(if (= n 0) (go end_label))
(setf noconj (char-equal trans #\T))
(setf nounit (char-equal diag #\N))
(cond
  ((<= incx 0)
   (setf kx
         (f2cl-lib:int-sub 1
                           (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                             incx))))
  ((/= incx 1)
   (setf kx 1)))
(cond
  ((char-equal trans #\N)
   (cond
     ((char-equal uplo #\U)
      (setf kplus1 (f2cl-lib:int-add k 1))
      (cond
        ((= incx 1)
         (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                       ((> j 1) nil)
           (tagbody
             (cond
               ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                (setf l (f2cl-lib:int-sub kplus1 j))
                (if nounit
                    (setf (f2cl-lib:fref x-%data%
                                         (j)
                                         ((1 *))
                                         x-%offset%)
                                  (/
                                   (f2cl-lib:fref x-%data%
                                                  (j)
                                                  ((1 *))
                                                  x-%offset%)
                                   (f2cl-lib:fref a-%data%
                                                  (kplus1 j)
                                                  ((1 lda) (1 *))
                                                  a-%offset%))))
                (setf temp
                        (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                (f2cl-lib:fdo (i
```

```
                              (f2cl-lib:int-add j
                                               (f2cl-lib:int-sub 1))
                              (f2cl-lib:int-add i
                                               (f2cl-lib:int-sub 1)))
                             ((> i
                                 (max (the fixnum 1)
                                      (the fixnum
                                           (f2cl-lib:int-add j
                                              (f2cl-lib:int-sub
                                                             k)))))
                             nil)
                    (tagbody
                      (setf (f2cl-lib:fref x-%data%
                                           (i)
                                           ((1 *))
                                           x-%offset%)
                            (-
                             (f2cl-lib:fref x-%data%
                                           (i)
                                           ((1 *))
                                           x-%offset%)
                             (* temp
                                (f2cl-lib:fref a-%data%
                                               ((f2cl-lib:int-add l i)
                                                j)
                                               ((1 lda) (1 *))
                                               a-%offset%)))))))))
          (t
           (setf kx
                 (f2cl-lib:int-add kx
                                   (f2cl-lib:int-mul
                                    (f2cl-lib:int-sub n 1)
                                    incx)))
           (setf jx kx)
           (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                         ((> j 1) nil)
             (tagbody
               (setf kx (f2cl-lib:int-sub kx incx))
               (cond
                 ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
                  (setf ix kx)
                  (setf l (f2cl-lib:int-sub kplus1 j))
                  (if nounit
                      (setf (f2cl-lib:fref x-%data%
                                           (jx)
                                           ((1 *))
                                           x-%offset%)
                            (/
                             (f2cl-lib:fref x-%data%
                                           (jx)
```

```
                                        ((1 *))
                                        x-%offset%)
                                (f2cl-lib:fref a-%data%
                                        (kplus1 j)
                                        ((1 lda) (1 *))
                                        a-%offset%))))
                        (setf temp
                                (f2cl-lib:fref x-%data%
                                        (jx)
                                        ((1 *))
                                        x-%offset%))
                        (f2cl-lib:fdo (i
                                       (f2cl-lib:int-add j
                                                (f2cl-lib:int-sub 1))
                                       (f2cl-lib:int-add i
                                                (f2cl-lib:int-sub 1)))
                                      ((> i
                                          (max (the fixnum 1)
                                               (the fixnum
                                                    (f2cl-lib:int-add j
                                                        (f2cl-lib:int-sub
                                                                k)))))
                                       nil)
                          (tagbody
                            (setf (f2cl-lib:fref x-%data%
                                                 (ix)
                                                 ((1 *))
                                                 x-%offset%)
                                  (-
                                   (f2cl-lib:fref x-%data%
                                                 (ix)
                                                 ((1 *))
                                                 x-%offset%)
                                   (* temp
                                      (f2cl-lib:fref a-%data%
                                                     ((f2cl-lib:int-add l i)
                                                      j)
                                                     ((1 lda) (1 *))
                                                     a-%offset%))))
                            (setf ix (f2cl-lib:int-sub ix incx))))))
                  (setf jx (f2cl-lib:int-sub jx incx)))))))
        (t
         (cond
           ((= incx 1)
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
              (tagbody
                (cond
                  ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                   (setf l (f2cl-lib:int-sub 1 j))
```

```
            (if nounit
                (setf (f2cl-lib:fref x-%data%
                                     (j)
                                     ((1 *))
                                     x-%offset%)
                      (/
                       (f2cl-lib:fref x-%data%
                                      (j)
                                      ((1 *))
                                      x-%offset%)
                       (f2cl-lib:fref a-%data%
                                      (1 j)
                                      ((1 lda) (1 *))
                                      a-%offset%))))
            (setf temp
                  (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
            (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                           (f2cl-lib:int-add i 1))
                          ((> i
                              (min (the fixnum n)
                                   (the fixnum
                                        (f2cl-lib:int-add j k))))
                           nil)
              (tagbody
                (setf (f2cl-lib:fref x-%data%
                                     (i)
                                     ((1 *))
                                     x-%offset%)
                      (-
                       (f2cl-lib:fref x-%data%
                                      (i)
                                      ((1 *))
                                      x-%offset%)
                       (* temp
                          (f2cl-lib:fref a-%data%
                                         ((f2cl-lib:int-add l i)
                                          j)
                                         ((1 lda) (1 *))
                                         a-%offset%))))))))))
      (t
       (setf jx kx)
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (setf kx (f2cl-lib:int-add kx incx))
           (cond
             ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
              (setf ix kx)
              (setf l (f2cl-lib:int-sub 1 j))
              (if nounit
```

```
                    (setf (f2cl-lib:fref x-%data%
                                         (jx)
                                         ((1 *))
                                         x-%offset%)
                                  (/
                                   (f2cl-lib:fref x-%data%
                                                 (jx)
                                                 ((1 *))
                                                 x-%offset%)
                                   (f2cl-lib:fref a-%data%
                                                 (1 j)
                                                 ((1 lda) (1 *))
                                                 a-%offset%))))
                  (setf temp
                        (f2cl-lib:fref x-%data%
                                       (jx)
                                       ((1 *))
                                       x-%offset%))
                  (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                   (f2cl-lib:int-add i 1))
                                ((> i
                                    (min (the fixnum n)
                                         (the fixnum
                                              (f2cl-lib:int-add j k))))
                                 nil)
                    (tagbody
                      (setf (f2cl-lib:fref x-%data%
                                           (ix)
                                           ((1 *))
                                           x-%offset%)
                                  (-
                                   (f2cl-lib:fref x-%data%
                                                 (ix)
                                                 ((1 *))
                                                 x-%offset%)
                                   (* temp
                                      (f2cl-lib:fref a-%data%
                                                     ((f2cl-lib:int-add l i)
                                                      j)
                                                     ((1 lda) (1 *))
                                                     a-%offset%))))
                      (setf ix (f2cl-lib:int-add ix incx))))))
            (setf jx (f2cl-lib:int-add jx incx)))))))))
(t
 (cond
   ((char-equal uplo #\U)
    (setf kplus1 (f2cl-lib:int-add k 1))
    (cond
      ((= incx 1)
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
```

```
           ((> j n) nil)
(tagbody
  (setf temp
         (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
  (setf l (f2cl-lib:int-sub kplus1 j))
  (cond
    (noconj
     (f2cl-lib:fdo (i
                    (max (the fixnum 1)
                         (the fixnum
                              (f2cl-lib:int-add j
                                               (f2cl-lib:int-sub
                                                k))))
                    (f2cl-lib:int-add i 1))
                   ((> i
                       (f2cl-lib:int-add j
                                        (f2cl-lib:int-sub
                                         1)))
                    nil)
       (tagbody
         (setf temp
                 (- temp
                    (*
                     (f2cl-lib:fref a-%data%
                                    ((f2cl-lib:int-add l i)
                                     j)
                                    ((1 lda) (1 *))
                                    a-%offset%)
                     (f2cl-lib:fref x-%data%
                                    (i)
                                    ((1 *))
                                    x-%offset%))))))
     (if nounit
         (setf temp
                 (/ temp
                    (f2cl-lib:fref a-%data%
                                   (kplus1 j)
                                   ((1 lda) (1 *))
                                   a-%offset%)))))
    (t
     (f2cl-lib:fdo (i
                    (max (the fixnum 1)
                         (the fixnum
                              (f2cl-lib:int-add j
                                               (f2cl-lib:int-sub
                                                k))))
                    (f2cl-lib:int-add i 1))
                   ((> i
                       (f2cl-lib:int-add j
                                        (f2cl-lib:int-sub
```

```
                                                  1)))
                                nil)
                          (tagbody
                            (setf temp
                                  (- temp
                                     (*
                                      (f2cl-lib:dconjg
                                       (f2cl-lib:fref a-%data%
                                                      ((f2cl-lib:int-add l i)
                                                       j)
                                                      ((1 lda) (1 *))
                                                      a-%offset%))
                                       (f2cl-lib:fref x-%data%
                                                      (i)
                                                      ((1 *))
                                                      x-%offset%))))))
                       (if nounit
                           (setf temp
                                  (/ temp
                                     (f2cl-lib:dconjg
                                      (f2cl-lib:fref a-%data%
                                                     (kplus1 j)
                                                     ((1 lda) (1 *))
                                                     a-%offset%)))))))
                    (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
                          temp))))
              (t
               (setf jx kx)
               (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                             ((> j n) nil)
                 (tagbody
                   (setf temp
                         (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
                   (setf ix kx)
                   (setf l (f2cl-lib:int-sub kplus1 j))
                   (cond
                     (noconj
                      (f2cl-lib:fdo (i
                                     (max (the fixnum 1)
                                          (the fixnum
                                               (f2cl-lib:int-add j
                                                                 (f2cl-lib:int-sub
                                                                  k))))
                                     (f2cl-lib:int-add i 1))
                                    ((> i
                                        (f2cl-lib:int-add j
                                                          (f2cl-lib:int-sub
                                                           1)))
                                     nil)
                        (tagbody
```

```
        (setf temp
                (- temp
                   (*
                    (f2cl-lib:fref a-%data%
                                   ((f2cl-lib:int-add l i)
                                    j)
                                   ((1 lda) (1 *))
                                   a-%offset%)
                    (f2cl-lib:fref x-%data%
                                   (ix)
                                   ((1 *))
                                   x-%offset%))))
        (setf ix (f2cl-lib:int-add ix incx))))
    (if nounit
        (setf temp
                (/ temp
                   (f2cl-lib:fref a-%data%
                                  (kplus1 j)
                                  ((1 lda) (1 *))
                                  a-%offset%)))))
   (t
    (f2cl-lib:fdo (i
                   (max (the fixnum 1)
                        (the fixnum
                             (f2cl-lib:int-add j
                                               (f2cl-lib:int-sub
                                                k))))
                   (f2cl-lib:int-add i 1))
                  ((> i
                      (f2cl-lib:int-add j
                                        (f2cl-lib:int-sub
                                         1)))
                   nil)
      (tagbody
        (setf temp
                (- temp
                   (*
                    (f2cl-lib:dconjg
                     (f2cl-lib:fref a-%data%
                                    ((f2cl-lib:int-add l i)
                                     j)
                                    ((1 lda) (1 *))
                                    a-%offset%))
                    (f2cl-lib:fref x-%data%
                                   (ix)
                                   ((1 *))
                                   x-%offset%))))
        (setf ix (f2cl-lib:int-add ix incx))))
    (if nounit
        (setf temp
```

```
                              (/ temp
                                 (f2cl-lib:dconjg
                                  (f2cl-lib:fref a-%data%
                                                 (kplus1 j)
                                                 ((1 lda) (1 *))
                                                 a-%offset%)))))))
                      (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                            temp)
                      (setf jx (f2cl-lib:int-add jx incx))
                      (if (> j k) (setf kx (f2cl-lib:int-add kx incx)))))))
          (t
           (cond
             ((= incx 1)
              (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                            ((> j 1) nil)
                (tagbody
                  (setf temp
                          (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                  (setf l (f2cl-lib:int-sub 1 j))
                  (cond
                    (noconj
                     (f2cl-lib:fdo (i
                                    (min (the fixnum n)
                                         (the fixnum
                                              (f2cl-lib:int-add j k)))
                                    (f2cl-lib:int-add i
                                                      (f2cl-lib:int-sub 1)))
                                   ((> i (f2cl-lib:int-add j 1)) nil)
                       (tagbody
                         (setf temp
                                 (- temp
                                    (*
                                     (f2cl-lib:fref a-%data%
                                                    ((f2cl-lib:int-add l i)
                                                     j)
                                                    ((1 lda) (1 *))
                                                    a-%offset%)
                                     (f2cl-lib:fref x-%data%
                                                    (i)
                                                    ((1 *))
                                                    x-%offset%))))))
                     (if nounit
                         (setf temp
                                 (/ temp
                                    (f2cl-lib:fref a-%data%
                                                   (1 j)
                                                   ((1 lda) (1 *))
                                                   a-%offset%)))))
                    (t
                     (f2cl-lib:fdo (i
```

```
                          (min (the fixnum n)
                               (the fixnum
                                    (f2cl-lib:int-add j k)))
                          (f2cl-lib:int-add i
                                            (f2cl-lib:int-sub 1)))
                         ((> i (f2cl-lib:int-add j 1)) nil)
            (tagbody
              (setf temp
                      (- temp
                         (*
                          (f2cl-lib:dconjg
                           (f2cl-lib:fref a-%data%
                                          ((f2cl-lib:int-add l i)
                                           j)
                                          ((1 lda) (1 *))
                                          a-%offset%))
                          (f2cl-lib:fref x-%data%
                                         (i)
                                         ((1 *))
                                         x-%offset%))))))
          (if nounit
              (setf temp
                      (/ temp
                         (f2cl-lib:dconjg
                          (f2cl-lib:fref a-%data%
                                         (1 j)
                                         ((1 lda) (1 *))
                                         a-%offset%)))))))
      (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
              temp))))
(t
 (setf kx
         (f2cl-lib:int-add kx
                           (f2cl-lib:int-mul
                            (f2cl-lib:int-sub n 1)
                            incx)))
 (setf jx kx)
 (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
               ((> j 1) nil)
   (tagbody
     (setf temp
             (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
     (setf ix kx)
     (setf l (f2cl-lib:int-sub 1 j))
     (cond
       (noconj
        (f2cl-lib:fdo (i
                       (min (the fixnum n)
                            (the fixnum
                                 (f2cl-lib:int-add j k)))
```

```
                (f2cl-lib:int-add i
                                  (f2cl-lib:int-sub 1)))
               ((> i (f2cl-lib:int-add j 1)) nil)
  (tagbody
    (setf temp
            (- temp
               (*
                (f2cl-lib:fref a-%data%
                               ((f2cl-lib:int-add l i)
                                j)
                               ((1 lda) (1 *))
                               a-%offset%)
                (f2cl-lib:fref x-%data%
                               (ix)
                               ((1 *))
                               x-%offset%))))
    (setf ix (f2cl-lib:int-sub ix incx))))
 (if nounit
    (setf temp
            (/ temp
               (f2cl-lib:fref a-%data%
                              (1 j)
                              ((1 lda) (1 *))
                              a-%offset%)))))
(t
 (f2cl-lib:fdo (i
                (min (the fixnum n)
                     (the fixnum
                          (f2cl-lib:int-add j k)))
                (f2cl-lib:int-add i
                                  (f2cl-lib:int-sub 1)))
              ((> i (f2cl-lib:int-add j 1)) nil)
  (tagbody
    (setf temp
            (- temp
               (*
                (f2cl-lib:dconjg
                 (f2cl-lib:fref a-%data%
                                ((f2cl-lib:int-add l i)
                                 j)
                                ((1 lda) (1 *))
                                a-%offset%))
                (f2cl-lib:fref x-%data%
                               (ix)
                               ((1 *))
                               x-%offset%))))
    (setf ix (f2cl-lib:int-sub ix incx))))
 (if nounit
    (setf temp
            (/ temp
```

```
                                    (f2cl-lib:dconjg
                                     (f2cl-lib:fref a-%data%
                                                    (1 j)
                                                    ((1 lda) (1 *))
                                                    a-%offset%)))))))
                      (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                              temp)
                      (setf jx (f2cl-lib:int-sub jx incx))
                      (if (>= (f2cl-lib:int-sub n j) k)
                          (setf kx (f2cl-lib:int-sub kx incx)))))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil))))))
```

———-

4.30 ztpmv BLAS

— **ztpmv.input** —

```
)set break resume
)sys rm -f ztpmv.output
)spool ztpmv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **ztpmv.help** —

```
==========================================================================
ztpmv examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      ZTPMV - perform one of the matrix-vector operations   x :=
      A*x, or x := A'*x, or x := conjg( A' )*x,
```

```
SYNOPSIS
     SUBROUTINE ZTPMV ( UPLO, TRANS, DIAG, N, AP, X, INCX )

         INTEGER      INCX, N

         CHARACTER*1  DIAG, TRANS, UPLO

         COMPLEX*16   AP( * ), X( * )

PURPOSE
     ZTPMV  performs one of the matrix-vector operations

     where x is an n element vector and  A is an n by n unit, or
     non-unit, upper or lower triangular matrix, supplied in
     packed form.

PARAMETERS
     UPLO   - CHARACTER*1.
            On entry, UPLO specifies whether the matrix is an
            upper or lower triangular matrix as follows:

            UPLO = 'U' or 'u'   A is an upper triangular matrix.

            UPLO = 'L' or 'l'   A is a lower triangular matrix.

            Unchanged on exit.

     TRANS  - CHARACTER*1.
            On entry, TRANS specifies the operation to be per-
            formed as follows:

            TRANS = 'N' or 'n'   x := A*x.

            TRANS = 'T' or 't'   x := A'*x.

            TRANS = 'C' or 'c'   x := conjg( A' )*x.

            Unchanged on exit.

     DIAG   - CHARACTER*1.
            On entry, DIAG specifies whether or not A is unit
            triangular as follows:

            DIAG = 'U' or 'u'   A is assumed to be unit triangu-
            lar.

            DIAG = 'N' or 'n'   A is not assumed to be unit

            triangular.
```

```
            Unchanged on exit.

      N     - INTEGER.
            On entry, N specifies the order of the matrix A.  N
            must be at least zero.  Unchanged on exit.

      AP    - COMPLEX*16       array of DIMENSION at least
            ( ( n*( n + 1 ) )/2 ).  Before entry with  UPLO = 'U'
            or 'u', the array AP must contain the upper triangu-
            lar matrix packed sequentially, column by column, so
            that AP( 1 ) contains a( 1, 1 ), AP( 2 ) and AP( 3 )
            contain a( 1, 2 ) and a( 2, 2 ) respectively, and so
            on.  Before entry with UPLO = 'L' or 'l', the array
            AP must contain the lower triangular matrix packed
            sequentially, column by column, so that AP( 1 ) con-
            tains a( 1, 1 ), AP( 2 ) and AP( 3 ) contain a( 2, 1
            ) and a( 3, 1 ) respectively, and so on.  Note that
            when  DIAG = 'U' or 'u', the diagonal elements of A
            are not referenced, but are assumed to be unity.
            Unchanged on exit.

      X     - COMPLEX*16       array of dimension at least
            ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
            incremented array X must contain the n element vector
            x. On exit, X is overwritten with the transformed
            vector x.

      INCX  - INTEGER.
            On entry, INCX specifies the increment for the ele-
            ments of X. INCX must not be zero.  Unchanged on
            exit.
```

———-

— ztpmv.f —

```
      SUBROUTINE ZTPMV ( UPLO, TRANS, DIAG, N, AP, X, INCX )
*     .. Scalar Arguments ..
      INTEGER            INCX, N
      CHARACTER*1        DIAG, TRANS, UPLO
*     .. Array Arguments ..
      COMPLEX*16         AP( * ), X( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
```

```
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     .. Local Scalars ..
      COMPLEX*16         TEMP
      INTEGER            I, INFO, IX, J, JX, K, KK, KX
      LOGICAL            NOCONJ, NOUNIT
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO , 'U' ).AND.
     $         .NOT.LSAME( UPLO , 'L' )      )THEN
         INFO = 1
      ELSE IF( .NOT.LSAME( TRANS, 'N' ).AND.
     $         .NOT.LSAME( TRANS, 'T' ).AND.
     $         .NOT.LSAME( TRANS, 'C' )      )THEN
         INFO = 2
      ELSE IF( .NOT.LSAME( DIAG , 'U' ).AND.
     $         .NOT.LSAME( DIAG , 'N' )      )THEN
         INFO = 3
      ELSE IF( N.LT.0 )THEN
         INFO = 4
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 7
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZTPMV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( N.EQ.0 )
     $   RETURN
*
```

```
      NOCONJ = LSAME( TRANS, 'T' )
      NOUNIT = LSAME( DIAG , 'N' )
*
*     Set up the start point in X if the increment is not unity. This
*     will be  ( N - 1 )*INCX  too small for descending loops.
*
      IF( INCX.LE.0 )THEN
         KX = 1 - ( N - 1 )*INCX
      ELSE IF( INCX.NE.1 )THEN
         KX = 1
      END IF
*
*     Start the operations. In this version the elements of AP are
*     accessed sequentially with one pass through AP.
*
      IF( LSAME( TRANS, 'N' ) )THEN
*
*        Form  x:= A*x.
*
         IF( LSAME( UPLO, 'U' ) )THEN
            KK = 1
            IF( INCX.EQ.1 )THEN
               DO 20, J = 1, N
                  IF( X( J ).NE.ZERO )THEN
                     TEMP = X( J )
                     K    = KK
                     DO 10, I = 1, J - 1
                        X( I ) = X( I ) + TEMP*AP( K )
                        K      = K      + 1
   10                CONTINUE
                     IF( NOUNIT )
     $                  X( J ) = X( J )*AP( KK + J - 1 )
                  END IF
                  KK = KK + J
   20          CONTINUE
            ELSE
               JX = KX
               DO 40, J = 1, N
                  IF( X( JX ).NE.ZERO )THEN
                     TEMP = X( JX )
                     IX   = KX
                     DO 30, K = KK, KK + J - 2
                        X( IX ) = X( IX ) + TEMP*AP( K )
                        IX      = IX      + INCX
   30                CONTINUE
                     IF( NOUNIT )
     $                  X( JX ) = X( JX )*AP( KK + J - 1 )
                  END IF
                  JX = JX + INCX
                  KK = KK + J
```

```
   40          CONTINUE
            END IF
         ELSE
            KK = ( N*( N + 1 ) )/2
            IF( INCX.EQ.1 )THEN
               DO 60, J = N, 1, -1
                  IF( X( J ).NE.ZERO )THEN
                     TEMP = X( J )
                     K    = KK
                     DO 50, I = N, J + 1, -1
                        X( I ) = X( I ) + TEMP*AP( K )
                        K      = K      - 1
   50                CONTINUE
                     IF( NOUNIT )
     $                  X( J ) = X( J )*AP( KK - N + J )
                  END IF
                  KK = KK - ( N - J + 1 )
   60          CONTINUE
            ELSE
               KX = KX + ( N - 1 )*INCX
               JX = KX
               DO 80, J = N, 1, -1
                  IF( X( JX ).NE.ZERO )THEN
                     TEMP = X( JX )
                     IX   = KX
                     DO 70, K = KK, KK - ( N - ( J + 1 ) ), -1
                        X( IX ) = X( IX ) + TEMP*AP( K )
                        IX      = IX      - INCX
   70                CONTINUE
                     IF( NOUNIT )
     $                  X( JX ) = X( JX )*AP( KK - N + J )
                  END IF
                  JX = JX - INCX
                  KK = KK - ( N - J + 1 )
   80          CONTINUE
            END IF
         END IF
      ELSE
*
*        Form  x := A'*x  or  x := conjg( A' )*x.
*
         IF( LSAME( UPLO, 'U' ) )THEN
            KK = ( N*( N + 1 ) )/2
            IF( INCX.EQ.1 )THEN
               DO 110, J = N, 1, -1
                  TEMP = X( J )
                  K    = KK     - 1
                  IF( NOCONJ )THEN
                     IF( NOUNIT )
     $                  TEMP = TEMP*AP( KK )
```

```
                  DO 90, I = J - 1, 1, -1
                     TEMP = TEMP + AP( K )*X( I )
                     K    = K    - 1
 90               CONTINUE
               ELSE
                  IF( NOUNIT )
   $                 TEMP = TEMP*DCONJG( AP( KK ) )
                  DO 100, I = J - 1, 1, -1
                     TEMP = TEMP + DCONJG( AP( K ) )*X( I )
                     K    = K    - 1
100               CONTINUE
               END IF
               X( J ) = TEMP
               KK     = KK   - J
110         CONTINUE
         ELSE
            JX = KX + ( N - 1 )*INCX
            DO 140, J = N, 1, -1
               TEMP = X( JX )
               IX   = JX
               IF( NOCONJ )THEN
                  IF( NOUNIT )
   $                 TEMP = TEMP*AP( KK )
                  DO 120, K = KK - 1, KK - J + 1, -1
                     IX   = IX   - INCX
                     TEMP = TEMP + AP( K )*X( IX )
120               CONTINUE
               ELSE
                  IF( NOUNIT )
   $                 TEMP = TEMP*DCONJG( AP( KK ) )
                  DO 130, K = KK - 1, KK - J + 1, -1
                     IX   = IX   - INCX
                     TEMP = TEMP + DCONJG( AP( K ) )*X( IX )
130               CONTINUE
               END IF
               X( JX ) = TEMP
               JX      = JX   - INCX
               KK      = KK   - J
140         CONTINUE
         END IF
      ELSE
         KK = 1
         IF( INCX.EQ.1 )THEN
            DO 170, J = 1, N
               TEMP = X( J )
               K    = KK     + 1
               IF( NOCONJ )THEN
                  IF( NOUNIT )
   $                 TEMP = TEMP*AP( KK )
                  DO 150, I = J + 1, N
```

```
                     TEMP = TEMP + AP( K )*X( I )
                     K    = K    + 1
  150             CONTINUE
                  ELSE
                     IF( NOUNIT )
     $               TEMP = TEMP*DCONJG( AP( KK ) )
                     DO 160, I = J + 1, N
                        TEMP = TEMP + DCONJG( AP( K ) )*X( I )
                        K    = K    + 1
  160                CONTINUE
                  END IF
                  X( J ) = TEMP
                  KK     = KK   + ( N - J + 1 )
  170             CONTINUE
               ELSE
                  JX = KX
                  DO 200, J = 1, N
                     TEMP = X( JX )
                     IX   = JX
                     IF( NOCONJ )THEN
                        IF( NOUNIT )
     $                    TEMP = TEMP*AP( KK )
                        DO 180, K = KK + 1, KK + N - J
                           IX   = IX   + INCX
                           TEMP = TEMP + AP( K )*X( IX )
  180                   CONTINUE
                     ELSE
                        IF( NOUNIT )
     $                    TEMP = TEMP*DCONJG( AP( KK ) )
                        DO 190, K = KK + 1, KK + N - J
                           IX   = IX   + INCX
                           TEMP = TEMP + DCONJG( AP( K ) )*X( IX )
  190                   CONTINUE
                     END IF
                     X( JX ) = TEMP
                     JX      = JX   + INCX
                     KK      = KK   + ( N - J + 1 )
  200             CONTINUE
               END IF
            END IF
         END IF
*
         RETURN
*
*     End of ZTPMV .
*
         END
```

— BLAS 2 ztpmv —

```
(let* ((zero (complex 0.0 0.0)))
  (declare (type (complex double-float) zero))
  (defun ztpmv (uplo trans diag n ap x incx)
    (declare (type (simple-array (complex double-float) (*)) x ap)
             (type fixnum incx n)
             (type character diag trans uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (ap (complex double-float) ap-%data% ap-%offset%)
         (x (complex double-float) x-%data% x-%offset%))
      (prog ((noconj nil) (nounit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0) (k 0)
             (kk 0) (kx 0) (temp #C(0.0 0.0)))
        (declare (type (member t nil) noconj nounit)
                 (type fixnum i info ix j jx k kk kx)
                 (type (complex double-float) temp))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
          ((and (not (char-equal trans #\N))
                (not (char-equal trans #\T))
                (not (char-equal trans #\C)))
           (setf info 2))
          ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
           (setf info 3))
          ((< n 0)
           (setf info 4))
          ((= incx 0)
           (setf info 7)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "ZTPMV" info)
           (go end_label)))
        (if (= n 0) (go end_label))
        (setf noconj (char-equal trans #\T))
        (setf nounit (char-equal diag #\N))
        (cond
          ((<= incx 0)
           (setf kx
                 (f2cl-lib:int-sub 1
                                   (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                     incx))))
          ((/= incx 1)
```

```
   (setf kx 1)))
(cond
  ((char-equal trans #\N)
   (cond
     ((char-equal uplo #\U)
      (setf kk 1)
      (cond
        ((= incx 1)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (cond
               ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                (setf temp
                        (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                (setf k kk)
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                              ((> i
                                  (f2cl-lib:int-add j
                                                    (f2cl-lib:int-sub
                                                     1)))
                               nil)
                  (tagbody
                    (setf (f2cl-lib:fref x-%data%
                                         (i)
                                         ((1 *))
                                         x-%offset%)
                          (+
                           (f2cl-lib:fref x-%data%
                                          (i)
                                          ((1 *))
                                          x-%offset%)
                           (* temp
                              (f2cl-lib:fref ap-%data%
                                             (k)
                                             ((1 *))
                                             ap-%offset%))))
                    (setf k (f2cl-lib:int-add k 1))))
                (if nounit
                    (setf (f2cl-lib:fref x-%data%
                                         (j)
                                         ((1 *))
                                         x-%offset%)
                          (*
                           (f2cl-lib:fref x-%data%
                                          (j)
                                          ((1 *))
                                          x-%offset%)
                           (f2cl-lib:fref ap-%data%
                                          ((f2cl-lib:int-sub
```

```
                                        (f2cl-lib:int-add kk j)
                                        1))
                                      ((1 *))
                                      ap-%offset%))))))
      (setf kk (f2cl-lib:int-add kk j)))))
 (t
  (setf jx kx)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                ((> j n) nil)
    (tagbody
      (cond
        ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
         (setf temp
                 (f2cl-lib:fref x-%data%
                                (jx)
                                ((1 *))
                                x-%offset%))
         (setf ix kx)
         (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
                       ((> k
                           (f2cl-lib:int-add kk
                                             j
                                             (f2cl-lib:int-sub
                                              2)))
                        nil)
           (tagbody
             (setf (f2cl-lib:fref x-%data%
                                  (ix)
                                  ((1 *))
                                  x-%offset%)
                     (+
                      (f2cl-lib:fref x-%data%
                                     (ix)
                                     ((1 *))
                                     x-%offset%)
                      (* temp
                         (f2cl-lib:fref ap-%data%
                                        (k)
                                        ((1 *))
                                        ap-%offset%))))
             (setf ix (f2cl-lib:int-add ix incx))))
         (if nounit
             (setf (f2cl-lib:fref x-%data%
                                  (jx)
                                  ((1 *))
                                  x-%offset%)
                     (*
                      (f2cl-lib:fref x-%data%
                                     (jx)
                                     ((1 *))
```

```
                                        x-%offset%)
                                (f2cl-lib:fref ap-%data%
                                        ((f2cl-lib:int-sub
                                          (f2cl-lib:int-add kk j)
                                          1))
                                        ((1 *))
                                        ap-%offset%))))))
                (setf jx (f2cl-lib:int-add jx incx))
                (setf kk (f2cl-lib:int-add kk j)))))))
           (t
            (setf kk (the fixnum (truncate (* n (+ n 1)) 2)))
            (cond
              ((= incx 1)
               (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                             ((> j 1) nil)
                 (tagbody
                   (cond
                     ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                      (setf temp
                              (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                      (setf k kk)
                      (f2cl-lib:fdo (i n
                                       (f2cl-lib:int-add i
                                                         (f2cl-lib:int-sub 1)))
                                    ((> i (f2cl-lib:int-add j 1)) nil)
                        (tagbody
                          (setf (f2cl-lib:fref x-%data%
                                               (i)
                                               ((1 *))
                                               x-%offset%)
                                (+
                                 (f2cl-lib:fref x-%data%
                                                (i)
                                                ((1 *))
                                                x-%offset%)
                                 (* temp
                                    (f2cl-lib:fref ap-%data%
                                                   (k)
                                                   ((1 *))
                                                   ap-%offset%))))
                          (setf k (f2cl-lib:int-sub k 1))))
                      (if nounit
                          (setf (f2cl-lib:fref x-%data%
                                               (j)
                                               ((1 *))
                                               x-%offset%)
                                (*
                                 (f2cl-lib:fref x-%data%
                                                (j)
                                                ((1 *))
```

```
                                        x-%offset%)
                          (f2cl-lib:fref ap-%data%
                                        ((f2cl-lib:int-add
                                          (f2cl-lib:int-sub kk n)
                                          j))
                                        ((1 *))
                                        ap-%offset%))))))
             (setf kk
                   (f2cl-lib:int-sub kk
                                     (f2cl-lib:int-add
                                      (f2cl-lib:int-sub n j)
                                      1))))))
        (t
         (setf kx
               (f2cl-lib:int-add kx
                                 (f2cl-lib:int-mul
                                  (f2cl-lib:int-sub n 1)
                                  incx)))
         (setf jx kx)
         (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                       ((> j 1) nil)
           (tagbody
             (cond
               ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
                (setf temp
                      (f2cl-lib:fref x-%data%
                                     (jx)
                                     ((1 *))
                                     x-%offset%))
                (setf ix kx)
                (f2cl-lib:fdo (k kk
                               (f2cl-lib:int-add k
                                                 (f2cl-lib:int-sub 1)))
                              ((> k
                                  (f2cl-lib:int-add kk
                                                    (f2cl-lib:int-sub
                                                     (f2cl-lib:int-add
                                                      n
                                                      (f2cl-lib:int-sub
                                                       (f2cl-lib:int-add
                                                        j
                                                        1))))))
                               nil)
                  (tagbody
                    (setf (f2cl-lib:fref x-%data%
                                         (ix)
                                         ((1 *))
                                         x-%offset%)
                          (+
                           (f2cl-lib:fref x-%data%
```

```
                                          (ix)
                                          ((1 *))
                                          x-%offset%)
                                  (* temp
                                     (f2cl-lib:fref ap-%data%
                                                    (k)
                                                    ((1 *))
                                                    ap-%offset%))))
                          (setf ix (f2cl-lib:int-sub ix incx))))
                      (if nounit
                          (setf (f2cl-lib:fref x-%data%
                                               (jx)
                                               ((1 *))
                                               x-%offset%)
                                (*
                                 (f2cl-lib:fref x-%data%
                                                (jx)
                                                ((1 *))
                                                x-%offset%)
                                 (f2cl-lib:fref ap-%data%
                                                ((f2cl-lib:int-add
                                                  (f2cl-lib:int-sub kk n)
                                                  j))
                                                ((1 *))
                                                ap-%offset%))))))
                (setf jx (f2cl-lib:int-sub jx incx))
                (setf kk
                        (f2cl-lib:int-sub kk
                                          (f2cl-lib:int-add
                                           (f2cl-lib:int-sub n j)
                                           1))))))))))
          (t
           (cond
             ((char-equal uplo #\U)
              (setf kk (the fixnum (truncate (* n (+ n 1)) 2)))
              (cond
                ((= incx 1)
                 (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                               ((> j 1) nil)
                   (tagbody
                     (setf temp
                             (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                     (setf k (f2cl-lib:int-sub kk 1))
                     (cond
                       (noconj
                        (if nounit
                            (setf temp
                                    (* temp
                                       (f2cl-lib:fref ap-%data%
                                                      (kk)
```

```
                                ((1 *))
                                ap-%offset%))))
 (f2cl-lib:fdo (i
                (f2cl-lib:int-add j
                                  (f2cl-lib:int-sub 1))
                (f2cl-lib:int-add i
                                  (f2cl-lib:int-sub 1)))
               ((> i 1) nil)
   (tagbody
     (setf temp
             (+ temp
                (*
                 (f2cl-lib:fref ap-%data%
                                (k)
                                ((1 *))
                                ap-%offset%)
                 (f2cl-lib:fref x-%data%
                                (i)
                                ((1 *))
                                x-%offset%))))
     (setf k (f2cl-lib:int-sub k 1)))))
(t
 (if nounit
     (setf temp
             (* temp
                (f2cl-lib:dconjg
                 (f2cl-lib:fref ap-%data%
                                (kk)
                                ((1 *))
                                ap-%offset%)))))
 (f2cl-lib:fdo (i
                (f2cl-lib:int-add j
                                  (f2cl-lib:int-sub 1))
                (f2cl-lib:int-add i
                                  (f2cl-lib:int-sub 1)))
               ((> i 1) nil)
   (tagbody
     (setf temp
             (+ temp
                (*
                 (f2cl-lib:dconjg
                  (f2cl-lib:fref ap-%data%
                                 (k)
                                 ((1 *))
                                 ap-%offset%))
                 (f2cl-lib:fref x-%data%
                                (i)
                                ((1 *))
                                x-%offset%))))
     (setf k (f2cl-lib:int-sub k 1))))))
```

```
     (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
            temp)
     (setf kk (f2cl-lib:int-sub kk j)))))
(t
 (setf jx
        (f2cl-lib:int-add kx
                          (f2cl-lib:int-mul
                           (f2cl-lib:int-sub n 1)
                           incx)))
 (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
               ((> j 1) nil)
   (tagbody
     (setf temp
            (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
     (setf ix jx)
     (cond
       (noconj
        (if nounit
            (setf temp
                    (* temp
                       (f2cl-lib:fref ap-%data%
                                      (kk)
                                      ((1 *))
                                      ap-%offset%))))
        (f2cl-lib:fdo (k
                       (f2cl-lib:int-add kk
                                         (f2cl-lib:int-sub 1))
                       (f2cl-lib:int-add k
                                         (f2cl-lib:int-sub 1)))
                      ((> k
                          (f2cl-lib:int-add kk
                                            (f2cl-lib:int-sub
                                             j)
                                            1))
                       nil)
          (tagbody
            (setf ix (f2cl-lib:int-sub ix incx))
            (setf temp
                    (+ temp
                       (*
                        (f2cl-lib:fref ap-%data%
                                       (k)
                                       ((1 *))
                                       ap-%offset%)
                        (f2cl-lib:fref x-%data%
                                       (ix)
                                       ((1 *))
                                       x-%offset%)))))))
       (t
        (if nounit
```

```
                    (setf temp
                            (* temp
                               (f2cl-lib:dconjg
                                (f2cl-lib:fref ap-%data%
                                               (kk)
                                               ((1 *))
                                               ap-%offset%)))))
                (f2cl-lib:fdo (k
                               (f2cl-lib:int-add kk
                                                 (f2cl-lib:int-sub 1))
                               (f2cl-lib:int-add k
                                                 (f2cl-lib:int-sub 1)))
                              ((> k
                                  (f2cl-lib:int-add kk
                                                    (f2cl-lib:int-sub
                                                     j)
                                                    1))
                               nil)
                  (tagbody
                    (setf ix (f2cl-lib:int-sub ix incx))
                    (setf temp
                            (+ temp
                               (*
                                (f2cl-lib:dconjg
                                 (f2cl-lib:fref ap-%data%
                                                (k)
                                                ((1 *))
                                                ap-%offset%))
                                (f2cl-lib:fref x-%data%
                                               (ix)
                                               ((1 *))
                                               x-%offset%)))))))
            (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                    temp)
            (setf jx (f2cl-lib:int-sub jx incx))
            (setf kk (f2cl-lib:int-sub kk j)))))))
    (t
     (setf kk 1)
     (cond
       ((= incx 1)
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                      ((> j n) nil)
          (tagbody
            (setf temp
                    (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
            (setf k (f2cl-lib:int-add kk 1))
            (cond
              (noconj
               (if nounit
                   (setf temp
```

```
                  (* temp
                     (f2cl-lib:fref ap-%data%
                                    (kk)
                                    ((1 *))
                                    ap-%offset%))))
     (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                      (f2cl-lib:int-add i 1))
                   ((> i n) nil)
       (tagbody
         (setf temp
                  (+ temp
                     (*
                      (f2cl-lib:fref ap-%data%
                                     (k)
                                     ((1 *))
                                     ap-%offset%)
                      (f2cl-lib:fref x-%data%
                                     (i)
                                     ((1 *))
                                     x-%offset%))))
         (setf k (f2cl-lib:int-add k 1)))))
    (t
     (if nounit
         (setf temp
                  (* temp
                     (f2cl-lib:dconjg
                      (f2cl-lib:fref ap-%data%
                                     (kk)
                                     ((1 *))
                                     ap-%offset%)))))
     (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                      (f2cl-lib:int-add i 1))
                   ((> i n) nil)
       (tagbody
         (setf temp
                  (+ temp
                     (*
                      (f2cl-lib:dconjg
                       (f2cl-lib:fref ap-%data%
                                      (k)
                                      ((1 *))
                                      ap-%offset%))
                      (f2cl-lib:fref x-%data%
                                     (i)
                                     ((1 *))
                                     x-%offset%))))
         (setf k (f2cl-lib:int-add k 1))))))
  (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
        temp)
  (setf kk
```

```
              (f2cl-lib:int-add kk
                                (f2cl-lib:int-add
                                 (f2cl-lib:int-sub n j)
                                 1))))))
(t
 (setf jx kx)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (setf temp
             (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
     (setf ix jx)
     (cond
       (noconj
        (if nounit
            (setf temp
                    (* temp
                       (f2cl-lib:fref ap-%data%
                                      (kk)
                                      ((1 *))
                                      ap-%offset%))))
        (f2cl-lib:fdo (k (f2cl-lib:int-add kk 1)
                         (f2cl-lib:int-add k 1))
                      ((> k
                          (f2cl-lib:int-add kk
                                            n
                                            (f2cl-lib:int-sub
                                             j)))
                       nil)
          (tagbody
            (setf ix (f2cl-lib:int-add ix incx))
            (setf temp
                    (+ temp
                       (*
                        (f2cl-lib:fref ap-%data%
                                       (k)
                                       ((1 *))
                                       ap-%offset%)
                        (f2cl-lib:fref x-%data%
                                       (ix)
                                       ((1 *))
                                       x-%offset%)))))))
       (t
        (if nounit
            (setf temp
                    (* temp
                       (f2cl-lib:dconjg
                        (f2cl-lib:fref ap-%data%
                                       (kk)
                                       ((1 *))
```

```
                                          ap-%offset%)))))
                    (f2cl-lib:fdo (k (f2cl-lib:int-add kk 1)
                                   (f2cl-lib:int-add k 1))
                                  ((> k
                                      (f2cl-lib:int-add kk
                                                        n
                                                        (f2cl-lib:int-sub
                                                         j)))
                                   nil)
                      (tagbody
                        (setf ix (f2cl-lib:int-add ix incx))
                        (setf temp
                              (+ temp
                                 (*
                                  (f2cl-lib:dconjg
                                   (f2cl-lib:fref ap-%data%
                                                  (k)
                                                  ((1 *))
                                                  ap-%offset%))
                                  (f2cl-lib:fref x-%data%
                                                 (ix)
                                                 ((1 *))
                                                 x-%offset%))))))
                    (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                          temp)
                    (setf jx (f2cl-lib:int-add jx incx))
                    (setf kk
                          (f2cl-lib:int-add kk
                                            (f2cl-lib:int-add
                                             (f2cl-lib:int-sub n j)
                                             1)))))))))
 end_label
        (return (values nil nil nil nil nil nil nil))))))
```

———-

4.31 ztpsv BLAS

— **ztpsv.input** —

```
)set break resume
)sys rm -f ztpsv.output
)spool ztpsv.output
)set message test on
)set message auto off
)clear all
```

```
)spool
)lisp (bye)
```

———-

— **ztpsv.help** —

```
==========================================================================
ztpsv examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      ZTPSV - solve one of the systems of equations   A*x = b, or
      A'*x = b, or conjg( A' )*x = b,

 SYNOPSIS
      SUBROUTINE ZTPSV ( UPLO, TRANS, DIAG, N, AP, X, INCX )

          INTEGER      INCX, N

          CHARACTER*1  DIAG, TRANS, UPLO

          COMPLEX*16   AP( * ), X( * )

 PURPOSE
      ZTPSV  solves one of the systems of equations

      where b and x are n element vectors and A is an n by n unit,
      or non-unit, upper or lower triangular matrix, supplied in
      packed form.

      No test for singularity or near-singularity is included in
      this routine. Such tests must be performed before calling
      this routine.

 PARAMETERS
      UPLO   - CHARACTER*1.
               On entry, UPLO specifies whether the matrix is an
               upper or lower triangular matrix as follows:

               UPLO = 'U' or 'u'   A is an upper triangular matrix.

               UPLO = 'L' or 'l'   A is a lower triangular matrix.
```

```
         Unchanged on exit.

TRANS  - CHARACTER*1.
         On entry, TRANS specifies the equations to be solved
         as follows:

         TRANS = 'N' or 'n'   A*x = b.

         TRANS = 'T' or 't'   A'*x = b.

         TRANS = 'C' or 'c'   conjg( A' )*x = b.

         Unchanged on exit.

DIAG   - CHARACTER*1.
         On entry, DIAG specifies whether or not A is unit
         triangular as follows:

         DIAG = 'U' or 'u'   A is assumed to be unit triangu-
         lar.

         DIAG = 'N' or 'n'   A is not assumed to be unit tri-
         angular.

         Unchanged on exit.

N      - INTEGER.
         On entry, N specifies the order of the matrix A.  N
         must be at least zero.  Unchanged on exit.

AP     - COMPLEX*16       array of DIMENSION at least
         ( ( n*( n + 1 ) )/2 ).  Before entry with  UPLO = 'U'
         or 'u', the array AP must contain the upper triangu-
         lar matrix packed sequentially, column by column, so
         that AP( 1 ) contains a( 1, 1 ), AP( 2 ) and AP( 3 )
         contain a( 1, 2 ) and a( 2, 2 ) respectively, and so
         on.  Before entry with UPLO = 'L' or 'l', the array
         AP must contain the lower triangular matrix packed
         sequentially, column by column, so that AP( 1 ) con-
         tains a( 1, 1 ), AP( 2 ) and AP( 3 ) contain a( 2, 1
         ) and a( 3, 1 ) respectively, and so on.  Note that
         when  DIAG = 'U' or 'u', the diagonal elements of A
         are not referenced, but are assumed to be unity.
         Unchanged on exit.

X      - COMPLEX*16       array of dimension at least
         ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
         incremented array X must contain the n element
         right-hand side vector b. On exit, X is overwritten
         with the solution vector x.
```

```
      INCX   - INTEGER.
             On entry, INCX specifies the increment for the ele-
             ments of X. INCX must not be zero.  Unchanged on
             exit.
```

———-

— **ztpsv.f** —

```
      SUBROUTINE ZTPSV ( UPLO, TRANS, DIAG, N, AP, X, INCX )
*     .. Scalar Arguments ..
      INTEGER            INCX, N
      CHARACTER*1        DIAG, TRANS, UPLO
*     .. Array Arguments ..
      COMPLEX*16         AP( * ), X( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     .. Local Scalars ..
      COMPLEX*16         TEMP
      INTEGER            I, INFO, IX, J, JX, K, KK, KX
      LOGICAL            NOCONJ, NOUNIT
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO , 'U' ).AND.
```

```
     $         .NOT.LSAME( UPLO , 'L' )      )THEN
          INFO = 1
       ELSE IF( .NOT.LSAME( TRANS, 'N' ).AND.
     $         .NOT.LSAME( TRANS, 'T' ).AND.
     $         .NOT.LSAME( TRANS, 'C' )      )THEN
          INFO = 2
       ELSE IF( .NOT.LSAME( DIAG , 'U' ).AND.
     $         .NOT.LSAME( DIAG , 'N' )      )THEN
          INFO = 3
       ELSE IF( N.LT.0 )THEN
          INFO = 4
       ELSE IF( INCX.EQ.0 )THEN
          INFO = 7
       END IF
       IF( INFO.NE.0 )THEN
          CALL XERBLA( 'ZTPSV ', INFO )
          RETURN
       END IF
*
*     Quick return if possible.
*
       IF( N.EQ.0 )
     $   RETURN
*
       NOCONJ = LSAME( TRANS, 'T' )
       NOUNIT = LSAME( DIAG , 'N' )
*
*     Set up the start point in X if the increment is not unity. This
*     will be  ( N - 1 )*INCX  too small for descending loops.
*
       IF( INCX.LE.0 )THEN
          KX = 1 - ( N - 1 )*INCX
       ELSE IF( INCX.NE.1 )THEN
          KX = 1
       END IF
*
*     Start the operations. In this version the elements of AP are
*     accessed sequentially with one pass through AP.
*
       IF( LSAME( TRANS, 'N' ) )THEN
*
*        Form  x := inv( A )*x.
*
          IF( LSAME( UPLO, 'U' ) )THEN
             KK = ( N*( N + 1 ) )/2
             IF( INCX.EQ.1 )THEN
                DO 20, J = N, 1, -1
                   IF( X( J ).NE.ZERO )THEN
                      IF( NOUNIT )
     $                   X( J ) = X( J )/AP( KK )
```

```
                  TEMP = X( J )
                  K    = KK     - 1
                  DO 10, I = J - 1, 1, -1
                     X( I ) = X( I ) - TEMP*AP( K )
                     K      = K      - 1
10                CONTINUE
               END IF
               KK = KK - J
20          CONTINUE
         ELSE
            JX = KX + ( N - 1 )*INCX
            DO 40, J = N, 1, -1
               IF( X( JX ).NE.ZERO )THEN
                  IF( NOUNIT )
     $               X( JX ) = X( JX )/AP( KK )
                  TEMP = X( JX )
                  IX   = JX
                  DO 30, K = KK - 1, KK - J + 1, -1
                     IX      = IX      - INCX
                     X( IX ) = X( IX ) - TEMP*AP( K )
30                CONTINUE
               END IF
               JX = JX - INCX
               KK = KK - J
40          CONTINUE
         END IF
      ELSE
         KK = 1
         IF( INCX.EQ.1 )THEN
            DO 60, J = 1, N
               IF( X( J ).NE.ZERO )THEN
                  IF( NOUNIT )
     $               X( J ) = X( J )/AP( KK )
                  TEMP = X( J )
                  K    = KK     + 1
                  DO 50, I = J + 1, N
                     X( I ) = X( I ) - TEMP*AP( K )
                     K      = K      + 1
50                CONTINUE
               END IF
               KK = KK + ( N - J + 1 )
60          CONTINUE
         ELSE
            JX = KX
            DO 80, J = 1, N
               IF( X( JX ).NE.ZERO )THEN
                  IF( NOUNIT )
     $               X( JX ) = X( JX )/AP( KK )
                  TEMP = X( JX )
                  IX   = JX
```

```
                  DO 70, K = KK + 1, KK + N - J
                     IX      = IX      + INCX
                     X( IX ) = X( IX ) - TEMP*AP( K )
   70             CONTINUE
               END IF
               JX = JX + INCX
               KK = KK + ( N - J + 1 )
   80       CONTINUE
         END IF
      END IF
   ELSE
*
*        Form  x := inv( A' )*x  or  x := inv( conjg( A' ) )*x.
*
         IF( LSAME( UPLO, 'U' ) )THEN
            KK = 1
            IF( INCX.EQ.1 )THEN
               DO 110, J = 1, N
                  TEMP = X( J )
                  K    = KK
                  IF( NOCONJ )THEN
                     DO 90, I = 1, J - 1
                        TEMP = TEMP - AP( K )*X( I )
                        K    = K    + 1
   90                CONTINUE
                     IF( NOUNIT )
     $                  TEMP = TEMP/AP( KK + J - 1 )
                  ELSE
                     DO 100, I = 1, J - 1
                        TEMP = TEMP - DCONJG( AP( K ) )*X( I )
                        K    = K    + 1
  100                CONTINUE
                     IF( NOUNIT )
     $                  TEMP = TEMP/DCONJG( AP( KK + J - 1 ) )
                  END IF
                  X( J ) = TEMP
                  KK     = KK   + J
  110          CONTINUE
            ELSE
               JX = KX
               DO 140, J = 1, N
                  TEMP = X( JX )
                  IX   = KX
                  IF( NOCONJ )THEN
                     DO 120, K = KK, KK + J - 2
                        TEMP = TEMP - AP( K )*X( IX )
                        IX   = IX   + INCX
  120                CONTINUE
                     IF( NOUNIT )
     $                  TEMP = TEMP/AP( KK + J - 1 )
```

```
               ELSE
                  DO 130, K = KK, KK + J - 2
                     TEMP = TEMP - DCONJG( AP( K ) )*X( IX )
                     IX   = IX   + INCX
130               CONTINUE
                  IF( NOUNIT )
     $               TEMP = TEMP/DCONJG( AP( KK + J - 1 ) )
               END IF
               X( JX ) = TEMP
               JX      = JX   + INCX
               KK      = KK   + J
140         CONTINUE
         END IF
      ELSE
         KK = ( N*( N + 1 ) )/2
         IF( INCX.EQ.1 )THEN
            DO 170, J = N, 1, -1
               TEMP = X( J )
               K    = KK
               IF( NOCONJ )THEN
                  DO 150, I = N, J + 1, -1
                     TEMP = TEMP - AP( K )*X( I )
                     K    = K    - 1
150               CONTINUE
                  IF( NOUNIT )
     $               TEMP = TEMP/AP( KK - N + J )
               ELSE
                  DO 160, I = N, J + 1, -1
                     TEMP = TEMP - DCONJG( AP( K ) )*X( I )
                     K    = K    - 1
160               CONTINUE
                  IF( NOUNIT )
     $               TEMP = TEMP/DCONJG( AP( KK - N + J ) )
               END IF
               X( J ) = TEMP
               KK     = KK   - ( N - J + 1 )
170         CONTINUE
         ELSE
            KX = KX + ( N - 1 )*INCX
            JX = KX
            DO 200, J = N, 1, -1
               TEMP = X( JX )
               IX   = KX
               IF( NOCONJ )THEN
                  DO 180, K = KK, KK - ( N - ( J + 1 ) ), -1
                     TEMP = TEMP - AP( K )*X( IX )
                     IX   = IX   - INCX
180               CONTINUE
                  IF( NOUNIT )
     $               TEMP = TEMP/AP( KK - N + J )
```

```
                ELSE
                   DO 190, K = KK, KK - ( N - ( J + 1 ) ), -1
                      TEMP = TEMP - DCONJG( AP( K ) )*X( IX )
                      IX   = IX   - INCX
  190              CONTINUE
                   IF( NOUNIT )
     $                TEMP = TEMP/DCONJG( AP( KK - N + J ) )
                END IF
                X( JX ) = TEMP
                JX      = JX   - INCX
                KK      = KK   - ( N - J + 1 )
  200          CONTINUE
            END IF
         END IF
      END IF
*
      RETURN
*
*     End of ZTPSV .
*
      END
```

— BLAS 2 ztpsv —

```
(let* ((zero (complex 0.0 0.0)))
  (declare (type (complex double-float) zero))
  (defun ztpsv (uplo trans diag n ap x incx)
    (declare (type (simple-array (complex double-float) (*)) x ap)
             (type fixnum incx n)
             (type character diag trans uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (ap (complex double-float) ap-%data% ap-%offset%)
         (x (complex double-float) x-%data% x-%offset%))
      (prog ((noconj nil) (nounit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0) (k 0)
             (kk 0) (kx 0) (temp #C(0.0 0.0)))
        (declare (type (member t nil) noconj nounit)
                 (type fixnum i info ix j jx k kk kx)
                 (type (complex double-float) temp))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
          ((and (not (char-equal trans #\N))
```

```
         (not (char-equal trans #\T))
         (not (char-equal trans #\C)))
    (setf info 2))
   ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
    (setf info 3))
   ((< n 0)
    (setf info 4))
   ((= incx 0)
    (setf info 7)))
 (cond
   ((/= info 0)
    (error
     " ** On entry to ~a parameter number ~a had an illegal value~%"
     "ZTPSV" info)
    (go end_label)))
 (if (= n 0) (go end_label))
 (setf noconj (char-equal trans #\T))
 (setf nounit (char-equal diag #\N))
 (cond
   ((<= incx 0)
    (setf kx
          (f2cl-lib:int-sub 1
                            (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                              incx))))
   ((/= incx 1)
    (setf kx 1)))
 (cond
   ((char-equal trans #\N)
    (cond
      ((char-equal uplo #\U)
       (setf kk (the fixnum (truncate (* n (+ n 1)) 2)))
       (cond
         ((= incx 1)
          (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                        ((> j 1) nil)
            (tagbody
              (cond
                ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                 (if nounit
                     (setf (f2cl-lib:fref x-%data%
                                          (j)
                                          ((1 *))
                                          x-%offset%)
                           (/
                            (f2cl-lib:fref x-%data%
                                           (j)
                                           ((1 *))
                                           x-%offset%)
                            (f2cl-lib:fref ap-%data%
                                           (kk)
```

```
                                    ((1 *))
                                    ap-%offset%))))
            (setf temp
                    (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
            (setf k (f2cl-lib:int-sub kk 1))
            (f2cl-lib:fdo (i
                           (f2cl-lib:int-add j
                                             (f2cl-lib:int-sub 1))
                           (f2cl-lib:int-add i
                                             (f2cl-lib:int-sub 1)))
                          ((> i 1) nil)
              (tagbody
                (setf (f2cl-lib:fref x-%data%
                                     (i)
                                     ((1 *))
                                     x-%offset%)
                      (-
                       (f2cl-lib:fref x-%data%
                                      (i)
                                      ((1 *))
                                      x-%offset%)
                       (* temp
                          (f2cl-lib:fref ap-%data%
                                         (k)
                                         ((1 *))
                                         ap-%offset%))))
                (setf k (f2cl-lib:int-sub k 1))))))
        (setf kk (f2cl-lib:int-sub kk j)))))
(t
 (setf jx
       (f2cl-lib:int-add kx
                         (f2cl-lib:int-mul
                          (f2cl-lib:int-sub n 1)
                          incx)))
 (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
               ((> j 1) nil)
   (tagbody
     (cond
       ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
        (if nounit
            (setf (f2cl-lib:fref x-%data%
                                 (jx)
                                 ((1 *))
                                 x-%offset%)
                  (/
                   (f2cl-lib:fref x-%data%
                                  (jx)
                                  ((1 *))
                                  x-%offset%)
                   (f2cl-lib:fref ap-%data%
```

```
                                    (kk)
                                    ((1 *))
                                    ap-%offset%))))
            (setf temp
                    (f2cl-lib:fref x-%data%
                                   (jx)
                                   ((1 *))
                                   x-%offset%))
            (setf ix jx)
            (f2cl-lib:fdo (k
                           (f2cl-lib:int-add kk
                                             (f2cl-lib:int-sub 1))
                           (f2cl-lib:int-add k
                                             (f2cl-lib:int-sub 1)))
                          ((> k
                              (f2cl-lib:int-add kk
                                                (f2cl-lib:int-sub
                                                 j)
                                                1))
                           nil)
              (tagbody
                (setf ix (f2cl-lib:int-sub ix incx))
                (setf (f2cl-lib:fref x-%data%
                                     (ix)
                                     ((1 *))
                                     x-%offset%)
                      (-
                       (f2cl-lib:fref x-%data%
                                      (ix)
                                      ((1 *))
                                      x-%offset%)
                       (* temp
                          (f2cl-lib:fref ap-%data%
                                         (k)
                                         ((1 *))
                                         ap-%offset%)))))))
        (setf jx (f2cl-lib:int-sub jx incx))
        (setf kk (f2cl-lib:int-sub kk j)))))
(t
 (setf kk 1)
 (cond
   ((= incx 1)
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j n) nil)
      (tagbody
        (cond
          ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
           (if nounit
               (setf (f2cl-lib:fref x-%data%
                                    (j)
```

```
                                        ((1 *))
                                        x-%offset%)
                                (/
                                 (f2cl-lib:fref x-%data%
                                                (j)
                                                ((1 *))
                                                x-%offset%)
                                 (f2cl-lib:fref ap-%data%
                                                (kk)
                                                ((1 *))
                                                ap-%offset%))))
                    (setf temp
                            (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                    (setf k (f2cl-lib:int-add kk 1))
                    (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                     (f2cl-lib:int-add i 1))
                                  ((> i n) nil)
                      (tagbody
                        (setf (f2cl-lib:fref x-%data%
                                             (i)
                                             ((1 *))
                                             x-%offset%)
                                (-
                                 (f2cl-lib:fref x-%data%
                                                (i)
                                                ((1 *))
                                                x-%offset%)
                                 (* temp
                                    (f2cl-lib:fref ap-%data%
                                                   (k)
                                                   ((1 *))
                                                   ap-%offset%))))
                        (setf k (f2cl-lib:int-add k 1))))))
                (setf kk
                        (f2cl-lib:int-add kk
                                          (f2cl-lib:int-add
                                           (f2cl-lib:int-sub n j)
                                           1))))))
          (t
           (setf jx kx)
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (cond
                 ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
                  (if nounit
                      (setf (f2cl-lib:fref x-%data%
                                           (jx)
                                           ((1 *))
                                           x-%offset%)
```

```
                                (/
                                 (f2cl-lib:fref x-%data%
                                                (jx)
                                                ((1 *))
                                                x-%offset%)
                                 (f2cl-lib:fref ap-%data%
                                                (kk)
                                                ((1 *))
                                                ap-%offset%))))
                           (setf temp
                                 (f2cl-lib:fref x-%data%
                                                (jx)
                                                ((1 *))
                                                x-%offset%))
                           (setf ix jx)
                           (f2cl-lib:fdo (k (f2cl-lib:int-add kk 1)
                                            (f2cl-lib:int-add k 1))
                                         ((> k
                                             (f2cl-lib:int-add kk
                                                               n
                                                               (f2cl-lib:int-sub
                                                                j)))
                                          nil)
                             (tagbody
                               (setf ix (f2cl-lib:int-add ix incx))
                               (setf (f2cl-lib:fref x-%data%
                                                    (ix)
                                                    ((1 *))
                                                    x-%offset%)
                                     (-
                                      (f2cl-lib:fref x-%data%
                                                     (ix)
                                                     ((1 *))
                                                     x-%offset%)
                                      (* temp
                                         (f2cl-lib:fref ap-%data%
                                                        (k)
                                                        ((1 *))
                                                        ap-%offset%)))))))
                     (setf jx (f2cl-lib:int-add jx incx))
                     (setf kk
                           (f2cl-lib:int-add kk
                                             (f2cl-lib:int-add
                                              (f2cl-lib:int-sub n j)
                                              1)))))))))
        (t
         (cond
           ((char-equal uplo #\U)
            (setf kk 1)
            (cond
```

```
((= incx 1)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (setf temp
             (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
     (setf k kk)
     (cond
       (noconj
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i
                          (f2cl-lib:int-add j
                                            (f2cl-lib:int-sub
                                             1)))
                       nil)
          (tagbody
            (setf temp
                    (- temp
                       (*
                        (f2cl-lib:fref ap-%data%
                                       (k)
                                       ((1 *))
                                       ap-%offset%)
                        (f2cl-lib:fref x-%data%
                                       (i)
                                       ((1 *))
                                       x-%offset%))))
            (setf k (f2cl-lib:int-add k 1))))
        (if nounit
            (setf temp
                    (/ temp
                       (f2cl-lib:fref ap-%data%
                                      ((f2cl-lib:int-sub
                                        (f2cl-lib:int-add kk j)
                                        1))
                                      ((1 *))
                                      ap-%offset%)))))
       (t
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i
                          (f2cl-lib:int-add j
                                            (f2cl-lib:int-sub
                                             1)))
                       nil)
          (tagbody
            (setf temp
                    (- temp
                       (*
                        (f2cl-lib:dconjg
                         (f2cl-lib:fref ap-%data%
```

```
                                        (k)
                                        ((1 *))
                                        ap-%offset%))
                            (f2cl-lib:fref x-%data%
                                           (i)
                                           ((1 *))
                                           x-%offset%))))
                (setf k (f2cl-lib:int-add k 1))))
            (if nounit
                (setf temp
                        (/ temp
                           (f2cl-lib:dconjg
                            (f2cl-lib:fref ap-%data%
                                           ((f2cl-lib:int-sub
                                             (f2cl-lib:int-add kk
                                                               j)
                                             1))
                                           ((1 *))
                                           ap-%offset%)))))))
        (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
                temp)
        (setf kk (f2cl-lib:int-add kk j)))))
    (t
     (setf jx kx)
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   ((> j n) nil)
       (tagbody
         (setf temp
                 (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
         (setf ix kx)
         (cond
           (noconj
            (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
                          ((> k
                              (f2cl-lib:int-add kk
                                                j
                                                (f2cl-lib:int-sub
                                                 2)))
                           nil)
              (tagbody
                (setf temp
                        (- temp
                           (*
                            (f2cl-lib:fref ap-%data%
                                           (k)
                                           ((1 *))
                                           ap-%offset%)
                            (f2cl-lib:fref x-%data%
                                           (ix)
                                           ((1 *))
```

```
                                        x-%offset%))))
                    (setf ix (f2cl-lib:int-add ix incx))))
                (if nounit
                    (setf temp
                            (/ temp
                               (f2cl-lib:fref ap-%data%
                                              ((f2cl-lib:int-sub
                                                (f2cl-lib:int-add kk j)
                                                1))
                                              ((1 *))
                                              ap-%offset%)))))
               (t
                (f2cl-lib:fdo (k kk (f2cl-lib:int-add k 1))
                              ((> k
                                  (f2cl-lib:int-add kk
                                                    j
                                                    (f2cl-lib:int-sub
                                                     2)))
                               nil)
                  (tagbody
                    (setf temp
                            (- temp
                               (*
                                (f2cl-lib:dconjg
                                 (f2cl-lib:fref ap-%data%
                                                (k)
                                                ((1 *))
                                                ap-%offset%))
                                (f2cl-lib:fref x-%data%
                                               (ix)
                                               ((1 *))
                                               x-%offset%))))
                    (setf ix (f2cl-lib:int-add ix incx))))
                (if nounit
                    (setf temp
                            (/ temp
                               (f2cl-lib:dconjg
                                (f2cl-lib:fref ap-%data%
                                               ((f2cl-lib:int-sub
                                                 (f2cl-lib:int-add kk
                                                                   j)
                                                 1))
                                               ((1 *))
                                               ap-%offset%)))))))
            (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                  temp)
            (setf jx (f2cl-lib:int-add jx incx))
            (setf kk (f2cl-lib:int-add kk j)))))))
       (t
        (setf kk (the fixnum (truncate (* n (+ n 1)) 2)))
```

```
(cond
  ((= incx 1)
   (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                 ((> j 1) nil)
     (tagbody
       (setf temp
               (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
       (setf k kk)
       (cond
         (noconj
          (f2cl-lib:fdo (i n
                         (f2cl-lib:int-add i
                                           (f2cl-lib:int-sub 1)))
                        ((> i (f2cl-lib:int-add j 1)) nil)
            (tagbody
              (setf temp
                      (- temp
                         (*
                          (f2cl-lib:fref ap-%data%
                                         (k)
                                         ((1 *))
                                         ap-%offset%)
                          (f2cl-lib:fref x-%data%
                                         (i)
                                         ((1 *))
                                         x-%offset%))))
              (setf k (f2cl-lib:int-sub k 1))))
          (if nounit
              (setf temp
                      (/ temp
                         (f2cl-lib:fref ap-%data%
                                        ((f2cl-lib:int-add
                                          (f2cl-lib:int-sub kk n)
                                          j))
                                        ((1 *))
                                        ap-%offset%)))))
         (t
          (f2cl-lib:fdo (i n
                         (f2cl-lib:int-add i
                                           (f2cl-lib:int-sub 1)))
                        ((> i (f2cl-lib:int-add j 1)) nil)
            (tagbody
              (setf temp
                      (- temp
                         (*
                          (f2cl-lib:dconjg
                           (f2cl-lib:fref ap-%data%
                                          (k)
                                          ((1 *))
                                          ap-%offset%))
```

```
                                (f2cl-lib:fref x-%data%
                                               (i)
                                               ((1 *))
                                               x-%offset%))))
                        (setf k (f2cl-lib:int-sub k 1))))
                    (if nounit
                        (setf temp
                              (/ temp
                                 (f2cl-lib:dconjg
                                  (f2cl-lib:fref ap-%data%
                                                 ((f2cl-lib:int-add
                                                   (f2cl-lib:int-sub kk
                                                                     n)
                                                   j))
                                                 ((1 *))
                                                 ap-%offset%)))))))
                (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
                      temp)
                (setf kk
                      (f2cl-lib:int-sub kk
                                        (f2cl-lib:int-add
                                         (f2cl-lib:int-sub n j)
                                         1))))))
            (t
             (setf kx
                   (f2cl-lib:int-add kx
                                     (f2cl-lib:int-mul
                                      (f2cl-lib:int-sub n 1)
                                      incx)))
             (setf jx kx)
             (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                           ((> j 1) nil)
               (tagbody
                 (setf temp
                       (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
                 (setf ix kx)
                 (cond
                   (noconj
                    (f2cl-lib:fdo (k kk
                                   (f2cl-lib:int-add k
                                                     (f2cl-lib:int-sub 1)))
                                  ((> k
                                      (f2cl-lib:int-add kk
                                                        (f2cl-lib:int-sub
                                                         (f2cl-lib:int-add
                                                          n
                                                          (f2cl-lib:int-sub
                                                           (f2cl-lib:int-add
                                                            j
                                                            1))))))
```

```
                nil)
    (tagbody
      (setf temp
              (- temp
                 (*
                  (f2cl-lib:fref ap-%data%
                                 (k)
                                 ((1 *))
                                 ap-%offset%)
                  (f2cl-lib:fref x-%data%
                                 (ix)
                                 ((1 *))
                                 x-%offset%))))
      (setf ix (f2cl-lib:int-sub ix incx))))
   (if nounit
      (setf temp
              (/ temp
                 (f2cl-lib:fref ap-%data%
                                ((f2cl-lib:int-add
                                  (f2cl-lib:int-sub kk n)
                                  j))
                                ((1 *))
                                ap-%offset%)))))
  (t
   (f2cl-lib:fdo (k kk
                  (f2cl-lib:int-add k
                                    (f2cl-lib:int-sub 1)))
                 ((> k
                     (f2cl-lib:int-add kk
                                       (f2cl-lib:int-sub
                                        (f2cl-lib:int-add
                                         n
                                         (f2cl-lib:int-sub
                                          (f2cl-lib:int-add
                                           j
                                           1))))))
                 nil)
    (tagbody
      (setf temp
              (- temp
                 (*
                  (f2cl-lib:dconjg
                   (f2cl-lib:fref ap-%data%
                                  (k)
                                  ((1 *))
                                  ap-%offset%))
                  (f2cl-lib:fref x-%data%
                                 (ix)
                                 ((1 *))
                                 x-%offset%))))
```

```
                        (setf ix (f2cl-lib:int-sub ix incx))))
                    (if nounit
                        (setf temp
                              (/ temp
                                 (f2cl-lib:dconjg
                                  (f2cl-lib:fref ap-%data%
                                                 ((f2cl-lib:int-add
                                                   (f2cl-lib:int-sub kk
                                                                     n)
                                                   j))
                                                 ((1 *))
                                                 ap-%offset%)))))))
                  (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                        temp)
                  (setf jx (f2cl-lib:int-sub jx incx))
                  (setf kk
                        (f2cl-lib:int-sub kk
                                          (f2cl-lib:int-add
                                           (f2cl-lib:int-sub n j)
                                           1)))))))))))
 end_label
        (return (values nil nil nil nil nil nil nil))))))
```

———-

4.32 ztrmv BLAS

— **ztrmv.input** —

```
)set break resume
)sys rm -f ztrmv.output
)spool ztrmv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **ztrmv.help** —

```
==========================================================================
ztrmv examples
```

```
==============================================================================

==============================================================================
Man Page Details
==============================================================================

 NAME
      ZTRMV - perform one of the matrix-vector operations   x :=
      A*x, or x := A'*x, or x := conjg( A' )*x,

 SYNOPSIS
      SUBROUTINE ZTRMV ( UPLO, TRANS, DIAG, N, A, LDA, X, INCX )

          INTEGER      INCX, LDA, N

          CHARACTER*1  DIAG, TRANS, UPLO

          COMPLEX*16   A( LDA, * ), X( * )

 PURPOSE
      ZTRMV  performs one of the matrix-vector operations

      where x is an n element vector and  A is an n by n unit, or
      non-unit, upper or lower triangular matrix.

 PARAMETERS
      UPLO   - CHARACTER*1.
               On entry, UPLO specifies whether the matrix is an
               upper or lower triangular matrix as follows:

               UPLO = 'U' or 'u'   A is an upper triangular matrix.

               UPLO = 'L' or 'l'   A is a lower triangular matrix.

               Unchanged on exit.

      TRANS  - CHARACTER*1.
               On entry, TRANS specifies the operation to be per-
               formed as follows:

               TRANS = 'N' or 'n'   x := A*x.

               TRANS = 'T' or 't'   x := A'*x.

               TRANS = 'C' or 'c'   x := conjg( A' )*x.

               Unchanged on exit.

      DIAG   - CHARACTER*1.
               On entry, DIAG specifies whether or not A is unit
```

```
        triangular as follows:

        DIAG = 'U' or 'u'   A is assumed to be unit triangu-
        lar.

        DIAG = 'N' or 'n'   A is not assumed to be unit tri-
        angular.

        Unchanged on exit.

N       - INTEGER.
        On entry, N specifies the order of the matrix A.  N
        must be at least zero.  Unchanged on exit.

A       - COMPLEX*16       array of DIMENSION ( LDA, n ).
        Before entry with  UPLO = 'U' or 'u', the leading n
        by n upper triangular part of the array A must con-
        tain the upper triangular matrix and the strictly
        lower triangular part of A is not referenced.  Before
        entry with UPLO = 'L' or 'l', the leading n by n
        lower triangular part of the array A must contain the
        lower triangular matrix and the strictly upper tri-
        angular part of A is not referenced.  Note that when
        DIAG = 'U' or 'u', the diagonal elements of A are not
        referenced either, but are assumed to be unity.
        Unchanged on exit.

LDA     - INTEGER.
        On entry, LDA specifies the first dimension of A as
        declared in the calling (sub) program. LDA must be at
        least max( 1, n ).  Unchanged on exit.

X       - COMPLEX*16       array of dimension at least
        ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
        incremented array X must contain the n element vector
        x. On exit, X is overwritten with the transformed
        vector x.

INCX    - INTEGER.
        On entry, INCX specifies the increment for the ele-
        ments of X. INCX must not be zero.  Unchanged on
        exit.
```

———-

— ztrmv.f —

```
SUBROUTINE ZTRMV ( UPLO, TRANS, DIAG, N, A, LDA, X, INCX )
```

```
*     .. Scalar Arguments ..
      INTEGER            INCX, LDA, N
      CHARACTER*1        DIAG, TRANS, UPLO
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), X( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
*     .. Parameters ..
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     .. Local Scalars ..
      COMPLEX*16         TEMP
      INTEGER            I, INFO, IX, J, JX, KX
      LOGICAL            NOCONJ, NOUNIT
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG, MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO , 'U' ).AND.
     $         .NOT.LSAME( UPLO , 'L' )      )THEN
         INFO = 1
      ELSE IF( .NOT.LSAME( TRANS, 'N' ).AND.
     $         .NOT.LSAME( TRANS, 'T' ).AND.
     $         .NOT.LSAME( TRANS, 'C' )      )THEN
         INFO = 2
      ELSE IF( .NOT.LSAME( DIAG , 'U' ).AND.
     $         .NOT.LSAME( DIAG , 'N' )      )THEN
         INFO = 3
      ELSE IF( N.LT.0 )THEN
         INFO = 4
      ELSE IF( LDA.LT.MAX( 1, N ) )THEN
         INFO = 6
```

```
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 8
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZTRMV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( N.EQ.0 )
     $   RETURN
*
      NOCONJ = LSAME( TRANS, 'T' )
      NOUNIT = LSAME( DIAG , 'N' )
*
*     Set up the start point in X if the increment is not unity. This
*     will be  ( N - 1 )*INCX  too small for descending loops.
*
      IF( INCX.LE.0 )THEN
         KX = 1 - ( N - 1 )*INCX
      ELSE IF( INCX.NE.1 )THEN
         KX = 1
      END IF
*
*     Start the operations. In this version the elements of A are
*     accessed sequentially with one pass through A.
*
      IF( LSAME( TRANS, 'N' ) )THEN
*
*        Form  x := A*x.
*
         IF( LSAME( UPLO, 'U' ) )THEN
            IF( INCX.EQ.1 )THEN
               DO 20, J = 1, N
                  IF( X( J ).NE.ZERO )THEN
                     TEMP = X( J )
                     DO 10, I = 1, J - 1
                        X( I ) = X( I ) + TEMP*A( I, J )
   10                CONTINUE
                     IF( NOUNIT )
     $                  X( J ) = X( J )*A( J, J )
                  END IF
   20          CONTINUE
            ELSE
               JX = KX
               DO 40, J = 1, N
                  IF( X( JX ).NE.ZERO )THEN
                     TEMP = X( JX )
                     IX   = KX
```

```
                  DO 30, I = 1, J - 1
                     X( IX ) = X( IX ) + TEMP*A( I, J )
                     IX      = IX      + INCX
   30             CONTINUE
                  IF( NOUNIT )
     $               X( JX ) = X( JX )*A( J, J )
                END IF
                JX = JX + INCX
   40         CONTINUE
           END IF
        ELSE
           IF( INCX.EQ.1 )THEN
              DO 60, J = N, 1, -1
                 IF( X( J ).NE.ZERO )THEN
                    TEMP = X( J )
                    DO 50, I = N, J + 1, -1
                       X( I ) = X( I ) + TEMP*A( I, J )
   50               CONTINUE
                    IF( NOUNIT )
     $                 X( J ) = X( J )*A( J, J )
                 END IF
   60         CONTINUE
           ELSE
              KX = KX + ( N - 1 )*INCX
              JX = KX
              DO 80, J = N, 1, -1
                 IF( X( JX ).NE.ZERO )THEN
                    TEMP = X( JX )
                    IX   = KX
                    DO 70, I = N, J + 1, -1
                       X( IX ) = X( IX ) + TEMP*A( I, J )
                       IX      = IX      - INCX
   70               CONTINUE
                    IF( NOUNIT )
     $                 X( JX ) = X( JX )*A( J, J )
                 END IF
                 JX = JX - INCX
   80         CONTINUE
           END IF
        END IF
     ELSE
*
*        Form  x := A'*x  or  x := conjg( A' )*x.
*
         IF( LSAME( UPLO, 'U' ) )THEN
            IF( INCX.EQ.1 )THEN
               DO 110, J = N, 1, -1
                  TEMP = X( J )
                  IF( NOCONJ )THEN
                     IF( NOUNIT )
```

```
     $                  TEMP = TEMP*A( J, J )
                     DO 90, I = J - 1, 1, -1
                        TEMP = TEMP + A( I, J )*X( I )
  90                 CONTINUE
                  ELSE
                     IF( NOUNIT )
     $                  TEMP = TEMP*DCONJG( A( J, J ) )
                     DO 100, I = J - 1, 1, -1
                        TEMP = TEMP + DCONJG( A( I, J ) )*X( I )
 100                 CONTINUE
                  END IF
                  X( J ) = TEMP
 110           CONTINUE
            ELSE
               JX = KX + ( N - 1 )*INCX
               DO 140, J = N, 1, -1
                  TEMP = X( JX )
                  IX   = JX
                  IF( NOCONJ )THEN
                     IF( NOUNIT )
     $                  TEMP = TEMP*A( J, J )
                     DO 120, I = J - 1, 1, -1
                        IX   = IX   - INCX
                        TEMP = TEMP + A( I, J )*X( IX )
 120                 CONTINUE
                  ELSE
                     IF( NOUNIT )
     $                  TEMP = TEMP*DCONJG( A( J, J ) )
                     DO 130, I = J - 1, 1, -1
                        IX   = IX   - INCX
                        TEMP = TEMP + DCONJG( A( I, J ) )*X( IX )
 130                 CONTINUE
                  END IF
                  X( JX ) = TEMP
                  JX      = JX   - INCX
 140           CONTINUE
            END IF
         ELSE
            IF( INCX.EQ.1 )THEN
               DO 170, J = 1, N
                  TEMP = X( J )
                  IF( NOCONJ )THEN
                     IF( NOUNIT )
     $                  TEMP = TEMP*A( J, J )
                     DO 150, I = J + 1, N
                        TEMP = TEMP + A( I, J )*X( I )
 150                 CONTINUE
                  ELSE
                     IF( NOUNIT )
     $                  TEMP = TEMP*DCONJG( A( J, J ) )
```

```
                     DO 160, I = J + 1, N
                        TEMP = TEMP + DCONJG( A( I, J ) )*X( I )
  160                CONTINUE
                  END IF
                  X( J ) = TEMP
  170          CONTINUE
            ELSE
               JX = KX
               DO 200, J = 1, N
                  TEMP = X( JX )
                  IX   = JX
                  IF( NOCONJ )THEN
                     IF( NOUNIT )
     $                  TEMP = TEMP*A( J, J )
                     DO 180, I = J + 1, N
                        IX   = IX   + INCX
                        TEMP = TEMP + A( I, J )*X( IX )
  180                CONTINUE
                  ELSE
                     IF( NOUNIT )
     $                  TEMP = TEMP*DCONJG( A( J, J ) )
                     DO 190, I = J + 1, N
                        IX   = IX   + INCX
                        TEMP = TEMP + DCONJG( A( I, J ) )*X( IX )
  190                CONTINUE
                  END IF
                  X( JX ) = TEMP
                  JX      = JX   + INCX
  200          CONTINUE
            END IF
         END IF
      END IF
*
      RETURN
*
*     End of ZTRMV .
*
      END
```

———-

— BLAS 2 ztrmv —

```
(let* ((zero (complex 0.0 0.0)))
  (declare (type (complex double-float) zero))
  (defun ztrmv (uplo trans diag n a lda x incx)
    (declare (type (simple-array (complex double-float) (*)) x a)
             (type fixnum incx lda n)
```

```
         (type character diag trans uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (x (complex double-float) x-%data% x-%offset%))
      (prog ((noconj nil) (nounit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0)
             (kx 0) (temp #C(0.0 0.0)))
        (declare (type (member t nil) noconj nounit)
                 (type fixnum i info ix j jx kx)
                 (type (complex double-float) temp))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
          ((and (not (char-equal trans #\N))
                (not (char-equal trans #\T))
                (not (char-equal trans #\C)))
           (setf info 2))
          ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
           (setf info 3))
          ((< n 0)
           (setf info 4))
          ((< lda (max (the fixnum 1) (the fixnum n)))
           (setf info 6))
          ((= incx 0)
           (setf info 8)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "ZTRMV" info)
           (go end_label)))
        (if (= n 0) (go end_label))
        (setf noconj (char-equal trans #\T))
        (setf nounit (char-equal diag #\N))
        (cond
          ((<= incx 0)
           (setf kx
                   (f2cl-lib:int-sub 1
                                     (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                                       incx))))
          ((/= incx 1)
           (setf kx 1)))
        (cond
          ((char-equal trans #\N)
           (cond
             ((char-equal uplo #\U)
              (cond
```

```
((= incx 1)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (cond
       ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
        (setf temp
                (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i
                          (f2cl-lib:int-add j
                                           (f2cl-lib:int-sub
                                            1)))
                       nil)
          (tagbody
            (setf (f2cl-lib:fref x-%data%
                                 (i)
                                 ((1 *))
                                 x-%offset%)
                  (+
                   (f2cl-lib:fref x-%data%
                                  (i)
                                  ((1 *))
                                  x-%offset%)
                   (* temp
                      (f2cl-lib:fref a-%data%
                                     (i j)
                                     ((1 lda) (1 *))
                                     a-%offset%))))))
        (if nounit
            (setf (f2cl-lib:fref x-%data%
                                 (j)
                                 ((1 *))
                                 x-%offset%)
                  (*
                   (f2cl-lib:fref x-%data%
                                  (j)
                                  ((1 *))
                                  x-%offset%)
                   (f2cl-lib:fref a-%data%
                                  (j j)
                                  ((1 lda) (1 *))
                                  a-%offset%)))))))))
(t
 (setf jx kx)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (cond
       ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
```

```
                (setf temp
                        (f2cl-lib:fref x-%data%
                                       (jx)
                                       ((1 *))
                                       x-%offset%))
                (setf ix kx)
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                              ((> i
                                  (f2cl-lib:int-add j
                                                    (f2cl-lib:int-sub
                                                     1)))
                               nil)
                  (tagbody
                    (setf (f2cl-lib:fref x-%data%
                                         (ix)
                                         ((1 *))
                                         x-%offset%)
                                  (+
                                   (f2cl-lib:fref x-%data%
                                                  (ix)
                                                  ((1 *))
                                                  x-%offset%)
                                   (* temp
                                      (f2cl-lib:fref a-%data%
                                                     (i j)
                                                     ((1 lda) (1 *))
                                                     a-%offset%))))
                    (setf ix (f2cl-lib:int-add ix incx))))
                (if nounit
                    (setf (f2cl-lib:fref x-%data%
                                         (jx)
                                         ((1 *))
                                         x-%offset%)
                                  (*
                                   (f2cl-lib:fref x-%data%
                                                  (jx)
                                                  ((1 *))
                                                  x-%offset%)
                                   (f2cl-lib:fref a-%data%
                                                  (j j)
                                                  ((1 lda) (1 *))
                                                  a-%offset%))))))
            (setf jx (f2cl-lib:int-add jx incx)))))))
      (t
       (cond
         ((= incx 1)
          (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                        ((> j 1) nil)
            (tagbody
              (cond
```

```
                ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                 (setf temp
                         (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                 (f2cl-lib:fdo (i n
                                (f2cl-lib:int-add i
                                                  (f2cl-lib:int-sub 1)))
                               ((> i (f2cl-lib:int-add j 1)) nil)
                   (tagbody
                     (setf (f2cl-lib:fref x-%data%
                                          (i)
                                          ((1 *))
                                          x-%offset%)
                             (+
                              (f2cl-lib:fref x-%data%
                                             (i)
                                             ((1 *))
                                             x-%offset%)
                              (* temp
                                 (f2cl-lib:fref a-%data%
                                                (i j)
                                                ((1 lda) (1 *))
                                                a-%offset%))))))
                 (if nounit
                     (setf (f2cl-lib:fref x-%data%
                                          (j)
                                          ((1 *))
                                          x-%offset%)
                             (*
                              (f2cl-lib:fref x-%data%
                                             (j)
                                             ((1 *))
                                             x-%offset%)
                              (f2cl-lib:fref a-%data%
                                             (j j)
                                             ((1 lda) (1 *))
                                             a-%offset%)))))))
          (t
           (setf kx
                   (f2cl-lib:int-add kx
                                     (f2cl-lib:int-mul
                                      (f2cl-lib:int-sub n 1)
                                      incx)))
           (setf jx kx)
           (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                         ((> j 1) nil)
             (tagbody
               (cond
                 ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
                  (setf temp
                          (f2cl-lib:fref x-%data%
```

```
                                        (jx)
                                        ((1 *))
                                        x-%offset%))
                    (setf ix kx)
                    (f2cl-lib:fdo (i n
                                   (f2cl-lib:int-add i
                                                     (f2cl-lib:int-sub 1)))
                                  ((> i (f2cl-lib:int-add j 1)) nil)
                      (tagbody
                        (setf (f2cl-lib:fref x-%data%
                                             (ix)
                                             ((1 *))
                                             x-%offset%)
                                    (+
                                     (f2cl-lib:fref x-%data%
                                                    (ix)
                                                    ((1 *))
                                                    x-%offset%)
                                     (* temp
                                        (f2cl-lib:fref a-%data%
                                                       (i j)
                                                       ((1 lda) (1 *))
                                                       a-%offset%))))
                        (setf ix (f2cl-lib:int-sub ix incx))))
                    (if nounit
                        (setf (f2cl-lib:fref x-%data%
                                             (jx)
                                             ((1 *))
                                             x-%offset%)
                                    (*
                                     (f2cl-lib:fref x-%data%
                                                    (jx)
                                                    ((1 *))
                                                    x-%offset%)
                                     (f2cl-lib:fref a-%data%
                                                    (j j)
                                                    ((1 lda) (1 *))
                                                    a-%offset%))))))
              (setf jx (f2cl-lib:int-sub jx incx)))))))))
(t
 (cond
   ((char-equal uplo #\U)
    (cond
      ((= incx 1)
       (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                     ((> j 1) nil)
         (tagbody
           (setf temp
                   (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
           (cond
```

```
(noconj
 (if nounit
     (setf temp
             (* temp
                (f2cl-lib:fref a-%data%
                               (j j)
                               ((1 lda) (1 *))
                               a-%offset%))))
 (f2cl-lib:fdo (i
                (f2cl-lib:int-add j
                                  (f2cl-lib:int-sub 1))
                (f2cl-lib:int-add i
                                  (f2cl-lib:int-sub 1)))
               ((> i 1) nil)
   (tagbody
     (setf temp
             (+ temp
                (*
                 (f2cl-lib:fref a-%data%
                                (i j)
                                ((1 lda) (1 *))
                                a-%offset%)
                 (f2cl-lib:fref x-%data%
                                (i)
                                ((1 *))
                                x-%offset%)))))))
(t
 (if nounit
     (setf temp
             (* temp
                (f2cl-lib:dconjg
                 (f2cl-lib:fref a-%data%
                                (j j)
                                ((1 lda) (1 *))
                                a-%offset%)))))
 (f2cl-lib:fdo (i
                (f2cl-lib:int-add j
                                  (f2cl-lib:int-sub 1))
                (f2cl-lib:int-add i
                                  (f2cl-lib:int-sub 1)))
               ((> i 1) nil)
   (tagbody
     (setf temp
             (+ temp
                (*
                 (f2cl-lib:dconjg
                  (f2cl-lib:fref a-%data%
                                 (i j)
                                 ((1 lda) (1 *))
                                 a-%offset%))
```

```
                          (f2cl-lib:fref x-%data%
                                         (i)
                                         ((1 *))
                                         x-%offset%))))))))
      (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
            temp))))
(t
 (setf jx
       (f2cl-lib:int-add kx
                         (f2cl-lib:int-mul
                          (f2cl-lib:int-sub n 1)
                          incx)))
 (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
               ((> j 1) nil)
   (tagbody
     (setf temp
           (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
     (setf ix jx)
     (cond
       (noconj
        (if nounit
            (setf temp
                  (* temp
                     (f2cl-lib:fref a-%data%
                                    (j j)
                                    ((1 lda) (1 *))
                                    a-%offset%))))
        (f2cl-lib:fdo (i
                       (f2cl-lib:int-add j
                                         (f2cl-lib:int-sub 1))
                       (f2cl-lib:int-add i
                                         (f2cl-lib:int-sub 1)))
                      ((> i 1) nil)
          (tagbody
            (setf ix (f2cl-lib:int-sub ix incx))
            (setf temp
                  (+ temp
                     (*
                      (f2cl-lib:fref a-%data%
                                     (i j)
                                     ((1 lda) (1 *))
                                     a-%offset%)
                      (f2cl-lib:fref x-%data%
                                     (ix)
                                     ((1 *))
                                     x-%offset%)))))))
       (t
        (if nounit
            (setf temp
                  (* temp
```

```
                                (f2cl-lib:dconjg
                                 (f2cl-lib:fref a-%data%
                                                (j j)
                                                ((1 lda) (1 *))
                                                a-%offset%)))))
                    (f2cl-lib:fdo (i
                                   (f2cl-lib:int-add j
                                                     (f2cl-lib:int-sub 1))
                                   (f2cl-lib:int-add i
                                                     (f2cl-lib:int-sub 1)))
                                  ((> i 1) nil)
                      (tagbody
                        (setf ix (f2cl-lib:int-sub ix incx))
                        (setf temp
                                (+ temp
                                   (*
                                    (f2cl-lib:dconjg
                                     (f2cl-lib:fref a-%data%
                                                    (i j)
                                                    ((1 lda) (1 *))
                                                    a-%offset%))
                                    (f2cl-lib:fref x-%data%
                                                   (ix)
                                                   ((1 *))
                                                   x-%offset%)))))))
                (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                       temp)
                (setf jx (f2cl-lib:int-sub jx incx)))))))
        (t
         (cond
           ((= incx 1)
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
              (tagbody
                (setf temp
                        (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                (cond
                  (noconj
                   (if nounit
                       (setf temp
                               (* temp
                                  (f2cl-lib:fref a-%data%
                                                 (j j)
                                                 ((1 lda) (1 *))
                                                 a-%offset%))))
                   (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                  (f2cl-lib:int-add i 1))
                                 ((> i n) nil)
                     (tagbody
                       (setf temp
```

```
                        (+ temp
                           (*
                            (f2cl-lib:fref a-%data%
                                           (i j)
                                           ((1 lda) (1 *))
                                           a-%offset%)
                            (f2cl-lib:fref x-%data%
                                           (i)
                                           ((1 *))
                                           x-%offset%)))))))
                 (t
                  (if nounit
                      (setf temp
                              (* temp
                                 (f2cl-lib:dconjg
                                  (f2cl-lib:fref a-%data%
                                                 (j j)
                                                 ((1 lda) (1 *))
                                                 a-%offset%)))))
                  (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                 (f2cl-lib:int-add i 1))
                                ((> i n) nil)
                    (tagbody
                      (setf temp
                              (+ temp
                                 (*
                                  (f2cl-lib:dconjg
                                   (f2cl-lib:fref a-%data%
                                                  (i j)
                                                  ((1 lda) (1 *))
                                                  a-%offset%))
                                  (f2cl-lib:fref x-%data%
                                                 (i)
                                                 ((1 *))
                                                 x-%offset%)))))))
                  (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
                        temp))))
          (t
           (setf jx kx)
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (setf temp
                       (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
               (setf ix jx)
               (cond
                 (noconj
                  (if nounit
                      (setf temp
                              (* temp
```

```
                        (f2cl-lib:fref a-%data%
                                       (j j)
                                       ((1 lda) (1 *))
                                       a-%offset%))))
          (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                         (f2cl-lib:int-add i 1))
                        ((> i n) nil)
            (tagbody
              (setf ix (f2cl-lib:int-add ix incx))
              (setf temp
                      (+ temp
                         (*
                          (f2cl-lib:fref a-%data%
                                         (i j)
                                         ((1 lda) (1 *))
                                         a-%offset%)
                          (f2cl-lib:fref x-%data%
                                         (ix)
                                         ((1 *))
                                         x-%offset%)))))))
         (t
          (if nounit
              (setf temp
                      (* temp
                         (f2cl-lib:dconjg
                          (f2cl-lib:fref a-%data%
                                         (j j)
                                         ((1 lda) (1 *))
                                         a-%offset%)))))
          (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                         (f2cl-lib:int-add i 1))
                        ((> i n) nil)
            (tagbody
              (setf ix (f2cl-lib:int-add ix incx))
              (setf temp
                      (+ temp
                         (*
                          (f2cl-lib:dconjg
                           (f2cl-lib:fref a-%data%
                                          (i j)
                                          ((1 lda) (1 *))
                                          a-%offset%))
                          (f2cl-lib:fref x-%data%
                                         (ix)
                                         ((1 *))
                                         x-%offset%)))))))
         (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
               temp)
         (setf jx (f2cl-lib:int-add jx incx))))))))
end_label
```

```
        (return (values nil nil nil nil nil nil nil nil))))))
```

———-

4.33 ztrsv BLAS

— **ztrsv.input** —

```
)set break resume
)sys rm -f ztrsv.output
)spool ztrsv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **ztrsv.help** —

```
=====================================================================
ztrsv examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 NAME
      ZTRSV - solve one of the systems of equations   A*x = b, or
      A'*x = b, or conjg( A' )*x = b,

 SYNOPSIS
      SUBROUTINE ZTRSV ( UPLO, TRANS, DIAG, N, A, LDA, X, INCX )

          INTEGER      INCX, LDA, N

          CHARACTER*1  DIAG, TRANS, UPLO

          COMPLEX*16   A( LDA, * ), X( * )

 PURPOSE
      ZTRSV  solves one of the systems of equations
```

```
     where b and x are n element vectors and A is an n by n unit,
     or non-unit, upper or lower triangular matrix.

     No test for singularity or near-singularity is included in
     this routine. Such tests must be performed before calling
     this routine.

PARAMETERS
     UPLO   - CHARACTER*1.
            On entry, UPLO specifies whether the matrix is an
            upper or lower triangular matrix as follows:

            UPLO = 'U' or 'u'   A is an upper triangular matrix.

            UPLO = 'L' or 'l'   A is a lower triangular matrix.

            Unchanged on exit.

     TRANS  - CHARACTER*1.
            On entry, TRANS specifies the equations to be solved
            as follows:

            TRANS = 'N' or 'n'   A*x = b.

            TRANS = 'T' or 't'   A'*x = b.

            TRANS = 'C' or 'c'   conjg( A' )*x = b.

            Unchanged on exit.

     DIAG   - CHARACTER*1.
            On entry, DIAG specifies whether or not A is unit
            triangular as follows:

            DIAG = 'U' or 'u'   A is assumed to be unit

            triangular.

            DIAG = 'N' or 'n'   A is not assumed to be unit tri-
            angular.

            Unchanged on exit.

     N      - INTEGER.
            On entry, N specifies the order of the matrix A.  N
            must be at least zero.  Unchanged on exit.

     A      - COMPLEX*16       array of DIMENSION ( LDA, n ).
            Before entry with  UPLO = 'U' or 'u', the leading n
```

```
            by n upper triangular part of the array A must con-
            tain the upper triangular matrix and the strictly
            lower triangular part of A is not referenced.  Before
            entry with UPLO = 'L' or 'l', the leading n by n
            lower triangular part of the array A must contain the
            lower triangular matrix and the strictly upper tri-
            angular part of A is not referenced.  Note that when
            DIAG = 'U' or 'u', the diagonal elements of A are not
            referenced either, but are assumed to be unity.
            Unchanged on exit.

      LDA   - INTEGER.
            On entry, LDA specifies the first dimension of A as
            declared in the calling (sub) program. LDA must be at
            least max( 1, n ).  Unchanged on exit.

      X     - COMPLEX*16       array of dimension at least
            ( 1 + ( n - 1 )*abs( INCX ) ).  Before entry, the
            incremented array X must contain the n element
            right-hand side vector b. On exit, X is overwritten
            with the solution vector x.

      INCX  - INTEGER.
            On entry, INCX specifies the increment for the ele-
            ments of X. INCX must not be zero.  Unchanged on
            exit.


            ________-


            — ztrsv.f —

      SUBROUTINE ZTRSV ( UPLO, TRANS, DIAG, N, A, LDA, X, INCX )
*     .. Scalar Arguments ..
      INTEGER            INCX, LDA, N
      CHARACTER*1        DIAG, TRANS, UPLO
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), X( * )
*     ..
*
*  Level 2 Blas routine.
*
*  -- Written on 22-October-1986.
*     Jack Dongarra, Argonne National Lab.
*     Jeremy Du Croz, Nag Central Office.
*     Sven Hammarling, Nag Central Office.
*     Richard Hanson, Sandia National Labs.
*
*
```

```
*     .. Parameters ..
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     .. Local Scalars ..
      COMPLEX*16         TEMP
      INTEGER            I, INFO, IX, J, JX, KX
      LOGICAL            NOCONJ, NOUNIT
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG, MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF     ( .NOT.LSAME( UPLO , 'U' ).AND.
     $         .NOT.LSAME( UPLO , 'L' )      )THEN
         INFO = 1
      ELSE IF( .NOT.LSAME( TRANS, 'N' ).AND.
     $         .NOT.LSAME( TRANS, 'T' ).AND.
     $         .NOT.LSAME( TRANS, 'C' )      )THEN
         INFO = 2
      ELSE IF( .NOT.LSAME( DIAG , 'U' ).AND.
     $         .NOT.LSAME( DIAG , 'N' )      )THEN
         INFO = 3
      ELSE IF( N.LT.0 )THEN
         INFO = 4
      ELSE IF( LDA.LT.MAX( 1, N ) )THEN
         INFO = 6
      ELSE IF( INCX.EQ.0 )THEN
         INFO = 8
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZTRSV ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( N.EQ.0 )
     $   RETURN
*
      NOCONJ = LSAME( TRANS, 'T' )
      NOUNIT = LSAME( DIAG , 'N' )
*
```

```
*     Set up the start point in X if the increment is not unity. This
*     will be  ( N - 1 )*INCX  too small for descending loops.
*
      IF( INCX.LE.0 )THEN
         KX = 1 - ( N - 1 )*INCX
      ELSE IF( INCX.NE.1 )THEN
         KX = 1
      END IF
*
*     Start the operations. In this version the elements of A are
*     accessed sequentially with one pass through A.
*
      IF( LSAME( TRANS, 'N' ) )THEN
*
*        Form  x := inv( A )*x.
*
         IF( LSAME( UPLO, 'U' ) )THEN
            IF( INCX.EQ.1 )THEN
               DO 20, J = N, 1, -1
                  IF( X( J ).NE.ZERO )THEN
                     IF( NOUNIT )
     $                  X( J ) = X( J )/A( J, J )
                     TEMP = X( J )
                     DO 10, I = J - 1, 1, -1
                        X( I ) = X( I ) - TEMP*A( I, J )
   10                CONTINUE
                  END IF
   20          CONTINUE
            ELSE
               JX = KX + ( N - 1 )*INCX
               DO 40, J = N, 1, -1
                  IF( X( JX ).NE.ZERO )THEN
                     IF( NOUNIT )
     $                  X( JX ) = X( JX )/A( J, J )
                     TEMP = X( JX )
                     IX   = JX
                     DO 30, I = J - 1, 1, -1
                        IX      = IX      - INCX
                        X( IX ) = X( IX ) - TEMP*A( I, J )
   30                CONTINUE
                  END IF
                  JX = JX - INCX
   40          CONTINUE
            END IF
         ELSE
            IF( INCX.EQ.1 )THEN
               DO 60, J = 1, N
                  IF( X( J ).NE.ZERO )THEN
                     IF( NOUNIT )
     $                  X( J ) = X( J )/A( J, J )
```

```
                  TEMP = X( J )
                  DO 50, I = J + 1, N
                     X( I ) = X( I ) - TEMP*A( I, J )
   50             CONTINUE
               END IF
   60          CONTINUE
            ELSE
               JX = KX
               DO 80, J = 1, N
                  IF( X( JX ).NE.ZERO )THEN
                     IF( NOUNIT )
     $                X( JX ) = X( JX )/A( J, J )
                     TEMP = X( JX )
                     IX   = JX
                     DO 70, I = J + 1, N
                        IX      = IX      + INCX
                        X( IX ) = X( IX ) - TEMP*A( I, J )
   70                CONTINUE
                  END IF
                  JX = JX + INCX
   80          CONTINUE
            END IF
         END IF
      ELSE
*
*        Form  x := inv( A' )*x  or  x := inv( conjg( A' ) )*x.
*
         IF( LSAME( UPLO, 'U' ) )THEN
            IF( INCX.EQ.1 )THEN
               DO 110, J = 1, N
                  TEMP = X( J )
                  IF( NOCONJ )THEN
                     DO 90, I = 1, J - 1
                        TEMP = TEMP - A( I, J )*X( I )
   90                CONTINUE
                     IF( NOUNIT )
     $                  TEMP = TEMP/A( J, J )
                  ELSE
                     DO 100, I = 1, J - 1
                        TEMP = TEMP - DCONJG( A( I, J ) )*X( I )
  100                CONTINUE
                     IF( NOUNIT )
     $                  TEMP = TEMP/DCONJG( A( J, J ) )
                  END IF
                  X( J ) = TEMP
  110          CONTINUE
            ELSE
               JX = KX
               DO 140, J = 1, N
                  IX   = KX
```

```
               TEMP = X( JX )
               IF( NOCONJ )THEN
                  DO 120, I = 1, J - 1
                     TEMP = TEMP - A( I, J )*X( IX )
                     IX   = IX   + INCX
  120             CONTINUE
                  IF( NOUNIT )
     $               TEMP = TEMP/A( J, J )
               ELSE
                  DO 130, I = 1, J - 1
                     TEMP = TEMP - DCONJG( A( I, J ) )*X( IX )
                     IX   = IX   + INCX
  130             CONTINUE
                  IF( NOUNIT )
     $               TEMP = TEMP/DCONJG( A( J, J ) )
               END IF
               X( JX ) = TEMP
               JX      = JX   + INCX
  140          CONTINUE
            END IF
         ELSE
            IF( INCX.EQ.1 )THEN
               DO 170, J = N, 1, -1
                  TEMP = X( J )
                  IF( NOCONJ )THEN
                     DO 150, I = N, J + 1, -1
                        TEMP = TEMP - A( I, J )*X( I )
  150                CONTINUE
                     IF( NOUNIT )
     $                  TEMP = TEMP/A( J, J )
                  ELSE
                     DO 160, I = N, J + 1, -1
                        TEMP = TEMP - DCONJG( A( I, J ) )*X( I )
  160                CONTINUE
                     IF( NOUNIT )
     $                  TEMP = TEMP/DCONJG( A( J, J ) )
                  END IF
                  X( J ) = TEMP
  170             CONTINUE
               ELSE
                  KX = KX + ( N - 1 )*INCX
                  JX = KX
                  DO 200, J = N, 1, -1
                     IX   = KX
                     TEMP = X( JX )
                     IF( NOCONJ )THEN
                        DO 180, I = N, J + 1, -1
                           TEMP = TEMP - A( I, J )*X( IX )
                           IX   = IX   - INCX
  180                   CONTINUE
```

```
                  IF( NOUNIT )
     $               TEMP = TEMP/A( J, J )
                ELSE
                  DO 190, I = N, J + 1, -1
                     TEMP = TEMP - DCONJG( A( I, J ) )*X( IX )
                     IX   = IX   - INCX
  190             CONTINUE
                  IF( NOUNIT )
     $               TEMP = TEMP/DCONJG( A( J, J ) )
                END IF
                X( JX ) = TEMP
                JX      = JX   - INCX
  200         CONTINUE
           END IF
        END IF
      END IF
*
      RETURN
*
*     End of ZTRSV .
*
      END
```

———-

— BLAS 2 ztrsv —

```
(let* ((zero (complex 0.0 0.0)))
  (declare (type (complex double-float) zero))
  (defun ztrsv (uplo trans diag n a lda x incx)
    (declare (type (simple-array (complex double-float) (*)) x a)
             (type fixnum incx lda n)
             (type character diag trans uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (diag character diag-%data% diag-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (x (complex double-float) x-%data% x-%offset%))
      (prog ((noconj nil) (nounit nil) (i 0) (info 0) (ix 0) (j 0) (jx 0)
             (kx 0) (temp #C(0.0 0.0)))
        (declare (type (member t nil) noconj nounit)
                 (type fixnum i info ix j jx kx)
                 (type (complex double-float) temp))
        (setf info 0)
        (cond
          ((and (not (char-equal uplo #\U)) (not (char-equal uplo #\L)))
           (setf info 1))
```

```
  ((and (not (char-equal trans #\N))
        (not (char-equal trans #\T))
        (not (char-equal trans #\C)))
   (setf info 2))
  ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
   (setf info 3))
  ((< n 0)
   (setf info 4))
  ((< lda (max (the fixnum 1) (the fixnum n)))
   (setf info 6))
  ((= incx 0)
   (setf info 8)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "ZTRSV" info)
   (go end_label)))
(if (= n 0) (go end_label))
(setf noconj (char-equal trans #\T))
(setf nounit (char-equal diag #\N))
(cond
  ((<= incx 0)
   (setf kx
         (f2cl-lib:int-sub 1
                           (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
                                             incx))))
  ((/= incx 1)
   (setf kx 1)))
(cond
  ((char-equal trans #\N)
   (cond
     ((char-equal uplo #\U)
      (cond
        ((= incx 1)
         (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                       ((> j 1) nil)
           (tagbody
             (cond
               ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                (if nounit
                    (setf (f2cl-lib:fref x-%data%
                                         (j)
                                         ((1 *))
                                         x-%offset%)
                          (/
                           (f2cl-lib:fref x-%data%
                                          (j)
                                          ((1 *))
                                          x-%offset%)
```

```
                        (f2cl-lib:fref a-%data%
                                       (j j)
                                       ((1 lda) (1 *))
                                       a-%offset%))))
              (setf temp
                    (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
              (f2cl-lib:fdo (i
                             (f2cl-lib:int-add j
                                               (f2cl-lib:int-sub 1))
                             (f2cl-lib:int-add i
                                               (f2cl-lib:int-sub 1)))
                            ((> i 1) nil)
                (tagbody
                  (setf (f2cl-lib:fref x-%data%
                                       (i)
                                       ((1 *))
                                       x-%offset%)
                        (-
                         (f2cl-lib:fref x-%data%
                                        (i)
                                        ((1 *))
                                        x-%offset%)
                         (* temp
                            (f2cl-lib:fref a-%data%
                                           (i j)
                                           ((1 lda) (1 *))
                                           a-%offset%)))))))))
      (t
       (setf jx
             (f2cl-lib:int-add kx
                               (f2cl-lib:int-mul
                                (f2cl-lib:int-sub n 1)
                                incx)))
       (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                     ((> j 1) nil)
         (tagbody
           (cond
             ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
              (if nounit
                  (setf (f2cl-lib:fref x-%data%
                                       (jx)
                                       ((1 *))
                                       x-%offset%)
                        (/
                         (f2cl-lib:fref x-%data%
                                        (jx)
                                        ((1 *))
                                        x-%offset%)
                         (f2cl-lib:fref a-%data%
                                        (j j)
```

```
                                        ((1 lda) (1 *))
                                        a-%offset%))))
                    (setf temp
                            (f2cl-lib:fref x-%data%
                                           (jx)
                                           ((1 *))
                                           x-%offset%))
                    (setf ix jx)
                    (f2cl-lib:fdo (i
                                   (f2cl-lib:int-add j
                                                     (f2cl-lib:int-sub 1))
                                   (f2cl-lib:int-add i
                                                     (f2cl-lib:int-sub 1)))
                                  ((> i 1) nil)
                      (tagbody
                        (setf ix (f2cl-lib:int-sub ix incx))
                        (setf (f2cl-lib:fref x-%data%
                                             (ix)
                                             ((1 *))
                                             x-%offset%)
                                    (-
                                     (f2cl-lib:fref x-%data%
                                                    (ix)
                                                    ((1 *))
                                                    x-%offset%)
                                     (* temp
                                        (f2cl-lib:fref a-%data%
                                                       (i j)
                                                       ((1 lda) (1 *))
                                                       a-%offset%))))))))
                (setf jx (f2cl-lib:int-sub jx incx)))))))
        (t
         (cond
           ((= incx 1)
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
              (tagbody
                (cond
                  ((/= (f2cl-lib:fref x (j) ((1 *))) zero)
                   (if nounit
                       (setf (f2cl-lib:fref x-%data%
                                            (j)
                                            ((1 *))
                                            x-%offset%)
                             (/
                              (f2cl-lib:fref x-%data%
                                             (j)
                                             ((1 *))
                                             x-%offset%)
                              (f2cl-lib:fref a-%data%
```

```
                                        (j j)
                                        ((1 lda) (1 *))
                                        a-%offset%))))
                (setf temp
                        (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                 (f2cl-lib:int-add i 1))
                              ((> i n) nil)
                  (tagbody
                    (setf (f2cl-lib:fref x-%data%
                                         (i)
                                         ((1 *))
                                         x-%offset%)
                                  (-
                                   (f2cl-lib:fref x-%data%
                                                  (i)
                                                  ((1 *))
                                                  x-%offset%)
                                   (* temp
                                      (f2cl-lib:fref a-%data%
                                                     (i j)
                                                     ((1 lda) (1 *))
                                                     a-%offset%))))))))
          (t
           (setf jx kx)
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (cond
                 ((/= (f2cl-lib:fref x (jx) ((1 *))) zero)
                  (if nounit
                      (setf (f2cl-lib:fref x-%data%
                                           (jx)
                                           ((1 *))
                                           x-%offset%)
                                  (/
                                   (f2cl-lib:fref x-%data%
                                                  (jx)
                                                  ((1 *))
                                                  x-%offset%)
                                   (f2cl-lib:fref a-%data%
                                                  (j j)
                                                  ((1 lda) (1 *))
                                                  a-%offset%))))
                      (setf temp
                              (f2cl-lib:fref x-%data%
                                             (jx)
                                             ((1 *))
                                             x-%offset%))
                      (setf ix jx)
```

```
                    (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                   (f2cl-lib:int-add i 1))
                                  ((> i n) nil)
                      (tagbody
                        (setf ix (f2cl-lib:int-add ix incx))
                        (setf (f2cl-lib:fref x-%data%
                                             (ix)
                                             ((1 *))
                                             x-%offset%)
                                      (-
                                       (f2cl-lib:fref x-%data%
                                                      (ix)
                                                      ((1 *))
                                                      x-%offset%)
                                       (* temp
                                          (f2cl-lib:fref a-%data%
                                                         (i j)
                                                         ((1 lda) (1 *))
                                                         a-%offset%))))))))
                    (setf jx (f2cl-lib:int-add jx incx)))))))))
          (t
           (cond
             ((char-equal uplo #\U)
              (cond
                ((= incx 1)
                 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                               ((> j n) nil)
                   (tagbody
                     (setf temp
                             (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
                     (cond
                       (noconj
                        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                      ((> i
                                          (f2cl-lib:int-add j
                                                            (f2cl-lib:int-sub
                                                             1)))
                                       nil)
                          (tagbody
                            (setf temp
                                    (- temp
                                       (*
                                        (f2cl-lib:fref a-%data%
                                                       (i j)
                                                       ((1 lda) (1 *))
                                                       a-%offset%)
                                        (f2cl-lib:fref x-%data%
                                                       (i)
                                                       ((1 *))
                                                       x-%offset%))))))
```

```
                (if nounit
                    (setf temp
                            (/ temp
                               (f2cl-lib:fref a-%data%
                                              (j j)
                                              ((1 lda) (1 *))
                                              a-%offset%)))))
               (t
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                              ((> i
                                  (f2cl-lib:int-add j
                                                    (f2cl-lib:int-sub
                                                     1)))
                               nil)
                  (tagbody
                    (setf temp
                            (- temp
                               (*
                                (f2cl-lib:dconjg
                                 (f2cl-lib:fref a-%data%
                                                (i j)
                                                ((1 lda) (1 *))
                                                a-%offset%))
                                (f2cl-lib:fref x-%data%
                                               (i)
                                               ((1 *))
                                               x-%offset%))))))
                (if nounit
                    (setf temp
                            (/ temp
                               (f2cl-lib:dconjg
                                (f2cl-lib:fref a-%data%
                                               (j j)
                                               ((1 lda) (1 *))
                                               a-%offset%)))))))
            (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
                    temp))))
       (t
        (setf jx kx)
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                      ((> j n) nil)
          (tagbody
            (setf ix kx)
            (setf temp
                    (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
            (cond
              (noconj
               (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                             ((> i
                                 (f2cl-lib:int-add j
```

```
                                        (f2cl-lib:int-sub
                                         1)))
                    nil)
      (tagbody
        (setf temp
                (- temp
                   (*
                    (f2cl-lib:fref a-%data%
                                   (i j)
                                   ((1 lda) (1 *))
                                   a-%offset%)
                    (f2cl-lib:fref x-%data%
                                   (ix)
                                   ((1 *))
                                   x-%offset%))))
        (setf ix (f2cl-lib:int-add ix incx))))
     (if nounit
         (setf temp
                 (/ temp
                    (f2cl-lib:fref a-%data%
                                   (j j)
                                   ((1 lda) (1 *))
                                   a-%offset%)))))
    (t
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                   ((> i
                       (f2cl-lib:int-add j
                                         (f2cl-lib:int-sub
                                          1)))
                    nil)
       (tagbody
         (setf temp
                 (- temp
                    (*
                     (f2cl-lib:dconjg
                      (f2cl-lib:fref a-%data%
                                     (i j)
                                     ((1 lda) (1 *))
                                     a-%offset%))
                     (f2cl-lib:fref x-%data%
                                    (ix)
                                    ((1 *))
                                    x-%offset%))))
         (setf ix (f2cl-lib:int-add ix incx))))
     (if nounit
         (setf temp
                 (/ temp
                    (f2cl-lib:dconjg
                     (f2cl-lib:fref a-%data%
                                    (j j)
```

```
                                          ((1 lda) (1 *))
                                          a-%offset%)))))))
          (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                temp)
          (setf jx (f2cl-lib:int-add jx incx)))))))
(t
 (cond
   ((= incx 1)
    (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                  ((> j 1) nil)
      (tagbody
        (setf temp
                (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%))
        (cond
          (noconj
           (f2cl-lib:fdo (i n
                          (f2cl-lib:int-add i
                                            (f2cl-lib:int-sub 1)))
                         ((> i (f2cl-lib:int-add j 1)) nil)
             (tagbody
               (setf temp
                       (- temp
                          (*
                           (f2cl-lib:fref a-%data%
                                          (i j)
                                          ((1 lda) (1 *))
                                          a-%offset%)
                           (f2cl-lib:fref x-%data%
                                          (i)
                                          ((1 *))
                                          x-%offset%))))))
           (if nounit
               (setf temp
                       (/ temp
                          (f2cl-lib:fref a-%data%
                                         (j j)
                                         ((1 lda) (1 *))
                                         a-%offset%)))))
          (t
           (f2cl-lib:fdo (i n
                          (f2cl-lib:int-add i
                                            (f2cl-lib:int-sub 1)))
                         ((> i (f2cl-lib:int-add j 1)) nil)
             (tagbody
               (setf temp
                       (- temp
                          (*
                           (f2cl-lib:dconjg
                            (f2cl-lib:fref a-%data%
                                           (i j)
```

```
                                          ((1 lda) (1 *))
                                          a-%offset%))
                            (f2cl-lib:fref x-%data%
                                          (i)
                                          ((1 *))
                                          x-%offset%))))))
          (if nounit
              (setf temp
                      (/ temp
                         (f2cl-lib:dconjg
                          (f2cl-lib:fref a-%data%
                                         (j j)
                                         ((1 lda) (1 *))
                                         a-%offset%)))))))
      (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%)
            temp))))
(t
 (setf kx
       (f2cl-lib:int-add kx
                         (f2cl-lib:int-mul
                          (f2cl-lib:int-sub n 1)
                          incx)))
 (setf jx kx)
 (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
               ((> j 1) nil)
   (tagbody
     (setf ix kx)
     (setf temp
           (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%))
     (cond
       (noconj
        (f2cl-lib:fdo (i n
                       (f2cl-lib:int-add i
                                         (f2cl-lib:int-sub 1)))
                      ((> i (f2cl-lib:int-add j 1)) nil)
          (tagbody
            (setf temp
                    (- temp
                       (*
                        (f2cl-lib:fref a-%data%
                                       (i j)
                                       ((1 lda) (1 *))
                                       a-%offset%)
                        (f2cl-lib:fref x-%data%
                                       (ix)
                                       ((1 *))
                                       x-%offset%))))
            (setf ix (f2cl-lib:int-sub ix incx))))
        (if nounit
            (setf temp
```

```
                                (/ temp
                                   (f2cl-lib:fref a-%data%
                                                  (j j)
                                                  ((1 lda) (1 *))
                                                  a-%offset%)))))
                          (t
                           (f2cl-lib:fdo (i n
                                          (f2cl-lib:int-add i
                                                            (f2cl-lib:int-sub 1)))
                                         ((> i (f2cl-lib:int-add j 1)) nil)
                             (tagbody
                               (setf temp
                                       (- temp
                                          (*
                                           (f2cl-lib:dconjg
                                            (f2cl-lib:fref a-%data%
                                                           (i j)
                                                           ((1 lda) (1 *))
                                                           a-%offset%))
                                           (f2cl-lib:fref x-%data%
                                                          (ix)
                                                          ((1 *))
                                                          x-%offset%))))
                                   (setf ix (f2cl-lib:int-sub ix incx))))
                             (if nounit
                                 (setf temp
                                         (/ temp
                                            (f2cl-lib:dconjg
                                             (f2cl-lib:fref a-%data%
                                                            (j j)
                                                            ((1 lda) (1 *))
                                                            a-%offset%)))))))
                          (setf (f2cl-lib:fref x-%data% (jx) ((1 *)) x-%offset%)
                                 temp)
                          (setf jx (f2cl-lib:int-sub jx incx))))))))))
end_label
       (return (values nil nil nil nil nil nil nil nil))))))
```

———-

Chapter 5

BLAS Level 3

5.1 dgemm BLAS

— dgemm.input —

```
)set break resume
)sys rm -f dgemm.output
)spool dgemm.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dgemm.help —

```
========================================================================
dgemm examples
========================================================================

========================================================================
Man Page Details
========================================================================

 NAME
      DGEMM - perform one of the matrix-matrix operations   C :=
      alpha*op( A )*op( B ) + beta*C,
```

```
SYNOPSIS
     SUBROUTINE DGEMM ( TRANSA, TRANSB, M, N, K, ALPHA, A, LDA,
                     B, LDB, BETA, C, LDC )

         CHARACTER*1  TRANSA, TRANSB

         INTEGER      M, N, K, LDA, LDB, LDC

         DOUBLE       PRECISION ALPHA, BETA

         DOUBLE       PRECISION A( LDA, * ), B( LDB, * ), C( LDC,
                      * )

PURPOSE
     DGEMM  performs one of the matrix-matrix operations

     where  op( X ) is one of

        op( X ) = X   or   op( X ) = X',

     alpha and beta are scalars, and A, B and C are matrices,
     with op( A ) an m by k matrix,  op( B )  a  k by n matrix
     and  C an m by n matrix.

PARAMETERS
     TRANSA - CHARACTER*1.  On entry, TRANSA specifies the form
     of op( A ) to be used in the matrix multiplication as fol-
     lows:

     TRANSA = 'N' or 'n',  op( A ) = A.

     TRANSA = 'T' or 't',  op( A ) = A'.

     TRANSA = 'C' or 'c',  op( A ) = A'.

     Unchanged on exit.

     TRANSB - CHARACTER*1.  On entry, TRANSB specifies the form
     of op( B ) to be used in the matrix multiplication as fol-
     lows:

     TRANSB = 'N' or 'n',  op( B ) = B.

     TRANSB = 'T' or 't',  op( B ) = B'.

     TRANSB = 'C' or 'c',  op( B ) = B'.

     Unchanged on exit.

     M      - INTEGER.
```

```
             On entry,  M  specifies  the number  of rows  of the
             matrix op( A )  and of the  matrix  C.  M  must  be
             at least  zero.  Unchanged on exit.

      N      - INTEGER.
             On entry,  N  specifies the number  of columns of the
             matrix op( B ) and the number of columns of the
             matrix C. N must be at least zero.  Unchanged on
             exit.

      K      - INTEGER.
             On entry,  K  specifies  the number of columns of the
             matrix op( A ) and the number of rows of the matrix
             op( B ). K must be at least  zero.  Unchanged on
             exit.

      ALPHA  - DOUBLE PRECISION.
             On entry, ALPHA specifies the scalar alpha.
             Unchanged on exit.

ka is
      A      -
              DOUBLE PRECISION array of DIMENSION ( LDA, ka ), where
             k  when  TRANSA = 'N' or 'n',  and is  m  otherwise.
             Before entry with  TRANSA = 'N' or 'n',  the leading
             m by k part of the array  A  must contain the matrix
             A,  otherwise the leading  k by m  part of the array
             A  must contain  the matrix A.  Unchanged on exit.

      LDA    - INTEGER.
             On entry, LDA specifies the first dimension of A as
             declared in the calling (sub) program. When  TRANSA =
             'N' or 'n' then LDA must be at least  max( 1, m ),
             otherwise  LDA must be at least  max( 1, k ).
             Unchanged on exit.

kb is
      B      -
              DOUBLE PRECISION array of DIMENSION ( LDB, kb ), where
             n  when  TRANSB = 'N' or 'n',  and is  k  otherwise.
             Before entry with  TRANSB = 'N' or 'n',  the leading
             k by n part of the array  B  must contain the matrix
             B,  otherwise the leading  n by k  part of the array
             B  must contain  the matrix B.  Unchanged on exit.

      LDB    - INTEGER.
             On entry, LDB specifies the first dimension of B as
             declared in the calling (sub) program. When  TRANSB =
             'N' or 'n' then LDB must be at least  max( 1, k ),
```

```
            otherwise  LDB must be at least  max( 1, n ).
            Unchanged on exit.

      BETA   - DOUBLE PRECISION.
            On entry,  BETA  specifies the scalar  beta.  When
            BETA  is supplied as zero then C need not be set on
            input.  Unchanged on exit.

      C      - DOUBLE PRECISION array of DIMENSION ( LDC, n ).
            Before entry, the leading  m by n  part of the array
            C must contain the matrix  C,  except when  beta  is
            zero, in which case C need not be set on entry.  On
            exit, the array  C  is overwritten by the  m by n
            matrix ( alpha*op( A )*op( B ) + beta*C ).

      LDC    - INTEGER.
            On entry, LDC specifies the first dimension of C as
            declared in  the  calling  (sub)  program.   LDC
            must  be  at  least max( 1, m ).  Unchanged on exit.
```

— dgemm.f —

```
      SUBROUTINE DGEMM ( TRANSA, TRANSB, M, N, K, ALPHA, A, LDA, B, LDB,
     $                   BETA, C, LDC )
*     .. Scalar Arguments ..
      CHARACTER*1        TRANSA, TRANSB
      INTEGER            M, N, K, LDA, LDB, LDC
      DOUBLE PRECISION   ALPHA, BETA
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), B( LDB, * ), C( LDC, * )
*     ..
*
*  Level 3 Blas routine.
*
*  -- Written on 8-February-1989.
*     Jack Dongarra, Argonne National Laboratory.
*     Iain Duff, AERE Harwell.
*     Jeremy Du Croz, Numerical Algorithms Group Ltd.
*     Sven Hammarling, Numerical Algorithms Group Ltd.
*
*
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
```

```
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     .. Local Scalars ..
      LOGICAL            NOTA, NOTB
      INTEGER            I, INFO, J, L, NCOLA, NROWA, NROWB
      DOUBLE PRECISION   TEMP
*     .. Parameters ..
      DOUBLE PRECISION   ONE         , ZERO
      PARAMETER        ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. Executable Statements ..
*
*     Set  NOTA  and  NOTB  as  true if  A  and  B  respectively are not
*     transposed and set  NROWA, NCOLA and  NROWB  as the number of rows
*     and  columns of  A  and the  number of  rows  of  B  respectively.
*
      NOTA  = LSAME( TRANSA, 'N' )
      NOTB  = LSAME( TRANSB, 'N' )
      IF( NOTA )THEN
         NROWA = M
         NCOLA = K
      ELSE
         NROWA = K
         NCOLA = M
      END IF
      IF( NOTB )THEN
         NROWB = K
      ELSE
         NROWB = N
      END IF
*
*     Test the input parameters.
*
      INFO = 0
      IF(      ( .NOT.NOTA                 ).AND.
     $         ( .NOT.LSAME( TRANSA, 'C' ) ).AND.
     $         ( .NOT.LSAME( TRANSA, 'T' ) )      )THEN
         INFO = 1
      ELSE IF( ( .NOT.NOTB                 ).AND.
     $         ( .NOT.LSAME( TRANSB, 'C' ) ).AND.
     $         ( .NOT.LSAME( TRANSB, 'T' ) )      )THEN
         INFO = 2
      ELSE IF( M  .LT.0               )THEN
         INFO = 3
      ELSE IF( N  .LT.0               )THEN
         INFO = 4
      ELSE IF( K  .LT.0               )THEN
         INFO = 5
      ELSE IF( LDA.LT.MAX( 1, NROWA ) )THEN
         INFO = 8
```

```
      ELSE IF( LDB.LT.MAX( 1, NROWB ) )THEN
         INFO = 10
      ELSE IF( LDC.LT.MAX( 1, M     ) )THEN
         INFO = 13
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DGEMM ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( M.EQ.0 ).OR.( N.EQ.0 ).OR.
     $    ( ( ( ALPHA.EQ.ZERO ).OR.( K.EQ.0 ) ).AND.( BETA.EQ.ONE ) ) )
     $   RETURN
*
*     And if  alpha.eq.zero.
*
      IF( ALPHA.EQ.ZERO )THEN
         IF( BETA.EQ.ZERO )THEN
            DO 20, J = 1, N
               DO 10, I = 1, M
                  C( I, J ) = ZERO
   10          CONTINUE
   20       CONTINUE
         ELSE
            DO 40, J = 1, N
               DO 30, I = 1, M
                  C( I, J ) = BETA*C( I, J )
   30          CONTINUE
   40       CONTINUE
         END IF
         RETURN
      END IF
*
*     Start the operations.
*
      IF( NOTB )THEN
         IF( NOTA )THEN
*
*           Form  C := alpha*A*B + beta*C.
*
            DO 90, J = 1, N
               IF( BETA.EQ.ZERO )THEN
                  DO 50, I = 1, M
                     C( I, J ) = ZERO
   50             CONTINUE
               ELSE IF( BETA.NE.ONE )THEN
                  DO 60, I = 1, M
                     C( I, J ) = BETA*C( I, J )
```

```
   60            CONTINUE
              END IF
              DO 80, L = 1, K
                 IF( B( L, J ).NE.ZERO )THEN
                    TEMP = ALPHA*B( L, J )
                    DO 70, I = 1, M
                       C( I, J ) = C( I, J ) + TEMP*A( I, L )
   70               CONTINUE
                 END IF
   80         CONTINUE
   90       CONTINUE
         ELSE
*
*           Form  C := alpha*A'*B + beta*C
*
            DO 120, J = 1, N
               DO 110, I = 1, M
                  TEMP = ZERO
                  DO 100, L = 1, K
                     TEMP = TEMP + A( L, I )*B( L, J )
  100             CONTINUE
                  IF( BETA.EQ.ZERO )THEN
                     C( I, J ) = ALPHA*TEMP
                  ELSE
                     C( I, J ) = ALPHA*TEMP + BETA*C( I, J )
                  END IF
  110          CONTINUE
  120       CONTINUE
         END IF
      ELSE
         IF( NOTA )THEN
*
*           Form  C := alpha*A*B' + beta*C
*
            DO 170, J = 1, N
               IF( BETA.EQ.ZERO )THEN
                  DO 130, I = 1, M
                     C( I, J ) = ZERO
  130             CONTINUE
               ELSE IF( BETA.NE.ONE )THEN
                  DO 140, I = 1, M
                     C( I, J ) = BETA*C( I, J )
  140             CONTINUE
               END IF
               DO 160, L = 1, K
                  IF( B( J, L ).NE.ZERO )THEN
                     TEMP = ALPHA*B( J, L )
                     DO 150, I = 1, M
                        C( I, J ) = C( I, J ) + TEMP*A( I, L )
  150                CONTINUE
```

```
                END IF
  160          CONTINUE
  170       CONTINUE
         ELSE
*
*           Form  C := alpha*A'*B' + beta*C
*
            DO 200, J = 1, N
               DO 190, I = 1, M
                  TEMP = ZERO
                  DO 180, L = 1, K
                     TEMP = TEMP + A( L, I )*B( J, L )
  180             CONTINUE
                  IF( BETA.EQ.ZERO )THEN
                     C( I, J ) = ALPHA*TEMP
                  ELSE
                     C( I, J ) = ALPHA*TEMP + BETA*C( I, J )
                  END IF
  190          CONTINUE
  200       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of DGEMM .
*
      END
```

———-

— BLAS 3 dgemm —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dgemm (transa transb m n k alpha a lda b ldb$ beta c ldc)
    (declare (type (simple-array double-float (*)) c b a)
             (type (double-float) beta alpha)
             (type fixnum ldc ldb$ lda k n m)
             (type character transb transa))
    (f2cl-lib:with-multi-array-data
        ((transa character transa-%data% transa-%offset%)
         (transb character transb-%data% transb-%offset%)
         (a double-float a-%data% a-%offset%)
         (b double-float b-%data% b-%offset%)
         (c double-float c-%data% c-%offset%))
      (prog ((temp 0.0) (i 0) (info 0) (j 0) (l 0) (ncola 0) (nrowa 0)
```

```
     (nrowb 0) (nota nil) (notb nil))
(declare (type (double-float) temp)
         (type fixnum i info j l ncola nrowa nrowb)
         (type (member t nil) nota notb))
(setf nota (char-equal transa #\N))
(setf notb (char-equal transb #\N))
(cond
  (nota
   (setf nrowa m)
   (setf ncola k))
  (t
   (setf nrowa k)
   (setf ncola m)))
(cond
  (notb
   (setf nrowb k))
  (t
   (setf nrowb n)))
(setf info 0)
(cond
  ((and (not nota) (not (char-equal transa #\C))
        (not (char-equal transa #\T)))
   (setf info 1))
  ((and (not notb) (not (char-equal transb #\C))
        (not (char-equal transb #\T)))
   (setf info 2))
  ((< m 0)
   (setf info 3))
  ((< n 0)
   (setf info 4))
  ((< k 0)
   (setf info 5))
  ((< lda (max (the fixnum 1) (the fixnum nrowa)))
   (setf info 8))
  ((< ldb$
      (max (the fixnum 1) (the fixnum nrowb)))
   (setf info 10))
  ((< ldc (max (the fixnum 1) (the fixnum m)))
   (setf info 13)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DGEMM" info)
   (go end_label)))
(if (or (= m 0) (= n 0) (and (or (= alpha zero) (= k 0)) (= beta one)))
    (go end_label))
(cond
  ((= alpha zero)
   (cond
```

```
      ((= beta zero)
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i m) nil)
             (tagbody
               (setf (f2cl-lib:fref c-%data%
                                    (i j)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                     zero))))))
      (t
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i m) nil)
             (tagbody
               (setf (f2cl-lib:fref c-%data%
                                    (i j)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                     (* beta
                        (f2cl-lib:fref c-%data%
                                       (i j)
                                       ((1 ldc) (1 *))
                                       c-%offset%)))))))))
   (go end_label)))
(cond
  (notb
   (cond
     (nota
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (cond
            ((= beta zero)
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i m) nil)
               (tagbody
                 (setf (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       zero))))
            ((/= beta one)
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i m) nil)
               (tagbody
```

```
              (setf (f2cl-lib:fref c-%data%
                                   (i j)
                                   ((1 ldc) (1 *))
                                   c-%offset%)
                    (* beta
                       (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)))))))
      (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                    ((> l k) nil)
        (tagbody
          (cond
            ((/= (f2cl-lib:fref b (l j) ((1 ldb$) (1 *))) zero)
             (setf temp
                    (* alpha
                       (f2cl-lib:fref b-%data%
                                      (l j)
                                      ((1 ldb$) (1 *))
                                      b-%offset%)))
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i m) nil)
               (tagbody
                 (setf (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (+
                        (f2cl-lib:fref c-%data%
                                       (i j)
                                       ((1 ldc) (1 *))
                                       c-%offset%)
                        (* temp
                           (f2cl-lib:fref a-%data%
                                          (i l)
                                          ((1 lda) (1 *))
                                          a-%offset%)))))))))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                   ((> i m) nil)
       (tagbody
         (setf temp zero)
         (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                       ((> l k) nil)
           (tagbody
             (setf temp
                    (+ temp
```

```
                                (*
                                 (f2cl-lib:fref a-%data%
                                                (l i)
                                                ((1 lda) (1 *))
                                                a-%offset%)
                                 (f2cl-lib:fref b-%data%
                                                (l j)
                                                ((1 ldb$) (1 *))
                                                b-%offset%))))))
                          (cond
                            ((= beta zero)
                             (setf (f2cl-lib:fref c-%data%
                                                  (i j)
                                                  ((1 ldc) (1 *))
                                                  c-%offset%)
                                   (* alpha temp)))
                            (t
                             (setf (f2cl-lib:fref c-%data%
                                                  (i j)
                                                  ((1 ldc) (1 *))
                                                  c-%offset%)
                                   (+ (* alpha temp)
                                      (* beta
                                         (f2cl-lib:fref c-%data%
                                                        (i j)
                                                        ((1 ldc) (1 *))
                                                        c-%offset%)))))))))))
        (t
         (cond
           (nota
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
              (tagbody
                (cond
                  ((= beta zero)
                   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                 ((> i m) nil)
                     (tagbody
                       (setf (f2cl-lib:fref c-%data%
                                            (i j)
                                            ((1 ldc) (1 *))
                                            c-%offset%)
                             zero))))
                  ((/= beta one)
                   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                 ((> i m) nil)
                     (tagbody
                       (setf (f2cl-lib:fref c-%data%
                                            (i j)
                                            ((1 ldc) (1 *))
```

```
                                    c-%offset%)
                          (* beta
                             (f2cl-lib:fref c-%data%
                                            (i j)
                                            ((1 ldc) (1 *))
                                            c-%offset%)))))))
          (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                        ((> l k) nil)
            (tagbody
              (cond
                ((/= (f2cl-lib:fref b (j l) ((1 ldb$) (1 *))) zero)
                 (setf temp
                         (* alpha
                            (f2cl-lib:fref b-%data%
                                           (j l)
                                           ((1 ldb$) (1 *))
                                           b-%offset%)))
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                               ((> i m) nil)
                   (tagbody
                     (setf (f2cl-lib:fref c-%data%
                                          (i j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)
                           (+
                            (f2cl-lib:fref c-%data%
                                           (i j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                            (* temp
                               (f2cl-lib:fref a-%data%
                                              (i l)
                                              ((1 lda) (1 *))
                                              a-%offset%)))))))))))
        (t
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i m) nil)
               (tagbody
                 (setf temp zero)
                 (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                               ((> l k) nil)
                   (tagbody
                     (setf temp
                             (+ temp
                                (*
                                 (f2cl-lib:fref a-%data%
                                                (l i)
```

```
                                                ((1 lda) (1 *))
                                                a-%offset%)
                                    (f2cl-lib:fref b-%data%
                                                (j l)
                                                ((1 ldb$) (1 *))
                                                b-%offset%))))))
                          (cond
                            ((= beta zero)
                             (setf (f2cl-lib:fref c-%data%
                                                  (i j)
                                                  ((1 ldc) (1 *))
                                                  c-%offset%)
                                   (* alpha temp)))
                            (t
                             (setf (f2cl-lib:fref c-%data%
                                                  (i j)
                                                  ((1 ldc) (1 *))
                                                  c-%offset%)
                                   (+ (* alpha temp)
                                      (* beta
                                         (f2cl-lib:fref c-%data%
                                                        (i j)
                                                        ((1 ldc) (1 *))
                                                        c-%offset%))))))))))))
 end_label
        (return
         (values nil nil nil nil nil nil nil nil nil nil nil nil))))))
```

———-

5.2 dsymm BLAS

— **dsymm.input** —

```
)set break resume
)sys rm -f dsymm.output
)spool dsymm.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dsymm.help —

```
=====================================================================
dsymm examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 NAME
      DSYMM - perform one of the matrix-matrix operations   C :=
      alpha*A*B + beta*C,

 SYNOPSIS
      SUBROUTINE DSYMM ( SIDE, UPLO, M, N, ALPHA, A, LDA, B, LDB,
                      BETA, C, LDC )

          CHARACTER*1  SIDE, UPLO

          INTEGER      M, N, LDA, LDB, LDC

          DOUBLE       PRECISION ALPHA, BETA

          DOUBLE       PRECISION A( LDA, * ), B( LDB, * ), C( LDC,
                       * )

 PURPOSE
      DSYMM  performs one of the matrix-matrix operations

      or

         C := alpha*B*A + beta*C,

      where alpha and beta are scalars,  A is a symmetric matrix
      and  B and C are  m by n matrices.

 PARAMETERS
      SIDE   - CHARACTER*1.
             On entry,  SIDE  specifies whether  the  symmetric
             matrix  A appears on the  left or right  in the
             operation as follows:

             SIDE = 'L' or 'l'   C := alpha*A*B + beta*C,

             SIDE = 'R' or 'r'   C := alpha*B*A + beta*C,

             Unchanged on exit.
```

```
     UPLO   - CHARACTER*1.
            On  entry,   UPLO  specifies  whether  the  upper  or
            lower triangular  part  of  the  symmetric  matrix
            A  is  to  be referenced as follows:

            UPLO = 'U' or 'u'   Only the upper triangular part of
            the symmetric matrix is to be referenced.

            UPLO = 'L' or 'l'   Only the lower triangular part of
            the symmetric matrix is to be referenced.

            Unchanged on exit.

     M      - INTEGER.
            On entry,  M  specifies the number of rows of the
            matrix  C.  M  must be at least zero.  Unchanged on
            exit.

     N      - INTEGER.
            On entry, N specifies the number of columns of the
            matrix C.  N  must be at least zero.  Unchanged on
            exit.

     ALPHA  - DOUBLE PRECISION.
            On entry, ALPHA specifies the scalar alpha.
            Unchanged on exit.

ka is
     A      -
             DOUBLE PRECISION array of DIMENSION ( LDA, ka ), where
            m  when  SIDE = 'L' or 'l'  and is  n otherwise.
            Before entry  with  SIDE = 'L' or 'l',  the  m by m
            part of the array  A  must contain the  symmetric
            matrix,  such that when  UPLO = 'U' or 'u', the lead-
            ing m by m upper triangular part of the array  A
            must contain the upper triangular part of the  sym-
            metric matrix and the  strictly  lower triangular
            part of  A  is not referenced,  and when  UPLO = 'L'
            or 'l', the leading  m by m  lower triangular part
            of the  array  A must  contain  the  lower triangular
            part  of the  symmetric matrix and the  strictly
            upper triangular part of  A  is not referenced.
            Before entry  with  SIDE = 'R' or 'r',  the  n by n
            part of the array  A  must contain the  symmetric
            matrix,  such that when  UPLO = 'U' or 'u', the lead-
            ing n by n upper triangular part of the array  A
            must contain the upper triangular part of the  sym-
            metric matrix and the  strictly  lower triangular
            part of  A  is not referenced,  and when  UPLO = 'L'
            or 'l', the leading  n by n  lower triangular part
```

```
           of the  array  A must  contain  the  lower triangular
           part  of the  symmetric matrix and the  strictly
           upper triangular part of  A  is not referenced.
           Unchanged on exit.

     LDA   - INTEGER.
           On entry, LDA specifies the first dimension of A as
           declared in the calling (sub) program.  When  SIDE =
           'L' or 'l'  then LDA must be at least  max( 1, m ),
           otherwise  LDA must be at least  max( 1, n ).
           Unchanged on exit.

     B     - DOUBLE PRECISION array of DIMENSION ( LDB, n ).
           Before entry, the leading  m by n part of the array
           B  must contain the matrix B.  Unchanged on exit.

     LDB   - INTEGER.
           On entry, LDB specifies the first dimension of B as
           declared in  the  calling  (sub)  program.   LDB
           must  be  at  least max( 1, m ).  Unchanged on exit.

     BETA  - DOUBLE PRECISION.
           On entry,  BETA  specifies the scalar  beta.  When
           BETA  is supplied as zero then C need not be set on
           input.  Unchanged on exit.

     C     - DOUBLE PRECISION array of DIMENSION ( LDC, n ).
           Before entry, the leading  m by n  part of the array
           C must contain the matrix  C,  except when  beta  is
           zero, in which case C need not be set on entry.  On
           exit, the array  C  is overwritten by the  m by n
           updated matrix.

     LDC   - INTEGER.
           On entry, LDC specifies the first dimension of C as
           declared in  the  calling  (sub)  program.   LDC
           must  be  at  least max( 1, m ).  Unchanged on exit.

           Level 3 Blas routine.
```

— dsymm.f —

```
      SUBROUTINE DSYMM ( SIDE, UPLO, M, N, ALPHA, A, LDA, B, LDB,
     $                   BETA, C, LDC )
*     .. Scalar Arguments ..
      CHARACTER*1        SIDE, UPLO
```

```
      INTEGER            M, N, LDA, LDB, LDC
      DOUBLE PRECISION   ALPHA, BETA
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), B( LDB, * ), C( LDC, * )
*     ..
*
*  Level 3 Blas routine.
*
*  -- Written on 8-February-1989.
*     Jack Dongarra, Argonne National Laboratory.
*     Iain Duff, AERE Harwell.
*     Jeremy Du Croz, Numerical Algorithms Group Ltd.
*     Sven Hammarling, Numerical Algorithms Group Ltd.
*
*
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     .. Local Scalars ..
      LOGICAL            UPPER
      INTEGER            I, INFO, J, K, NROWA
      DOUBLE PRECISION   TEMP1, TEMP2
*     .. Parameters ..
      DOUBLE PRECISION   ONE         , ZERO
      PARAMETER        ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. Executable Statements ..
*
*     Set NROWA as the number of rows of A.
*
      IF( LSAME( SIDE, 'L' ) )THEN
         NROWA = M
      ELSE
         NROWA = N
      END IF
      UPPER = LSAME( UPLO, 'U' )
*
*     Test the input parameters.
*
      INFO = 0
      IF(      ( .NOT.LSAME( SIDE, 'L' ) ).AND.
     $         ( .NOT.LSAME( SIDE, 'R' ) )      )THEN
         INFO = 1
      ELSE IF( ( .NOT.UPPER              ).AND.
     $         ( .NOT.LSAME( UPLO, 'L' ) )      )THEN
         INFO = 2
```

```
      ELSE IF( M  .LT.0               )THEN
         INFO = 3
      ELSE IF( N  .LT.0               )THEN
         INFO = 4
      ELSE IF( LDA.LT.MAX( 1, NROWA ) )THEN
         INFO = 7
      ELSE IF( LDB.LT.MAX( 1, M     ) )THEN
         INFO = 9
      ELSE IF( LDC.LT.MAX( 1, M     ) )THEN
         INFO = 12
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DSYMM ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( M.EQ.0 ).OR.( N.EQ.0 ).OR.
     $    ( ( ALPHA.EQ.ZERO ).AND.( BETA.EQ.ONE ) ) )
     $   RETURN
*
*     And when  alpha.eq.zero.
*
      IF( ALPHA.EQ.ZERO )THEN
         IF( BETA.EQ.ZERO )THEN
            DO 20, J = 1, N
               DO 10, I = 1, M
                  C( I, J ) = ZERO
   10          CONTINUE
   20       CONTINUE
         ELSE
            DO 40, J = 1, N
               DO 30, I = 1, M
                  C( I, J ) = BETA*C( I, J )
   30          CONTINUE
   40       CONTINUE
         END IF
         RETURN
      END IF
*
*     Start the operations.
*
      IF( LSAME( SIDE, 'L' ) )THEN
*
*        Form  C := alpha*A*B + beta*C.
*
         IF( UPPER )THEN
            DO 70, J = 1, N
               DO 60, I = 1, M
```

```
                  TEMP1 = ALPHA*B( I, J )
                  TEMP2 = ZERO
                  DO 50, K = 1, I - 1
                     C( K, J ) = C( K, J ) + TEMP1    *A( K, I )
                     TEMP2     = TEMP2     + B( K, J )*A( K, I )
   50             CONTINUE
                  IF( BETA.EQ.ZERO )THEN
                     C( I, J ) = TEMP1*A( I, I ) + ALPHA*TEMP2
                  ELSE
                     C( I, J ) = BETA *C( I, J ) +
     $                           TEMP1*A( I, I ) + ALPHA*TEMP2
                  END IF
   60          CONTINUE
   70       CONTINUE
         ELSE
            DO 100, J = 1, N
               DO 90, I = M, 1, -1
                  TEMP1 = ALPHA*B( I, J )
                  TEMP2 = ZERO
                  DO 80, K = I + 1, M
                     C( K, J ) = C( K, J ) + TEMP1    *A( K, I )
                     TEMP2     = TEMP2     + B( K, J )*A( K, I )
   80             CONTINUE
                  IF( BETA.EQ.ZERO )THEN
                     C( I, J ) = TEMP1*A( I, I ) + ALPHA*TEMP2
                  ELSE
                     C( I, J ) = BETA *C( I, J ) +
     $                           TEMP1*A( I, I ) + ALPHA*TEMP2
                  END IF
   90          CONTINUE
  100       CONTINUE
         END IF
      ELSE
*
*        Form  C := alpha*B*A + beta*C.
*
         DO 170, J = 1, N
            TEMP1 = ALPHA*A( J, J )
            IF( BETA.EQ.ZERO )THEN
               DO 110, I = 1, M
                  C( I, J ) = TEMP1*B( I, J )
  110          CONTINUE
            ELSE
               DO 120, I = 1, M
                  C( I, J ) = BETA*C( I, J ) + TEMP1*B( I, J )
  120          CONTINUE
            END IF
            DO 140, K = 1, J - 1
               IF( UPPER )THEN
                  TEMP1 = ALPHA*A( K, J )
```

```
               ELSE
                  TEMP1 = ALPHA*A( J, K )
               END IF
               DO 130, I = 1, M
                  C( I, J ) = C( I, J ) + TEMP1*B( I, K )
  130          CONTINUE
  140       CONTINUE
            DO 160, K = J + 1, N
               IF( UPPER )THEN
                  TEMP1 = ALPHA*A( J, K )
               ELSE
                  TEMP1 = ALPHA*A( K, J )
               END IF
               DO 150, I = 1, M
                  C( I, J ) = C( I, J ) + TEMP1*B( I, K )
  150          CONTINUE
  160       CONTINUE
  170    CONTINUE
      END IF
*
      RETURN
*
*     End of DSYMM .
*
      END
```

———-

— BLAS 3 dsymm —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dsymm (side uplo m n alpha a lda b ldb$ beta c ldc)
    (declare (type (simple-array double-float (*)) c b a)
             (type (double-float) beta alpha)
             (type fixnum ldc ldb$ lda n m)
             (type character uplo side))
    (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (uplo character uplo-%data% uplo-%offset%)
         (a double-float a-%data% a-%offset%)
         (b double-float b-%data% b-%offset%)
         (c double-float c-%data% c-%offset%))
      (prog ((temp1 0.0) (temp2 0.0) (i 0) (info 0) (j 0) (k 0) (nrowa 0)
             (upper nil))
        (declare (type (double-float) temp1 temp2)
                 (type fixnum i info j k nrowa)
```

```
         (type (member t nil) upper))
(cond
  ((char-equal side #\L)
   (setf nrowa m))
  (t
   (setf nrowa n)))
(setf upper (char-equal uplo #\U))
(setf info 0)
(cond
  ((and (not (char-equal side #\L)) (not (char-equal side #\R)))
   (setf info 1))
  ((and (not upper) (not (char-equal uplo #\L)))
   (setf info 2))
  ((< m 0)
   (setf info 3))
  ((< n 0)
   (setf info 4))
  ((< lda (max (the fixnum 1) (the fixnum nrowa)))
   (setf info 7))
  ((< ldb$ (max (the fixnum 1) (the fixnum m)))
   (setf info 9))
  ((< ldc (max (the fixnum 1) (the fixnum m)))
   (setf info 12)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DSYMM" info)
   (go end_label)))
(if (or (= m 0) (= n 0) (and (= alpha zero) (= beta one)))
    (go end_label))
(cond
  ((= alpha zero)
   (cond
     ((= beta zero)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref c-%data%
                                   (i j)
                                   ((1 ldc) (1 *))
                                   c-%offset%)
                    zero))))))
     (t
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
```

```
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          ((> i m) nil)
              (tagbody
                (setf (f2cl-lib:fref c-%data%
                                     (i j)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                        (* beta
                           (f2cl-lib:fref c-%data%
                                          (i j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)))))))))
   (go end_label)))
(cond
  ((char-equal side #\L)
   (cond
     (upper
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i m) nil)
            (tagbody
              (setf temp1
                      (* alpha
                         (f2cl-lib:fref b-%data%
                                        (i j)
                                        ((1 ldb$) (1 *))
                                        b-%offset%)))
              (setf temp2 zero)
              (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                            ((> k
                                (f2cl-lib:int-add i
                                                  (f2cl-lib:int-sub
                                                   1)))
                             nil)
                (tagbody
                  (setf (f2cl-lib:fref c-%data%
                                       (k j)
                                       ((1 ldc) (1 *))
                                       c-%offset%)
                          (+
                           (f2cl-lib:fref c-%data%
                                          (k j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)
                           (* temp1
                              (f2cl-lib:fref a-%data%
                                             (k i)
                                             ((1 lda) (1 *))
```

```
                                        a-%offset%))))
                    (setf temp2
                            (+ temp2
                               (*
                                (f2cl-lib:fref b-%data%
                                               (k j)
                                               ((1 ldb$) (1 *))
                                               b-%offset%)
                                (f2cl-lib:fref a-%data%
                                               (k i)
                                               ((1 lda) (1 *))
                                               a-%offset%))))))
                  (cond
                    ((= beta zero)
                     (setf (f2cl-lib:fref c-%data%
                                          (i j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)
                             (+
                              (* temp1
                                 (f2cl-lib:fref a-%data%
                                                (i i)
                                                ((1 lda) (1 *))
                                                a-%offset%))
                              (* alpha temp2))))
                    (t
                     (setf (f2cl-lib:fref c-%data%
                                          (i j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)
                             (+
                              (* beta
                                 (f2cl-lib:fref c-%data%
                                                (i j)
                                                ((1 ldc) (1 *))
                                                c-%offset%))
                              (* temp1
                                 (f2cl-lib:fref a-%data%
                                                (i i)
                                                ((1 lda) (1 *))
                                                a-%offset%))
                              (* alpha temp2))))))))
            (t
             (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                           ((> j n) nil)
               (tagbody
                 (f2cl-lib:fdo (i m (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                               ((> i 1) nil)
                   (tagbody
                     (setf temp1
```

```
        (* alpha
           (f2cl-lib:fref b-%data%
                          (i j)
                          ((1 ldb$) (1 *))
                          b-%offset%)))
(setf temp2 zero)
(f2cl-lib:fdo (k (f2cl-lib:int-add i 1)
                 (f2cl-lib:int-add k 1))
              ((> k m) nil)
  (tagbody
    (setf (f2cl-lib:fref c-%data%
                         (k j)
                         ((1 ldc) (1 *))
                         c-%offset%)
            (+
             (f2cl-lib:fref c-%data%
                            (k j)
                            ((1 ldc) (1 *))
                            c-%offset%)
             (* temp1
                (f2cl-lib:fref a-%data%
                               (k i)
                               ((1 lda) (1 *))
                               a-%offset%))))
    (setf temp2
            (+ temp2
               (*
                (f2cl-lib:fref b-%data%
                               (k j)
                               ((1 ldb$) (1 *))
                               b-%offset%)
                (f2cl-lib:fref a-%data%
                               (k i)
                               ((1 lda) (1 *))
                               a-%offset%))))))
(cond
  ((= beta zero)
   (setf (f2cl-lib:fref c-%data%
                        (i j)
                        ((1 ldc) (1 *))
                        c-%offset%)
           (+
            (* temp1
               (f2cl-lib:fref a-%data%
                              (i i)
                              ((1 lda) (1 *))
                              a-%offset%))
            (* alpha temp2))))
  (t
   (setf (f2cl-lib:fref c-%data%
```

```
                                        (i j)
                                        ((1 ldc) (1 *))
                                        c-%offset%)
                                (+
                                 (* beta
                                    (f2cl-lib:fref c-%data%
                                                   (i j)
                                                   ((1 ldc) (1 *))
                                                   c-%offset%))
                                 (* temp1
                                    (f2cl-lib:fref a-%data%
                                                   (i i)
                                                   ((1 lda) (1 *))
                                                   a-%offset%))
                                 (* alpha temp2))))))))))))
          (t
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (setf temp1
                       (* alpha
                          (f2cl-lib:fref a-%data%
                                         (j j)
                                         ((1 lda) (1 *))
                                         a-%offset%)))
               (cond
                 ((= beta zero)
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                ((> i m) nil)
                    (tagbody
                      (setf (f2cl-lib:fref c-%data%
                                           (i j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                            (* temp1
                               (f2cl-lib:fref b-%data%
                                              (i j)
                                              ((1 ldb$) (1 *))
                                              b-%offset%))))))
                 (t
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                ((> i m) nil)
                    (tagbody
                      (setf (f2cl-lib:fref c-%data%
                                           (i j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                            (+
                             (* beta
                                (f2cl-lib:fref c-%data%
```

```
                                    (i j)
                                    ((1 ldc) (1 *))
                                    c-%offset%))
                    (* temp1
                       (f2cl-lib:fref b-%data%
                                    (i j)
                                    ((1 ldb$) (1 *))
                                    b-%offset%))))))))
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
              ((> k (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
               nil)
  (tagbody
    (cond
      (upper
       (setf temp1
               (* alpha
                  (f2cl-lib:fref a-%data%
                                 (k j)
                                 ((1 lda) (1 *))
                                 a-%offset%))))
      (t
       (setf temp1
               (* alpha
                  (f2cl-lib:fref a-%data%
                                 (j k)
                                 ((1 lda) (1 *))
                                 a-%offset%)))))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  ((> i m) nil)
      (tagbody
        (setf (f2cl-lib:fref c-%data%
                             (i j)
                             ((1 ldc) (1 *))
                             c-%offset%)
                (+
                 (f2cl-lib:fref c-%data%
                                (i j)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* temp1
                    (f2cl-lib:fref b-%data%
                                   (i k)
                                   ((1 ldb$) (1 *))
                                   b-%offset%))))))))
(f2cl-lib:fdo (k (f2cl-lib:int-add j 1) (f2cl-lib:int-add k 1))
              ((> k n) nil)
  (tagbody
    (cond
      (upper
       (setf temp1
```

```
                              (* alpha
                                 (f2cl-lib:fref a-%data%
                                                (j k)
                                                ((1 lda) (1 *))
                                                a-%offset%))))
                        (t
                         (setf temp1
                                 (* alpha
                                    (f2cl-lib:fref a-%data%
                                                   (k j)
                                                   ((1 lda) (1 *))
                                                   a-%offset%)))))
                      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                    ((> i m) nil)
                        (tagbody
                          (setf (f2cl-lib:fref c-%data%
                                               (i j)
                                               ((1 ldc) (1 *))
                                               c-%offset%)
                                 (+
                                  (f2cl-lib:fref c-%data%
                                                 (i j)
                                                 ((1 ldc) (1 *))
                                                 c-%offset%)
                                  (* temp1
                                     (f2cl-lib:fref b-%data%
                                                    (i k)
                                                    ((1 ldb$) (1 *))
                                                    b-%offset%))))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil nil nil nil))))))
```

———-

5.3 dsyr2k BLAS

— dsyr2k.input —

```
)set break resume
)sys rm -f dsyr2k.output
)spool dsyr2k.output
)set message test on
)set message auto off
)clear all

)spool
```

```
)lisp (bye)
```

———-

— dsyr2k.help —

```
==========================================================================
dsyr2k examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      DSYR2K - perform one of the symmetric rank 2k operations   C
      := alpha*A*B' + alpha*B*A' + beta*C,

 SYNOPSIS
      SUBROUTINE DSYR2K( UPLO, TRANS, N, K, ALPHA, A, LDA, B, LDB,
                         BETA, C, LDC )

          CHARACTER*1    UPLO, TRANS

          INTEGER        N, K, LDA, LDB, LDC

          DOUBLE         PRECISION ALPHA, BETA

          DOUBLE         PRECISION A( LDA, * ), B( LDB, * ), C(
                         LDC, * )

 PURPOSE
      DSYR2K  performs one of the symmetric rank 2k operations

      or

         C := alpha*A'*B + alpha*B'*A + beta*C,

      where  alpha and beta  are scalars, C is an  n by n  sym-
      metric matrix and  A and B  are  n by k  matrices  in the
      first  case  and  k by n matrices in the second case.

 PARAMETERS
      UPLO   - CHARACTER*1.
               On  entry,   UPLO  specifies  whether  the  upper  or
               lower triangular  part  of the  array  C  is to be
               referenced  as follows:

               UPLO = 'U' or 'u'   Only the  upper triangular part
```

```
            of  C is to be referenced.

            UPLO = 'L' or 'l'   Only the  lower triangular part
            of  C is to be referenced.

            Unchanged on exit.

      TRANS  - CHARACTER*1.
            On entry,  TRANS  specifies the operation to be per-
            formed as follows:

            TRANS = 'N' or 'n'   C := alpha*A*B' + alpha*B*A' +
            beta*C.

            TRANS = 'T' or 't'   C := alpha*A'*B + alpha*B'*A +
            beta*C.

            TRANS = 'C' or 'c'   C := alpha*A'*B + alpha*B'*A +
            beta*C.

            Unchanged on exit.

      N      - INTEGER.
            On entry,  N specifies the order of the matrix C.  N
            must be at least zero.  Unchanged on exit.

      K      - INTEGER.
            On entry with  TRANS = 'N' or 'n',  K  specifies  the
            number of  columns  of the  matrices  A and B,  and
            on  entry  with TRANS = 'T' or 't' or 'C' or 'c',  K
            specifies  the  number of rows of the matrices  A and
            B.  K must be at least  zero.  Unchanged on exit.

      ALPHA  - DOUBLE PRECISION.
            On entry, ALPHA specifies the scalar alpha.
            Unchanged on exit.

ka is
      A      -
             DOUBLE PRECISION array of DIMENSION ( LDA, ka ), where
            k  when  TRANS = 'N' or 'n',  and is  n  otherwise.
            Before entry with  TRANS = 'N' or 'n',  the  leading
            n by k part of the array  A  must contain the matrix
            A,  otherwise the leading  k by n  part of the array
            A  must contain  the matrix A.  Unchanged on exit.

      LDA    - INTEGER.
            On entry, LDA specifies the first dimension of A as
            declared in  the  calling  (sub)  program.   When
            TRANS = 'N' or 'n' then  LDA must be at least  max(
```

```
            1, n ), otherwise  LDA must be at least  max( 1, k ).
            Unchanged on exit.

 kb is
      B      -
             DOUBLE PRECISION array of DIMENSION ( LDB, kb ), where
            k  when  TRANS = 'N' or 'n',  and is  n  otherwise.
            Before entry with  TRANS = 'N' or 'n',  the  leading
            n by k part of the array  B  must contain the matrix
            B,  otherwise the leading  k by n  part of the array
            B  must contain  the matrix B.  Unchanged on exit.

      LDB    - INTEGER.
            On entry, LDB specifies the first dimension of B as
            declared in  the  calling  (sub)  program.   When
            TRANS = 'N' or 'n' then  LDB must be at least  max(
            1, n ), otherwise  LDB must be at least  max( 1, k ).
            Unchanged on exit.

      BETA   - DOUBLE PRECISION.
            On entry, BETA specifies the scalar beta.  Unchanged
            on exit.

      C      - DOUBLE PRECISION array of DIMENSION ( LDC, n ).
            Before entry  with  UPLO = 'U' or 'u',  the leading
            n by n upper triangular part of the array C must con-
            tain the upper triangular part  of the  symmetric
            matrix  and the strictly lower triangular part of C
            is not referenced.  On exit, the upper triangular
            part of the array  C is overwritten by the upper tri-
            angular part of the updated matrix.  Before entry
            with  UPLO = 'L' or 'l',  the leading  n by n lower
            triangular part of the array C must contain the lower
            triangular part  of the  symmetric matrix  and the
            strictly upper triangular part of C is not refer-
            enced.  On exit, the lower triangular part of the
            array  C is overwritten by the lower triangular part
            of the updated matrix.

      LDC    - INTEGER.
            On entry, LDC specifies the first dimension of C as
            declared in  the  calling  (sub)  program.   LDC
            must  be  at  least max( 1, n ).  Unchanged on exit.
```

———-

— dsyr2k.f —

```
      SUBROUTINE DSYR2K( UPLO, TRANS, N, K, ALPHA, A, LDA, B, LDB,
     $                   BETA, C, LDC )
*     .. Scalar Arguments ..
      CHARACTER*1        UPLO, TRANS
      INTEGER            N, K, LDA, LDB, LDC
      DOUBLE PRECISION   ALPHA, BETA
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), B( LDB, * ), C( LDC, * )
*     ..
*
*  Level 3 Blas routine.
*
*
*  -- Written on 8-February-1989.
*     Jack Dongarra, Argonne National Laboratory.
*     Iain Duff, AERE Harwell.
*     Jeremy Du Croz, Numerical Algorithms Group Ltd.
*     Sven Hammarling, Numerical Algorithms Group Ltd.
*
*
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     .. Local Scalars ..
      LOGICAL            UPPER
      INTEGER            I, INFO, J, L, NROWA
      DOUBLE PRECISION   TEMP1, TEMP2
*     .. Parameters ..
      DOUBLE PRECISION   ONE         , ZERO
      PARAMETER        ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      IF( LSAME( TRANS, 'N' ) )THEN
         NROWA = N
      ELSE
         NROWA = K
      END IF
      UPPER = LSAME( UPLO, 'U' )
*
      INFO = 0
      IF(      ( .NOT.UPPER               ).AND.
     $         ( .NOT.LSAME( UPLO , 'L' ) )      )THEN
         INFO = 1
```

```
      ELSE IF( ( .NOT.LSAME( TRANS, 'N' ) ).AND.
     $         ( .NOT.LSAME( TRANS, 'T' ) ).AND.
     $         ( .NOT.LSAME( TRANS, 'C' ) )      )THEN
         INFO = 2
      ELSE IF( N  .LT.0               )THEN
         INFO = 3
      ELSE IF( K  .LT.0               )THEN
         INFO = 4
      ELSE IF( LDA.LT.MAX( 1, NROWA ) )THEN
         INFO = 7
      ELSE IF( LDB.LT.MAX( 1, NROWA ) )THEN
         INFO = 9
      ELSE IF( LDC.LT.MAX( 1, N     ) )THEN
         INFO = 12
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DSYR2K', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( N.EQ.0 ).OR.
     $    ( ( ( ALPHA.EQ.ZERO ).OR.( K.EQ.0 ) ).AND.( BETA.EQ.ONE ) ) )
     $   RETURN
*
*     And when  alpha.eq.zero.
*
      IF( ALPHA.EQ.ZERO )THEN
         IF( UPPER )THEN
            IF( BETA.EQ.ZERO )THEN
               DO 20, J = 1, N
                  DO 10, I = 1, J
                     C( I, J ) = ZERO
   10             CONTINUE
   20          CONTINUE
            ELSE
               DO 40, J = 1, N
                  DO 30, I = 1, J
                     C( I, J ) = BETA*C( I, J )
   30             CONTINUE
   40          CONTINUE
            END IF
         ELSE
            IF( BETA.EQ.ZERO )THEN
               DO 60, J = 1, N
                  DO 50, I = J, N
                     C( I, J ) = ZERO
   50             CONTINUE
   60          CONTINUE
```

```
            ELSE
               DO 80, J = 1, N
                  DO 70, I = J, N
                     C( I, J ) = BETA*C( I, J )
   70             CONTINUE
   80          CONTINUE
            END IF
         END IF
         RETURN
      END IF
*
*     Start the operations.
*
      IF( LSAME( TRANS, 'N' ) )THEN
*
*        Form  C := alpha*A*B' + alpha*B*A' + C.
*
         IF( UPPER )THEN
            DO 130, J = 1, N
               IF( BETA.EQ.ZERO )THEN
                  DO 90, I = 1, J
                     C( I, J ) = ZERO
   90             CONTINUE
               ELSE IF( BETA.NE.ONE )THEN
                  DO 100, I = 1, J
                     C( I, J ) = BETA*C( I, J )
  100             CONTINUE
               END IF
               DO 120, L = 1, K
                  IF( ( A( J, L ).NE.ZERO ).OR.
     $                ( B( J, L ).NE.ZERO )     )THEN
                     TEMP1 = ALPHA*B( J, L )
                     TEMP2 = ALPHA*A( J, L )
                     DO 110, I = 1, J
                        C( I, J ) = C( I, J ) +
     $                              A( I, L )*TEMP1 + B( I, L )*TEMP2
  110                CONTINUE
                  END IF
  120          CONTINUE
  130       CONTINUE
         ELSE
            DO 180, J = 1, N
               IF( BETA.EQ.ZERO )THEN
                  DO 140, I = J, N
                     C( I, J ) = ZERO
  140             CONTINUE
               ELSE IF( BETA.NE.ONE )THEN
                  DO 150, I = J, N
                     C( I, J ) = BETA*C( I, J )
  150             CONTINUE
```

```
               END IF
               DO 170, L = 1, K
                  IF( ( A( J, L ).NE.ZERO ).OR.
     $                ( B( J, L ).NE.ZERO )     )THEN
                     TEMP1 = ALPHA*B( J, L )
                     TEMP2 = ALPHA*A( J, L )
                     DO 160, I = J, N
                        C( I, J ) = C( I, J ) +
     $                              A( I, L )*TEMP1 + B( I, L )*TEMP2
  160                CONTINUE
                  END IF
  170          CONTINUE
  180       CONTINUE
         END IF
      ELSE
*
*        Form  C := alpha*A'*B + alpha*B'*A + C.
*
         IF( UPPER )THEN
            DO 210, J = 1, N
               DO 200, I = 1, J
                  TEMP1 = ZERO
                  TEMP2 = ZERO
                  DO 190, L = 1, K
                     TEMP1 = TEMP1 + A( L, I )*B( L, J )
                     TEMP2 = TEMP2 + B( L, I )*A( L, J )
  190             CONTINUE
                  IF( BETA.EQ.ZERO )THEN
                     C( I, J ) = ALPHA*TEMP1 + ALPHA*TEMP2
                  ELSE
                     C( I, J ) = BETA *C( I, J ) +
     $                           ALPHA*TEMP1 + ALPHA*TEMP2
                  END IF
  200          CONTINUE
  210       CONTINUE
         ELSE
            DO 240, J = 1, N
               DO 230, I = J, N
                  TEMP1 = ZERO
                  TEMP2 = ZERO
                  DO 220, L = 1, K
                     TEMP1 = TEMP1 + A( L, I )*B( L, J )
                     TEMP2 = TEMP2 + B( L, I )*A( L, J )
  220             CONTINUE
                  IF( BETA.EQ.ZERO )THEN
                     C( I, J ) = ALPHA*TEMP1 + ALPHA*TEMP2
                  ELSE
                     C( I, J ) = BETA *C( I, J ) +
     $                           ALPHA*TEMP1 + ALPHA*TEMP2
                  END IF
```

```
  230          CONTINUE
  240       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of DSYR2K.
*
      END
```

———-

— BLAS 3 dsyr2k —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dsyr2k (uplo trans n k alpha a lda b ldb$ beta c ldc)
    (declare (type (simple-array double-float (*)) c b a)
             (type (double-float) beta alpha)
             (type fixnum ldc ldb$ lda k n)
             (type character trans uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (a double-float a-%data% a-%offset%)
         (b double-float b-%data% b-%offset%)
         (c double-float c-%data% c-%offset%))
      (prog ((temp1 0.0) (temp2 0.0) (i 0) (info 0) (j 0) (l 0) (nrowa 0)
             (upper nil))
        (declare (type (double-float) temp1 temp2)
                 (type fixnum i info j l nrowa)
                 (type (member t nil) upper))
        (cond
          ((char-equal trans #\N)
           (setf nrowa n))
          (t
           (setf nrowa k)))
        (setf upper (char-equal uplo #\U))
        (setf info 0)
        (cond
          ((and (not upper) (not (char-equal uplo #\L)))
           (setf info 1))
          ((and (not (char-equal trans #\N))
                (not (char-equal trans #\T))
                (not (char-equal trans #\C)))
           (setf info 2))
```

```
  ((< n 0)
   (setf info 3))
  ((< k 0)
   (setf info 4))
  ((< lda (max (the fixnum 1) (the fixnum nrowa)))
   (setf info 7))
  ((< ldb$
      (max (the fixnum 1) (the fixnum nrowa)))
   (setf info 9))
  ((< ldc (max (the fixnum 1) (the fixnum n)))
   (setf info 12)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DSYR2K" info)
   (go end_label)))
(if (or (= n 0) (and (or (= alpha zero) (= k 0)) (= beta one)))
    (go end_label))
(cond
  ((= alpha zero)
   (cond
     (upper
      (cond
        ((= beta zero)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i j) nil)
               (tagbody
                 (setf (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       zero))))))
        (t
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i j) nil)
               (tagbody
                 (setf (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (* beta
                          (f2cl-lib:fref c-%data%
                                         (i j)
```

```
                                          ((1 ldc) (1 *))
                                          c-%offset%))))))))))
          (t
           (cond
             ((= beta zero)
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
                (tagbody
                  (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                                ((> i n) nil)
                    (tagbody
                      (setf (f2cl-lib:fref c-%data%
                                           (i j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                            zero))))))
             (t
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
                (tagbody
                  (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                                ((> i n) nil)
                    (tagbody
                      (setf (f2cl-lib:fref c-%data%
                                           (i j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                            (* beta
                               (f2cl-lib:fref c-%data%
                                              (i j)
                                              ((1 ldc) (1 *))
                                              c-%offset%)))))))))))
       (go end_label)))
    (cond
      ((char-equal trans #\N)
       (cond
         (upper
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                        ((> j n) nil)
            (tagbody
              (cond
                ((= beta zero)
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                               ((> i j) nil)
                   (tagbody
                     (setf (f2cl-lib:fref c-%data%
                                          (i j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)
                           zero))))
```

```
  ((/= beta one)
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i j) nil)
     (tagbody
       (setf (f2cl-lib:fref c-%data%
                            (i j)
                            ((1 ldc) (1 *))
                            c-%offset%)
                (* beta
                   (f2cl-lib:fref c-%data%
                                  (i j)
                                  ((1 ldc) (1 *))
                                  c-%offset%)))))))
(f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
              ((> l k) nil)
  (tagbody
    (cond
      ((or (/= (f2cl-lib:fref a (j l) ((1 lda) (1 *))) zero)
           (/= (f2cl-lib:fref b (j l) ((1 ldb$) (1 *))) zero))
       (setf temp1
                (* alpha
                   (f2cl-lib:fref b-%data%
                                  (j l)
                                  ((1 ldb$) (1 *))
                                  b-%offset%)))
       (setf temp2
                (* alpha
                   (f2cl-lib:fref a-%data%
                                  (j l)
                                  ((1 lda) (1 *))
                                  a-%offset%)))
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i j) nil)
         (tagbody
           (setf (f2cl-lib:fref c-%data%
                                (i j)
                                ((1 ldc) (1 *))
                                c-%offset%)
                  (+
                   (f2cl-lib:fref c-%data%
                                  (i j)
                                  ((1 ldc) (1 *))
                                  c-%offset%)
                   (*
                    (f2cl-lib:fref a-%data%
                                   (i l)
                                   ((1 lda) (1 *))
                                   a-%offset%)
                    temp1)
                   (*
```

```
                                (f2cl-lib:fref b-%data%
                                               (i l)
                                               ((1 ldb$) (1 *))
                                               b-%offset%)
                                temp2))))))))))))
            (t
             (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                           ((> j n) nil)
               (tagbody
                 (cond
                   ((= beta zero)
                    (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                                  ((> i n) nil)
                      (tagbody
                        (setf (f2cl-lib:fref c-%data%
                                             (i j)
                                             ((1 ldc) (1 *))
                                             c-%offset%)
                                      zero))))
                   ((/= beta one)
                    (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                                  ((> i n) nil)
                      (tagbody
                        (setf (f2cl-lib:fref c-%data%
                                             (i j)
                                             ((1 ldc) (1 *))
                                             c-%offset%)
                                      (* beta
                                         (f2cl-lib:fref c-%data%
                                                        (i j)
                                                        ((1 ldc) (1 *))
                                                        c-%offset%)))))))
                 (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                               ((> l k) nil)
                   (tagbody
                     (cond
                       ((or (/= (f2cl-lib:fref a (j l) ((1 lda) (1 *))) zero)
                            (/= (f2cl-lib:fref b (j l) ((1 ldb$) (1 *))) zero))
                        (setf temp1
                                (* alpha
                                   (f2cl-lib:fref b-%data%
                                                  (j l)
                                                  ((1 ldb$) (1 *))
                                                  b-%offset%)))
                        (setf temp2
                                (* alpha
                                   (f2cl-lib:fref a-%data%
                                                  (j l)
                                                  ((1 lda) (1 *))
                                                  a-%offset%)))
```

```
                  (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                                ((> i n) nil)
                    (tagbody
                      (setf (f2cl-lib:fref c-%data%
                                           (i j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                                    (+
                                     (f2cl-lib:fref c-%data%
                                                    (i j)
                                                    ((1 ldc) (1 *))
                                                    c-%offset%)
                                     (*
                                      (f2cl-lib:fref a-%data%
                                                     (i l)
                                                     ((1 lda) (1 *))
                                                     a-%offset%)
                                      temp1)
                                     (*
                                      (f2cl-lib:fref b-%data%
                                                     (i l)
                                                     ((1 ldb$) (1 *))
                                                     b-%offset%)
                                      temp2))))))))))))))
(t
 (cond
   (upper
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j n) nil)
      (tagbody
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i j) nil)
          (tagbody
            (setf temp1 zero)
            (setf temp2 zero)
            (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                          ((> l k) nil)
              (tagbody
                (setf temp1
                        (+ temp1
                           (*
                            (f2cl-lib:fref a-%data%
                                           (l i)
                                           ((1 lda) (1 *))
                                           a-%offset%)
                            (f2cl-lib:fref b-%data%
                                           (l j)
                                           ((1 ldb$) (1 *))
                                           b-%offset%))))
                (setf temp2
```

```
                        (+ temp2
                           (*
                            (f2cl-lib:fref b-%data%
                                           (l i)
                                           ((1 ldb$) (1 *))
                                           b-%offset%)
                            (f2cl-lib:fref a-%data%
                                           (l j)
                                           ((1 lda) (1 *))
                                           a-%offset%))))))
                (cond
                  ((= beta zero)
                   (setf (f2cl-lib:fref c-%data%
                                        (i j)
                                        ((1 ldc) (1 *))
                                        c-%offset%)
                           (+ (* alpha temp1) (* alpha temp2))))
                  (t
                   (setf (f2cl-lib:fref c-%data%
                                        (i j)
                                        ((1 ldc) (1 *))
                                        c-%offset%)
                           (+
                            (* beta
                               (f2cl-lib:fref c-%data%
                                              (i j)
                                              ((1 ldc) (1 *))
                                              c-%offset%))
                            (* alpha temp1)
                            (* alpha temp2)))))))))
        (t
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                           ((> i n) nil)
               (tagbody
                 (setf temp1 zero)
                 (setf temp2 zero)
                 (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                               ((> l k) nil)
                   (tagbody
                     (setf temp1
                             (+ temp1
                                (*
                                 (f2cl-lib:fref a-%data%
                                                (l i)
                                                ((1 lda) (1 *))
                                                a-%offset%)
                                 (f2cl-lib:fref b-%data%
```

```
                                          (l j)
                                          ((1 ldb$) (1 *))
                                          b-%offset%))))
                    (setf temp2
                            (+ temp2
                               (*
                                (f2cl-lib:fref b-%data%
                                          (l i)
                                          ((1 ldb$) (1 *))
                                          b-%offset%)
                                (f2cl-lib:fref a-%data%
                                          (l j)
                                          ((1 lda) (1 *))
                                          a-%offset%))))))
                (cond
                  ((= beta zero)
                   (setf (f2cl-lib:fref c-%data%
                                        (i j)
                                        ((1 ldc) (1 *))
                                        c-%offset%)
                           (+ (* alpha temp1) (* alpha temp2))))
                  (t
                   (setf (f2cl-lib:fref c-%data%
                                        (i j)
                                        ((1 ldc) (1 *))
                                        c-%offset%)
                           (+
                            (* beta
                               (f2cl-lib:fref c-%data%
                                          (i j)
                                          ((1 ldc) (1 *))
                                          c-%offset%))
                            (* alpha temp1)
                            (* alpha temp2)))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil nil nil))))))
```

———-

5.4 dsyrk BLAS

— dsyrk.input —

```
)set break resume
)sys rm -f dsyrk.output
)spool dsyrk.output
```

```
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dsyrk.help —

```
==========================================================================
dsyrk examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      DSYRK - perform one of the symmetric rank k operations   C
      := alpha*A*A' + beta*C,

 SYNOPSIS
      SUBROUTINE DSYRK ( UPLO, TRANS, N, K, ALPHA, A, LDA, BETA,
                         C, LDC )

          CHARACTER*1  UPLO, TRANS

          INTEGER      N, K, LDA, LDC

          DOUBLE       PRECISION ALPHA, BETA

          DOUBLE       PRECISION A( LDA, * ), C( LDC, * )

 PURPOSE
      DSYRK  performs one of the symmetric rank k operations

      or

         C := alpha*A'*A + beta*C,

      where  alpha and beta  are scalars, C is an  n by n  sym-
      metric matrix and  A  is an  n by k  matrix in the first
      case and a  k by n  matrix in the second case.

 PARAMETERS
      UPLO   - CHARACTER*1.
               On  entry,   UPLO  specifies  whether  the  upper  or
```

```
           lower triangular  part  of the  array  C  is to be
           referenced  as follows:

           UPLO = 'U' or 'u'   Only the  upper triangular part
           of  C is to be referenced.

           UPLO = 'L' or 'l'   Only the  lower triangular part
           of  C is to be referenced.

           Unchanged on exit.

     TRANS  - CHARACTER*1.
           On entry,  TRANS  specifies the operation to be per-
           formed as follows:

           TRANS = 'N' or 'n'   C := alpha*A*A' + beta*C.

           TRANS = 'T' or 't'   C := alpha*A'*A + beta*C.

           TRANS = 'C' or 'c'   C := alpha*A'*A + beta*C.

           Unchanged on exit.

     N      - INTEGER.
           On entry,  N specifies the order of the matrix C.  N
           must be at least zero.  Unchanged on exit.

     K      - INTEGER.
           On entry with  TRANS = 'N' or 'n',  K  specifies  the
           number of  columns   of  the   matrix   A,   and  on
           entry   with TRANS = 'T' or 't' or 'C' or 'c',  K
           specifies  the  number of rows of the matrix  A.  K
           must be at least zero.  Unchanged on exit.

     ALPHA  - DOUBLE PRECISION.
           On entry, ALPHA specifies the scalar alpha.
           Unchanged on exit.

ka is
     A      -
            DOUBLE PRECISION array of DIMENSION ( LDA, ka ), where
           k  when  TRANS = 'N' or 'n',  and is  n  otherwise.
           Before entry with  TRANS = 'N' or 'n',  the  leading
           n by k part of the array  A  must contain the matrix
           A,  otherwise the leading  k by n  part of the array
           A  must contain  the matrix A.  Unchanged on exit.

     LDA    - INTEGER.
           On entry, LDA specifies the first dimension of A as
           declared in  the  calling  (sub)  program.   When
```

```
            TRANS = 'N' or 'n' then  LDA must be at least  max(
            1, n ), otherwise  LDA must be at least  max( 1, k ).
            Unchanged on exit.

      BETA  - DOUBLE PRECISION.
            On entry, BETA specifies the scalar beta.  Unchanged
            on exit.

      C     - DOUBLE PRECISION array of DIMENSION ( LDC, n ).
            Before entry  with  UPLO = 'U' or 'u',  the leading
            n by n upper triangular part of the array C must con-
            tain the upper triangular part  of the  symmetric
            matrix  and the strictly lower triangular part of C
            is not referenced.  On exit, the upper triangular
            part of the array  C is overwritten by the upper tri-
            angular part of the updated matrix.  Before entry
            with  UPLO = 'L' or 'l',  the leading  n by n lower
            triangular part of the array C must contain the lower
            triangular part  of the  symmetric matrix  and the
            strictly upper triangular part of C is not refer-
            enced.  On exit, the lower triangular part of the
            array  C is overwritten by the lower triangular part
            of the updated matrix.

      LDC   - INTEGER.
            On entry, LDC specifies the first dimension of C as
            declared in  the  calling  (sub)  program.   LDC
            must  be  at  least max( 1, n ).  Unchanged on exit.
```

———-

— dsyrk.f —

```
      SUBROUTINE DSYRK ( UPLO, TRANS, N, K, ALPHA, A, LDA,
     $                   BETA, C, LDC )
*     .. Scalar Arguments ..
      CHARACTER*1        UPLO, TRANS
      INTEGER            N, K, LDA, LDC
      DOUBLE PRECISION   ALPHA, BETA
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), C( LDC, * )
*     ..
*
*  Level 3 Blas routine.
*
*  -- Written on 8-February-1989.
*     Jack Dongarra, Argonne National Laboratory.
*     Iain Duff, AERE Harwell.
```

```
*     Jeremy Du Croz, Numerical Algorithms Group Ltd.
*     Sven Hammarling, Numerical Algorithms Group Ltd.
*
*
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     .. Local Scalars ..
      LOGICAL            UPPER
      INTEGER            I, INFO, J, L, NROWA
      DOUBLE PRECISION   TEMP
*     .. Parameters ..
      DOUBLE PRECISION   ONE ,         ZERO
      PARAMETER        ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      IF( LSAME( TRANS, 'N' ) )THEN
         NROWA = N
      ELSE
         NROWA = K
      END IF
      UPPER = LSAME( UPLO, 'U' )
*
      INFO = 0
      IF(      ( .NOT.UPPER               ).AND.
     $         ( .NOT.LSAME( UPLO , 'L' ) )      )THEN
         INFO = 1
      ELSE IF( ( .NOT.LSAME( TRANS, 'N' ) ).AND.
     $         ( .NOT.LSAME( TRANS, 'T' ) ).AND.
     $         ( .NOT.LSAME( TRANS, 'C' ) )      )THEN
         INFO = 2
      ELSE IF( N  .LT.0               )THEN
         INFO = 3
      ELSE IF( K  .LT.0               )THEN
         INFO = 4
      ELSE IF( LDA.LT.MAX( 1, NROWA ) )THEN
         INFO = 7
      ELSE IF( LDC.LT.MAX( 1, N     ) )THEN
         INFO = 10
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DSYRK ', INFO )
         RETURN
```

```
      END IF
*
*     Quick return if possible.
*
      IF( ( N.EQ.0 ).OR.
     $    ( ( ( ALPHA.EQ.ZERO ).OR.( K.EQ.0 ) ).AND.( BETA.EQ.ONE ) ) )
     $   RETURN
*
*     And when  alpha.eq.zero.
*
      IF( ALPHA.EQ.ZERO )THEN
         IF( UPPER )THEN
            IF( BETA.EQ.ZERO )THEN
               DO 20, J = 1, N
                  DO 10, I = 1, J
                     C( I, J ) = ZERO
   10             CONTINUE
   20          CONTINUE
            ELSE
               DO 40, J = 1, N
                  DO 30, I = 1, J
                     C( I, J ) = BETA*C( I, J )
   30             CONTINUE
   40          CONTINUE
            END IF
         ELSE
            IF( BETA.EQ.ZERO )THEN
               DO 60, J = 1, N
                  DO 50, I = J, N
                     C( I, J ) = ZERO
   50             CONTINUE
   60          CONTINUE
            ELSE
               DO 80, J = 1, N
                  DO 70, I = J, N
                     C( I, J ) = BETA*C( I, J )
   70             CONTINUE
   80          CONTINUE
            END IF
         END IF
         RETURN
      END IF
*
*     Start the operations.
*
      IF( LSAME( TRANS, 'N' ) )THEN
*
*        Form  C := alpha*A*A' + beta*C.
*
         IF( UPPER )THEN
```

```
            DO 130, J = 1, N
               IF( BETA.EQ.ZERO )THEN
                  DO 90, I = 1, J
                     C( I, J ) = ZERO
   90             CONTINUE
               ELSE IF( BETA.NE.ONE )THEN
                  DO 100, I = 1, J
                     C( I, J ) = BETA*C( I, J )
  100             CONTINUE
               END IF
               DO 120, L = 1, K
                  IF( A( J, L ).NE.ZERO )THEN
                     TEMP = ALPHA*A( J, L )
                     DO 110, I = 1, J
                        C( I, J ) = C( I, J ) + TEMP*A( I, L )
  110                CONTINUE
                  END IF
  120             CONTINUE
  130          CONTINUE
            ELSE
               DO 180, J = 1, N
                  IF( BETA.EQ.ZERO )THEN
                     DO 140, I = J, N
                        C( I, J ) = ZERO
  140                CONTINUE
                  ELSE IF( BETA.NE.ONE )THEN
                     DO 150, I = J, N
                        C( I, J ) = BETA*C( I, J )
  150                CONTINUE
                  END IF
                  DO 170, L = 1, K
                     IF( A( J, L ).NE.ZERO )THEN
                        TEMP      = ALPHA*A( J, L )
                        DO 160, I = J, N
                           C( I, J ) = C( I, J ) + TEMP*A( I, L )
  160                   CONTINUE
                     END IF
  170             CONTINUE
  180          CONTINUE
            END IF
         ELSE
*
*           Form  C := alpha*A'*A + beta*C.
*
            IF( UPPER )THEN
               DO 210, J = 1, N
                  DO 200, I = 1, J
                     TEMP = ZERO
                     DO 190, L = 1, K
                        TEMP = TEMP + A( L, I )*A( L, J )
```

```
  190             CONTINUE
                  IF( BETA.EQ.ZERO )THEN
                     C( I, J ) = ALPHA*TEMP
                  ELSE
                     C( I, J ) = ALPHA*TEMP + BETA*C( I, J )
                  END IF
  200          CONTINUE
  210       CONTINUE
         ELSE
            DO 240, J = 1, N
               DO 230, I = J, N
                  TEMP = ZERO
                  DO 220, L = 1, K
                     TEMP = TEMP + A( L, I )*A( L, J )
  220             CONTINUE
                  IF( BETA.EQ.ZERO )THEN
                     C( I, J ) = ALPHA*TEMP
                  ELSE
                     C( I, J ) = ALPHA*TEMP + BETA*C( I, J )
                  END IF
  230          CONTINUE
  240       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of DSYRK .
*
      END
```

———-

— BLAS 3 dsyrk —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dsyrk (uplo trans n k alpha a lda beta c ldc)
    (declare (type (simple-array double-float (*)) c a)
             (type (double-float) beta alpha)
             (type fixnum ldc lda k n)
             (type character trans uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (a double-float a-%data% a-%offset%)
         (c double-float c-%data% c-%offset%))
```

```
(prog ((temp 0.0) (i 0) (info 0) (j 0) (l 0) (nrowa 0) (upper nil))
  (declare (type (double-float) temp)
           (type fixnum i info j l nrowa)
           (type (member t nil) upper))
  (cond
    ((char-equal trans #\N)
     (setf nrowa n))
    (t
     (setf nrowa k)))
  (setf upper (char-equal uplo #\U))
  (setf info 0)
  (cond
    ((and (not upper) (not (char-equal uplo #\L)))
     (setf info 1))
    ((and (not (char-equal trans #\N))
          (not (char-equal trans #\T))
          (not (char-equal trans #\C)))
     (setf info 2))
    ((< n 0)
     (setf info 3))
    ((< k 0)
     (setf info 4))
    ((< lda (max (the fixnum 1) (the fixnum nrowa)))
     (setf info 7))
    ((< ldc (max (the fixnum 1) (the fixnum n)))
     (setf info 10)))
  (cond
    ((/= info 0)
     (error
      " ** On entry to ~a parameter number ~a had an illegal value~%"
      "DSYRK" info)
     (go end_label)))
  (if (or (= n 0) (and (or (= alpha zero) (= k 0)) (= beta one)))
      (go end_label))
  (cond
    ((= alpha zero)
     (cond
       (upper
        (cond
          ((= beta zero)
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                             ((> i j) nil)
                 (tagbody
                   (setf (f2cl-lib:fref c-%data%
                                        (i j)
                                        ((1 ldc) (1 *))
                                        c-%offset%)
```

```
                        zero))))))
              (t
               (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                             ((> j n) nil)
                 (tagbody
                   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                 ((> i j) nil)
                     (tagbody
                       (setf (f2cl-lib:fref c-%data%
                                            (i j)
                                            ((1 ldc) (1 *))
                                            c-%offset%)
                             (* beta
                                (f2cl-lib:fref c-%data%
                                               (i j)
                                               ((1 ldc) (1 *))
                                               c-%offset%)))))))))
            (t
             (cond
               ((= beta zero)
                (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                              ((> j n) nil)
                  (tagbody
                    (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                                  ((> i n) nil)
                      (tagbody
                        (setf (f2cl-lib:fref c-%data%
                                             (i j)
                                             ((1 ldc) (1 *))
                                             c-%offset%)
                              zero))))))
               (t
                (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                              ((> j n) nil)
                  (tagbody
                    (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                                  ((> i n) nil)
                      (tagbody
                        (setf (f2cl-lib:fref c-%data%
                                             (i j)
                                             ((1 ldc) (1 *))
                                             c-%offset%)
                              (* beta
                                 (f2cl-lib:fref c-%data%
                                                (i j)
                                                ((1 ldc) (1 *))
                                                c-%offset%)))))))))))
         (go end_label)))
      (cond
        ((char-equal trans #\N)
```

```
(cond
  (upper
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
     (tagbody
       (cond
         ((= beta zero)
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i j) nil)
            (tagbody
              (setf (f2cl-lib:fref c-%data%
                                   (i j)
                                   ((1 ldc) (1 *))
                                   c-%offset%)
                    zero))))
         ((/= beta one)
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i j) nil)
            (tagbody
              (setf (f2cl-lib:fref c-%data%
                                   (i j)
                                   ((1 ldc) (1 *))
                                   c-%offset%)
                    (* beta
                       (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)))))))
       (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                     ((> l k) nil)
         (tagbody
           (cond
             ((/= (f2cl-lib:fref a (j l) ((1 lda) (1 *))) zero)
              (setf temp
                      (* alpha
                         (f2cl-lib:fref a-%data%
                                        (j l)
                                        ((1 lda) (1 *))
                                        a-%offset%)))
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                            ((> i j) nil)
                (tagbody
                  (setf (f2cl-lib:fref c-%data%
                                       (i j)
                                       ((1 ldc) (1 *))
                                       c-%offset%)
                        (+
                         (f2cl-lib:fref c-%data%
                                        (i j)
                                        ((1 ldc) (1 *))
```

```
                                                c-%offset%)
                                    (* temp
                                       (f2cl-lib:fref a-%data%
                                                      (i l)
                                                      ((1 lda) (1 *))
                                                      a-%offset%)))))))))))))
          (t
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (cond
                 ((= beta zero)
                  (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                                ((> i n) nil)
                    (tagbody
                      (setf (f2cl-lib:fref c-%data%
                                           (i j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                            zero))))
                 ((/= beta one)
                  (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                                ((> i n) nil)
                    (tagbody
                      (setf (f2cl-lib:fref c-%data%
                                           (i j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                            (* beta
                               (f2cl-lib:fref c-%data%
                                              (i j)
                                              ((1 ldc) (1 *))
                                              c-%offset%)))))))
               (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                             ((> l k) nil)
                 (tagbody
                   (cond
                     ((/= (f2cl-lib:fref a (j l) ((1 lda) (1 *))) zero)
                      (setf temp
                              (* alpha
                                 (f2cl-lib:fref a-%data%
                                                (j l)
                                                ((1 lda) (1 *))
                                                a-%offset%)))
                      (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                                    ((> i n) nil)
                        (tagbody
                          (setf (f2cl-lib:fref c-%data%
                                               (i j)
                                               ((1 ldc) (1 *))
```

```
                                        c-%offset%)
                                (+
                                 (f2cl-lib:fref c-%data%
                                                (i j)
                                                ((1 ldc) (1 *))
                                                c-%offset%)
                                 (* temp
                                    (f2cl-lib:fref a-%data%
                                                   (i l)
                                                   ((1 lda) (1 *))
                                                   a-%offset%)))))))))))))))
          (t
           (cond
             (upper
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
                (tagbody
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                ((> i j) nil)
                    (tagbody
                      (setf temp zero)
                      (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                                    ((> l k) nil)
                        (tagbody
                          (setf temp
                                  (+ temp
                                     (*
                                      (f2cl-lib:fref a-%data%
                                                     (l i)
                                                     ((1 lda) (1 *))
                                                     a-%offset%)
                                      (f2cl-lib:fref a-%data%
                                                     (l j)
                                                     ((1 lda) (1 *))
                                                     a-%offset%))))))
                      (cond
                        ((= beta zero)
                         (setf (f2cl-lib:fref c-%data%
                                              (i j)
                                              ((1 ldc) (1 *))
                                              c-%offset%)
                                 (* alpha temp)))
                        (t
                         (setf (f2cl-lib:fref c-%data%
                                              (i j)
                                              ((1 ldc) (1 *))
                                              c-%offset%)
                                 (+ (* alpha temp)
                                    (* beta
                                       (f2cl-lib:fref c-%data%
```

```
                                                (i j)
                                                ((1 ldc) (1 *))
                                                c-%offset%))))))))))))
                (t
                 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                               ((> j n) nil)
                   (tagbody
                     (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                                   ((> i n) nil)
                       (tagbody
                         (setf temp zero)
                         (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                                       ((> l k) nil)
                           (tagbody
                             (setf temp
                                     (+ temp
                                        (*
                                         (f2cl-lib:fref a-%data%
                                                        (l i)
                                                        ((1 lda) (1 *))
                                                        a-%offset%)
                                         (f2cl-lib:fref a-%data%
                                                        (l j)
                                                        ((1 lda) (1 *))
                                                        a-%offset%))))))
                         (cond
                           ((= beta zero)
                            (setf (f2cl-lib:fref c-%data%
                                                 (i j)
                                                 ((1 ldc) (1 *))
                                                 c-%offset%)
                                  (* alpha temp)))
                           (t
                            (setf (f2cl-lib:fref c-%data%
                                                 (i j)
                                                 ((1 ldc) (1 *))
                                                 c-%offset%)
                                  (+ (* alpha temp)
                                     (* beta
                                        (f2cl-lib:fref c-%data%
                                                       (i j)
                                                       ((1 ldc) (1 *))
                                                       c-%offset%)))))))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil nil))))))
```

5.5 dtrmm BLAS

— **dtrmm.input** —

```
)set break resume
)sys rm -f dtrmm.output
)spool dtrmm.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

————-

— **dtrmm.help** —

```
==========================================================================
dtrmm examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      DTRMM - perform one of the matrix-matrix operations   B :=
      alpha*op( A )*B, or B := alpha*B*op( A ),

 SYNOPSIS
      SUBROUTINE DTRMM ( SIDE, UPLO, TRANSA, DIAG, M, N, ALPHA, A,
                         LDA, B, LDB )

          CHARACTER*1  SIDE, UPLO, TRANSA, DIAG

          INTEGER      M, N, LDA, LDB

          DOUBLE       PRECISION ALPHA

          DOUBLE       PRECISION A( LDA, * ), B( LDB, * )

 PURPOSE
      DTRMM  performs one of the matrix-matrix operations

      where  alpha  is a scalar,  B  is an m by n matrix,  A  is a
      unit, or non-unit,  upper or lower triangular matrix  and
      op( A )  is one  of
```

```
        op( A ) = A   or   op( A ) = A'.

PARAMETERS
     SIDE   - CHARACTER*1.
            On entry,  SIDE specifies whether  op( A ) multiplies
            B from the left or right as follows:

            SIDE = 'L' or 'l'   B := alpha*op( A )*B.

            SIDE = 'R' or 'r'   B := alpha*B*op( A ).

            Unchanged on exit.

     UPLO   - CHARACTER*1.
            On entry, UPLO specifies whether the matrix A is an
            upper or lower triangular matrix as follows:

            UPLO = 'U' or 'u'   A is an upper triangular matrix.

            UPLO = 'L' or 'l'   A is a lower triangular matrix.

            Unchanged on exit.

            TRANSA - CHARACTER*1.  On entry, TRANSA specifies the
            form of op( A ) to be used in the matrix multiplica-
            tion as follows:

            TRANSA = 'N' or 'n'   op( A ) = A.

            TRANSA = 'T' or 't'   op( A ) = A'.

            TRANSA = 'C' or 'c'   op( A ) = A'.

            Unchanged on exit.

     DIAG   - CHARACTER*1.
            On entry, DIAG specifies whether or not A is unit
            triangular as follows:

            DIAG = 'U' or 'u'   A is assumed to be unit triangu-
            lar.

            DIAG = 'N' or 'n'   A is not assumed to be unit tri-
            angular.

            Unchanged on exit.

     M      - INTEGER.
            On entry, M specifies the number of rows of B. M must
```

```
           be at least zero.  Unchanged on exit.

     N     - INTEGER.
           On entry, N specifies the number of columns of B.  N
           must be at least zero.  Unchanged on exit.

     ALPHA - DOUBLE PRECISION.
           On entry,  ALPHA specifies the scalar  alpha. When
           alpha is zero then  A is not referenced and  B need
           not be set before entry.  Unchanged on exit.

is m
     A     -
            DOUBLE PRECISION array of DIMENSION ( LDA, k ), where k
           when  SIDE = 'L' or 'l'  and is  n  when  SIDE = 'R'
           or 'r'.  Before entry  with  UPLO = 'U' or 'u',  the
           leading  k by k upper triangular part of the array  A
           must contain the upper triangular matrix  and the
           strictly lower triangular part of A is not refer-
           enced.  Before entry  with  UPLO = 'L' or 'l',  the
           leading  k by k lower triangular part of the array  A
           must contain the lower triangular matrix  and the
           strictly upper triangular part of A is not refer-
           enced.  Note that when  DIAG = 'U' or 'u',  the diag-
           onal elements of A  are not referenced either,  but
           are assumed to be  unity.  Unchanged on exit.

     LDA   - INTEGER.
           On entry, LDA specifies the first dimension of A as
           declared in the calling (sub) program.  When  SIDE =
           'L' or 'l'  then LDA  must be at least  max( 1, m ),
           when  SIDE = 'R' or 'r' then LDA must be at least

           max( 1, n ).  Unchanged on exit.

     B     - DOUBLE PRECISION array of DIMENSION ( LDB, n ).
           Before entry,  the leading  m by n part of the array
           B must contain the matrix  B,  and  on exit  is
           overwritten  by the transformed matrix.

     LDB   - INTEGER.
           On entry, LDB specifies the first dimension of B as
           declared in  the  calling  (sub)  program.   LDB
           must  be  at  least max( 1, m ).  Unchanged on exit.
```

———-

— **dtrmm.f** —

```
      SUBROUTINE DTRMM ( SIDE, UPLO, TRANSA, DIAG, M, N, ALPHA, A, LDA,
     $                   B, LDB )
*     .. Scalar Arguments ..
      CHARACTER*1        SIDE, UPLO, TRANSA, DIAG
      INTEGER            M, N, LDA, LDB
      DOUBLE PRECISION   ALPHA
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), B( LDB, * )
*     ..
*
*  Level 3 Blas routine.
*
*  -- Written on 8-February-1989.
*     Jack Dongarra, Argonne National Laboratory.
*     Iain Duff, AERE Harwell.
*     Jeremy Du Croz, Numerical Algorithms Group Ltd.
*     Sven Hammarling, Numerical Algorithms Group Ltd.
*
*
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     .. Local Scalars ..
      LOGICAL            LSIDE, NOUNIT, UPPER
      INTEGER            I, INFO, J, K, NROWA
      DOUBLE PRECISION   TEMP
*     .. Parameters ..
      DOUBLE PRECISION   ONE         , ZERO
      PARAMETER        ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      LSIDE  = LSAME( SIDE  , 'L' )
      IF( LSIDE )THEN
         NROWA = M
      ELSE
         NROWA = N
      END IF
      NOUNIT = LSAME( DIAG  , 'N' )
      UPPER  = LSAME( UPLO  , 'U' )
*
      INFO   = 0
      IF(      ( .NOT.LSIDE                ).AND.
     $         ( .NOT.LSAME( SIDE  , 'R' ) )      )THEN
```

```
         INFO = 1
      ELSE IF( ( .NOT.UPPER               ).AND.
     $         ( .NOT.LSAME( UPLO  , 'L' ) )      )THEN
         INFO = 2
      ELSE IF( ( .NOT.LSAME( TRANSA, 'N' ) ).AND.
     $         ( .NOT.LSAME( TRANSA, 'T' ) ).AND.
     $         ( .NOT.LSAME( TRANSA, 'C' ) )      )THEN
         INFO = 3
      ELSE IF( ( .NOT.LSAME( DIAG  , 'U' ) ).AND.
     $         ( .NOT.LSAME( DIAG  , 'N' ) )      )THEN
         INFO = 4
      ELSE IF( M  .LT.0               )THEN
         INFO = 5
      ELSE IF( N  .LT.0               )THEN
         INFO = 6
      ELSE IF( LDA.LT.MAX( 1, NROWA ) )THEN
         INFO = 9
      ELSE IF( LDB.LT.MAX( 1, M     ) )THEN
         INFO = 11
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DTRMM ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( N.EQ.0 )
     $   RETURN
*
*     And when  alpha.eq.zero.
*
      IF( ALPHA.EQ.ZERO )THEN
         DO 20, J = 1, N
            DO 10, I = 1, M
               B( I, J ) = ZERO
   10       CONTINUE
   20    CONTINUE
         RETURN
      END IF
*
*     Start the operations.
*
      IF( LSIDE )THEN
         IF( LSAME( TRANSA, 'N' ) )THEN
*
*           Form  B := alpha*A*B.
*
            IF( UPPER )THEN
               DO 50, J = 1, N
```

```
                  DO 40, K = 1, M
                     IF( B( K, J ).NE.ZERO )THEN
                        TEMP = ALPHA*B( K, J )
                        DO 30, I = 1, K - 1
                           B( I, J ) = B( I, J ) + TEMP*A( I, K )
   30                   CONTINUE
                        IF( NOUNIT )
     $                     TEMP = TEMP*A( K, K )
                        B( K, J ) = TEMP
                     END IF
   40                CONTINUE
   50             CONTINUE
               ELSE
                  DO 80, J = 1, N
                     DO 70 K = M, 1, -1
                        IF( B( K, J ).NE.ZERO )THEN
                           TEMP      = ALPHA*B( K, J )
                           B( K, J ) = TEMP
                           IF( NOUNIT )
     $                        B( K, J ) = B( K, J )*A( K, K )
                           DO 60, I = K + 1, M
                              B( I, J ) = B( I, J ) + TEMP*A( I, K )
   60                      CONTINUE
                        END IF
   70                CONTINUE
   80             CONTINUE
               END IF
            ELSE
*
*              Form  B := alpha*A'*B.
*
               IF( UPPER )THEN
                  DO 110, J = 1, N
                     DO 100, I = M, 1, -1
                        TEMP = B( I, J )
                        IF( NOUNIT )
     $                     TEMP = TEMP*A( I, I )
                        DO 90, K = 1, I - 1
                           TEMP = TEMP + A( K, I )*B( K, J )
   90                   CONTINUE
                        B( I, J ) = ALPHA*TEMP
  100                CONTINUE
  110             CONTINUE
               ELSE
                  DO 140, J = 1, N
                     DO 130, I = 1, M
                        TEMP = B( I, J )
                        IF( NOUNIT )
     $                     TEMP = TEMP*A( I, I )
                        DO 120, K = I + 1, M
```

```
                     TEMP = TEMP + A( K, I )*B( K, J )
  120             CONTINUE
                  B( I, J ) = ALPHA*TEMP
  130          CONTINUE
  140       CONTINUE
         END IF
      END IF
   ELSE
      IF( LSAME( TRANSA, 'N' ) )THEN
*
*        Form  B := alpha*B*A.
*
         IF( UPPER )THEN
            DO 180, J = N, 1, -1
               TEMP = ALPHA
               IF( NOUNIT )
     $            TEMP = TEMP*A( J, J )
               DO 150, I = 1, M
                  B( I, J ) = TEMP*B( I, J )
  150          CONTINUE
               DO 170, K = 1, J - 1
                  IF( A( K, J ).NE.ZERO )THEN
                     TEMP = ALPHA*A( K, J )
                     DO 160, I = 1, M
                        B( I, J ) = B( I, J ) + TEMP*B( I, K )
  160                CONTINUE
                  END IF
  170          CONTINUE
  180       CONTINUE
         ELSE
            DO 220, J = 1, N
               TEMP = ALPHA
               IF( NOUNIT )
     $            TEMP = TEMP*A( J, J )
               DO 190, I = 1, M
                  B( I, J ) = TEMP*B( I, J )
  190          CONTINUE
               DO 210, K = J + 1, N
                  IF( A( K, J ).NE.ZERO )THEN
                     TEMP = ALPHA*A( K, J )
                     DO 200, I = 1, M
                        B( I, J ) = B( I, J ) + TEMP*B( I, K )
  200                CONTINUE
                  END IF
  210          CONTINUE
  220       CONTINUE
         END IF
      ELSE
*
*        Form  B := alpha*B*A'.
```

```
*
           IF( UPPER )THEN
              DO 260, K = 1, N
                 DO 240, J = 1, K - 1
                    IF( A( J, K ).NE.ZERO )THEN
                       TEMP = ALPHA*A( J, K )
                       DO 230, I = 1, M
                          B( I, J ) = B( I, J ) + TEMP*B( I, K )
  230                  CONTINUE
                    END IF
  240            CONTINUE
                 TEMP = ALPHA
                 IF( NOUNIT )
     $              TEMP = TEMP*A( K, K )
                 IF( TEMP.NE.ONE )THEN
                    DO 250, I = 1, M
                       B( I, K ) = TEMP*B( I, K )
  250               CONTINUE
                 END IF
  260         CONTINUE
           ELSE
              DO 300, K = N, 1, -1
                 DO 280, J = K + 1, N
                    IF( A( J, K ).NE.ZERO )THEN
                       TEMP = ALPHA*A( J, K )
                       DO 270, I = 1, M
                          B( I, J ) = B( I, J ) + TEMP*B( I, K )
  270                  CONTINUE
                    END IF
  280            CONTINUE
                 TEMP = ALPHA
                 IF( NOUNIT )
     $              TEMP = TEMP*A( K, K )
                 IF( TEMP.NE.ONE )THEN
                    DO 290, I = 1, M
                       B( I, K ) = TEMP*B( I, K )
  290               CONTINUE
                 END IF
  300         CONTINUE
           END IF
        END IF
     END IF
*
     RETURN
*
*     End of DTRMM .
*
     END
```

———-

— BLAS 3 dtrmm —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dtrmm (side uplo transa diag m n alpha a lda b ldb$)
    (declare (type (simple-array double-float (*)) b a)
             (type (double-float) alpha)
             (type fixnum ldb$ lda n m)
             (type character diag transa uplo side))
    (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (uplo character uplo-%data% uplo-%offset%)
         (transa character transa-%data% transa-%offset%)
         (diag character diag-%data% diag-%offset%)
         (a double-float a-%data% a-%offset%)
         (b double-float b-%data% b-%offset%))
      (prog ((temp 0.0) (i 0) (info 0) (j 0) (k 0) (nrowa 0) (lside nil)
             (nounit nil) (upper nil))
        (declare (type (double-float) temp)
                 (type fixnum i info j k nrowa)
                 (type (member t nil) lside nounit upper))
        (setf lside (char-equal side #\L))
        (cond
          (lside
           (setf nrowa m))
          (t
           (setf nrowa n)))
        (setf nounit (char-equal diag #\N))
        (setf upper (char-equal uplo #\U))
        (setf info 0)
        (cond
          ((and (not lside) (not (char-equal side #\R)))
           (setf info 1))
          ((and (not upper) (not (char-equal uplo #\L)))
           (setf info 2))
          ((and (not (char-equal transa #\N))
                (not (char-equal transa #\T))
                (not (char-equal transa #\C)))
           (setf info 3))
          ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
           (setf info 4))
          ((< m 0)
           (setf info 5))
          ((< n 0)
           (setf info 6))
          ((< lda (max (the fixnum 1) (the fixnum nrowa)))
```

```
   (setf info 9))
  ((< ldb$ (max (the fixnum 1) (the fixnum m)))
   (setf info 11)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DTRMM" info)
   (go end_label)))
(if (= n 0) (go end_label))
(cond
  ((= alpha zero)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
     (tagbody
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i m) nil)
         (tagbody
           (setf (f2cl-lib:fref b-%data%
                                (i j)
                                ((1 ldb$) (1 *))
                                b-%offset%)
                 zero)))))
   (go end_label)))
(cond
  (lside
   (cond
     ((char-equal transa #\N)
      (cond
        (upper
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                           ((> k m) nil)
               (tagbody
                 (cond
                   ((/= (f2cl-lib:fref b (k j) ((1 ldb$) (1 *))) zero)
                    (setf temp
                            (* alpha
                               (f2cl-lib:fref b-%data%
                                              (k j)
                                              ((1 ldb$) (1 *))
                                              b-%offset%)))
                    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                  ((> i
                                      (f2cl-lib:int-add k
                                                        (f2cl-lib:int-sub
                                                         1)))
                                   nil)
```

```
                  (tagbody
                    (setf (f2cl-lib:fref b-%data%
                                         (i j)
                                         ((1 ldb$) (1 *))
                                         b-%offset%)
                          (+
                           (f2cl-lib:fref b-%data%
                                          (i j)
                                          ((1 ldb$) (1 *))
                                          b-%offset%)
                           (* temp
                              (f2cl-lib:fref a-%data%
                                             (i k)
                                             ((1 lda) (1 *))
                                             a-%offset%))))))
                (if nounit
                    (setf temp
                          (* temp
                             (f2cl-lib:fref a-%data%
                                            (k k)
                                            ((1 lda) (1 *))
                                            a-%offset%))))
                (setf (f2cl-lib:fref b-%data%
                                     (k j)
                                     ((1 ldb$) (1 *))
                                     b-%offset%)
                      temp))))))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (f2cl-lib:fdo (k m
                    (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
                   ((> k 1) nil)
       (tagbody
         (cond
           ((/= (f2cl-lib:fref b (k j) ((1 ldb$) (1 *))) zero)
            (setf temp
                  (* alpha
                     (f2cl-lib:fref b-%data%
                                    (k j)
                                    ((1 ldb$) (1 *))
                                    b-%offset%)))
            (setf (f2cl-lib:fref b-%data%
                                 (k j)
                                 ((1 ldb$) (1 *))
                                 b-%offset%)
                  temp)
            (if nounit
                (setf (f2cl-lib:fref b-%data%
```

```
                                        (k j)
                                        ((1 ldb$) (1 *))
                                        b-%offset%)
                                (*
                                 (f2cl-lib:fref b-%data%
                                                (k j)
                                                ((1 ldb$) (1 *))
                                                b-%offset%)
                                 (f2cl-lib:fref a-%data%
                                                (k k)
                                                ((1 lda) (1 *))
                                                a-%offset%))))
                          (f2cl-lib:fdo (i (f2cl-lib:int-add k 1)
                                           (f2cl-lib:int-add i 1))
                                        ((> i m) nil)
                            (tagbody
                              (setf (f2cl-lib:fref b-%data%
                                                   (i j)
                                                   ((1 ldb$) (1 *))
                                                   b-%offset%)
                                    (+
                                     (f2cl-lib:fref b-%data%
                                                    (i j)
                                                    ((1 ldb$) (1 *))
                                                    b-%offset%)
                                     (* temp
                                        (f2cl-lib:fref a-%data%
                                                       (i k)
                                                       ((1 lda) (1 *))
                                                       a-%offset%)))))))))))
        (t
         (cond
           (upper
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
              (tagbody
                (f2cl-lib:fdo (i m
                               (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                              ((> i 1) nil)
                  (tagbody
                    (setf temp
                            (f2cl-lib:fref b-%data%
                                           (i j)
                                           ((1 ldb$) (1 *))
                                           b-%offset%))
                    (if nounit
                        (setf temp
                                (* temp
                                   (f2cl-lib:fref a-%data%
                                                  (i i)
```

```
                                        ((1 lda) (1 *))
                                        a-%offset%))))
            (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                          ((> k
                              (f2cl-lib:int-add i
                                                (f2cl-lib:int-sub
                                                 1)))
                           nil)
              (tagbody
                (setf temp
                        (+ temp
                           (*
                            (f2cl-lib:fref a-%data%
                                           (k i)
                                           ((1 lda) (1 *))
                                           a-%offset%)
                            (f2cl-lib:fref b-%data%
                                           (k j)
                                           ((1 ldb$) (1 *))
                                           b-%offset%))))))
            (setf (f2cl-lib:fref b-%data%
                                 (i j)
                                 ((1 ldb$) (1 *))
                                 b-%offset%)
                  (* alpha temp)))))))
    (t
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   ((> j n) nil)
       (tagbody
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i m) nil)
           (tagbody
             (setf temp
                     (f2cl-lib:fref b-%data%
                                    (i j)
                                    ((1 ldb$) (1 *))
                                    b-%offset%))
             (if nounit
                 (setf temp
                         (* temp
                            (f2cl-lib:fref a-%data%
                                           (i i)
                                           ((1 lda) (1 *))
                                           a-%offset%))))
             (f2cl-lib:fdo (k (f2cl-lib:int-add i 1)
                              (f2cl-lib:int-add k 1))
                           ((> k m) nil)
               (tagbody
                 (setf temp
                         (+ temp
```

```
                                    (*
                                     (f2cl-lib:fref a-%data%
                                                    (k i)
                                                    ((1 lda) (1 *))
                                                    a-%offset%)
                                     (f2cl-lib:fref b-%data%
                                                    (k j)
                                                    ((1 ldb$) (1 *))
                                                    b-%offset%))))))
                        (setf (f2cl-lib:fref b-%data%
                                             (i j)
                                             ((1 ldb$) (1 *))
                                             b-%offset%)
                              (* alpha temp))))))))))))
          (t
           (cond
             ((char-equal transa #\N)
              (cond
                (upper
                 (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                               ((> j 1) nil)
                   (tagbody
                     (setf temp alpha)
                     (if nounit
                         (setf temp
                                 (* temp
                                    (f2cl-lib:fref a-%data%
                                                   (j j)
                                                   ((1 lda) (1 *))
                                                   a-%offset%))))
                     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                   ((> i m) nil)
                       (tagbody
                         (setf (f2cl-lib:fref b-%data%
                                              (i j)
                                              ((1 ldb$) (1 *))
                                              b-%offset%)
                                 (* temp
                                    (f2cl-lib:fref b-%data%
                                                   (i j)
                                                   ((1 ldb$) (1 *))
                                                   b-%offset%)))))
                     (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                                   ((> k
                                       (f2cl-lib:int-add j
                                                         (f2cl-lib:int-sub 1)))
                                    nil)
                       (tagbody
                         (cond
                           ((/= (f2cl-lib:fref a (k j) ((1 lda) (1 *))) zero)
```

```
                (setf temp
                        (* alpha
                           (f2cl-lib:fref a-%data%
                                          (k j)
                                          ((1 lda) (1 *))
                                          a-%offset%)))
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                              ((> i m) nil)
                  (tagbody
                    (setf (f2cl-lib:fref b-%data%
                                         (i j)
                                         ((1 ldb$) (1 *))
                                         b-%offset%)
                            (+
                             (f2cl-lib:fref b-%data%
                                            (i j)
                                            ((1 ldb$) (1 *))
                                            b-%offset%)
                             (* temp
                                (f2cl-lib:fref b-%data%
                                               (i k)
                                               ((1 ldb$) (1 *))
                                               b-%offset%)))))))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (setf temp alpha)
     (if nounit
         (setf temp
                 (* temp
                    (f2cl-lib:fref a-%data%
                                   (j j)
                                   ((1 lda) (1 *))
                                   a-%offset%))))
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                   ((> i m) nil)
       (tagbody
         (setf (f2cl-lib:fref b-%data%
                              (i j)
                              ((1 ldb$) (1 *))
                              b-%offset%)
                 (* temp
                    (f2cl-lib:fref b-%data%
                                   (i j)
                                   ((1 ldb$) (1 *))
                                   b-%offset%)))))
     (f2cl-lib:fdo (k (f2cl-lib:int-add j 1)
                    (f2cl-lib:int-add k 1))
                   ((> k n) nil)
```

```
                    (tagbody
                      (cond
                        (((/= (f2cl-lib:fref a (k j) ((1 lda) (1 *))) zero)
                         (setf temp
                                 (* alpha
                                    (f2cl-lib:fref a-%data%
                                                   (k j)
                                                   ((1 lda) (1 *))
                                                   a-%offset%)))
                         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                       ((> i m) nil)
                           (tagbody
                             (setf (f2cl-lib:fref b-%data%
                                                  (i j)
                                                  ((1 ldb$) (1 *))
                                                  b-%offset%)
                                   (+
                                    (f2cl-lib:fref b-%data%
                                                   (i j)
                                                   ((1 ldb$) (1 *))
                                                   b-%offset%)
                                    (* temp
                                       (f2cl-lib:fref b-%data%
                                                      (i k)
                                                      ((1 ldb$) (1 *))
                                                      b-%offset%)))))))))))
               (t
                (cond
                  (upper
                   (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                                 ((> k n) nil)
                     (tagbody
                       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                                     ((> j
                                         (f2cl-lib:int-add k
                                                           (f2cl-lib:int-sub 1)))
                                      nil)
                         (tagbody
                           (cond
                             (((/= (f2cl-lib:fref a (j k) ((1 lda) (1 *))) zero)
                              (setf temp
                                      (* alpha
                                         (f2cl-lib:fref a-%data%
                                                        (j k)
                                                        ((1 lda) (1 *))
                                                        a-%offset%)))
                              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                            ((> i m) nil)
                                (tagbody
                                  (setf (f2cl-lib:fref b-%data%
```

```
                                        (i j)
                                        ((1 ldb$) (1 *))
                                        b-%offset%)
                                (+
                                 (f2cl-lib:fref b-%data%
                                                (i j)
                                                ((1 ldb$) (1 *))
                                                b-%offset%)
                                 (* temp
                                    (f2cl-lib:fref b-%data%
                                                   (i k)
                                                   ((1 ldb$) (1 *))
                                                   b-%offset%)))))))))))
            (setf temp alpha)
            (if nounit
                (setf temp
                        (* temp
                           (f2cl-lib:fref a-%data%
                                          (k k)
                                          ((1 lda) (1 *))
                                          a-%offset%))))
            (cond
              ((/= temp one)
               (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                             ((> i m) nil)
                 (tagbody
                   (setf (f2cl-lib:fref b-%data%
                                        (i k)
                                        ((1 ldb$) (1 *))
                                        b-%offset%)
                           (* temp
                              (f2cl-lib:fref b-%data%
                                             (i k)
                                             ((1 ldb$) (1 *))
                                             b-%offset%)))))))))))
        (t
         (f2cl-lib:fdo (k n (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
                       ((> k 1) nil)
           (tagbody
             (f2cl-lib:fdo (j (f2cl-lib:int-add k 1)
                              (f2cl-lib:int-add j 1))
                           ((> j n) nil)
               (tagbody
                 (cond
                   ((/= (f2cl-lib:fref a (j k) ((1 lda) (1 *))) zero)
                    (setf temp
                            (* alpha
                               (f2cl-lib:fref a-%data%
                                              (j k)
                                              ((1 lda) (1 *))
```

```
                                        a-%offset%)))
                        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                      ((> i m) nil)
                          (tagbody
                            (setf (f2cl-lib:fref b-%data%
                                                 (i j)
                                                 ((1 ldb$) (1 *))
                                                 b-%offset%)
                                  (+
                                   (f2cl-lib:fref b-%data%
                                                  (i j)
                                                  ((1 ldb$) (1 *))
                                                  b-%offset%)
                                   (* temp
                                      (f2cl-lib:fref b-%data%
                                                     (i k)
                                                     ((1 ldb$) (1 *))
                                                     b-%offset%)))))))))
                 (setf temp alpha)
                 (if nounit
                     (setf temp
                             (* temp
                                (f2cl-lib:fref a-%data%
                                               (k k)
                                               ((1 lda) (1 *))
                                               a-%offset%))))
                 (cond
                   ((/= temp one)
                    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                  ((> i m) nil)
                      (tagbody
                        (setf (f2cl-lib:fref b-%data%
                                             (i k)
                                             ((1 ldb$) (1 *))
                                             b-%offset%)
                              (* temp
                                 (f2cl-lib:fref b-%data%
                                                (i k)
                                                ((1 ldb$) (1 *))
                                                b-%offset%)))))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil nil nil))))))
```

5.6 dtrsm BLAS

— dtrsm.input —

```
)set break resume
)sys rm -f dtrsm.output
)spool dtrsm.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

————-

— dtrsm.help —

```
==========================================================================
dtrsm examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      DTRSM - solve one of the matrix equations   op( A )*X =
      alpha*B, or X*op( A ) = alpha*B,

 SYNOPSIS
      SUBROUTINE DTRSM ( SIDE, UPLO, TRANSA, DIAG, M, N, ALPHA, A,
                         LDA, B, LDB )

          CHARACTER*1  SIDE, UPLO, TRANSA, DIAG

          INTEGER      M, N, LDA, LDB

          DOUBLE       PRECISION ALPHA

          DOUBLE       PRECISION A( LDA, * ), B( LDB, * )

 PURPOSE
      DTRSM  solves one of the matrix equations

      where alpha is a scalar, X and B are m by n matrices, A is a
      unit, or non-unit,  upper or lower triangular matrix  and
      op( A )  is one  of
```

```
        op( A ) = A   or   op( A ) = A'.

     The matrix X is overwritten on B.

 PARAMETERS
     SIDE   - CHARACTER*1.
            On entry, SIDE specifies whether op( A ) appears on
            the left or right of X as follows:

            SIDE = 'L' or 'l'   op( A )*X = alpha*B.

            SIDE = 'R' or 'r'   X*op( A ) = alpha*B.

            Unchanged on exit.

     UPLO   - CHARACTER*1.
            On entry, UPLO specifies whether the matrix A is an
            upper or lower triangular matrix as follows:

            UPLO = 'U' or 'u'   A is an upper triangular matrix.

            UPLO = 'L' or 'l'   A is a lower triangular matrix.

            Unchanged on exit.

            TRANSA - CHARACTER*1.  On entry, TRANSA specifies the
            form of op( A ) to be used in the matrix multiplica-
            tion as follows:

            TRANSA = 'N' or 'n'   op( A ) = A.

            TRANSA = 'T' or 't'   op( A ) = A'.

            TRANSA = 'C' or 'c'   op( A ) = A'.

            Unchanged on exit.

     DIAG   - CHARACTER*1.
            On entry, DIAG specifies whether or not A is unit
            triangular as follows:

            DIAG = 'U' or 'u'   A is assumed to be unit triangu-
            lar.

            DIAG = 'N' or 'n'   A is not assumed to be unit tri-
            angular.

            Unchanged on exit.
```

```
     M      - INTEGER.
              On entry, M specifies the number of rows of B. M must
              be at least zero.  Unchanged on exit.

     N      - INTEGER.
              On entry, N specifies the number of columns of B.  N
              must be at least zero.  Unchanged on exit.

     ALPHA  - DOUBLE PRECISION.
              On entry,  ALPHA specifies the scalar  alpha. When
              alpha is zero then  A is not referenced and  B need
              not be set before entry.  Unchanged on exit.

is m
     A      -
              DOUBLE PRECISION array of DIMENSION ( LDA, k ), where k
              when  SIDE = 'L' or 'l'  and is  n  when  SIDE = 'R'
              or 'r'.  Before entry  with  UPLO = 'U' or 'u',  the
              leading  k by k upper triangular part of the array  A
              must contain the upper triangular matrix  and the
              strictly lower triangular part of A is not refer-
              enced.  Before entry  with  UPLO = 'L' or 'l',  the
              leading  k by k lower triangular part of the array  A
              must contain the lower triangular matrix  and the
              strictly upper triangular part of A is not refer-
              enced.  Note that when  DIAG = 'U' or 'u',  the diag-
              onal elements of A  are not referenced either,  but
              are assumed to be  unity.  Unchanged on exit.

     LDA    - INTEGER.
              On entry, LDA specifies the first dimension of A as
              declared in the calling (sub) program.  When  SIDE =

              'L' or 'l'  then LDA  must be at least  max( 1, m ),
              when  SIDE = 'R' or 'r' then LDA must be at least
              max( 1, n ).  Unchanged on exit.

     B      - DOUBLE PRECISION array of DIMENSION ( LDB, n ).
              Before entry,  the leading  m by n part of the array
              B must contain  the  right-hand  side  matrix  B,
              and  on exit  is overwritten by the solution matrix
              X.

     LDB    - INTEGER.
              On entry, LDB specifies the first dimension of B as
              declared in  the  calling  (sub)  program.   LDB
              must  be  at  least max( 1, m ).  Unchanged on exit.
```

— dtrsm.f —

```
      SUBROUTINE DTRSM ( SIDE, UPLO, TRANSA, DIAG, M, N, ALPHA, A, LDA,
     $                   B, LDB )
*     .. Scalar Arguments ..
      CHARACTER*1        SIDE, UPLO, TRANSA, DIAG
      INTEGER            M, N, LDA, LDB
      DOUBLE PRECISION   ALPHA
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), B( LDB, * )
*     ..
*
*  Level 3 Blas routine.
*
*
*  -- Written on 8-February-1989.
*     Jack Dongarra, Argonne National Laboratory.
*     Iain Duff, AERE Harwell.
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*
*
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     .. Local Scalars ..
      LOGICAL            LSIDE, NOUNIT, UPPER
      INTEGER            I, INFO, J, K, NROWA
      DOUBLE PRECISION   TEMP
*     .. Parameters ..
      DOUBLE PRECISION   ONE         , ZERO
      PARAMETER        ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      LSIDE  = LSAME( SIDE  , 'L' )
      IF( LSIDE )THEN
         NROWA = M
      ELSE
         NROWA = N
      END IF
      NOUNIT = LSAME( DIAG  , 'N' )
      UPPER  = LSAME( UPLO  , 'U' )
```

```
*
      INFO   = 0
      IF(      ( .NOT.LSIDE                ).AND.
     $         ( .NOT.LSAME( SIDE  , 'R' ) )      )THEN
         INFO = 1
      ELSE IF( ( .NOT.UPPER                ).AND.
     $         ( .NOT.LSAME( UPLO  , 'L' ) )      )THEN
         INFO = 2
      ELSE IF( ( .NOT.LSAME( TRANSA, 'N' ) ).AND.
     $         ( .NOT.LSAME( TRANSA, 'T' ) ).AND.
     $         ( .NOT.LSAME( TRANSA, 'C' ) )      )THEN
         INFO = 3
      ELSE IF( ( .NOT.LSAME( DIAG  , 'U' ) ).AND.
     $         ( .NOT.LSAME( DIAG  , 'N' ) )      )THEN
         INFO = 4
      ELSE IF( M  .LT.0               )THEN
         INFO = 5
      ELSE IF( N  .LT.0               )THEN
         INFO = 6
      ELSE IF( LDA.LT.MAX( 1, NROWA ) )THEN
         INFO = 9
      ELSE IF( LDB.LT.MAX( 1, M     ) )THEN
         INFO = 11
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'DTRSM ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( N.EQ.0 )
     $   RETURN
*
*     And when  alpha.eq.zero.
*
      IF( ALPHA.EQ.ZERO )THEN
         DO 20, J = 1, N
            DO 10, I = 1, M
               B( I, J ) = ZERO
   10       CONTINUE
   20    CONTINUE
         RETURN
      END IF
*
*     Start the operations.
*
      IF( LSIDE )THEN
         IF( LSAME( TRANSA, 'N' ) )THEN
*
```

```
*           Form  B := alpha*inv( A )*B.
*
            IF( UPPER )THEN
               DO 60, J = 1, N
                  IF( ALPHA.NE.ONE )THEN
                     DO 30, I = 1, M
                        B( I, J ) = ALPHA*B( I, J )
   30                CONTINUE
                  END IF
                  DO 50, K = M, 1, -1
                     IF( B( K, J ).NE.ZERO )THEN
                        IF( NOUNIT )
     $                     B( K, J ) = B( K, J )/A( K, K )
                        DO 40, I = 1, K - 1
                           B( I, J ) = B( I, J ) - B( K, J )*A( I, K )
   40                   CONTINUE
                     END IF
   50                CONTINUE
   60             CONTINUE
            ELSE
               DO 100, J = 1, N
                  IF( ALPHA.NE.ONE )THEN
                     DO 70, I = 1, M
                        B( I, J ) = ALPHA*B( I, J )
   70                CONTINUE
                  END IF
                  DO 90 K = 1, M
                     IF( B( K, J ).NE.ZERO )THEN
                        IF( NOUNIT )
     $                     B( K, J ) = B( K, J )/A( K, K )
                        DO 80, I = K + 1, M
                           B( I, J ) = B( I, J ) - B( K, J )*A( I, K )
   80                   CONTINUE
                     END IF
   90                CONTINUE
  100             CONTINUE
               END IF
         ELSE
*
*           Form  B := alpha*inv( A' )*B.
*
            IF( UPPER )THEN
               DO 130, J = 1, N
                  DO 120, I = 1, M
                     TEMP = ALPHA*B( I, J )
                     DO 110, K = 1, I - 1
                        TEMP = TEMP - A( K, I )*B( K, J )
  110                CONTINUE
                     IF( NOUNIT )
     $                  TEMP = TEMP/A( I, I )
```

```
                  B( I, J ) = TEMP
  120          CONTINUE
  130       CONTINUE
         ELSE
            DO 160, J = 1, N
               DO 150, I = M, 1, -1
                  TEMP = ALPHA*B( I, J )
                  DO 140, K = I + 1, M
                     TEMP = TEMP - A( K, I )*B( K, J )
  140             CONTINUE
                  IF( NOUNIT )
     $               TEMP = TEMP/A( I, I )
                  B( I, J ) = TEMP
  150          CONTINUE
  160       CONTINUE
         END IF
      END IF
   ELSE
      IF( LSAME( TRANSA, 'N' ) )THEN
*
*        Form  B := alpha*B*inv( A ).
*
         IF( UPPER )THEN
            DO 210, J = 1, N
               IF( ALPHA.NE.ONE )THEN
                  DO 170, I = 1, M
                     B( I, J ) = ALPHA*B( I, J )
  170             CONTINUE
               END IF
               DO 190, K = 1, J - 1
                  IF( A( K, J ).NE.ZERO )THEN
                     DO 180, I = 1, M
                        B( I, J ) = B( I, J ) - A( K, J )*B( I, K )
  180                CONTINUE
                  END IF
  190          CONTINUE
               IF( NOUNIT )THEN
                  TEMP = ONE/A( J, J )
                  DO 200, I = 1, M
                     B( I, J ) = TEMP*B( I, J )
  200             CONTINUE
               END IF
  210       CONTINUE
         ELSE
            DO 260, J = N, 1, -1
               IF( ALPHA.NE.ONE )THEN
                  DO 220, I = 1, M
                     B( I, J ) = ALPHA*B( I, J )
  220             CONTINUE
               END IF
```

```
                DO 240, K = J + 1, N
                   IF( A( K, J ).NE.ZERO )THEN
                      DO 230, I = 1, M
                         B( I, J ) = B( I, J ) - A( K, J )*B( I, K )
  230                 CONTINUE
                   END IF
  240           CONTINUE
                IF( NOUNIT )THEN
                   TEMP = ONE/A( J, J )
                   DO 250, I = 1, M
                     B( I, J ) = TEMP*B( I, J )
  250              CONTINUE
                END IF
  260        CONTINUE
          END IF
        ELSE
*
*          Form  B := alpha*B*inv( A' ).
*
           IF( UPPER )THEN
              DO 310, K = N, 1, -1
                 IF( NOUNIT )THEN
                    TEMP = ONE/A( K, K )
                    DO 270, I = 1, M
                       B( I, K ) = TEMP*B( I, K )
  270              CONTINUE
                 END IF
                 DO 290, J = 1, K - 1
                    IF( A( J, K ).NE.ZERO )THEN
                       TEMP = A( J, K )
                       DO 280, I = 1, M
                          B( I, J ) = B( I, J ) - TEMP*B( I, K )
  280                  CONTINUE
                    END IF
  290            CONTINUE
                 IF( ALPHA.NE.ONE )THEN
                    DO 300, I = 1, M
                       B( I, K ) = ALPHA*B( I, K )
  300               CONTINUE
                 END IF
  310         CONTINUE
           ELSE
              DO 360, K = 1, N
                 IF( NOUNIT )THEN
                    TEMP = ONE/A( K, K )
                    DO 320, I = 1, M
                       B( I, K ) = TEMP*B( I, K )
  320               CONTINUE
                 END IF
                 DO 340, J = K + 1, N
```

```
                     IF( A( J, K ).NE.ZERO )THEN
                        TEMP = A( J, K )
                        DO 330, I = 1, M
                           B( I, J ) = B( I, J ) - TEMP*B( I, K )
  330                   CONTINUE
                     END IF
  340             CONTINUE
                  IF( ALPHA.NE.ONE )THEN
                     DO 350, I = 1, M
                        B( I, K ) = ALPHA*B( I, K )
  350                CONTINUE
                  END IF
  360          CONTINUE
            END IF
         END IF
      END IF
*
      RETURN
*
*     End of DTRSM .
*
      END
```

———-

— BLAS 3 dtrsm —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dtrsm (side uplo transa diag m n alpha a lda b ldb$)
    (declare (type (simple-array double-float (*)) b a)
             (type (double-float) alpha)
             (type fixnum ldb$ lda n m)
             (type character diag transa uplo side))
    (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (uplo character uplo-%data% uplo-%offset%)
         (transa character transa-%data% transa-%offset%)
         (diag character diag-%data% diag-%offset%)
         (a double-float a-%data% a-%offset%)
         (b double-float b-%data% b-%offset%))
      (prog ((temp 0.0) (i 0) (info 0) (j 0) (k 0) (nrowa 0) (lside nil)
             (nounit nil) (upper nil))
        (declare (type (double-float) temp)
                 (type fixnum i info j k nrowa)
                 (type (member t nil) lside nounit upper))
        (setf lside (char-equal side #\L))
```

```
(cond
  (lside
   (setf nrowa m))
  (t
   (setf nrowa n)))
(setf nounit (char-equal diag #\N))
(setf upper (char-equal uplo #\U))
(setf info 0)
(cond
  ((and (not lside) (not (char-equal side #\R)))
   (setf info 1))
  ((and (not upper) (not (char-equal uplo #\L)))
   (setf info 2))
  ((and (not (char-equal transa #\N))
        (not (char-equal transa #\T))
        (not (char-equal transa #\C)))
   (setf info 3))
  ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
   (setf info 4))
  ((< m 0)
   (setf info 5))
  ((< n 0)
   (setf info 6))
  ((< lda (max (the fixnum 1) (the fixnum nrowa)))
   (setf info 9))
  ((< ldb$ (max (the fixnum 1) (the fixnum m)))
   (setf info 11)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DTRSM" info)
   (go end_label)))
(if (= n 0) (go end_label))
(cond
  ((= alpha zero)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
     (tagbody
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i m) nil)
         (tagbody
           (setf (f2cl-lib:fref b-%data%
                                (i j)
                                ((1 ldb$) (1 *))
                                b-%offset%)
                 zero)))))
   (go end_label)))
(cond
  (lside
```

```
(cond
  ((char-equal transa #\N)
   (cond
     (upper
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (cond
            ((/= alpha one)
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i m) nil)
               (tagbody
                 (setf (f2cl-lib:fref b-%data%
                                      (i j)
                                      ((1 ldb$) (1 *))
                                      b-%offset%)
                       (* alpha
                          (f2cl-lib:fref b-%data%
                                         (i j)
                                         ((1 ldb$) (1 *))
                                         b-%offset%)))))))
          (f2cl-lib:fdo (k m
                         (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
                        ((> k 1) nil)
            (tagbody
              (cond
                ((/= (f2cl-lib:fref b (k j) ((1 ldb$) (1 *))) zero)
                 (if nounit
                     (setf (f2cl-lib:fref b-%data%
                                          (k j)
                                          ((1 ldb$) (1 *))
                                          b-%offset%)
                           (/
                            (f2cl-lib:fref b-%data%
                                           (k j)
                                           ((1 ldb$) (1 *))
                                           b-%offset%)
                            (f2cl-lib:fref a-%data%
                                           (k k)
                                           ((1 lda) (1 *))
                                           a-%offset%))))
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                               ((> i
                                   (f2cl-lib:int-add k
                                                     (f2cl-lib:int-sub
                                                      1)))
                                nil)
                   (tagbody
                     (setf (f2cl-lib:fref b-%data%
                                          (i j)
```

```
                                          ((1 ldb$) (1 *))
                                          b-%offset%)
                                  (-
                                   (f2cl-lib:fref b-%data%
                                                  (i j)
                                                  ((1 ldb$) (1 *))
                                                  b-%offset%)
                                   (*
                                    (f2cl-lib:fref b-%data%
                                                   (k j)
                                                   ((1 ldb$) (1 *))
                                                   b-%offset%)
                                    (f2cl-lib:fref a-%data%
                                                   (i k)
                                                   ((1 lda) (1 *))
                                                   a-%offset%))))))))))))))
          (t
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (cond
                 ((/= alpha one)
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                ((> i m) nil)
                    (tagbody
                      (setf (f2cl-lib:fref b-%data%
                                           (i j)
                                           ((1 ldb$) (1 *))
                                           b-%offset%)
                            (* alpha
                               (f2cl-lib:fref b-%data%
                                              (i j)
                                              ((1 ldb$) (1 *))
                                              b-%offset%)))))))
               (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                             ((> k m) nil)
                 (tagbody
                   (cond
                     ((/= (f2cl-lib:fref b (k j) ((1 ldb$) (1 *))) zero)
                      (if nounit
                          (setf (f2cl-lib:fref b-%data%
                                               (k j)
                                               ((1 ldb$) (1 *))
                                               b-%offset%)
                                (/
                                 (f2cl-lib:fref b-%data%
                                                (k j)
                                                ((1 ldb$) (1 *))
                                                b-%offset%)
                                 (f2cl-lib:fref a-%data%
```

```
                                          (k k)
                                          ((1 lda) (1 *))
                                          a-%offset%))))
                    (f2cl-lib:fdo (i (f2cl-lib:int-add k 1)
                                   (f2cl-lib:int-add i 1))
                                  ((> i m) nil)
                      (tagbody
                        (setf (f2cl-lib:fref b-%data%
                                             (i j)
                                             ((1 ldb$) (1 *))
                                             b-%offset%)
                                      (-
                                       (f2cl-lib:fref b-%data%
                                                      (i j)
                                                      ((1 ldb$) (1 *))
                                                      b-%offset%)
                                       (*
                                        (f2cl-lib:fref b-%data%
                                                       (k j)
                                                       ((1 ldb$) (1 *))
                                                       b-%offset%)
                                        (f2cl-lib:fref a-%data%
                                                  (i k)
                                                  ((1 lda) (1 *))
                                                  a-%offset%))))))))))))))))
(t
 (cond
   (upper
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j n) nil)
      (tagbody
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i m) nil)
          (tagbody
            (setf temp
                    (* alpha
                       (f2cl-lib:fref b-%data%
                                      (i j)
                                      ((1 ldb$) (1 *))
                                      b-%offset%)))
            (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                          ((> k
                              (f2cl-lib:int-add i
                                                (f2cl-lib:int-sub
                                                 1)))
                           nil)
              (tagbody
                (setf temp
                        (- temp
                           (*
```

```
                                (f2cl-lib:fref a-%data%
                                               (k i)
                                               ((1 lda) (1 *))
                                               a-%offset%)
                                (f2cl-lib:fref b-%data%
                                               (k j)
                                               ((1 ldb$) (1 *))
                                               b-%offset%))))))
                    (if nounit
                        (setf temp
                                (/ temp
                                   (f2cl-lib:fref a-%data%
                                                  (i i)
                                                  ((1 lda) (1 *))
                                                  a-%offset%))))
                    (setf (f2cl-lib:fref b-%data%
                                         (i j)
                                         ((1 ldb$) (1 *))
                                         b-%offset%)
                          temp))))))
          (t
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (f2cl-lib:fdo (i m
                               (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                             ((> i 1) nil)
                 (tagbody
                   (setf temp
                           (* alpha
                              (f2cl-lib:fref b-%data%
                                             (i j)
                                             ((1 ldb$) (1 *))
                                             b-%offset%)))
                   (f2cl-lib:fdo (k (f2cl-lib:int-add i 1)
                                    (f2cl-lib:int-add k 1))
                                 ((> k m) nil)
                     (tagbody
                       (setf temp
                               (- temp
                                  (*
                                   (f2cl-lib:fref a-%data%
                                                  (k i)
                                                  ((1 lda) (1 *))
                                                  a-%offset%)
                                   (f2cl-lib:fref b-%data%
                                                  (k j)
                                                  ((1 ldb$) (1 *))
                                                  b-%offset%))))))
                   (if nounit
```

```
                    (setf temp
                            (/ temp
                               (f2cl-lib:fref a-%data%
                                              (i i)
                                              ((1 lda) (1 *))
                                              a-%offset%))))
                (setf (f2cl-lib:fref b-%data%
                                     (i j)
                                     ((1 ldb$) (1 *))
                                     b-%offset%)
                      temp))))))))))
(t
 (cond
   ((char-equal transa #\N)
    (cond
      (upper
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (cond
             ((/= alpha one)
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                            ((> i m) nil)
                (tagbody
                  (setf (f2cl-lib:fref b-%data%
                                       (i j)
                                       ((1 ldb$) (1 *))
                                       b-%offset%)
                        (* alpha
                           (f2cl-lib:fref b-%data%
                                          (i j)
                                          ((1 ldb$) (1 *))
                                          b-%offset%)))))))
           (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                         ((> k
                             (f2cl-lib:int-add j
                                               (f2cl-lib:int-sub 1)))
                          nil)
             (tagbody
               (cond
                 ((/= (f2cl-lib:fref a (k j) ((1 lda) (1 *))) zero)
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                ((> i m) nil)
                    (tagbody
                      (setf (f2cl-lib:fref b-%data%
                                           (i j)
                                           ((1 ldb$) (1 *))
                                           b-%offset%)
                            (-
                             (f2cl-lib:fref b-%data%
```

```
                                                (i j)
                                                ((1 ldb$) (1 *))
                                                b-%offset%)
                                        (*
                                         (f2cl-lib:fref a-%data%
                                                        (k j)
                                                        ((1 lda) (1 *))
                                                        a-%offset%)
                                         (f2cl-lib:fref b-%data%
                                                   (i k)
                                                   ((1 ldb$) (1 *))
                                                   b-%offset%))))))))))
                    (cond
                      (nounit
                       (setf temp
                             (/ one
                                (f2cl-lib:fref a-%data%
                                               (j j)
                                               ((1 lda) (1 *))
                                               a-%offset%)))
                       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                     ((> i m) nil)
                         (tagbody
                           (setf (f2cl-lib:fref b-%data%
                                                (i j)
                                                ((1 ldb$) (1 *))
                                                b-%offset%)
                                 (* temp
                                    (f2cl-lib:fref b-%data%
                                                   (i j)
                                                   ((1 ldb$) (1 *))
                                                   b-%offset%)))))))))
                   (t
                    (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                                  ((> j 1) nil)
                      (tagbody
                        (cond
                          ((/= alpha one)
                           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                         ((> i m) nil)
                             (tagbody
                               (setf (f2cl-lib:fref b-%data%
                                                    (i j)
                                                    ((1 ldb$) (1 *))
                                                    b-%offset%)
                                     (* alpha
                                        (f2cl-lib:fref b-%data%
                                                       (i j)
                                                       ((1 ldb$) (1 *))
                                                       b-%offset%)))))))))))
```

```
                (f2cl-lib:fdo (k (f2cl-lib:int-add j 1)
                               (f2cl-lib:int-add k 1))
                              ((> k n) nil)
                  (tagbody
                    (cond
                      (((/= (f2cl-lib:fref a (k j) ((1 lda) (1 *))) zero)
                       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                     ((> i m) nil)
                         (tagbody
                           (setf (f2cl-lib:fref b-%data%
                                                (i j)
                                                ((1 ldb$) (1 *))
                                                b-%offset%)
                                 (-
                                  (f2cl-lib:fref b-%data%
                                                 (i j)
                                                 ((1 ldb$) (1 *))
                                                 b-%offset%)
                                  (*
                                   (f2cl-lib:fref a-%data%
                                                  (k j)
                                                  ((1 lda) (1 *))
                                                  a-%offset%)
                                   (f2cl-lib:fref b-%data%
                                                  (i k)
                                                  ((1 ldb$) (1 *))
                                                  b-%offset%)))))))))
                (cond
                  (nounit
                   (setf temp
                           (/ one
                              (f2cl-lib:fref a-%data%
                                             (j j)
                                             ((1 lda) (1 *))
                                             a-%offset%)))
                   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                 ((> i m) nil)
                     (tagbody
                       (setf (f2cl-lib:fref b-%data%
                                            (i j)
                                            ((1 ldb$) (1 *))
                                            b-%offset%)
                             (* temp
                                (f2cl-lib:fref b-%data%
                                               (i j)
                                               ((1 ldb$) (1 *))
                                               b-%offset%)))))))))
          (t
           (cond
             (upper
```

```
(f2cl-lib:fdo (k n (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
              ((> k 1) nil)
  (tagbody
    (cond
      (nounit
       (setf temp
              (/ one
                 (f2cl-lib:fref a-%data%
                                (k k)
                                ((1 lda) (1 *))
                                a-%offset%)))
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i m) nil)
         (tagbody
           (setf (f2cl-lib:fref b-%data%
                                (i k)
                                ((1 ldb$) (1 *))
                                b-%offset%)
                 (* temp
                    (f2cl-lib:fref b-%data%
                                   (i k)
                                   ((1 ldb$) (1 *))
                                   b-%offset%)))))))
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j
                      (f2cl-lib:int-add k
                                        (f2cl-lib:int-sub 1)))
                   nil)
      (tagbody
        (cond
          ((/= (f2cl-lib:fref a (j k) ((1 lda) (1 *))) zero)
           (setf temp
                  (f2cl-lib:fref a-%data%
                                 (j k)
                                 ((1 lda) (1 *))
                                 a-%offset%))
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i m) nil)
             (tagbody
               (setf (f2cl-lib:fref b-%data%
                                    (i j)
                                    ((1 ldb$) (1 *))
                                    b-%offset%)
                     (-
                      (f2cl-lib:fref b-%data%
                                     (i j)
                                     ((1 ldb$) (1 *))
                                     b-%offset%)
                      (* temp
                         (f2cl-lib:fref b-%data%
```

```
                                        (i k)
                                        ((1 ldb$) (1 *))
                                        b-%offset%))))))))))
      (cond
        ((/= alpha one)
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i m) nil)
           (tagbody
             (setf (f2cl-lib:fref b-%data%
                                  (i k)
                                  ((1 ldb$) (1 *))
                                  b-%offset%)
                     (* alpha
                        (f2cl-lib:fref b-%data%
                                       (i k)
                                       ((1 ldb$) (1 *))
                                       b-%offset%)))))))
(t
 (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
               ((> k n) nil)
   (tagbody
     (cond
       (nounit
        (setf temp
                (/ one
                   (f2cl-lib:fref a-%data%
                                  (k k)
                                  ((1 lda) (1 *))
                                  a-%offset%)))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i m) nil)
          (tagbody
            (setf (f2cl-lib:fref b-%data%
                                 (i k)
                                 ((1 ldb$) (1 *))
                                 b-%offset%)
                    (* temp
                       (f2cl-lib:fref b-%data%
                                      (i k)
                                      ((1 ldb$) (1 *))
                                      b-%offset%)))))))
     (f2cl-lib:fdo (j (f2cl-lib:int-add k 1)
                    (f2cl-lib:int-add j 1))
                   ((> j n) nil)
       (tagbody
         (cond
           ((/= (f2cl-lib:fref a (j k) ((1 lda) (1 *))) zero)
            (setf temp
                    (f2cl-lib:fref a-%data%
                                   (j k)
```

```
                                        ((1 lda) (1 *))
                                        a-%offset%))
                          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                        ((> i m) nil)
                            (tagbody
                              (setf (f2cl-lib:fref b-%data%
                                                   (i j)
                                                   ((1 ldb$) (1 *))
                                                   b-%offset%)
                                    (-
                                     (f2cl-lib:fref b-%data%
                                                    (i j)
                                                    ((1 ldb$) (1 *))
                                                    b-%offset%)
                                     (* temp
                                        (f2cl-lib:fref b-%data%
                                                       (i k)
                                                       ((1 ldb$) (1 *))
                                                       b-%offset%)))))))))
                    (cond
                      ((/= alpha one)
                       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                     ((> i m) nil)
                         (tagbody
                           (setf (f2cl-lib:fref b-%data%
                                                (i k)
                                                ((1 ldb$) (1 *))
                                                b-%offset%)
                                 (* alpha
                                    (f2cl-lib:fref b-%data%
                                                   (i k)
                                                   ((1 ldb$) (1 *))
                                                   b-%offset%)))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil nil nil))))))
```

———-

5.7 zgemm BLAS

— zgemm.input —

```
)set break resume
)sys rm -f zgemm.output
)spool zgemm.output
)set message test on
```

```
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— zgemm.help —

```
=====================================================================
zgemm examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 NAME
      ZGEMM - perform one of the matrix-matrix operations   C :=
      alpha*op( A )*op( B ) + beta*C,

 SYNOPSIS
      SUBROUTINE ZGEMM ( TRANSA, TRANSB, M, N, K, ALPHA, A, LDA,
                         B, LDB, BETA, C, LDC )

          CHARACTER*1  TRANSA, TRANSB

          INTEGER      M, N, K, LDA, LDB, LDC

          COMPLEX*16   ALPHA, BETA

          COMPLEX*16   A( LDA, * ), B( LDB, * ), C( LDC, * )

 PURPOSE
      ZGEMM  performs one of the matrix-matrix operations

      where  op( X ) is one of

         op( X ) = X   or   op( X ) = X'   or   op( X ) = conjg(
      X' ),

      alpha and beta are scalars, and A, B and C are matrices,
      with op( A ) an m by k matrix,  op( B )  a  k by n matrix
      and  C an m by n matrix.

 PARAMETERS
      TRANSA - CHARACTER*1.  On entry, TRANSA specifies the form
      of op( A ) to be used in the matrix multiplication as fol-
```

```
     lows:

     TRANSA = 'N' or 'n',  op( A ) = A.

     TRANSA = 'T' or 't',  op( A ) = A'.

     TRANSA = 'C' or 'c',  op( A ) = conjg( A' ).

     Unchanged on exit.

     TRANSB - CHARACTER*1.  On entry, TRANSB specifies the form
     of op( B ) to be used in the matrix multiplication as fol-
     lows:

     TRANSB = 'N' or 'n',  op( B ) = B.

     TRANSB = 'T' or 't',  op( B ) = B'.

     TRANSB = 'C' or 'c',  op( B ) = conjg( B' ).

     Unchanged on exit.

     M      - INTEGER.
              On entry,  M  specifies  the number  of rows  of the
              matrix op( A )  and of the  matrix  C.  M  must  be
              at least  zero.  Unchanged on exit.

     N      - INTEGER.
              On entry,  N  specifies the number  of columns of the
              matrix op( B ) and the number of columns of the
              matrix C. N must be at least zero.  Unchanged on
              exit.

     K      - INTEGER.
              On entry,  K  specifies  the number of columns of the
              matrix op( A ) and the number of rows of the matrix
              op( B ). K must be at least  zero.  Unchanged on
              exit.

     ALPHA  - COMPLEX*16      .
              On entry, ALPHA specifies the scalar alpha.
              Unchanged on exit.

ka is
     A      -
              COMPLEX*16       array of DIMENSION ( LDA, ka ), where
              k  when  TRANSA = 'N' or 'n',  and is  m  otherwise.
              Before entry with  TRANSA = 'N' or 'n',  the leading
              m by k part of the array  A  must contain the matrix
              A,  otherwise the leading  k by m  part of the array
```

```
            A  must contain  the matrix A.  Unchanged on exit.

      LDA   - INTEGER.
            On entry, LDA specifies the first dimension of A as
            declared in the calling (sub) program. When  TRANSA =
            'N' or 'n' then LDA must be at least  max( 1, m ),
            otherwise  LDA must be at least  max( 1, k ).
            Unchanged on exit.

kb is
      B     -
             COMPLEX*16       array of DIMENSION ( LDB, kb ), where
            n  when  TRANSB = 'N' or 'n',  and is  k  otherwise.
            Before entry with  TRANSB = 'N' or 'n',  the leading
            k by n part of the array  B  must contain the matrix
            B,  otherwise the leading  n by k  part of the array
            B  must contain  the matrix B.  Unchanged on exit.

      LDB   - INTEGER.
            On entry, LDB specifies the first dimension of B as
            declared in the calling (sub) program. When  TRANSB =
            'N' or 'n' then LDB must be at least  max( 1, k ),

            otherwise  LDB must be at least  max( 1, n ).
            Unchanged on exit.

      BETA  - COMPLEX*16      .
            On entry,  BETA  specifies the scalar  beta.  When
            BETA  is supplied as zero then C need not be set on
            input.  Unchanged on exit.

      C     - COMPLEX*16       array of DIMENSION ( LDC, n ).
            Before entry, the leading  m by n  part of the array
            C must contain the matrix  C,  except when  beta  is
            zero, in which case C need not be set on entry.  On
            exit, the array  C  is overwritten by the  m by n
            matrix ( alpha*op( A )*op( B ) + beta*C ).

      LDC   - INTEGER.
            On entry, LDC specifies the first dimension of C as
            declared in  the  calling  (sub)  program.   LDC
            must  be  at  least max( 1, m ).  Unchanged on exit.
```

———-

— zgemm.f —

```
      SUBROUTINE ZGEMM ( TRANSA, TRANSB, M, N, K, ALPHA, A, LDA, B, LDB,
```

```
     $                   BETA, C, LDC )
*     .. Scalar Arguments ..
      CHARACTER*1         TRANSA, TRANSB
      INTEGER             M, N, K, LDA, LDB, LDC
      COMPLEX*16          ALPHA, BETA
*     .. Array Arguments ..
      COMPLEX*16          A( LDA, * ), B( LDB, * ), C( LDC, * )
*     ..
*
*  Level 3 Blas routine.
*
*  -- Written on 8-February-1989.
*     Jack Dongarra, Argonne National Laboratory.
*     Iain Duff, AERE Harwell.
*     Jeremy Du Croz, Numerical Algorithms Group Ltd.
*     Sven Hammarling, Numerical Algorithms Group Ltd.
*
*
*     .. External Functions ..
      LOGICAL             LSAME
      EXTERNAL            LSAME
*     .. External Subroutines ..
      EXTERNAL            XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC           DCONJG, MAX
*     .. Local Scalars ..
      LOGICAL             CONJA, CONJB, NOTA, NOTB
      INTEGER             I, INFO, J, L, NCOLA, NROWA, NROWB
      COMPLEX*16          TEMP
*     .. Parameters ..
      COMPLEX*16          ONE
      PARAMETER         ( ONE  = ( 1.0D+0, 0.0D+0 ) )
      COMPLEX*16          ZERO
      PARAMETER         ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     ..
*     .. Executable Statements ..
*
*     Set  NOTA  and  NOTB  as  true if  A  and  B  respectively are not
*     conjugated or transposed, set  CONJA and CONJB  as true if  A  and
*     B  respectively are to be  transposed but  not conjugated  and set
*     NROWA, NCOLA and  NROWB  as the number of rows and  columns  of  A
*     and the number of rows of  B  respectively.
*
      NOTA  = LSAME( TRANSA, 'N' )
      NOTB  = LSAME( TRANSB, 'N' )
      CONJA = LSAME( TRANSA, 'C' )
      CONJB = LSAME( TRANSB, 'C' )
      IF( NOTA )THEN
         NROWA = M
         NCOLA = K
```

```
      ELSE
         NROWA = K
         NCOLA = M
      END IF
      IF( NOTB )THEN
         NROWB = K
      ELSE
         NROWB = N
      END IF
*
*     Test the input parameters.
*
      INFO = 0
      IF(      ( .NOT.NOTA                 ).AND.
     $         ( .NOT.CONJA                ).AND.
     $         ( .NOT.LSAME( TRANSA, 'T' ) )      )THEN
         INFO = 1
      ELSE IF( ( .NOT.NOTB                 ).AND.
     $         ( .NOT.CONJB                ).AND.
     $         ( .NOT.LSAME( TRANSB, 'T' ) )      )THEN
         INFO = 2
      ELSE IF( M  .LT.0               )THEN
         INFO = 3
      ELSE IF( N  .LT.0               )THEN
         INFO = 4
      ELSE IF( K  .LT.0               )THEN
         INFO = 5
      ELSE IF( LDA.LT.MAX( 1, NROWA ) )THEN
         INFO = 8
      ELSE IF( LDB.LT.MAX( 1, NROWB ) )THEN
         INFO = 10
      ELSE IF( LDC.LT.MAX( 1, M     ) )THEN
         INFO = 13
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZGEMM ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( M.EQ.0 ).OR.( N.EQ.0 ).OR.
     $    ( ( ( ALPHA.EQ.ZERO ).OR.( K.EQ.0 ) ).AND.( BETA.EQ.ONE ) ) )
     $   RETURN
*
*     And when  alpha.eq.zero.
*
      IF( ALPHA.EQ.ZERO )THEN
         IF( BETA.EQ.ZERO )THEN
            DO 20, J = 1, N
```

```
               DO 10, I = 1, M
                  C( I, J ) = ZERO
   10          CONTINUE
   20       CONTINUE
         ELSE
            DO 40, J = 1, N
               DO 30, I = 1, M
                  C( I, J ) = BETA*C( I, J )
   30          CONTINUE
   40       CONTINUE
         END IF
         RETURN
      END IF
*
*     Start the operations.
*
      IF( NOTB )THEN
         IF( NOTA )THEN
*
*           Form  C := alpha*A*B + beta*C.
*
            DO 90, J = 1, N
               IF( BETA.EQ.ZERO )THEN
                  DO 50, I = 1, M
                     C( I, J ) = ZERO
   50             CONTINUE
               ELSE IF( BETA.NE.ONE )THEN
                  DO 60, I = 1, M
                     C( I, J ) = BETA*C( I, J )
   60             CONTINUE
               END IF
               DO 80, L = 1, K
                  IF( B( L, J ).NE.ZERO )THEN
                     TEMP = ALPHA*B( L, J )
                     DO 70, I = 1, M
                        C( I, J ) = C( I, J ) + TEMP*A( I, L )
   70                CONTINUE
                  END IF
   80          CONTINUE
   90       CONTINUE
         ELSE IF( CONJA )THEN
*
*           Form  C := alpha*conjg( A' )*B + beta*C.
*
            DO 120, J = 1, N
               DO 110, I = 1, M
                  TEMP = ZERO
                  DO 100, L = 1, K
                     TEMP = TEMP + DCONJG( A( L, I ) )*B( L, J )
  100             CONTINUE
```

```
                  IF( BETA.EQ.ZERO )THEN
                     C( I, J ) = ALPHA*TEMP
                  ELSE
                     C( I, J ) = ALPHA*TEMP + BETA*C( I, J )
                  END IF
  110          CONTINUE
  120       CONTINUE
         ELSE
*
*           Form  C := alpha*A'*B + beta*C
*
            DO 150, J = 1, N
               DO 140, I = 1, M
                  TEMP = ZERO
                  DO 130, L = 1, K
                     TEMP = TEMP + A( L, I )*B( L, J )
  130             CONTINUE
                  IF( BETA.EQ.ZERO )THEN
                     C( I, J ) = ALPHA*TEMP
                  ELSE
                     C( I, J ) = ALPHA*TEMP + BETA*C( I, J )
                  END IF
  140          CONTINUE
  150       CONTINUE
         END IF
      ELSE IF( NOTA )THEN
         IF( CONJB )THEN
*
*           Form  C := alpha*A*conjg( B' ) + beta*C.
*
            DO 200, J = 1, N
               IF( BETA.EQ.ZERO )THEN
                  DO 160, I = 1, M
                     C( I, J ) = ZERO
  160             CONTINUE
               ELSE IF( BETA.NE.ONE )THEN
                  DO 170, I = 1, M
                     C( I, J ) = BETA*C( I, J )
  170             CONTINUE
               END IF
               DO 190, L = 1, K
                  IF( B( J, L ).NE.ZERO )THEN
                     TEMP = ALPHA*DCONJG( B( J, L ) )
                     DO 180, I = 1, M
                        C( I, J ) = C( I, J ) + TEMP*A( I, L )
  180                CONTINUE
                  END IF
  190          CONTINUE
  200       CONTINUE
         ELSE
```

```
*
*           Form  C := alpha*A*B'          + beta*C
*
            DO 250, J = 1, N
               IF( BETA.EQ.ZERO )THEN
                  DO 210, I = 1, M
                     C( I, J ) = ZERO
  210             CONTINUE
               ELSE IF( BETA.NE.ONE )THEN
                  DO 220, I = 1, M
                     C( I, J ) = BETA*C( I, J )
  220             CONTINUE
               END IF
               DO 240, L = 1, K
                  IF( B( J, L ).NE.ZERO )THEN
                     TEMP = ALPHA*B( J, L )
                     DO 230, I = 1, M
                        C( I, J ) = C( I, J ) + TEMP*A( I, L )
  230                CONTINUE
                  END IF
  240          CONTINUE
  250       CONTINUE
         END IF
      ELSE IF( CONJA )THEN
         IF( CONJB )THEN
*
*           Form  C := alpha*conjg( A' )*conjg( B' ) + beta*C.
*
            DO 280, J = 1, N
               DO 270, I = 1, M
                  TEMP = ZERO
                  DO 260, L = 1, K
                     TEMP = TEMP +
     $                    DCONJG( A( L, I ) )*DCONJG( B( J, L ) )
  260             CONTINUE
                  IF( BETA.EQ.ZERO )THEN
                     C( I, J ) = ALPHA*TEMP
                  ELSE
                     C( I, J ) = ALPHA*TEMP + BETA*C( I, J )
                  END IF
  270          CONTINUE
  280       CONTINUE
         ELSE
*
*           Form  C := alpha*conjg( A' )*B' + beta*C
*
            DO 310, J = 1, N
               DO 300, I = 1, M
                  TEMP = ZERO
                  DO 290, L = 1, K
```

```
                  TEMP = TEMP + DCONJG( A( L, I ) )*B( J, L )
  290             CONTINUE
                  IF( BETA.EQ.ZERO )THEN
                     C( I, J ) = ALPHA*TEMP
                  ELSE
                     C( I, J ) = ALPHA*TEMP + BETA*C( I, J )
                  END IF
  300          CONTINUE
  310       CONTINUE
         END IF
      ELSE
         IF( CONJB )THEN
*
*           Form  C := alpha*A'*conjg( B' ) + beta*C
*
            DO 340, J = 1, N
               DO 330, I = 1, M
                  TEMP = ZERO
                  DO 320, L = 1, K
                     TEMP = TEMP + A( L, I )*DCONJG( B( J, L ) )
  320             CONTINUE
                  IF( BETA.EQ.ZERO )THEN
                     C( I, J ) = ALPHA*TEMP
                  ELSE
                     C( I, J ) = ALPHA*TEMP + BETA*C( I, J )
                  END IF
  330          CONTINUE
  340       CONTINUE
         ELSE
*
*           Form  C := alpha*A'*B' + beta*C
*
            DO 370, J = 1, N
               DO 360, I = 1, M
                  TEMP = ZERO
                  DO 350, L = 1, K
                     TEMP = TEMP + A( L, I )*B( J, L )
  350             CONTINUE
                  IF( BETA.EQ.ZERO )THEN
                     C( I, J ) = ALPHA*TEMP
                  ELSE
                     C( I, J ) = ALPHA*TEMP + BETA*C( I, J )
                  END IF
  360          CONTINUE
  370       CONTINUE
         END IF
      END IF
*
      RETURN
*
```

```
*     End of ZGEMM .
*
      END
```

— BLAS 3 zgemm —

```
(let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
 (declare (type (complex double-float) one) (type (complex double-float) zero))
  (defun zgemm (transa transb m n k alpha a lda b ldb$ beta c ldc)
    (declare (type (simple-array (complex double-float) (*)) c b a)
             (type (complex double-float) beta alpha)
             (type fixnum ldc ldb$ lda k n m)
             (type character transb transa))
    (f2cl-lib:with-multi-array-data
        ((transa character transa-%data% transa-%offset%)
         (transb character transb-%data% transb-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (b (complex double-float) b-%data% b-%offset%)
         (c (complex double-float) c-%data% c-%offset%))
      (prog ((temp #C(0.0 0.0)) (i 0) (info 0) (j 0) (l 0) (ncola 0) (nrowa 0)
             (nrowb 0) (conja nil) (conjb nil) (nota nil) (notb nil))
        (declare (type (complex double-float) temp)
                 (type fixnum i info j l ncola nrowa nrowb)
                 (type (member t nil) conja conjb nota notb))
        (setf nota (char-equal transa #\N))
        (setf notb (char-equal transb #\N))
        (setf conja (char-equal transa #\C))
        (setf conjb (char-equal transb #\C))
        (cond
          (nota
           (setf nrowa m)
           (setf ncola k))
          (t
           (setf nrowa k)
           (setf ncola m)))
        (cond
          (notb
           (setf nrowb k))
          (t
           (setf nrowb n)))
        (setf info 0)
        (cond
          ((and (not nota) (not conja) (not (char-equal transa #\T)))
           (setf info 1))
          ((and (not notb) (not conjb) (not (char-equal transb #\T)))
           (setf info 2))
```

```
  ((< m 0)
   (setf info 3))
  ((< n 0)
   (setf info 4))
  ((< k 0)
   (setf info 5))
  ((< lda (max (the fixnum 1) (the fixnum nrowa)))
   (setf info 8))
  ((< ldb$
      (max (the fixnum 1) (the fixnum nrowb)))
   (setf info 10))
  ((< ldc (max (the fixnum 1) (the fixnum m)))
   (setf info 13)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "ZGEMM" info)
   (go end_label)))
(if (or (= m 0) (= n 0) (and (or (= alpha zero) (= k 0)) (= beta one)))
    (go end_label))
(cond
  ((= alpha zero)
   (cond
     ((= beta zero)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref c-%data%
                                   (i j)
                                   ((1 ldc) (1 *))
                                   c-%offset%)
                    zero))))))
     (t
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref c-%data%
                                   (i j)
                                   ((1 ldc) (1 *))
                                   c-%offset%)
                    (* beta
                       (f2cl-lib:fref c-%data%
                                      (i j)
```

```
                                        ((1 ldc) (1 *))
                                        c-%offset%))))))))))
   (go end_label)))
(cond
  (notb
   (cond
     (nota
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (cond
            ((= beta zero)
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i m) nil)
               (tagbody
                 (setf (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       zero))))
            ((/= beta one)
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i m) nil)
               (tagbody
                 (setf (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (* beta
                          (f2cl-lib:fref c-%data%
                                         (i j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)))))))
          (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                        ((> l k) nil)
            (tagbody
              (cond
                ((/= (f2cl-lib:fref b (l j) ((1 ldb$) (1 *))) zero)
                 (setf temp
                         (* alpha
                            (f2cl-lib:fref b-%data%
                                           (l j)
                                           ((1 ldb$) (1 *))
                                           b-%offset%)))
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                               ((> i m) nil)
                   (tagbody
                     (setf (f2cl-lib:fref c-%data%
                                          (i j)
                                          ((1 ldc) (1 *))
```

```
                                        c-%offset%)
                                (+
                                 (f2cl-lib:fref c-%data%
                                                (i j)
                                                ((1 ldc) (1 *))
                                                c-%offset%)
                                 (* temp
                                    (f2cl-lib:fref a-%data%
                                                   (i l)
                                                   ((1 lda) (1 *))
                                                   a-%offset%)))))))))))))
(conja
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                   ((> i m) nil)
       (tagbody
         (setf temp zero)
         (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                       ((> l k) nil)
           (tagbody
             (setf temp
                     (+ temp
                        (*
                         (f2cl-lib:dconjg
                          (f2cl-lib:fref a-%data%
                                         (l i)
                                         ((1 lda) (1 *))
                                         a-%offset%))
                         (f2cl-lib:fref b-%data%
                                        (l j)
                                        ((1 ldb$) (1 *))
                                        b-%offset%))))))
         (cond
           ((= beta zero)
            (setf (f2cl-lib:fref c-%data%
                                 (i j)
                                 ((1 ldc) (1 *))
                                 c-%offset%)
                  (* alpha temp)))
           (t
            (setf (f2cl-lib:fref c-%data%
                                 (i j)
                                 ((1 ldc) (1 *))
                                 c-%offset%)
                  (+ (* alpha temp)
                     (* beta
                        (f2cl-lib:fref c-%data%
                                       (i j)
```

```
                                                ((1 ldc) (1 *))
                                                c-%offset%))))))))))))
                    (t
                     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                                   ((> j n) nil)
                       (tagbody
                         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                       ((> i m) nil)
                           (tagbody
                             (setf temp zero)
                             (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                                           ((> l k) nil)
                               (tagbody
                                 (setf temp
                                         (+ temp
                                            (*
                                             (f2cl-lib:fref a-%data%
                                                            (l i)
                                                            ((1 lda) (1 *))
                                                            a-%offset%)
                                             (f2cl-lib:fref b-%data%
                                                            (l j)
                                                            ((1 ldb$) (1 *))
                                                            b-%offset%))))))
                             (cond
                               ((= beta zero)
                                (setf (f2cl-lib:fref c-%data%
                                                     (i j)
                                                     ((1 ldc) (1 *))
                                                     c-%offset%)
                                      (* alpha temp)))
                               (t
                                (setf (f2cl-lib:fref c-%data%
                                                     (i j)
                                                     ((1 ldc) (1 *))
                                                     c-%offset%)
                                      (+ (* alpha temp)
                                         (* beta
                                            (f2cl-lib:fref c-%data%
                                                           (i j)
                                                           ((1 ldc) (1 *))
                                                           c-%offset%))))))))))))
                (nota
                 (cond
                   (conjb
                    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                                  ((> j n) nil)
                      (tagbody
                        (cond
                          ((= beta zero)
```

```
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i m) nil)
     (tagbody
       (setf (f2cl-lib:fref c-%data%
                            (i j)
                            ((1 ldc) (1 *))
                            c-%offset%)
                zero))))
  ((/= beta one)
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i m) nil)
     (tagbody
       (setf (f2cl-lib:fref c-%data%
                            (i j)
                            ((1 ldc) (1 *))
                            c-%offset%)
               (* beta
                  (f2cl-lib:fref c-%data%
                                 (i j)
                                 ((1 ldc) (1 *))
                                 c-%offset%)))))))
(f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
              ((> l k) nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref b (j l) ((1 ldb$) (1 *))) zero)
       (setf temp
               (* alpha
                  (f2cl-lib:dconjg
                   (f2cl-lib:fref b-%data%
                                  (j l)
                                  ((1 ldb$) (1 *))
                                  b-%offset%))))
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i m) nil)
         (tagbody
           (setf (f2cl-lib:fref c-%data%
                                (i j)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (+
                  (f2cl-lib:fref c-%data%
                                 (i j)
                                 ((1 ldc) (1 *))
                                 c-%offset%)
                  (* temp
                     (f2cl-lib:fref a-%data%
                                    (i l)
                                    ((1 lda) (1 *))
                                    a-%offset%)))))))))))
```

```
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (cond
       ((= beta zero)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i m) nil)
          (tagbody
            (setf (f2cl-lib:fref c-%data%
                                 (i j)
                                 ((1 ldc) (1 *))
                                 c-%offset%)
                  zero))))
       ((/= beta one)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i m) nil)
          (tagbody
            (setf (f2cl-lib:fref c-%data%
                                 (i j)
                                 ((1 ldc) (1 *))
                                 c-%offset%)
                  (* beta
                     (f2cl-lib:fref c-%data%
                                    (i j)
                                    ((1 ldc) (1 *))
                                    c-%offset%)))))))
     (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                   ((> l k) nil)
       (tagbody
         (cond
           ((/= (f2cl-lib:fref b (j l) ((1 ldb$) (1 *))) zero)
            (setf temp
                    (* alpha
                       (f2cl-lib:fref b-%data%
                                      (j l)
                                      ((1 ldb$) (1 *))
                                      b-%offset%)))
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          ((> i m) nil)
              (tagbody
                (setf (f2cl-lib:fref c-%data%
                                     (i j)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (+
                       (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
```

```
                              (* temp
                                 (f2cl-lib:fref a-%data%
                                           (i l)
                                           ((1 lda) (1 *))
                                           a-%offset%))))))))))))))))
          (conja
           (cond
             (conjb
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
                (tagbody
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                ((> i m) nil)
                    (tagbody
                      (setf temp zero)
                      (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                                    ((> l k) nil)
                        (tagbody
                          (setf temp
                                  (+ temp
                                     (*
                                      (f2cl-lib:dconjg
                                       (f2cl-lib:fref a-%data%
                                                      (l i)
                                                      ((1 lda) (1 *))
                                                      a-%offset%))
                                      (f2cl-lib:dconjg
                                       (f2cl-lib:fref b-%data%
                                                      (j l)
                                                      ((1 ldb$) (1 *))
                                                      b-%offset%)))))))
                      (cond
                        ((= beta zero)
                         (setf (f2cl-lib:fref c-%data%
                                              (i j)
                                              ((1 ldc) (1 *))
                                              c-%offset%)
                                 (* alpha temp)))
                        (t
                         (setf (f2cl-lib:fref c-%data%
                                              (i j)
                                              ((1 ldc) (1 *))
                                              c-%offset%)
                                 (+ (* alpha temp)
                                    (* beta
                                       (f2cl-lib:fref c-%data%
                                                      (i j)
                                                      ((1 ldc) (1 *))
                                                      c-%offset%)))))))))))
             (t
```

```
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i m) nil)
            (tagbody
              (setf temp zero)
              (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                            ((> l k) nil)
                (tagbody
                  (setf temp
                          (+ temp
                             (*
                              (f2cl-lib:dconjg
                               (f2cl-lib:fref a-%data%
                                              (l i)
                                              ((1 lda) (1 *))
                                              a-%offset%))
                              (f2cl-lib:fref b-%data%
                                             (j l)
                                             ((1 ldb$) (1 *))
                                             b-%offset%))))))
              (cond
                ((= beta zero)
                 (setf (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (* alpha temp)))
                (t
                 (setf (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (+ (* alpha temp)
                          (* beta
                             (f2cl-lib:fref c-%data%
                                            (i j)
                                            ((1 ldc) (1 *))
                                            c-%offset%)))))))))))
    (t
     (cond
       (conjb
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                      ((> j n) nil)
          (tagbody
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          ((> i m) nil)
              (tagbody
                (setf temp zero)
```

```
            (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                          ((> l k) nil)
              (tagbody
                (setf temp
                        (+ temp
                           (*
                            (f2cl-lib:fref a-%data%
                                           (l i)
                                           ((1 lda) (1 *))
                                           a-%offset%)
                            (f2cl-lib:dconjg
                             (f2cl-lib:fref b-%data%
                                            (j l)
                                            ((1 ldb$) (1 *))
                                            b-%offset%)))))))
            (cond
              ((= beta zero)
               (setf (f2cl-lib:fref c-%data%
                                    (i j)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                       (* alpha temp)))
              (t
               (setf (f2cl-lib:fref c-%data%
                                    (i j)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                       (+ (* alpha temp)
                          (* beta
                             (f2cl-lib:fref c-%data%
                                            (i j)
                                            ((1 ldc) (1 *))
                                            c-%offset%)))))))))
      (t
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i m) nil)
             (tagbody
               (setf temp zero)
               (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                             ((> l k) nil)
                 (tagbody
                   (setf temp
                           (+ temp
                              (*
                               (f2cl-lib:fref a-%data%
                                              (l i)
                                              ((1 lda) (1 *))
```

```
                                                a-%offset%)
                                      (f2cl-lib:fref b-%data%
                                                     (j l)
                                                     ((1 ldb$) (1 *))
                                                     b-%offset%))))))
                            (cond
                              ((= beta zero)
                               (setf (f2cl-lib:fref c-%data%
                                                    (i j)
                                                    ((1 ldc) (1 *))
                                                    c-%offset%)
                                     (* alpha temp)))
                              (t
                               (setf (f2cl-lib:fref c-%data%
                                                    (i j)
                                                    ((1 ldc) (1 *))
                                                    c-%offset%)
                                     (+ (* alpha temp)
                                        (* beta
                                           (f2cl-lib:fref c-%data%
                                                          (i j)
                                                          ((1 ldc) (1 *))
                                                          c-%offset%))))))))))))
 end_label
        (return
         (values nil nil nil nil nil nil nil nil nil nil nil nil nil))))))
```

———-

5.8 zhemm BLAS

— **zhemm.input** —

```
)set break resume
)sys rm -f zhemm.output
)spool zhemm.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zhemm.help** —

```
=====================================================================
zhemm examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 NAME
      ZHEMM - perform one of the matrix-matrix operations   C :=
      alpha*A*B + beta*C,

 SYNOPSIS
      SUBROUTINE ZHEMM ( SIDE, UPLO, M, N, ALPHA, A, LDA, B, LDB,
                         BETA, C, LDC )

          CHARACTER*1  SIDE, UPLO

          INTEGER      M, N, LDA, LDB, LDC

          COMPLEX*16   ALPHA, BETA

          COMPLEX*16   A( LDA, * ), B( LDB, * ), C( LDC, * )

 PURPOSE
      ZHEMM  performs one of the matrix-matrix operations

      or

         C := alpha*B*A + beta*C,

      where alpha and beta are scalars, A is an hermitian matrix
      and  B and C are m by n matrices.

 PARAMETERS
      SIDE   - CHARACTER*1.
               On entry,  SIDE  specifies whether  the  hermitian
               matrix  A appears on the  left or right  in the
               operation as follows:

               SIDE = 'L' or 'l'   C := alpha*A*B + beta*C,

               SIDE = 'R' or 'r'   C := alpha*B*A + beta*C,

               Unchanged on exit.

      UPLO   - CHARACTER*1.
               On  entry,   UPLO  specifies  whether  the  upper  or
               lower triangular  part  of  the  hermitian  matrix
               A  is  to  be referenced as follows:
```

```
          UPLO = 'U' or 'u'   Only the upper triangular part of
          the hermitian matrix is to be referenced.

          UPLO = 'L' or 'l'   Only the lower triangular part of
          the hermitian matrix is to be referenced.

          Unchanged on exit.

     M    - INTEGER.
          On entry,  M  specifies the number of rows of the
          matrix  C.  M  must be at least zero.  Unchanged on
          exit.

     N    - INTEGER.
          On entry, N specifies the number of columns of the
          matrix C.  N  must be at least zero.  Unchanged on
          exit.

     ALPHA - COMPLEX*16      .
          On entry, ALPHA specifies the scalar alpha.
          Unchanged on exit.

ka is
     A    -
           COMPLEX*16       array of DIMENSION ( LDA, ka ), where
          m  when  SIDE = 'L' or 'l'  and is n  otherwise.
          Before entry  with  SIDE = 'L' or 'l',  the  m by m
          part of the array  A  must contain the  hermitian
          matrix,  such that when  UPLO = 'U' or 'u', the lead-
          ing m by m upper triangular part of the array  A
          must contain the upper triangular part of the  hermi-
          tian matrix and the  strictly  lower triangular part
          of  A  is not referenced,  and when  UPLO = 'L' or
          'l', the leading  m by m  lower triangular part  of
          the  array  A must  contain  the  lower triangular
          part  of the  hermitian matrix and the  strictly
          upper triangular part of  A  is not referenced.
          Before entry  with  SIDE = 'R' or 'r',  the  n by n
          part of the array  A  must contain the  hermitian
          matrix,  such that when  UPLO = 'U' or 'u', the lead-
          ing n by n upper triangular part of the array  A
          must contain the upper triangular part of the  hermi-
          tian matrix and the  strictly  lower triangular part
          of  A  is not referenced,  and when  UPLO = 'L' or
          'l', the leading  n by n  lower triangular part  of
          the  array  A must  contain  the  lower triangular
          part  of the  hermitian matrix and the  strictly
          upper triangular part of  A  is not referenced.  Note
          that the imaginary parts  of the diagonal elements
```

```
              need not be set, they are assumed to be zero.
              Unchanged on exit.

      LDA     - INTEGER.
              On entry, LDA specifies the first dimension of A as
              declared in the  calling (sub) program. When  SIDE =
              'L' or 'l'  then LDA must be at least  max( 1, m ),
              otherwise  LDA must be at least max( 1, n ).
              Unchanged on exit.

      B       - COMPLEX*16       array of DIMENSION ( LDB, n ).

              Before entry, the leading  m by n part of the array
              B  must contain the matrix B.  Unchanged on exit.

      LDB     - INTEGER.
              On entry, LDB specifies the first dimension of B as
              declared in  the  calling  (sub)  program.   LDB
              must  be  at  least max( 1, m ).  Unchanged on exit.

      BETA    - COMPLEX*16      .
              On entry,  BETA  specifies the scalar  beta.  When
              BETA  is supplied as zero then C need not be set on
              input.  Unchanged on exit.

      C       - COMPLEX*16       array of DIMENSION ( LDC, n ).
              Before entry, the leading  m by n  part of the array
              C must contain the matrix  C,  except when  beta  is
              zero, in which case C need not be set on entry.  On
              exit, the array  C  is overwritten by the  m by n
              updated matrix.

      LDC     - INTEGER.
              On entry, LDC specifies the first dimension of C as
              declared in  the  calling  (sub)  program.   LDC
              must  be  at  least max( 1, m ).  Unchanged on exit.


              ________-
```

— zhemm.f —

```
      SUBROUTINE ZHEMM ( SIDE, UPLO, M, N, ALPHA, A, LDA, B, LDB,
     $                   BETA, C, LDC )
*     .. Scalar Arguments ..
      CHARACTER*1        SIDE, UPLO
      INTEGER            M, N, LDA, LDB, LDC
      COMPLEX*16         ALPHA, BETA
*     .. Array Arguments ..
```

```
      COMPLEX*16         A( LDA, * ), B( LDB, * ), C( LDC, * )
*     ..
*
*  Level 3 Blas routine.
*
*  -- Written on 8-February-1989.
*     Jack Dongarra, Argonne National Laboratory.
*     Iain Duff, AERE Harwell.
*     Jeremy Du Croz, Numerical Algorithms Group Ltd.
*     Sven Hammarling, Numerical Algorithms Group Ltd.
*
*
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG, MAX, DBLE
*     .. Local Scalars ..
      LOGICAL            UPPER
      INTEGER            I, INFO, J, K, NROWA
      COMPLEX*16         TEMP1, TEMP2
*     .. Parameters ..
      COMPLEX*16         ONE
      PARAMETER        ( ONE  = ( 1.0D+0, 0.0D+0 ) )
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     ..
*     .. Executable Statements ..
*
*     Set NROWA as the number of rows of A.
*
      IF( LSAME( SIDE, 'L' ) )THEN
         NROWA = M
      ELSE
         NROWA = N
      END IF
      UPPER = LSAME( UPLO, 'U' )
*
*     Test the input parameters.
*
      INFO = 0
      IF(      ( .NOT.LSAME( SIDE, 'L' ) ).AND.
     $         ( .NOT.LSAME( SIDE, 'R' ) )      )THEN
         INFO = 1
      ELSE IF( ( .NOT.UPPER              ).AND.
     $         ( .NOT.LSAME( UPLO, 'L' ) )      )THEN
         INFO = 2
      ELSE IF( M  .LT.0               )THEN
```

```
         INFO = 3
      ELSE IF( N  .LT.0               )THEN
         INFO = 4
      ELSE IF( LDA.LT.MAX( 1, NROWA ) )THEN
         INFO = 7
      ELSE IF( LDB.LT.MAX( 1, M     ) )THEN
         INFO = 9
      ELSE IF( LDC.LT.MAX( 1, M     ) )THEN
         INFO = 12
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZHEMM ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( M.EQ.0 ).OR.( N.EQ.0 ).OR.
     $    ( ( ALPHA.EQ.ZERO ).AND.( BETA.EQ.ONE ) ) )
     $   RETURN
*
*     And when  alpha.eq.zero.
*
      IF( ALPHA.EQ.ZERO )THEN
         IF( BETA.EQ.ZERO )THEN
            DO 20, J = 1, N
               DO 10, I = 1, M
                  C( I, J ) = ZERO
   10          CONTINUE
   20       CONTINUE
         ELSE
            DO 40, J = 1, N
               DO 30, I = 1, M
                  C( I, J ) = BETA*C( I, J )
   30          CONTINUE
   40       CONTINUE
         END IF
         RETURN
      END IF
*
*     Start the operations.
*
      IF( LSAME( SIDE, 'L' ) )THEN
*
*        Form  C := alpha*A*B + beta*C.
*
         IF( UPPER )THEN
            DO 70, J = 1, N
               DO 60, I = 1, M
                  TEMP1 = ALPHA*B( I, J )
```

```
                  TEMP2 = ZERO
                  DO 50, K = 1, I - 1
                     C( K, J ) = C( K, J ) + TEMP1*A( K, I )
                     TEMP2     = TEMP2     +
     $                           B( K, J )*DCONJG( A( K, I ) )
   50             CONTINUE
                  IF( BETA.EQ.ZERO )THEN
                     C( I, J ) = TEMP1*DBLE( A( I, I ) ) +
     $                           ALPHA*TEMP2
                  ELSE
                     C( I, J ) = BETA *C( I, J )         +
     $                           TEMP1*DBLE( A( I, I ) ) +
     $                           ALPHA*TEMP2
                  END IF
   60          CONTINUE
   70       CONTINUE
         ELSE
            DO 100, J = 1, N
               DO 90, I = M, 1, -1
                  TEMP1 = ALPHA*B( I, J )
                  TEMP2 = ZERO
                  DO 80, K = I + 1, M
                     C( K, J ) = C( K, J ) + TEMP1*A( K, I )
                     TEMP2     = TEMP2     +
     $                           B( K, J )*DCONJG( A( K, I ) )
   80             CONTINUE
                  IF( BETA.EQ.ZERO )THEN
                     C( I, J ) = TEMP1*DBLE( A( I, I ) ) +
     $                           ALPHA*TEMP2
                  ELSE
                     C( I, J ) = BETA *C( I, J )         +
     $                           TEMP1*DBLE( A( I, I ) ) +
     $                           ALPHA*TEMP2
                  END IF
   90          CONTINUE
  100       CONTINUE
         END IF
      ELSE
*
*        Form  C := alpha*B*A + beta*C.
*
         DO 170, J = 1, N
            TEMP1 = ALPHA*DBLE( A( J, J ) )
            IF( BETA.EQ.ZERO )THEN
               DO 110, I = 1, M
                  C( I, J ) = TEMP1*B( I, J )
  110          CONTINUE
            ELSE
               DO 120, I = 1, M
                  C( I, J ) = BETA*C( I, J ) + TEMP1*B( I, J )
```

```
  120          CONTINUE
               END IF
               DO 140, K = 1, J - 1
                  IF( UPPER )THEN
                     TEMP1 = ALPHA*A( K, J )
                  ELSE
                     TEMP1 = ALPHA*DCONJG( A( J, K ) )
                  END IF
                  DO 130, I = 1, M
                     C( I, J ) = C( I, J ) + TEMP1*B( I, K )
  130             CONTINUE
  140          CONTINUE
               DO 160, K = J + 1, N
                  IF( UPPER )THEN
                     TEMP1 = ALPHA*DCONJG( A( J, K ) )
                  ELSE
                     TEMP1 = ALPHA*A( K, J )
                  END IF
                  DO 150, I = 1, M
                     C( I, J ) = C( I, J ) + TEMP1*B( I, K )
  150             CONTINUE
  160          CONTINUE
  170       CONTINUE
         END IF
*
         RETURN
*
*     End of ZHEMM .
*
         END
```

———-

— BLAS 3 zhemm —

```
(let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
 (declare (type (complex double-float) one) (type (complex double-float) zero))
  (defun zhemm (side uplo m n alpha a lda b ldb$ beta c ldc)
    (declare (type (simple-array (complex double-float) (*)) c b a)
             (type (complex double-float) beta alpha)
             (type fixnum ldc ldb$ lda n m)
             (type character uplo side))
    (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (uplo character uplo-%data% uplo-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (b (complex double-float) b-%data% b-%offset%)
         (c (complex double-float) c-%data% c-%offset%))
```

```
(prog ((temp1 #C(0.0 0.0)) (temp2 #C(0.0 0.0)) (i 0) (info 0) (j 0) (k 0)
       (nrowa 0) (upper nil))
  (declare (type (complex double-float) temp1 temp2)
           (type fixnum i info j k nrowa)
           (type (member t nil) upper))
  (cond
    ((char-equal side #\L)
     (setf nrowa m))
    (t
     (setf nrowa n)))
  (setf upper (char-equal uplo #\U))
  (setf info 0)
  (cond
    ((and (not (char-equal side #\L)) (not (char-equal side #\R)))
     (setf info 1))
    ((and (not upper) (not (char-equal uplo #\L)))
     (setf info 2))
    ((< m 0)
     (setf info 3))
    ((< n 0)
     (setf info 4))
    ((< lda (max (the fixnum 1) (the fixnum nrowa)))
     (setf info 7))
    ((< ldb$ (max (the fixnum 1) (the fixnum m)))
     (setf info 9))
    ((< ldc (max (the fixnum 1) (the fixnum m)))
     (setf info 12)))
  (cond
    ((/= info 0)
     (error
      " ** On entry to ~a parameter number ~a had an illegal value~%"
      "ZHEMM" info)
     (go end_label)))
  (if (or (= m 0) (= n 0) (and (= alpha zero) (= beta one)))
      (go end_label))
  (cond
    ((= alpha zero)
     (cond
       ((= beta zero)
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                      ((> j n) nil)
          (tagbody
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          ((> i m) nil)
              (tagbody
                (setf (f2cl-lib:fref c-%data%
                                     (i j)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      zero))))))))
```

```
          (t
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                             ((> i m) nil)
                 (tagbody
                   (setf (f2cl-lib:fref c-%data%
                                        (i j)
                                        ((1 ldc) (1 *))
                                        c-%offset%)
                           (* beta
                              (f2cl-lib:fref c-%data%
                                             (i j)
                                             ((1 ldc) (1 *))
                                             c-%offset%)))))))))
     (go end_label)))
  (cond
    ((char-equal side #\L)
     (cond
       (upper
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                      ((> j n) nil)
          (tagbody
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          ((> i m) nil)
              (tagbody
                (setf temp1
                        (* alpha
                           (f2cl-lib:fref b-%data%
                                          (i j)
                                          ((1 ldb$) (1 *))
                                          b-%offset%)))
                (setf temp2 zero)
                (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                              ((> k
                                  (f2cl-lib:int-add i
                                                    (f2cl-lib:int-sub
                                                     1)))
                               nil)
                  (tagbody
                    (setf (f2cl-lib:fref c-%data%
                                         (k j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                            (+
                             (f2cl-lib:fref c-%data%
                                            (k j)
                                            ((1 ldc) (1 *))
                                            c-%offset%)
```

```
                                (* temp1
                                   (f2cl-lib:fref a-%data%
                                                  (k i)
                                                  ((1 lda) (1 *))
                                                  a-%offset%))))
                            (setf temp2
                                    (+ temp2
                                       (*
                                        (f2cl-lib:fref b-%data%
                                                       (k j)
                                                       ((1 ldb$) (1 *))
                                                       b-%offset%)
                                        (f2cl-lib:dconjg
                                         (f2cl-lib:fref a-%data%
                                                        (k i)
                                                        ((1 lda) (1 *))
                                                        a-%offset%)))))))
                          (cond
                            ((= beta zero)
                             (setf
                              (f2cl-lib:fref c-%data% (i j) ((1 ldc) (1 *))
                                             c-%offset%)
                              (+
                               (* temp1
                                (coerce (realpart
                                 (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *))
                                                a-%offset%))
                                   'double-float))
                               (* alpha temp2))))
                            (t
                             (setf (f2cl-lib:fref c-%data%
                                                  (i j)
                                                  ((1 ldc) (1 *))
                                                  c-%offset%)
                                     (+
                                      (* beta
                                         (f2cl-lib:fref c-%data%
                                                        (i j)
                                                        ((1 ldc) (1 *))
                                                        c-%offset%))
                                      (* temp1
                                         (coerce (realpart
                                          (f2cl-lib:fref a-%data%
                                                    (i i)
                                                    ((1 lda) (1 *))
                                                    a-%offset%)) 'double-float))

                                      (* alpha temp2)))))))))
                        (t
                         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
```

```
            ((> j n) nil)
(tagbody
  (f2cl-lib:fdo (i m (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                ((> i 1) nil)
    (tagbody
      (setf temp1
              (* alpha
                 (f2cl-lib:fref b-%data%
                                (i j)
                                ((1 ldb$) (1 *))
                                b-%offset%)))
      (setf temp2 zero)
      (f2cl-lib:fdo (k (f2cl-lib:int-add i 1)
                       (f2cl-lib:int-add k 1))
                    ((> k m) nil)
        (tagbody
          (setf (f2cl-lib:fref c-%data%
                               (k j)
                               ((1 ldc) (1 *))
                               c-%offset%)
                (+
                 (f2cl-lib:fref c-%data%
                                (k j)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* temp1
                    (f2cl-lib:fref a-%data%
                                   (k i)
                                   ((1 lda) (1 *))
                                   a-%offset%))))
          (setf temp2
                  (+ temp2
                     (*
                      (f2cl-lib:fref b-%data%
                                     (k j)
                                     ((1 ldb$) (1 *))
                                     b-%offset%)
                      (f2cl-lib:dconjg
                       (f2cl-lib:fref a-%data%
                                      (k i)
                                      ((1 lda) (1 *))
                                      a-%offset%)))))))
      (cond
        ((= beta zero)
         (setf (f2cl-lib:fref c-%data%
                              (i j)
                              ((1 ldc) (1 *))
                              c-%offset%)
                (+
                 (* temp1
```

```
                                (coerce (realpart
                                 (f2cl-lib:fref a-%data%
                                           (i i)
                                           ((1 lda) (1 *))
                                           a-%offset%)) 'double-float))
                               (* alpha temp2))))
                        (t
                         (setf (f2cl-lib:fref c-%data%
                                              (i j)
                                              ((1 ldc) (1 *))
                                              c-%offset%)
                               (+
                                (* beta
                                   (f2cl-lib:fref c-%data%
                                                  (i j)
                                                  ((1 ldc) (1 *))
                                                  c-%offset%))
                                (* temp1
                                   (coerce (realpart
                                    (f2cl-lib:fref a-%data%
                                              (i i)
                                              ((1 lda) (1 *))
                                              a-%offset%)) 'double-float))
                                (* alpha temp2)))))))))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (setf temp1
             (* alpha
                (coerce (realpart
                 (f2cl-lib:fref a-%data%
                                (j j)
                                ((1 lda) (1 *))
                                a-%offset%)) 'double-float)))
     (cond
       ((= beta zero)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i m) nil)
          (tagbody
            (setf (f2cl-lib:fref c-%data%
                                 (i j)
                                 ((1 ldc) (1 *))
                                 c-%offset%)
                  (* temp1
                     (f2cl-lib:fref b-%data%
                                    (i j)
                                    ((1 ldb$) (1 *))
                                    b-%offset%))))))
       (t
```

```
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i m) nil)
     (tagbody
       (setf (f2cl-lib:fref c-%data%
                            (i j)
                            ((1 ldc) (1 *))
                            c-%offset%)
                (+
                 (* beta
                    (f2cl-lib:fref c-%data%
                                   (i j)
                                   ((1 ldc) (1 *))
                                   c-%offset%))
                 (* temp1
                    (f2cl-lib:fref b-%data%
                                   (i j)
                                   ((1 ldb$) (1 *))
                                   b-%offset%))))))))
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
              ((> k (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
               nil)
  (tagbody
    (cond
      (upper
       (setf temp1
                (* alpha
                   (f2cl-lib:fref a-%data%
                                  (k j)
                                  ((1 lda) (1 *))
                                  a-%offset%))))
      (t
       (setf temp1
                (* alpha
                   (f2cl-lib:dconjg
                    (f2cl-lib:fref a-%data%
                                   (j k)
                                   ((1 lda) (1 *))
                                   a-%offset%))))))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  ((> i m) nil)
      (tagbody
        (setf (f2cl-lib:fref c-%data%
                             (i j)
                             ((1 ldc) (1 *))
                             c-%offset%)
                 (+
                  (f2cl-lib:fref c-%data%
                                 (i j)
                                 ((1 ldc) (1 *))
                                 c-%offset%)
```

```
                              (* temp1
                                 (f2cl-lib:fref b-%data%
                                                (i k)
                                                ((1 ldb$) (1 *))
                                                b-%offset%))))))))
                (f2cl-lib:fdo (k (f2cl-lib:int-add j 1) (f2cl-lib:int-add k 1))
                              ((> k n) nil)
                  (tagbody
                    (cond
                      (upper
                       (setf temp1
                               (* alpha
                                  (f2cl-lib:dconjg
                                   (f2cl-lib:fref a-%data%
                                                  (j k)
                                                  ((1 lda) (1 *))
                                                  a-%offset%)))))
                      (t
                       (setf temp1
                               (* alpha
                                  (f2cl-lib:fref a-%data%
                                                 (k j)
                                                 ((1 lda) (1 *))
                                                 a-%offset%)))))
                    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                  ((> i m) nil)
                      (tagbody
                        (setf (f2cl-lib:fref c-%data%
                                             (i j)
                                             ((1 ldc) (1 *))
                                             c-%offset%)
                                (+
                                 (f2cl-lib:fref c-%data%
                                                (i j)
                                                ((1 ldc) (1 *))
                                                c-%offset%)
                                 (* temp1
                                    (f2cl-lib:fref b-%data%
                                                   (i k)
                                                   ((1 ldb$) (1 *))
                                                   b-%offset%))))))))))
end_label
       (return (values nil nil nil nil nil nil nil nil nil nil nil nil)))))
```

5.9 zher2k BLAS

— zher2k.input —

```
)set break resume
)sys rm -f zher2k.output
)spool zher2k.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

————-

— zher2k.help —

```
==========================================================================
zher2k examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      ZHER2K - perform one of the hermitian rank 2k operations   C
      := alpha*A*conjg( B' ) + conjg( alpha )*B*conjg( A' ) +
      beta*C,

 SYNOPSIS
      SUBROUTINE ZHER2K( UPLO, TRANS, N, K, ALPHA, A, LDA, B, LDB,
                         BETA, C, LDC )

          CHARACTER*1    UPLO, TRANS

          INTEGER        N, K, LDA, LDB, LDC

          DOUBLE         PRECISION BETA

          COMPLEX*16     ALPHA

          COMPLEX*16     A( LDA, * ), B( LDB, * ), C( LDC, * )

 PURPOSE
      ZHER2K  performs one of the hermitian rank 2k operations
```

```
     or

        C := alpha*conjg( A' )*B + conjg( alpha )*conjg( B' )*A +
     beta*C,

     where  alpha and beta  are scalars with  beta  real,  C is
     an  n by n hermitian matrix and  A and B  are  n by k
     matrices in the first case and  k by n  matrices in the
     second case.

PARAMETERS
     UPLO   - CHARACTER*1.
              On  entry,   UPLO  specifies  whether  the  upper  or
              lower triangular  part  of the  array  C  is to be
              referenced  as follows:

              UPLO = 'U' or 'u'   Only the  upper triangular part
              of  C is to be referenced.

              UPLO = 'L' or 'l'   Only the  lower triangular part
              of  C is to be referenced.

              Unchanged on exit.

     TRANS  - CHARACTER*1.
              On entry,  TRANS  specifies the operation to be per-
              formed as follows:

              TRANS = 'N' or 'n'    C := alpha*A*conjg( B' )

              + conjg( alpha )*B*conjg( A' ) + beta*C.

              TRANS = 'C' or 'c'    C := alpha*conjg( A' )*B
              + conjg( alpha )*conjg( B' )*A + beta*C.

              Unchanged on exit.

     N      - INTEGER.
              On entry,  N specifies the order of the matrix C.  N
              must be at least zero.  Unchanged on exit.

     K      - INTEGER.
              On entry with  TRANS = 'N' or 'n',  K  specifies  the
              number of  columns  of the  matrices  A and B,  and
              on  entry  with TRANS = 'C' or 'c',  K  specifies
              the number of rows of the matrices  A and B.  K must
              be at least zero.  Unchanged on exit.

     ALPHA  - COMPLEX*16      .
              On entry, ALPHA specifies the scalar alpha.
```

```
            Unchanged on exit.

ka is
     A      -
             COMPLEX*16       array of DIMENSION ( LDA, ka ), where
            k  when  TRANS = 'N' or 'n',  and is  n  otherwise.
            Before entry with  TRANS = 'N' or 'n',  the  leading
            n by k part of the array  A  must contain the matrix
            A,  otherwise the leading  k by n  part of the array
            A  must contain  the matrix A.  Unchanged on exit.

     LDA    - INTEGER.
            On entry, LDA specifies the first dimension of A as
            declared in  the  calling  (sub)  program.   When
            TRANS = 'N' or 'n' then  LDA must be at least  max(
            1, n ), otherwise  LDA must be at least  max( 1, k ).
            Unchanged on exit.

kb is
     B      -
             COMPLEX*16       array of DIMENSION ( LDB, kb ), where
            k  when  TRANS = 'N' or 'n',  and is  n  otherwise.
            Before entry with  TRANS = 'N' or 'n',  the  leading
            n by k part of the array  B  must contain the matrix
            B,  otherwise the leading  k by n  part of the array
            B  must contain  the matrix B.  Unchanged on exit.

     LDB    - INTEGER.
            On entry, LDB specifies the first dimension of B as
            declared in  the  calling  (sub)  program.   When
            TRANS = 'N' or 'n' then  LDB must be at least  max(
            1, n ), otherwise  LDB must be at least  max( 1, k ).

            Unchanged on exit.

     BETA   - DOUBLE PRECISION.
            On entry, BETA specifies the scalar beta.  Unchanged
            on exit.

     C      - COMPLEX*16       array of DIMENSION ( LDC, n ).
            Before entry  with  UPLO = 'U' or 'u',  the leading
            n by n upper triangular part of the array C must con-
            tain the upper triangular part  of the  hermitian
            matrix  and the strictly lower triangular part of C
            is not referenced.  On exit, the upper triangular
            part of the array  C is overwritten by the upper tri-
            angular part of the updated matrix.  Before entry
            with  UPLO = 'L' or 'l',  the leading  n by n lower
            triangular part of the array C must contain the lower
            triangular part  of the  hermitian matrix  and the
```

```
            strictly upper triangular part of C is not refer-
            enced.  On exit, the lower triangular part of the
            array  C is overwritten by the lower triangular part
            of the updated matrix.  Note that the imaginary parts
            of the diagonal elements need not be set,  they are
            assumed to be zero,  and on exit they are set to
            zero.

      LDC    - INTEGER.
             On entry, LDC specifies the first dimension of C as
             declared in  the  calling  (sub)  program.   LDC
             must  be  at  least max( 1, n ).  Unchanged on exit.
```

———-

— zher2k.f —

```
      SUBROUTINE ZHER2K( UPLO, TRANS, N, K, ALPHA, A, LDA, B, LDB, BETA,
     $                   C, LDC )
*     .. Scalar Arguments ..
      CHARACTER          TRANS, UPLO
      INTEGER            K, LDA, LDB, LDC, N
      DOUBLE PRECISION   BETA
      COMPLEX*16         ALPHA
*     ..
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), B( LDB, * ), C( LDC, * )
*     ..
*
*  Level 3 Blas routine.
*
*  -- Written on 8-February-1989.
*     Jack Dongarra, Argonne National Laboratory.
*     Iain Duff, AERE Harwell.
*     Jeremy Du Croz, Numerical Algorithms Group Ltd.
*     Sven Hammarling, Numerical Algorithms Group Ltd.
*
*  -- Modified 8-Nov-93 to set C(J,J) to DBLE( C(J,J) ) when BETA = 1.
*     Ed Anderson, Cray Research Inc.
*
*
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     ..
```

```
*     .. Intrinsic Functions ..
      INTRINSIC          DBLE, DCONJG, MAX
*     ..
*     .. Local Scalars ..
      LOGICAL            UPPER
      INTEGER            I, INFO, J, L, NROWA
      COMPLEX*16         TEMP1, TEMP2
*     ..
*     .. Parameters ..
      DOUBLE PRECISION   ONE
      PARAMETER          ( ONE = 1.0D+0 )
      COMPLEX*16         ZERO
      PARAMETER          ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      IF( LSAME( TRANS, 'N' ) ) THEN
         NROWA = N
      ELSE
         NROWA = K
      END IF
      UPPER = LSAME( UPLO, 'U' )
*
      INFO = 0
      IF( ( .NOT.UPPER ) .AND. ( .NOT.LSAME( UPLO, 'L' ) ) ) THEN
         INFO = 1
      ELSE IF( ( .NOT.LSAME( TRANS, 'N' ) ) .AND.
     $         ( .NOT.LSAME( TRANS, 'C' ) ) ) THEN
         INFO = 2
      ELSE IF( N.LT.0 ) THEN
         INFO = 3
      ELSE IF( K.LT.0 ) THEN
         INFO = 4
      ELSE IF( LDA.LT.MAX( 1, NROWA ) ) THEN
         INFO = 7
      ELSE IF( LDB.LT.MAX( 1, NROWA ) ) THEN
         INFO = 9
      ELSE IF( LDC.LT.MAX( 1, N ) ) THEN
         INFO = 12
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'ZHER2K', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( N.EQ.0 ) .OR. ( ( ( ALPHA.EQ.ZERO ) .OR. ( K.EQ.0 ) ) .AND.
```

```
     $    ( BETA.EQ.ONE ) ) )RETURN
*
*     And when  alpha.eq.zero.
*
      IF( ALPHA.EQ.ZERO ) THEN
         IF( UPPER ) THEN
            IF( BETA.EQ.DBLE( ZERO ) ) THEN
               DO 20 J = 1, N
                  DO 10 I = 1, J
                     C( I, J ) = ZERO
   10             CONTINUE
   20          CONTINUE
            ELSE
               DO 40 J = 1, N
                  DO 30 I = 1, J - 1
                     C( I, J ) = BETA*C( I, J )
   30             CONTINUE
                  C( J, J ) = BETA*DBLE( C( J, J ) )
   40          CONTINUE
            END IF
         ELSE
            IF( BETA.EQ.DBLE( ZERO ) ) THEN
               DO 60 J = 1, N
                  DO 50 I = J, N
                     C( I, J ) = ZERO
   50             CONTINUE
   60          CONTINUE
            ELSE
               DO 80 J = 1, N
                  C( J, J ) = BETA*DBLE( C( J, J ) )
                  DO 70 I = J + 1, N
                     C( I, J ) = BETA*C( I, J )
   70             CONTINUE
   80          CONTINUE
            END IF
         END IF
         RETURN
      END IF
*
*     Start the operations.
*
      IF( LSAME( TRANS, 'N' ) ) THEN
*
*        Form  C := alpha*A*conjg( B' ) + conjg( alpha )*B*conjg( A' ) +
*                   C.
*
         IF( UPPER ) THEN
            DO 130 J = 1, N
               IF( BETA.EQ.DBLE( ZERO ) ) THEN
                  DO 90 I = 1, J
```

```
                  C( I, J ) = ZERO
 90               CONTINUE
               ELSE IF( BETA.NE.ONE ) THEN
                  DO 100 I = 1, J - 1
                     C( I, J ) = BETA*C( I, J )
100               CONTINUE
                  C( J, J ) = BETA*DBLE( C( J, J ) )
               ELSE
                  C( J, J ) = DBLE( C( J, J ) )
               END IF
               DO 120 L = 1, K
                  IF( ( A( J, L ).NE.ZERO ) .OR. ( B( J, L ).NE.ZERO ) )
     $                 THEN
                     TEMP1 = ALPHA*DCONJG( B( J, L ) )
                     TEMP2 = DCONJG( ALPHA*A( J, L ) )
                     DO 110 I = 1, J - 1
                        C( I, J ) = C( I, J ) + A( I, L )*TEMP1 +
     $                              B( I, L )*TEMP2
110                  CONTINUE
                     C( J, J ) = DBLE( C( J, J ) ) +
     $                           DBLE( A( J, L )*TEMP1+B( J, L )*TEMP2 )
                  END IF
120               CONTINUE
130            CONTINUE
            ELSE
               DO 180 J = 1, N
                  IF( BETA.EQ.DBLE( ZERO ) ) THEN
                     DO 140 I = J, N
                        C( I, J ) = ZERO
140                  CONTINUE
                  ELSE IF( BETA.NE.ONE ) THEN
                     DO 150 I = J + 1, N
                        C( I, J ) = BETA*C( I, J )
150                  CONTINUE
                     C( J, J ) = BETA*DBLE( C( J, J ) )
                  ELSE
                     C( J, J ) = DBLE( C( J, J ) )
                  END IF
                  DO 170 L = 1, K
                     IF( ( A( J, L ).NE.ZERO ) .OR. ( B( J, L ).NE.ZERO ) )
     $                    THEN
                        TEMP1 = ALPHA*DCONJG( B( J, L ) )
                        TEMP2 = DCONJG( ALPHA*A( J, L ) )
                        DO 160 I = J + 1, N
                           C( I, J ) = C( I, J ) + A( I, L )*TEMP1 +
     $                                 B( I, L )*TEMP2
160                     CONTINUE
                        C( J, J ) = DBLE( C( J, J ) ) +
     $                              DBLE( A( J, L )*TEMP1+B( J, L )*TEMP2 )
                     END IF
```

```
  170          CONTINUE
  180       CONTINUE
         END IF
      ELSE
*
*        Form  C := alpha*conjg( A' )*B + conjg( alpha )*conjg( B' )*A +
*                  C.
*
         IF( UPPER ) THEN
            DO 210 J = 1, N
               DO 200 I = 1, J
                  TEMP1 = ZERO
                  TEMP2 = ZERO
                  DO 190 L = 1, K
                     TEMP1 = TEMP1 + DCONJG( A( L, I ) )*B( L, J )
                     TEMP2 = TEMP2 + DCONJG( B( L, I ) )*A( L, J )
  190             CONTINUE
                  IF( I.EQ.J ) THEN
                     IF( BETA.EQ.DBLE( ZERO ) ) THEN
                        C( J, J ) = DBLE( ALPHA*TEMP1+DCONJG( ALPHA )*
     $                              TEMP2 )
                     ELSE
                        C( J, J ) = BETA*DBLE( C( J, J ) ) +
     $                              DBLE( ALPHA*TEMP1+DCONJG( ALPHA )*
     $                              TEMP2 )
                     END IF
                  ELSE
                     IF( BETA.EQ.DBLE( ZERO ) ) THEN
                        C( I, J ) = ALPHA*TEMP1 + DCONJG( ALPHA )*TEMP2
                     ELSE
                        C( I, J ) = BETA*C( I, J ) + ALPHA*TEMP1 +
     $                              DCONJG( ALPHA )*TEMP2
                     END IF
                  END IF
  200          CONTINUE
  210       CONTINUE
         ELSE
            DO 240 J = 1, N
               DO 230 I = J, N
                  TEMP1 = ZERO
                  TEMP2 = ZERO
                  DO 220 L = 1, K
                     TEMP1 = TEMP1 + DCONJG( A( L, I ) )*B( L, J )
                     TEMP2 = TEMP2 + DCONJG( B( L, I ) )*A( L, J )
  220             CONTINUE
                  IF( I.EQ.J ) THEN
                     IF( BETA.EQ.DBLE( ZERO ) ) THEN
                        C( J, J ) = DBLE( ALPHA*TEMP1+DCONJG( ALPHA )*
     $                              TEMP2 )
                     ELSE
```

```
                     C( J, J ) = BETA*DBLE( C( J, J ) ) +
     $                           DBLE( ALPHA*TEMP1+DCONJG( ALPHA )*
     $                           TEMP2 )
                  END IF
               ELSE
                  IF( BETA.EQ.DBLE( ZERO ) ) THEN
                     C( I, J ) = ALPHA*TEMP1 + DCONJG( ALPHA )*TEMP2
                  ELSE
                     C( I, J ) = BETA*C( I, J ) + ALPHA*TEMP1 +
     $                           DCONJG( ALPHA )*TEMP2
                  END IF
               END IF
  230          CONTINUE
  240       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of ZHER2K.
*
      END
```

———-

— BLAS 3 zher2k —

```
(let* ((one 1.0) (zero (complex 0.0 0.0)))
 (declare (type (double-float 1.0 1.0) one) (type (complex double-float) zero))
  (defun zher2k (uplo trans n k alpha a lda b ldb$ beta c ldc)
    (declare (type (double-float) beta)
             (type (simple-array (complex double-float) (*)) c b a)
             (type (complex double-float) alpha)
             (type fixnum ldc ldb$ lda k n)
             (type character trans uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (b (complex double-float) b-%data% b-%offset%)
         (c (complex double-float) c-%data% c-%offset%))
      (prog ((temp1 #C(0.0 0.0)) (temp2 #C(0.0 0.0)) (i 0) (info 0) (j 0) (l 0)
             (nrowa 0) (upper nil))
        (declare (type (complex double-float) temp1 temp2)
                 (type fixnum i info j l nrowa)
                 (type (member t nil) upper))
        (cond
          ((char-equal trans #\N)
```

```
   (setf nrowa n))
  (t
   (setf nrowa k)))
(setf upper (char-equal uplo #\U))
(setf info 0)
(cond
  ((and (not upper) (not (char-equal uplo #\L)))
   (setf info 1))
  ((and (not (char-equal trans #\N)) (not (char-equal trans #\C)))
   (setf info 2))
  ((< n 0)
   (setf info 3))
  ((< k 0)
   (setf info 4))
  ((< lda (max (the fixnum 1) (the fixnum nrowa)))
   (setf info 7))
  ((< ldb$
      (max (the fixnum 1) (the fixnum nrowa)))
   (setf info 9))
  ((< ldc (max (the fixnum 1) (the fixnum n)))
   (setf info 12)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "ZHER2K" info)
   (go end_label)))
(if (or (= n 0) (and (or (= alpha zero) (= k 0)) (= beta one)))
    (go end_label))
(cond
  ((= alpha zero)
   (cond
     (upper
      (cond
        ((= beta (coerce (realpart zero) 'double-float))
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i j) nil)
               (tagbody
                 (setf (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       zero))))))
        (t
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
```

```
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                              ((> i
                                  (f2cl-lib:int-add j
                                                   (f2cl-lib:int-sub 1)))
                               nil)
                  (tagbody
                    (setf (f2cl-lib:fref c-%data%
                                         (i j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                              (* beta
                                 (f2cl-lib:fref c-%data%
                                                (i j)
                                                ((1 ldc) (1 *))
                                                c-%offset%)))))
                (setf (f2cl-lib:fref c-%data%
                                     (j j)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (coerce
                       (* beta
                          (coerce (realpart
                                   (f2cl-lib:fref c-%data%
                                                  (j j)
                                                  ((1 ldc) (1 *))
                                                  c-%offset%)) 'double-float))
                       '(complex double-float))))))))
          (t
           (cond
             ((= beta (coerce (realpart zero) 'double-float))
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
                (tagbody
                  (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                                ((> i n) nil)
                    (tagbody
                      (setf (f2cl-lib:fref c-%data%
                                           (i j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                            zero))))))
             (t
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
                (tagbody
                  (setf (f2cl-lib:fref c-%data%
                                       (j j)
                                       ((1 ldc) (1 *))
                                       c-%offset%)
                        (coerce
```

```
                        (* beta
                           (coerce (realpart
                            (f2cl-lib:fref c-%data%
                                           (j j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)) 'double-float))
                        '(complex double-float)))
                 (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                  (f2cl-lib:int-add i 1))
                               ((> i n) nil)
                   (tagbody
                     (setf (f2cl-lib:fref c-%data%
                                          (i j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)
                           (* beta
                              (f2cl-lib:fref c-%data%
                                             (i j)
                                             ((1 ldc) (1 *))
                                             c-%offset%)))))))
     (go end_label)))
  (cond
    ((char-equal trans #\N)
     (cond
       (upper
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                      ((> j n) nil)
          (tagbody
            (cond
              ((= beta (coerce (realpart zero) 'double-float))
               (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                             ((> i j) nil)
                 (tagbody
                   (setf (f2cl-lib:fref c-%data%
                                        (i j)
                                        ((1 ldc) (1 *))
                                        c-%offset%)
                         zero))))
              ((/= beta one)
               (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                             ((> i
                                 (f2cl-lib:int-add j
                                                   (f2cl-lib:int-sub 1)))
                              nil)
                 (tagbody
                   (setf (f2cl-lib:fref c-%data%
                                        (i j)
                                        ((1 ldc) (1 *))
                                        c-%offset%)
                         (* beta
```

```
                    (f2cl-lib:fref c-%data%
                                  (i j)
                                  ((1 ldc) (1 *))
                                  c-%offset%)))))
     (setf (f2cl-lib:fref c-%data%
                          (j j)
                          ((1 ldc) (1 *))
                          c-%offset%)
             (coerce
              (* beta
                 (coerce (realpart
                  (f2cl-lib:fref c-%data%
                                 (j j)
                                 ((1 ldc) (1 *))
                                 c-%offset%)) 'double-float))
              '(complex double-float))))
    (t
     (setf (f2cl-lib:fref c-%data%
                          (j j)
                          ((1 ldc) (1 *))
                          c-%offset%)
             (coerce
              (coerce (realpart
               (f2cl-lib:fref c-%data%
                              (j j)
                              ((1 ldc) (1 *))
                              c-%offset%)) 'double-float)
              '(complex double-float)))))
(f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
              ((> l k) nil)
  (tagbody
    (cond
      ((or (/= (f2cl-lib:fref a (j l) ((1 lda) (1 *))) zero)
           (/= (f2cl-lib:fref b (j l) ((1 ldb$) (1 *))) zero))
       (setf temp1
               (* alpha
                  (f2cl-lib:dconjg
                   (f2cl-lib:fref b-%data%
                                  (j l)
                                  ((1 ldb$) (1 *))
                                  b-%offset%))))
       (setf temp2
               (coerce
                (f2cl-lib:dconjg
                 (* alpha
                    (f2cl-lib:fref a-%data%
                                   (j l)
                                   ((1 lda) (1 *))
                                   a-%offset%)))
                '(complex double-float)))
```

```
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i
                  (f2cl-lib:int-add j
                                    (f2cl-lib:int-sub
                                     1)))
               nil)
  (tagbody
    (setf (f2cl-lib:fref c-%data%
                         (i j)
                         ((1 ldc) (1 *))
                         c-%offset%)
            (+
             (f2cl-lib:fref c-%data%
                            (i j)
                            ((1 ldc) (1 *))
                            c-%offset%)
             (*
              (f2cl-lib:fref a-%data%
                             (i l)
                             ((1 lda) (1 *))
                             a-%offset%)
              temp1)
             (*
              (f2cl-lib:fref b-%data%
                             (i l)
                             ((1 ldb$) (1 *))
                             b-%offset%)
              temp2)))))
(setf (f2cl-lib:fref c-%data%
                     (j j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (coerce
         (+
          (coerce (realpart
           (f2cl-lib:fref c-%data%
                          (j j)
                          ((1 ldc) (1 *))
                          c-%offset%)) 'double-float)
          (coerce (realpart
           (+
            (*
             (f2cl-lib:fref a-%data%
                            (j l)
                            ((1 lda) (1 *))
                            a-%offset%)
             temp1)
            (*
             (f2cl-lib:fref b-%data%
                            (j l)
```

```
                                          ((1 ldb$) (1 *))
                                          b-%offset%)
                          temp2))) 'double-float))
                       '(complex double-float))))))))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (cond
       ((= beta (coerce (realpart zero) 'double-float))
        (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                      ((> i n) nil)
          (tagbody
            (setf (f2cl-lib:fref c-%data%
                                 (i j)
                                 ((1 ldc) (1 *))
                                 c-%offset%)
                  zero))))
       ((/= beta one)
        (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                       (f2cl-lib:int-add i 1))
                      ((> i n) nil)
          (tagbody
            (setf (f2cl-lib:fref c-%data%
                                 (i j)
                                 ((1 ldc) (1 *))
                                 c-%offset%)
                  (* beta
                     (f2cl-lib:fref c-%data%
                                    (i j)
                                    ((1 ldc) (1 *))
                                    c-%offset%)))))
        (setf (f2cl-lib:fref c-%data%
                             (j j)
                             ((1 ldc) (1 *))
                             c-%offset%)
              (coerce
               (* beta
                  (coerce (realpart
                           (f2cl-lib:fref c-%data%
                                          (j j)
                                          ((1 ldc) (1 *))
                                          c-%offset%))' double-float))
               '(complex double-float))))
       (t
        (setf (f2cl-lib:fref c-%data%
                             (j j)
                             ((1 ldc) (1 *))
                             c-%offset%)
              (coerce
```

```
                (coerce (realpart
                 (f2cl-lib:fref c-%data%
                                (j j)
                                ((1 ldc) (1 *))
                                c-%offset%)) 'double-float)
                '(complex double-float)))))
(f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
              ((> l k) nil)
  (tagbody
    (cond
     ((or (/= (f2cl-lib:fref a (j l) ((1 lda) (1 *))) zero)
          (/= (f2cl-lib:fref b (j l) ((1 ldb$) (1 *))) zero))
       (setf temp1
             (* alpha
                (f2cl-lib:dconjg
                 (f2cl-lib:fref b-%data%
                                (j l)
                                ((1 ldb$) (1 *))
                                b-%offset%))))
       (setf temp2
             (coerce
              (f2cl-lib:dconjg
               (* alpha
                  (f2cl-lib:fref a-%data%
                                 (j l)
                                 ((1 lda) (1 *))
                                 a-%offset%)))
              '(complex double-float)))
       (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                        (f2cl-lib:int-add i 1))
                     ((> i n) nil)
         (tagbody
           (setf (f2cl-lib:fref c-%data%
                                (i j)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (+
                  (f2cl-lib:fref c-%data%
                                 (i j)
                                 ((1 ldc) (1 *))
                                 c-%offset%)
                  (*
                   (f2cl-lib:fref a-%data%
                                  (i l)
                                  ((1 lda) (1 *))
                                  a-%offset%)
                   temp1)
                  (*
                   (f2cl-lib:fref b-%data%
                                  (i l)
```

```
                                          ((1 ldb$) (1 *))
                                          b-%offset%)
                              temp2)))))
                  (setf (f2cl-lib:fref c-%data%
                                       (j j)
                                       ((1 ldc) (1 *))
                                       c-%offset%)
                        (coerce
                         (+
                          (coerce (realpart
                           (f2cl-lib:fref c-%data%
                                          (j j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)) 'double-float)
                          (coerce (realpart
                           (+
                            (*
                             (f2cl-lib:fref a-%data%
                                            (j l)
                                            ((1 lda) (1 *))
                                            a-%offset%)
                             temp1)
                            (*
                             (f2cl-lib:fref b-%data%
                                            (j l)
                                            ((1 ldb$) (1 *))
                                            b-%offset%)
                             temp2))) 'double-float))
                         '(complex double-float))))))))))))
(t
 (cond
   (upper
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j n) nil)
      (tagbody
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i j) nil)
          (tagbody
            (setf temp1 zero)
            (setf temp2 zero)
            (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                          ((> l k) nil)
              (tagbody
                (setf temp1
                        (+ temp1
                           (*
                            (f2cl-lib:dconjg
                             (f2cl-lib:fref a-%data%
                                            (l i)
                                            ((1 lda) (1 *))
```

```
                                        a-%offset%))
                        (f2cl-lib:fref b-%data%
                                       (l j)
                                       ((1 ldb$) (1 *))
                                       b-%offset%))))
          (setf temp2
                  (+ temp2
                     (*
                      (f2cl-lib:dconjg
                       (f2cl-lib:fref b-%data%
                                      (l i)
                                      ((1 ldb$) (1 *))
                                      b-%offset%))
                      (f2cl-lib:fref a-%data%
                                     (l j)
                                     ((1 lda) (1 *))
                                     a-%offset%))))))
      (cond
        ((= i j)
         (cond
           ((= beta (coerce (realpart zero) 'double-float))
            (setf (f2cl-lib:fref c-%data%
                                 (j j)
                                 ((1 ldc) (1 *))
                                 c-%offset%)
                  (coerce
                   (coerce (realpart
                    (+ (* alpha temp1)
                       (* (f2cl-lib:dconjg alpha) temp2)))
                      'double-float)
                   '(complex double-float))))
           (t
            (setf (f2cl-lib:fref c-%data%
                                 (j j)
                                 ((1 ldc) (1 *))
                                 c-%offset%)
                  (coerce
                   (+
                    (* beta
                       (coerce (realpart
                        (f2cl-lib:fref c-%data%
                                       (j j)
                                       ((1 ldc) (1 *))
                                       c-%offset%))
                          'double-float))
                    (coerce (realpart
                     (+ (* alpha temp1)
                        (* (f2cl-lib:dconjg alpha) temp2)))
                     'double-float))
                   '(complex double-float))))))
```

```
                (t
                 (cond
                   ((= beta (coerce (realpart zero) 'double-float))
                    (setf (f2cl-lib:fref c-%data%
                                         (i j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                          (+ (* alpha temp1)
                             (* (f2cl-lib:dconjg alpha) temp2))))
                   (t
                    (setf (f2cl-lib:fref c-%data%
                                         (i j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                          (+
                           (* beta
                              (f2cl-lib:fref c-%data%
                                             (i j)
                                             ((1 ldc) (1 *))
                                             c-%offset%))
                           (* alpha temp1)
                           (* (f2cl-lib:dconjg alpha) temp2)))))))))))
          (t
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                             ((> i n) nil)
                 (tagbody
                   (setf temp1 zero)
                   (setf temp2 zero)
                   (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                                 ((> l k) nil)
                     (tagbody
                       (setf temp1
                             (+ temp1
                                (*
                                 (f2cl-lib:dconjg
                                  (f2cl-lib:fref a-%data%
                                                 (l i)
                                                 ((1 lda) (1 *))
                                                 a-%offset%))
                                 (f2cl-lib:fref b-%data%
                                                (l j)
                                                ((1 ldb$) (1 *))
                                                b-%offset%))))
                       (setf temp2
                             (+ temp2
                                (*
                                 (f2cl-lib:dconjg
```

```
                    (f2cl-lib:fref b-%data%
                                   (l i)
                                   ((1 ldb$) (1 *))
                                   b-%offset%))
                  (f2cl-lib:fref a-%data%
                                 (l j)
                                 ((1 lda) (1 *))
                                 a-%offset%))))))
(cond
  ((= i j)
   (cond
     ((= beta (coerce (realpart zero) 'double-float))
      (setf (f2cl-lib:fref c-%data%
                           (j j)
                           ((1 ldc) (1 *))
                           c-%offset%)
              (coerce
               (coerce (realpart
                (+ (* alpha temp1)
                   (* (f2cl-lib:dconjg alpha) temp2)))
                'double-float)
               '(complex double-float))))
     (t
      (setf (f2cl-lib:fref c-%data%
                           (j j)
                           ((1 ldc) (1 *))
                           c-%offset%)
              (coerce
               (+
                (* beta
                   (coerce (realpart
                    (f2cl-lib:fref c-%data%
                                   (j j)
                                   ((1 ldc) (1 *))
                                   c-%offset%))
                    'double-float))
                (coerce (realpart
                 (+ (* alpha temp1)
                    (* (f2cl-lib:dconjg alpha) temp2)))
                  'double-float))
               '(complex double-float))))))
  (t
   (cond
     ((= beta (coerce (realpart zero) 'double-float))
      (setf (f2cl-lib:fref c-%data%
                           (i j)
                           ((1 ldc) (1 *))
                           c-%offset%)
              (+ (* alpha temp1)
                 (* (f2cl-lib:dconjg alpha) temp2))))
```

```
                          (t
                           (setf (f2cl-lib:fref c-%data%
                                                (i j)
                                                ((1 ldc) (1 *))
                                                c-%offset%)
                                 (+
                                  (* beta
                                     (f2cl-lib:fref c-%data%
                                                    (i j)
                                                    ((1 ldc) (1 *))
                                                    c-%offset%))
                                  (* alpha temp1)
                                  (* (f2cl-lib:dconjg alpha) temp2)))))))))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil nil nil nil))))))
```

———-

5.10 zherk BLAS

— **zherk.input** —

```
)set break resume
)sys rm -f zherk.output
)spool zherk.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zherk.help** —

```
====================================================================
zherk examples
====================================================================

====================================================================
Man Page Details
====================================================================

 NAME
```

```
     ZHERK - perform one of the hermitian rank k operations   C
     := alpha*A*conjg( A' ) + beta*C,

SYNOPSIS
     SUBROUTINE ZHERK ( UPLO, TRANS, N, K, ALPHA, A, LDA, BETA,
                        C, LDC )

         CHARACTER*1  UPLO, TRANS

         INTEGER      N, K, LDA, LDC

         DOUBLE       PRECISION ALPHA, BETA

         COMPLEX*16   A( LDA, * ), C( LDC, * )

PURPOSE
     ZHERK  performs one of the hermitian rank k operations

     or

        C := alpha*conjg( A' )*A + beta*C,

     where  alpha and beta  are  real scalars,  C is an  n by n
     hermitian matrix and  A  is an  n by k  matrix in the  first
     case and a  k by n matrix in the second case.

PARAMETERS
     UPLO   - CHARACTER*1.
            On  entry,   UPLO  specifies  whether  the  upper  or
            lower triangular  part  of the  array  C  is to be
            referenced  as follows:

            UPLO = 'U' or 'u'   Only the  upper triangular part
            of  C is to be referenced.

            UPLO = 'L' or 'l'   Only the  lower triangular part
            of  C is to be referenced.

            Unchanged on exit.

     TRANS  - CHARACTER*1.
            On entry,  TRANS  specifies the operation to be per-
            formed as follows:

            TRANS = 'N' or 'n'   C := alpha*A*conjg( A' ) +
            beta*C.

            TRANS = 'C' or 'c'   C := alpha*conjg( A' )*A +
            beta*C.
```

```
              Unchanged on exit.

       N      - INTEGER.
              On entry,  N specifies the order of the matrix C.  N
              must be at least zero.  Unchanged on exit.

       K      - INTEGER.
              On entry with  TRANS = 'N' or 'n',  K  specifies  the
              number of  columns   of  the   matrix   A,   and  on
              entry   with TRANS = 'C' or 'c',  K  specifies  the
              number of rows of the matrix A.  K must be at least
              zero.  Unchanged on exit.

       ALPHA  - DOUBLE PRECISION.
              On entry, ALPHA specifies the scalar alpha.
              Unchanged on exit.

ka is
       A      -
               COMPLEX*16       array of DIMENSION ( LDA, ka ), where
              k  when  TRANS = 'N' or 'n',  and is  n  otherwise.
              Before entry with  TRANS = 'N' or 'n',  the  leading
              n by k part of the array  A  must contain the matrix
              A,  otherwise the leading  k by n  part of the array
              A  must contain  the matrix A.  Unchanged on exit.

       LDA    - INTEGER.
              On entry, LDA specifies the first dimension of A as
              declared in  the  calling  (sub)  program.   When
              TRANS = 'N' or 'n' then  LDA must be at least  max(
              1, n ), otherwise  LDA must be at least  max( 1, k ).
              Unchanged on exit.

       BETA   - DOUBLE PRECISION.
              On entry, BETA specifies the scalar beta.  Unchanged
              on exit.

       C      - COMPLEX*16       array of DIMENSION ( LDC, n ).
              Before entry  with  UPLO = 'U' or 'u',  the leading
              n by n upper triangular part of the array C must con-
              tain the upper triangular part  of the  hermitian
              matrix  and the strictly lower triangular part of C
              is not referenced.  On exit, the upper triangular
              part of the array  C is overwritten by the upper tri-
              angular part of the updated matrix.  Before entry
              with  UPLO = 'L' or 'l',  the leading  n by n lower
              triangular part of the array C must contain the lower
              triangular part  of the  hermitian matrix  and the
              strictly upper triangular part of C is not refer-
              enced.  On exit, the lower triangular part of the
```

```
            array  C is overwritten by the lower triangular part
            of the updated matrix.  Note that the imaginary parts

            of the diagonal elements need not be set,  they are
            assumed to be zero,  and on exit they are set to
            zero.

      LDC   - INTEGER.
            On entry, LDC specifies the first dimension of C as
            declared in  the  calling  (sub)  program.   LDC
            must  be  at  least max( 1, n ).  Unchanged on exit.
```

———-

— zherk.f —

```
      SUBROUTINE ZHERK( UPLO, TRANS, N, K, ALPHA, A, LDA, BETA, C, LDC )
*     .. Scalar Arguments ..
      CHARACTER          TRANS, UPLO
      INTEGER            K, LDA, LDC, N
      DOUBLE PRECISION   ALPHA, BETA
*     ..
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), C( LDC, * )
*     ..
*
*  Level 3 Blas routine.
*
*  -- Written on 8-February-1989.
*     Jack Dongarra, Argonne National Laboratory.
*     Iain Duff, AERE Harwell.
*     Jeremy Du Croz, Numerical Algorithms Group Ltd.
*     Sven Hammarling, Numerical Algorithms Group Ltd.
*
*  -- Modified 8-Nov-93 to set C(J,J) to DBLE( C(J,J) ) when BETA = 1.
*     Ed Anderson, Cray Research Inc.
*
*
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          DBLE, DCMPLX, DCONJG, MAX
*     ..
```

```
*     .. Local Scalars ..
      LOGICAL            UPPER
      INTEGER            I, INFO, J, L, NROWA
      DOUBLE PRECISION   RTEMP
      COMPLEX*16         TEMP
*     ..
*     .. Parameters ..
      DOUBLE PRECISION   ONE, ZERO
      PARAMETER          ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      IF( LSAME( TRANS, 'N' ) ) THEN
         NROWA = N
      ELSE
         NROWA = K
      END IF
      UPPER = LSAME( UPLO, 'U' )
*
      INFO = 0
      IF( ( .NOT.UPPER ) .AND. ( .NOT.LSAME( UPLO, 'L' ) ) ) THEN
         INFO = 1
      ELSE IF( ( .NOT.LSAME( TRANS, 'N' ) ) .AND.
     $         ( .NOT.LSAME( TRANS, 'C' ) ) ) THEN
         INFO = 2
      ELSE IF( N.LT.0 ) THEN
         INFO = 3
      ELSE IF( K.LT.0 ) THEN
         INFO = 4
      ELSE IF( LDA.LT.MAX( 1, NROWA ) ) THEN
         INFO = 7
      ELSE IF( LDC.LT.MAX( 1, N ) ) THEN
         INFO = 10
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'ZHERK ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( N.EQ.0 ) .OR. ( ( ( ALPHA.EQ.ZERO ) .OR. ( K.EQ.0 ) ) .AND.
     $    ( BETA.EQ.ONE ) ) )RETURN
*
*     And when  alpha.eq.zero.
*
      IF( ALPHA.EQ.ZERO ) THEN
         IF( UPPER ) THEN
```

```
            IF( BETA.EQ.ZERO ) THEN
               DO 20 J = 1, N
                  DO 10 I = 1, J
                     C( I, J ) = ZERO
   10             CONTINUE
   20          CONTINUE
            ELSE
               DO 40 J = 1, N
                  DO 30 I = 1, J - 1
                     C( I, J ) = BETA*C( I, J )
   30             CONTINUE
                  C( J, J ) = BETA*DBLE( C( J, J ) )
   40          CONTINUE
            END IF
         ELSE
            IF( BETA.EQ.ZERO ) THEN
               DO 60 J = 1, N
                  DO 50 I = J, N
                     C( I, J ) = ZERO
   50             CONTINUE
   60          CONTINUE
            ELSE
               DO 80 J = 1, N
                  C( J, J ) = BETA*DBLE( C( J, J ) )
                  DO 70 I = J + 1, N
                     C( I, J ) = BETA*C( I, J )
   70             CONTINUE
   80          CONTINUE
            END IF
         END IF
         RETURN
      END IF
*
*     Start the operations.
*
      IF( LSAME( TRANS, 'N' ) ) THEN
*
*        Form  C := alpha*A*conjg( A' ) + beta*C.
*
         IF( UPPER ) THEN
            DO 130 J = 1, N
               IF( BETA.EQ.ZERO ) THEN
                  DO 90 I = 1, J
                     C( I, J ) = ZERO
   90             CONTINUE
               ELSE IF( BETA.NE.ONE ) THEN
                  DO 100 I = 1, J - 1
                     C( I, J ) = BETA*C( I, J )
  100             CONTINUE
                  C( J, J ) = BETA*DBLE( C( J, J ) )
```

```
               ELSE
                  C( J, J ) = DBLE( C( J, J ) )
               END IF
               DO 120 L = 1, K
                  IF( A( J, L ).NE.DCMPLX( ZERO ) ) THEN
                     TEMP = ALPHA*DCONJG( A( J, L ) )
                     DO 110 I = 1, J - 1
                        C( I, J ) = C( I, J ) + TEMP*A( I, L )
  110                CONTINUE
                     C( J, J ) = DBLE( C( J, J ) ) +
     $                            DBLE( TEMP*A( I, L ) )
                  END IF
  120          CONTINUE
  130       CONTINUE
         ELSE
            DO 180 J = 1, N
               IF( BETA.EQ.ZERO ) THEN
                  DO 140 I = J, N
                     C( I, J ) = ZERO
  140             CONTINUE
               ELSE IF( BETA.NE.ONE ) THEN
                  C( J, J ) = BETA*DBLE( C( J, J ) )
                  DO 150 I = J + 1, N
                     C( I, J ) = BETA*C( I, J )
  150             CONTINUE
               ELSE
                  C( J, J ) = DBLE( C( J, J ) )
               END IF
               DO 170 L = 1, K
                  IF( A( J, L ).NE.DCMPLX( ZERO ) ) THEN
                     TEMP = ALPHA*DCONJG( A( J, L ) )
                     C( J, J ) = DBLE( C( J, J ) ) +
     $                            DBLE( TEMP*A( J, L ) )
                     DO 160 I = J + 1, N
                        C( I, J ) = C( I, J ) + TEMP*A( I, L )
  160                CONTINUE
                  END IF
  170          CONTINUE
  180       CONTINUE
         END IF
      ELSE
*
*        Form  C := alpha*conjg( A' )*A + beta*C.
*
         IF( UPPER ) THEN
            DO 220 J = 1, N
               DO 200 I = 1, J - 1
                  TEMP = ZERO
                  DO 190 L = 1, K
                     TEMP = TEMP + DCONJG( A( L, I ) )*A( L, J )
```

```
  190            CONTINUE
                 IF( BETA.EQ.ZERO ) THEN
                    C( I, J ) = ALPHA*TEMP
                 ELSE
                    C( I, J ) = ALPHA*TEMP + BETA*C( I, J )
                 END IF
  200          CONTINUE
               RTEMP = ZERO
               DO 210 L = 1, K
                  RTEMP = RTEMP + DCONJG( A( L, J ) )*A( L, J )
  210          CONTINUE
               IF( BETA.EQ.ZERO ) THEN
                  C( J, J ) = ALPHA*RTEMP
               ELSE
                  C( J, J ) = ALPHA*RTEMP + BETA*DBLE( C( J, J ) )
               END IF
  220       CONTINUE
         ELSE
            DO 260 J = 1, N
               RTEMP = ZERO
               DO 230 L = 1, K
                  RTEMP = RTEMP + DCONJG( A( L, J ) )*A( L, J )
  230          CONTINUE
               IF( BETA.EQ.ZERO ) THEN
                  C( J, J ) = ALPHA*RTEMP
               ELSE
                  C( J, J ) = ALPHA*RTEMP + BETA*DBLE( C( J, J ) )
               END IF
               DO 250 I = J + 1, N
                  TEMP = ZERO
                  DO 240 L = 1, K
                     TEMP = TEMP + DCONJG( A( L, I ) )*A( L, J )
  240             CONTINUE
                  IF( BETA.EQ.ZERO ) THEN
                     C( I, J ) = ALPHA*TEMP
                  ELSE
                     C( I, J ) = ALPHA*TEMP + BETA*C( I, J )
                  END IF
  250          CONTINUE
  260       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of ZHERK .
*
      END
```

———-

— **BLAS 3 zherk** —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun zherk (uplo trans n k alpha a lda beta c ldc)
    (declare (type (simple-array (complex double-float) (*)) c a)
             (type (double-float) beta alpha)
             (type fixnum ldc lda k n)
             (type character trans uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (c (complex double-float) c-%data% c-%offset%))
      (prog ((temp #C(0.0 0.0)) (rtemp 0.0) (i 0) (info 0) (j 0) (l 0)
             (nrowa 0) (upper nil))
        (declare (type (complex double-float) temp)
                 (type (double-float) rtemp)
                 (type fixnum i info j l nrowa)
                 (type (member t nil) upper))
        (cond
          ((char-equal trans #\N)
           (setf nrowa n))
          (t
           (setf nrowa k)))
        (setf upper (char-equal uplo #\U))
        (setf info 0)
        (cond
          ((and (not upper) (not (char-equal uplo #\L)))
           (setf info 1))
          ((and (not (char-equal trans #\N)) (not (char-equal trans #\C)))
           (setf info 2))
          ((< n 0)
           (setf info 3))
          ((< k 0)
           (setf info 4))
          ((< lda (max (the fixnum 1) (the fixnum nrowa)))
           (setf info 7))
          ((< ldc (max (the fixnum 1) (the fixnum n)))
           (setf info 10)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "ZHERK" info)
           (go end_label)))
```

```
(if (or (= n 0) (and (or (= alpha zero) (= k 0)) (= beta one)))
    (go end_label))
(cond
  ((= alpha zero)
   (cond
     (upper
      (cond
        ((= beta zero)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i j) nil)
               (tagbody
                 (setf (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (coerce zero '(complex double-float))))))))
        (t
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i
                               (f2cl-lib:int-add j
                                                 (f2cl-lib:int-sub 1)))
                            nil)
               (tagbody
                 (setf (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (* beta
                          (f2cl-lib:fref c-%data%
                                         (i j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)))))
             (setf (f2cl-lib:fref c-%data%
                                  (j j)
                                  ((1 ldc) (1 *))
                                  c-%offset%)
                   (coerce
                    (* beta
                       (coerce (realpart
                                (f2cl-lib:fref c-%data%
                                               (j j)
                                               ((1 ldc) (1 *))
                                               c-%offset%)) 'double-float))
                    '(complex double-float)))))))))
```

```
        (t
         (cond
           ((= beta zero)
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
              (tagbody
                (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                              ((> i n) nil)
                  (tagbody
                    (setf (f2cl-lib:fref c-%data%
                                         (i j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                          (coerce zero '(complex double-float))))))))
           (t
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
              (tagbody
                (setf (f2cl-lib:fref c-%data%
                                     (j j)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (coerce
                       (* beta
                          (coerce (realpart
                                   (f2cl-lib:fref c-%data%
                                                  (j j)
                                                  ((1 ldc) (1 *))
                                                  c-%offset%)) 'double-float))
                       '(complex double-float)))
                (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                 (f2cl-lib:int-add i 1))
                              ((> i n) nil)
                  (tagbody
                    (setf (f2cl-lib:fref c-%data%
                                         (i j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                          (* beta
                             (f2cl-lib:fref c-%data%
                                            (i j)
                                            ((1 ldc) (1 *))
                                            c-%offset%)))))))))))
      (go end_label)))
    (cond
      ((char-equal trans #\N)
       (cond
         (upper
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                        ((> j n) nil)
```

```
(tagbody
  (cond
    ((= beta zero)
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                   ((> i j) nil)
       (tagbody
         (setf (f2cl-lib:fref c-%data%
                              (i j)
                              ((1 ldc) (1 *))
                              c-%offset%)
                 (coerce zero '(complex double-float))))))
    ((/= beta one)
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                   ((> i
                       (f2cl-lib:int-add j
                                         (f2cl-lib:int-sub 1)))
                    nil)
       (tagbody
         (setf (f2cl-lib:fref c-%data%
                              (i j)
                              ((1 ldc) (1 *))
                              c-%offset%)
                 (* beta
                    (f2cl-lib:fref c-%data%
                                   (i j)
                                   ((1 ldc) (1 *))
                                   c-%offset%)))))
     (setf (f2cl-lib:fref c-%data%
                          (j j)
                          ((1 ldc) (1 *))
                          c-%offset%)
             (coerce
              (* beta
                 (coerce (realpart
                  (f2cl-lib:fref c-%data%
                                 (j j)
                                 ((1 ldc) (1 *))
                                 c-%offset%)) 'double-float))
              '(complex double-float))))
    (t
     (setf (f2cl-lib:fref c-%data%
                          (j j)
                          ((1 ldc) (1 *))
                          c-%offset%)
             (coerce
              (coerce (realpart
               (f2cl-lib:fref c-%data%
                              (j j)
                              ((1 ldc) (1 *))
                              c-%offset%)) 'double-float)
```

```
            '(complex double-float)))))
(f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
              ((> l k) nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref a (j l) ((1 lda) (1 *)))
           (coerce (complex zero) '(complex double-float)))
       (setf temp
             (coerce
              (* alpha
                 (f2cl-lib:dconjg
                  (f2cl-lib:fref a-%data%
                                 (j l)
                                 ((1 lda) (1 *))
                                 a-%offset%)))
              '(complex double-float)))
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i
                         (f2cl-lib:int-add j
                                           (f2cl-lib:int-sub
                                            1)))
                      nil)
         (tagbody
           (setf (f2cl-lib:fref c-%data%
                                (i j)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (+
                  (f2cl-lib:fref c-%data%
                                 (i j)
                                 ((1 ldc) (1 *))
                                 c-%offset%)
                  (* temp
                     (f2cl-lib:fref a-%data%
                                    (i l)
                                    ((1 lda) (1 *))
                                    a-%offset%))))))))
       (setf (f2cl-lib:fref c-%data%
                            (j j)
                            ((1 ldc) (1 *))
                            c-%offset%)
             (coerce
              (+
               (coerce (realpart
                        (f2cl-lib:fref c-%data%
                                       (j j)
                                       ((1 ldc) (1 *))
                                       c-%offset%)) 'double-float)
               (coerce (realpart
                        (* temp
```

```
                                (f2cl-lib:fref a-%data%
                                               (i l)
                                               ((1 lda) (1 *))
                                               a-%offset%)))
                           'double-float))
                         '(complex double-float))))))))))
        (t
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (cond
               ((= beta zero)
                (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                              ((> i n) nil)
                  (tagbody
                    (setf (f2cl-lib:fref c-%data%
                                         (i j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                          (coerce zero '(complex double-float))))))
               ((/= beta one)
                (setf (f2cl-lib:fref c-%data%
                                     (j j)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                        (coerce
                         (* beta
                            (coerce (realpart
                             (f2cl-lib:fref c-%data%
                                            (j j)
                                            ((1 ldc) (1 *))
                                            c-%offset%)) 'double-float))
                         '(complex double-float)))
                (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                 (f2cl-lib:int-add i 1))
                              ((> i n) nil)
                  (tagbody
                    (setf (f2cl-lib:fref c-%data%
                                         (i j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                          (* beta
                             (f2cl-lib:fref c-%data%
                                            (i j)
                                            ((1 ldc) (1 *))
                                            c-%offset%))))))
               (t
                (setf (f2cl-lib:fref c-%data%
                                     (j j)
                                     ((1 ldc) (1 *))
```

```
                        c-%offset%)
            (coerce
             (coerce (realpart
              (f2cl-lib:fref c-%data%
                             (j j)
                             ((1 ldc) (1 *))
                             c-%offset%)) 'double-float)
             '(complex double-float)))))
(f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
              ((> l k) nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref a (j l) ((1 lda) (1 *)))
           (coerce (complex zero) '(complex double-float)))
       (setf temp
             (coerce
              (* alpha
                 (f2cl-lib:dconjg
                  (f2cl-lib:fref a-%data%
                                 (j l)
                                 ((1 lda) (1 *))
                                 a-%offset%)))
              '(complex double-float)))
       (setf (f2cl-lib:fref c-%data%
                            (j j)
                            ((1 ldc) (1 *))
                            c-%offset%)
             (coerce
              (+
               (coerce (realpart
                (f2cl-lib:fref c-%data%
                               (j j)
                               ((1 ldc) (1 *))
                               c-%offset%)) 'double-float)
               (coerce (realpart
                (* temp
                   (f2cl-lib:fref a-%data%
                                  (j l)
                                  ((1 lda) (1 *))
                                  a-%offset%)))
                   'double-float))
              '(complex double-float)))
       (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                        (f2cl-lib:int-add i 1))
                     ((> i n) nil)
         (tagbody
           (setf (f2cl-lib:fref c-%data%
                                (i j)
                                ((1 ldc) (1 *))
                                c-%offset%)
```

```
                                (+
                                 (f2cl-lib:fref c-%data%
                                                (i j)
                                                ((1 ldc) (1 *))
                                                c-%offset%)
                                 (* temp
                                    (f2cl-lib:fref a-%data%
                                                   (i l)
                                                   ((1 lda) (1 *))
                                                   a-%offset%)))))))))))))))
          (t
           (cond
             (upper
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
                (tagbody
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                ((> i
                                    (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                                 nil)
                    (tagbody
                      (setf temp (coerce zero '(complex double-float)))
                      (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                                    ((> l k) nil)
                        (tagbody
                          (setf temp
                                  (+ temp
                                     (*
                                      (f2cl-lib:dconjg
                                       (f2cl-lib:fref a-%data%
                                                      (l i)
                                                      ((1 lda) (1 *))
                                                      a-%offset%))
                                      (f2cl-lib:fref a-%data%
                                                     (l j)
                                                     ((1 lda) (1 *))
                                                     a-%offset%))))))
                      (cond
                        ((= beta zero)
                         (setf (f2cl-lib:fref c-%data%
                                              (i j)
                                              ((1 ldc) (1 *))
                                              c-%offset%)
                                 (* alpha temp)))
                        (t
                         (setf (f2cl-lib:fref c-%data%
                                              (i j)
                                              ((1 ldc) (1 *))
                                              c-%offset%)
                                 (+ (* alpha temp)
```

```
                        (* beta
                           (f2cl-lib:fref c-%data%
                                          (i j)
                                          ((1 ldc) (1 *))
                                          c-%offset%))))))))
      (setf rtemp zero)
      (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                    ((> l k) nil)
        (tagbody
          (setf rtemp
                  (coerce
                   (realpart
                    (+ rtemp
                       (*
                        (f2cl-lib:dconjg
                         (f2cl-lib:fref a-%data%
                                        (l j)
                                        ((1 lda) (1 *))
                                        a-%offset%))
                        (f2cl-lib:fref a-%data%
                                       (l j)
                                       ((1 lda) (1 *))
                                       a-%offset%))))
                    'double-float))))
      (cond
        ((= beta zero)
         (setf (f2cl-lib:fref c-%data%
                              (j j)
                              ((1 ldc) (1 *))
                              c-%offset%)
                 (coerce (* alpha rtemp) '(complex double-float))))
        (t
         (setf (f2cl-lib:fref c-%data%
                              (j j)
                              ((1 ldc) (1 *))
                              c-%offset%)
                 (coerce
                  (+ (* alpha rtemp)
                     (* beta
                        (coerce (realpart
                         (f2cl-lib:fref c-%data%
                                        (j j)
                                        ((1 ldc) (1 *))
                                        c-%offset%))
                          'double-float)))
                  '(complex double-float)))))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
```

```
(setf rtemp zero)
(f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
              ((> l k) nil)
  (tagbody
    (setf rtemp
            (coerce
             (realpart
              (+ rtemp
                 (*
                  (f2cl-lib:dconjg
                   (f2cl-lib:fref a-%data%
                                  (l j)
                                  ((1 lda) (1 *))
                                  a-%offset%))
                  (f2cl-lib:fref a-%data%
                                 (l j)
                                 ((1 lda) (1 *))
                                 a-%offset%))))
             'double-float))))
(cond
  ((= beta zero)
   (setf (f2cl-lib:fref c-%data%
                        (j j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (coerce (* alpha rtemp) '(complex double-float))))
  (t
   (setf (f2cl-lib:fref c-%data%
                        (j j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (coerce
          (+ (* alpha rtemp)
             (* beta
                (coerce (realpart
                 (f2cl-lib:fref c-%data%
                                (j j)
                                ((1 ldc) (1 *))
                                c-%offset%))
                  'double-float)))
          '(complex double-float)))))
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                 (f2cl-lib:int-add i 1))
              ((> i n) nil)
  (tagbody
    (setf temp (coerce zero '(complex double-float)))
    (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                  ((> l k) nil)
      (tagbody
        (setf temp
```

```
                                (+ temp
                                   (*
                                    (f2cl-lib:dconjg
                                     (f2cl-lib:fref a-%data%
                                                    (l i)
                                                    ((1 lda) (1 *))
                                                    a-%offset%))
                                     (f2cl-lib:fref a-%data%
                                                    (l j)
                                                    ((1 lda) (1 *))
                                                    a-%offset%))))))
                        (cond
                          ((= beta zero)
                           (setf (f2cl-lib:fref c-%data%
                                                (i j)
                                                ((1 ldc) (1 *))
                                                c-%offset%)
                                 (* alpha temp)))
                          (t
                           (setf (f2cl-lib:fref c-%data%
                                                (i j)
                                                ((1 ldc) (1 *))
                                                c-%offset%)
                                 (+ (* alpha temp)
                                    (* beta
                                       (f2cl-lib:fref c-%data%
                                                      (i j)
                                                      ((1 ldc) (1 *))
                                                      c-%offset%)))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil nil))))))
```

———-

5.11 zsymm BLAS

— **zsymm.input** —

```
)set break resume
)sys rm -f zsymm.output
)spool zsymm.output
)set message test on
)set message auto off
)clear all

)spool
```

```
)lisp (bye)
```

— zsymm.help —

```
==========================================================================
zsymm examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      ZSYMM - perform one of the matrix-matrix operations   C :=
      alpha*A*B + beta*C,

 SYNOPSIS
      SUBROUTINE ZSYMM ( SIDE, UPLO, M, N, ALPHA, A, LDA, B, LDB,
                         BETA, C, LDC )

          CHARACTER*1  SIDE, UPLO

          INTEGER      M, N, LDA, LDB, LDC

          COMPLEX*16   ALPHA, BETA

          COMPLEX*16   A( LDA, * ), B( LDB, * ), C( LDC, * )

 PURPOSE
      ZSYMM  performs one of the matrix-matrix operations

      or

         C := alpha*B*A + beta*C,

      where  alpha and beta are scalars, A is a symmetric matrix
      and  B and C are m by n matrices.

 PARAMETERS
      SIDE   - CHARACTER*1.
               On entry,  SIDE  specifies whether  the  symmetric
               matrix  A appears on the  left or right  in the
               operation as follows:

               SIDE = 'L' or 'l'   C := alpha*A*B + beta*C,

               SIDE = 'R' or 'r'   C := alpha*B*A + beta*C,
```

```
            Unchanged on exit.

      UPLO  - CHARACTER*1.
            On  entry,  UPLO  specifies  whether  the  upper  or
            lower triangular  part  of  the  symmetric  matrix
            A  is  to  be referenced as follows:

            UPLO = 'U' or 'u'   Only the upper triangular part of
            the symmetric matrix is to be referenced.

            UPLO = 'L' or 'l'   Only the lower triangular part of
            the symmetric matrix is to be referenced.

            Unchanged on exit.

      M     - INTEGER.
            On entry,  M  specifies the number of rows of the
            matrix  C.  M  must be at least zero.  Unchanged on
            exit.

      N     - INTEGER.
            On entry, N specifies the number of columns of the
            matrix C.  N  must be at least zero.  Unchanged on
            exit.

      ALPHA - COMPLEX*16      .
            On entry, ALPHA specifies the scalar alpha.
            Unchanged on exit.

 ka is
      A     -
             COMPLEX*16       array of DIMENSION ( LDA, ka ), where
            m  when  SIDE = 'L' or 'l'  and is n  otherwise.
            Before entry  with  SIDE = 'L' or 'l',  the  m by m
            part of the array  A  must contain the  symmetric
            matrix,  such that when  UPLO = 'U' or 'u', the lead-
            ing m by m upper triangular part of the array  A
            must contain the upper triangular part of the  sym-
            metric matrix and the  strictly  lower triangular
            part of  A  is not referenced,  and when  UPLO = 'L'
            or 'l', the leading  m by m  lower triangular part
            of the  array  A must  contain  the  lower triangular
            part  of the  symmetric matrix and the  strictly
            upper triangular part of  A  is not referenced.
            Before entry  with  SIDE = 'R' or 'r',  the  n by n
            part of the array  A  must contain the  symmetric
            matrix,  such that when  UPLO = 'U' or 'u', the lead-
            ing n by n upper triangular part of the array  A
            must contain the upper triangular part of the  sym-
```

```
*           metric matrix and the  strictly  lower triangular
*           part of  A  is not referenced,  and when  UPLO = 'L'
*           or 'l', the leading  n by n  lower triangular part
*           of the  array  A must  contain  the  lower triangular
*           part  of the  symmetric matrix and the  strictly
*           upper triangular part of  A  is not referenced.
*           Unchanged on exit.
*
*  LDA    - INTEGER.
*           On entry, LDA specifies the first dimension of A as
*           declared in the  calling (sub) program. When  SIDE =
*           'L' or 'l'  then LDA must be at least  max( 1, m ),
*           otherwise  LDA must be at least max( 1, n ).
*           Unchanged on exit.
*
*  B      - COMPLEX*16       array of DIMENSION ( LDB, n ).
*           Before entry, the leading  m by n part of the array
*           B  must contain the matrix B.  Unchanged on exit.
*
*  LDB    - INTEGER.
*           On entry, LDB specifies the first dimension of B as
*           declared in  the  calling  (sub)  program.   LDB
*           must  be  at  least max( 1, m ).  Unchanged on exit.
*
*  BETA   - COMPLEX*16      .
*           On entry,  BETA  specifies the scalar  beta.  When
*           BETA  is supplied as zero then C need not be set on
*           input.  Unchanged on exit.
*
*  C      - COMPLEX*16       array of DIMENSION ( LDC, n ).
*           Before entry, the leading  m by n  part of the array
*           C must contain the matrix  C,  except when  beta  is
*           zero, in which case C need not be set on entry.  On
*           exit, the array  C  is overwritten by the  m by n
*           updated matrix.
*
*  LDC    - INTEGER.
*           On entry, LDC specifies the first dimension of C as
*           declared in  the  calling  (sub)  program.   LDC
*           must  be  at  least max( 1, m ).  Unchanged on exit.
*
*
*  -------------
*
*  -- zsymm.f --
*
      SUBROUTINE ZSYMM ( SIDE, UPLO, M, N, ALPHA, A, LDA, B, LDB,
     $                   BETA, C, LDC )
*     .. Scalar Arguments ..
```

```
      CHARACTER*1        SIDE, UPLO
      INTEGER            M, N, LDA, LDB, LDC
      COMPLEX*16         ALPHA, BETA
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), B( LDB, * ), C( LDC, * )
*     ..
*
*  Level 3 Blas routine.
*
*  -- Written on 8-February-1989.
*     Jack Dongarra, Argonne National Laboratory.
*     Iain Duff, AERE Harwell.
*     Jeremy Du Croz, Numerical Algorithms Group Ltd.
*     Sven Hammarling, Numerical Algorithms Group Ltd.
*
*
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     .. Local Scalars ..
      LOGICAL            UPPER
      INTEGER            I, INFO, J, K, NROWA
      COMPLEX*16         TEMP1, TEMP2
*     .. Parameters ..
      COMPLEX*16         ONE
      PARAMETER        ( ONE  = ( 1.0D+0, 0.0D+0 ) )
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     ..
*     .. Executable Statements ..
*
*     Set NROWA as the number of rows of A.
*
      IF( LSAME( SIDE, 'L' ) )THEN
         NROWA = M
      ELSE
         NROWA = N
      END IF
      UPPER = LSAME( UPLO, 'U' )
*
*     Test the input parameters.
*
      INFO = 0
      IF(      ( .NOT.LSAME( SIDE, 'L' ) ).AND.
     $         ( .NOT.LSAME( SIDE, 'R' ) )      )THEN
         INFO = 1
```

```
      ELSE IF( ( .NOT.UPPER              ).AND.
     $         ( .NOT.LSAME( UPLO, 'L' ) )      )THEN
         INFO = 2
      ELSE IF( M  .LT.0               )THEN
         INFO = 3
      ELSE IF( N  .LT.0               )THEN
         INFO = 4
      ELSE IF( LDA.LT.MAX( 1, NROWA ) )THEN
         INFO = 7
      ELSE IF( LDB.LT.MAX( 1, M     ) )THEN
         INFO = 9
      ELSE IF( LDC.LT.MAX( 1, M     ) )THEN
         INFO = 12
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZSYMM ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( M.EQ.0 ).OR.( N.EQ.0 ).OR.
     $    ( ( ALPHA.EQ.ZERO ).AND.( BETA.EQ.ONE ) ) )
     $   RETURN
*
*     And when  alpha.eq.zero.
*
      IF( ALPHA.EQ.ZERO )THEN
         IF( BETA.EQ.ZERO )THEN
            DO 20, J = 1, N
               DO 10, I = 1, M
                  C( I, J ) = ZERO
   10          CONTINUE
   20       CONTINUE
         ELSE
            DO 40, J = 1, N
               DO 30, I = 1, M
                  C( I, J ) = BETA*C( I, J )
   30          CONTINUE
   40       CONTINUE
         END IF
         RETURN
      END IF
*
*     Start the operations.
*
      IF( LSAME( SIDE, 'L' ) )THEN
*
*        Form  C := alpha*A*B + beta*C.
*
```

```
         IF( UPPER )THEN
            DO 70, J = 1, N
               DO 60, I = 1, M
                  TEMP1 = ALPHA*B( I, J )
                  TEMP2 = ZERO
                  DO 50, K = 1, I - 1
                     C( K, J ) = C( K, J ) + TEMP1    *A( K, I )
                     TEMP2     = TEMP2     + B( K, J )*A( K, I )
   50             CONTINUE
                  IF( BETA.EQ.ZERO )THEN
                     C( I, J ) = TEMP1*A( I, I ) + ALPHA*TEMP2
                  ELSE
                     C( I, J ) = BETA *C( I, J ) +
     $                           TEMP1*A( I, I ) + ALPHA*TEMP2
                  END IF
   60          CONTINUE
   70       CONTINUE
         ELSE
            DO 100, J = 1, N
               DO 90, I = M, 1, -1
                  TEMP1 = ALPHA*B( I, J )
                  TEMP2 = ZERO
                  DO 80, K = I + 1, M
                     C( K, J ) = C( K, J ) + TEMP1    *A( K, I )
                     TEMP2     = TEMP2     + B( K, J )*A( K, I )
   80             CONTINUE
                  IF( BETA.EQ.ZERO )THEN
                     C( I, J ) = TEMP1*A( I, I ) + ALPHA*TEMP2
                  ELSE
                     C( I, J ) = BETA *C( I, J ) +
     $                           TEMP1*A( I, I ) + ALPHA*TEMP2
                  END IF
   90          CONTINUE
  100       CONTINUE
         END IF
      ELSE
*
*        Form  C := alpha*B*A + beta*C.
*
         DO 170, J = 1, N
            TEMP1 = ALPHA*A( J, J )
            IF( BETA.EQ.ZERO )THEN
               DO 110, I = 1, M
                  C( I, J ) = TEMP1*B( I, J )
  110          CONTINUE
            ELSE
               DO 120, I = 1, M
                  C( I, J ) = BETA*C( I, J ) + TEMP1*B( I, J )
  120          CONTINUE
            END IF
```

```
            DO 140, K = 1, J - 1
               IF( UPPER )THEN
                  TEMP1 = ALPHA*A( K, J )
               ELSE
                  TEMP1 = ALPHA*A( J, K )
               END IF
               DO 130, I = 1, M
                  C( I, J ) = C( I, J ) + TEMP1*B( I, K )
  130          CONTINUE
  140       CONTINUE
            DO 160, K = J + 1, N
               IF( UPPER )THEN
                  TEMP1 = ALPHA*A( J, K )
               ELSE
                  TEMP1 = ALPHA*A( K, J )
               END IF
               DO 150, I = 1, M
                  C( I, J ) = C( I, J ) + TEMP1*B( I, K )
  150          CONTINUE
  160       CONTINUE
  170    CONTINUE
      END IF
*
      RETURN
*
*     End of ZSYMM .
*
      END
```

———-

— BLAS 3 zsymm —

```
(let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
 (declare (type (complex double-float) one) (type (complex double-float) zero))
  (defun zsymm (side uplo m n alpha a lda b ldb$ beta c ldc)
    (declare (type (simple-array (complex double-float) (*)) c b a)
             (type (complex double-float) beta alpha)
             (type fixnum ldc ldb$ lda n m)
             (type character uplo side))
    (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (uplo character uplo-%data% uplo-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (b (complex double-float) b-%data% b-%offset%)
         (c (complex double-float) c-%data% c-%offset%))
      (prog ((temp1 #C(0.0 0.0)) (temp2 #C(0.0 0.0)) (i 0) (info 0) (j 0) (k 0)
             (nrowa 0) (upper nil))
```

```
(declare (type (complex double-float) temp1 temp2)
         (type fixnum i info j k nrowa)
         (type (member t nil) upper))
(cond
  ((char-equal side #\L)
   (setf nrowa m))
  (t
   (setf nrowa n)))
(setf upper (char-equal uplo #\U))
(setf info 0)
(cond
  ((and (not (char-equal side #\L)) (not (char-equal side #\R)))
   (setf info 1))
  ((and (not upper) (not (char-equal uplo #\L)))
   (setf info 2))
  ((< m 0)
   (setf info 3))
  ((< n 0)
   (setf info 4))
  ((< lda (max (the fixnum 1) (the fixnum nrowa)))
   (setf info 7))
  ((< ldb$ (max (the fixnum 1) (the fixnum m)))
   (setf info 9))
  ((< ldc (max (the fixnum 1) (the fixnum m)))
   (setf info 12)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "ZSYMM" info)
   (go end_label)))
(if (or (= m 0) (= n 0) (and (= alpha zero) (= beta one)))
    (go end_label))
(cond
  ((= alpha zero)
   (cond
     ((= beta zero)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref c-%data%
                                   (i j)
                                   ((1 ldc) (1 *))
                                   c-%offset%)
                    zero))))))
     (t
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
```

```
                    ((> j n) nil)
            (tagbody
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                            ((> i m) nil)
                (tagbody
                  (setf (f2cl-lib:fref c-%data%
                                       (i j)
                                       ((1 ldc) (1 *))
                                       c-%offset%)
                          (* beta
                             (f2cl-lib:fref c-%data%
                                            (i j)
                                            ((1 ldc) (1 *))
                                            c-%offset%)))))))
       (go end_label)))
    (cond
      ((char-equal side #\L)
       (cond
         (upper
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                        ((> j n) nil)
            (tagbody
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                            ((> i m) nil)
                (tagbody
                  (setf temp1
                          (* alpha
                             (f2cl-lib:fref b-%data%
                                            (i j)
                                            ((1 ldb$) (1 *))
                                            b-%offset%)))
                  (setf temp2 zero)
                  (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                                ((> k
                                    (f2cl-lib:int-add i
                                                      (f2cl-lib:int-sub
                                                       1)))
                                 nil)
                    (tagbody
                      (setf (f2cl-lib:fref c-%data%
                                           (k j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                              (+
                               (f2cl-lib:fref c-%data%
                                              (k j)
                                              ((1 ldc) (1 *))
                                              c-%offset%)
                               (* temp1
                                  (f2cl-lib:fref a-%data%
```

```
                                          (k i)
                                          ((1 lda) (1 *))
                                          a-%offset%))))
                    (setf temp2
                            (+ temp2
                               (*
                                (f2cl-lib:fref b-%data%
                                          (k j)
                                          ((1 ldb$) (1 *))
                                          b-%offset%)
                                (f2cl-lib:fref a-%data%
                                          (k i)
                                          ((1 lda) (1 *))
                                          a-%offset%))))))
              (cond
                ((= beta zero)
                 (setf (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (+
                        (* temp1
                           (f2cl-lib:fref a-%data%
                                          (i i)
                                          ((1 lda) (1 *))
                                          a-%offset%))
                        (* alpha temp2))))
                (t
                 (setf (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (+
                        (* beta
                           (f2cl-lib:fref c-%data%
                                          (i j)
                                          ((1 ldc) (1 *))
                                          c-%offset%))
                        (* temp1
                           (f2cl-lib:fref a-%data%
                                          (i i)
                                          ((1 lda) (1 *))
                                          a-%offset%))
                        (* alpha temp2)))))))))
        (t
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (f2cl-lib:fdo (i m (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                           ((> i 1) nil)
```

```
(tagbody
  (setf temp1
        (* alpha
           (f2cl-lib:fref b-%data%
                          (i j)
                          ((1 ldb$) (1 *))
                          b-%offset%)))
  (setf temp2 zero)
  (f2cl-lib:fdo (k (f2cl-lib:int-add i 1)
                 (f2cl-lib:int-add k 1))
                ((> k m) nil)
    (tagbody
      (setf (f2cl-lib:fref c-%data%
                           (k j)
                           ((1 ldc) (1 *))
                           c-%offset%)
            (+
             (f2cl-lib:fref c-%data%
                            (k j)
                            ((1 ldc) (1 *))
                            c-%offset%)
             (* temp1
                (f2cl-lib:fref a-%data%
                               (k i)
                               ((1 lda) (1 *))
                               a-%offset%))))
      (setf temp2
            (+ temp2
               (*
                (f2cl-lib:fref b-%data%
                               (k j)
                               ((1 ldb$) (1 *))
                               b-%offset%)
                (f2cl-lib:fref a-%data%
                               (k i)
                               ((1 lda) (1 *))
                               a-%offset%))))))
  (cond
    ((= beta zero)
     (setf (f2cl-lib:fref c-%data%
                          (i j)
                          ((1 ldc) (1 *))
                          c-%offset%)
           (+
            (* temp1
               (f2cl-lib:fref a-%data%
                              (i i)
                              ((1 lda) (1 *))
                              a-%offset%))
            (* alpha temp2))))
```

```
                (t
                 (setf (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (+
                        (* beta
                           (f2cl-lib:fref c-%data%
                                          (i j)
                                          ((1 ldc) (1 *))
                                          c-%offset%))
                        (* temp1
                           (f2cl-lib:fref a-%data%
                                          (i i)
                                          ((1 lda) (1 *))
                                          a-%offset%))
                        (* alpha temp2))))))))))))
          (t
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (setf temp1
                     (* alpha
                        (f2cl-lib:fref a-%data%
                                       (j j)
                                       ((1 lda) (1 *))
                                       a-%offset%)))
               (cond
                 ((= beta zero)
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                ((> i m) nil)
                    (tagbody
                      (setf (f2cl-lib:fref c-%data%
                                           (i j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                            (* temp1
                               (f2cl-lib:fref b-%data%
                                              (i j)
                                              ((1 ldb$) (1 *))
                                              b-%offset%))))))
                 (t
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                ((> i m) nil)
                    (tagbody
                      (setf (f2cl-lib:fref c-%data%
                                           (i j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                            (+
```

```
                    (* beta
                       (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%))
                    (* temp1
                       (f2cl-lib:fref b-%data%
                                      (i j)
                                      ((1 ldb$) (1 *))
                                      b-%offset%))))))))
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
              ((> k (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
               nil)
  (tagbody
    (cond
      (upper
       (setf temp1
               (* alpha
                  (f2cl-lib:fref a-%data%
                                 (k j)
                                 ((1 lda) (1 *))
                                 a-%offset%))))
      (t
       (setf temp1
               (* alpha
                  (f2cl-lib:fref a-%data%
                                 (j k)
                                 ((1 lda) (1 *))
                                 a-%offset%)))))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  ((> i m) nil)
      (tagbody
        (setf (f2cl-lib:fref c-%data%
                             (i j)
                             ((1 ldc) (1 *))
                             c-%offset%)
                (+
                 (f2cl-lib:fref c-%data%
                                (i j)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* temp1
                    (f2cl-lib:fref b-%data%
                                   (i k)
                                   ((1 ldb$) (1 *))
                                   b-%offset%))))))))
(f2cl-lib:fdo (k (f2cl-lib:int-add j 1) (f2cl-lib:int-add k 1))
              ((> k n) nil)
  (tagbody
    (cond
```

```
                    (upper
                     (setf temp1
                             (* alpha
                                (f2cl-lib:fref a-%data%
                                               (j k)
                                               ((1 lda) (1 *))
                                               a-%offset%))))
                    (t
                     (setf temp1
                             (* alpha
                                (f2cl-lib:fref a-%data%
                                               (k j)
                                               ((1 lda) (1 *))
                                               a-%offset%)))))
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                ((> i m) nil)
                    (tagbody
                      (setf (f2cl-lib:fref c-%data%
                                           (i j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                             (+
                              (f2cl-lib:fref c-%data%
                                             (i j)
                                             ((1 ldc) (1 *))
                                             c-%offset%)
                              (* temp1
                                 (f2cl-lib:fref b-%data%
                                                (i k)
                                                ((1 ldb$) (1 *))
                                                b-%offset%))))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil nil nil nil))))))
```

———-

5.12 zsyr2k BLAS

— **zsyr2k.input** —

```
)set break resume
)sys rm -f zsyr2k.output
)spool zsyr2k.output
)set message test on
)set message auto off
)clear all
```

```
)spool
)lisp (bye)
```

———-

— zsyr2k.help —

```
==========================================================================
zsyr2k examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      ZSYR2K - perform one of the symmetric rank 2k operations   C
      := alpha*A*B' + alpha*B*A' + beta*C,

 SYNOPSIS
      SUBROUTINE ZSYR2K( UPLO, TRANS, N, K, ALPHA, A, LDA, B, LDB,
                         BETA, C, LDC )

          CHARACTER*1    UPLO, TRANS

          INTEGER        N, K, LDA, LDB, LDC

          COMPLEX*16     ALPHA, BETA

          COMPLEX*16     A( LDA, * ), B( LDB, * ), C( LDC, * )

 PURPOSE
      ZSYR2K  performs one of the symmetric rank 2k operations

      or

         C := alpha*A'*B + alpha*B'*A + beta*C,

      where  alpha and beta  are scalars,  C is an  n by n sym-
      metric matrix and  A and B  are  n by k  matrices  in the
      first  case  and  k by n matrices in the second case.

 PARAMETERS
      UPLO   - CHARACTER*1.
               On  entry,   UPLO  specifies  whether  the  upper  or
               lower triangular  part  of the  array  C  is to be
               referenced  as follows:
```

```
           UPLO = 'U' or 'u'   Only the  upper triangular part
           of  C is to be referenced.

           UPLO = 'L' or 'l'   Only the  lower triangular part
           of  C is to be referenced.

           Unchanged on exit.

     TRANS  - CHARACTER*1.
           On entry,  TRANS  specifies the operation to be per-
           formed as follows:

           TRANS = 'N' or 'n'    C := alpha*A*B' + alpha*B*A' +
           beta*C.

           TRANS = 'T' or 't'    C := alpha*A'*B + alpha*B'*A +
           beta*C.

           Unchanged on exit.

     N      - INTEGER.
           On entry,  N specifies the order of the matrix C.  N
           must be at least zero.  Unchanged on exit.

     K      - INTEGER.
           On entry with  TRANS = 'N' or 'n',  K  specifies  the
           number of  columns  of the  matrices  A and B,  and
           on  entry  with TRANS = 'T' or 't',  K  specifies
           the number of rows of the matrices  A and B.  K must
           be at least zero.  Unchanged on exit.

     ALPHA  - COMPLEX*16      .
           On entry, ALPHA specifies the scalar alpha.
           Unchanged on exit.

ka is
     A      -
            COMPLEX*16       array of DIMENSION ( LDA, ka ), where
           k  when  TRANS = 'N' or 'n',  and is  n  otherwise.
           Before entry with  TRANS = 'N' or 'n',  the  leading
           n by k part of the array  A  must contain the matrix
           A,  otherwise the leading  k by n  part of the array
           A  must contain  the matrix A.  Unchanged on exit.

     LDA    - INTEGER.
           On entry, LDA specifies the first dimension of A as
           declared in  the  calling  (sub)  program.   When
           TRANS = 'N' or 'n' then  LDA must be at least  max(
           1, n ), otherwise  LDA must be at least  max( 1, k ).
           Unchanged on exit.
```

```
kb is
     B      -
             COMPLEX*16       array of DIMENSION ( LDB, kb ), where
            k  when  TRANS = 'N' or 'n',  and is  n  otherwise.
            Before entry with  TRANS = 'N' or 'n',  the  leading
            n by k part of the array  B  must contain the matrix
            B,  otherwise the leading  k by n  part of the array
            B  must contain  the matrix B.  Unchanged on exit.

     LDB    - INTEGER.
            On entry, LDB specifies the first dimension of B as
            declared in  the  calling  (sub)  program.   When
            TRANS = 'N' or 'n' then  LDB must be at least  max(
            1, n ), otherwise  LDB must be at least  max( 1, k ).
            Unchanged on exit.

     BETA   - COMPLEX*16      .
            On entry, BETA specifies the scalar beta.  Unchanged
            on exit.

     C      - COMPLEX*16       array of DIMENSION ( LDC, n ).
            Before entry  with  UPLO = 'U' or 'u',  the leading
            n by n upper triangular part of the array C must con-
            tain the upper triangular part  of the  symmetric
            matrix  and the strictly lower triangular part of C
            is not referenced.  On exit, the upper triangular
            part of the array  C is overwritten by the upper tri-
            angular part of the updated matrix.  Before entry
            with  UPLO = 'L' or 'l',  the leading  n by n lower
            triangular part of the array C must contain the lower
            triangular part  of the  symmetric matrix  and the
            strictly upper triangular part of C is not refer-
            enced.  On exit, the lower triangular part of the
            array  C is overwritten by the lower triangular part
            of the updated matrix.

     LDC    - INTEGER.
            On entry, LDC specifies the first dimension of C as
            declared in  the  calling  (sub)  program.   LDC
            must  be  at  least max( 1, n ).  Unchanged on exit.
```

———-

— **zsyr2k.f** —

```
      SUBROUTINE ZSYR2K( UPLO, TRANS, N, K, ALPHA, A, LDA, B, LDB,
     $                   BETA, C, LDC )
```

```
*     .. Scalar Arguments ..
      CHARACTER*1        UPLO, TRANS
      INTEGER            N, K, LDA, LDB, LDC
      COMPLEX*16         ALPHA, BETA
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), B( LDB, * ), C( LDC, * )
*     ..
*
*  Level 3 Blas routine.
*
*  -- Written on 8-February-1989.
*     Jack Dongarra, Argonne National Laboratory.
*     Iain Duff, AERE Harwell.
*     Jeremy Du Croz, Numerical Algorithms Group Ltd.
*     Sven Hammarling, Numerical Algorithms Group Ltd.
*
*
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     .. Local Scalars ..
      LOGICAL            UPPER
      INTEGER            I, INFO, J, L, NROWA
      COMPLEX*16         TEMP1, TEMP2
*     .. Parameters ..
      COMPLEX*16         ONE
      PARAMETER        ( ONE  = ( 1.0D+0, 0.0D+0 ) )
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      IF( LSAME( TRANS, 'N' ) )THEN
         NROWA = N
      ELSE
         NROWA = K
      END IF
      UPPER = LSAME( UPLO, 'U' )
*
      INFO = 0
      IF(      ( .NOT.UPPER               ).AND.
     $         ( .NOT.LSAME( UPLO , 'L' ) )      )THEN
         INFO = 1
      ELSE IF( ( .NOT.LSAME( TRANS, 'N' ) ).AND.
```

```
     $         ( .NOT.LSAME( TRANS, 'T' ) )      )THEN
          INFO = 2
       ELSE IF( N  .LT.0               )THEN
          INFO = 3
       ELSE IF( K  .LT.0               )THEN
          INFO = 4
       ELSE IF( LDA.LT.MAX( 1, NROWA ) )THEN
          INFO = 7
       ELSE IF( LDB.LT.MAX( 1, NROWA ) )THEN
          INFO = 9
       ELSE IF( LDC.LT.MAX( 1, N     ) )THEN
          INFO = 12
       END IF
       IF( INFO.NE.0 )THEN
          CALL XERBLA( 'ZSYR2K', INFO )
          RETURN
       END IF
*
*      Quick return if possible.
*
       IF( ( N.EQ.0 ).OR.
     $    ( ( ( ALPHA.EQ.ZERO ).OR.( K.EQ.0 ) ).AND.( BETA.EQ.ONE ) ) )
     $   RETURN
*
*      And when  alpha.eq.zero.
*
       IF( ALPHA.EQ.ZERO )THEN
          IF( UPPER )THEN
             IF( BETA.EQ.ZERO )THEN
                DO 20, J = 1, N
                   DO 10, I = 1, J
                      C( I, J ) = ZERO
   10              CONTINUE
   20           CONTINUE
             ELSE
                DO 40, J = 1, N
                   DO 30, I = 1, J
                      C( I, J ) = BETA*C( I, J )
   30              CONTINUE
   40           CONTINUE
             END IF
          ELSE
             IF( BETA.EQ.ZERO )THEN
                DO 60, J = 1, N
                   DO 50, I = J, N
                      C( I, J ) = ZERO
   50              CONTINUE
   60           CONTINUE
             ELSE
                DO 80, J = 1, N
```

```
                  DO 70, I = J, N
                     C( I, J ) = BETA*C( I, J )
   70             CONTINUE
   80          CONTINUE
            END IF
         END IF
         RETURN
      END IF
*
*     Start the operations.
*
      IF( LSAME( TRANS, 'N' ) )THEN
*
*        Form  C := alpha*A*B' + alpha*B*A' + C.
*
         IF( UPPER )THEN
            DO 130, J = 1, N
               IF( BETA.EQ.ZERO )THEN
                  DO 90, I = 1, J
                     C( I, J ) = ZERO
   90             CONTINUE
               ELSE IF( BETA.NE.ONE )THEN
                  DO 100, I = 1, J
                     C( I, J ) = BETA*C( I, J )
  100             CONTINUE
               END IF
               DO 120, L = 1, K
                  IF( ( A( J, L ).NE.ZERO ).OR.
     $                ( B( J, L ).NE.ZERO )     )THEN
                     TEMP1 = ALPHA*B( J, L )
                     TEMP2 = ALPHA*A( J, L )
                     DO 110, I = 1, J
                        C( I, J ) = C( I, J ) + A( I, L )*TEMP1 +
     $                                          B( I, L )*TEMP2
  110                CONTINUE
                  END IF
  120          CONTINUE
  130       CONTINUE
         ELSE
            DO 180, J = 1, N
               IF( BETA.EQ.ZERO )THEN
                  DO 140, I = J, N
                     C( I, J ) = ZERO
  140             CONTINUE
               ELSE IF( BETA.NE.ONE )THEN
                  DO 150, I = J, N
                     C( I, J ) = BETA*C( I, J )
  150             CONTINUE
               END IF
               DO 170, L = 1, K
```

```
                  IF( ( A( J, L ).NE.ZERO ).OR.
     $                ( B( J, L ).NE.ZERO )     )THEN
                     TEMP1 = ALPHA*B( J, L )
                     TEMP2 = ALPHA*A( J, L )
                     DO 160, I = J, N
                        C( I, J ) = C( I, J ) + A( I, L )*TEMP1 +
     $                                          B( I, L )*TEMP2
  160                CONTINUE
                  END IF
  170             CONTINUE
  180          CONTINUE
            END IF
         ELSE
*
*           Form  C := alpha*A'*B + alpha*B'*A + C.
*
            IF( UPPER )THEN
               DO 210, J = 1, N
                  DO 200, I = 1, J
                     TEMP1 = ZERO
                     TEMP2 = ZERO
                     DO 190, L = 1, K
                        TEMP1 = TEMP1 + A( L, I )*B( L, J )
                        TEMP2 = TEMP2 + B( L, I )*A( L, J )
  190                CONTINUE
                     IF( BETA.EQ.ZERO )THEN
                        C( I, J ) = ALPHA*TEMP1 + ALPHA*TEMP2
                     ELSE
                        C( I, J ) = BETA *C( I, J ) +
     $                              ALPHA*TEMP1 + ALPHA*TEMP2
                     END IF
  200             CONTINUE
  210          CONTINUE
            ELSE
               DO 240, J = 1, N
                  DO 230, I = J, N
                     TEMP1 = ZERO
                     TEMP2 = ZERO
                     DO 220, L = 1, K
                        TEMP1 = TEMP1 + A( L, I )*B( L, J )
                        TEMP2 = TEMP2 + B( L, I )*A( L, J )
  220                CONTINUE
                     IF( BETA.EQ.ZERO )THEN
                        C( I, J ) = ALPHA*TEMP1 + ALPHA*TEMP2
                     ELSE
                        C( I, J ) = BETA *C( I, J ) +
     $                              ALPHA*TEMP1 + ALPHA*TEMP2
                     END IF
  230             CONTINUE
  240          CONTINUE
```

```
         END IF
      END IF
*
      RETURN
*
*     End of ZSYR2K.
*
      END
```

———-

— BLAS 3 zsyr2k —

```
(let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
 (declare (type (complex double-float) one) (type (complex double-float) zero))
  (defun zsyr2k (uplo trans n k alpha a lda b ldb$ beta c ldc)
    (declare (type (simple-array (complex double-float) (*)) c b a)
             (type (complex double-float) beta alpha)
             (type fixnum ldc ldb$ lda k n)
             (type character trans uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (b (complex double-float) b-%data% b-%offset%)
         (c (complex double-float) c-%data% c-%offset%))
      (prog ((temp1 #C(0.0 0.0)) (temp2 #C(0.0 0.0)) (i 0) (info 0) (j 0) (l 0)
             (nrowa 0) (upper nil))
        (declare (type (complex double-float) temp1 temp2)
                 (type fixnum i info j l nrowa)
                 (type (member t nil) upper))
        (cond
          ((char-equal trans #\N)
           (setf nrowa n))
          (t
           (setf nrowa k)))
        (setf upper (char-equal uplo #\U))
        (setf info 0)
        (cond
          ((and (not upper) (not (char-equal uplo #\L)))
           (setf info 1))
          ((and (not (char-equal trans #\N)) (not (char-equal trans #\T)))
           (setf info 2))
          ((< n 0)
           (setf info 3))
          ((< k 0)
           (setf info 4))
          ((< lda (max (the fixnum 1) (the fixnum nrowa)))
```

```
   (setf info 7))
  ((< ldb$
      (max (the fixnum 1) (the fixnum nrowa)))
   (setf info 9))
  ((< ldc (max (the fixnum 1) (the fixnum n)))
   (setf info 12)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "ZSYR2K" info)
   (go end_label)))
(if (or (= n 0) (and (or (= alpha zero) (= k 0)) (= beta one)))
    (go end_label))
(cond
  ((= alpha zero)
   (cond
     (upper
      (cond
        ((= beta zero)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i j) nil)
               (tagbody
                 (setf (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       zero))))))
        (t
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i j) nil)
               (tagbody
                 (setf (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (* beta
                          (f2cl-lib:fref c-%data%
                                         (i j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)))))))))
     (t
      (cond
        ((= beta zero)
```

```
             (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                           ((> j n) nil)
               (tagbody
                 (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                               ((> i n) nil)
                   (tagbody
                     (setf (f2cl-lib:fref c-%data%
                                          (i j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)
                             zero))))))
            (t
             (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                           ((> j n) nil)
               (tagbody
                 (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                               ((> i n) nil)
                   (tagbody
                     (setf (f2cl-lib:fref c-%data%
                                          (i j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)
                             (* beta
                                (f2cl-lib:fref c-%data%
                                               (i j)
                                               ((1 ldc) (1 *))
                                               c-%offset%)))))))))
       (go end_label)))
    (cond
      ((char-equal trans #\N)
       (cond
         (upper
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                        ((> j n) nil)
            (tagbody
              (cond
                ((= beta zero)
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                               ((> i j) nil)
                   (tagbody
                     (setf (f2cl-lib:fref c-%data%
                                          (i j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)
                             zero))))
                ((/= beta one)
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                               ((> i j) nil)
                   (tagbody
                     (setf (f2cl-lib:fref c-%data%
```

```
                                    (i j)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                            (* beta
                               (f2cl-lib:fref c-%data%
                                              (i j)
                                              ((1 ldc) (1 *))
                                              c-%offset%)))))))
          (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                        ((> l k) nil)
            (tagbody
              (cond
                ((or (/= (f2cl-lib:fref a (j l) ((1 lda) (1 *))) zero)
                     (/= (f2cl-lib:fref b (j l) ((1 ldb$) (1 *))) zero))
                 (setf temp1
                         (* alpha
                            (f2cl-lib:fref b-%data%
                                           (j l)
                                           ((1 ldb$) (1 *))
                                           b-%offset%)))
                 (setf temp2
                         (* alpha
                            (f2cl-lib:fref a-%data%
                                           (j l)
                                           ((1 lda) (1 *))
                                           a-%offset%)))
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                               ((> i j) nil)
                   (tagbody
                     (setf (f2cl-lib:fref c-%data%
                                          (i j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)
                           (+
                            (f2cl-lib:fref c-%data%
                                           (i j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                            (*
                             (f2cl-lib:fref a-%data%
                                            (i l)
                                            ((1 lda) (1 *))
                                            a-%offset%)
                             temp1)
                            (*
                             (f2cl-lib:fref b-%data%
                                            (i l)
                                            ((1 ldb$) (1 *))
                                            b-%offset%)
                             temp2)))))))))))
```

```
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (cond
       ((= beta zero)
        (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                      ((> i n) nil)
          (tagbody
            (setf (f2cl-lib:fref c-%data%
                                 (i j)
                                 ((1 ldc) (1 *))
                                 c-%offset%)
                  zero))))
       ((/= beta one)
        (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                      ((> i n) nil)
          (tagbody
            (setf (f2cl-lib:fref c-%data%
                                 (i j)
                                 ((1 ldc) (1 *))
                                 c-%offset%)
                  (* beta
                     (f2cl-lib:fref c-%data%
                                    (i j)
                                    ((1 ldc) (1 *))
                                    c-%offset%)))))))
     (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                   ((> l k) nil)
       (tagbody
         (cond
           ((or (/= (f2cl-lib:fref a (j l) ((1 lda) (1 *))) zero)
                (/= (f2cl-lib:fref b (j l) ((1 ldb$) (1 *))) zero))
            (setf temp1
                  (* alpha
                     (f2cl-lib:fref b-%data%
                                    (j l)
                                    ((1 ldb$) (1 *))
                                    b-%offset%)))
            (setf temp2
                  (* alpha
                     (f2cl-lib:fref a-%data%
                                    (j l)
                                    ((1 lda) (1 *))
                                    a-%offset%)))
            (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                          ((> i n) nil)
              (tagbody
                (setf (f2cl-lib:fref c-%data%
                                     (i j)
```

```
                                          ((1 ldc) (1 *))
                                          c-%offset%)
                                  (+
                                   (f2cl-lib:fref c-%data%
                                                  (i j)
                                                  ((1 ldc) (1 *))
                                                  c-%offset%)
                                   (*
                                    (f2cl-lib:fref a-%data%
                                                   (i l)
                                                   ((1 lda) (1 *))
                                                   a-%offset%)
                                    temp1)
                                   (*
                                    (f2cl-lib:fref b-%data%
                                                   (i l)
                                                   ((1 ldb$) (1 *))
                                                   b-%offset%)
                                    temp2)))))))))))))))
          (t
           (cond
             (upper
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
                (tagbody
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                ((> i j) nil)
                    (tagbody
                      (setf temp1 zero)
                      (setf temp2 zero)
                      (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                                    ((> l k) nil)
                        (tagbody
                          (setf temp1
                                  (+ temp1
                                     (*
                                      (f2cl-lib:fref a-%data%
                                                     (l i)
                                                     ((1 lda) (1 *))
                                                     a-%offset%)
                                      (f2cl-lib:fref b-%data%
                                                     (l j)
                                                     ((1 ldb$) (1 *))
                                                     b-%offset%))))
                          (setf temp2
                                  (+ temp2
                                     (*
                                      (f2cl-lib:fref b-%data%
                                                     (l i)
                                                     ((1 ldb$) (1 *))
```

```
                                        b-%offset%)
                              (f2cl-lib:fref a-%data%
                                             (l j)
                                             ((1 lda) (1 *))
                                             a-%offset%))))))
            (cond
              ((= beta zero)
               (setf (f2cl-lib:fref c-%data%
                                    (i j)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                     (+ (* alpha temp1) (* alpha temp2))))
              (t
               (setf (f2cl-lib:fref c-%data%
                                    (i j)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                     (+
                      (* beta
                         (f2cl-lib:fref c-%data%
                                        (i j)
                                        ((1 ldc) (1 *))
                                        c-%offset%))
                      (* alpha temp1)
                      (* alpha temp2)))))))))
    (t
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   ((> j n) nil)
       (tagbody
         (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                       ((> i n) nil)
           (tagbody
             (setf temp1 zero)
             (setf temp2 zero)
             (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                           ((> l k) nil)
               (tagbody
                 (setf temp1
                       (+ temp1
                          (*
                           (f2cl-lib:fref a-%data%
                                          (l i)
                                          ((1 lda) (1 *))
                                          a-%offset%)
                           (f2cl-lib:fref b-%data%
                                          (l j)
                                          ((1 ldb$) (1 *))
                                          b-%offset%))))
                 (setf temp2
                       (+ temp2
```

```
                                    (*
                                     (f2cl-lib:fref b-%data%
                                                    (l i)
                                                    ((1 ldb$) (1 *))
                                                    b-%offset%)
                                     (f2cl-lib:fref a-%data%
                                                    (l j)
                                                    ((1 lda) (1 *))
                                                    a-%offset%))))))
                          (cond
                            ((= beta zero)
                             (setf (f2cl-lib:fref c-%data%
                                                  (i j)
                                                  ((1 ldc) (1 *))
                                                  c-%offset%)
                                     (+ (* alpha temp1) (* alpha temp2))))
                            (t
                             (setf (f2cl-lib:fref c-%data%
                                                  (i j)
                                                  ((1 ldc) (1 *))
                                                  c-%offset%)
                                     (+
                                      (* beta
                                         (f2cl-lib:fref c-%data%
                                                        (i j)
                                                        ((1 ldc) (1 *))
                                                        c-%offset%))
                                      (* alpha temp1)
                                      (* alpha temp2)))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil nil nil nil))))))
```

———-

5.13 zsyrk BLAS

— **zsyrk.input** —

```
)set break resume
)sys rm -f zsyrk.output
)spool zsyrk.output
)set message test on
)set message auto off
)clear all

)spool
```

```
)lisp (bye)
```

———-

— **zsyrk.help** —

```
==========================================================================
zsyrk examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      ZSYRK - perform one of the symmetric rank k operations   C
      := alpha*A*A' + beta*C,

 SYNOPSIS
      SUBROUTINE ZSYRK ( UPLO, TRANS, N, K, ALPHA, A, LDA, BETA,
                      C, LDC )

          CHARACTER*1  UPLO, TRANS

          INTEGER      N, K, LDA, LDC

          COMPLEX*16   ALPHA, BETA

          COMPLEX*16   A( LDA, * ), C( LDC, * )

 PURPOSE
      ZSYRK  performs one of the symmetric rank k operations

      or

         C := alpha*A'*A + beta*C,

      where  alpha and beta  are scalars,  C is an  n by n sym-
      metric matrix and  A  is an  n by k  matrix in the first
      case and a  k by n  matrix in the second case.

 PARAMETERS
      UPLO   - CHARACTER*1.
               On  entry,   UPLO  specifies  whether  the  upper  or
               lower triangular  part  of the  array  C  is to be
               referenced  as follows:

               UPLO = 'U' or 'u'   Only the  upper triangular part
               of  C is to be referenced.
```

```
           UPLO = 'L' or 'l'   Only the  lower triangular part
           of  C is to be referenced.

           Unchanged on exit.

     TRANS  - CHARACTER*1.
           On entry,  TRANS  specifies the operation to be per-
           formed as follows:

           TRANS = 'N' or 'n'   C := alpha*A*A' + beta*C.

           TRANS = 'T' or 't'   C := alpha*A'*A + beta*C.

           Unchanged on exit.

     N     - INTEGER.
           On entry,  N specifies the order of the matrix C.  N
           must be at least zero.  Unchanged on exit.

     K     - INTEGER.
           On entry with  TRANS = 'N' or 'n',  K  specifies  the
           number of  columns   of  the   matrix   A,   and  on
           entry   with TRANS = 'T' or 't',  K  specifies  the
           number of rows of the matrix A.  K must be at least
           zero.  Unchanged on exit.

     ALPHA  - COMPLEX*16      .
           On entry, ALPHA specifies the scalar alpha.
           Unchanged on exit.

ka is
     A     -
            COMPLEX*16       array of DIMENSION ( LDA, ka ), where
           k  when  TRANS = 'N' or 'n',  and is  n  otherwise.
           Before entry with  TRANS = 'N' or 'n',  the  leading
           n by k part of the array  A  must contain the matrix
           A,  otherwise the leading  k by n  part of the array
           A  must contain  the matrix A.  Unchanged on exit.

     LDA    - INTEGER.
           On entry, LDA specifies the first dimension of A as
           declared in  the  calling  (sub)  program.   When
           TRANS = 'N' or 'n' then  LDA must be at least  max(
           1, n ), otherwise  LDA must be at least  max( 1, k ).
           Unchanged on exit.

     BETA   - COMPLEX*16      .
           On entry, BETA specifies the scalar beta.  Unchanged
           on exit.
```

```
      C      - COMPLEX*16       array of DIMENSION ( LDC, n ).
             Before entry  with  UPLO = 'U' or 'u',  the leading
             n by n upper triangular part of the array C must con-
             tain the upper triangular part  of the  symmetric
             matrix  and the strictly lower triangular part of C
             is not referenced.  On exit, the upper triangular
             part of the array  C is overwritten by the upper tri-
             angular part of the updated matrix.  Before entry
             with  UPLO = 'L' or 'l',  the leading  n by n lower
             triangular part of the array C must contain the lower
             triangular part  of the  symmetric matrix  and the
             strictly upper triangular part of C is not refer-
             enced.  On exit, the lower triangular part of the
             array  C is overwritten by the lower triangular part
             of the updated matrix.

      LDC    - INTEGER.

             On entry, LDC specifies the first dimension of C as
             declared in  the  calling  (sub)  program.   LDC
             must  be  at  least max( 1, n ).  Unchanged on exit.
```

———-

— **zsyrk.f** —

```
      SUBROUTINE ZSYRK ( UPLO, TRANS, N, K, ALPHA, A, LDA,
     $                   BETA, C, LDC )
*     .. Scalar Arguments ..
      CHARACTER*1        UPLO, TRANS
      INTEGER            N, K, LDA, LDC
      COMPLEX*16         ALPHA, BETA
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), C( LDC, * )
*     ..
*
*  Level 3 Blas routine.
*
*  -- Written on 8-February-1989.
*     Jack Dongarra, Argonne National Laboratory.
*     Iain Duff, AERE Harwell.
*     Jeremy Du Croz, Numerical Algorithms Group Ltd.
*     Sven Hammarling, Numerical Algorithms Group Ltd.
*
*
*     .. External Functions ..
      LOGICAL            LSAME
```

```
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     .. Local Scalars ..
      LOGICAL            UPPER
      INTEGER            I, INFO, J, L, NROWA
      COMPLEX*16         TEMP
*     .. Parameters ..
      COMPLEX*16         ONE
      PARAMETER        ( ONE  = ( 1.0D+0, 0.0D+0 ) )
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      IF( LSAME( TRANS, 'N' ) )THEN
         NROWA = N
      ELSE
         NROWA = K
      END IF
      UPPER = LSAME( UPLO, 'U' )
*
      INFO = 0
      IF(      ( .NOT.UPPER               ).AND.
     $         ( .NOT.LSAME( UPLO , 'L' ) )      )THEN
         INFO = 1
      ELSE IF( ( .NOT.LSAME( TRANS, 'N' ) ).AND.
     $         ( .NOT.LSAME( TRANS, 'T' ) )      )THEN
         INFO = 2
      ELSE IF( N  .LT.0               )THEN
         INFO = 3
      ELSE IF( K  .LT.0               )THEN
         INFO = 4
      ELSE IF( LDA.LT.MAX( 1, NROWA ) )THEN
         INFO = 7
      ELSE IF( LDC.LT.MAX( 1, N     ) )THEN
         INFO = 10
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZSYRK ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( ( N.EQ.0 ).OR.
```

```
     $    ( ( ( ALPHA.EQ.ZERO ).OR.( K.EQ.0 ) ).AND.( BETA.EQ.ONE ) ) )
     $   RETURN
*
*     And when  alpha.eq.zero.
*
      IF( ALPHA.EQ.ZERO )THEN
         IF( UPPER )THEN
            IF( BETA.EQ.ZERO )THEN
               DO 20, J = 1, N
                  DO 10, I = 1, J
                     C( I, J ) = ZERO
   10             CONTINUE
   20          CONTINUE
            ELSE
               DO 40, J = 1, N
                  DO 30, I = 1, J
                     C( I, J ) = BETA*C( I, J )
   30             CONTINUE
   40          CONTINUE
            END IF
         ELSE
            IF( BETA.EQ.ZERO )THEN
               DO 60, J = 1, N
                  DO 50, I = J, N
                     C( I, J ) = ZERO
   50             CONTINUE
   60          CONTINUE
            ELSE
               DO 80, J = 1, N
                  DO 70, I = J, N
                     C( I, J ) = BETA*C( I, J )
   70             CONTINUE
   80          CONTINUE
            END IF
         END IF
         RETURN
      END IF
*
*     Start the operations.
*
      IF( LSAME( TRANS, 'N' ) )THEN
*
*        Form  C := alpha*A*A' + beta*C.
*
         IF( UPPER )THEN
            DO 130, J = 1, N
               IF( BETA.EQ.ZERO )THEN
                  DO 90, I = 1, J
                     C( I, J ) = ZERO
   90             CONTINUE
```

```
            ELSE IF( BETA.NE.ONE )THEN
               DO 100, I = 1, J
                  C( I, J ) = BETA*C( I, J )
  100          CONTINUE
            END IF
            DO 120, L = 1, K
               IF( A( J, L ).NE.ZERO )THEN
                  TEMP = ALPHA*A( J, L )
                  DO 110, I = 1, J
                     C( I, J ) = C( I, J ) + TEMP*A( I, L )
  110             CONTINUE
               END IF
  120       CONTINUE
  130    CONTINUE
      ELSE
         DO 180, J = 1, N
            IF( BETA.EQ.ZERO )THEN
               DO 140, I = J, N
                  C( I, J ) = ZERO
  140          CONTINUE
            ELSE IF( BETA.NE.ONE )THEN
               DO 150, I = J, N
                  C( I, J ) = BETA*C( I, J )
  150          CONTINUE
            END IF
            DO 170, L = 1, K
               IF( A( J, L ).NE.ZERO )THEN
                  TEMP      = ALPHA*A( J, L )
                  DO 160, I = J, N
                     C( I, J ) = C( I, J ) + TEMP*A( I, L )
  160             CONTINUE
               END IF
  170       CONTINUE
  180    CONTINUE
      END IF
   ELSE
*
*     Form  C := alpha*A'*A + beta*C.
*
      IF( UPPER )THEN
         DO 210, J = 1, N
            DO 200, I = 1, J
               TEMP = ZERO
               DO 190, L = 1, K
                  TEMP = TEMP + A( L, I )*A( L, J )
  190          CONTINUE
               IF( BETA.EQ.ZERO )THEN
                  C( I, J ) = ALPHA*TEMP
               ELSE
                  C( I, J ) = ALPHA*TEMP + BETA*C( I, J )
```

```
                END IF
  200          CONTINUE
  210       CONTINUE
         ELSE
            DO 240, J = 1, N
               DO 230, I = J, N
                  TEMP = ZERO
                  DO 220, L = 1, K
                     TEMP = TEMP + A( L, I )*A( L, J )
  220             CONTINUE
                  IF( BETA.EQ.ZERO )THEN
                     C( I, J ) = ALPHA*TEMP
                  ELSE
                     C( I, J ) = ALPHA*TEMP + BETA*C( I, J )
                  END IF
  230          CONTINUE
  240       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of ZSYRK .
*
      END
```

———-

— BLAS 3 zsyrk —

```
(let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
 (declare (type (complex double-float) one) (type (complex double-float) zero))
  (defun zsyrk (uplo trans n k alpha a lda beta c ldc)
    (declare (type (simple-array (complex double-float) (*)) c a)
             (type (complex double-float) beta alpha)
             (type fixnum ldc lda k n)
             (type character trans uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (trans character trans-%data% trans-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (c (complex double-float) c-%data% c-%offset%))
      (prog ((temp #C(0.0 0.0)) (i 0) (info 0) (j 0) (l 0) (nrowa 0)
             (upper nil))
        (declare (type (complex double-float) temp)
                 (type fixnum i info j l nrowa)
                 (type (member t nil) upper))
        (cond
```

```
  ((char-equal trans #\N)
   (setf nrowa n))
  (t
   (setf nrowa k)))
(setf upper (char-equal uplo #\U))
(setf info 0)
(cond
  ((and (not upper) (not (char-equal uplo #\L)))
   (setf info 1))
  ((and (not (char-equal trans #\N)) (not (char-equal trans #\T)))
   (setf info 2))
  ((< n 0)
   (setf info 3))
  ((< k 0)
   (setf info 4))
  ((< lda (max (the fixnum 1) (the fixnum nrowa)))
   (setf info 7))
  ((< ldc (max (the fixnum 1) (the fixnum n)))
   (setf info 10)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "ZSYRK" info)
   (go end_label)))
(if (or (= n 0) (and (or (= alpha zero) (= k 0)) (= beta one)))
    (go end_label))
(cond
  ((= alpha zero)
   (cond
     (upper
      (cond
        ((= beta zero)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i j) nil)
               (tagbody
                 (setf (f2cl-lib:fref c-%data%
                                      (i j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       zero))))))
        (t
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i j) nil)
```

```
                    (tagbody
                      (setf (f2cl-lib:fref c-%data%
                                           (i j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                            (* beta
                               (f2cl-lib:fref c-%data%
                                              (i j)
                                              ((1 ldc) (1 *))
                                              c-%offset%)))))))))
          (t
           (cond
             ((= beta zero)
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
                (tagbody
                  (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                                ((> i n) nil)
                    (tagbody
                      (setf (f2cl-lib:fref c-%data%
                                           (i j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                            zero))))))
             (t
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
                (tagbody
                  (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                                ((> i n) nil)
                    (tagbody
                      (setf (f2cl-lib:fref c-%data%
                                           (i j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                            (* beta
                               (f2cl-lib:fref c-%data%
                                              (i j)
                                              ((1 ldc) (1 *))
                                              c-%offset%)))))))))))
       (go end_label)))
    (cond
      ((char-equal trans #\N)
       (cond
         (upper
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                        ((> j n) nil)
            (tagbody
              (cond
                ((= beta zero)
```

```
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                              ((> i j) nil)
                  (tagbody
                    (setf (f2cl-lib:fref c-%data%
                                         (i j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                                  zero))))
               ((/= beta one)
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                              ((> i j) nil)
                  (tagbody
                    (setf (f2cl-lib:fref c-%data%
                                         (i j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                                  (* beta
                                     (f2cl-lib:fref c-%data%
                                                    (i j)
                                                    ((1 ldc) (1 *))
                                                    c-%offset%)))))))
              (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                            ((> l k) nil)
                (tagbody
                  (cond
                    ((/= (f2cl-lib:fref a (j l) ((1 lda) (1 *))) zero)
                     (setf temp
                             (* alpha
                                (f2cl-lib:fref a-%data%
                                               (j l)
                                               ((1 lda) (1 *))
                                               a-%offset%)))
                     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                   ((> i j) nil)
                       (tagbody
                         (setf (f2cl-lib:fref c-%data%
                                              (i j)
                                              ((1 ldc) (1 *))
                                              c-%offset%)
                                       (+
                                        (f2cl-lib:fref c-%data%
                                                       (i j)
                                                       ((1 ldc) (1 *))
                                                       c-%offset%)
                                        (* temp
                                           (f2cl-lib:fref a-%data%
                                                          (i l)
                                                          ((1 lda) (1 *))
                                                          a-%offset%)))))))))))
             (t
```

```
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j n) nil)
  (tagbody
    (cond
      ((= beta zero)
       (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                     ((> i n) nil)
         (tagbody
           (setf (f2cl-lib:fref c-%data%
                                (i j)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 zero))))
      ((/= beta one)
       (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                     ((> i n) nil)
         (tagbody
           (setf (f2cl-lib:fref c-%data%
                                (i j)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* beta
                    (f2cl-lib:fref c-%data%
                                   (i j)
                                   ((1 ldc) (1 *))
                                   c-%offset%)))))))
    (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                  ((> l k) nil)
      (tagbody
        (cond
          ((/= (f2cl-lib:fref a (j l) ((1 lda) (1 *))) zero)
           (setf temp
                   (* alpha
                      (f2cl-lib:fref a-%data%
                                     (j l)
                                     ((1 lda) (1 *))
                                     a-%offset%)))
           (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                         ((> i n) nil)
             (tagbody
               (setf (f2cl-lib:fref c-%data%
                                    (i j)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                     (+
                      (f2cl-lib:fref c-%data%
                                     (i j)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (* temp
```

```
                                    (f2cl-lib:fref a-%data%
                                                   (i l)
                                                   ((1 lda) (1 *))
                                                   a-%offset%)))))))))))))))
          (t
           (cond
             (upper
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
                (tagbody
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                ((> i j) nil)
                    (tagbody
                      (setf temp zero)
                      (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                                    ((> l k) nil)
                        (tagbody
                          (setf temp
                                  (+ temp
                                     (*
                                      (f2cl-lib:fref a-%data%
                                                     (l i)
                                                     ((1 lda) (1 *))
                                                     a-%offset%)
                                      (f2cl-lib:fref a-%data%
                                                     (l j)
                                                     ((1 lda) (1 *))
                                                     a-%offset%))))))
                      (cond
                        ((= beta zero)
                         (setf (f2cl-lib:fref c-%data%
                                              (i j)
                                              ((1 ldc) (1 *))
                                              c-%offset%)
                                 (* alpha temp)))
                        (t
                         (setf (f2cl-lib:fref c-%data%
                                              (i j)
                                              ((1 ldc) (1 *))
                                              c-%offset%)
                                 (+ (* alpha temp)
                                    (* beta
                                       (f2cl-lib:fref c-%data%
                                                      (i j)
                                                      ((1 ldc) (1 *))
                                                      c-%offset%)))))))))))
             (t
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
                (tagbody
```

```
                (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                              ((> i n) nil)
                  (tagbody
                    (setf temp zero)
                    (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                                  ((> l k) nil)
                      (tagbody
                        (setf temp
                                (+ temp
                                   (*
                                    (f2cl-lib:fref a-%data%
                                                   (l i)
                                                   ((1 lda) (1 *))
                                                   a-%offset%)
                                    (f2cl-lib:fref a-%data%
                                                   (l j)
                                                   ((1 lda) (1 *))
                                                   a-%offset%))))))
                    (cond
                      ((= beta zero)
                       (setf (f2cl-lib:fref c-%data%
                                            (i j)
                                            ((1 ldc) (1 *))
                                            c-%offset%)
                             (* alpha temp)))
                      (t
                       (setf (f2cl-lib:fref c-%data%
                                            (i j)
                                            ((1 ldc) (1 *))
                                            c-%offset%)
                             (+ (* alpha temp)
                                (* beta
                                   (f2cl-lib:fref c-%data%
                                                  (i j)
                                                  ((1 ldc) (1 *))
                                                  c-%offset%)))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil nil))))))
```

———-

5.14 ztrmm BLAS

— **ztrmm.input** —

```
)set break resume
```

```
)sys rm -f ztrmm.output
)spool ztrmm.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— ztrmm.help —

```
==========================================================================
ztrmm examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 NAME
      ZTRMM - perform one of the matrix-matrix operations   B :=
      alpha*op( A )*B, or B := alpha*B*op( A )  where alpha is a
      scalar, B is an m by n matrix, A is a unit, or non-unit,
      upper or lower triangular matrix and op( A ) is one of   op(
      A ) = A or op( A ) = A' or op( A ) = conjg( A' )

 SYNOPSIS
      SUBROUTINE ZTRMM ( SIDE, UPLO, TRANSA, DIAG, M, N, ALPHA, A,
                         LDA, B, LDB )

          CHARACTER*1  SIDE, UPLO, TRANSA, DIAG

          INTEGER      M, N, LDA, LDB

          COMPLEX*16   ALPHA

          COMPLEX*16   A( LDA, * ), B( LDB, * )

 PURPOSE
      ZTRMM  performs one of the matrix-matrix operations

 PARAMETERS
      SIDE   - CHARACTER*1.
               On entry,  SIDE specifies whether  op( A ) multiplies
               B from the left or right as follows:

               SIDE = 'L' or 'l'   B := alpha*op( A )*B.
```

```
       SIDE = 'R' or 'r'   B := alpha*B*op( A ).

       Unchanged on exit.

UPLO   - CHARACTER*1.
       On entry, UPLO specifies whether the matrix A is an
       upper or lower triangular matrix as follows:

       UPLO = 'U' or 'u'   A is an upper triangular matrix.

       UPLO = 'L' or 'l'   A is a lower triangular matrix.

       Unchanged on exit.

       TRANSA - CHARACTER*1.  On entry, TRANSA specifies the
       form of op( A ) to be used in the matrix multiplica-
       tion as follows:

       TRANSA = 'N' or 'n'   op( A ) = A.

       TRANSA = 'T' or 't'   op( A ) = A'.

       TRANSA = 'C' or 'c'   op( A ) = conjg( A' ).

       Unchanged on exit.

DIAG   - CHARACTER*1.
       On entry, DIAG specifies whether or not A is unit
       triangular as follows:

       DIAG = 'U' or 'u'   A is assumed to be unit triangu-
       lar.

       DIAG = 'N' or 'n'   A is not assumed to be unit tri-
       angular.

       Unchanged on exit.

M      - INTEGER.
       On entry, M specifies the number of rows of B. M must
       be at least zero.  Unchanged on exit.

N      - INTEGER.
       On entry, N specifies the number of columns of B.  N
       must be at least zero.  Unchanged on exit.

ALPHA  - COMPLEX*16      .
       On entry,  ALPHA specifies the scalar  alpha. When
       alpha is zero then  A is not referenced and  B need
```

```
            not be set before entry.  Unchanged on exit.

 is m
      A      -
             COMPLEX*16       array of DIMENSION ( LDA, k ), where k
             when  SIDE = 'L' or 'l'  and is  n  when  SIDE = 'R'
             or 'r'.  Before entry  with  UPLO = 'U' or 'u',  the
             leading  k by k upper triangular part of the array  A
             must contain the upper triangular matrix  and the
             strictly lower triangular part of A is not refer-
             enced.  Before entry  with  UPLO = 'L' or 'l',  the
             leading  k by k lower triangular part of the array  A
             must contain the lower triangular matrix  and the
             strictly upper triangular part of A is not refer-
             enced.  Note that when  DIAG = 'U' or 'u',  the diag-
             onal elements of A  are not referenced either,  but
             are assumed to be  unity.  Unchanged on exit.

      LDA    - INTEGER.
             On entry, LDA specifies the first dimension of A as
             declared in the calling (sub) program.  When  SIDE =
             'L' or 'l'  then LDA  must be at least  max( 1, m ),
             when  SIDE = 'R' or 'r' then LDA must be at least
             max( 1, n ).  Unchanged on exit.

      B      - COMPLEX*16       array of DIMENSION ( LDB, n ).
             Before entry,  the leading  m by n part of the array
             B must contain the matrix  B,  and  on exit  is
             overwritten  by the transformed matrix.

      LDB    - INTEGER.
             On entry, LDB specifies the first dimension of B as
             declared in  the  calling  (sub)  program.   LDB
             must  be  at  least max( 1, m ).  Unchanged on exit.


            ________-


            — ztrmm.f —

      SUBROUTINE ZTRMM ( SIDE, UPLO, TRANSA, DIAG, M, N, ALPHA, A, LDA,
     $                   B, LDB )
*     .. Scalar Arguments ..
      CHARACTER*1        SIDE, UPLO, TRANSA, DIAG
      INTEGER            M, N, LDA, LDB
      COMPLEX*16         ALPHA
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), B( LDB, * )
*     ..
```

```
*
*  Level 3 Blas routine.
*
*  -- Written on 8-February-1989.
*     Jack Dongarra, Argonne National Laboratory.
*     Iain Duff, AERE Harwell.
*     Jeremy Du Croz, Numerical Algorithms Group Ltd.
*     Sven Hammarling, Numerical Algorithms Group Ltd.
*
*
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG, MAX
*     .. Local Scalars ..
      LOGICAL            LSIDE, NOCONJ, NOUNIT, UPPER
      INTEGER            I, INFO, J, K, NROWA
      COMPLEX*16         TEMP
*     .. Parameters ..
      COMPLEX*16         ONE
      PARAMETER        ( ONE  = ( 1.0D+0, 0.0D+0 ) )
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      LSIDE  = LSAME( SIDE  , 'L' )
      IF( LSIDE )THEN
         NROWA = M
      ELSE
         NROWA = N
      END IF
      NOCONJ = LSAME( TRANSA, 'T' )
      NOUNIT = LSAME( DIAG  , 'N' )
      UPPER  = LSAME( UPLO  , 'U' )
*
      INFO   = 0
      IF(      ( .NOT.LSIDE                ).AND.
     $         ( .NOT.LSAME( SIDE  , 'R' ) )      )THEN
         INFO = 1
      ELSE IF( ( .NOT.UPPER                ).AND.
     $         ( .NOT.LSAME( UPLO  , 'L' ) )      )THEN
         INFO = 2
      ELSE IF( ( .NOT.LSAME( TRANSA, 'N' ) ).AND.
     $         ( .NOT.LSAME( TRANSA, 'T' ) ).AND.
```

```
     $         ( .NOT.LSAME( TRANSA, 'C' ) )      )THEN
          INFO = 3
       ELSE IF( ( .NOT.LSAME( DIAG  , 'U' ) ).AND.
     $         ( .NOT.LSAME( DIAG  , 'N' ) )      )THEN
          INFO = 4
       ELSE IF( M  .LT.0               )THEN
          INFO = 5
       ELSE IF( N  .LT.0               )THEN
          INFO = 6
       ELSE IF( LDA.LT.MAX( 1, NROWA ) )THEN
          INFO = 9
       ELSE IF( LDB.LT.MAX( 1, M     ) )THEN
          INFO = 11
       END IF
       IF( INFO.NE.0 )THEN
          CALL XERBLA( 'ZTRMM ', INFO )
          RETURN
       END IF
*
*     Quick return if possible.
*
       IF( N.EQ.0 )
     $   RETURN
*
*     And when  alpha.eq.zero.
*
       IF( ALPHA.EQ.ZERO )THEN
          DO 20, J = 1, N
             DO 10, I = 1, M
                B( I, J ) = ZERO
   10        CONTINUE
   20     CONTINUE
          RETURN
       END IF
*
*     Start the operations.
*
       IF( LSIDE )THEN
          IF( LSAME( TRANSA, 'N' ) )THEN
*
*           Form  B := alpha*A*B.
*
             IF( UPPER )THEN
                DO 50, J = 1, N
                   DO 40, K = 1, M
                      IF( B( K, J ).NE.ZERO )THEN
                         TEMP = ALPHA*B( K, J )
                         DO 30, I = 1, K - 1
                            B( I, J ) = B( I, J ) + TEMP*A( I, K )
   30                    CONTINUE
```

```
                     IF( NOUNIT )
     $                  TEMP = TEMP*A( K, K )
                     B( K, J ) = TEMP
                  END IF
   40             CONTINUE
   50          CONTINUE
            ELSE
               DO 80, J = 1, N
                  DO 70 K = M, 1, -1
                     IF( B( K, J ).NE.ZERO )THEN
                        TEMP      = ALPHA*B( K, J )
                        B( K, J ) = TEMP
                        IF( NOUNIT )
     $                     B( K, J ) = B( K, J )*A( K, K )
                        DO 60, I = K + 1, M
                           B( I, J ) = B( I, J ) + TEMP*A( I, K )
   60                   CONTINUE
                     END IF
   70             CONTINUE
   80          CONTINUE
            END IF
         ELSE
*
*           Form  B := alpha*A'*B   or   B := alpha*conjg( A' )*B.
*
            IF( UPPER )THEN
               DO 120, J = 1, N
                  DO 110, I = M, 1, -1
                     TEMP = B( I, J )
                     IF( NOCONJ )THEN
                        IF( NOUNIT )
     $                     TEMP = TEMP*A( I, I )
                        DO 90, K = 1, I - 1
                           TEMP = TEMP + A( K, I )*B( K, J )
   90                   CONTINUE
                     ELSE
                        IF( NOUNIT )
     $                     TEMP = TEMP*DCONJG( A( I, I ) )
                        DO 100, K = 1, I - 1
                           TEMP = TEMP + DCONJG( A( K, I ) )*B( K, J )
  100                   CONTINUE
                     END IF
                     B( I, J ) = ALPHA*TEMP
  110             CONTINUE
  120          CONTINUE
            ELSE
               DO 160, J = 1, N
                  DO 150, I = 1, M
                     TEMP = B( I, J )
                     IF( NOCONJ )THEN
```

```
                     IF( NOUNIT )
     $                  TEMP = TEMP*A( I, I )
                     DO 130, K = I + 1, M
                        TEMP = TEMP + A( K, I )*B( K, J )
  130                CONTINUE
                  ELSE
                     IF( NOUNIT )
     $                  TEMP = TEMP*DCONJG( A( I, I ) )
                     DO 140, K = I + 1, M
                        TEMP = TEMP + DCONJG( A( K, I ) )*B( K, J )
  140                CONTINUE
                  END IF
                  B( I, J ) = ALPHA*TEMP
  150             CONTINUE
  160          CONTINUE
            END IF
         END IF
      ELSE
         IF( LSAME( TRANSA, 'N' ) )THEN
*
*           Form  B := alpha*B*A.
*
            IF( UPPER )THEN
               DO 200, J = N, 1, -1
                  TEMP = ALPHA
                  IF( NOUNIT )
     $               TEMP = TEMP*A( J, J )
                  DO 170, I = 1, M
                     B( I, J ) = TEMP*B( I, J )
  170             CONTINUE
                  DO 190, K = 1, J - 1
                     IF( A( K, J ).NE.ZERO )THEN
                        TEMP = ALPHA*A( K, J )
                        DO 180, I = 1, M
                           B( I, J ) = B( I, J ) + TEMP*B( I, K )
  180                   CONTINUE
                     END IF
  190             CONTINUE
  200          CONTINUE
            ELSE
               DO 240, J = 1, N
                  TEMP = ALPHA
                  IF( NOUNIT )
     $               TEMP = TEMP*A( J, J )
                  DO 210, I = 1, M
                     B( I, J ) = TEMP*B( I, J )
  210             CONTINUE
                  DO 230, K = J + 1, N
                     IF( A( K, J ).NE.ZERO )THEN
                        TEMP = ALPHA*A( K, J )
```

```
                     DO 220, I = 1, M
                        B( I, J ) = B( I, J ) + TEMP*B( I, K )
  220                CONTINUE
                  END IF
  230             CONTINUE
  240          CONTINUE
            END IF
         ELSE
*
*           Form  B := alpha*B*A'   or   B := alpha*B*conjg( A' ).
*
            IF( UPPER )THEN
               DO 280, K = 1, N
                  DO 260, J = 1, K - 1
                     IF( A( J, K ).NE.ZERO )THEN
                        IF( NOCONJ )THEN
                           TEMP = ALPHA*A( J, K )
                        ELSE
                           TEMP = ALPHA*DCONJG( A( J, K ) )
                        END IF
                        DO 250, I = 1, M
                           B( I, J ) = B( I, J ) + TEMP*B( I, K )
  250                   CONTINUE
                     END IF
  260             CONTINUE
                  TEMP = ALPHA
                  IF( NOUNIT )THEN
                     IF( NOCONJ )THEN
                        TEMP = TEMP*A( K, K )
                     ELSE
                        TEMP = TEMP*DCONJG( A( K, K ) )
                     END IF
                  END IF
                  IF( TEMP.NE.ONE )THEN
                     DO 270, I = 1, M
                        B( I, K ) = TEMP*B( I, K )
  270                CONTINUE
                  END IF
  280          CONTINUE
            ELSE
               DO 320, K = N, 1, -1
                  DO 300, J = K + 1, N
                     IF( A( J, K ).NE.ZERO )THEN
                        IF( NOCONJ )THEN
                           TEMP = ALPHA*A( J, K )
                        ELSE
                           TEMP = ALPHA*DCONJG( A( J, K ) )
                        END IF
                        DO 290, I = 1, M
                           B( I, J ) = B( I, J ) + TEMP*B( I, K )
```

```
  290                   CONTINUE
                     END IF
  300             CONTINUE
                  TEMP = ALPHA
                  IF( NOUNIT )THEN
                     IF( NOCONJ )THEN
                        TEMP = TEMP*A( K, K )
                     ELSE
                        TEMP = TEMP*DCONJG( A( K, K ) )
                     END IF
                  END IF
                  IF( TEMP.NE.ONE )THEN
                     DO 310, I = 1, M
                        B( I, K ) = TEMP*B( I, K )
  310                CONTINUE
                  END IF
  320          CONTINUE
            END IF
         END IF
      END IF
*
      RETURN
*
*     End of ZTRMM .
*
      END
```

— BLAS 3 ztrmm —

```
(let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
 (declare (type (complex double-float) one) (type (complex double-float) zero))
  (defun ztrmm (side uplo transa diag m n alpha a lda b ldb$)
    (declare (type (simple-array (complex double-float) (*)) b a)
             (type (complex double-float) alpha)
             (type fixnum ldb$ lda n m)
             (type character diag transa uplo side))
    (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (uplo character uplo-%data% uplo-%offset%)
         (transa character transa-%data% transa-%offset%)
         (diag character diag-%data% diag-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (b (complex double-float) b-%data% b-%offset%))
      (prog ((temp #C(0.0 0.0)) (i 0) (info 0) (j 0) (k 0) (nrowa 0)
             (lside nil) (noconj nil) (nounit nil) (upper nil))
        (declare (type (complex double-float) temp)
```

```
         (type fixnum i info j k nrowa)
         (type (member t nil) lside noconj nounit upper))
(setf lside (char-equal side #\L))
(cond
  (lside
   (setf nrowa m))
  (t
   (setf nrowa n)))
(setf noconj (char-equal transa #\T))
(setf nounit (char-equal diag #\N))
(setf upper (char-equal uplo #\U))
(setf info 0)
(cond
  ((and (not lside) (not (char-equal side #\R)))
   (setf info 1))
  ((and (not upper) (not (char-equal uplo #\L)))
   (setf info 2))
  ((and (not (char-equal transa #\N))
        (not (char-equal transa #\T))
        (not (char-equal transa #\C)))
   (setf info 3))
  ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
   (setf info 4))
  ((< m 0)
   (setf info 5))
  ((< n 0)
   (setf info 6))
  ((< lda (max (the fixnum 1) (the fixnum nrowa)))
   (setf info 9))
  ((< ldb$ (max (the fixnum 1) (the fixnum m)))
   (setf info 11)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "ZTRMM" info)
   (go end_label)))
(if (= n 0) (go end_label))
(cond
  ((= alpha zero)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
     (tagbody
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i m) nil)
         (tagbody
           (setf (f2cl-lib:fref b-%data%
                                (i j)
                                ((1 ldb$) (1 *))
                                b-%offset%)
```

```
                    zero)))))
    (go end_label)))
(cond
  (lside
   (cond
     ((char-equal transa #\N)
      (cond
        (upper
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                           ((> k m) nil)
               (tagbody
                 (cond
                   ((/= (f2cl-lib:fref b (k j) ((1 ldb$) (1 *))) zero)
                    (setf temp
                            (* alpha
                               (f2cl-lib:fref b-%data%
                                              (k j)
                                              ((1 ldb$) (1 *))
                                              b-%offset%)))
                    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                  ((> i
                                      (f2cl-lib:int-add k
                                                        (f2cl-lib:int-sub
                                                         1)))
                                   nil)
                      (tagbody
                        (setf (f2cl-lib:fref b-%data%
                                             (i j)
                                             ((1 ldb$) (1 *))
                                             b-%offset%)
                                (+
                                 (f2cl-lib:fref b-%data%
                                                (i j)
                                                ((1 ldb$) (1 *))
                                                b-%offset%)
                                 (* temp
                                    (f2cl-lib:fref a-%data%
                                                   (i k)
                                                   ((1 lda) (1 *))
                                                   a-%offset%))))))
                    (if nounit
                        (setf temp
                                (* temp
                                   (f2cl-lib:fref a-%data%
                                                  (k k)
                                                  ((1 lda) (1 *))
                                                  a-%offset%))))
```

```
                (setf (f2cl-lib:fref b-%data%
                                     (k j)
                                     ((1 ldb$) (1 *))
                                     b-%offset%)
                      temp))))))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (f2cl-lib:fdo (k m
                    (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
                   ((> k 1) nil)
       (tagbody
         (cond
           ((/= (f2cl-lib:fref b (k j) ((1 ldb$) (1 *))) zero)
            (setf temp
                    (* alpha
                       (f2cl-lib:fref b-%data%
                                      (k j)
                                      ((1 ldb$) (1 *))
                                      b-%offset%)))
            (setf (f2cl-lib:fref b-%data%
                                 (k j)
                                 ((1 ldb$) (1 *))
                                 b-%offset%)
                  temp)
            (if nounit
                (setf (f2cl-lib:fref b-%data%
                                     (k j)
                                     ((1 ldb$) (1 *))
                                     b-%offset%)
                      (*
                       (f2cl-lib:fref b-%data%
                                      (k j)
                                      ((1 ldb$) (1 *))
                                      b-%offset%)
                       (f2cl-lib:fref a-%data%
                                      (k k)
                                      ((1 lda) (1 *))
                                      a-%offset%))))
            (f2cl-lib:fdo (i (f2cl-lib:int-add k 1)
                             (f2cl-lib:int-add i 1))
                          ((> i m) nil)
              (tagbody
                (setf (f2cl-lib:fref b-%data%
                                     (i j)
                                     ((1 ldb$) (1 *))
                                     b-%offset%)
                      (+
                       (f2cl-lib:fref b-%data%
```

```
                                                  (i j)
                                                  ((1 ldb$) (1 *))
                                                  b-%offset%)
                                     (* temp
                                        (f2cl-lib:fref a-%data%
                                                       (i k)
                                                       ((1 lda) (1 *))
                                                       a-%offset%)))))))))))))))
                (t
                 (cond
                   (upper
                    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                                  ((> j n) nil)
                      (tagbody
                        (f2cl-lib:fdo (i m
                                       (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                                      ((> i 1) nil)
                          (tagbody
                            (setf temp
                                    (f2cl-lib:fref b-%data%
                                                   (i j)
                                                   ((1 ldb$) (1 *))
                                                   b-%offset%))
                            (cond
                              (noconj
                               (if nounit
                                   (setf temp
                                           (* temp
                                              (f2cl-lib:fref a-%data%
                                                             (i i)
                                                             ((1 lda) (1 *))
                                                             a-%offset%))))
                               (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                                             ((> k
                                                 (f2cl-lib:int-add i
                                                                   (f2cl-lib:int-sub
                                                                    1)))
                                              nil)
                                 (tagbody
                                   (setf temp
                                           (+ temp
                                              (*
                                               (f2cl-lib:fref a-%data%
                                                              (k i)
                                                              ((1 lda) (1 *))
                                                              a-%offset%)
                                               (f2cl-lib:fref b-%data%
                                                              (k j)
                                                              ((1 ldb$) (1 *))
                                                              b-%offset%)))))))))))))))
```

```
                (t
                 (if nounit
                     (setf temp
                             (* temp
                                (f2cl-lib:dconjg
                                 (f2cl-lib:fref a-%data%
                                                (i i)
                                                ((1 lda) (1 *))
                                                a-%offset%)))))
                 (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                               ((> k
                                   (f2cl-lib:int-add i
                                                     (f2cl-lib:int-sub
                                                      1)))
                                nil)
                   (tagbody
                     (setf temp
                             (+ temp
                                (*
                                 (f2cl-lib:dconjg
                                  (f2cl-lib:fref a-%data%
                                                 (k i)
                                                 ((1 lda) (1 *))
                                                 a-%offset%))
                                 (f2cl-lib:fref b-%data%
                                                (k j)
                                                ((1 ldb$) (1 *))
                                                b-%offset%)))))))
         (setf (f2cl-lib:fref b-%data%
                              (i j)
                              ((1 ldb$) (1 *))
                              b-%offset%)
               (* alpha temp)))))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                   ((> i m) nil)
       (tagbody
         (setf temp
                 (f2cl-lib:fref b-%data%
                                (i j)
                                ((1 ldb$) (1 *))
                                b-%offset%))
         (cond
           (noconj
            (if nounit
                (setf temp
                        (* temp
```

```
                                (f2cl-lib:fref a-%data%
                                               (i i)
                                               ((1 lda) (1 *))
                                               a-%offset%))))
                          (f2cl-lib:fdo (k (f2cl-lib:int-add i 1)
                                           (f2cl-lib:int-add k 1))
                                        ((> k m) nil)
                            (tagbody
                              (setf temp
                                      (+ temp
                                         (*
                                          (f2cl-lib:fref a-%data%
                                                         (k i)
                                                         ((1 lda) (1 *))
                                                         a-%offset%)
                                          (f2cl-lib:fref b-%data%
                                                         (k j)
                                                         ((1 ldb$) (1 *))
                                                         b-%offset%)))))))
                         (t
                          (if nounit
                              (setf temp
                                      (* temp
                                         (f2cl-lib:dconjg
                                          (f2cl-lib:fref a-%data%
                                                         (i i)
                                                         ((1 lda) (1 *))
                                                         a-%offset%)))))
                          (f2cl-lib:fdo (k (f2cl-lib:int-add i 1)
                                           (f2cl-lib:int-add k 1))
                                        ((> k m) nil)
                            (tagbody
                              (setf temp
                                      (+ temp
                                         (*
                                          (f2cl-lib:dconjg
                                           (f2cl-lib:fref a-%data%
                                                          (k i)
                                                          ((1 lda) (1 *))
                                                          a-%offset%))
                                          (f2cl-lib:fref b-%data%
                                                         (k j)
                                                         ((1 ldb$) (1 *))
                                                         b-%offset%)))))))
                        (setf (f2cl-lib:fref b-%data%
                                             (i j)
                                             ((1 ldb$) (1 *))
                                             b-%offset%)
                              (* alpha temp)))))))))
                   (t
```

```
(cond
  ((char-equal transa #\N)
   (cond
     (upper
      (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                    ((> j 1) nil)
        (tagbody
          (setf temp alpha)
          (if nounit
              (setf temp
                      (* temp
                         (f2cl-lib:fref a-%data%
                                        (j j)
                                        ((1 lda) (1 *))
                                        a-%offset%))))
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref b-%data%
                                   (i j)
                                   ((1 ldb$) (1 *))
                                   b-%offset%)
                      (* temp
                         (f2cl-lib:fref b-%data%
                                        (i j)
                                        ((1 ldb$) (1 *))
                                        b-%offset%)))))
          (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                        ((> k
                            (f2cl-lib:int-add j
                                              (f2cl-lib:int-sub 1)))
                         nil)
            (tagbody
              (cond
                ((/= (f2cl-lib:fref a (k j) ((1 lda) (1 *))) zero)
                 (setf temp
                         (* alpha
                            (f2cl-lib:fref a-%data%
                                           (k j)
                                           ((1 lda) (1 *))
                                           a-%offset%)))
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                               ((> i m) nil)
                   (tagbody
                     (setf (f2cl-lib:fref b-%data%
                                          (i j)
                                          ((1 ldb$) (1 *))
                                          b-%offset%)
                             (+
                              (f2cl-lib:fref b-%data%
```

```
                                                (i j)
                                                ((1 ldb$) (1 *))
                                                b-%offset%)
                                    (* temp
                                       (f2cl-lib:fref b-%data%
                                                      (i k)
                                                      ((1 ldb$) (1 *))
                                                      b-%offset%)))))))))))))
                (t
                 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                               ((> j n) nil)
                   (tagbody
                     (setf temp alpha)
                     (if nounit
                         (setf temp
                                 (* temp
                                    (f2cl-lib:fref a-%data%
                                                   (j j)
                                                   ((1 lda) (1 *))
                                                   a-%offset%))))
                     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                   ((> i m) nil)
                       (tagbody
                         (setf (f2cl-lib:fref b-%data%
                                              (i j)
                                              ((1 ldb$) (1 *))
                                              b-%offset%)
                                 (* temp
                                    (f2cl-lib:fref b-%data%
                                                   (i j)
                                                   ((1 ldb$) (1 *))
                                                   b-%offset%)))))
                     (f2cl-lib:fdo (k (f2cl-lib:int-add j 1)
                                    (f2cl-lib:int-add k 1))
                                   ((> k n) nil)
                       (tagbody
                         (cond
                           ((/= (f2cl-lib:fref a (k j) ((1 lda) (1 *))) zero)
                            (setf temp
                                    (* alpha
                                       (f2cl-lib:fref a-%data%
                                                      (k j)
                                                      ((1 lda) (1 *))
                                                      a-%offset%)))
                            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                          ((> i m) nil)
                              (tagbody
                                (setf (f2cl-lib:fref b-%data%
                                                     (i j)
                                                     ((1 ldb$) (1 *))
```

```
                                        b-%offset%)
                                (+
                                 (f2cl-lib:fref b-%data%
                                                (i j)
                                                ((1 ldb$) (1 *))
                                                b-%offset%)
                                 (* temp
                                    (f2cl-lib:fref b-%data%
                                                   (i k)
                                                   ((1 ldb$) (1 *))
                                                   b-%offset%)))))))))))))))
          (t
           (cond
             (upper
              (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                            ((> k n) nil)
                (tagbody
                  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                                ((> j
                                    (f2cl-lib:int-add k
                                                      (f2cl-lib:int-sub 1)))
                                 nil)
                    (tagbody
                      (cond
                        ((/= (f2cl-lib:fref a (j k) ((1 lda) (1 *))) zero)
                         (cond
                           (noconj
                            (setf temp
                                    (* alpha
                                       (f2cl-lib:fref a-%data%
                                                      (j k)
                                                      ((1 lda) (1 *))
                                                      a-%offset%))))
                           (t
                            (setf temp
                                    (* alpha
                                       (f2cl-lib:dconjg
                                        (f2cl-lib:fref a-%data%
                                                       (j k)
                                                       ((1 lda) (1 *))
                                                       a-%offset%))))))
                         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                       ((> i m) nil)
                           (tagbody
                             (setf (f2cl-lib:fref b-%data%
                                                  (i j)
                                                  ((1 ldb$) (1 *))
                                                  b-%offset%)
                                     (+
                                      (f2cl-lib:fref b-%data%
```

```
                                          (i j)
                                          ((1 ldb$) (1 *))
                                          b-%offset%)
                                (* temp
                                   (f2cl-lib:fref b-%data%
                                                  (i k)
                                                  ((1 ldb$) (1 *))
                                                  b-%offset%))))))))))
          (setf temp alpha)
          (cond
            (nounit
             (cond
               (noconj
                (setf temp
                        (* temp
                           (f2cl-lib:fref a-%data%
                                          (k k)
                                          ((1 lda) (1 *))
                                          a-%offset%))))
               (t
                (setf temp
                        (* temp
                           (f2cl-lib:dconjg
                            (f2cl-lib:fref a-%data%
                                           (k k)
                                           ((1 lda) (1 *))
                                           a-%offset%)))))))
          (cond
            ((/= temp one)
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i m) nil)
               (tagbody
                 (setf (f2cl-lib:fref b-%data%
                                      (i k)
                                      ((1 ldb$) (1 *))
                                      b-%offset%)
                         (* temp
                            (f2cl-lib:fref b-%data%
                                           (i k)
                                           ((1 ldb$) (1 *))
                                           b-%offset%)))))))))
        (t
         (f2cl-lib:fdo (k n (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
                       ((> k 1) nil)
           (tagbody
             (f2cl-lib:fdo (j (f2cl-lib:int-add k 1)
                              (f2cl-lib:int-add j 1))
                           ((> j n) nil)
               (tagbody
                 (cond
```

```
                ((/= (f2cl-lib:fref a (j k) ((1 lda) (1 *))) zero)
                 (cond
                   (noconj
                    (setf temp
                            (* alpha
                               (f2cl-lib:fref a-%data%
                                              (j k)
                                              ((1 lda) (1 *))
                                              a-%offset%))))
                   (t
                    (setf temp
                            (* alpha
                               (f2cl-lib:dconjg
                                (f2cl-lib:fref a-%data%
                                               (j k)
                                               ((1 lda) (1 *))
                                               a-%offset%))))))
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                               ((> i m) nil)
                   (tagbody
                     (setf (f2cl-lib:fref b-%data%
                                          (i j)
                                          ((1 ldb$) (1 *))
                                          b-%offset%)
                             (+
                              (f2cl-lib:fref b-%data%
                                             (i j)
                                             ((1 ldb$) (1 *))
                                             b-%offset%)
                              (* temp
                                 (f2cl-lib:fref b-%data%
                                                (i k)
                                                ((1 ldb$) (1 *))
                                                b-%offset%)))))))))
          (setf temp alpha)
          (cond
            (nounit
             (cond
               (noconj
                (setf temp
                        (* temp
                           (f2cl-lib:fref a-%data%
                                          (k k)
                                          ((1 lda) (1 *))
                                          a-%offset%))))
               (t
                (setf temp
                        (* temp
                           (f2cl-lib:dconjg
                            (f2cl-lib:fref a-%data%
```

```
                                                (k k)
                                                ((1 lda) (1 *))
                                                a-%offset%))))))))
                        (cond
                          ((/= temp one)
                           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                         ((> i m) nil)
                             (tagbody
                               (setf (f2cl-lib:fref b-%data%
                                                    (i k)
                                                    ((1 ldb$) (1 *))
                                                    b-%offset%)
                                     (* temp
                                        (f2cl-lib:fref b-%data%
                                                       (i k)
                                                       ((1 ldb$) (1 *))
                                                       b-%offset%)))))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil nil nil))))))
```

———-

5.15 ztrsm BLAS

— **ztrsm.input** —

```
)set break resume
)sys rm -f ztrsm.output
)spool ztrsm.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **ztrsm.help** —

```
=======================================================================
ztrsm examples
=======================================================================

=======================================================================
```

```
Man Page Details
=====================================================================

 NAME
      ZTRSM - solve one of the matrix equations   op( A )*X =
      alpha*B, or X*op( A ) = alpha*B,

 SYNOPSIS
      SUBROUTINE ZTRSM ( SIDE, UPLO, TRANSA, DIAG, M, N, ALPHA, A,
                         LDA, B, LDB )

          CHARACTER*1  SIDE, UPLO, TRANSA, DIAG

          INTEGER      M, N, LDA, LDB

          COMPLEX*16   ALPHA

          COMPLEX*16   A( LDA, * ), B( LDB, * )

 PURPOSE
      ZTRSM  solves one of the matrix equations

      where alpha is a scalar, X and B are m by n matrices, A is a
      unit, or non-unit,  upper or lower triangular matrix  and
      op( A )  is one  of

         op( A ) = A   or   op( A ) = A'   or   op( A ) = conjg(
      A' ).

      The matrix X is overwritten on B.

 PARAMETERS
      SIDE   - CHARACTER*1.
               On entry, SIDE specifies whether op( A ) appears on
               the left or right of X as follows:

               SIDE = 'L' or 'l'   op( A )*X = alpha*B.

               SIDE = 'R' or 'r'   X*op( A ) = alpha*B.

               Unchanged on exit.

      UPLO   - CHARACTER*1.
               On entry, UPLO specifies whether the matrix A is an
               upper or lower triangular matrix as follows:

               UPLO = 'U' or 'u'   A is an upper triangular matrix.

               UPLO = 'L' or 'l'   A is a lower triangular matrix.
```

```
            Unchanged on exit.

            TRANSA - CHARACTER*1.  On entry, TRANSA specifies the
            form of op( A ) to be used in the matrix

            multiplication as follows:

            TRANSA = 'N' or 'n'   op( A ) = A.

            TRANSA = 'T' or 't'   op( A ) = A'.

            TRANSA = 'C' or 'c'   op( A ) = conjg( A' ).

            Unchanged on exit.

      DIAG  - CHARACTER*1.
            On entry, DIAG specifies whether or not A is unit
            triangular as follows:

            DIAG = 'U' or 'u'   A is assumed to be unit triangu-
            lar.

            DIAG = 'N' or 'n'   A is not assumed to be unit tri-
            angular.

            Unchanged on exit.

      M     - INTEGER.
            On entry, M specifies the number of rows of B. M must
            be at least zero.  Unchanged on exit.

      N     - INTEGER.
            On entry, N specifies the number of columns of B.  N
            must be at least zero.  Unchanged on exit.

      ALPHA - COMPLEX*16      .
            On entry,  ALPHA specifies the scalar  alpha. When
            alpha is zero then  A is not referenced and  B need
            not be set before entry.  Unchanged on exit.

is m
      A     -
             COMPLEX*16       array of DIMENSION ( LDA, k ), where k
            when  SIDE = 'L' or 'l'  and is  n  when  SIDE = 'R'
            or 'r'.  Before entry  with  UPLO = 'U' or 'u',  the
            leading  k by k upper triangular part of the array  A
            must contain the upper triangular matrix  and the
            strictly lower triangular part of A is not refer-
            enced.  Before entry  with  UPLO = 'L' or 'l',  the
            leading  k by k lower triangular part of the array  A
```

```
           must contain the lower triangular matrix  and the
           strictly upper triangular part of A is not refer-
           enced.  Note that when  DIAG = 'U' or 'u',  the diag-
           onal elements of A  are not referenced either,  but
           are assumed to be  unity.  Unchanged on exit.

     LDA   - INTEGER.

           On entry, LDA specifies the first dimension of A as
           declared in the calling (sub) program.  When  SIDE =
           'L' or 'l'  then LDA  must be at least  max( 1, m ),
           when  SIDE = 'R' or 'r' then LDA must be at least
           max( 1, n ).  Unchanged on exit.

     B     - COMPLEX*16       array of DIMENSION ( LDB, n ).
           Before entry,  the leading  m by n part of the array
           B must contain  the  right-hand  side  matrix  B,
           and  on exit  is overwritten by the solution matrix
           X.

     LDB   - INTEGER.
           On entry, LDB specifies the first dimension of B as
           declared in  the  calling  (sub)  program.   LDB
           must  be  at  least max( 1, m ).  Unchanged on exit.


           ________-
```

— ztrsm.f —

```
     SUBROUTINE ZTRSM ( SIDE, UPLO, TRANSA, DIAG, M, N, ALPHA, A, LDA,
    $                   B, LDB )
*     .. Scalar Arguments ..
      CHARACTER*1        SIDE, UPLO, TRANSA, DIAG
      INTEGER            M, N, LDA, LDB
      COMPLEX*16         ALPHA
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), B( LDB, * )
*     ..
*
*  Level 3 Blas routine.
*
*  -- Written on 8-February-1989.
*     Jack Dongarra, Argonne National Laboratory.
*     Iain Duff, AERE Harwell.
*     Jeremy Du Croz, Numerical Algorithms Group Ltd.
*     Sven Hammarling, Numerical Algorithms Group Ltd.
*
*
```

```
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG, MAX
*     .. Local Scalars ..
      LOGICAL            LSIDE, NOCONJ, NOUNIT, UPPER
      INTEGER            I, INFO, J, K, NROWA
      COMPLEX*16         TEMP
*     .. Parameters ..
      COMPLEX*16         ONE
      PARAMETER        ( ONE  = ( 1.0D+0, 0.0D+0 ) )
      COMPLEX*16         ZERO
      PARAMETER        ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      LSIDE  = LSAME( SIDE  , 'L' )
      IF( LSIDE )THEN
         NROWA = M
      ELSE
         NROWA = N
      END IF
      NOCONJ = LSAME( TRANSA, 'T' )
      NOUNIT = LSAME( DIAG  , 'N' )
      UPPER  = LSAME( UPLO  , 'U' )
*
      INFO   = 0
      IF(      ( .NOT.LSIDE                ).AND.
     $         ( .NOT.LSAME( SIDE  , 'R' ) )      )THEN
         INFO = 1
      ELSE IF( ( .NOT.UPPER                ).AND.
     $         ( .NOT.LSAME( UPLO  , 'L' ) )      )THEN
         INFO = 2
      ELSE IF( ( .NOT.LSAME( TRANSA, 'N' ) ).AND.
     $         ( .NOT.LSAME( TRANSA, 'T' ) ).AND.
     $         ( .NOT.LSAME( TRANSA, 'C' ) )      )THEN
         INFO = 3
      ELSE IF( ( .NOT.LSAME( DIAG  , 'U' ) ).AND.
     $         ( .NOT.LSAME( DIAG  , 'N' ) )      )THEN
         INFO = 4
      ELSE IF( M  .LT.0               )THEN
         INFO = 5
      ELSE IF( N  .LT.0               )THEN
         INFO = 6
      ELSE IF( LDA.LT.MAX( 1, NROWA ) )THEN
```

```
         INFO = 9
      ELSE IF( LDB.LT.MAX( 1, M     ) )THEN
         INFO = 11
      END IF
      IF( INFO.NE.0 )THEN
         CALL XERBLA( 'ZTRSM ', INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( N.EQ.0 )
     $   RETURN
*
*     And when  alpha.eq.zero.
*
      IF( ALPHA.EQ.ZERO )THEN
         DO 20, J = 1, N
            DO 10, I = 1, M
               B( I, J ) = ZERO
   10       CONTINUE
   20    CONTINUE
         RETURN
      END IF
*
*     Start the operations.
*
      IF( LSIDE )THEN
         IF( LSAME( TRANSA, 'N' ) )THEN
*
*           Form  B := alpha*inv( A )*B.
*
            IF( UPPER )THEN
               DO 60, J = 1, N
                  IF( ALPHA.NE.ONE )THEN
                     DO 30, I = 1, M
                        B( I, J ) = ALPHA*B( I, J )
   30                CONTINUE
                  END IF
                  DO 50, K = M, 1, -1
                     IF( B( K, J ).NE.ZERO )THEN
                        IF( NOUNIT )
     $                     B( K, J ) = B( K, J )/A( K, K )
                        DO 40, I = 1, K - 1
                           B( I, J ) = B( I, J ) - B( K, J )*A( I, K )
   40                   CONTINUE
                     END IF
   50             CONTINUE
   60          CONTINUE
            ELSE
```

```
            DO 100, J = 1, N
               IF( ALPHA.NE.ONE )THEN
                  DO 70, I = 1, M
                     B( I, J ) = ALPHA*B( I, J )
   70             CONTINUE
               END IF
               DO 90 K = 1, M
                  IF( B( K, J ).NE.ZERO )THEN
                     IF( NOUNIT )
     $                  B( K, J ) = B( K, J )/A( K, K )
                     DO 80, I = K + 1, M
                        B( I, J ) = B( I, J ) - B( K, J )*A( I, K )
   80                CONTINUE
                  END IF
   90             CONTINUE
  100          CONTINUE
            END IF
         ELSE
*
*           Form  B := alpha*inv( A' )*B
*           or    B := alpha*inv( conjg( A' ) )*B.
*
            IF( UPPER )THEN
               DO 140, J = 1, N
                  DO 130, I = 1, M
                     TEMP = ALPHA*B( I, J )
                     IF( NOCONJ )THEN
                        DO 110, K = 1, I - 1
                           TEMP = TEMP - A( K, I )*B( K, J )
  110                   CONTINUE
                        IF( NOUNIT )
     $                     TEMP = TEMP/A( I, I )
                     ELSE
                        DO 120, K = 1, I - 1
                           TEMP = TEMP - DCONJG( A( K, I ) )*B( K, J )
  120                   CONTINUE
                        IF( NOUNIT )
     $                     TEMP = TEMP/DCONJG( A( I, I ) )
                     END IF
                     B( I, J ) = TEMP
  130             CONTINUE
  140          CONTINUE
            ELSE
               DO 180, J = 1, N
                  DO 170, I = M, 1, -1
                     TEMP = ALPHA*B( I, J )
                     IF( NOCONJ )THEN
                        DO 150, K = I + 1, M
                           TEMP = TEMP - A( K, I )*B( K, J )
  150                   CONTINUE
```

```
                     IF( NOUNIT )
     $                  TEMP = TEMP/A( I, I )
                   ELSE
                     DO 160, K = I + 1, M
                        TEMP = TEMP - DCONJG( A( K, I ) )*B( K, J )
  160                CONTINUE
                     IF( NOUNIT )
     $                  TEMP = TEMP/DCONJG( A( I, I ) )
                   END IF
                   B( I, J ) = TEMP
  170            CONTINUE
  180         CONTINUE
           END IF
        END IF
     ELSE
        IF( LSAME( TRANSA, 'N' ) )THEN
*
*          Form  B := alpha*B*inv( A ).
*
           IF( UPPER )THEN
              DO 230, J = 1, N
                 IF( ALPHA.NE.ONE )THEN
                    DO 190, I = 1, M
                       B( I, J ) = ALPHA*B( I, J )
  190               CONTINUE
                 END IF
                 DO 210, K = 1, J - 1
                    IF( A( K, J ).NE.ZERO )THEN
                       DO 200, I = 1, M
                          B( I, J ) = B( I, J ) - A( K, J )*B( I, K )
  200                  CONTINUE
                    END IF
  210            CONTINUE
                 IF( NOUNIT )THEN
                    TEMP = ONE/A( J, J )
                    DO 220, I = 1, M
                       B( I, J ) = TEMP*B( I, J )
  220               CONTINUE
                 END IF
  230         CONTINUE
           ELSE
              DO 280, J = N, 1, -1
                 IF( ALPHA.NE.ONE )THEN
                    DO 240, I = 1, M
                       B( I, J ) = ALPHA*B( I, J )
  240               CONTINUE
                 END IF
                 DO 260, K = J + 1, N
                    IF( A( K, J ).NE.ZERO )THEN
                       DO 250, I = 1, M
```

```
                        B( I, J ) = B( I, J ) - A( K, J )*B( I, K )
  250                CONTINUE
                  END IF
  260             CONTINUE
                  IF( NOUNIT )THEN
                     TEMP = ONE/A( J, J )
                     DO 270, I = 1, M
                       B( I, J ) = TEMP*B( I, J )
  270                CONTINUE
                  END IF
  280          CONTINUE
            END IF
         ELSE
*
*           Form  B := alpha*B*inv( A' )
*           or    B := alpha*B*inv( conjg( A' ) ).
*
            IF( UPPER )THEN
               DO 330, K = N, 1, -1
                  IF( NOUNIT )THEN
                     IF( NOCONJ )THEN
                        TEMP = ONE/A( K, K )
                     ELSE
                        TEMP = ONE/DCONJG( A( K, K ) )
                     END IF
                     DO 290, I = 1, M
                        B( I, K ) = TEMP*B( I, K )
  290                CONTINUE
                  END IF
                  DO 310, J = 1, K - 1
                     IF( A( J, K ).NE.ZERO )THEN
                        IF( NOCONJ )THEN
                           TEMP = A( J, K )
                        ELSE
                           TEMP = DCONJG( A( J, K ) )
                        END IF
                        DO 300, I = 1, M
                           B( I, J ) = B( I, J ) - TEMP*B( I, K )
  300                   CONTINUE
                     END IF
  310             CONTINUE
                  IF( ALPHA.NE.ONE )THEN
                     DO 320, I = 1, M
                        B( I, K ) = ALPHA*B( I, K )
  320                CONTINUE
                  END IF
  330          CONTINUE
            ELSE
               DO 380, K = 1, N
                  IF( NOUNIT )THEN
```

```
                     IF( NOCONJ )THEN
                        TEMP = ONE/A( K, K )
                     ELSE
                        TEMP = ONE/DCONJG( A( K, K ) )
                     END IF
                     DO 340, I = 1, M
                        B( I, K ) = TEMP*B( I, K )
  340                CONTINUE
                  END IF
                  DO 360, J = K + 1, N
                     IF( A( J, K ).NE.ZERO )THEN
                        IF( NOCONJ )THEN
                           TEMP = A( J, K )
                        ELSE
                           TEMP = DCONJG( A( J, K ) )
                        END IF
                        DO 350, I = 1, M
                           B( I, J ) = B( I, J ) - TEMP*B( I, K )
  350                   CONTINUE
                     END IF
  360             CONTINUE
                  IF( ALPHA.NE.ONE )THEN
                     DO 370, I = 1, M
                        B( I, K ) = ALPHA*B( I, K )
  370                CONTINUE
                  END IF
  380          CONTINUE
            END IF
         END IF
      END IF
*
      RETURN
*
*     End of ZTRSM .
*
      END
```

———-

— BLAS 3 ztrsm —

```
(let* ((one (complex 1.0 0.0)) (zero (complex 0.0 0.0)))
 (declare (type (complex double-float) one) (type (complex double-float) zero))
  (defun ztrsm (side uplo transa diag m n alpha a lda b ldb$)
    (declare (type (simple-array (complex double-float) (*)) b a)
             (type (complex double-float) alpha)
             (type fixnum ldb$ lda n m)
             (type character diag transa uplo side))
```

```
(f2cl-lib:with-multi-array-data
    ((side character side-%data% side-%offset%)
     (uplo character uplo-%data% uplo-%offset%)
     (transa character transa-%data% transa-%offset%)
     (diag character diag-%data% diag-%offset%)
     (a (complex double-float) a-%data% a-%offset%)
     (b (complex double-float) b-%data% b-%offset%))
  (prog ((temp #C(0.0 0.0)) (i 0) (info 0) (j 0) (k 0) (nrowa 0)
         (lside nil) (noconj nil) (nounit nil) (upper nil))
    (declare (type (complex double-float) temp)
             (type fixnum i info j k nrowa)
             (type (member t nil) lside noconj nounit upper))
    (setf lside (char-equal side #\L))
    (cond
      (lside
       (setf nrowa m))
      (t
       (setf nrowa n)))
    (setf noconj (char-equal transa #\T))
    (setf nounit (char-equal diag #\N))
    (setf upper (char-equal uplo #\U))
    (setf info 0)
    (cond
      ((and (not lside) (not (char-equal side #\R)))
       (setf info 1))
      ((and (not upper) (not (char-equal uplo #\L)))
       (setf info 2))
      ((and (not (char-equal transa #\N))
            (not (char-equal transa #\T))
            (not (char-equal transa #\C)))
       (setf info 3))
      ((and (not (char-equal diag #\U)) (not (char-equal diag #\N)))
       (setf info 4))
      ((< m 0)
       (setf info 5))
      ((< n 0)
       (setf info 6))
      ((< lda (max (the fixnum 1) (the fixnum nrowa)))
       (setf info 9))
      ((< ldb$ (max (the fixnum 1) (the fixnum m)))
       (setf info 11)))
    (cond
      ((/= info 0)
       (error
        " ** On entry to ~a parameter number ~a had an illegal value~%"
        "ZTRSM" info)
       (go end_label)))
    (if (= n 0) (go end_label))
    (cond
      ((= alpha zero)
```

```
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref b-%data%
                                   (i j)
                                   ((1 ldb$) (1 *))
                                   b-%offset%)
                    zero)))))
      (go end_label)))
   (cond
     (lside
      (cond
        ((char-equal transa #\N)
         (cond
           (upper
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
              (tagbody
                (cond
                  ((/= alpha one)
                   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                 ((> i m) nil)
                     (tagbody
                       (setf (f2cl-lib:fref b-%data%
                                            (i j)
                                            ((1 ldb$) (1 *))
                                            b-%offset%)
                             (* alpha
                                (f2cl-lib:fref b-%data%
                                               (i j)
                                               ((1 ldb$) (1 *))
                                               b-%offset%)))))))
                (f2cl-lib:fdo (k m
                               (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
                              ((> k 1) nil)
                  (tagbody
                    (cond
                      ((/= (f2cl-lib:fref b (k j) ((1 ldb$) (1 *))) zero)
                       (if nounit
                           (setf (f2cl-lib:fref b-%data%
                                                (k j)
                                                ((1 ldb$) (1 *))
                                                b-%offset%)
                                 (/
                                  (f2cl-lib:fref b-%data%
                                                 (k j)
                                                 ((1 ldb$) (1 *))
```

```
                                        b-%offset%)
                                (f2cl-lib:fref a-%data%
                                        (k k)
                                        ((1 lda) (1 *))
                                        a-%offset%))))
                        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                      ((> i
                                          (f2cl-lib:int-add k
                                                            (f2cl-lib:int-sub
                                                             1)))
                                       nil)
                          (tagbody
                            (setf (f2cl-lib:fref b-%data%
                                                 (i j)
                                                 ((1 ldb$) (1 *))
                                                 b-%offset%)
                                  (-
                                   (f2cl-lib:fref b-%data%
                                                  (i j)
                                                  ((1 ldb$) (1 *))
                                                  b-%offset%)
                                   (*
                                    (f2cl-lib:fref b-%data%
                                                   (k j)
                                                   ((1 ldb$) (1 *))
                                                   b-%offset%)
                                    (f2cl-lib:fref a-%data%
                                                   (i k)
                                                   ((1 lda) (1 *))
                                                   a-%offset%))))))))))))
(t
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (cond
       ((/= alpha one)
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i m) nil)
          (tagbody
            (setf (f2cl-lib:fref b-%data%
                                 (i j)
                                 ((1 ldb$) (1 *))
                                 b-%offset%)
                  (* alpha
                     (f2cl-lib:fref b-%data%
                                    (i j)
                                    ((1 ldb$) (1 *))
                                    b-%offset%)))))))
     (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                   ((> k m) nil)
```

```
                (tagbody
                  (cond
                    ((/= (f2cl-lib:fref b (k j) ((1 ldb$) (1 *))) zero)
                     (if nounit
                         (setf (f2cl-lib:fref b-%data%
                                              (k j)
                                              ((1 ldb$) (1 *))
                                              b-%offset%)
                               (/
                                (f2cl-lib:fref b-%data%
                                               (k j)
                                               ((1 ldb$) (1 *))
                                               b-%offset%)
                                (f2cl-lib:fref a-%data%
                                               (k k)
                                               ((1 lda) (1 *))
                                               a-%offset%))))
                         (f2cl-lib:fdo (i (f2cl-lib:int-add k 1)
                                        (f2cl-lib:int-add i 1))
                                       ((> i m) nil)
                           (tagbody
                             (setf (f2cl-lib:fref b-%data%
                                                  (i j)
                                                  ((1 ldb$) (1 *))
                                                  b-%offset%)
                                   (-
                                    (f2cl-lib:fref b-%data%
                                                   (i j)
                                                   ((1 ldb$) (1 *))
                                                   b-%offset%)
                                    (*
                                     (f2cl-lib:fref b-%data%
                                                    (k j)
                                                    ((1 ldb$) (1 *))
                                                    b-%offset%)
                                     (f2cl-lib:fref a-%data%
                                                    (i k)
                                                    ((1 lda) (1 *))
                                                    a-%offset%))))))))))))
            (t
             (cond
               (upper
                (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                              ((> j n) nil)
                  (tagbody
                    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                  ((> i m) nil)
                      (tagbody
                        (setf temp
                                (* alpha
```

```
                (f2cl-lib:fref b-%data%
                               (i j)
                               ((1 ldb$) (1 *))
                               b-%offset%)))
          (cond
            (noconj
             (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                           ((> k
                               (f2cl-lib:int-add i
                                                 (f2cl-lib:int-sub
                                                  1)))
                            nil)
               (tagbody
                 (setf temp
                         (- temp
                            (*
                             (f2cl-lib:fref a-%data%
                                            (k i)
                                            ((1 lda) (1 *))
                                            a-%offset%)
                             (f2cl-lib:fref b-%data%
                                            (k j)
                                            ((1 ldb$) (1 *))
                                            b-%offset%))))))
             (if nounit
                 (setf temp
                         (/ temp
                            (f2cl-lib:fref a-%data%
                                           (i i)
                                           ((1 lda) (1 *))
                                           a-%offset%)))))
            (t
             (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                           ((> k
                               (f2cl-lib:int-add i
                                                 (f2cl-lib:int-sub
                                                  1)))
                            nil)
               (tagbody
                 (setf temp
                         (- temp
                            (*
                             (f2cl-lib:dconjg
                              (f2cl-lib:fref a-%data%
                                             (k i)
                                             ((1 lda) (1 *))
                                             a-%offset%))
                             (f2cl-lib:fref b-%data%
                                            (k j)
                                            ((1 ldb$) (1 *))
```

```
                                                b-%offset%))))))
                    (if nounit
                        (setf temp
                                (/ temp
                                   (f2cl-lib:dconjg
                                    (f2cl-lib:fref a-%data%
                                                   (i i)
                                                   ((1 lda) (1 *))
                                                   a-%offset%)))))))
                  (setf (f2cl-lib:fref b-%data%
                                       (i j)
                                       ((1 ldb$) (1 *))
                                       b-%offset%)
                        temp))))))
          (t
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (f2cl-lib:fdo (i m
                              (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                             ((> i 1) nil)
                 (tagbody
                   (setf temp
                           (* alpha
                              (f2cl-lib:fref b-%data%
                                             (i j)
                                             ((1 ldb$) (1 *))
                                             b-%offset%)))
                   (cond
                     (noconj
                      (f2cl-lib:fdo (k (f2cl-lib:int-add i 1)
                                     (f2cl-lib:int-add k 1))
                                    ((> k m) nil)
                        (tagbody
                          (setf temp
                                  (- temp
                                     (*
                                      (f2cl-lib:fref a-%data%
                                                     (k i)
                                                     ((1 lda) (1 *))
                                                     a-%offset%)
                                      (f2cl-lib:fref b-%data%
                                                     (k j)
                                                     ((1 ldb$) (1 *))
                                                     b-%offset%))))))))
                     (if nounit
                         (setf temp
                                 (/ temp
                                    (f2cl-lib:fref a-%data%
                                                   (i i)
```

```
                                                ((1 lda) (1 *))
                                                a-%offset%)))))
                        (t
                         (f2cl-lib:fdo (k (f2cl-lib:int-add i 1)
                                          (f2cl-lib:int-add k 1))
                                       ((> k m) nil)
                           (tagbody
                             (setf temp
                                     (- temp
                                        (*
                                         (f2cl-lib:dconjg
                                          (f2cl-lib:fref a-%data%
                                                         (k i)
                                                         ((1 lda) (1 *))
                                                         a-%offset%))
                                         (f2cl-lib:fref b-%data%
                                                        (k j)
                                                        ((1 ldb$) (1 *))
                                                        b-%offset%))))))
                         (if nounit
                             (setf temp
                                     (/ temp
                                        (f2cl-lib:dconjg
                                         (f2cl-lib:fref a-%data%
                                                        (i i)
                                                        ((1 lda) (1 *))
                                                        a-%offset%)))))))
                       (setf (f2cl-lib:fref b-%data%
                                            (i j)
                                            ((1 ldb$) (1 *))
                                            b-%offset%)
                             temp))))))))))
          (t
           (cond
             ((char-equal transa #\N)
              (cond
                (upper
                 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                               ((> j n) nil)
                   (tagbody
                     (cond
                       ((/= alpha one)
                        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                      ((> i m) nil)
                          (tagbody
                            (setf (f2cl-lib:fref b-%data%
                                                 (i j)
                                                 ((1 ldb$) (1 *))
                                                 b-%offset%)
                                  (* alpha
```

```
                    (f2cl-lib:fref b-%data%
                                  (i j)
                                  ((1 ldb$) (1 *))
                                  b-%offset%)))))))
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
              ((> k
                  (f2cl-lib:int-add j
                                    (f2cl-lib:int-sub 1)))
               nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref a (k j) ((1 lda) (1 *))) zero)
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i m) nil)
         (tagbody
           (setf (f2cl-lib:fref b-%data%
                                (i j)
                                ((1 ldb$) (1 *))
                                b-%offset%)
                 (-
                  (f2cl-lib:fref b-%data%
                                 (i j)
                                 ((1 ldb$) (1 *))
                                 b-%offset%)
                  (*
                   (f2cl-lib:fref a-%data%
                                  (k j)
                                  ((1 lda) (1 *))
                                  a-%offset%)
                   (f2cl-lib:fref b-%data%
                                  (i k)
                                  ((1 ldb$) (1 *))
                                  b-%offset%)))))))))
(cond
  (nounit
   (setf temp
         (/ one
            (f2cl-lib:fref a-%data%
                           (j j)
                           ((1 lda) (1 *))
                           a-%offset%)))
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i m) nil)
     (tagbody
       (setf (f2cl-lib:fref b-%data%
                            (i j)
                            ((1 ldb$) (1 *))
                            b-%offset%)
             (* temp
                (f2cl-lib:fref b-%data%
```

```
                                        (i j)
                                        ((1 ldb$) (1 *))
                                        b-%offset%))))))))))
                (t
                 (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                               ((> j 1) nil)
                   (tagbody
                     (cond
                       ((/= alpha one)
                        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                      ((> i m) nil)
                          (tagbody
                            (setf (f2cl-lib:fref b-%data%
                                                 (i j)
                                                 ((1 ldb$) (1 *))
                                                 b-%offset%)
                                  (* alpha
                                     (f2cl-lib:fref b-%data%
                                                    (i j)
                                                    ((1 ldb$) (1 *))
                                                    b-%offset%)))))))
                     (f2cl-lib:fdo (k (f2cl-lib:int-add j 1)
                                    (f2cl-lib:int-add k 1))
                                   ((> k n) nil)
                       (tagbody
                         (cond
                           ((/= (f2cl-lib:fref a (k j) ((1 lda) (1 *))) zero)
                            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                          ((> i m) nil)
                              (tagbody
                                (setf (f2cl-lib:fref b-%data%
                                                     (i j)
                                                     ((1 ldb$) (1 *))
                                                     b-%offset%)
                                      (-
                                       (f2cl-lib:fref b-%data%
                                                      (i j)
                                                      ((1 ldb$) (1 *))
                                                      b-%offset%)
                                       (*
                                        (f2cl-lib:fref a-%data%
                                                       (k j)
                                                       ((1 lda) (1 *))
                                                       a-%offset%)
                                        (f2cl-lib:fref b-%data%
                                                       (i k)
                                                       ((1 ldb$) (1 *))
                                                       b-%offset%)))))))))))
                     (cond
                       (nounit
```

```
                (setf temp
                        (/ one
                           (f2cl-lib:fref a-%data%
                                          (j j)
                                          ((1 lda) (1 *))
                                          a-%offset%)))
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                              ((> i m) nil)
                  (tagbody
                    (setf (f2cl-lib:fref b-%data%
                                         (i j)
                                         ((1 ldb$) (1 *))
                                         b-%offset%)
                           (* temp
                              (f2cl-lib:fref b-%data%
                                             (i j)
                                             ((1 ldb$) (1 *))
                                             b-%offset%)))))))))
          (t
           (cond
             (upper
              (f2cl-lib:fdo (k n (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
                            ((> k 1) nil)
                (tagbody
                  (cond
                    (nounit
                     (cond
                       (noconj
                        (setf temp
                                (/ one
                                   (f2cl-lib:fref a-%data%
                                                  (k k)
                                                  ((1 lda) (1 *))
                                                  a-%offset%))))
                       (t
                        (setf temp
                                (/ one
                                   (f2cl-lib:dconjg
                                    (f2cl-lib:fref a-%data%
                                                   (k k)
                                                   ((1 lda) (1 *))
                                                   a-%offset%))))))))
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                              ((> i m) nil)
                  (tagbody
                    (setf (f2cl-lib:fref b-%data%
                                         (i k)
                                         ((1 ldb$) (1 *))
                                         b-%offset%)
                           (* temp
```

```
                    (f2cl-lib:fref b-%data%
                                   (i k)
                                   ((1 ldb$) (1 *))
                                   b-%offset%)))))))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j
                  (f2cl-lib:int-add k
                                    (f2cl-lib:int-sub 1)))
               nil)
  (tagbody
    (cond
      ((/= (f2cl-lib:fref a (j k) ((1 lda) (1 *))) zero)
       (cond
         (noconj
          (setf temp
                  (f2cl-lib:fref a-%data%
                                 (j k)
                                 ((1 lda) (1 *))
                                 a-%offset%)))
         (t
          (setf temp
                  (coerce
                   (f2cl-lib:dconjg
                    (f2cl-lib:fref a-%data%
                                   (j k)
                                   ((1 lda) (1 *))
                                   a-%offset%))
                   '(complex double-float)))))
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i m) nil)
         (tagbody
           (setf (f2cl-lib:fref b-%data%
                                (i j)
                                ((1 ldb$) (1 *))
                                b-%offset%)
                 (-
                  (f2cl-lib:fref b-%data%
                                 (i j)
                                 ((1 ldb$) (1 *))
                                 b-%offset%)
                  (* temp
                     (f2cl-lib:fref b-%data%
                                    (i k)
                                    ((1 ldb$) (1 *))
                                    b-%offset%)))))))))
(cond
  ((/= alpha one)
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i m) nil)
     (tagbody
```

```
                (setf (f2cl-lib:fref b-%data%
                                     (i k)
                                     ((1 ldb$) (1 *))
                                     b-%offset%)
                      (* alpha
                         (f2cl-lib:fref b-%data%
                                        (i k)
                                        ((1 ldb$) (1 *))
                                        b-%offset%)))))))))))
(t
 (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
               ((> k n) nil)
   (tagbody
     (cond
       (nounit
        (cond
          (noconj
           (setf temp
                 (/ one
                    (f2cl-lib:fref a-%data%
                                   (k k)
                                   ((1 lda) (1 *))
                                   a-%offset%))))
          (t
           (setf temp
                 (/ one
                    (f2cl-lib:dconjg
                     (f2cl-lib:fref a-%data%
                                    (k k)
                                    ((1 lda) (1 *))
                                    a-%offset%))))))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i m) nil)
          (tagbody
            (setf (f2cl-lib:fref b-%data%
                                 (i k)
                                 ((1 ldb$) (1 *))
                                 b-%offset%)
                  (* temp
                     (f2cl-lib:fref b-%data%
                                    (i k)
                                    ((1 ldb$) (1 *))
                                    b-%offset%)))))))
       (f2cl-lib:fdo (j (f2cl-lib:int-add k 1)
                      (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (cond
             ((/= (f2cl-lib:fref a (j k) ((1 lda) (1 *))) zero)
              (cond
```

```
                              (noconj
                               (setf temp
                                       (f2cl-lib:fref a-%data%
                                                      (j k)
                                                      ((1 lda) (1 *))
                                                      a-%offset%)))
                              (t
                               (setf temp
                                       (coerce
                                        (f2cl-lib:dconjg
                                         (f2cl-lib:fref a-%data%
                                                        (j k)
                                                        ((1 lda) (1 *))
                                                        a-%offset%))
                                         '(complex double-float)))))
                            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                          ((> i m) nil)
                              (tagbody
                                (setf (f2cl-lib:fref b-%data%
                                                     (i j)
                                                     ((1 ldb$) (1 *))
                                                     b-%offset%)
                                      (-
                                       (f2cl-lib:fref b-%data%
                                                      (i j)
                                                      ((1 ldb$) (1 *))
                                                      b-%offset%)
                                       (* temp
                                          (f2cl-lib:fref b-%data%
                                                         (i k)
                                                         ((1 ldb$) (1 *))
                                                         b-%offset%)))))))))
                       (cond
                         ((/= alpha one)
                          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                        ((> i m) nil)
                            (tagbody
                              (setf (f2cl-lib:fref b-%data%
                                                   (i k)
                                                   ((1 ldb$) (1 *))
                                                   b-%offset%)
                                    (* alpha
                                       (f2cl-lib:fref b-%data%
                                                      (i k)
                                                      ((1 ldb$) (1 *))
                                                      b-%offset%))))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil nil nil))))))
```

Chapter 6

LAPACK

6.1 dbdsdc LAPACK

— **dbdsdc.input** —

```
)set break resume
)sys rm -f dbdsdc.output
)spool dbdsdc.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dbdsdc.help** —

```
=======================================================================
dbdsdc examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

NAME
       DBDSDC - the singular value decomposition (SVD) of a real N-by-N (upper
       or lower) bidiagonal matrix B
```

```
SYNOPSIS
       SUBROUTINE DBDSDC( UPLO, COMPQ, N, D, E, U, LDU, VT, LDVT, Q, IQ, WORK,
                          IWORK, INFO )

           CHARACTER      COMPQ, UPLO

           INTEGER        INFO, LDU, LDVT, N

           INTEGER        IQ( * ), IWORK( * )

           DOUBLE         PRECISION  D(  * ), E( * ), Q( * ), U( LDU, * ), VT(
                          LDVT, * ), WORK( * )

PURPOSE
       DBDSDC computes the singular value decomposition (SVD) of a real N-by-N
       (upper  or  lower) bidiagonal matrix B:  B = U * S * VT, using a divide
       and conquer method, where S is  a  diagonal  matrix  with  non-negative
       diagonal elements (the singular values of B), and U and VT are orthogo-
       nal matrices of left and right singular vectors,  respectively.  DBDSDC
       can  be  used  to compute all singular values, and optionally, singular
       vectors or singular vectors in compact form.

       This code makes very mild assumptions about floating point  arithmetic.
       It  will  work  on  machines  with a guard digit in add/subtract, or on
       those binary machines without guard digits which subtract like the Cray
       X-MP,  Cray  Y-MP,  Cray C-90, or Cray-2.  It could conceivably fail on
       hexadecimal or decimal machines without guard digits, but  we  know  of
       none.  See DLASD3 for details.

       The  code  currently  calls DLASDQ if singular values only are desired.
       However, it can be slightly modified to compute singular  values  using
       the divide and conquer method.


ARGUMENTS
       UPLO    (input) CHARACTER*1
               = 'U':  B is upper bidiagonal.
               = 'L':  B is lower bidiagonal.

       COMPQ   (input) CHARACTER*1
               Specifies  whether  singular vectors are to be computed as fol-
               lows:
               = 'N':  Compute singular values only;
               = 'P':  Compute singular values and compute singular vectors in
               compact form; = 'I':  Compute singular values and singular vec-
               tors.

       N       (input) INTEGER
               The order of the matrix B.  N >= 0.
```

D (input/output) DOUBLE PRECISION array, dimension (N)
On entry, the n diagonal elements of the bidiagonal matrix B. On exit, if INFO=0, the singular values of B.

E (input/output) DOUBLE PRECISION array, dimension (N-1)
On entry, the elements of E contain the offdiagonal elements of the bidiagonal matrix whose SVD is desired. On exit, E has been destroyed.

U (output) DOUBLE PRECISION array, dimension (LDU,N)
If COMPQ = 'I', then: On exit, if INFO = 0, U contains the left singular vectors of the bidiagonal matrix. For other values of COMPQ, U is not referenced.

LDU (input) INTEGER
The leading dimension of the array U. LDU >= 1. If singular vectors are desired, then LDU >= max(1, N).

VT (output) DOUBLE PRECISION array, dimension (LDVT,N)
If COMPQ = 'I', then: On exit, if INFO = 0, VT' contains the right singular vectors of the bidiagonal matrix. For other values of COMPQ, VT is not referenced.

LDVT (input) INTEGER
The leading dimension of the array VT. LDVT >= 1. If singular vectors are desired, then LDVT >= max(1, N).

Q (output) DOUBLE PRECISION array, dimension (LDQ)
If COMPQ = 'P', then: On exit, if INFO = 0, Q and IQ contain the left and right singular vectors in a compact form, requiring O(N log N) space instead of 2*N**2. In particular, Q contains all the DOUBLE PRECISION data in LDQ >= N*(11 + 2*SMLSIZ + 8*INT(LOG_2(N/(SMLSIZ+1)))) words of memory, where SMLSIZ is returned by ILAENV and is equal to the maximum size of the subproblems at the bottom of the computation tree (usually about 25). For other values of COMPQ, Q is not referenced.

IQ (output) INTEGER array, dimension (LDIQ)
If COMPQ = 'P', then: On exit, if INFO = 0, Q and IQ contain the left and right singular vectors in a compact form, requiring O(N log N) space instead of 2*N**2. In particular, IQ contains all INTEGER data in LDIQ >= N*(3 + 3*INT(LOG_2(N/(SMLSIZ+1)))) words of memory, where SMLSIZ is returned by ILAENV and is equal to the maximum size of the subproblems at the bottom of the computation tree (usually about 25). For other values of COMPQ, IQ is not referenced.

WORK (workspace) DOUBLE PRECISION array, dimension (MAX(1,LWORK))
If COMPQ = 'N' then LWORK >= (4 * N). If COMPQ = 'P' then LWORK >= (6 * N). If COMPQ = 'I' then LWORK >= (3 * N**2 + 4 *

```
              N).

       IWORK   (workspace) INTEGER array, dimension (8*N)

       INFO    (output) INTEGER
               = 0:  successful exit.
               < 0:  if INFO = -i, the i-th argument had an illegal value.
               >  0:   The algorithm failed to compute an singular value.  The
               update process of divide and conquer failed.

 Further Details
 ===============

  Based on contributions by
     Ming Gu and Huan Ren, Computer Science Division, University of
     California at Berkeley, USA
```

The input arguments are:

- uplo - simple-array character (1)
- compq - (simple-array character (1)
- n - fixnum
- d - array doublefloat
- e - array doublefloat
- u - array doublefloat
- ldu - fixnum
- vt - doublefloat
- ldvt - fixnum
- q - array doublefloat
- iq - array fixnum
- work - array doublefloat
- iwork - array fixnum
- info - fixnum

The return values are:

- uplo - nil
- compq - nil
- n - nil
- d - nil
- e - nil
- u - nil
- ldu - nil
- vt - nil
- ldvt - nil
- q - nil
- iq - nil
- work - nil
- iwork - nil
- info - info

[dlasr p??]
[dswap p??]
[dlasda p??]
[dlasd0 p??]
[dlamch p??]
[dlascl p??]
[dlanst p??]
[dlaset p??]
[dlasdq p??]
[dlartg p??]
[dcopy p??]
[ilaenv p??]
[xerbla p??]
[char-equal p??]

— dbdsdc.f —

```
      SUBROUTINE DBDSDC( UPLO, COMPQ, N, D, E, U, LDU, VT, LDVT, Q, IQ,
     $                   WORK, IWORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
```

```
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     December 1, 1999
*
*     .. Scalar Arguments ..
      CHARACTER          COMPQ, UPLO
      INTEGER            INFO, LDU, LDVT, N
*     ..
*     .. Array Arguments ..
      INTEGER            IQ( * ), IWORK( * )
      DOUBLE PRECISION   D( * ), E( * ), Q( * ), U( LDU, * ),
     $                   VT( LDVT, * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE, TWO
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0, TWO = 2.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            DIFL, DIFR, GIVCOL, GIVNUM, GIVPTR, I, IC,
     $                   ICOMPQ, IERR, II, IS, IU, IUPLO, IVT, J, K, KK,
     $                   MLVL, NM1, NSIZE, PERM, POLES, QSTART, SMLSIZ,
     $                   SMLSZP, SQRE, START, WSTART, Z
      DOUBLE PRECISION   CS, EPS, ORGNRM, P, R, SN
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      INTEGER            ILAENV
      DOUBLE PRECISION   DLAMCH, DLANST
      EXTERNAL           LSAME, ILAENV, DLAMCH, DLANST
*     ..
*     .. External Subroutines ..
      EXTERNAL           DCOPY, DLARTG, DLASCL, DLASD0, DLASDA, DLASDQ,
     $                   DLASET, DLASR, DSWAP, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, DBLE, INT, LOG, SIGN
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
*
      IUPLO = 0
      IF( LSAME( UPLO, 'U' ) )
     $   IUPLO = 1
      IF( LSAME( UPLO, 'L' ) )
```

```
     $   IUPLO = 2
      IF( LSAME( COMPQ, 'N' ) ) THEN
         ICOMPQ = 0
      ELSE IF( LSAME( COMPQ, 'P' ) ) THEN
         ICOMPQ = 1
      ELSE IF( LSAME( COMPQ, 'I' ) ) THEN
         ICOMPQ = 2
      ELSE
         ICOMPQ = -1
      END IF
      IF( IUPLO.EQ.0 ) THEN
         INFO = -1
      ELSE IF( ICOMPQ.LT.0 ) THEN
         INFO = -2
      ELSE IF( N.LT.0 ) THEN
         INFO = -3
      ELSE IF( ( LDU.LT.1 ) .OR. ( ( ICOMPQ.EQ.2 ) .AND. ( LDU.LT.
     $         N ) ) ) THEN
         INFO = -7
      ELSE IF( ( LDVT.LT.1 ) .OR. ( ( ICOMPQ.EQ.2 ) .AND. ( LDVT.LT.
     $         N ) ) ) THEN
         INFO = -9
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DBDSDC', -INFO )
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( N.EQ.0 )
     $   RETURN
      SMLSIZ = ILAENV( 9, 'DBDSDC', ' ', 0, 0, 0, 0 )
      IF( N.EQ.1 ) THEN
         IF( ICOMPQ.EQ.1 ) THEN
            Q( 1 ) = SIGN( ONE, D( 1 ) )
            Q( 1+SMLSIZ*N ) = ONE
         ELSE IF( ICOMPQ.EQ.2 ) THEN
            U( 1, 1 ) = SIGN( ONE, D( 1 ) )
            VT( 1, 1 ) = ONE
         END IF
         D( 1 ) = ABS( D( 1 ) )
         RETURN
      END IF
      NM1 = N - 1
*
*     If matrix lower bidiagonal, rotate to be upper bidiagonal
*     by applying Givens rotations on the left
*
      WSTART = 1
```

```
      QSTART = 3
      IF( ICOMPQ.EQ.1 ) THEN
         CALL DCOPY( N, D, 1, Q( 1 ), 1 )
         CALL DCOPY( N-1, E, 1, Q( N+1 ), 1 )
      END IF
      IF( IUPLO.EQ.2 ) THEN
         QSTART = 5
         WSTART = 2*N - 1
         DO 10 I = 1, N - 1
            CALL DLARTG( D( I ), E( I ), CS, SN, R )
            D( I ) = R
            E( I ) = SN*D( I+1 )
            D( I+1 ) = CS*D( I+1 )
            IF( ICOMPQ.EQ.1 ) THEN
               Q( I+2*N ) = CS
               Q( I+3*N ) = SN
            ELSE IF( ICOMPQ.EQ.2 ) THEN
               WORK( I ) = CS
               WORK( NM1+I ) = -SN
            END IF
   10    CONTINUE
      END IF
*
*     If ICOMPQ = 0, use DLASDQ to compute the singular values.
*
      IF( ICOMPQ.EQ.0 ) THEN
         CALL DLASDQ( 'U', 0, N, 0, 0, 0, D, E, VT, LDVT, U, LDU, U,
     $                LDU, WORK( WSTART ), INFO )
         GO TO 40
      END IF
*
*     If N is smaller than the minimum divide size SMLSIZ, then solve
*     the problem with another solver.
*
      IF( N.LE.SMLSIZ ) THEN
         IF( ICOMPQ.EQ.2 ) THEN
            CALL DLASET( 'A', N, N, ZERO, ONE, U, LDU )
            CALL DLASET( 'A', N, N, ZERO, ONE, VT, LDVT )
            CALL DLASDQ( 'U', 0, N, N, N, 0, D, E, VT, LDVT, U, LDU, U,
     $                   LDU, WORK( WSTART ), INFO )
         ELSE IF( ICOMPQ.EQ.1 ) THEN
            IU = 1
            IVT = IU + N
            CALL DLASET( 'A', N, N, ZERO, ONE, Q( IU+( QSTART-1 )*N ),
     $                   N )
            CALL DLASET( 'A', N, N, ZERO, ONE, Q( IVT+( QSTART-1 )*N ),
     $                   N )
            CALL DLASDQ( 'U', 0, N, N, N, 0, D, E,
     $                   Q( IVT+( QSTART-1 )*N ), N,
     $                   Q( IU+( QSTART-1 )*N ), N,
```

```
     $                   Q( IU+( QSTART-1 )*N ), N, WORK( WSTART ),
     $                   INFO )
         END IF
         GO TO 40
      END IF
*
      IF( ICOMPQ.EQ.2 ) THEN
         CALL DLASET( 'A', N, N, ZERO, ONE, U, LDU )
         CALL DLASET( 'A', N, N, ZERO, ONE, VT, LDVT )
      END IF
*
*     Scale.
*
      ORGNRM = DLANST( 'M', N, D, E )
      IF( ORGNRM.EQ.ZERO )
     $   RETURN
      CALL DLASCL( 'G', 0, 0, ORGNRM, ONE, N, 1, D, N, IERR )
      CALL DLASCL( 'G', 0, 0, ORGNRM, ONE, NM1, 1, E, NM1, IERR )
*
      EPS = DLAMCH( 'Epsilon' )
*
      MLVL = INT( LOG( DBLE( N ) / DBLE( SMLSIZ+1 ) ) / LOG( TWO ) ) + 1
      SMLSZP = SMLSIZ + 1
*
      IF( ICOMPQ.EQ.1 ) THEN
         IU = 1
         IVT = 1 + SMLSIZ
         DIFL = IVT + SMLSZP
         DIFR = DIFL + MLVL
         Z = DIFR + MLVL*2
         IC = Z + MLVL
         IS = IC + 1
         POLES = IS + 1
         GIVNUM = POLES + 2*MLVL
*
         K = 1
         GIVPTR = 2
         PERM = 3
         GIVCOL = PERM + MLVL
      END IF
*
      DO 20 I = 1, N
         IF( ABS( D( I ) ).LT.EPS ) THEN
            D( I ) = SIGN( EPS, D( I ) )
         END IF
   20 CONTINUE
*
      START = 1
      SQRE = 0
*
```

```
      DO 30 I = 1, NM1
         IF( ( ABS( E( I ) ).LT.EPS ) .OR. ( I.EQ.NM1 ) ) THEN
*
*        Subproblem found. First determine its size and then
*        apply divide and conquer on it.
*
            IF( I.LT.NM1 ) THEN
*
*        A subproblem with E(I) small for I < NM1.
*
               NSIZE = I - START + 1
            ELSE IF( ABS( E( I ) ).GE.EPS ) THEN
*
*        A subproblem with E(NM1) not too small but I = NM1.
*
               NSIZE = N - START + 1
            ELSE
*
*        A subproblem with E(NM1) small. This implies an
*        1-by-1 subproblem at D(N). Solve this 1-by-1 problem
*        first.
*
               NSIZE = I - START + 1
               IF( ICOMPQ.EQ.2 ) THEN
                  U( N, N ) = SIGN( ONE, D( N ) )
                  VT( N, N ) = ONE
               ELSE IF( ICOMPQ.EQ.1 ) THEN
                  Q( N+( QSTART-1 )*N ) = SIGN( ONE, D( N ) )
                  Q( N+( SMLSIZ+QSTART-1 )*N ) = ONE
               END IF
               D( N ) = ABS( D( N ) )
            END IF
            IF( ICOMPQ.EQ.2 ) THEN
               CALL DLASD0( NSIZE, SQRE, D( START ), E( START ),
     $                      U( START, START ), LDU, VT( START, START ),
     $                      LDVT, SMLSIZ, IWORK, WORK( WSTART ), INFO )
            ELSE
               CALL DLASDA( ICOMPQ, SMLSIZ, NSIZE, SQRE, D( START ),
     $                      E( START ), Q( START+( IU+QSTART-2 )*N ), N,
     $                      Q( START+( IVT+QSTART-2 )*N ),
     $                      IQ( START+K*N ), Q( START+( DIFL+QSTART-2 )*
     $                      N ), Q( START+( DIFR+QSTART-2 )*N ),
     $                      Q( START+( Z+QSTART-2 )*N ),
     $                      Q( START+( POLES+QSTART-2 )*N ),
     $                      IQ( START+GIVPTR*N ), IQ( START+GIVCOL*N ),
     $                      N, IQ( START+PERM*N ),
     $                      Q( START+( GIVNUM+QSTART-2 )*N ),
     $                      Q( START+( IC+QSTART-2 )*N ),
     $                      Q( START+( IS+QSTART-2 )*N ),
     $                      WORK( WSTART ), IWORK, INFO )
```

```
               IF( INFO.NE.0 ) THEN
                  RETURN
               END IF
            END IF
            START = I + 1
         END IF
   30 CONTINUE
*
*     Unscale
*
      CALL DLASCL( 'G', 0, 0, ONE, ORGNRM, N, 1, D, N, IERR )
   40 CONTINUE
*
*     Use Selection Sort to minimize swaps of singular vectors
*
      DO 60 II = 2, N
         I = II - 1
         KK = I
         P = D( I )
         DO 50 J = II, N
            IF( D( J ).GT.P ) THEN
               KK = J
               P = D( J )
            END IF
   50    CONTINUE
         IF( KK.NE.I ) THEN
            D( KK ) = D( I )
            D( I ) = P
            IF( ICOMPQ.EQ.1 ) THEN
               IQ( I ) = KK
            ELSE IF( ICOMPQ.EQ.2 ) THEN
               CALL DSWAP( N, U( 1, I ), 1, U( 1, KK ), 1 )
               CALL DSWAP( N, VT( I, 1 ), LDVT, VT( KK, 1 ), LDVT )
            END IF
         ELSE IF( ICOMPQ.EQ.1 ) THEN
            IQ( I ) = I
         END IF
   60 CONTINUE
*
*     If ICOMPQ = 1, use IQ(N,1) as the indicator for UPLO
*
      IF( ICOMPQ.EQ.1 ) THEN
         IF( IUPLO.EQ.1 ) THEN
            IQ( N ) = 1
         ELSE
            IQ( N ) = 0
         END IF
      END IF
*
*     If B is lower bidiagonal, update U by those Givens rotations
```

```
*     which rotated B to be upper bidiagonal
*
      IF( ( IUPLO.EQ.2 ) .AND. ( ICOMPQ.EQ.2 ) )
     $   CALL DLASR( 'L', 'V', 'B', N, N, WORK( 1 ), WORK( N ), U, LDU )
*
      RETURN
*
*     End of DBDSDC
*
      END
```

— LAPACK dbdsdc —

```
(let* ((zero 0.0) (one 1.0) (two 2.0))
 (declare (type (double-float 0.0 0.0) zero)
          (type (double-float 1.0 1.0) one)
          (type (double-float 2.0 2.0) two))
 (defun dbdsdc (uplo compq n d e u ldu vt ldvt q iq work iwork info)
  (declare (type (simple-array fixnum (*)) iwork iq)
           (type (simple-array double-float (*)) work q vt u e d)
           (type fixnum info ldvt ldu n)
           (type character compq uplo))
   (f2cl-lib:with-multi-array-data
    ((uplo character uplo-%data% uplo-%offset%)
     (compq character compq-%data% compq-%offset%)
     (d double-float d-%data% d-%offset%)
     (e double-float e-%data% e-%offset%)
     (u double-float u-%data% u-%offset%)
     (vt double-float vt-%data% vt-%offset%)
     (q double-float q-%data% q-%offset%)
     (work double-float work-%data% work-%offset%)
     (iq fixnum iq-%data% iq-%offset%)
     (iwork fixnum iwork-%data% iwork-%offset%))
    (prog ((cs 0.0) (eps 0.0) (orgnrm 0.0) (p 0.0) (r 0.0) (sn 0.0) (difl 0)
           (difr 0) (givcol 0) (givnum 0) (givptr 0) (i 0) (ic 0) (icompq 0)
           (ierr 0) (ii 0) (is 0) (iu 0) (iuplo 0) (ivt 0) (j 0) (k 0) (kk 0)
           (mlvl 0) (nm1 0) (nsize 0) (perm 0) (poles 0) (qstart 0)
           (smlsiz 0) (smlszp 0) (sqre 0) (start 0) (wstart 0) (z 0))
     (declare (type (double-float) cs eps orgnrm p r sn)
              (type fixnum difl difr givcol givnum givptr i ic
                                      icompq ierr ii is iu iuplo ivt j k
                                      kk mlvl nm1 nsize perm poles qstart
                                      smlsiz smlszp sqre start wstart z))
      (setf info 0)
      (setf iuplo 0)
      (if (char-equal uplo #\U) (setf iuplo 1))
```

```
(if (char-equal uplo #\L) (setf iuplo 2))
(cond
 ((char-equal compq #\N) (setf icompq 0))
 ((char-equal compq #\P) (setf icompq 1))
 ((char-equal compq #\I) (setf icompq 2))
 (t                 (setf icompq -1)))
(cond
 ((= iuplo 0)                                    (setf info -1))
 ((< icompq 0)                                   (setf info -2))
 ((< n 0)                                        (setf info -3))
 ((or (< ldu 1) (and (= icompq 2) (< ldu n)))    (setf info -7))
 ((or (< ldvt 1) (and (= icompq 2) (< ldvt n))) (setf info -9)))
(cond
 ((/= info 0)
  (error
   " ** On entry to ~a parameter number ~a had an illegal value~%"
   "DBDSDC" (f2cl-lib:int-sub info))
  (go end_label)))
(if (= n 0) (go end_label))
(setf smlsiz (ilaenv 9 "DBDSDC" " " 0 0 0 0))
(cond
 ((= n 1)
  (cond
   ((= icompq 1)
    (setf
     (f2cl-lib:fref q-%data% (1) ((1 *)) q-%offset%)
     (f2cl-lib:sign one
      (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)))
    (setf
     (f2cl-lib:fref q-%data%
      ((f2cl-lib:int-add 1
       (f2cl-lib:int-mul smlsiz n))) ((1 *)) q-%offset%)
     one))
   ((= icompq 2)
    (setf
     (f2cl-lib:fref u-%data% (1 1) ((1 ldu) (1 *)) u-%offset%)
     (f2cl-lib:sign one (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)))
    (setf
      (f2cl-lib:fref vt-%data% (1 1) ((1 ldvt) (1 *)) vt-%offset%)
      one)))
  (setf (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)
        (abs (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)))
  (go end_label)))
(setf nm1 (f2cl-lib:int-sub n 1))
(setf wstart 1)
(setf qstart 3)
(cond
 ((= icompq 1)
  (dcopy n d 1 (f2cl-lib:array-slice q double-float (1) ((1 *))) 1)
  (dcopy (f2cl-lib:int-sub n 1) e 1
```

```
    (f2cl-lib:array-slice q double-float ((+ n 1)) ((1 *))) 1)))
(cond
 ((= iuplo 2)
  (setf qstart 5)
  (setf wstart (f2cl-lib:int-sub (f2cl-lib:int-mul 2 n) 1))
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                ((> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
   (tagbody
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
     (dlartg (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
             (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%) cs sn r)
      (declare (ignore var-0 var-1))
      (setf cs var-2)
      (setf sn var-3)
      (setf r var-4))
      (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) r)
      (setf
       (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)
       (* sn (f2cl-lib:fref
              d-%data% ((f2cl-lib:int-add i 1)) ((1 *)) d-%offset%)))
      (setf
       (f2cl-lib:fref d-%data%
         ((f2cl-lib:int-add i 1)) ((1 *)) d-%offset%)
       (* cs (f2cl-lib:fref
              d-%data% ((f2cl-lib:int-add i 1)) ((1 *)) d-%offset%)))
      (cond
       ((= icompq 1)
        (setf
         (f2cl-lib:fref q-%data%
          ((f2cl-lib:int-add i (f2cl-lib:int-mul 2 n)))
           ((1 *)) q-%offset%)
         cs)
        (setf
         (f2cl-lib:fref q-%data%
          ((f2cl-lib:int-add i (f2cl-lib:int-mul 3 n)))
           ((1 *)) q-%offset%)
         sn))
       ((= icompq 2)
        (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%) cs)
        (setf
         (f2cl-lib:fref work-%data%
          ((f2cl-lib:int-add nm1 i)) ((1 *)) work-%offset%)
         (- sn))))))))
(cond
 ((= icompq 0)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
    var-10 var-11 var-12 var-13 var-14 var-15)
   (dlasdq "U" 0 n 0 0 0 d e vt ldvt u ldu u ldu
    (f2cl-lib:array-slice work double-float (wstart) ((1 *))) info)
```

```
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                     var-8 var-9 var-10 var-11 var-12 var-13 var-14))
    (setf info var-15))
   (go label40)))
 (cond
  ((<= n smlsiz)
   (cond
    ((= icompq 2)
     (dlaset "A" n n zero one u ldu)
     (dlaset "A" n n zero one vt ldvt)
     (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13 var-14 var-15)
      (dlasdq "U" 0 n n n 0 d e vt ldvt u ldu u ldu
       (f2cl-lib:array-slice work double-float (wstart) ((1 *)))
       info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                var-7 var-8 var-9 var-10 var-11 var-12 var-13 var-14))
      (setf info var-15)))
    ((= icompq 1)
     (setf iu 1)
     (setf ivt (f2cl-lib:int-add iu n))
     (dlaset "A" n n zero one
      (f2cl-lib:array-slice q double-float
       ((+ iu
           (f2cl-lib:int-mul
            (f2cl-lib:int-add qstart (f2cl-lib:int-sub 1)) n)))
       ((1 *)))
      n)
     (dlaset "A" n n zero one
      (f2cl-lib:array-slice q double-float
       ((+ ivt
           (f2cl-lib:int-mul
            (f2cl-lib:int-add qstart (f2cl-lib:int-sub 1)) n)))
       ((1 *)))
      n)
     (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13 var-14 var-15)
      (dlasdq "U" 0 n n n 0 d e
       (f2cl-lib:array-slice q double-float
        ((+ ivt
            (f2cl-lib:int-mul
             (f2cl-lib:int-add qstart (f2cl-lib:int-sub 1))
             n)))
        ((1 *)))
       n
       (f2cl-lib:array-slice q double-float
        ((+ iu
            (f2cl-lib:int-mul
```

```
              (f2cl-lib:int-add qstart (f2cl-lib:int-sub 1))
              n)))
        ((1 *)))
        n
        (f2cl-lib:array-slice q double-float
         ((+ iu
             (f2cl-lib:int-mul
              (f2cl-lib:int-add qstart (f2cl-lib:int-sub 1))
              n)))
         ((1 *)))
         n
         (f2cl-lib:array-slice work double-float (wstart) ((1 *)))
         info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                var-7 var-8 var-9 var-10 var-11 var-12 var-13 var-14))
      (setf info var-15))))
      (go label40)))
(cond
 ((= icompq 2)
  (dlaset "A" n n zero one u ldu)
  (dlaset "A" n n zero one vt ldvt)))
(setf orgnrm (dlanst "M" n d e))
(if (= orgnrm zero) (go end_label))
(multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
  (dlascl "G" 0 0 orgnrm one n 1 d n ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
            var-8))
  (setf ierr var-9))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
 (dlascl "G" 0 0 orgnrm one nm1 1 e nm1 ierr)
 (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
           var-8))
 (setf ierr var-9))
(setf eps (dlamch "Epsilon"))
(setf mlvl
 (f2cl-lib:int-add
  (f2cl-lib:int
   (/
    (f2cl-lib:flog
     (/ (coerce (realpart n) 'double-float)
        (coerce (realpart (f2cl-lib:int-add smlsiz 1)) 'double-float)))
    (f2cl-lib:flog two)))
   1))
(setf smlszp (f2cl-lib:int-add smlsiz 1))
(cond
 ((= icompq 1)
  (setf iu 1)
  (setf ivt (f2cl-lib:int-add 1 smlsiz))
```

```
  (setf difl (f2cl-lib:int-add ivt smlszp))
  (setf difr (f2cl-lib:int-add difl mlvl))
  (setf z (f2cl-lib:int-add difr (f2cl-lib:int-mul mlvl 2)))
  (setf ic (f2cl-lib:int-add z mlvl))
  (setf is (f2cl-lib:int-add ic 1))
  (setf poles (f2cl-lib:int-add is 1))
  (setf givnum (f2cl-lib:int-add poles (f2cl-lib:int-mul 2 mlvl)))
  (setf k 1)
  (setf givptr 2)
  (setf perm 3)
   (setf givcol (f2cl-lib:int-add perm mlvl))))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i n) nil)
 (tagbody
  (cond
   ((< (abs (f2cl-lib:fref d (i) ((1 *)))) eps)
    (setf
     (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
     (f2cl-lib:sign eps
      (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)))))))
(setf start 1)
(setf sqre 0)
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i nm1) nil)
 (tagbody
  (cond
   ((or (< (abs (f2cl-lib:fref e (i) ((1 *)))) eps) (= i nm1))
    (cond
     ((< i nm1)
      (setf nsize (f2cl-lib:int-add (f2cl-lib:int-sub i start) 1)))
     ((>= (abs (f2cl-lib:fref e (i) ((1 *)))) eps)
      (setf nsize (f2cl-lib:int-add (f2cl-lib:int-sub n start) 1)))
     (t
      (setf nsize (f2cl-lib:int-add (f2cl-lib:int-sub i start) 1))
      (cond
       ((= icompq 2)
        (setf
         (f2cl-lib:fref u-%data% (n n) ((1 ldu) (1 *)) u-%offset%)
         (f2cl-lib:sign one
          (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)))
        (setf
         (f2cl-lib:fref vt-%data% (n n) ((1 ldvt) (1 *)) vt-%offset%)
         one))
       ((= icompq 1)
        (setf
         (f2cl-lib:fref q-%data%
          ((f2cl-lib:int-add n
            (f2cl-lib:int-mul (f2cl-lib:int-sub qstart 1) n)))
           ((1 *)) q-%offset%)
         (f2cl-lib:sign one
```

```
      (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)))
    (setf
     (f2cl-lib:fref q-%data%
      ((f2cl-lib:int-add n
       (f2cl-lib:int-mul
        (f2cl-lib:int-sub
         (f2cl-lib:int-add smlsiz qstart) 1) n)))
      ((1 *)) q-%offset%)
     one)))
    (setf
     (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
     (abs (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)))))
(cond
 ((= icompq 2)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
    var-9 var-10 var-11)
   (dlasd0 nsize sqre
    (f2cl-lib:array-slice d double-float (start) ((1 *)))
    (f2cl-lib:array-slice e double-float (start) ((1 *)))
    (f2cl-lib:array-slice u double-float
     (start start) ((1 ldu) (1 *)))
    ldu
    (f2cl-lib:array-slice vt double-float
     (start start) ((1 ldvt) (1 *)))
    ldvt
    smlsiz
    iwork
    (f2cl-lib:array-slice work double-float (wstart) ((1 *))) info)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
             var-7 var-8 var-9 var-10))
   (setf info var-11)))
 (t
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
    var-9 var-10 var-11 var-12 var-13 var-14 var-15 var-16
    var-17 var-18 var-19 var-20 var-21 var-22 var-23)
   (dlasda icompq smlsiz nsize sqre
    (f2cl-lib:array-slice d double-float (start) ((1 *)))
    (f2cl-lib:array-slice e double-float (start) ((1 *)))
    (f2cl-lib:array-slice q double-float
     ((+ start (f2cl-lib:int-mul (f2cl-lib:int-add iu qstart
       (f2cl-lib:int-sub 2)) n))) ((1 *)))
    n
    (f2cl-lib:array-slice q double-float
     ((+ start (f2cl-lib:int-mul (f2cl-lib:int-add ivt qstart
       (f2cl-lib:int-sub 2)) n))) ((1 *)))
    (f2cl-lib:array-slice iq fixnum
     ((+ start (f2cl-lib:int-mul k n))) ((1 *)))
    (f2cl-lib:array-slice q double-float
```

```
              ((+ start (f2cl-lib:int-mul (f2cl-lib:int-add difl qstart
                         (f2cl-lib:int-sub 2)) n))) ((1 *)))
             (f2cl-lib:array-slice q double-float
              ((+ start (f2cl-lib:int-mul (f2cl-lib:int-add difr qstart
                         (f2cl-lib:int-sub 2)) n))) ((1 *)))
             (f2cl-lib:array-slice q double-float
              ((+ start (f2cl-lib:int-mul (f2cl-lib:int-add z qstart
                         (f2cl-lib:int-sub 2)) n))) ((1 *)))
             (f2cl-lib:array-slice q double-float
              ((+ start (f2cl-lib:int-mul (f2cl-lib:int-add poles qstart
                         (f2cl-lib:int-sub 2)) n))) ((1 *)))
             (f2cl-lib:array-slice iq fixnum
              ((+ start (f2cl-lib:int-mul givptr n))) ((1 *)))
             (f2cl-lib:array-slice iq fixnum
              ((+ start (f2cl-lib:int-mul givcol n))) ((1 *)))
             n
             (f2cl-lib:array-slice iq fixnum
              ((+ start (f2cl-lib:int-mul perm n))) ((1 *)))
             (f2cl-lib:array-slice q double-float
              ((+ start (f2cl-lib:int-mul (f2cl-lib:int-add givnum qstart
                         (f2cl-lib:int-sub 2)) n))) ((1 *)))
             (f2cl-lib:array-slice q double-float
              ((+ start (f2cl-lib:int-mul (f2cl-lib:int-add ic qstart
                         (f2cl-lib:int-sub 2)) n))) ((1 *)))
             (f2cl-lib:array-slice q double-float
              ((+ start (f2cl-lib:int-mul (f2cl-lib:int-add is qstart
                         (f2cl-lib:int-sub 2)) n))) ((1 *)))
             (f2cl-lib:array-slice work double-float (wstart) ((1 *)))
             iwork
             info)
             (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                              var-7 var-8 var-9 var-10 var-11 var-12
                              var-13 var-14 var-15 var-16 var-17 var-18
                              var-19 var-20 var-21 var-22))
             (setf info var-23))
            (cond
             ((/= info 0) (go end_label)))))
          (setf start (f2cl-lib:int-add i 1))))))
      (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
       (dlascl "G" 0 0 one orgnrm n 1 d n ierr)
       (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8))
       (setf ierr var-9))
label40
      (f2cl-lib:fdo (ii 2 (f2cl-lib:int-add ii 1))
                    ((> ii n) nil)
       (tagbody
        (setf i (f2cl-lib:int-sub ii 1))
        (setf kk i)
        (setf p (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
```

```
        (f2cl-lib:fdo (j ii (f2cl-lib:int-add j 1))
                      ((> j n) nil)
         (tagbody
          (cond
           ((> (f2cl-lib:fref d (j) ((1 *))) p)
            (setf kk j)
            (setf p (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%))))
          (cond
           ((/= kk i)
            (setf (f2cl-lib:fref d-%data% (kk) ((1 *)) d-%offset%)
                  (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
            (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) p)
            (cond
             ((= icompq 1)
              (setf (f2cl-lib:fref iq-%data% (i) ((1 *)) iq-%offset%) kk))
             ((= icompq 2)
              (dswap n
               (f2cl-lib:array-slice u double-float (1 i) ((1 ldu) (1 *)))
               1
               (f2cl-lib:array-slice u double-float (1 kk) ((1 ldu) (1 *)))
               1)
              (dswap n
               (f2cl-lib:array-slice vt double-float (i 1) ((1 ldvt) (1 *)))
               ldvt
               (f2cl-lib:array-slice vt double-float (kk 1) ((1 ldvt) (1 *)))
               ldvt))))
           ((= icompq 1)
            (setf (f2cl-lib:fref iq-%data% (i) ((1 *)) iq-%offset%) i)))))
      (cond
       ((= icompq 1)
        (cond
         ((= iuplo 1)
          (setf (f2cl-lib:fref iq-%data% (n) ((1 *)) iq-%offset%) 1))
         (t
          (setf (f2cl-lib:fref iq-%data% (n) ((1 *)) iq-%offset%) 0)))))
      (if (and (= iuplo 2) (= icompq 2))
       (dlasr "L" "V" "B" n n
        (f2cl-lib:array-slice work double-float (1) ((1 *)))
        (f2cl-lib:array-slice work double-float (n) ((1 *))) u ldu))
 end_label
      (return
       (values nil nil nil nil nil nil nil nil nil nil nil nil nil info))))))
```

6.2 dbdsqr LAPACK

— dbdsqr.input —

```
)set break resume
)sys rm -f dbdsqr.output
)spool dbdsqr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dbdsqr.help —

```
==========================================================================
dbdsqr examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

NAME
       DBDSQR  -  the  singular  values and, optionally, the right and/or left
       singular vectors from the singular value decomposition (SVD) of a  real
       N-by-N  (upper  or  lower) bidiagonal matrix B using the implicit zero-
       shift QR algorithm

SYNOPSIS
       SUBROUTINE DBDSQR( UPLO, N, NCVT, NRU, NCC, D, E, VT, LDVT, U, LDU,  C,
                          LDC, WORK, INFO )

           CHARACTER      UPLO

           INTEGER        INFO, LDC, LDU, LDVT, N, NCC, NCVT, NRU

           DOUBLE         PRECISION  C( LDC, * ), D( * ), E( * ), U( LDU, * ),
                          VT( LDVT, * ), WORK( * )

PURPOSE
       DBDSQR computes the singular values and, optionally, the  right  and/or
       left  singular vectors from the singular value decomposition (SVD) of a
       real N-by-N (upper or lower) bidiagonal matrix  B  using  the  implicit
       zero-shift QR algorithm.  The SVD of B has the form
```

```
   B = Q * S * P**T

where  S  is the diagonal matrix of singular values, Q is an orthogonal
matrix of left singular vectors, and P is an orthogonal matrix of right
singular vectors.  If left singular vectors are requested, this subrou-
tine actually returns U*Q instead of Q, and, if right singular  vectors
are  requested,  this  subroutine  returns P**T*VT instead of P**T, for
given real input matrices U and VT.  When U and VT are  the  orthogonal
matrices  that  reduce  a  general  matrix  A  to bidiagonal form:  A =
U*B*VT, as computed by DGEBRD, then

   A = (U*Q) * S * (P**T*VT)

is the SVD of A.  Optionally, the subroutine may  also  compute  Q**T*C
for a given real input matrix C.

See "Computing  Small Singular Values of Bidiagonal Matrices With Guar-
anteed High Relative Accuracy," by J. Demmel and W. Kahan, LAPACK Work-
ing  Note  #3  (or  SIAM  J.  Sci. Statist. Comput. vol. 11, no. 5, pp.
873-912, Sept 1990) and
"Accurate singular values and differential qd algorithms," by  B.  Par-
lett  and  V.  Fernando, Technical Report CPAM-554, Mathematics Depart-
ment, University of California at Berkeley, July 1992  for  a  detailed
description of the algorithm.


ARGUMENTS
       UPLO    (input) CHARACTER*1
               = 'U':  B is upper bidiagonal;
               = 'L':  B is lower bidiagonal.

       N       (input) INTEGER
               The order of the matrix B.  N >= 0.

       NCVT    (input) INTEGER
               The number of columns of the matrix VT. NCVT >= 0.

       NRU     (input) INTEGER
               The number of rows of the matrix U. NRU >= 0.

       NCC     (input) INTEGER
               The number of columns of the matrix C. NCC >= 0.

       D       (input/output) DOUBLE PRECISION array, dimension (N)
               On  entry,  the n diagonal elements of the bidiagonal matrix B.
               On exit, if INFO=0, the singular  values  of  B  in  decreasing
               order.

       E       (input/output) DOUBLE PRECISION array, dimension (N-1)
```

```
            On entry, the N-1 offdiagonal elements of the bidiagonal matrix
            B.  On exit, if INFO = 0, E is destroyed; if INFO > 0, D and  E
            will contain the diagonal and superdiagonal elements of a bidi-
            agonal matrix orthogonally  equivalent  to  the  one  given  as
            input.

       VT   (input/output) DOUBLE PRECISION array, dimension (LDVT, NCVT)
            On  entry,  an N-by-NCVT matrix VT.  On exit, VT is overwritten
            by P**T * VT.  Not referenced if NCVT = 0.

       LDVT (input) INTEGER
            The leading dimension of the array VT.   LDVT  >=  max(1,N)  if
            NCVT > 0; LDVT >= 1 if NCVT = 0.

       U    (input/output) DOUBLE PRECISION array, dimension (LDU, N)
            On entry, an NRU-by-N matrix U.  On exit, U is overwritten by U
            * Q.  Not referenced if NRU = 0.

       LDU  (input) INTEGER
            The leading dimension of the array U.  LDU >= max(1,NRU).

       C    (input/output) DOUBLE PRECISION array, dimension (LDC, NCC)
            On entry, an N-by-NCC matrix C.  On exit, C is  overwritten  by
            Q**T * C.  Not referenced if NCC = 0.

       LDC  (input) INTEGER
            The leading dimension of the array C.  LDC >= max(1,N) if NCC >
            0; LDC >=1 if NCC = 0.

       WORK (workspace) DOUBLE PRECISION array, dimension (2*N)
            if NCVT = NRU = NCC = 0, (max(1, 4*N)) otherwise

       INFO (output) INTEGER
            = 0:  successful exit
            < 0:  If INFO = -i, the i-th argument had an illegal value
            > 0:  the algorithm did not converge; D and E contain the  ele-
            ments  of  a bidiagonal matrix which is orthogonally similar to
            the input matrix B;  if INFO = i, i elements of E have not con-
            verged to zero.

PARAMETERS
       TOLMUL  DOUBLE PRECISION, default = max(10,min(100,EPS**(-1/8)))
            TOLMUL  controls  the convergence criterion of the QR loop.  If
            it is positive, TOLMUL*EPS is the desired relative precision in
            the  computed  singular  values.   If  it is negative, abs(TOL-
            MUL*EPS*sigma_max) is the desired absolute accuracy in the com-
            puted  singular  values  (corresponds  to  relative  accuracy
            abs(TOLMUL*EPS) in the  largest  singular  value.   abs(TOLMUL)
            should  be  between 1 and 1/EPS, and preferably between 10 (for
            fast convergence) and .1/EPS (for there to be some accuracy  in
```

```
              the  results).  Default is to lose at either one eighth or 2 of
              the available decimal digits in each  computed  singular  value
              (whichever is smaller).

       MAXITR  INTEGER, default = 6
              MAXITR  controls  the maximum number of passes of the algorithm
              through its inner loop. The algorithms stops (and so  fails  to
              converge)  if  the  number  of  passes  through  the inner loop
              exceeds MAXITR*N**2.
```

— dbdsqr.f —

```
      SUBROUTINE DBDSQR( UPLO, N, NCVT, NRU, NCC, D, E, VT, LDVT, U,
     $                   LDU, C, LDC, WORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1999
*
*     .. Scalar Arguments ..
      CHARACTER          UPLO
      INTEGER            INFO, LDC, LDU, LDVT, N, NCC, NCVT, NRU
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   C( LDC, * ), D( * ), E( * ), U( LDU, * ),
     $                   VT( LDVT, * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER          ( ZERO = 0.0D0 )
      DOUBLE PRECISION   ONE
      PARAMETER          ( ONE = 1.0D0 )
      DOUBLE PRECISION   NEGONE
      PARAMETER          ( NEGONE = -1.0D0 )
      DOUBLE PRECISION   HNDRTH
      PARAMETER          ( HNDRTH = 0.01D0 )
      DOUBLE PRECISION   TEN
      PARAMETER          ( TEN = 10.0D0 )
      DOUBLE PRECISION   HNDRD
      PARAMETER          ( HNDRD = 100.0D0 )
      DOUBLE PRECISION   MEIGTH
      PARAMETER          ( MEIGTH = -0.125D0 )
```

```
      INTEGER            MAXITR
      PARAMETER          ( MAXITR = 6 )
*     ..
*     .. Local Scalars ..
      LOGICAL            LOWER, ROTATE
      INTEGER            I, IDIR, ISUB, ITER, J, LL, LLL, M, MAXIT, NM1,
     $                   NM12, NM13, OLDLL, OLDM
      DOUBLE PRECISION   ABSE, ABSS, COSL, COSR, CS, EPS, F, G, H, MU,
     $                   OLDCS, OLDSN, R, SHIFT, SIGMN, SIGMX, SINL,
     $                   SINR, SLL, SMAX, SMIN, SMINL, SMINLO, SMINOA,
     $                   SN, THRESH, TOL, TOLMUL, UNFL
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      DOUBLE PRECISION   DLAMCH
      EXTERNAL           LSAME, DLAMCH
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLARTG, DLAS2, DLASQ1, DLASR, DLASV2, DROT,
     $                   DSCAL, DSWAP, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, DBLE, MAX, MIN, SIGN, SQRT
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      LOWER = LSAME( UPLO, 'L' )
      IF( .NOT.LSAME( UPLO, 'U' ) .AND. .NOT.LOWER ) THEN
         INFO = -1
      ELSE IF( N.LT.0 ) THEN
         INFO = -2
      ELSE IF( NCVT.LT.0 ) THEN
         INFO = -3
      ELSE IF( NRU.LT.0 ) THEN
         INFO = -4
      ELSE IF( NCC.LT.0 ) THEN
         INFO = -5
      ELSE IF( ( NCVT.EQ.0 .AND. LDVT.LT.1 ) .OR.
     $         ( NCVT.GT.0 .AND. LDVT.LT.MAX( 1, N ) ) ) THEN
         INFO = -9
      ELSE IF( LDU.LT.MAX( 1, NRU ) ) THEN
         INFO = -11
      ELSE IF( ( NCC.EQ.0 .AND. LDC.LT.1 ) .OR.
     $         ( NCC.GT.0 .AND. LDC.LT.MAX( 1, N ) ) ) THEN
         INFO = -13
      END IF
      IF( INFO.NE.0 ) THEN
```

```
         CALL XERBLA( 'DBDSQR', -INFO )
         RETURN
      END IF
      IF( N.EQ.0 )
     $   RETURN
      IF( N.EQ.1 )
     $   GO TO 160
*
*     ROTATE is true if any singular vectors desired, false otherwise
*
      ROTATE = ( NCVT.GT.0 ) .OR. ( NRU.GT.0 ) .OR. ( NCC.GT.0 )
*
*     If no singular vectors desired, use qd algorithm
*
      IF( .NOT.ROTATE ) THEN
         CALL DLASQ1( N, D, E, WORK, INFO )
         RETURN
      END IF
*
      NM1 = N - 1
      NM12 = NM1 + NM1
      NM13 = NM12 + NM1
      IDIR = 0
*
*     Get machine constants
*
      EPS = DLAMCH( 'Epsilon' )
      UNFL = DLAMCH( 'Safe minimum' )
*
*     If matrix lower bidiagonal, rotate to be upper bidiagonal
*     by applying Givens rotations on the left
*
      IF( LOWER ) THEN
         DO 10 I = 1, N - 1
            CALL DLARTG( D( I ), E( I ), CS, SN, R )
            D( I ) = R
            E( I ) = SN*D( I+1 )
            D( I+1 ) = CS*D( I+1 )
            WORK( I ) = CS
            WORK( NM1+I ) = SN
   10    CONTINUE
*
*        Update singular vectors if desired
*
         IF( NRU.GT.0 )
     $      CALL DLASR( 'R', 'V', 'F', NRU, N, WORK( 1 ), WORK( N ), U,
     $                  LDU )
         IF( NCC.GT.0 )
     $      CALL DLASR( 'L', 'V', 'F', N, NCC, WORK( 1 ), WORK( N ), C,
     $                  LDC )
```

```
      END IF
*
*     Compute singular values to relative accuracy TOL
*     (By setting TOL to be negative, algorithm will compute
*     singular values to absolute accuracy ABS(TOL)*norm(input matrix))
*
      TOLMUL = MAX( TEN, MIN( HNDRD, EPS**MEIGTH ) )
      TOL = TOLMUL*EPS
*
*     Compute approximate maximum, minimum singular values
*
      SMAX = ZERO
      DO 20 I = 1, N
         SMAX = MAX( SMAX, ABS( D( I ) ) )
   20 CONTINUE
      DO 30 I = 1, N - 1
         SMAX = MAX( SMAX, ABS( E( I ) ) )
   30 CONTINUE
      SMINL = ZERO
      IF( TOL.GE.ZERO ) THEN
*
*        Relative accuracy desired
*
         SMINOA = ABS( D( 1 ) )
         IF( SMINOA.EQ.ZERO )
     $      GO TO 50
         MU = SMINOA
         DO 40 I = 2, N
            MU = ABS( D( I ) )*( MU / ( MU+ABS( E( I-1 ) ) ) )
            SMINOA = MIN( SMINOA, MU )
            IF( SMINOA.EQ.ZERO )
     $         GO TO 50
   40    CONTINUE
   50    CONTINUE
         SMINOA = SMINOA / SQRT( DBLE( N ) )
         THRESH = MAX( TOL*SMINOA, MAXITR*N*N*UNFL )
      ELSE
*
*        Absolute accuracy desired
*
         THRESH = MAX( ABS( TOL )*SMAX, MAXITR*N*N*UNFL )
      END IF
*
*     Prepare for main iteration loop for the singular values
*     (MAXIT is the maximum number of passes through the inner
*     loop permitted before nonconvergence signalled.)
*
      MAXIT = MAXITR*N*N
      ITER = 0
      OLDLL = -1
```

```
      OLDM = -1
*
*     M points to last element of unconverged part of matrix
*
      M = N
*
*     Begin main iteration loop
*
   60 CONTINUE
*
*     Check for convergence or exceeding iteration count
*
      IF( M.LE.1 )
     $   GO TO 160
      IF( ITER.GT.MAXIT )
     $   GO TO 200
*
*     Find diagonal block of matrix to work on
*
      IF( TOL.LT.ZERO .AND. ABS( D( M ) ).LE.THRESH )
     $   D( M ) = ZERO
      SMAX = ABS( D( M ) )
      SMIN = SMAX
      DO 70 LLL = 1, M - 1
         LL = M - LLL
         ABSS = ABS( D( LL ) )
         ABSE = ABS( E( LL ) )
         IF( TOL.LT.ZERO .AND. ABSS.LE.THRESH )
     $      D( LL ) = ZERO
         IF( ABSE.LE.THRESH )
     $      GO TO 80
         SMIN = MIN( SMIN, ABSS )
         SMAX = MAX( SMAX, ABSS, ABSE )
   70 CONTINUE
      LL = 0
      GO TO 90
   80 CONTINUE
      E( LL ) = ZERO
*
*     Matrix splits since E(LL) = 0
*
      IF( LL.EQ.M-1 ) THEN
*
*        Convergence of bottom singular value, return to top of loop
*
         M = M - 1
         GO TO 60
      END IF
   90 CONTINUE
      LL = LL + 1
```

```
*
*     E(LL) through E(M-1) are nonzero, E(LL-1) is zero
*
      IF( LL.EQ.M-1 ) THEN
*
*        2 by 2 block, handle separately
*
         CALL DLASV2( D( M-1 ), E( M-1 ), D( M ), SIGMN, SIGMX, SINR,
     $                COSR, SINL, COSL )
         D( M-1 ) = SIGMX
         E( M-1 ) = ZERO
         D( M ) = SIGMN
*
*        Compute singular vectors, if desired
*
         IF( NCVT.GT.0 )
     $      CALL DROT( NCVT, VT( M-1, 1 ), LDVT, VT( M, 1 ), LDVT, COSR,
     $                 SINR )
         IF( NRU.GT.0 )
     $      CALL DROT( NRU, U( 1, M-1 ), 1, U( 1, M ), 1, COSL, SINL )
         IF( NCC.GT.0 )
     $      CALL DROT( NCC, C( M-1, 1 ), LDC, C( M, 1 ), LDC, COSL,
     $                 SINL )
         M = M - 2
         GO TO 60
      END IF
*
*     If working on new submatrix, choose shift direction
*     (from larger end diagonal element towards smaller)
*
      IF( LL.GT.OLDM .OR. M.LT.OLDLL ) THEN
         IF( ABS( D( LL ) ).GE.ABS( D( M ) ) ) THEN
*
*           Chase bulge from top (big end) to bottom (small end)
*
            IDIR = 1
         ELSE
*
*           Chase bulge from bottom (big end) to top (small end)
*
            IDIR = 2
         END IF
      END IF
*
*     Apply convergence tests
*
      IF( IDIR.EQ.1 ) THEN
*
*        Run convergence test in forward direction
*        First apply standard test to bottom of matrix
```

```
*
        IF( ABS( E( M-1 ) ).LE.ABS( TOL )*ABS( D( M ) ) .OR.
     $       ( TOL.LT.ZERO .AND. ABS( E( M-1 ) ).LE.THRESH ) ) THEN
           E( M-1 ) = ZERO
           GO TO 60
        END IF
*
        IF( TOL.GE.ZERO ) THEN
*
*          If relative accuracy desired,
*          apply convergence criterion forward
*
           MU = ABS( D( LL ) )
           SMINL = MU
           DO 100 LLL = LL, M - 1
              IF( ABS( E( LLL ) ).LE.TOL*MU ) THEN
                 E( LLL ) = ZERO
                 GO TO 60
              END IF
              SMINLO = SMINL
              MU = ABS( D( LLL+1 ) )*( MU / ( MU+ABS( E( LLL ) ) ) )
              SMINL = MIN( SMINL, MU )
  100       CONTINUE
        END IF
*
     ELSE
*
*       Run convergence test in backward direction
*       First apply standard test to top of matrix
*
        IF( ABS( E( LL ) ).LE.ABS( TOL )*ABS( D( LL ) ) .OR.
     $       ( TOL.LT.ZERO .AND. ABS( E( LL ) ).LE.THRESH ) ) THEN
           E( LL ) = ZERO
           GO TO 60
        END IF
*
        IF( TOL.GE.ZERO ) THEN
*
*          If relative accuracy desired,
*          apply convergence criterion backward
*
           MU = ABS( D( M ) )
           SMINL = MU
           DO 110 LLL = M - 1, LL, -1
              IF( ABS( E( LLL ) ).LE.TOL*MU ) THEN
                 E( LLL ) = ZERO
                 GO TO 60
              END IF
              SMINLO = SMINL
              MU = ABS( D( LLL ) )*( MU / ( MU+ABS( E( LLL ) ) ) )
```

```
               SMINL = MIN( SMINL, MU )
  110       CONTINUE
         END IF
      END IF
      OLDLL = LL
      OLDM = M
*
*     Compute shift.  First, test if shifting would ruin relative
*     accuracy, and if so set the shift to zero.
*
      IF( TOL.GE.ZERO .AND. N*TOL*( SMINL / SMAX ).LE.
     $    MAX( EPS, HNDRTH*TOL ) ) THEN
*
*        Use a zero shift to avoid loss of relative accuracy
*
         SHIFT = ZERO
      ELSE
*
*        Compute the shift from 2-by-2 block at end of matrix
*
         IF( IDIR.EQ.1 ) THEN
            SLL = ABS( D( LL ) )
            CALL DLAS2( D( M-1 ), E( M-1 ), D( M ), SHIFT, R )
         ELSE
            SLL = ABS( D( M ) )
            CALL DLAS2( D( LL ), E( LL ), D( LL+1 ), SHIFT, R )
         END IF
*
*        Test if shift negligible, and if so set to zero
*
         IF( SLL.GT.ZERO ) THEN
            IF( ( SHIFT / SLL )**2.LT.EPS )
     $         SHIFT = ZERO
         END IF
      END IF
*
*     Increment iteration count
*
      ITER = ITER + M - LL
*
*     If SHIFT = 0, do simplified QR iteration
*
      IF( SHIFT.EQ.ZERO ) THEN
         IF( IDIR.EQ.1 ) THEN
*
*           Chase bulge from top to bottom
*           Save cosines and sines for later singular vector updates
*
            CS = ONE
            OLDCS = ONE
```

```
            DO 120 I = LL, M - 1
               CALL DLARTG( D( I )*CS, E( I ), CS, SN, R )
               IF( I.GT.LL )
     $            E( I-1 ) = OLDSN*R
               CALL DLARTG( OLDCS*R, D( I+1 )*SN, OLDCS, OLDSN, D( I ) )
               WORK( I-LL+1 ) = CS
               WORK( I-LL+1+NM1 ) = SN
               WORK( I-LL+1+NM12 ) = OLDCS
               WORK( I-LL+1+NM13 ) = OLDSN
  120       CONTINUE
            H = D( M )*CS
            D( M ) = H*OLDCS
            E( M-1 ) = H*OLDSN
*
*           Update singular vectors
*
            IF( NCVT.GT.0 )
     $         CALL DLASR( 'L', 'V', 'F', M-LL+1, NCVT, WORK( 1 ),
     $                     WORK( N ), VT( LL, 1 ), LDVT )
            IF( NRU.GT.0 )
     $         CALL DLASR( 'R', 'V', 'F', NRU, M-LL+1, WORK( NM12+1 ),
     $                     WORK( NM13+1 ), U( 1, LL ), LDU )
            IF( NCC.GT.0 )
     $         CALL DLASR( 'L', 'V', 'F', M-LL+1, NCC, WORK( NM12+1 ),
     $                     WORK( NM13+1 ), C( LL, 1 ), LDC )
*
*           Test convergence
*
            IF( ABS( E( M-1 ) ).LE.THRESH )
     $         E( M-1 ) = ZERO
*
         ELSE
*
*           Chase bulge from bottom to top
*           Save cosines and sines for later singular vector updates
*
            CS = ONE
            OLDCS = ONE
            DO 130 I = M, LL + 1, -1
               CALL DLARTG( D( I )*CS, E( I-1 ), CS, SN, R )
               IF( I.LT.M )
     $            E( I ) = OLDSN*R
               CALL DLARTG( OLDCS*R, D( I-1 )*SN, OLDCS, OLDSN, D( I ) )
               WORK( I-LL ) = CS
               WORK( I-LL+NM1 ) = -SN
               WORK( I-LL+NM12 ) = OLDCS
               WORK( I-LL+NM13 ) = -OLDSN
  130       CONTINUE
            H = D( LL )*CS
            D( LL ) = H*OLDCS
```

```
            E( LL ) = H*OLDSN
*
*           Update singular vectors
*
            IF( NCVT.GT.0 )
     $         CALL DLASR( 'L', 'V', 'B', M-LL+1, NCVT, WORK( NM12+1 ),
     $                     WORK( NM13+1 ), VT( LL, 1 ), LDVT )
            IF( NRU.GT.0 )
     $         CALL DLASR( 'R', 'V', 'B', NRU, M-LL+1, WORK( 1 ),
     $                     WORK( N ), U( 1, LL ), LDU )
            IF( NCC.GT.0 )
     $         CALL DLASR( 'L', 'V', 'B', M-LL+1, NCC, WORK( 1 ),
     $                     WORK( N ), C( LL, 1 ), LDC )
*
*           Test convergence
*
            IF( ABS( E( LL ) ).LE.THRESH )
     $         E( LL ) = ZERO
         END IF
      ELSE
*
*        Use nonzero shift
*
         IF( IDIR.EQ.1 ) THEN
*
*           Chase bulge from top to bottom
*           Save cosines and sines for later singular vector updates
*
            F = ( ABS( D( LL ) )-SHIFT )*
     $          ( SIGN( ONE, D( LL ) )+SHIFT / D( LL ) )
            G = E( LL )
            DO 140 I = LL, M - 1
               CALL DLARTG( F, G, COSR, SINR, R )
               IF( I.GT.LL )
     $            E( I-1 ) = R
               F = COSR*D( I ) + SINR*E( I )
               E( I ) = COSR*E( I ) - SINR*D( I )
               G = SINR*D( I+1 )
               D( I+1 ) = COSR*D( I+1 )
               CALL DLARTG( F, G, COSL, SINL, R )
               D( I ) = R
               F = COSL*E( I ) + SINL*D( I+1 )
               D( I+1 ) = COSL*D( I+1 ) - SINL*E( I )
               IF( I.LT.M-1 ) THEN
                  G = SINL*E( I+1 )
                  E( I+1 ) = COSL*E( I+1 )
               END IF
               WORK( I-LL+1 ) = COSR
               WORK( I-LL+1+NM1 ) = SINR
               WORK( I-LL+1+NM12 ) = COSL
```

```
               WORK( I-LL+1+NM13 ) = SINL
  140       CONTINUE
            E( M-1 ) = F
*
*           Update singular vectors
*
            IF( NCVT.GT.0 )
     $         CALL DLASR( 'L', 'V', 'F', M-LL+1, NCVT, WORK( 1 ),
     $                     WORK( N ), VT( LL, 1 ), LDVT )
            IF( NRU.GT.0 )
     $         CALL DLASR( 'R', 'V', 'F', NRU, M-LL+1, WORK( NM12+1 ),
     $                     WORK( NM13+1 ), U( 1, LL ), LDU )
            IF( NCC.GT.0 )
     $         CALL DLASR( 'L', 'V', 'F', M-LL+1, NCC, WORK( NM12+1 ),
     $                     WORK( NM13+1 ), C( LL, 1 ), LDC )
*
*           Test convergence
*
            IF( ABS( E( M-1 ) ).LE.THRESH )
     $         E( M-1 ) = ZERO
*
         ELSE
*
*           Chase bulge from bottom to top
*           Save cosines and sines for later singular vector updates
*
            F = ( ABS( D( M ) )-SHIFT )*( SIGN( ONE, D( M ) )+SHIFT /
     $          D( M ) )
            G = E( M-1 )
            DO 150 I = M, LL + 1, -1
               CALL DLARTG( F, G, COSR, SINR, R )
               IF( I.LT.M )
     $            E( I ) = R
               F = COSR*D( I ) + SINR*E( I-1 )
               E( I-1 ) = COSR*E( I-1 ) - SINR*D( I )
               G = SINR*D( I-1 )
               D( I-1 ) = COSR*D( I-1 )
               CALL DLARTG( F, G, COSL, SINL, R )
               D( I ) = R
               F = COSL*E( I-1 ) + SINL*D( I-1 )
               D( I-1 ) = COSL*D( I-1 ) - SINL*E( I-1 )
               IF( I.GT.LL+1 ) THEN
                  G = SINL*E( I-2 )
                  E( I-2 ) = COSL*E( I-2 )
               END IF
               WORK( I-LL ) = COSR
               WORK( I-LL+NM1 ) = -SINR
               WORK( I-LL+NM12 ) = COSL
               WORK( I-LL+NM13 ) = -SINL
  150       CONTINUE
```

```
            E( LL ) = F
*
*           Test convergence
*
            IF( ABS( E( LL ) ).LE.THRESH )
     $         E( LL ) = ZERO
*
*           Update singular vectors if desired
*
            IF( NCVT.GT.0 )
     $         CALL DLASR( 'L', 'V', 'B', M-LL+1, NCVT, WORK( NM12+1 ),
     $                     WORK( NM13+1 ), VT( LL, 1 ), LDVT )
            IF( NRU.GT.0 )
     $         CALL DLASR( 'R', 'V', 'B', NRU, M-LL+1, WORK( 1 ),
     $                     WORK( N ), U( 1, LL ), LDU )
            IF( NCC.GT.0 )
     $         CALL DLASR( 'L', 'V', 'B', M-LL+1, NCC, WORK( 1 ),
     $                     WORK( N ), C( LL, 1 ), LDC )
         END IF
      END IF
*
*     QR iteration finished, go back and check convergence
*
      GO TO 60
*
*     All singular values converged, so make them positive
*
  160 CONTINUE
      DO 170 I = 1, N
         IF( D( I ).LT.ZERO ) THEN
            D( I ) = -D( I )
*
*           Change sign of singular vectors, if desired
*
            IF( NCVT.GT.0 )
     $         CALL DSCAL( NCVT, NEGONE, VT( I, 1 ), LDVT )
         END IF
  170 CONTINUE
*
*     Sort the singular values into decreasing order (insertion sort on
*     singular values, but only one transposition per singular vector)
*
      DO 190 I = 1, N - 1
*
*        Scan for smallest D(I)
*
         ISUB = 1
         SMIN = D( 1 )
         DO 180 J = 2, N + 1 - I
            IF( D( J ).LE.SMIN ) THEN
```

```
               ISUB = J
               SMIN = D( J )
            END IF
  180    CONTINUE
         IF( ISUB.NE.N+1-I ) THEN
*
*           Swap singular values and vectors
*
            D( ISUB ) = D( N+1-I )
            D( N+1-I ) = SMIN
            IF( NCVT.GT.0 )
     $         CALL DSWAP( NCVT, VT( ISUB, 1 ), LDVT, VT( N+1-I, 1 ),
     $                     LDVT )
            IF( NRU.GT.0 )
     $         CALL DSWAP( NRU, U( 1, ISUB ), 1, U( 1, N+1-I ), 1 )
            IF( NCC.GT.0 )
     $         CALL DSWAP( NCC, C( ISUB, 1 ), LDC, C( N+1-I, 1 ), LDC )
         END IF
  190 CONTINUE
      GO TO 220
*
*     Maximum number of iterations exceeded, failure to converge
*
  200 CONTINUE
      INFO = 0
      DO 210 I = 1, N - 1
         IF( E( I ).NE.ZERO )
     $      INFO = INFO + 1
  210 CONTINUE
  220 CONTINUE
      RETURN
*
*     End of DBDSQR
*
      END
```

———-

— LAPACK dbdsqr —

```
(let* ((zero 0.0)
       (one 1.0)
       (negone (- 1.0))
       (hndrth 0.01)
       (ten 10.0)
       (hndrd 100.0)
       (meigth (- 0.125))
       (maxitr 6))
```

```
(declare (type (double-float 0.0 0.0) zero)
         (type (double-float 1.0 1.0) one)
         (type (double-float) negone)
         (type (double-float 0.01 0.01) hndrth)
         (type (double-float 10.0 10.0) ten)
         (type (double-float 100.0 100.0) hndrd)
         (type (double-float) meigth)
         (type (fixnum 6 6) maxitr))
(defun dbdsqr (uplo n ncvt nru ncc d e vt ldvt u ldu c ldc work info)
  (declare (type (simple-array double-float (*)) work c u vt e d)
           (type fixnum info ldc ldu ldvt ncc nru ncvt n)
           (type character uplo))
  (f2cl-lib:with-multi-array-data
      ((uplo character uplo-%data% uplo-%offset%)
       (d double-float d-%data% d-%offset%)
       (e double-float e-%data% e-%offset%)
       (vt double-float vt-%data% vt-%offset%)
       (u double-float u-%data% u-%offset%)
       (c double-float c-%data% c-%offset%)
       (work double-float work-%data% work-%offset%))
    (prog ((abse 0.0) (abss 0.0) (cosl 0.0) (cosr 0.0) (cs 0.0) (eps 0.0)
           (f 0.0) (g 0.0) (h 0.0) (mu 0.0) (oldcs 0.0) (oldsn 0.0) (r 0.0)
           (shift 0.0) (sigmn 0.0) (sigmx 0.0) (sinl 0.0) (sinr 0.0)
           (sll 0.0) (smax 0.0) (smin 0.0) (sminl 0.0) (sminlo 0.0)
           (sminoa 0.0) (sn 0.0) (thresh 0.0) (tol 0.0) (tolmul 0.0)
           (unfl 0.0) (i 0) (idir 0) (isub 0) (iter 0) (j 0) (ll 0) (lll 0)
           (m 0) (maxit 0) (nm1 0) (nm12 0) (nm13 0) (oldll 0) (oldm 0)
           (lower nil) (rotate nil))
      (declare (type (double-float) abse abss cosl cosr cs eps f g h mu oldcs
                                    oldsn r shift sigmn sigmx sinl sinr sll
                                    smax smin sminl sminlo sminoa sn thresh
                                    tol tolmul unfl)
               (type fixnum i idir isub iter j ll lll m maxit
                                     nm1 nm12 nm13 oldll oldm)
               (type (member t nil) lower rotate))
      (setf info 0)
      (setf lower (char-equal uplo #\L))
      (cond
        ((and (not (char-equal uplo #\U)) (not lower))
         (setf info -1))
        ((< n 0)
         (setf info -2))
        ((< ncvt 0)
         (setf info -3))
        ((< nru 0)
         (setf info -4))
        ((< ncc 0)
         (setf info -5))
        ((or (and (= ncvt 0) (< ldvt 1))
             (and (> ncvt 0)
```

```
             (< ldvt
                (max (the fixnum 1)
                     (the fixnum n)))))
   (setf info -9))
  ((< ldu (max (the fixnum 1) (the fixnum nru)))
   (setf info -11))
  ((or (and (= ncc 0) (< ldc 1))
       (and (> ncc 0)
            (< ldc
               (max (the fixnum 1)
                    (the fixnum n)))))
   (setf info -13)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DBDSQR" (f2cl-lib:int-sub info))
   (go end_label)))
(if (= n 0) (go end_label))
(if (= n 1) (go label160))
(setf rotate (or (> ncvt 0) (> nru 0) (> ncc 0)))
(cond
  ((not rotate)
   (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
       (dlasq1 n d e work info)
     (declare (ignore var-0 var-1 var-2 var-3))
     (setf info var-4))
   (go end_label)))
(setf nm1 (f2cl-lib:int-sub n 1))
(setf nm12 (f2cl-lib:int-add nm1 nm1))
(setf nm13 (f2cl-lib:int-add nm12 nm1))
(setf idir 0)
(setf eps (dlamch "Epsilon"))
(setf unfl (dlamch "Safe minimum"))
(cond
  (lower
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
     (tagbody
       (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
           (dlartg (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
            (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%) cs sn r)
         (declare (ignore var-0 var-1))
         (setf cs var-2)
         (setf sn var-3)
         (setf r var-4))
       (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) r)
       (setf (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)
               (* sn
                  (f2cl-lib:fref d-%data%
```

```
                                    ((f2cl-lib:int-add i 1))
                                    ((1 *))
                                    d-%offset%)))
          (setf (f2cl-lib:fref d-%data%
                               ((f2cl-lib:int-add i 1))
                               ((1 *))
                               d-%offset%)
                (* cs
                   (f2cl-lib:fref d-%data%
                                  ((f2cl-lib:int-add i 1))
                                  ((1 *))
                                  d-%offset%)))
          (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%) cs)
          (setf (f2cl-lib:fref work-%data%
                               ((f2cl-lib:int-add nm1 i))
                               ((1 *))
                               work-%offset%)
                sn)))
     (if (> nru 0)
         (dlasr "R" "V" "F" nru n
          (f2cl-lib:array-slice work double-float (1) ((1 *)))
          (f2cl-lib:array-slice work double-float (n) ((1 *))) u ldu))
     (if (> ncc 0)
         (dlasr "L" "V" "F" n ncc
          (f2cl-lib:array-slice work double-float (1) ((1 *)))
          (f2cl-lib:array-slice work double-float (n) ((1 *))) c ldc))))
(setf tolmul (max ten (min hndrd (expt eps meigth))))
(setf tol (* tolmul eps))
(setf smax zero)
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i n) nil)
  (tagbody
    (setf smax
            (max smax
                 (abs
                  (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))))))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
  (tagbody
    (setf smax
            (max smax
                 (abs
                  (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%))))))
(setf sminl zero)
(cond
  ((>= tol zero)
   (tagbody
     (setf sminoa
             (abs (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)))
     (if (= sminoa zero) (go label50))
```

```
            (setf mu sminoa)
            (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
                          ((> i n) nil)
              (tagbody
                (setf mu
                        (*
                         (abs (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
                         (/ mu
                            (+ mu
                               (abs
                                (f2cl-lib:fref e-%data%
                                               ((f2cl-lib:int-sub i 1))
                                               ((1 *))
                                               e-%offset%))))))
                (setf sminoa (min sminoa mu))
                (if (= sminoa zero) (go label50))))
label50
            (setf sminoa
             (/ sminoa (f2cl-lib:fsqrt (coerce (realpart n) 'double-float))))
            (setf thresh (max (* tol sminoa) (* maxitr n n unfl)))))
          (t
           (setf thresh (max (* (abs tol) smax) (* maxitr n n unfl)))))
        (setf maxit (f2cl-lib:int-mul maxitr n n))
        (setf iter 0)
        (setf oldll -1)
        (setf oldm -1)
        (setf m n)
label60
        (if (<= m 1) (go label160))
        (if (> iter maxit) (go label200))
        (if
         (and (< tol zero)
              (<= (abs (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%))
                  thresh))
         (setf (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%) zero))
        (setf smax (abs (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%)))
        (setf smin smax)
        (f2cl-lib:fdo (lll 1 (f2cl-lib:int-add lll 1))
                      ((> lll (f2cl-lib:int-add m (f2cl-lib:int-sub 1))) nil)
          (tagbody
            (setf ll (f2cl-lib:int-sub m lll))
            (setf abss (abs (f2cl-lib:fref d-%data% (ll) ((1 *)) d-%offset%)))
            (setf abse (abs (f2cl-lib:fref e-%data% (ll) ((1 *)) e-%offset%)))
            (if (and (< tol zero) (<= abss thresh))
                (setf (f2cl-lib:fref d-%data% (ll) ((1 *)) d-%offset%) zero))
            (if (<= abse thresh) (go label80))
            (setf smin (min smin abss))
            (setf smax (max smax abss abse))))
        (setf ll 0)
        (go label90)
```

```
label80
       (setf (f2cl-lib:fref e-%data% (ll) ((1 *)) e-%offset%) zero)
       (cond
         ((= ll (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
          (setf m (f2cl-lib:int-sub m 1))
          (go label60)))
label90
       (setf ll (f2cl-lib:int-add ll 1))
       (cond
         ((= ll (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
          (multiple-value-bind
                (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
              (dlasv2
               (f2cl-lib:fref d-%data%
                              ((f2cl-lib:int-sub m 1))
                              ((1 *))
                              d-%offset%)
               (f2cl-lib:fref e-%data%
                              ((f2cl-lib:int-sub m 1))
                              ((1 *))
                              e-%offset%)
               (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%) sigmn sigmx
               sinr cosr sinl cosl)
            (declare (ignore var-0 var-1 var-2))
            (setf sigmn var-3)
            (setf sigmx var-4)
            (setf sinr var-5)
            (setf cosr var-6)
            (setf sinl var-7)
            (setf cosl var-8))
          (setf (f2cl-lib:fref d-%data%
                               ((f2cl-lib:int-sub m 1))
                               ((1 *))
                               d-%offset%)
                  sigmx)
          (setf (f2cl-lib:fref e-%data%
                               ((f2cl-lib:int-sub m 1))
                               ((1 *))
                               e-%offset%)
                  zero)
          (setf (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%) sigmn)
          (if (> ncvt 0)
              (drot ncvt
               (f2cl-lib:array-slice vt
                                     double-float
                                     ((+ m (f2cl-lib:int-sub 1)) 1)
                                     ((1 ldvt) (1 *)))
               ldvt
               (f2cl-lib:array-slice vt double-float (m 1) ((1 ldvt) (1 *)))
               ldvt cosr sinr))
```

```
   (if (> nru 0)
       (drot nru
        (f2cl-lib:array-slice u
                              double-float
                              (1 (f2cl-lib:int-sub m 1))
                              ((1 ldu) (1 *)))
        1 (f2cl-lib:array-slice u double-float (1 m) ((1 ldu) (1 *))) 1
        cosl sinl))
   (if (> ncc 0)
       (drot ncc
        (f2cl-lib:array-slice c
                              double-float
                              ((+ m (f2cl-lib:int-sub 1)) 1)
                              ((1 ldc) (1 *)))
        ldc (f2cl-lib:array-slice c double-float (m 1) ((1 ldc) (1 *)))
        ldc cosl sinl))
   (setf m (f2cl-lib:int-sub m 2))
   (go label60)))
(cond
  ((or (> ll oldm) (< m oldll))
   (cond
     ((>= (abs (f2cl-lib:fref d (ll) ((1 *))))
          (abs (f2cl-lib:fref d (m) ((1 *)))))
      (setf idir 1))
     (t
      (setf idir 2)))))
(cond
  ((= idir 1)
   (cond
     ((or
       (<=
        (abs
         (f2cl-lib:fref e
                        ((f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
                        ((1 *))))
        (* (abs tol) (abs (f2cl-lib:fref d (m) ((1 *))))))
       (and (< tol zero)
            (<=
             (abs
              (f2cl-lib:fref e
                             ((f2cl-lib:int-add m
                                                (f2cl-lib:int-sub 1)))
                             ((1 *))))
             thresh)))
      (setf (f2cl-lib:fref e-%data%
                           ((f2cl-lib:int-sub m 1))
                           ((1 *))
                           e-%offset%)
            zero)
      (go label60)))
```

```
(cond
  ((>= tol zero)
   (setf mu (abs (f2cl-lib:fref d-%data% (ll) ((1 *)) d-%offset%)))
   (setf sminl mu)
   (f2cl-lib:fdo (lll ll (f2cl-lib:int-add lll 1))
                 ((> lll (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
                  nil)
     (tagbody
       (cond
         ((<= (abs (f2cl-lib:fref e (lll) ((1 *)))) (* tol mu))
          (setf (f2cl-lib:fref e-%data% (lll) ((1 *)) e-%offset%)
                  zero)
          (go label60)))
       (setf sminlo sminl)
       (setf mu
               (*
                (abs
                 (f2cl-lib:fref d-%data%
                                ((f2cl-lib:int-add lll 1))
                                ((1 *))
                                d-%offset%))
                (/ mu
                   (+ mu
                      (abs
                       (f2cl-lib:fref e-%data%
                                      (lll)
                                      ((1 *))
                                      e-%offset%))))))
       (setf sminl (min sminl mu)))))
(t
 (cond
   ((or
     (<= (abs (f2cl-lib:fref e (ll) ((1 *))))
         (* (abs tol) (abs (f2cl-lib:fref d (ll) ((1 *))))))
     (and (< tol zero)
          (<= (abs (f2cl-lib:fref e (ll) ((1 *)))) thresh)))
    (setf (f2cl-lib:fref e-%data% (ll) ((1 *)) e-%offset%) zero)
    (go label60)))
 (cond
   ((>= tol zero)
    (setf mu (abs (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%)))
    (setf sminl mu)
    (f2cl-lib:fdo (lll (f2cl-lib:int-add m (f2cl-lib:int-sub 1))
                   (f2cl-lib:int-add lll (f2cl-lib:int-sub 1)))
                  ((> lll ll) nil)
      (tagbody
        (cond
          ((<= (abs (f2cl-lib:fref e (lll) ((1 *)))) (* tol mu))
           (setf (f2cl-lib:fref e-%data% (lll) ((1 *)) e-%offset%)
                   zero)
```

```
              (go label60)))
            (setf sminlo sminl)
            (setf mu
                    (*
                     (abs
                      (f2cl-lib:fref d-%data% (lll) ((1 *)) d-%offset%))
                     (/ mu
                        (+ mu
                           (abs
                            (f2cl-lib:fref e-%data%
                                           (lll)
                                           ((1 *))
                                           e-%offset%))))))
            (setf sminl (min sminl mu))))))))
(setf oldll ll)
(setf oldm m)
(cond
  ((and (>= tol zero)
        (<= (* n tol (f2cl-lib:f2cl/ sminl smax))
            (max eps (* hndrth tol))))
   (setf shift zero))
  (t
   (cond
     ((= idir 1)
      (setf sll (abs (f2cl-lib:fref d-%data% (ll) ((1 *)) d-%offset%)))
      (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
          (dlas2
           (f2cl-lib:fref d-%data%
                          ((f2cl-lib:int-sub m 1))
                          ((1 *))
                          d-%offset%)
           (f2cl-lib:fref e-%data%
                          ((f2cl-lib:int-sub m 1))
                          ((1 *))
                          e-%offset%)
           (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%) shift r)
        (declare (ignore var-0 var-1 var-2))
        (setf shift var-3)
        (setf r var-4)))
     (t
      (setf sll (abs (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%)))
      (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
          (dlas2 (f2cl-lib:fref d-%data% (ll) ((1 *)) d-%offset%)
           (f2cl-lib:fref e-%data% (ll) ((1 *)) e-%offset%)
           (f2cl-lib:fref d-%data%
                          ((f2cl-lib:int-add ll 1))
                          ((1 *))
                          d-%offset%)
           shift r)
        (declare (ignore var-0 var-1 var-2))
```

```
          (setf shift var-3)
          (setf r var-4))))
     (cond
       ((> sll zero)
        (if (< (expt (/ shift sll) 2) eps) (setf shift zero))))))
(setf iter (f2cl-lib:int-sub (f2cl-lib:int-add iter m) ll))
(cond
  ((= shift zero)
   (cond
     ((= idir 1)
      (setf cs one)
      (setf oldcs one)
      (f2cl-lib:fdo (i ll (f2cl-lib:int-add i 1))
                    ((> i (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
                     nil)
        (tagbody
          (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
              (dlartg
               (* (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) cs)
               (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%) cs sn r)
            (declare (ignore var-0 var-1))
            (setf cs var-2)
            (setf sn var-3)
            (setf r var-4))
          (if (> i ll)
              (setf (f2cl-lib:fref e-%data%
                                   ((f2cl-lib:int-sub i 1))
                                   ((1 *))
                                   e-%offset%)
                    (* oldsn r)))
          (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
              (dlartg (* oldcs r)
               (*
                (f2cl-lib:fref d-%data%
                               ((f2cl-lib:int-add i 1))
                               ((1 *))
                               d-%offset%)
                sn)
               oldcs oldsn
               (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
            (declare (ignore var-0 var-1))
            (setf oldcs var-2)
            (setf oldsn var-3)
            (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
                    var-4))
          (setf (f2cl-lib:fref work-%data%
                               ((f2cl-lib:int-add
                                 (f2cl-lib:int-sub i ll)
                                 1))
                               ((1 *))
```

```
                              work-%offset%)
                cs)
        (setf (f2cl-lib:fref work-%data%
                              ((f2cl-lib:int-add
                                (f2cl-lib:int-sub i ll)
                                1
                                nm1))
                              ((1 *))
                              work-%offset%)
                sn)
        (setf (f2cl-lib:fref work-%data%
                              ((f2cl-lib:int-add
                                (f2cl-lib:int-sub i ll)
                                1
                                nm12))
                              ((1 *))
                              work-%offset%)
                oldcs)
        (setf (f2cl-lib:fref work-%data%
                              ((f2cl-lib:int-add
                                (f2cl-lib:int-sub i ll)
                                1
                                nm13))
                              ((1 *))
                              work-%offset%)
                oldsn)))
    (setf h (* (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%) cs))
    (setf (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%) (* h oldcs))
    (setf (f2cl-lib:fref e-%data%
                         ((f2cl-lib:int-sub m 1))
                         ((1 *))
                         e-%offset%)
            (* h oldsn))
    (if (> ncvt 0)
        (dlasr "L" "V" "F"
         (f2cl-lib:int-add (f2cl-lib:int-sub m ll) 1) ncvt
         (f2cl-lib:array-slice work double-float (1) ((1 *)))
         (f2cl-lib:array-slice work double-float (n) ((1 *)))
         (f2cl-lib:array-slice vt
                               double-float
                               (ll 1)
                               ((1 ldvt) (1 *)))
         ldvt))
    (if (> nru 0)
        (dlasr "R" "V" "F" nru
         (f2cl-lib:int-add (f2cl-lib:int-sub m ll) 1)
         (f2cl-lib:array-slice work
                               double-float
                               ((+ nm12 1))
                               ((1 *)))
```

```
      (f2cl-lib:array-slice work
                            double-float
                            ((+ nm13 1))
                            ((1 *)))
      (f2cl-lib:array-slice u double-float (1 ll) ((1 ldu) (1 *)))
      ldu))
 (if (> ncc 0)
     (dlasr "L" "V" "F"
      (f2cl-lib:int-add (f2cl-lib:int-sub m ll) 1) ncc
      (f2cl-lib:array-slice work
                            double-float
                            ((+ nm12 1))
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            ((+ nm13 1))
                            ((1 *)))
      (f2cl-lib:array-slice c double-float (ll 1) ((1 ldc) (1 *)))
      ldc))
 (if
  (<=
   (abs
    (f2cl-lib:fref e-%data%
                   ((f2cl-lib:int-sub m 1))
                   ((1 *))
                   e-%offset%))
   thresh)
  (setf (f2cl-lib:fref e-%data%
                       ((f2cl-lib:int-sub m 1))
                       ((1 *))
                       e-%offset%)
        zero)))
(t
 (setf cs one)
 (setf oldcs one)
 (f2cl-lib:fdo (i m (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
               ((> i (f2cl-lib:int-add ll 1)) nil)
   (tagbody
     (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
         (dlartg
          (* (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) cs)
          (f2cl-lib:fref e-%data%
                         ((f2cl-lib:int-sub i 1))
                         ((1 *))
                         e-%offset%)
          cs sn r)
       (declare (ignore var-0 var-1))
       (setf cs var-2)
       (setf sn var-3)
       (setf r var-4))
```

```
      (if (< i m)
          (setf (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)
                (* oldsn r)))
      (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
          (dlartg (* oldcs r)
           (*
            (f2cl-lib:fref d-%data%
                           ((f2cl-lib:int-sub i 1))
                           ((1 *))
                           d-%offset%)
            sn)
           oldcs oldsn
           (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
        (declare (ignore var-0 var-1))
        (setf oldcs var-2)
        (setf oldsn var-3)
        (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
                var-4))
      (setf (f2cl-lib:fref work-%data%
                           ((f2cl-lib:int-sub i ll))
                           ((1 *))
                           work-%offset%)
              cs)
      (setf (f2cl-lib:fref work-%data%
                           ((f2cl-lib:int-add
                             (f2cl-lib:int-sub i ll)
                             nm1))
                           ((1 *))
                           work-%offset%)
              (- sn))
      (setf (f2cl-lib:fref work-%data%
                           ((f2cl-lib:int-add
                             (f2cl-lib:int-sub i ll)
                             nm12))
                           ((1 *))
                           work-%offset%)
              oldcs)
      (setf (f2cl-lib:fref work-%data%
                           ((f2cl-lib:int-add
                             (f2cl-lib:int-sub i ll)
                             nm13))
                           ((1 *))
                           work-%offset%)
              (- oldsn))))
(setf h (* (f2cl-lib:fref d-%data% (ll) ((1 *)) d-%offset%) cs))
(setf (f2cl-lib:fref d-%data% (ll) ((1 *)) d-%offset%)
        (* h oldcs))
(setf (f2cl-lib:fref e-%data% (ll) ((1 *)) e-%offset%)
        (* h oldsn))
(if (> ncvt 0)
```

```
            (dlasr "L" "V" "B"
             (f2cl-lib:int-add (f2cl-lib:int-sub m ll) 1) ncvt
             (f2cl-lib:array-slice work
                                   double-float
                                   ((+ nm12 1))
                                   ((1 *)))
             (f2cl-lib:array-slice work
                                   double-float
                                   ((+ nm13 1))
                                   ((1 *)))
             (f2cl-lib:array-slice vt
                                   double-float
                                   (ll 1)
                                   ((1 ldvt) (1 *)))
             ldvt))
        (if (> nru 0)
            (dlasr "R" "V" "B" nru
             (f2cl-lib:int-add (f2cl-lib:int-sub m ll) 1)
             (f2cl-lib:array-slice work double-float (1) ((1 *)))
             (f2cl-lib:array-slice work double-float (n) ((1 *)))
             (f2cl-lib:array-slice u double-float (1 ll) ((1 ldu) (1 *)))
             ldu))
        (if (> ncc 0)
            (dlasr "L" "V" "B"
             (f2cl-lib:int-add (f2cl-lib:int-sub m ll) 1) ncc
             (f2cl-lib:array-slice work double-float (1) ((1 *)))
             (f2cl-lib:array-slice work double-float (n) ((1 *)))
             (f2cl-lib:array-slice c double-float (ll 1) ((1 ldc) (1 *)))
             ldc))
        (if
         (<= (abs (f2cl-lib:fref e-%data% (ll) ((1 *)) e-%offset%))
             thresh)
         (setf (f2cl-lib:fref e-%data% (ll) ((1 *)) e-%offset%) zero)))))
    (t
     (cond
       ((= idir 1)
        (setf f
              (*
               (-
                (abs (f2cl-lib:fref d-%data% (ll) ((1 *)) d-%offset%))
                shift)
               (+
                (f2cl-lib:sign one
                               (f2cl-lib:fref d-%data%
                                             (ll)
                                             ((1 *))
                                             d-%offset%))
                (/ shift
                   (f2cl-lib:fref d-%data% (ll) ((1 *)) d-%offset%)))))
        (setf g (f2cl-lib:fref e-%data% (ll) ((1 *)) e-%offset%))
```

```
(f2cl-lib:fdo (i ll (f2cl-lib:int-add i 1))
              ((> i (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
               nil)
  (tagbody
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
        (dlartg f g cosr sinr r)
      (declare (ignore var-0 var-1))
      (setf cosr var-2)
      (setf sinr var-3)
      (setf r var-4))
    (if (> i ll)
        (setf (f2cl-lib:fref e-%data%
                             ((f2cl-lib:int-sub i 1))
                             ((1 *))
                             e-%offset%)
              r))
    (setf f
          (+
           (* cosr
              (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
           (* sinr
              (f2cl-lib:fref e-%data%
                             (i)
                             ((1 *))
                             e-%offset%))))
    (setf (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)
          (-
           (* cosr
              (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%))
           (* sinr
              (f2cl-lib:fref d-%data%
                             (i)
                             ((1 *))
                             d-%offset%))))
    (setf g
          (* sinr
             (f2cl-lib:fref d-%data%
                            ((f2cl-lib:int-add i 1))
                            ((1 *))
                            d-%offset%)))
    (setf (f2cl-lib:fref d-%data%
                         ((f2cl-lib:int-add i 1))
                         ((1 *))
                         d-%offset%)
          (* cosr
             (f2cl-lib:fref d-%data%
                            ((f2cl-lib:int-add i 1))
                            ((1 *))
                            d-%offset%)))
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
```

```
    (dlartg f g cosl sinl r)
  (declare (ignore var-0 var-1))
  (setf cosl var-2)
  (setf sinl var-3)
  (setf r var-4))
(setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) r)
(setf f
        (+
         (* cosl
            (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%))
         (* sinl
            (f2cl-lib:fref d-%data%
                          ((f2cl-lib:int-add i 1))
                          ((1 *))
                          d-%offset%))))
(setf (f2cl-lib:fref d-%data%
                     ((f2cl-lib:int-add i 1))
                     ((1 *))
                     d-%offset%)
        (-
         (* cosl
            (f2cl-lib:fref d-%data%
                          ((f2cl-lib:int-add i 1))
                          ((1 *))
                          d-%offset%))
         (* sinl
            (f2cl-lib:fref e-%data%
                          (i)
                          ((1 *))
                          e-%offset%))))
(cond
  ((< i (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
   (setf g
           (* sinl
              (f2cl-lib:fref e-%data%
                             ((f2cl-lib:int-add i 1))
                             ((1 *))
                             e-%offset%)))
   (setf (f2cl-lib:fref e-%data%
                        ((f2cl-lib:int-add i 1))
                        ((1 *))
                        e-%offset%)
           (* cosl
              (f2cl-lib:fref e-%data%
                             ((f2cl-lib:int-add i 1))
                             ((1 *))
                             e-%offset%)))))
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add
                       (f2cl-lib:int-sub i ll)
```

```
                              1))
                             ((1 *))
                             work-%offset%)
                    cosr)
        (setf (f2cl-lib:fref work-%data%
                             ((f2cl-lib:int-add
                               (f2cl-lib:int-sub i ll)
                               1
                               nm1))
                             ((1 *))
                             work-%offset%)
                    sinr)
        (setf (f2cl-lib:fref work-%data%
                             ((f2cl-lib:int-add
                               (f2cl-lib:int-sub i ll)
                               1
                               nm12))
                             ((1 *))
                             work-%offset%)
                    cosl)
        (setf (f2cl-lib:fref work-%data%
                             ((f2cl-lib:int-add
                               (f2cl-lib:int-sub i ll)
                               1
                               nm13))
                             ((1 *))
                             work-%offset%)
                    sinl)))
    (setf (f2cl-lib:fref e-%data%
                         ((f2cl-lib:int-sub m 1))
                         ((1 *))
                         e-%offset%)
            f)
    (if (> ncvt 0)
        (dlasr "L" "V" "F"
         (f2cl-lib:int-add (f2cl-lib:int-sub m ll) 1) ncvt
         (f2cl-lib:array-slice work double-float (1) ((1 *)))
         (f2cl-lib:array-slice work double-float (n) ((1 *)))
         (f2cl-lib:array-slice vt
                               double-float
                               (ll 1)
                               ((1 ldvt) (1 *)))
         ldvt))
    (if (> nru 0)
        (dlasr "R" "V" "F" nru
         (f2cl-lib:int-add (f2cl-lib:int-sub m ll) 1)
         (f2cl-lib:array-slice work
                               double-float
                               ((+ nm12 1))
                               ((1 *)))
```

```
      (f2cl-lib:array-slice work
                            double-float
                            ((+ nm13 1))
                            ((1 *)))
      (f2cl-lib:array-slice u double-float (1 ll) ((1 ldu) (1 *)))
      ldu))
 (if (> ncc 0)
     (dlasr "L" "V" "F"
      (f2cl-lib:int-add (f2cl-lib:int-sub m ll) 1) ncc
      (f2cl-lib:array-slice work
                            double-float
                            ((+ nm12 1))
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            ((+ nm13 1))
                            ((1 *)))
      (f2cl-lib:array-slice c double-float (ll 1) ((1 ldc) (1 *)))
      ldc))
 (if
  (<=
   (abs
    (f2cl-lib:fref e-%data%
                   ((f2cl-lib:int-sub m 1))
                   ((1 *))
                   e-%offset%))
   thresh)
  (setf (f2cl-lib:fref e-%data%
                       ((f2cl-lib:int-sub m 1))
                       ((1 *))
                       e-%offset%)
          zero)))
(t
 (setf f
         (*
          (- (abs (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%))
             shift)
          (+
           (f2cl-lib:sign one
                          (f2cl-lib:fref d-%data%
                                         (m)
                                         ((1 *))
                                         d-%offset%))
           (/ shift
              (f2cl-lib:fref d-%data% (m) ((1 *)) d-%offset%)))))
 (setf g
         (f2cl-lib:fref e-%data%
                        ((f2cl-lib:int-sub m 1))
                        ((1 *))
                        e-%offset%))
```

```
(f2cl-lib:fdo (i m (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
              ((> i (f2cl-lib:int-add ll 1)) nil)
  (tagbody
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
        (dlartg f g cosr sinr r)
      (declare (ignore var-0 var-1))
      (setf cosr var-2)
      (setf sinr var-3)
      (setf r var-4))
    (if (< i m)
        (setf (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%) r))
    (setf f
            (+
             (* cosr
                (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
             (* sinr
                (f2cl-lib:fref e-%data%
                               ((f2cl-lib:int-sub i 1))
                               ((1 *))
                               e-%offset%))))
    (setf (f2cl-lib:fref e-%data%
                         ((f2cl-lib:int-sub i 1))
                         ((1 *))
                         e-%offset%)
            (-
             (* cosr
                (f2cl-lib:fref e-%data%
                               ((f2cl-lib:int-sub i 1))
                               ((1 *))
                               e-%offset%))
             (* sinr
                (f2cl-lib:fref d-%data%
                               (i)
                               ((1 *))
                               d-%offset%))))
    (setf g
            (* sinr
               (f2cl-lib:fref d-%data%
                              ((f2cl-lib:int-sub i 1))
                              ((1 *))
                              d-%offset%)))
    (setf (f2cl-lib:fref d-%data%
                         ((f2cl-lib:int-sub i 1))
                         ((1 *))
                         d-%offset%)
            (* cosr
               (f2cl-lib:fref d-%data%
                              ((f2cl-lib:int-sub i 1))
                              ((1 *))
                              d-%offset%)))
```

```
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
    (dlartg f g cosl sinl r)
  (declare (ignore var-0 var-1))
  (setf cosl var-2)
  (setf sinl var-3)
  (setf r var-4))
(setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) r)
(setf f
        (+
         (* cosl
            (f2cl-lib:fref e-%data%
                           ((f2cl-lib:int-sub i 1))
                           ((1 *))
                           e-%offset%))
         (* sinl
            (f2cl-lib:fref d-%data%
                           ((f2cl-lib:int-sub i 1))
                           ((1 *))
                           d-%offset%))))
(setf (f2cl-lib:fref d-%data%
                     ((f2cl-lib:int-sub i 1))
                     ((1 *))
                     d-%offset%)
        (-
         (* cosl
            (f2cl-lib:fref d-%data%
                           ((f2cl-lib:int-sub i 1))
                           ((1 *))
                           d-%offset%))
         (* sinl
            (f2cl-lib:fref e-%data%
                           ((f2cl-lib:int-sub i 1))
                           ((1 *))
                           e-%offset%))))
(cond
  ((> i (f2cl-lib:int-add ll 1))
   (setf g
           (* sinl
              (f2cl-lib:fref e-%data%
                             ((f2cl-lib:int-sub i 2))
                             ((1 *))
                             e-%offset%)))
   (setf (f2cl-lib:fref e-%data%
                        ((f2cl-lib:int-sub i 2))
                        ((1 *))
                        e-%offset%)
           (* cosl
              (f2cl-lib:fref e-%data%
                             ((f2cl-lib:int-sub i 2))
                             ((1 *))
```

```
                                    e-%offset%)))))
    (setf (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-sub i ll))
                         ((1 *))
                         work-%offset%)
          cosr)
    (setf (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-add
                           (f2cl-lib:int-sub i ll)
                           nm1))
                         ((1 *))
                         work-%offset%)
          (- sinr))
    (setf (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-add
                           (f2cl-lib:int-sub i ll)
                           nm12))
                         ((1 *))
                         work-%offset%)
          cosl)
    (setf (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-add
                           (f2cl-lib:int-sub i ll)
                           nm13))
                         ((1 *))
                         work-%offset%)
          (- sinl))))
(setf (f2cl-lib:fref e-%data% (ll) ((1 *)) e-%offset%) f)
(if
 (<= (abs (f2cl-lib:fref e-%data% (ll) ((1 *)) e-%offset%))
     thresh)
 (setf (f2cl-lib:fref e-%data% (ll) ((1 *)) e-%offset%) zero))
(if (> ncvt 0)
    (dlasr "L" "V" "B"
     (f2cl-lib:int-add (f2cl-lib:int-sub m ll) 1) ncvt
     (f2cl-lib:array-slice work
                           double-float
                           ((+ nm12 1))
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           ((+ nm13 1))
                           ((1 *)))
     (f2cl-lib:array-slice vt
                           double-float
                           (ll 1)
                           ((1 ldvt) (1 *)))
     ldvt))
(if (> nru 0)
    (dlasr "R" "V" "B" nru
```

```
                (f2cl-lib:int-add (f2cl-lib:int-sub m ll) 1)
                (f2cl-lib:array-slice work double-float (1) ((1 *)))
                (f2cl-lib:array-slice work double-float (n) ((1 *)))
                (f2cl-lib:array-slice u double-float (1 ll) ((1 ldu) (1 *)))
                ldu))
            (if (> ncc 0)
                (dlasr "L" "V" "B"
                 (f2cl-lib:int-add (f2cl-lib:int-sub m ll) 1) ncc
                 (f2cl-lib:array-slice work double-float (1) ((1 *)))
                 (f2cl-lib:array-slice work double-float (n) ((1 *)))
                 (f2cl-lib:array-slice c double-float (ll 1) ((1 ldc) (1 *)))
                 ldc))))))
       (go label60)
label160
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i n) nil)
         (tagbody
           (cond
             ((< (f2cl-lib:fref d (i) ((1 *))) zero)
              (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
                      (- (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)))
              (if (> ncvt 0)
                  (dscal ncvt negone
                   (f2cl-lib:array-slice vt
                                         double-float
                                         (i 1)
                                         ((1 ldvt) (1 *)))
                   ldvt))))))
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
         (tagbody
           (setf isub 1)
           (setf smin (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%))
           (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
                         ((> j (f2cl-lib:int-add n 1 (f2cl-lib:int-sub i)))
                          nil)
             (tagbody
               (cond
                 ((<= (f2cl-lib:fref d (j) ((1 *))) smin)
                  (setf isub j)
                  (setf smin
                        (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%))))))
           (cond
             ((/= isub (f2cl-lib:int-add n 1 (f2cl-lib:int-sub i)))
              (setf (f2cl-lib:fref d-%data% (isub) ((1 *)) d-%offset%)
                      (f2cl-lib:fref d-%data%
                                     ((f2cl-lib:int-sub (f2cl-lib:int-add n 1)
                                                        i))
                                     ((1 *))
                                     d-%offset%))
```

```
              (setf (f2cl-lib:fref d-%data%
                                   ((f2cl-lib:int-sub (f2cl-lib:int-add n 1)
                                                      i))
                                   ((1 *))
                                   d-%offset%)
                    smin)
              (if (> ncvt 0)
                  (dswap ncvt
                   (f2cl-lib:array-slice vt
                                         double-float
                                         (isub 1)
                                         ((1 ldvt) (1 *)))
                   ldvt
                   (f2cl-lib:array-slice vt
                                         double-float
                                         ((+ n 1 (f2cl-lib:int-sub i)) 1)
                                         ((1 ldvt) (1 *)))
                   ldvt))
              (if (> nru 0)
                  (dswap nru
                   (f2cl-lib:array-slice u
                                         double-float
                                         (1 isub)
                                         ((1 ldu) (1 *)))
                   1
                   (f2cl-lib:array-slice u
                                         double-float
                                         (1
                                          (f2cl-lib:int-sub
                                           (f2cl-lib:int-add n 1)
                                           i))
                                         ((1 ldu) (1 *)))
                   1))
              (if (> ncc 0)
                  (dswap ncc
                   (f2cl-lib:array-slice c
                                         double-float
                                         (isub 1)
                                         ((1 ldc) (1 *)))
                   ldc
                   (f2cl-lib:array-slice c
                                         double-float
                                         ((+ n 1 (f2cl-lib:int-sub i)) 1)
                                         ((1 ldc) (1 *)))
                   ldc))))))
       (go end_label)
label200
       (setf info 0)
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
```

```
          (tagbody
            (if (/= (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%) zero)
                (setf info (f2cl-lib:int-add info 1)))))
 end_label
        (return
         (values nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 info))))))
```

———-

6.3 ddisna LAPACK

— **ddisna.input** —

```
)set break resume
)sys rm -f ddisna.output
)spool ddisna.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **ddisna.help** —

```
==========================================================================
ddisna examples
==========================================================================
```

```
=====================================================================
Man Page Details
=====================================================================

NAME
       DDISNA  -  the  reciprocal  condition numbers for the eigenvectors of a
       real symmetric or complex Hermitian matrix or for  the  left  or  right
       singular vectors of a general m-by-n matrix

SYNOPSIS
       SUBROUTINE DDISNA( JOB, M, N, D, SEP, INFO )

           CHARACTER      JOB

           INTEGER        INFO, M, N

           DOUBLE         PRECISION D( * ), SEP( * )

PURPOSE
       DDISNA  computes  the reciprocal condition numbers for the eigenvectors
       of a real symmetric or complex Hermitian matrix  or  for  the  left  or
       right  singular vectors of a general m-by-n matrix. The reciprocal con-
       dition number is the 'gap' between the corresponding eigenvalue or sin-
       gular value and the nearest other one.

       The  bound on the error, measured by angle in radians, in the I-th com-
       puted vector is given by

              DLAMCH( 'E' ) * ( ANORM / SEP( I ) )

       where ANORM = 2-norm(A) = max( abs( D(j) ) ).  SEP(I) is not allowed to
       be  smaller  than DLAMCH( 'E' )*ANORM in order to limit the size of the
       error bound.

       DDISNA may also be used to compute error bounds for eigenvectors of the
       generalized symmetric definite eigenproblem.


ARGUMENTS
       JOB     (input) CHARACTER*1
               Specifies  for  which  problem the reciprocal condition numbers
               should be computed:
               = 'E':  the eigenvectors of a symmetric/Hermitian matrix;
               = 'L':  the left singular vectors of a general matrix;
               = 'R':  the right singular vectors of a general matrix.

       M       (input) INTEGER
               The number of rows of the matrix. M >= 0.

       N       (input) INTEGER
```

```
              If JOB = 'L' or 'R', the number of columns of  the  matrix,  in
              which case N >= 0. Ignored if JOB = 'E'.

       D      (input) DOUBLE PRECISION array, dimension (M) if JOB = 'E'
              dimension  (min(M,N))  if  JOB = 'L' or 'R' The eigenvalues (if
              JOB = 'E') or singular values (if JOB =  'L'  or  'R')  of  the
              matrix,  in  either increasing or decreasing order. If singular
              values, they must be non-negative.

       SEP    (output) DOUBLE PRECISION array, dimension (M) if JOB = 'E'
              dimension (min(M,N)) if JOB = 'L' or 'R' The reciprocal  condi-
              tion numbers of the vectors.

       INFO   (output) INTEGER
              = 0:  successful exit.
              < 0:  if INFO = -i, the i-th argument had an illegal value.
```

———-

— ddisna.f —

```
      SUBROUTINE DDISNA( JOB, M, N, D, SEP, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     September 30, 1994
*
*     .. Scalar Arguments ..
      CHARACTER          JOB
      INTEGER            INFO, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   D( * ), SEP( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER          ( ZERO = 0.0D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            DECR, EIGEN, INCR, LEFT, RIGHT, SING
      INTEGER            I, K
      DOUBLE PRECISION   ANORM, EPS, NEWGAP, OLDGAP, SAFMIN, THRESH
*     ..
*     .. External Functions ..
```

```
      LOGICAL            LSAME
      DOUBLE PRECISION   DLAMCH
      EXTERNAL           LSAME, DLAMCH
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX, MIN
*     ..
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      EIGEN = LSAME( JOB, 'E' )
      LEFT = LSAME( JOB, 'L' )
      RIGHT = LSAME( JOB, 'R' )
      SING = LEFT .OR. RIGHT
      IF( EIGEN ) THEN
         K = M
      ELSE IF( SING ) THEN
         K = MIN( M, N )
      END IF
      IF( .NOT.EIGEN .AND. .NOT.SING ) THEN
         INFO = -1
      ELSE IF( M.LT.0 ) THEN
         INFO = -2
      ELSE IF( K.LT.0 ) THEN
         INFO = -3
      ELSE
         INCR = .TRUE.
         DECR = .TRUE.
         DO 10 I = 1, K - 1
            IF( INCR )
     $         INCR = INCR .AND. D( I ).LE.D( I+1 )
            IF( DECR )
     $         DECR = DECR .AND. D( I ).GE.D( I+1 )
   10    CONTINUE
         IF( SING .AND. K.GT.0 ) THEN
            IF( INCR )
     $         INCR = INCR .AND. ZERO.LE.D( 1 )
            IF( DECR )
     $         DECR = DECR .AND. D( K ).GE.ZERO
         END IF
         IF( .NOT.( INCR .OR. DECR ) )
     $      INFO = -4
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DDISNA', -INFO )
```

```
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( K.EQ.0 )
     $   RETURN
*
*     Compute reciprocal condition numbers
*
      IF( K.EQ.1 ) THEN
         SEP( 1 ) = DLAMCH( 'O' )
      ELSE
         OLDGAP = ABS( D( 2 )-D( 1 ) )
         SEP( 1 ) = OLDGAP
         DO 20 I = 2, K - 1
            NEWGAP = ABS( D( I+1 )-D( I ) )
            SEP( I ) = MIN( OLDGAP, NEWGAP )
            OLDGAP = NEWGAP
   20    CONTINUE
         SEP( K ) = OLDGAP
      END IF
      IF( SING ) THEN
         IF( ( LEFT .AND. M.GT.N ) .OR. ( RIGHT .AND. M.LT.N ) ) THEN
            IF( INCR )
     $         SEP( 1 ) = MIN( SEP( 1 ), D( 1 ) )
            IF( DECR )
     $         SEP( K ) = MIN( SEP( K ), D( K ) )
         END IF
      END IF
*
*     Ensure that reciprocal condition numbers are not less than
*     threshold, in order to limit the size of the error bound
*
      EPS = DLAMCH( 'E' )
      SAFMIN = DLAMCH( 'S' )
      ANORM = MAX( ABS( D( 1 ) ), ABS( D( K ) ) )
      IF( ANORM.EQ.ZERO ) THEN
         THRESH = EPS
      ELSE
         THRESH = MAX( EPS*ANORM, SAFMIN )
      END IF
      DO 30 I = 1, K
         SEP( I ) = MAX( SEP( I ), THRESH )
   30 CONTINUE
*
      RETURN
*
*     End of DDISNA
*
```

```
      END
```

— LAPACK ddisna —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun ddisna (job m n d sep info)
    (declare (type (simple-array double-float (*)) sep d)
             (type fixnum info n m)
             (type character job))
    (f2cl-lib:with-multi-array-data
        ((job character job-%data% job-%offset%)
         (d double-float d-%data% d-%offset%)
         (sep double-float sep-%data% sep-%offset%))
      (prog ((anorm 0.0) (eps 0.0) (newgap 0.0) (oldgap 0.0) (safmin 0.0)
             (thresh 0.0) (i 0) (k 0) (decr nil) (eigen nil) (incr nil)
             (left nil) (right nil) (sing nil))
        (declare (type (double-float) anorm eps newgap oldgap safmin thresh)
                 (type fixnum i k)
                 (type (member t nil) decr eigen incr left right sing))
        (setf info 0)
        (setf eigen (char-equal job #\E))
        (setf left (char-equal job #\L))
        (setf right (char-equal job #\R))
        (setf sing (or left right))
        (cond
          (eigen
           (setf k m))
          (sing
           (setf k (min (the fixnum m) (the fixnum n)))))
        (cond
          ((and (not eigen) (not sing))
           (setf info -1))
          ((< m 0)
           (setf info -2))
          ((< k 0)
           (setf info -3))
          (t
           (setf incr t)
           (setf decr t)
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i (f2cl-lib:int-add k (f2cl-lib:int-sub 1))) nil)
             (tagbody
               (if incr
                   (setf incr
                           (and incr
```

```
                          (<=
                           (f2cl-lib:fref d-%data%
                                          (i)
                                          ((1 *))
                                          d-%offset%)
                           (f2cl-lib:fref d-%data%
                                          ((f2cl-lib:int-add i 1))
                                          ((1 *))
                                          d-%offset%)))))
          (if decr
              (setf decr
                      (and decr
                           (>=
                            (f2cl-lib:fref d-%data%
                                          (i)
                                          ((1 *))
                                          d-%offset%)
                            (f2cl-lib:fref d-%data%
                                          ((f2cl-lib:int-add i 1))
                                          ((1 *))
                                          d-%offset%)))))))
     (cond
       ((and sing (> k 0))
        (if incr
            (setf incr
                    (and incr
                         (<= zero
                             (f2cl-lib:fref d-%data%
                                            (1)
                                            ((1 *))
                                            d-%offset%)))))
        (if decr
            (setf decr
                    (and decr
                         (>=
                          (f2cl-lib:fref d-%data% (k) ((1 *)) d-%offset%)
                          zero))))))
     (if (not (or incr decr)) (setf info -4))))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DDISNA" (f2cl-lib:int-sub info))
   (go end_label)))
(if (= k 0) (go end_label))
(cond
  ((= k 1)
   (setf (f2cl-lib:fref sep-%data% (1) ((1 *)) sep-%offset%)
           (dlamch "O")))
  (t
```

```
   (setf oldgap
           (abs
            (- (f2cl-lib:fref d-%data% (2) ((1 *)) d-%offset%)
               (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%))))
   (setf (f2cl-lib:fref sep-%data% (1) ((1 *)) sep-%offset%) oldgap)
   (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
                 ((> i (f2cl-lib:int-add k (f2cl-lib:int-sub 1))) nil)
     (tagbody
       (setf newgap
               (abs
                (-
                 (f2cl-lib:fref d-%data%
                                ((f2cl-lib:int-add i 1))
                                ((1 *))
                                d-%offset%)
                 (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))))
       (setf (f2cl-lib:fref sep-%data% (i) ((1 *)) sep-%offset%)
               (min oldgap newgap))
       (setf oldgap newgap)))
   (setf (f2cl-lib:fref sep-%data% (k) ((1 *)) sep-%offset%) oldgap)))
(cond
  (sing
   (cond
     ((or (and left (> m n)) (and right (< m n)))
      (if incr
          (setf (f2cl-lib:fref sep-%data% (1) ((1 *)) sep-%offset%)
                  (min
                   (f2cl-lib:fref sep-%data% (1) ((1 *)) sep-%offset%)
                   (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%))))
      (if decr
          (setf (f2cl-lib:fref sep-%data% (k) ((1 *)) sep-%offset%)
                  (min
                   (f2cl-lib:fref sep-%data% (k) ((1 *)) sep-%offset%)
                   (f2cl-lib:fref d-%data%
                                  (k)
                                  ((1 *))
                                  d-%offset%)))))))
(setf eps (dlamch "E"))
(setf safmin (dlamch "S"))
(setf anorm
       (max (abs (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%))
            (abs (f2cl-lib:fref d-%data% (k) ((1 *)) d-%offset%))))
(cond
  ((= anorm zero)
   (setf thresh eps))
  (t
   (setf thresh (max (* eps anorm) safmin))))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i k) nil)
  (tagbody
```

```
            (setf (f2cl-lib:fref sep-%data% (i) ((1 *)) sep-%offset%)
                    (max (f2cl-lib:fref sep-%data% (i) ((1 *)) sep-%offset%)
                         thresh))))
 end_label
        (return (values nil nil nil nil nil info))))))
```

———-

6.4 dgebak LAPACK

— **dgebak.input** —

```
)set break resume
)sys rm -f dgebak.output
)spool dgebak.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dgebak.help** —

```
=====================================================================
dgebak examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DGEBAK  -  the  right  or left eigenvectors of a real general matrix by
       backward transformation on the computed eigenvectors  of  the  balanced
       matrix output by DGEBAL

SYNOPSIS
       SUBROUTINE DGEBAK( JOB, SIDE, N, ILO, IHI, SCALE, M, V, LDV, INFO )

           CHARACTER      JOB, SIDE

           INTEGER        IHI, ILO, INFO, LDV, M, N
```

```
          DOUBLE         PRECISION SCALE( * ), V( LDV, * )

PURPOSE
      DGEBAK forms the right or left eigenvectors of a real general matrix by
      backward transformation on the computed eigenvectors  of  the  balanced
      matrix output by DGEBAL.


ARGUMENTS
      JOB     (input) CHARACTER*1
              Specifies  the type of backward transformation required: = 'N',
              do nothing, return immediately; = 'P', do backward  transforma-
              tion  for  permutation  only; = 'S', do backward transformation
              for scaling only; = 'B', do backward transformations  for  both
              permutation  and scaling.  JOB must be the same as the argument
              JOB supplied to DGEBAL.

      SIDE    (input) CHARACTER*1
              = 'R':  V contains right eigenvectors;
              = 'L':  V contains left eigenvectors.

      N       (input) INTEGER
              The number of rows of the matrix V.  N >= 0.

      ILO     (input) INTEGER
              IHI     (input) INTEGER The integers ILO and IHI determined  by
              DGEBAL.   1  <=  ILO <= IHI <= N, if N > 0; ILO=1 and IHI=0, if
              N=0.

      SCALE   (input) DOUBLE PRECISION array, dimension (N)
              Details of the permutation and scaling factors, as returned  by
              DGEBAL.

      M       (input) INTEGER
              The number of columns of the matrix V.  M >= 0.

      V       (input/output) DOUBLE PRECISION array, dimension (LDV,M)
              On entry, the matrix of right or left eigenvectors to be trans-
              formed, as returned by DHSEIN or DTREVC.  On exit, V  is  over-
              written by the transformed eigenvectors.

      LDV     (input) INTEGER
              The leading dimension of the array V. LDV >= max(1,N).

      INFO    (output) INTEGER
              = 0:  successful exit
              < 0:  if INFO = -i, the i-th argument had an illegal value.
```

———-

— **dgebak.f** —

```
      SUBROUTINE DGEBAK( JOB, SIDE, N, ILO, IHI, SCALE, M, V, LDV,
     $                   INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     September 30, 1994
*
*     .. Scalar Arguments ..
      CHARACTER          JOB, SIDE
      INTEGER            IHI, ILO, INFO, LDV, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   SCALE( * ), V( LDV, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE
      PARAMETER          ( ONE = 1.0D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            LEFTV, RIGHTV
      INTEGER            I, II, K
      DOUBLE PRECISION   S
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. External Subroutines ..
      EXTERNAL           DSCAL, DSWAP, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Decode and Test the input parameters
*
      RIGHTV = LSAME( SIDE, 'R' )
      LEFTV = LSAME( SIDE, 'L' )
*
      INFO = 0
```

```
      IF( .NOT.LSAME( JOB, 'N' ) .AND. .NOT.LSAME( JOB, 'P' ) .AND.
     $    .NOT.LSAME( JOB, 'S' ) .AND. .NOT.LSAME( JOB, 'B' ) ) THEN
         INFO = -1
      ELSE IF( .NOT.RIGHTV .AND. .NOT.LEFTV ) THEN
         INFO = -2
      ELSE IF( N.LT.0 ) THEN
         INFO = -3
      ELSE IF( ILO.LT.1 .OR. ILO.GT.MAX( 1, N ) ) THEN
         INFO = -4
      ELSE IF( IHI.LT.MIN( ILO, N ) .OR. IHI.GT.N ) THEN
         INFO = -5
      ELSE IF( M.LT.0 ) THEN
         INFO = -7
      ELSE IF( LDV.LT.MAX( 1, N ) ) THEN
         INFO = -9
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DGEBAK', -INFO )
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( N.EQ.0 )
     $   RETURN
      IF( M.EQ.0 )
     $   RETURN
      IF( LSAME( JOB, 'N' ) )
     $   RETURN
*
      IF( ILO.EQ.IHI )
     $   GO TO 30
*
*     Backward balance
*
      IF( LSAME( JOB, 'S' ) .OR. LSAME( JOB, 'B' ) ) THEN
*
         IF( RIGHTV ) THEN
            DO 10 I = ILO, IHI
               S = SCALE( I )
               CALL DSCAL( M, S, V( I, 1 ), LDV )
   10       CONTINUE
         END IF
*
         IF( LEFTV ) THEN
            DO 20 I = ILO, IHI
               S = ONE / SCALE( I )
               CALL DSCAL( M, S, V( I, 1 ), LDV )
   20       CONTINUE
         END IF
```

```
*
      END IF
*
*     Backward permutation
*
*     For  I = ILO-1 step -1 until 1,
*              IHI+1 step 1 until N do --
*
   30 CONTINUE
      IF( LSAME( JOB, 'P' ) .OR. LSAME( JOB, 'B' ) ) THEN
         IF( RIGHTV ) THEN
            DO 40 II = 1, N
               I = II
               IF( I.GE.ILO .AND. I.LE.IHI )
     $            GO TO 40
               IF( I.LT.ILO )
     $            I = ILO - II
               K = SCALE( I )
               IF( K.EQ.I )
     $            GO TO 40
               CALL DSWAP( M, V( I, 1 ), LDV, V( K, 1 ), LDV )
   40       CONTINUE
         END IF
*
         IF( LEFTV ) THEN
            DO 50 II = 1, N
               I = II
               IF( I.GE.ILO .AND. I.LE.IHI )
     $            GO TO 50
               IF( I.LT.ILO )
     $            I = ILO - II
               K = SCALE( I )
               IF( K.EQ.I )
     $            GO TO 50
               CALL DSWAP( M, V( I, 1 ), LDV, V( K, 1 ), LDV )
   50       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of DGEBAK
*
      END
```

———-

— LAPACK dgebak —

```
(let* ((one 1.0))
  (declare (type (double-float 1.0 1.0) one))
  (defun dgebak (job side n ilo ihi scale m v ldv info)
    (declare (type (simple-array double-float (*)) v scale)
             (type fixnum info ldv m ihi ilo n)
             (type character side job))
    (f2cl-lib:with-multi-array-data
        ((job character job-%data% job-%offset%)
         (side character side-%data% side-%offset%)
         (scale double-float scale-%data% scale-%offset%)
         (v double-float v-%data% v-%offset%))
      (prog ((s 0.0) (i 0) (ii 0) (k 0) (leftv nil) (rightv nil))
        (declare (type (double-float) s)
                 (type fixnum i ii k)
                 (type (member t nil) leftv rightv))
        (setf rightv (char-equal side #\R))
        (setf leftv (char-equal side #\L))
        (setf info 0)
        (cond
          ((and (not (char-equal job #\N))
                (not (char-equal job #\P))
                (not (char-equal job #\S))
                (not (char-equal job #\B)))
           (setf info -1))
          ((and (not rightv) (not leftv))
           (setf info -2))
          ((< n 0)
           (setf info -3))
          ((or (< ilo 1)
               (> ilo
                  (max (the fixnum 1) (the fixnum n))))
           (setf info -4))
          ((or
            (< ihi (min (the fixnum ilo) (the fixnum n)))
            (> ihi n))
           (setf info -5))
          ((< m 0)
           (setf info -7))
          ((< ldv (max (the fixnum 1) (the fixnum n)))
           (setf info -9)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DGEBAK" (f2cl-lib:int-sub info))
           (go end_label)))
        (if (= n 0) (go end_label))
        (if (= m 0) (go end_label))
        (if (char-equal job #\N) (go end_label))
        (if (= ilo ihi) (go label30))
```

```
        (cond
          ((or (char-equal job #\S) (char-equal job #\B))
           (cond
             (rightv
              (f2cl-lib:fdo (i ilo (f2cl-lib:int-add i 1))
                            ((> i ihi) nil)
                (tagbody
                  (setf s
                          (f2cl-lib:fref scale-%data%
                                        (i)
                                        ((1 *))
                                        scale-%offset%))
                  (dscal m s
                   (f2cl-lib:array-slice v double-float (i 1) ((1 ldv) (1 *)))
                   ldv)))))
           (cond
             (leftv
              (f2cl-lib:fdo (i ilo (f2cl-lib:int-add i 1))
                            ((> i ihi) nil)
                (tagbody
                  (setf s
                          (/ one
                             (f2cl-lib:fref scale-%data%
                                           (i)
                                           ((1 *))
                                           scale-%offset%)))
                  (dscal m s
                   (f2cl-lib:array-slice v double-float (i 1) ((1 ldv) (1 *)))
                   ldv)))))))
label30
        (cond
          ((or (char-equal job #\P) (char-equal job #\B))
           (cond
             (rightv
              (f2cl-lib:fdo (ii 1 (f2cl-lib:int-add ii 1))
                            ((> ii n) nil)
                (tagbody
                  (setf i ii)
                  (if (and (>= i ilo) (<= i ihi)) (go label40))
                  (if (< i ilo) (setf i (f2cl-lib:int-sub ilo ii)))
                  (setf k
                          (f2cl-lib:int
                           (f2cl-lib:fref scale-%data%
                                         (i)
                                         ((1 *))
                                         scale-%offset%)))
                  (if (= k i) (go label40))
                  (dswap m
                   (f2cl-lib:array-slice v double-float (i 1) ((1 ldv) (1 *)))
                   ldv
```

```
                  (f2cl-lib:array-slice v double-float (k 1) ((1 ldv) (1 *)))
                  ldv)
 label40))))
           (cond
             (leftv
              (f2cl-lib:fdo (ii 1 (f2cl-lib:int-add ii 1))
                            ((> ii n) nil)
                (tagbody
                  (setf i ii)
                  (if (and (>= i ilo) (<= i ihi)) (go label50))
                  (if (< i ilo) (setf i (f2cl-lib:int-sub ilo ii)))
                  (setf k
                          (f2cl-lib:int
                           (f2cl-lib:fref scale-%data%
                                          (i)
                                          ((1 *))
                                          scale-%offset%)))
                  (if (= k i) (go label50))
                  (dswap m
                   (f2cl-lib:array-slice v double-float (i 1) ((1 ldv) (1 *)))
                   ldv
                   (f2cl-lib:array-slice v double-float (k 1) ((1 ldv) (1 *)))
                   ldv)
 label50))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil info))))))
```

———-

6.5 dgebal LAPACK

— **dgebal.input** —

```
)set break resume
)sys rm -f dgebal.output
)spool dgebal.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dgebal.help** —

```
=============================================================
dgebal examples
=============================================================

=============================================================
Man Page Details
=============================================================

NAME
       DGEBAL - a general real matrix A

SYNOPSIS
       SUBROUTINE DGEBAL( JOB, N, A, LDA, ILO, IHI, SCALE, INFO )

           CHARACTER      JOB

           INTEGER        IHI, ILO, INFO, LDA, N

           DOUBLE         PRECISION A( LDA, * ), SCALE( * )

PURPOSE
       DGEBAL balances a general real matrix A.  This involves, first, permut-
       ing A by a similarity transformation  to  isolate  eigenvalues  in  the
       first 1 to ILO-1 and last IHI+1 to N elements on the diagonal; and sec-
       ond, applying a diagonal similarity transformation to rows and  columns
       ILO  to  IHI to make the rows and columns as close in norm as possible.
       Both steps are optional.

       Balancing may reduce the 1-norm of the matrix, and improve the accuracy
       of the computed eigenvalues and/or eigenvectors.


ARGUMENTS
       JOB     (input) CHARACTER*1
               Specifies the operations to be performed on A:
               =  'N':  none:  simply set ILO = 1, IHI = N, SCALE(I) = 1.0 for
               i = 1,...,N; = 'P':  permute only;
               = 'S':  scale only;
               = 'B':  both permute and scale.

       N       (input) INTEGER
               The order of the matrix A.  N >= 0.

       A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
               On entry, the input matrix A.  On exit,  A  is  overwritten  by
               the  balanced  matrix.  If JOB = 'N', A is not referenced.  See
               Further Details.  LDA     (input) INTEGER The leading dimension
               of the array A.  LDA >= max(1,N).

       ILO     (output) INTEGER
```

```
            IHI      (output)  INTEGER ILO and IHI are set to integers such
            that on exit A(i,j) = 0 if i > j and j =  1,...,ILO-1  or  I  =
            IHI+1,...,N.  If JOB = 'N' or 'S', ILO = 1 and IHI = N.

      SCALE   (output) DOUBLE PRECISION array, dimension (N)
            Details  of  the permutations and scaling factors applied to A.
            If P(j) is the index of the row and  column  interchanged  with
            row  and column j and D(j) is the scaling factor applied to row
            and column j, then SCALE(j) = P(j)    for  j  =  1,...,ILO-1  =
            D(j)    for j = ILO,...,IHI = P(j)    for j = IHI+1,...,N.  The
            order in which the interchanges are made is N to IHI+1, then  1
            to ILO-1.

      INFO    (output) INTEGER
            = 0:  successful exit.
            < 0:  if INFO = -i, the i-th argument had an illegal value.

FURTHER DETAILS
      The  permutations  consist of row and column interchanges which put the
      matrix in the form

                 ( T1   X   Y  )
         P A P = (  0   B   Z  )
                 (  0   0   T2 )

      where T1 and T2 are upper triangular  matrices  whose  eigenvalues  lie
      along  the  diagonal.  The column indices ILO and IHI mark the starting
      and ending columns of the submatrix B. Balancing consists of applying a
      diagonal  similarity  transformation inv(D) * B * D to make the 1-norms
      of each row of B and its corresponding column nearly equal.  The output
      matrix is

         ( T1     X*D          Y    )
         (  0  inv(D)*B*D  inv(D)*Z ).
         (  0      0           T2   )

      Information  about  the  permutations  P  and  the diagonal matrix D is
      returned in the vector SCALE.

      This subroutine is based on the EISPACK routine BALANC.

  Modified by Tzu-Yi Chen, Computer Science Division, University of
    California at Berkeley, USA
```

— dgebal.f —

```
      SUBROUTINE DGEBAL( JOB, N, A, LDA, ILO, IHI, SCALE, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      CHARACTER          JOB
      INTEGER            IHI, ILO, INFO, LDA, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), SCALE( * )
*     ..
*
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0 )
      DOUBLE PRECISION   SCLFAC
      PARAMETER          ( SCLFAC = 0.8D+1 )
      DOUBLE PRECISION   FACTOR
      PARAMETER          ( FACTOR = 0.95D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            NOCONV
      INTEGER            I, ICA, IEXC, IRA, J, K, L, M
      DOUBLE PRECISION   C, CA, F, G, R, RA, S, SFMAX1, SFMAX2, SFMIN1,
     $                   SFMIN2
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      INTEGER            IDAMAX
      DOUBLE PRECISION   DLAMCH
      EXTERNAL           LSAME, IDAMAX, DLAMCH
*     ..
*     .. External Subroutines ..
      EXTERNAL           DSCAL, DSWAP, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters
*
      INFO = 0
      IF( .NOT.LSAME( JOB, 'N' ) .AND. .NOT.LSAME( JOB, 'P' ) .AND.
```

```
     $    .NOT.LSAME( JOB, 'S' ) .AND. .NOT.LSAME( JOB, 'B' ) ) THEN
          INFO = -1
        ELSE IF( N.LT.0 ) THEN
          INFO = -2
        ELSE IF( LDA.LT.MAX( 1, N ) ) THEN
          INFO = -4
        END IF
        IF( INFO.NE.0 ) THEN
          CALL XERBLA( 'DGEBAL', -INFO )
          RETURN
        END IF
*
        K = 1
        L = N
*
        IF( N.EQ.0 )
     $    GO TO 210
*
        IF( LSAME( JOB, 'N' ) ) THEN
          DO 10 I = 1, N
            SCALE( I ) = ONE
   10     CONTINUE
          GO TO 210
        END IF
*
        IF( LSAME( JOB, 'S' ) )
     $    GO TO 120
*
*       Permutation to isolate eigenvalues if possible
*
        GO TO 50
*
*       Row and column exchange.
*
   20   CONTINUE
        SCALE( M ) = J
        IF( J.EQ.M )
     $    GO TO 30
*
        CALL DSWAP( L, A( 1, J ), 1, A( 1, M ), 1 )
        CALL DSWAP( N-K+1, A( J, K ), LDA, A( M, K ), LDA )
*
   30   CONTINUE
        GO TO ( 40, 80 )IEXC
*
*       Search for rows isolating an eigenvalue and push them down.
*
   40   CONTINUE
        IF( L.EQ.1 )
     $    GO TO 210
```

```
      L = L - 1
*
   50 CONTINUE
      DO 70 J = L, 1, -1
*
         DO 60 I = 1, L
            IF( I.EQ.J )
     $         GO TO 60
            IF( A( J, I ).NE.ZERO )
     $         GO TO 70
   60    CONTINUE
*
         M = L
         IEXC = 1
         GO TO 20
   70 CONTINUE
*
      GO TO 90
*
*     Search for columns isolating an eigenvalue and push them left.
*
   80 CONTINUE
      K = K + 1
*
   90 CONTINUE
      DO 110 J = K, L
*
         DO 100 I = K, L
            IF( I.EQ.J )
     $         GO TO 100
            IF( A( I, J ).NE.ZERO )
     $         GO TO 110
  100    CONTINUE
*
         M = K
         IEXC = 2
         GO TO 20
  110 CONTINUE
*
  120 CONTINUE
      DO 130 I = K, L
         SCALE( I ) = ONE
  130 CONTINUE
*
      IF( LSAME( JOB, 'P' ) )
     $   GO TO 210
*
*     Balance the submatrix in rows K to L.
*
*     Iterative loop for norm reduction
```

```
*
      SFMIN1 = DLAMCH( 'S' ) / DLAMCH( 'P' )
      SFMAX1 = ONE / SFMIN1
      SFMIN2 = SFMIN1*SCLFAC
      SFMAX2 = ONE / SFMIN2
  140 CONTINUE
      NOCONV = .FALSE.
*
      DO 200 I = K, L
         C = ZERO
         R = ZERO
*
         DO 150 J = K, L
            IF( J.EQ.I )
     $         GO TO 150
            C = C + ABS( A( J, I ) )
            R = R + ABS( A( I, J ) )
  150    CONTINUE
         ICA = IDAMAX( L, A( 1, I ), 1 )
         CA = ABS( A( ICA, I ) )
         IRA = IDAMAX( N-K+1, A( I, K ), LDA )
         RA = ABS( A( I, IRA+K-1 ) )
*
*        Guard against zero C or R due to underflow.
*
         IF( C.EQ.ZERO .OR. R.EQ.ZERO )
     $      GO TO 200
         G = R / SCLFAC
         F = ONE
         S = C + R
  160    CONTINUE
         IF( C.GE.G .OR. MAX( F, C, CA ).GE.SFMAX2 .OR.
     $       MIN( R, G, RA ).LE.SFMIN2 )GO TO 170
         F = F*SCLFAC
         C = C*SCLFAC
         CA = CA*SCLFAC
         R = R / SCLFAC
         G = G / SCLFAC
         RA = RA / SCLFAC
         GO TO 160
*
  170    CONTINUE
         G = C / SCLFAC
  180    CONTINUE
         IF( G.LT.R .OR. MAX( R, RA ).GE.SFMAX2 .OR.
     $       MIN( F, C, G, CA ).LE.SFMIN2 )GO TO 190
         F = F / SCLFAC
         C = C / SCLFAC
         G = G / SCLFAC
         CA = CA / SCLFAC
```

```
         R = R*SCLFAC
         RA = RA*SCLFAC
         GO TO 180
*
*        Now balance.
*
  190    CONTINUE
         IF( ( C+R ).GE.FACTOR*S )
     $      GO TO 200
         IF( F.LT.ONE .AND. SCALE( I ).LT.ONE ) THEN
            IF( F*SCALE( I ).LE.SFMIN1 )
     $         GO TO 200
         END IF
         IF( F.GT.ONE .AND. SCALE( I ).GT.ONE ) THEN
            IF( SCALE( I ).GE.SFMAX1 / F )
     $         GO TO 200
         END IF
         G = ONE / F
         SCALE( I ) = SCALE( I )*F
         NOCONV = .TRUE.
*
         CALL DSCAL( N-K+1, G, A( I, K ), LDA )
         CALL DSCAL( L, F, A( 1, I ), 1 )
*
  200 CONTINUE
*
      IF( NOCONV )
     $   GO TO 140
*
  210 CONTINUE
      ILO = K
      IHI = L
*
      RETURN
*
*     End of DGEBAL
*
      END
```

———-

— LAPACK dgebal —

```
(let* ((zero 0.0) (one 1.0) (sclfac 8.0) (factor 0.95))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one)
           (type (double-float 8.0 8.0) sclfac)
           (type (double-float 0.95 0.95) factor))
```

```
 (defun dgebal (job n a lda ilo ihi scale info)
   (declare (type (simple-array double-float (*)) scale a)
            (type fixnum info ihi ilo lda n)
            (type character job))
   (f2cl-lib:with-multi-array-data
       ((job character job-%data% job-%offset%)
        (a double-float a-%data% a-%offset%)
        (scale double-float scale-%data% scale-%offset%))
     (prog ((c 0.0) (ca 0.0) (f 0.0) (g 0.0) (r 0.0) (ra 0.0) (s 0.0)
            (sfmax1 0.0) (sfmax2 0.0) (sfmin1 0.0) (sfmin2 0.0) (i 0) (ica 0)
            (iexc 0) (ira 0) (j 0) (k 0) (l 0) (m 0) (noconv nil))
       (declare (type (double-float) c ca f g r ra s sfmax1 sfmax2 sfmin1
                                       sfmin2)
                (type fixnum i ica iexc ira j k l m)
                (type (member t nil) noconv))
       (setf info 0)
       (cond
         ((and (not (char-equal job #\N))
               (not (char-equal job #\P))
               (not (char-equal job #\S))
               (not (char-equal job #\B)))
          (setf info -1))
         ((< n 0)
          (setf info -2))
         ((< lda (max (the fixnum 1) (the fixnum n)))
          (setf info -4)))
       (cond
         ((/= info 0)
          (error
           " ** On entry to ~a parameter number ~a had an illegal value~%"
           "DGEBAL" (f2cl-lib:int-sub info))
          (go end_label)))
       (setf k 1)
       (setf l n)
       (if (= n 0) (go label210))
       (cond
         ((char-equal job #\N)
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i n) nil)
            (tagbody
              (setf (f2cl-lib:fref scale-%data% (i) ((1 *)) scale-%offset%)
                      one)))
          (go label210)))
       (if (char-equal job #\S) (go label120))
       (go label50)
label20
       (setf (f2cl-lib:fref scale-%data% (m) ((1 *)) scale-%offset%)
             (coerce (the fixnum j) 'double-float))
       (if (= j m) (go label30))
       (dswap l (f2cl-lib:array-slice a double-float (1 j) ((1 lda) (1 *))) 1
```

```
         (f2cl-lib:array-slice a double-float (1 m) ((1 lda) (1 *))) 1)
        (dswap (f2cl-lib:int-add (f2cl-lib:int-sub n k) 1)
         (f2cl-lib:array-slice a double-float (j k) ((1 lda) (1 *))) lda
         (f2cl-lib:array-slice a double-float (m k) ((1 lda) (1 *))) lda)
label30
        (f2cl-lib:computed-goto (label40 label80) iexc)
label40
        (if (= l 1) (go label210))
        (setf l (f2cl-lib:int-sub l 1))
label50
        (f2cl-lib:fdo (j l (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                      ((> j 1) nil)
          (tagbody
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          ((> i l) nil)
              (tagbody
                (if (= i j) (go label60))
                (if
                 (/= (f2cl-lib:fref a-%data% (j i) ((1 lda) (1 *)) a-%offset%)
                     zero)
                 (go label70))
label60))
            (setf m l)
            (setf iexc 1)
            (go label20)
label70))
        (go label90)
label80
        (setf k (f2cl-lib:int-add k 1))
label90
        (f2cl-lib:fdo (j k (f2cl-lib:int-add j 1))
                      ((> j l) nil)
          (tagbody
            (f2cl-lib:fdo (i k (f2cl-lib:int-add i 1))
                          ((> i l) nil)
              (tagbody
                (if (= i j) (go label100))
                (if
                 (/= (f2cl-lib:fref a-%data% (i j) ((1 lda) (1 *)) a-%offset%)
                     zero)
                 (go label110))
label100))
            (setf m k)
            (setf iexc 2)
            (go label20)
label110))
label120
        (f2cl-lib:fdo (i k (f2cl-lib:int-add i 1))
                      ((> i l) nil)
          (tagbody
```

```
          (setf (f2cl-lib:fref scale-%data% (i) ((1 *)) scale-%offset%) one)))
       (if (char-equal job #\P) (go label210))
       (setf sfmin1 (/ (dlamch "S") (dlamch "P")))
       (setf sfmax1 (/ one sfmin1))
       (setf sfmin2 (* sfmin1 sclfac))
       (setf sfmax2 (/ one sfmin2))
label140
       (setf noconv nil)
       (f2cl-lib:fdo (i k (f2cl-lib:int-add i 1))
                     ((> i l) nil)
         (tagbody
           (setf c zero)
           (setf r zero)
           (f2cl-lib:fdo (j k (f2cl-lib:int-add j 1))
                         ((> j l) nil)
             (tagbody
               (if (= j i) (go label150))
               (setf c
                       (+ c
                          (abs
                           (f2cl-lib:fref a-%data%
                                          (j i)
                                          ((1 lda) (1 *))
                                          a-%offset%))))
               (setf r
                       (+ r
                          (abs
                           (f2cl-lib:fref a-%data%
                                          (i j)
                                          ((1 lda) (1 *))
                                          a-%offset%))))
label150))
           (setf ica
                   (idamax l
                    (f2cl-lib:array-slice a
                                          double-float
                                          (1 i)
                                          ((1 lda) (1 *)))
                    1))
           (setf ca
                   (abs
                    (f2cl-lib:fref a-%data%
                                   (ica i)
                                   ((1 lda) (1 *))
                                   a-%offset%)))
           (setf ira
                   (idamax (f2cl-lib:int-add (f2cl-lib:int-sub n k) 1)
                    (f2cl-lib:array-slice a
                                          double-float
                                          (i k)
```

```
                                        ((1 lda) (1 *)))
                 lda))
            (setf ra
                  (abs
                   (f2cl-lib:fref a-%data%
                                  (i
                                   (f2cl-lib:int-sub (f2cl-lib:int-add ira k)
                                                     1))
                                  ((1 lda) (1 *))
                                  a-%offset%)))
            (if (or (= c zero) (= r zero)) (go label200))
            (setf g (/ r sclfac))
            (setf f one)
            (setf s (+ c r))
label160
            (if (or (>= c g) (>= (max f c ca) sfmax2) (<= (min r g ra) sfmin2))
                (go label170))
            (setf f (* f sclfac))
            (setf c (* c sclfac))
            (setf ca (* ca sclfac))
            (setf r (/ r sclfac))
            (setf g (/ g sclfac))
            (setf ra (/ ra sclfac))
            (go label160)
label170
            (setf g (/ c sclfac))
label180
            (if (or (< g r) (>= (max r ra) sfmax2) (<= (min f c g ca) sfmin2))
                (go label190))
            (setf f (/ f sclfac))
            (setf c (/ c sclfac))
            (setf g (/ g sclfac))
            (setf ca (/ ca sclfac))
            (setf r (* r sclfac))
            (setf ra (* ra sclfac))
            (go label180)
label190
            (if (>= (+ c r) (* factor s)) (go label200))
            (cond
              ((and (< f one) (< (f2cl-lib:fref scale (i) ((1 *))) one))
               (if
                (<=
                 (* f (f2cl-lib:fref scale-%data% (i) ((1 *)) scale-%offset%))
                 sfmin1)
                (go label200))))
            (cond
              ((and (> f one) (> (f2cl-lib:fref scale (i) ((1 *))) one))
               (if
                (>= (f2cl-lib:fref scale-%data% (i) ((1 *)) scale-%offset%)
                    (/ sfmax1 f))
```

```
              (go label200))))
            (setf g (/ one f))
            (setf (f2cl-lib:fref scale-%data% (i) ((1 *)) scale-%offset%)
                    (* (f2cl-lib:fref scale-%data% (i) ((1 *)) scale-%offset%)
                       f))
            (setf noconv t)
            (dscal (f2cl-lib:int-add (f2cl-lib:int-sub n k) 1) g
             (f2cl-lib:array-slice a double-float (i k) ((1 lda) (1 *))) lda)
            (dscal l f
             (f2cl-lib:array-slice a double-float (1 i) ((1 lda) (1 *))) 1)
 label200))
        (if noconv (go label140))
 label210
        (setf ilo k)
        (setf ihi l)
 end_label
        (return (values nil nil nil nil ilo ihi nil info))))))
```

———-

6.6 dgebd2 LAPACK

— **dgebd2.input** —

```
)set break resume
)sys rm -f dgebd2.output
)spool dgebd2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dgebd2.help** —

```
=====================================================================
dgebd2 examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================
```

```
NAME
       DGEBD2  -  a  real general m by n matrix A to upper or lower bidiagonal
       form B by an orthogonal transformation

SYNOPSIS
       SUBROUTINE DGEBD2( M, N, A, LDA, D, E, TAUQ, TAUP, WORK, INFO )

           INTEGER        INFO, LDA, M, N

           DOUBLE         PRECISION A( LDA, * ), D( * ), E( * ),  TAUP(  *  ),
                          TAUQ( * ), WORK( * )

PURPOSE
       DGEBD2 reduces a real general m by n matrix A to upper or lower bidiag-
       onal form B by an orthogonal transformation: Q' * A * P = B.

       If m >= n, B is upper bidiagonal; if m < n, B is lower bidiagonal.


ARGUMENTS
       M       (input) INTEGER
               The number of rows in the matrix A.  M >= 0.

       N       (input) INTEGER
               The number of columns in the matrix A.  N >= 0.

       A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
               On entry, the m by n general matrix to be reduced.  On exit, if
               m  >= n, the diagonal and the first superdiagonal are overwrit-
               ten with the upper bidiagonal matrix B; the elements below  the
               diagonal,  with the array TAUQ, represent the orthogonal matrix
               Q as a product of elementary reflectors, and the elements above
               the  first  superdiagonal,  with  the array TAUP, represent the
               orthogonal matrix P as a product of elementary reflectors; if m
               <  n,  the  diagonal  and the first subdiagonal are overwritten
               with the lower bidiagonal matrix  B;  the  elements  below  the
               first  subdiagonal, with the array TAUQ, represent the orthogo-
               nal matrix Q as a product of  elementary  reflectors,  and  the
               elements above the diagonal, with the array TAUP, represent the
               orthogonal matrix P as a product of elementary reflectors.  See
               Further Details.  LDA     (input) INTEGER The leading dimension
               of the array A.  LDA >= max(1,M).

       D       (output) DOUBLE PRECISION array, dimension (min(M,N))
               The diagonal elements  of  the  bidiagonal  matrix  B:  D(i)  =
               A(i,i).

       E       (output) DOUBLE PRECISION array, dimension (min(M,N)-1)
               The  off-diagonal  elements of the bidiagonal matrix B: if m >=
```

```
          n, E(i) = A(i,i+1) for i =  1,2,...,n-1;  if  m  <  n,  E(i)  =
          A(i+1,i) for i = 1,2,...,m-1.

      TAUQ    (output) DOUBLE PRECISION array dimension (min(M,N))
              The scalar factors of the elementary reflectors which represent
              the orthogonal matrix Q. See Further Details.  TAUP    (output)
              DOUBLE PRECISION array, dimension (min(M,N)) The scalar factors
              of the elementary reflectors  which  represent  the  orthogonal
              matrix P. See Further Details.  WORK    (workspace) DOUBLE PRE-
              CISION array, dimension (max(M,N))

      INFO    (output) INTEGER
              = 0: successful exit.
              < 0: if INFO = -i, the i-th argument had an illegal value.

FURTHER DETAILS
      The matrices Q and P are represented as products of elementary  reflec-
      tors:

      If m >= n,

         Q = H(1) H(2) . . . H(n)  and  P = G(1) G(2) . . . G(n-1)

      Each H(i) and G(i) has the form:

         H(i) = I - tauq * v * v'  and G(i) = I - taup * u * u'

      where  tauq  and  taup  are real scalars, and v and u are real vectors;
      v(1:i-1) = 0, v(i) = 1, and v(i+1:m) is stored on exit  in  A(i+1:m,i);
      u(1:i)  =  0, u(i+1) = 1, and u(i+2:n) is stored on exit in A(i,i+2:n);
      tauq is stored in TAUQ(i) and taup in TAUP(i).

      If m < n,

         Q = H(1) H(2) . . . H(m-1)  and  P = G(1) G(2) . . . G(m)

      Each H(i) and G(i) has the form:

         H(i) = I - tauq * v * v'  and G(i) = I - taup * u * u'

      where tauq and taup are real scalars, and v and  u  are  real  vectors;
      v(1:i)  =  0, v(i+1) = 1, and v(i+2:m) is stored on exit in A(i+2:m,i);
      u(1:i-1) = 0, u(i) = 1, and u(i+1:n) is stored on exit  in  A(i,i+1:n);
      tauq is stored in TAUQ(i) and taup in TAUP(i).

      The contents of A on exit are illustrated by the following examples:

      m = 6 and n = 5 (m > n):          m = 5 and n = 6 (m < n):

        (  d   e   u1  u1  u1 )           (  d   u1  u1  u1  u1  u1 )
```

```
  (  v1  d   e   u2  u2 )          (  e   d   u2  u2  u2  u2 )
  (  v1  v2  d   e   u3 )          (  v1  e   d   u3  u3  u3 )
  (  v1  v2  v3  d   e  )          (  v1  v2  e   d   u4  u4 )
  (  v1  v2  v3  v4  d  )          (  v1  v2  v3  e   d   u5 )
  (  v1  v2  v3  v4  v5 )
```

where d and e denote diagonal and off-diagonal elements of B, vi denotes an element of the vector defining H(i), and ui an element of the vector defining G(i).

———-

— **dgebd2.f** —

```
      SUBROUTINE DGEBD2( M, N, A, LDA, D, E, TAUQ, TAUP, WORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     February 29, 1992
*
*     .. Scalar Arguments ..
      INTEGER            INFO, LDA, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), D( * ), E( * ), TAUP( * ),
     $                   TAUQ( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLARF, DLARFG, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters
*
```

```
      INFO = 0
      IF( M.LT.0 ) THEN
         INFO = -1
      ELSE IF( N.LT.0 ) THEN
         INFO = -2
      ELSE IF( LDA.LT.MAX( 1, M ) ) THEN
         INFO = -4
      END IF
      IF( INFO.LT.0 ) THEN
         CALL XERBLA( 'DGEBD2', -INFO )
         RETURN
      END IF
*
      IF( M.GE.N ) THEN
*
*        Reduce to upper bidiagonal form
*
         DO 10 I = 1, N
*
*           Generate elementary reflector H(i) to annihilate A(i+1:m,i)
*
            CALL DLARFG( M-I+1, A( I, I ), A( MIN( I+1, M ), I ), 1,
     $                   TAUQ( I ) )
            D( I ) = A( I, I )
            A( I, I ) = ONE
*
*           Apply H(i) to A(i:m,i+1:n) from the left
*
            CALL DLARF( 'Left', M-I+1, N-I, A( I, I ), 1, TAUQ( I ),
     $                  A( I, I+1 ), LDA, WORK )
            A( I, I ) = D( I )
*
            IF( I.LT.N ) THEN
*
*              Generate elementary reflector G(i) to annihilate
*              A(i,i+2:n)
*
               CALL DLARFG( N-I, A( I, I+1 ), A( I, MIN( I+2, N ) ),
     $                      LDA, TAUP( I ) )
               E( I ) = A( I, I+1 )
               A( I, I+1 ) = ONE
*
*              Apply G(i) to A(i+1:m,i+1:n) from the right
*
               CALL DLARF( 'Right', M-I, N-I, A( I, I+1 ), LDA,
     $                     TAUP( I ), A( I+1, I+1 ), LDA, WORK )
               A( I, I+1 ) = E( I )
            ELSE
               TAUP( I ) = ZERO
            END IF
```

```
   10    CONTINUE
      ELSE
*
*        Reduce to lower bidiagonal form
*
         DO 20 I = 1, M
*
*           Generate elementary reflector G(i) to annihilate A(i,i+1:n)
*
            CALL DLARFG( N-I+1, A( I, I ), A( I, MIN( I+1, N ) ), LDA,
     $                   TAUP( I ) )
            D( I ) = A( I, I )
            A( I, I ) = ONE
*
*           Apply G(i) to A(i+1:m,i:n) from the right
*
            CALL DLARF( 'Right', M-I, N-I+1, A( I, I ), LDA, TAUP( I ),
     $                  A( MIN( I+1, M ), I ), LDA, WORK )
            A( I, I ) = D( I )
*
            IF( I.LT.M ) THEN
*
*              Generate elementary reflector H(i) to annihilate
*              A(i+2:m,i)
*
               CALL DLARFG( M-I, A( I+1, I ), A( MIN( I+2, M ), I ), 1,
     $                      TAUQ( I ) )
               E( I ) = A( I+1, I )
               A( I+1, I ) = ONE
*
*              Apply H(i) to A(i+1:m,i+1:n) from the left
*
               CALL DLARF( 'Left', M-I, N-I, A( I+1, I ), 1, TAUQ( I ),
     $                     A( I+1, I+1 ), LDA, WORK )
               A( I+1, I ) = E( I )
            ELSE
               TAUQ( I ) = ZERO
            END IF
   20    CONTINUE
      END IF
      RETURN
*
*     End of DGEBD2
*
      END
```

— LAPACK dgebd2 —

```
(let* ((zero 0.0) (one 1.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one))
  (defun dgebd2 (m n a lda d e tauq taup work info)
    (declare (type (simple-array double-float (*)) work taup tauq e d a)
             (type fixnum info lda n m))
    (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (d double-float d-%data% d-%offset%)
         (e double-float e-%data% e-%offset%)
         (tauq double-float tauq-%data% tauq-%offset%)
         (taup double-float taup-%data% taup-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((i 0))
        (declare (type fixnum i))
        (setf info 0)
        (cond
          ((< m 0)
           (setf info -1))
          ((< n 0)
           (setf info -2))
          ((< lda (max (the fixnum 1) (the fixnum m)))
           (setf info -4)))
        (cond
          ((< info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DGEBD2" (f2cl-lib:int-sub info))
           (go end_label)))
        (cond
          ((>= m n)
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i n) nil)
             (tagbody
               (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
                   (dlarfg (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
                    (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
                    (f2cl-lib:array-slice a
                                          double-float
                                          ((min (f2cl-lib:int-add i 1) m) i)
                                          ((1 lda) (1 *)))
                    1 (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%))
                 (declare (ignore var-0 var-2 var-3))
                 (setf (f2cl-lib:fref a-%data%
                                      (i i)
                                      ((1 lda) (1 *))
                                      a-%offset%)
                       var-1)
```

```
  (setf (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%)
          var-4))
(setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
        (f2cl-lib:fref a-%data%
                       (i i)
                       ((1 lda) (1 *))
                       a-%offset%))
(setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
        one)
(dlarf "Left" (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
 (f2cl-lib:int-sub n i)
 (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) 1
 (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%)
 (f2cl-lib:array-slice a
                       double-float
                       (i (f2cl-lib:int-add i 1))
                       ((1 lda) (1 *)))
 lda work)
(setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
        (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
(cond
  ((< i n)
   (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
       (dlarfg (f2cl-lib:int-sub n i)
        (f2cl-lib:fref a-%data%
                       (i (f2cl-lib:int-add i 1))
                       ((1 lda) (1 *))
                       a-%offset%)
        (f2cl-lib:array-slice a
                              double-float
                              (i
                               (min
                                (the fixnum
                                     (f2cl-lib:int-add i 2))
                                (the fixnum n)))
                              ((1 lda) (1 *)))
        lda
        (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%))
     (declare (ignore var-0 var-2 var-3))
     (setf (f2cl-lib:fref a-%data%
                          (i (f2cl-lib:int-add i 1))
                          ((1 lda) (1 *))
                          a-%offset%)
           var-1)
     (setf (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%)
           var-4))
   (setf (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)
         (f2cl-lib:fref a-%data%
                        (i (f2cl-lib:int-add i 1))
                        ((1 lda) (1 *))
```

```
                                a-%offset%))
                 (setf (f2cl-lib:fref a-%data%
                                      (i (f2cl-lib:int-add i 1))
                                      ((1 lda) (1 *))
                                      a-%offset%)
                       one)
                 (dlarf "Right" (f2cl-lib:int-sub m i) (f2cl-lib:int-sub n i)
                  (f2cl-lib:array-slice a
                                        double-float
                                        (i (f2cl-lib:int-add i 1))
                                        ((1 lda) (1 *)))
                  lda (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%)
                  (f2cl-lib:array-slice a
                                        double-float
                                        ((+ i 1) (f2cl-lib:int-add i 1))
                                        ((1 lda) (1 *)))
                  lda work)
                 (setf (f2cl-lib:fref a-%data%
                                      (i (f2cl-lib:int-add i 1))
                                      ((1 lda) (1 *))
                                      a-%offset%)
                       (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)))
                (t
                 (setf (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%)
                       zero))))))
        (t
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i m) nil)
           (tagbody
             (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
                 (dlarfg (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
                  (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
                  (f2cl-lib:array-slice a
                                        double-float
                                        (i
                                         (min
                                          (the fixnum
                                               (f2cl-lib:int-add i 1))
                                          (the fixnum n)))
                                        ((1 lda) (1 *)))
                  lda (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%))
               (declare (ignore var-0 var-2 var-3))
               (setf (f2cl-lib:fref a-%data%
                                    (i i)
                                    ((1 lda) (1 *))
                                    a-%offset%)
                     var-1)
               (setf (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%)
                     var-4))
             (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
```

```
        (f2cl-lib:fref a-%data%
                       (i i)
                       ((1 lda) (1 *))
                       a-%offset%))
(setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
        one)
(dlarf "Right" (f2cl-lib:int-sub m i)
 (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
 (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
 (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%)
 (f2cl-lib:array-slice a
                       double-float
                       ((min (f2cl-lib:int-add i 1) m) i)
                       ((1 lda) (1 *)))
 lda work)
(setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
        (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
(cond
  ((< i m)
   (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
       (dlarfg (f2cl-lib:int-sub m i)
        (f2cl-lib:fref a-%data%
                       ((f2cl-lib:int-add i 1) i)
                       ((1 lda) (1 *))
                       a-%offset%)
        (f2cl-lib:array-slice a
                              double-float
                              ((min (f2cl-lib:int-add i 2) m) i)
                              ((1 lda) (1 *)))
        1 (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%))
     (declare (ignore var-0 var-2 var-3))
     (setf (f2cl-lib:fref a-%data%
                          ((f2cl-lib:int-add i 1) i)
                          ((1 lda) (1 *))
                          a-%offset%)
             var-1)
     (setf (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%)
             var-4))
   (setf (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)
           (f2cl-lib:fref a-%data%
                          ((f2cl-lib:int-add i 1) i)
                          ((1 lda) (1 *))
                          a-%offset%))
   (setf (f2cl-lib:fref a-%data%
                        ((f2cl-lib:int-add i 1) i)
                        ((1 lda) (1 *))
                        a-%offset%)
           one)
   (dlarf "Left" (f2cl-lib:int-sub m i) (f2cl-lib:int-sub n i)
    (f2cl-lib:array-slice a
```

```
                                    double-float
                                    ((+ i 1) i)
                                    ((1 lda) (1 *)))
                  1 (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%)
                  (f2cl-lib:array-slice a
                                    double-float
                                    ((+ i 1) (f2cl-lib:int-add i 1))
                                    ((1 lda) (1 *)))
                  lda work)
                 (setf (f2cl-lib:fref a-%data%
                                      ((f2cl-lib:int-add i 1) i)
                                      ((1 lda) (1 *))
                                      a-%offset%)
                       (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)))
                (t
                 (setf (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%)
                       zero)))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil info))))))
```

———-

6.7 dgebrd LAPACK

— **dgebrd.input** —

```
)set break resume
)sys rm -f dgebrd.output
)spool dgebrd.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dgebrd.help** —

```
======================================================================
dgebrd examples
======================================================================

======================================================================
```

```
Man Page Details
=================================================================

NAME
       DGEBRD  -  a  general real M-by-N matrix A to upper or lower bidiagonal
       form B by an orthogonal transformation

SYNOPSIS
       SUBROUTINE DGEBRD( M, N, A, LDA, D, E, TAUQ, TAUP, WORK, LWORK, INFO )

           INTEGER        INFO, LDA, LWORK, M, N

           DOUBLE         PRECISION A( LDA, * ), D( * ), E( * ),  TAUP(  *  ),
                          TAUQ( * ), WORK( * )

PURPOSE
       DGEBRD reduces a general real M-by-N matrix A to upper or lower bidiag-
       onal form B by an orthogonal transformation: Q**T * A * P = B.

       If m >= n, B is upper bidiagonal; if m < n, B is lower bidiagonal.


ARGUMENTS
       M       (input) INTEGER
               The number of rows in the matrix A.  M >= 0.

       N       (input) INTEGER
               The number of columns in the matrix A.  N >= 0.

       A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
               On entry, the M-by-N general matrix to be reduced.  On exit, if
               m  >= n, the diagonal and the first superdiagonal are overwrit-
               ten with the upper bidiagonal matrix B; the elements below  the
               diagonal,  with the array TAUQ, represent the orthogonal matrix
               Q as a product of elementary reflectors, and the elements above
               the  first  superdiagonal,  with  the array TAUP, represent the
               orthogonal matrix P as a product of elementary reflectors; if m
               <  n,  the  diagonal  and the first subdiagonal are overwritten
               with the lower bidiagonal matrix  B;  the  elements  below  the
               first  subdiagonal, with the array TAUQ, represent the orthogo-
               nal matrix Q as a product of  elementary  reflectors,  and  the
               elements above the diagonal, with the array TAUP, represent the
               orthogonal matrix P as a product of elementary reflectors.  See
               Further Details.  LDA     (input) INTEGER The leading dimension
               of the array A.  LDA >= max(1,M).

       D       (output) DOUBLE PRECISION array, dimension (min(M,N))
               The diagonal elements  of  the  bidiagonal  matrix  B:  D(i)  =
               A(i,i).
```

```
       E       (output) DOUBLE PRECISION array, dimension (min(M,N)-1)
               The  off-diagonal  elements of the bidiagonal matrix B: if m >=
               n, E(i) = A(i,i+1) for i =  1,2,...,n-1;  if  m  <  n,  E(i)  =
               A(i+1,i) for i = 1,2,...,m-1.

       TAUQ    (output) DOUBLE PRECISION array dimension (min(M,N))
               The scalar factors of the elementary reflectors which represent
               the orthogonal matrix Q. See Further Details.  TAUP    (output)
               DOUBLE PRECISION array, dimension (min(M,N)) The scalar factors
               of the elementary reflectors  which  represent  the  orthogonal
               matrix P. See Further Details.  WORK    (workspace/output) DOU-
               BLE PRECISION array, dimension (MAX(1,LWORK)) On exit, if  INFO
               = 0, WORK(1) returns the optimal LWORK.

       LWORK   (input) INTEGER
               The  length of the array WORK.  LWORK >= max(1,M,N).  For opti-
               mum performance LWORK >= (M+N)*NB,  where  NB  is  the  optimal
               blocksize.

               If  LWORK  = -1, then a workspace query is assumed; the routine
               only calculates the optimal size of  the  WORK  array,  returns
               this  value  as the first entry of the WORK array, and no error
               message related to LWORK is issued by XERBLA.

       INFO    (output) INTEGER
               = 0:  successful exit
               < 0:  if INFO = -i, the i-th argument had an illegal value.

FURTHER DETAILS
       The matrices Q and P are represented as products of elementary  reflec-
       tors:

       If m >= n,

          Q = H(1) H(2) . . . H(n)  and  P = G(1) G(2) . . . G(n-1)

       Each H(i) and G(i) has the form:

          H(i) = I - tauq * v * v'  and G(i) = I - taup * u * u'

       where  tauq  and  taup  are real scalars, and v and u are real vectors;
       v(1:i-1) = 0, v(i) = 1, and v(i+1:m) is stored on exit  in  A(i+1:m,i);
       u(1:i)  =  0, u(i+1) = 1, and u(i+2:n) is stored on exit in A(i,i+2:n);
       tauq is stored in TAUQ(i) and taup in TAUP(i).

       If m < n,

          Q = H(1) H(2) . . . H(m-1)  and  P = G(1) G(2) . . . G(m)

       Each H(i) and G(i) has the form:
```

```
   H(i) = I - tauq * v * v'  and G(i) = I - taup * u * u'

  where tauq and taup are real scalars, and v and  u  are  real  vectors;
  v(1:i)  =  0, v(i+1) = 1, and v(i+2:m) is stored on exit in A(i+2:m,i);
  u(1:i-1) = 0, u(i) = 1, and u(i+1:n) is stored on exit  in  A(i,i+1:n);
  tauq is stored in TAUQ(i) and taup in TAUP(i).

  The contents of A on exit are illustrated by the following examples:

  m = 6 and n = 5 (m > n):          m = 5 and n = 6 (m < n):

    (  d   e   u1  u1  u1 )           (  d   u1  u1  u1  u1  u1 )
    (  v1  d   e   u2  u2 )           (  e   d   u2  u2  u2  u2 )
    (  v1  v2  d   e   u3 )           (  v1  e   d   u3  u3  u3 )
    (  v1  v2  v3  d   e  )           (  v1  v2  e   d   u4  u4 )
    (  v1  v2  v3  v4  d  )           (  v1  v2  v3  e   d   u5 )
    (  v1  v2  v3  v4  v5 )

  where  d  and  e  denote  diagonal  and  off-diagonal elements of B, vi
  denotes an element of the vector defining H(i), and ui  an  element  of
  the vector defining G(i).
```

— dgebrd.f —

```
      SUBROUTINE DGEBRD( M, N, A, LDA, D, E, TAUQ, TAUP, WORK, LWORK,
     $                   INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      INTEGER            INFO, LDA, LWORK, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), D( * ), E( * ), TAUP( * ),
     $                   TAUQ( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE
      PARAMETER          ( ONE = 1.0D+0 )
```

```
*     ..
*     .. Local Scalars ..
      LOGICAL            LQUERY
      INTEGER            I, IINFO, J, LDWRKX, LDWRKY, LWKOPT, MINMN, NB,
     $                   NBMIN, NX
      DOUBLE PRECISION   WS
*     ..
*     .. External Subroutines ..
      EXTERNAL           DGEBD2, DGEMM, DLABRD, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          DBLE, MAX, MIN
*     ..
*     .. External Functions ..
      INTEGER            ILAENV
      EXTERNAL           ILAENV
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters
*
      INFO = 0
      NB = MAX( 1, ILAENV( 1, 'DGEBRD', ' ', M, N, -1, -1 ) )
      LWKOPT = ( M+N )*NB
      WORK( 1 ) = DBLE( LWKOPT )
      LQUERY = ( LWORK.EQ.-1 )
      IF( M.LT.0 ) THEN
         INFO = -1
      ELSE IF( N.LT.0 ) THEN
         INFO = -2
      ELSE IF( LDA.LT.MAX( 1, M ) ) THEN
         INFO = -4
      ELSE IF( LWORK.LT.MAX( 1, M, N ) .AND. .NOT.LQUERY ) THEN
         INFO = -10
      END IF
      IF( INFO.LT.0 ) THEN
         CALL XERBLA( 'DGEBRD', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Quick return if possible
*
      MINMN = MIN( M, N )
      IF( MINMN.EQ.0 ) THEN
         WORK( 1 ) = 1
         RETURN
      END IF
*
```

```
      WS = MAX( M, N )
      LDWRKX = M
      LDWRKY = N
*
      IF( NB.GT.1 .AND. NB.LT.MINMN ) THEN
*
*        Set the crossover point NX.
*
         NX = MAX( NB, ILAENV( 3, 'DGEBRD', ' ', M, N, -1, -1 ) )
*
*        Determine when to switch from blocked to unblocked code.
*
         IF( NX.LT.MINMN ) THEN
            WS = ( M+N )*NB
            IF( LWORK.LT.WS ) THEN
*
*              Not enough work space for the optimal NB, consider using
*              a smaller block size.
*
               NBMIN = ILAENV( 2, 'DGEBRD', ' ', M, N, -1, -1 )
               IF( LWORK.GE.( M+N )*NBMIN ) THEN
                  NB = LWORK / ( M+N )
               ELSE
                  NB = 1
                  NX = MINMN
               END IF
            END IF
         END IF
      ELSE
         NX = MINMN
      END IF
*
      DO 30 I = 1, MINMN - NX, NB
*
*        Reduce rows and columns i:i+nb-1 to bidiagonal form and return
*        the matrices X and Y which are needed to update the unreduced
*        part of the matrix
*
         CALL DLABRD( M-I+1, N-I+1, NB, A( I, I ), LDA, D( I ), E( I ),
     $                TAUQ( I ), TAUP( I ), WORK, LDWRKX,
     $                WORK( LDWRKX*NB+1 ), LDWRKY )
*
*        Update the trailing submatrix A(i+nb:m,i+nb:n), using an update
*        of the form  A := A - V*Y' - X*U'
*
         CALL DGEMM( 'No transpose', 'Transpose', M-I-NB+1, N-I-NB+1,
     $               NB, -ONE, A( I+NB, I ), LDA,
     $               WORK( LDWRKX*NB+NB+1 ), LDWRKY, ONE,
     $               A( I+NB, I+NB ), LDA )
         CALL DGEMM( 'No transpose', 'No transpose', M-I-NB+1, N-I-NB+1,
```

```
     $              NB, -ONE, WORK( NB+1 ), LDWRKX, A( I, I+NB ), LDA,
     $              ONE, A( I+NB, I+NB ), LDA )
*
*        Copy diagonal and off-diagonal elements of B back into A
*
         IF( M.GE.N ) THEN
            DO 10 J = I, I + NB - 1
               A( J, J ) = D( J )
               A( J, J+1 ) = E( J )
   10       CONTINUE
         ELSE
            DO 20 J = I, I + NB - 1
               A( J, J ) = D( J )
               A( J+1, J ) = E( J )
   20       CONTINUE
         END IF
   30 CONTINUE
*
*     Use unblocked code to reduce the remainder of the matrix
*
      CALL DGEBD2( M-I+1, N-I+1, A( I, I ), LDA, D( I ), E( I ),
     $             TAUQ( I ), TAUP( I ), WORK, IINFO )
      WORK( 1 ) = WS
      RETURN
*
*     End of DGEBRD
*
      END
```

— LAPACK dgebrd —

```
(let* ((one 1.0))
  (declare (type (double-float 1.0 1.0) one))
  (defun dgebrd (m n a lda d e tauq taup work lwork info)
    (declare (type (simple-array double-float (*)) work taup tauq e d a)
             (type fixnum info lwork lda n m))
    (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (d double-float d-%data% d-%offset%)
         (e double-float e-%data% e-%offset%)
         (tauq double-float tauq-%data% tauq-%offset%)
         (taup double-float taup-%data% taup-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((ws 0.0) (i 0) (iinfo 0) (j 0) (ldwrkx 0) (ldwrky 0) (lwkopt 0)
             (minmn 0) (nb 0) (nbmin 0) (nx 0) (lquery nil))
        (declare (type (double-float) ws)
```

```
         (type fixnum i iinfo j ldwrkx ldwrky lwkopt minmn
                                    nb nbmin nx)
         (type (member t nil) lquery))
(setf info 0)
(setf nb
        (max (the fixnum 1)
             (the fixnum
                  (ilaenv 1 "DGEBRD" " " m n -1 -1))))
(setf lwkopt (f2cl-lib:int-mul (f2cl-lib:int-add m n) nb))
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
        (coerce (realpart lwkopt) 'double-float))
(setf lquery (coerce (= lwork -1) '(member t nil)))
(cond
  ((< m 0)
   (setf info -1))
  ((< n 0)
   (setf info -2))
  ((< lda (max (the fixnum 1) (the fixnum m)))
   (setf info -4))
  ((and
    (< lwork
       (max (the fixnum 1)
            (the fixnum m)
            (the fixnum n)))
    (not lquery))
   (setf info -10)))
(cond
  ((< info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DGEBRD" (f2cl-lib:int-sub info))
   (go end_label))
  (lquery
   (go end_label)))
(setf minmn (min (the fixnum m) (the fixnum n)))
(cond
  ((= minmn 0)
   (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
           (coerce (the fixnum 1) 'double-float))
   (go end_label)))
(setf ws
        (coerce
         (the fixnum
              (max (the fixnum m)
                   (the fixnum n)))
         'double-float))
(setf ldwrkx m)
(setf ldwrky n)
(cond
  ((and (> nb 1) (< nb minmn))
```

```
   (setf nx
         (max (the fixnum nb)
              (the fixnum
                   (ilaenv 3 "DGEBRD" " " m n -1 -1))))
   (cond
     ((< nx minmn)
      (setf ws
            (coerce
             (the fixnum
                  (f2cl-lib:int-mul (f2cl-lib:int-add m n) nb))
             'double-float))
      (cond
        ((< lwork ws)
         (setf nbmin (ilaenv 2 "DGEBRD" " " m n -1 -1))
         (cond
           ((>= lwork (f2cl-lib:int-mul (f2cl-lib:int-add m n) nbmin))
            (setf nb (the fixnum (truncate lwork (+ m n)))))
           (t
            (setf nb 1)
            (setf nx minmn))))))))
  (t
   (setf nx minmn)))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i nb))
              ((> i (f2cl-lib:int-add minmn (f2cl-lib:int-sub nx))) nil)
  (tagbody
    (dlabrd (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
     (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1) nb
     (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
     (f2cl-lib:array-slice d double-float (i) ((1 *)))
     (f2cl-lib:array-slice e double-float (i) ((1 *)))
     (f2cl-lib:array-slice tauq double-float (i) ((1 *)))
     (f2cl-lib:array-slice taup double-float (i) ((1 *))) work ldwrkx
     (f2cl-lib:array-slice work
                           double-float
                           ((+ (f2cl-lib:int-mul ldwrkx nb) 1))
                           ((1 *)))
     ldwrky)
    (dgemm "No transpose" "Transpose"
     (f2cl-lib:int-add (f2cl-lib:int-sub m i nb) 1)
     (f2cl-lib:int-add (f2cl-lib:int-sub n i nb) 1) nb (- one)
     (f2cl-lib:array-slice a double-float ((+ i nb) i) ((1 lda) (1 *)))
     lda
     (f2cl-lib:array-slice work
                           double-float
                           ((+ (f2cl-lib:int-mul ldwrkx nb) nb 1))
                           ((1 *)))
     ldwrky one
     (f2cl-lib:array-slice a
                           double-float
                           ((+ i nb) (f2cl-lib:int-add i nb))
```

```
                          ((1 lda) (1 *)))
         lda)
        (dgemm "No transpose" "No transpose"
         (f2cl-lib:int-add (f2cl-lib:int-sub m i nb) 1)
         (f2cl-lib:int-add (f2cl-lib:int-sub n i nb) 1) nb (- one)
         (f2cl-lib:array-slice work double-float ((+ nb 1)) ((1 *))) ldwrkx
         (f2cl-lib:array-slice a
                          double-float
                          (i (f2cl-lib:int-add i nb))
                          ((1 lda) (1 *)))
         lda one
         (f2cl-lib:array-slice a
                          double-float
                          ((+ i nb) (f2cl-lib:int-add i nb))
                          ((1 lda) (1 *)))
         lda)
        (cond
          ((>= m n)
           (f2cl-lib:fdo (j i (f2cl-lib:int-add j 1))
                         ((> j
                             (f2cl-lib:int-add i nb (f2cl-lib:int-sub 1)))
                          nil)
             (tagbody
               (setf (f2cl-lib:fref a-%data%
                                    (j j)
                                    ((1 lda) (1 *))
                                    a-%offset%)
                     (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%))
               (setf (f2cl-lib:fref a-%data%
                                    (j (f2cl-lib:int-add j 1))
                                    ((1 lda) (1 *))
                                    a-%offset%)
                     (f2cl-lib:fref e-%data% (j) ((1 *)) e-%offset%)))))
          (t
           (f2cl-lib:fdo (j i (f2cl-lib:int-add j 1))
                         ((> j
                             (f2cl-lib:int-add i nb (f2cl-lib:int-sub 1)))
                          nil)
             (tagbody
               (setf (f2cl-lib:fref a-%data%
                                    (j j)
                                    ((1 lda) (1 *))
                                    a-%offset%)
                     (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%))
               (setf (f2cl-lib:fref a-%data%
                                    ((f2cl-lib:int-add j 1) j)
                                    ((1 lda) (1 *))
                                    a-%offset%)
                     (f2cl-lib:fref e-%data% (j) ((1 *)) e-%offset%)))))))))
    (multiple-value-bind
```

```
            (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
           (dgebd2 (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
            (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
            (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
            (f2cl-lib:array-slice d double-float (i) ((1 *)))
            (f2cl-lib:array-slice e double-float (i) ((1 *)))
            (f2cl-lib:array-slice tauq double-float (i) ((1 *)))
            (f2cl-lib:array-slice taup double-float (i) ((1 *))) work iinfo)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                           var-8))
          (setf iinfo var-9))
        (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%) ws)
 end_label
        (return (values nil nil nil nil nil nil nil nil nil nil info))))))
```

———-

6.8 dgeev LAPACK

— dgeev.input —

```
)set break resume
)sys rm -f dgeev.output
)spool dgeev.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dgeev.help —

```
======================================================================
dgeev examples
======================================================================

======================================================================
Man Page Details
======================================================================

NAME
       DGEEV  - for an N-by-N real nonsymmetric matrix A, the eigenvalues and,
```

```
       optionally, the left and/or right eigenvectors

SYNOPSIS
       SUBROUTINE DGEEV( JOBVL, JOBVR, N, A, LDA, WR, WI, VL, LDVL, VR,  LDVR,
                         WORK, LWORK, INFO )

           CHARACTER     JOBVL, JOBVR

           INTEGER       INFO, LDA, LDVL, LDVR, LWORK, N

           DOUBLE        PRECISION  A( LDA, * ), VL( LDVL, * ), VR( LDVR, * ),
                         WI( * ), WORK( * ), WR( * )

PURPOSE
       DGEEV computes for an N-by-N real nonsymmetric matrix A, the  eigenval-
       ues and, optionally, the left and/or right eigenvectors.

       The right eigenvector v(j) of A satisfies
                        A * v(j) = lambda(j) * v(j)
       where lambda(j) is its eigenvalue.
       The left eigenvector u(j) of A satisfies
                     u(j)**H * A = lambda(j) * u(j)**H
       where u(j)**H denotes the conjugate transpose of u(j).

       The  computed  eigenvectors are normalized to have Euclidean norm equal
       to 1 and largest component real.


ARGUMENTS
       JOBVL   (input) CHARACTER*1
               = 'N': left eigenvectors of A are not computed;
               = 'V': left eigenvectors of A are computed.

       JOBVR   (input) CHARACTER*1
               = 'N': right eigenvectors of A are not computed;
               = 'V': right eigenvectors of A are computed.

       N       (input) INTEGER
               The order of the matrix A. N >= 0.

       A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
               On entry, the N-by-N matrix A.  On exit, A has  been  overwrit-
               ten.

       LDA     (input) INTEGER
               The leading dimension of the array A.  LDA >= max(1,N).

       WR      (output) DOUBLE PRECISION array, dimension (N)
               WI       (output)  DOUBLE PRECISION array, dimension (N) WR and
               WI contain the real and imaginary parts, respectively,  of  the
```

```
          computed  eigenvalues.  Complex conjugate pairs of eigenvalues
          appear consecutively with the eigenvalue  having  the  positive
          imaginary part first.

VL        (output) DOUBLE PRECISION array, dimension (LDVL,N)
          If JOBVL = 'V', the left eigenvectors u(j) are stored one after
          another in the columns of VL, in the same order as their eigen-
          values.  If  JOBVL  =  'N', VL is not referenced.  If the j-th
          eigenvalue is real, then u(j) = VL(:,j), the j-th column of VL.
          If  the  j-th and (j+1)-st eigenvalues form a complex conjugate
          pair, then u(j) = VL(:,j) + i*VL(:,j+1) and
          u(j+1) = VL(:,j) - i*VL(:,j+1).

LDVL      (input) INTEGER
          The leading dimension of the array VL.  LDVL >= 1; if  JOBVL  =
          'V', LDVL >= N.

VR        (output) DOUBLE PRECISION array, dimension (LDVR,N)
          If  JOBVR  =  'V',  the  right eigenvectors v(j) are stored one
          after another in the columns of VR, in the same order as  their
          eigenvalues.  If JOBVR = 'N', VR is not referenced.  If the j-
          th eigenvalue is real, then v(j) = VR(:,j), the j-th column  of
          VR.  If the j-th and (j+1)-st eigenvalues form a complex conju-
          gate pair, then v(j) = VR(:,j) + i*VR(:,j+1) and
          v(j+1) = VR(:,j) - i*VR(:,j+1).

LDVR      (input) INTEGER
          The leading dimension of the array VR.  LDVR >= 1; if  JOBVR  =
          'V', LDVR >= N.

WORK      (workspace/output)  DOUBLE  PRECISION  array,  dimension
(MAX(1,LWORK))
          On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

LWORK     (input) INTEGER
          The  dimension  of the array WORK.  LWORK >= max(1,3*N), and if
          JOBVL = 'V' or JOBVR = 'V', LWORK >=  4*N.  For  good  perfor-
          mance, LWORK must generally be larger.

          If  LWORK  = -1, then a workspace query is assumed; the routine
          only calculates the optimal size of  the  WORK  array,  returns
          this  value  as the first entry of the WORK array, and no error
          message related to LWORK is issued by XERBLA.

INFO      (output) INTEGER
          = 0:  successful exit
          < 0:  if INFO = -i, the i-th argument had an illegal value.
          > 0:  if INFO = i, the QR algorithm failed to compute  all  the
          eigenvalues,  and  no eigenvectors have been computed; elements
          i+1:N of WR and WI contain eigenvalues which have converged.
```

———-

— **dgeev.f** —

```
      SUBROUTINE DGEEV( JOBVL, JOBVR, N, A, LDA, WR, WI, VL, LDVL, VR,
     $                  LDVR, WORK, LWORK, INFO )
*
*  -- LAPACK driver routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     December 8, 1999
*
*     .. Scalar Arguments ..
      CHARACTER          JOBVL, JOBVR
      INTEGER            INFO, LDA, LDVL, LDVR, LWORK, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), VL( LDVL, * ), VR( LDVR, * ),
     $                   WI( * ), WORK( * ), WR( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D0, ONE = 1.0D0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            LQUERY, SCALEA, WANTVL, WANTVR
      CHARACTER          SIDE
      INTEGER            HSWORK, I, IBAL, IERR, IHI, ILO, ITAU, IWRK, K,
     $                   MAXB, MAXWRK, MINWRK, NOUT
      DOUBLE PRECISION   ANRM, BIGNUM, CS, CSCALE, EPS, R, SCL, SMLNUM,
     $                   SN
*     ..
*     .. Local Arrays ..
      LOGICAL            SELECT( 1 )
      DOUBLE PRECISION   DUM( 1 )
*     ..
*     .. External Subroutines ..
      EXTERNAL           DGEBAK, DGEBAL, DGEHRD, DHSEQR, DLACPY, DLARTG,
     $                   DLASCL, DORGHR, DROT, DSCAL, DTREVC, XERBLA
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      INTEGER            IDAMAX, ILAENV
      DOUBLE PRECISION   DLAMCH, DLANGE, DLAPY2, DNRM2
```

```
      EXTERNAL           LSAME, IDAMAX, ILAENV, DLAMCH, DLANGE, DLAPY2,
     $                   DNRM2
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN, SQRT
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      LQUERY = ( LWORK.EQ.-1 )
      WANTVL = LSAME( JOBVL, 'V' )
      WANTVR = LSAME( JOBVR, 'V' )
      IF( ( .NOT.WANTVL ) .AND. ( .NOT.LSAME( JOBVL, 'N' ) ) ) THEN
         INFO = -1
      ELSE IF( ( .NOT.WANTVR ) .AND. ( .NOT.LSAME( JOBVR, 'N' ) ) ) THEN
         INFO = -2
      ELSE IF( N.LT.0 ) THEN
         INFO = -3
      ELSE IF( LDA.LT.MAX( 1, N ) ) THEN
         INFO = -5
      ELSE IF( LDVL.LT.1 .OR. ( WANTVL .AND. LDVL.LT.N ) ) THEN
         INFO = -9
      ELSE IF( LDVR.LT.1 .OR. ( WANTVR .AND. LDVR.LT.N ) ) THEN
         INFO = -11
      END IF
*
*     Compute workspace
*      (Note: Comments in the code beginning "Workspace:" describe the
*       minimal amount of workspace needed at that point in the code,
*       as well as the preferred amount for good performance.
*       NB refers to the optimal block size for the immediately
*       following subroutine, as returned by ILAENV.
*       HSWORK refers to the workspace preferred by DHSEQR, as
*       calculated below. HSWORK is computed assuming ILO=1 and IHI=N,
*       the worst case.)
*
      MINWRK = 1
      IF( INFO.EQ.0 .AND. ( LWORK.GE.1 .OR. LQUERY ) ) THEN
         MAXWRK = 2*N + N*ILAENV( 1, 'DGEHRD', ' ', N, 1, N, 0 )
         IF( ( .NOT.WANTVL ) .AND. ( .NOT.WANTVR ) ) THEN
            MINWRK = MAX( 1, 3*N )
            MAXB = MAX( ILAENV( 8, 'DHSEQR', 'EN', N, 1, N, -1 ), 2 )
            K = MIN( MAXB, N, MAX( 2, ILAENV( 4, 'DHSEQR', 'EN', N, 1,
     $          N, -1 ) ) )
            HSWORK = MAX( K*( K+2 ), 2*N )
            MAXWRK = MAX( MAXWRK, N+1, N+HSWORK )
         ELSE
            MINWRK = MAX( 1, 4*N )
```

```
            MAXWRK = MAX( MAXWRK, 2*N+( N-1 )*
     $                   ILAENV( 1, 'DORGHR', ' ', N, 1, N, -1 ) )
            MAXB = MAX( ILAENV( 8, 'DHSEQR', 'SV', N, 1, N, -1 ), 2 )
            K = MIN( MAXB, N, MAX( 2, ILAENV( 4, 'DHSEQR', 'SV', N, 1,
     $          N, -1 ) ) )
            HSWORK = MAX( K*( K+2 ), 2*N )
            MAXWRK = MAX( MAXWRK, N+1, N+HSWORK )
            MAXWRK = MAX( MAXWRK, 4*N )
         END IF
         WORK( 1 ) = MAXWRK
      END IF
      IF( LWORK.LT.MINWRK .AND. .NOT.LQUERY ) THEN
         INFO = -13
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DGEEV ', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( N.EQ.0 )
     $   RETURN
*
*     Get machine constants
*
      EPS = DLAMCH( 'P' )
      SMLNUM = DLAMCH( 'S' )
      BIGNUM = ONE / SMLNUM
      CALL DLABAD( SMLNUM, BIGNUM )
      SMLNUM = SQRT( SMLNUM ) / EPS
      BIGNUM = ONE / SMLNUM
*
*     Scale A if max element outside range [SMLNUM,BIGNUM]
*
      ANRM = DLANGE( 'M', N, N, A, LDA, DUM )
      SCALEA = .FALSE.
      IF( ANRM.GT.ZERO .AND. ANRM.LT.SMLNUM ) THEN
         SCALEA = .TRUE.
         CSCALE = SMLNUM
      ELSE IF( ANRM.GT.BIGNUM ) THEN
         SCALEA = .TRUE.
         CSCALE = BIGNUM
      END IF
      IF( SCALEA )
     $   CALL DLASCL( 'G', 0, 0, ANRM, CSCALE, N, N, A, LDA, IERR )
*
*     Balance the matrix
```

```
*     (Workspace: need N)
*
      IBAL = 1
      CALL DGEBAL( 'B', N, A, LDA, ILO, IHI, WORK( IBAL ), IERR )
*
*     Reduce to upper Hessenberg form
*     (Workspace: need 3*N, prefer 2*N+N*NB)
*
      ITAU = IBAL + N
      IWRK = ITAU + N
      CALL DGEHRD( N, ILO, IHI, A, LDA, WORK( ITAU ), WORK( IWRK ),
     $             LWORK-IWRK+1, IERR )
*
      IF( WANTVL ) THEN
*
*        Want left eigenvectors
*        Copy Householder vectors to VL
*
         SIDE = 'L'
         CALL DLACPY( 'L', N, N, A, LDA, VL, LDVL )
*
*        Generate orthogonal matrix in VL
*        (Workspace: need 3*N-1, prefer 2*N+(N-1)*NB)
*
         CALL DORGHR( N, ILO, IHI, VL, LDVL, WORK( ITAU ), WORK( IWRK ),
     $                LWORK-IWRK+1, IERR )
*
*        Perform QR iteration, accumulating Schur vectors in VL
*        (Workspace: need N+1, prefer N+HSWORK (see comments) )
*
         IWRK = ITAU
         CALL DHSEQR( 'S', 'V', N, ILO, IHI, A, LDA, WR, WI, VL, LDVL,
     $                WORK( IWRK ), LWORK-IWRK+1, INFO )
*
         IF( WANTVR ) THEN
*
*           Want left and right eigenvectors
*           Copy Schur vectors to VR
*
            SIDE = 'B'
            CALL DLACPY( 'F', N, N, VL, LDVL, VR, LDVR )
         END IF
*
      ELSE IF( WANTVR ) THEN
*
*        Want right eigenvectors
*        Copy Householder vectors to VR
*
         SIDE = 'R'
         CALL DLACPY( 'L', N, N, A, LDA, VR, LDVR )
```

```
*
*        Generate orthogonal matrix in VR
*        (Workspace: need 3*N-1, prefer 2*N+(N-1)*NB)
*
         CALL DORGHR( N, ILO, IHI, VR, LDVR, WORK( ITAU ), WORK( IWRK ),
     $                LWORK-IWRK+1, IERR )
*
*        Perform QR iteration, accumulating Schur vectors in VR
*        (Workspace: need N+1, prefer N+HSWORK (see comments) )
*
         IWRK = ITAU
         CALL DHSEQR( 'S', 'V', N, ILO, IHI, A, LDA, WR, WI, VR, LDVR,
     $                WORK( IWRK ), LWORK-IWRK+1, INFO )
*
      ELSE
*
*        Compute eigenvalues only
*        (Workspace: need N+1, prefer N+HSWORK (see comments) )
*
         IWRK = ITAU
         CALL DHSEQR( 'E', 'N', N, ILO, IHI, A, LDA, WR, WI, VR, LDVR,
     $                WORK( IWRK ), LWORK-IWRK+1, INFO )
      END IF
*
*     If INFO > 0 from DHSEQR, then quit
*
      IF( INFO.GT.0 )
     $   GO TO 50
*
      IF( WANTVL .OR. WANTVR ) THEN
*
*        Compute left and/or right eigenvectors
*        (Workspace: need 4*N)
*
         CALL DTREVC( SIDE, 'B', SELECT, N, A, LDA, VL, LDVL, VR, LDVR,
     $                N, NOUT, WORK( IWRK ), IERR )
      END IF
*
      IF( WANTVL ) THEN
*
*        Undo balancing of left eigenvectors
*        (Workspace: need N)
*
         CALL DGEBAK( 'B', 'L', N, ILO, IHI, WORK( IBAL ), N, VL, LDVL,
     $                IERR )
*
*        Normalize left eigenvectors and make largest component real
*
         DO 20 I = 1, N
            IF( WI( I ).EQ.ZERO ) THEN
```

```
            SCL = ONE / DNRM2( N, VL( 1, I ), 1 )
            CALL DSCAL( N, SCL, VL( 1, I ), 1 )
         ELSE IF( WI( I ).GT.ZERO ) THEN
            SCL = ONE / DLAPY2( DNRM2( N, VL( 1, I ), 1 ),
     $             DNRM2( N, VL( 1, I+1 ), 1 ) )
            CALL DSCAL( N, SCL, VL( 1, I ), 1 )
            CALL DSCAL( N, SCL, VL( 1, I+1 ), 1 )
            DO 10 K = 1, N
               WORK( IWRK+K-1 ) = VL( K, I )**2 + VL( K, I+1 )**2
   10       CONTINUE
            K = IDAMAX( N, WORK( IWRK ), 1 )
            CALL DLARTG( VL( K, I ), VL( K, I+1 ), CS, SN, R )
            CALL DROT( N, VL( 1, I ), 1, VL( 1, I+1 ), 1, CS, SN )
            VL( K, I+1 ) = ZERO
         END IF
   20    CONTINUE
      END IF
*
      IF( WANTVR ) THEN
*
*        Undo balancing of right eigenvectors
*        (Workspace: need N)
*
         CALL DGEBAK( 'B', 'R', N, ILO, IHI, WORK( IBAL ), N, VR, LDVR,
     $                IERR )
*
*        Normalize right eigenvectors and make largest component real
*
         DO 40 I = 1, N
            IF( WI( I ).EQ.ZERO ) THEN
               SCL = ONE / DNRM2( N, VR( 1, I ), 1 )
               CALL DSCAL( N, SCL, VR( 1, I ), 1 )
            ELSE IF( WI( I ).GT.ZERO ) THEN
               SCL = ONE / DLAPY2( DNRM2( N, VR( 1, I ), 1 ),
     $              DNRM2( N, VR( 1, I+1 ), 1 ) )
               CALL DSCAL( N, SCL, VR( 1, I ), 1 )
               CALL DSCAL( N, SCL, VR( 1, I+1 ), 1 )
               DO 30 K = 1, N
                  WORK( IWRK+K-1 ) = VR( K, I )**2 + VR( K, I+1 )**2
   30          CONTINUE
               K = IDAMAX( N, WORK( IWRK ), 1 )
               CALL DLARTG( VR( K, I ), VR( K, I+1 ), CS, SN, R )
               CALL DROT( N, VR( 1, I ), 1, VR( 1, I+1 ), 1, CS, SN )
               VR( K, I+1 ) = ZERO
            END IF
   40    CONTINUE
      END IF
*
*     Undo scaling if necessary
*
```

```
   50 CONTINUE
      IF( SCALEA ) THEN
         CALL DLASCL( 'G', 0, 0, CSCALE, ANRM, N-INFO, 1, WR( INFO+1 ),
     $                MAX( N-INFO, 1 ), IERR )
         CALL DLASCL( 'G', 0, 0, CSCALE, ANRM, N-INFO, 1, WI( INFO+1 ),
     $                MAX( N-INFO, 1 ), IERR )
         IF( INFO.GT.0 ) THEN
            CALL DLASCL( 'G', 0, 0, CSCALE, ANRM, ILO-1, 1, WR, N,
     $                   IERR )
            CALL DLASCL( 'G', 0, 0, CSCALE, ANRM, ILO-1, 1, WI, N,
     $                   IERR )
         END IF
      END IF
*
      WORK( 1 ) = MAXWRK
      RETURN
*
*     End of DGEEV
*
      END
```

———-

— LAPACK dgeev —

```
(let* ((zero 0.0) (one 1.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one))
  (defun dgeev (jobvl jobvr n a lda wr wi vl ldvl vr ldvr work lwork info)
    (declare (type (simple-array double-float (*)) work vr vl wi wr a)
             (type fixnum info lwork ldvr ldvl lda n)
             (type character jobvr jobvl))
    (f2cl-lib:with-multi-array-data
        ((jobvl character jobvl-%data% jobvl-%offset%)
         (jobvr character jobvr-%data% jobvr-%offset%)
         (a double-float a-%data% a-%offset%)
         (wr double-float wr-%data% wr-%offset%)
         (wi double-float wi-%data% wi-%offset%)
         (vl double-float vl-%data% vl-%offset%)
         (vr double-float vr-%data% vr-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((dum (make-array 1 :element-type 'double-float))
             (select (make-array 1 :element-type 't)) (anrm 0.0) (bignum 0.0)
             (cs 0.0) (cscale 0.0) (eps 0.0) (r 0.0) (scl 0.0) (smlnum 0.0)
             (sn 0.0) (hswork 0) (i 0) (ibal 0) (ierr 0) (ihi 0) (ilo 0)
             (itau 0) (iwrk 0) (k 0) (maxb 0) (maxwrk 0) (minwrk 0) (nout 0)
             (side
              (make-array '(1) :element-type 'character :initial-element #\ ))
```

```
     (lquery nil) (scalea nil) (wantvl nil) (wantvr nil))
(declare (type (simple-array double-float (1)) dum)
         (type (simple-array (member t nil) (1)) select)
         (type (double-float) anrm bignum cs cscale eps r scl smlnum
                              sn)
         (type fixnum hswork i ibal ierr ihi ilo itau iwrk
                                  k maxb maxwrk minwrk nout)
         (type (simple-array character (1)) side)
         (type (member t nil) lquery scalea wantvl wantvr))
(setf info 0)
(setf lquery (coerce (= lwork -1) '(member t nil)))
(setf wantvl (char-equal jobvl #\V))
(setf wantvr (char-equal jobvr #\V))
(cond
  ((and (not wantvl) (not (char-equal jobvl #\N)))
   (setf info -1))
  ((and (not wantvr) (not (char-equal jobvr #\N)))
   (setf info -2))
  ((< n 0)
   (setf info -3))
  ((< lda (max (the fixnum 1) (the fixnum n)))
   (setf info -5))
  ((or (< ldvl 1) (and wantvl (< ldvl n)))
   (setf info -9))
  ((or (< ldvr 1) (and wantvr (< ldvr n)))
   (setf info -11)))
(setf minwrk 1)
(cond
  ((and (= info 0) (or (>= lwork 1) lquery))
   (setf maxwrk
         (f2cl-lib:int-add (f2cl-lib:int-mul 2 n)
                           (f2cl-lib:int-mul n
                                             (ilaenv 1 "DGEHRD" " " n
                                              1 n 0))))
   (cond
     ((and (not wantvl) (not wantvr))
      (setf minwrk
            (max (the fixnum 1)
                 (the fixnum (f2cl-lib:int-mul 3 n))))
      (setf maxb
            (max
             (the fixnum
                  (ilaenv 8 "DHSEQR" "EN" n 1 n -1))
             (the fixnum 2)))
      (setf k
            (min (the fixnum maxb)
                 (the fixnum n)
                 (the fixnum
                      (max (the fixnum 2)
                           (the fixnum
```

```
                                    (ilaenv 4 "DHSEQR" "EN" n 1 n -1))))))
          (setf hswork
                (max
                 (the fixnum
                      (f2cl-lib:int-mul k (f2cl-lib:int-add k 2)))
                 (the fixnum (f2cl-lib:int-mul 2 n))))
          (setf maxwrk
                (max (the fixnum maxwrk)
                     (the fixnum (f2cl-lib:int-add n 1))
                     (the fixnum
                          (f2cl-lib:int-add n hswork)))))
         (t
          (setf minwrk
                (max (the fixnum 1)
                     (the fixnum (f2cl-lib:int-mul 4 n))))
          (setf maxwrk
                (max (the fixnum maxwrk)
                     (the fixnum
                          (f2cl-lib:int-add (f2cl-lib:int-mul 2 n)
                                            (f2cl-lib:int-mul
                                             (f2cl-lib:int-sub n 1)
                                             (ilaenv 1 "DORGHR" " " n 1 n
                                              -1))))))
          (setf maxb
                (max
                 (the fixnum
                      (ilaenv 8 "DHSEQR" "SV" n 1 n -1))
                 (the fixnum 2)))
          (setf k
                (min (the fixnum maxb)
                     (the fixnum n)
                     (the fixnum
                          (max (the fixnum 2)
                               (the fixnum
                                    (ilaenv 4 "DHSEQR" "SV" n 1 n -1))))))
          (setf hswork
                (max
                 (the fixnum
                      (f2cl-lib:int-mul k (f2cl-lib:int-add k 2)))
                 (the fixnum (f2cl-lib:int-mul 2 n))))
          (setf maxwrk
                (max (the fixnum maxwrk)
                     (the fixnum (f2cl-lib:int-add n 1))
                     (the fixnum (f2cl-lib:int-add n hswork))))
          (setf maxwrk
                (max (the fixnum maxwrk)
                     (the fixnum (f2cl-lib:int-mul 4 n))))))
    (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
          (coerce (the fixnum maxwrk) 'double-float))))
(cond
```

```
  ((and (< lwork minwrk) (not lquery))
   (setf info -13)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DGEEV " (f2cl-lib:int-sub info))
   (go end_label))
  (lquery
   (go end_label)))
(if (= n 0) (go end_label))
(setf eps (dlamch "P"))
(setf smlnum (dlamch "S"))
(setf bignum (/ one smlnum))
(multiple-value-bind (var-0 var-1)
    (dlabad smlnum bignum)
  (declare (ignore))
  (setf smlnum var-0)
  (setf bignum var-1))
(setf smlnum (/ (f2cl-lib:fsqrt smlnum) eps))
(setf bignum (/ one smlnum))
(setf anrm (dlange "M" n n a lda dum))
(setf scalea nil)
(cond
  ((and (> anrm zero) (< anrm smlnum))
   (setf scalea t)
   (setf cscale smlnum))
  ((> anrm bignum)
   (setf scalea t)
   (setf cscale bignum)))
(if scalea
    (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
        (dlascl "G" 0 0 anrm cscale n n a lda ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                       var-8))
      (setf ierr var-9)))
(setf ibal 1)
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgebal "B" n a lda ilo ihi
     (f2cl-lib:array-slice work double-float (ibal) ((1 *))) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-6))
  (setf ilo var-4)
  (setf ihi var-5)
  (setf ierr var-7))
(setf itau (f2cl-lib:int-add ibal n))
(setf iwrk (f2cl-lib:int-add itau n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
    (dgehrd n ilo ihi a lda
```

```
      (f2cl-lib:array-slice work double-float (itau) ((1 *)))
      (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7))
    (setf ierr var-8))
  (cond
    (wantvl
     (f2cl-lib:f2cl-set-string side "L" (string 1))
     (dlacpy "L" n n a lda vl ldvl)
     (multiple-value-bind
           (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
         (dorghr n ilo ihi vl ldvl
          (f2cl-lib:array-slice work double-float (itau) ((1 *)))
          (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
          (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) ierr)
       (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7))
       (setf ierr var-8))
     (setf iwrk itau)
     (multiple-value-bind
           (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
            var-10 var-11 var-12 var-13)
         (dhseqr "S" "V" n ilo ihi a lda wr wi vl ldvl
          (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
          (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) info)
       (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                        var-8 var-9 var-10 var-11 var-12))
       (setf info var-13))
     (cond
       (wantvr
        (f2cl-lib:f2cl-set-string side "B" (string 1))
        (dlacpy "F" n n vl ldvl vr ldvr))))
    (wantvr
     (f2cl-lib:f2cl-set-string side "R" (string 1))
     (dlacpy "L" n n a lda vr ldvr)
     (multiple-value-bind
           (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
         (dorghr n ilo ihi vr ldvr
          (f2cl-lib:array-slice work double-float (itau) ((1 *)))
          (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
          (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) ierr)
       (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7))
       (setf ierr var-8))
     (setf iwrk itau)
     (multiple-value-bind
           (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
            var-10 var-11 var-12 var-13)
         (dhseqr "S" "V" n ilo ihi a lda wr wi vr ldvr
          (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
          (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) info)
       (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
```

```
                    var-8 var-9 var-10 var-11 var-12))
     (setf info var-13)))
  (t
   (setf iwrk itau)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
          var-10 var-11 var-12 var-13)
       (dhseqr "E" "N" n ilo ihi a lda wr wi vr ldvr
        (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) info)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                    var-8 var-9 var-10 var-11 var-12))
     (setf info var-13))))
(if (> info 0) (go label50))
(cond
  ((or wantvl wantvr)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
          var-10 var-11 var-12 var-13)
       (dtrevc side "B" select n a lda vl ldvl vr ldvr n nout
        (f2cl-lib:array-slice work double-float (iwrk) ((1 *))) ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                    var-8 var-9 var-10 var-12))
     (setf nout var-11)
     (setf ierr var-13))))
(cond
  (wantvl
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
       (dgebak "B" "L" n ilo ihi
        (f2cl-lib:array-slice work double-float (ibal) ((1 *))) n vl
        ldvl ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                    var-8))
     (setf ierr var-9))
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i n) nil)
     (tagbody
       (cond
         ((= (f2cl-lib:fref wi (i) ((1 *))) zero)
          (setf scl
                  (/ one
                     (dnrm2 n
                      (f2cl-lib:array-slice vl
                                            double-float
                                            (1 i)
                                            ((1 ldvl) (1 *)))
                      1)))
          (dscal n scl
           (f2cl-lib:array-slice vl
```

```
                        double-float
                        (1 i)
                        ((1 ldvl) (1 *)))
  1))
 ((> (f2cl-lib:fref wi (i) ((1 *))) zero)
  (setf scl
         (/ one
            (dlapy2
             (dnrm2 n
              (f2cl-lib:array-slice vl
                                    double-float
                                    (1 i)
                                    ((1 ldvl) (1 *)))
              1)
             (dnrm2 n
              (f2cl-lib:array-slice vl
                                    double-float
                                    (1 (f2cl-lib:int-add i 1))
                                    ((1 ldvl) (1 *)))
              1))))
  (dscal n scl
   (f2cl-lib:array-slice vl
                        double-float
                        (1 i)
                        ((1 ldvl) (1 *)))
   1)
  (dscal n scl
   (f2cl-lib:array-slice vl
                        double-float
                        (1 (f2cl-lib:int-add i 1))
                        ((1 ldvl) (1 *)))
   1)
  (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                ((> k n) nil)
    (tagbody
      (setf (f2cl-lib:fref work-%data%
                           ((f2cl-lib:int-sub
                             (f2cl-lib:int-add iwrk k)
                             1))
                           ((1 *))
                           work-%offset%)
            (+
             (expt
              (f2cl-lib:fref vl-%data%
                             (k i)
                             ((1 ldvl) (1 *))
                             vl-%offset%)
              2)
             (expt
              (f2cl-lib:fref vl-%data%
```

```
                                        (k (f2cl-lib:int-add i 1))
                                        ((1 ldvl) (1 *))
                                        vl-%offset%)
                              2)))))
                    (setf k
                            (idamax n
                             (f2cl-lib:array-slice work
                                                   double-float
                                                   (iwrk)
                                                   ((1 *)))
                             1))
                    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
                        (dlartg
                         (f2cl-lib:fref vl-%data%
                                        (k i)
                                        ((1 ldvl) (1 *))
                                        vl-%offset%)
                         (f2cl-lib:fref vl-%data%
                                        (k (f2cl-lib:int-add i 1))
                                        ((1 ldvl) (1 *))
                                        vl-%offset%)
                         cs sn r)
                      (declare (ignore var-0 var-1))
                      (setf cs var-2)
                      (setf sn var-3)
                      (setf r var-4))
                    (drot n
                     (f2cl-lib:array-slice vl
                                           double-float
                                           (1 i)
                                           ((1 ldvl) (1 *)))
                     1
                     (f2cl-lib:array-slice vl
                                           double-float
                                           (1 (f2cl-lib:int-add i 1))
                                           ((1 ldvl) (1 *)))
                     1 cs sn)
                    (setf (f2cl-lib:fref vl-%data%
                                         (k (f2cl-lib:int-add i 1))
                                         ((1 ldvl) (1 *))
                                         vl-%offset%)
                          zero)))))))
          (cond
            (wantvr
             (multiple-value-bind
                   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
                 (dgebak "B" "R" n ilo ihi
                  (f2cl-lib:array-slice work double-float (ibal) ((1 *))) n vr
                  ldvr ierr)
               (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
```

```
                  var-8))
  (setf ierr var-9))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i n) nil)
  (tagbody
    (cond
      ((= (f2cl-lib:fref wi (i) ((1 *))) zero)
       (setf scl
             (/ one
                (dnrm2 n
                 (f2cl-lib:array-slice vr
                                       double-float
                                       (1 i)
                                       ((1 ldvr) (1 *)))
                 1)))
       (dscal n scl
        (f2cl-lib:array-slice vr
                              double-float
                              (1 i)
                              ((1 ldvr) (1 *)))
        1))
      ((> (f2cl-lib:fref wi (i) ((1 *))) zero)
       (setf scl
             (/ one
                (dlapy2
                 (dnrm2 n
                  (f2cl-lib:array-slice vr
                                        double-float
                                        (1 i)
                                        ((1 ldvr) (1 *)))
                  1)
                 (dnrm2 n
                  (f2cl-lib:array-slice vr
                                        double-float
                                        (1 (f2cl-lib:int-add i 1))
                                        ((1 ldvr) (1 *)))
                  1))))
       (dscal n scl
        (f2cl-lib:array-slice vr
                              double-float
                              (1 i)
                              ((1 ldvr) (1 *)))
        1)
       (dscal n scl
        (f2cl-lib:array-slice vr
                              double-float
                              (1 (f2cl-lib:int-add i 1))
                              ((1 ldvr) (1 *)))
        1)
       (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
```

```
              ((> k n) nil)
  (tagbody
    (setf (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-sub
                           (f2cl-lib:int-add iwrk k)
                           1))
                         ((1 *))
                         work-%offset%)
            (+
             (expt
              (f2cl-lib:fref vr-%data%
                             (k i)
                             ((1 ldvr) (1 *))
                             vr-%offset%)
              2)
             (expt
              (f2cl-lib:fref vr-%data%
                             (k (f2cl-lib:int-add i 1))
                             ((1 ldvr) (1 *))
                             vr-%offset%)
              2)))))
(setf k
        (idamax n
         (f2cl-lib:array-slice work
                               double-float
                               (iwrk)
                               ((1 *)))
         1))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
    (dlartg
     (f2cl-lib:fref vr-%data%
                    (k i)
                    ((1 ldvr) (1 *))
                    vr-%offset%)
     (f2cl-lib:fref vr-%data%
                    (k (f2cl-lib:int-add i 1))
                    ((1 ldvr) (1 *))
                    vr-%offset%)
     cs sn r)
  (declare (ignore var-0 var-1))
  (setf cs var-2)
  (setf sn var-3)
  (setf r var-4))
(drot n
 (f2cl-lib:array-slice vr
                       double-float
                       (1 i)
                       ((1 ldvr) (1 *)))
 1
 (f2cl-lib:array-slice vr
```

```
                                        double-float
                                        (1 (f2cl-lib:int-add i 1))
                                        ((1 ldvr) (1 *)))
                    1 cs sn)
                   (setf (f2cl-lib:fref vr-%data%
                                        (k (f2cl-lib:int-add i 1))
                                        ((1 ldvr) (1 *))
                                        vr-%offset%)
                         zero)))))))
label50
       (cond
         (scalea
          (multiple-value-bind
                (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
              (dlascl "G" 0 0 cscale anrm (f2cl-lib:int-sub n info) 1
               (f2cl-lib:array-slice wr double-float ((+ info 1)) ((1 *)))
               (max (the fixnum (f2cl-lib:int-sub n info))
                    (the fixnum 1))
               ierr)
            (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                             var-8))
            (setf ierr var-9))
          (multiple-value-bind
                (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
              (dlascl "G" 0 0 cscale anrm (f2cl-lib:int-sub n info) 1
               (f2cl-lib:array-slice wi double-float ((+ info 1)) ((1 *)))
               (max (the fixnum (f2cl-lib:int-sub n info))
                    (the fixnum 1))
               ierr)
            (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                             var-8))
            (setf ierr var-9))
          (cond
            ((> info 0)
             (multiple-value-bind
                   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                    var-9)
                 (dlascl "G" 0 0 cscale anrm (f2cl-lib:int-sub ilo 1) 1 wr n
                  ierr)
               (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                                var-7 var-8))
               (setf ierr var-9))
             (multiple-value-bind
                   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                    var-9)
                 (dlascl "G" 0 0 cscale anrm (f2cl-lib:int-sub ilo 1) 1 wi n
                  ierr)
               (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                                var-7 var-8))
               (setf ierr var-9))))))
```

```
        (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
                (coerce (the fixnum maxwrk) 'double-float))
 end_label
        (return
         (values nil nil nil nil nil nil nil nil nil nil nil nil nil info))))))
```

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6.9 dgeevx LAPACK

— **dgeevx.input** —

```
)set break resume
)sys rm -f dgeevx.output
)spool dgeevx.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dgeevx.help** —

```
======================================================================
dgeevx examples
======================================================================

======================================================================
Man Page Details
======================================================================

NAME
       DGEEVX - for an N-by-N real nonsymmetric matrix A, the eigenvalues and,
       optionally, the left and/or right eigenvectors

SYNOPSIS
       SUBROUTINE DGEEVX( BALANC, JOBVL, JOBVR, SENSE, N, A, LDA, WR, WI,  VL,
                          LDVL,  VR,  LDVR,  ILO,  IHI,  SCALE, ABNRM, RCONDE,
                          RCONDV, WORK, LWORK, IWORK, INFO )

           CHARACTER      BALANC, JOBVL, JOBVR, SENSE
```

```
          INTEGER        IHI, ILO, INFO, LDA, LDVL, LDVR, LWORK, N

          DOUBLE         PRECISION ABNRM

          INTEGER        IWORK( * )

          DOUBLE         PRECISION A( LDA, * ), RCONDE( *  ),  RCONDV(  *  ),
                         SCALE(  *  ), VL( LDVL, * ), VR( LDVR, * ), WI( * ),
                         WORK( * ), WR( * )

PURPOSE
       DGEEVX computes for an N-by-N real nonsymmetric matrix A, the eigenval-
       ues and, optionally, the left and/or right eigenvectors.

       Optionally  also, it computes a balancing transformation to improve the
       conditioning of the eigenvalues and eigenvectors (ILO, IHI, SCALE,  and
       ABNRM),  reciprocal condition numbers for the eigenvalues (RCONDE), and
       reciprocal condition numbers for the right
       eigenvectors (RCONDV).

       The right eigenvector v(j) of A satisfies
                        A * v(j) = lambda(j) * v(j)
       where lambda(j) is its eigenvalue.
       The left eigenvector u(j) of A satisfies
                     u(j)**H * A = lambda(j) * u(j)**H
       where u(j)**H denotes the conjugate transpose of u(j).

       The computed eigenvectors are normalized to have Euclidean  norm  equal
       to 1 and largest component real.

       Balancing a matrix means permuting the rows and columns to make it more
       nearly upper triangular, and applying a diagonal similarity transforma-
       tion  D  *  A * D**(-1), where D is a diagonal matrix, to make its rows
       and columns closer in norm and the condition numbers of its eigenvalues
       and  eigenvectors  smaller.   The computed reciprocal condition numbers
       correspond to the balanced matrix.  Permuting rows and columns will not
       change the condition numbers (in exact arithmetic) but diagonal scaling
       will.  For further explanation of balancing, see section 4.10.2 of  the
       LAPACK Users' Guide.


ARGUMENTS
       BALANC  (input) CHARACTER*1
               Indicates  how  the  input  matrix  should be diagonally scaled
               and/or permuted to improve the conditioning of its eigenvalues.
               = 'N': Do not diagonally scale or permute;
               =  'P':  Perform  permutations  to  make the matrix more nearly
               upper triangular. Do not diagonally scale;  =  'S':  Diagonally
               scale  the  matrix, i.e. replace A by D*A*D**(-1), where D is a
               diagonal matrix chosen to make the rows and columns of  A  more
```

```
          equal in norm. Do not permute; = 'B': Both diagonally scale and
          permute A.

          Computed reciprocal condition numbers will be  for  the  matrix
          after  balancing  and/or  permuting.  Permuting does not change
          condition numbers (in exact arithmetic), but balancing does.

     JOBVL   (input) CHARACTER*1
          = 'N': left eigenvectors of A are not computed;
          = 'V': left eigenvectors of A are computed.  If SENSE = 'E'  or
          'B', JOBVL must = 'V'.

     JOBVR   (input) CHARACTER*1
          = 'N': right eigenvectors of A are not computed;
          = 'V': right eigenvectors of A are computed.  If SENSE = 'E' or
          'B', JOBVR must = 'V'.

     SENSE   (input) CHARACTER*1
          Determines which reciprocal condition numbers are computed.   =
          'N': None are computed;
          = 'E': Computed for eigenvalues only;
          = 'V': Computed for right eigenvectors only;
          = 'B': Computed for eigenvalues and right eigenvectors.

          If  SENSE  =  'E' or 'B', both left and right eigenvectors must
          also be computed (JOBVL = 'V' and JOBVR = 'V').

     N       (input) INTEGER
          The order of the matrix A. N >= 0.

     A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
          On entry, the N-by-N matrix A.  On exit, A has  been  overwrit-
          ten.   If JOBVL = 'V' or JOBVR = 'V', A contains the real Schur
          form of the balanced version of the input matrix A.

     LDA     (input) INTEGER
          The leading dimension of the array A.  LDA >= max(1,N).

     WR      (output) DOUBLE PRECISION array, dimension (N)
          WI      (output) DOUBLE PRECISION array, dimension (N)  WR  and
          WI  contain  the real and imaginary parts, respectively, of the
          computed eigenvalues.  Complex conjugate pairs  of  eigenvalues
          will  appear consecutively with the eigenvalue having the posi-
          tive imaginary part first.

     VL      (output) DOUBLE PRECISION array, dimension (LDVL,N)
          If JOBVL = 'V', the left eigenvectors u(j) are stored one after
          another in the columns of VL, in the same order as their eigen-
          values.  If JOBVL = 'N', VL is not  referenced.   If  the  j-th
          eigenvalue is real, then u(j) = VL(:,j), the j-th column of VL.
```

```
        If the j-th and (j+1)-st eigenvalues form a  complex  conjugate
        pair, then u(j) = VL(:,j) + i*VL(:,j+1) and
        u(j+1) = VL(:,j) - i*VL(:,j+1).

LDVL    (input) INTEGER
        The  leading  dimension of the array VL.  LDVL >= 1; if JOBVL =
        'V', LDVL >= N.

VR      (output) DOUBLE PRECISION array, dimension (LDVR,N)
        If JOBVR = 'V', the right  eigenvectors  v(j)  are  stored  one
        after  another in the columns of VR, in the same order as their
        eigenvalues.  If JOBVR = 'N', VR is not referenced.  If the  j-
        th  eigenvalue is real, then v(j) = VR(:,j), the j-th column of
        VR.  If the j-th and (j+1)-st eigenvalues form a complex conju-
        gate pair, then v(j) = VR(:,j) + i*VR(:,j+1) and
        v(j+1) = VR(:,j) - i*VR(:,j+1).

LDVR    (input) INTEGER
        The leading dimension of the array VR.  LDVR >= 1, and if JOBVR
        = 'V', LDVR >= N.

ILO     (output) INTEGER
        IHI     (output) INTEGER ILO and IHI are integer values  deter-
        mined  when  A  was balanced.  The balanced A(i,j) = 0 if I > J
        and J = 1,...,ILO-1 or I = IHI+1,...,N.

SCALE   (output) DOUBLE PRECISION array, dimension (N)
        Details of the permutations and scaling  factors  applied  when
        balancing A.  If P(j) is the index of the row and column inter-
        changed with row and column j, and D(j) is the  scaling  factor
        applied  to  row and column j, then SCALE(J) = P(J),    for J =
        1,...,ILO-1 = D(J),    for J = ILO,...,IHI = P(J)     for  J  =
        IHI+1,...,N.  The order in which the interchanges are made is N
        to IHI+1, then 1 to ILO-1.

ABNRM   (output) DOUBLE PRECISION
        The one-norm of the balanced matrix (the maximum of the sum  of
        absolute values of elements of any column).

RCONDE  (output) DOUBLE PRECISION array, dimension (N)
        RCONDE(j) is the reciprocal condition number of the j-th eigen-
        value.

RCONDV  (output) DOUBLE PRECISION array, dimension (N)
        RCONDV(j) is the reciprocal condition number of the j-th  right
        eigenvector.

WORK       (workspace/output)   DOUBLE   PRECISION   array,   dimension
(MAX(1,LWORK))
        On exit, if INFO = 0, WORK(1) returns the optimal LWORK.
```

```
       LWORK   (input) INTEGER
               The dimension of the array WORK.   If SENSE = 'N' or 'E', LWORK
               >= max(1,2*N), and if JOBVL = 'V' or JOBVR = 'V', LWORK >= 3*N.
               If SENSE = 'V' or 'B', LWORK >= N*(N+6).  For good performance,
               LWORK must generally be larger.

               If LWORK = -1, then a workspace query is assumed;  the  routine
               only  calculates  the  optimal  size of the WORK array, returns
               this value as the first entry of the WORK array, and  no  error
               message related to LWORK is issued by XERBLA.

       IWORK   (workspace) INTEGER array, dimension (2*N-2)
               If SENSE = 'N' or 'E', not referenced.

       INFO    (output) INTEGER
               = 0:  successful exit
               < 0:  if INFO = -i, the i-th argument had an illegal value.
               >  0:   if INFO = i, the QR algorithm failed to compute all the
               eigenvalues, and no eigenvectors or condition numbers have been
               computed;  elements  1:ILO-1  and  i+1:N  of  WR and WI contain
               eigenvalues which have converged.
```

———-

— dgeevx.f —

```
      SUBROUTINE DGEEVX( BALANC, JOBVL, JOBVR, SENSE, N, A, LDA, WR, WI,
     $                   VL, LDVL, VR, LDVR, ILO, IHI, SCALE, ABNRM,
     $                   RCONDE, RCONDV, WORK, LWORK, IWORK, INFO )
*
*  -- LAPACK driver routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      CHARACTER          BALANC, JOBVL, JOBVR, SENSE
      INTEGER            IHI, ILO, INFO, LDA, LDVL, LDVR, LWORK, N
      DOUBLE PRECISION   ABNRM
*     ..
*     .. Array Arguments ..
      INTEGER            IWORK( * )
      DOUBLE PRECISION   A( LDA, * ), RCONDE( * ), RCONDV( * ),
     $                   SCALE( * ), VL( LDVL, * ), VR( LDVR, * ),
     $                   WI( * ), WORK( * ), WR( * )
*     ..
*
```

```
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D0, ONE = 1.0D0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            LQUERY, SCALEA, WANTVL, WANTVR, WNTSNB, WNTSNE,
     $                   WNTSNN, WNTSNV
      CHARACTER          JOB, SIDE
      INTEGER            HSWORK, I, ICOND, IERR, ITAU, IWRK, K, MAXB,
     $                   MAXWRK, MINWRK, NOUT
      DOUBLE PRECISION   ANRM, BIGNUM, CS, CSCALE, EPS, R, SCL, SMLNUM,
     $                   SN
*     ..
*     .. Local Arrays ..
      LOGICAL            SELECT( 1 )
      DOUBLE PRECISION   DUM( 1 )
*     ..
*     .. External Subroutines ..
      EXTERNAL           DGEBAK, DGEBAL, DGEHRD, DHSEQR, DLACPY, DLARTG,
     $                   DLASCL, DORGHR, DROT, DSCAL, DTREVC, DTRSNA,
     $                   XERBLA
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      INTEGER            IDAMAX, ILAENV
      DOUBLE PRECISION   DLAMCH, DLANGE, DLAPY2, DNRM2
      EXTERNAL           LSAME, IDAMAX, ILAENV, DLAMCH, DLANGE, DLAPY2,
     $                   DNRM2
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN, SQRT
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      LQUERY = ( LWORK.EQ.-1 )
      WANTVL = LSAME( JOBVL, 'V' )
      WANTVR = LSAME( JOBVR, 'V' )
      WNTSNN = LSAME( SENSE, 'N' )
      WNTSNE = LSAME( SENSE, 'E' )
      WNTSNV = LSAME( SENSE, 'V' )
      WNTSNB = LSAME( SENSE, 'B' )
      IF( .NOT.( LSAME( BALANC, 'N' ) .OR. LSAME( BALANC,
     $    'S' ) .OR. LSAME( BALANC, 'P' ) .OR. LSAME( BALANC, 'B' ) ) )
     $     THEN
         INFO = -1
```

```
      ELSE IF( ( .NOT.WANTVL ) .AND. ( .NOT.LSAME( JOBVL, 'N' ) ) ) THEN
         INFO = -2
      ELSE IF( ( .NOT.WANTVR ) .AND. ( .NOT.LSAME( JOBVR, 'N' ) ) ) THEN
         INFO = -3
      ELSE IF( .NOT.( WNTSNN .OR. WNTSNE .OR. WNTSNB .OR. WNTSNV ) .OR.
     $         ( ( WNTSNE .OR. WNTSNB ) .AND. .NOT.( WANTVL .AND.
     $         WANTVR ) ) ) THEN
         INFO = -4
      ELSE IF( N.LT.0 ) THEN
         INFO = -5
      ELSE IF( LDA.LT.MAX( 1, N ) ) THEN
         INFO = -7
      ELSE IF( LDVL.LT.1 .OR. ( WANTVL .AND. LDVL.LT.N ) ) THEN
         INFO = -11
      ELSE IF( LDVR.LT.1 .OR. ( WANTVR .AND. LDVR.LT.N ) ) THEN
         INFO = -13
      END IF
*
*     Compute workspace
*      (Note: Comments in the code beginning "Workspace:" describe the
*       minimal amount of workspace needed at that point in the code,
*       as well as the preferred amount for good performance.
*       NB refers to the optimal block size for the immediately
*       following subroutine, as returned by ILAENV.
*       HSWORK refers to the workspace preferred by DHSEQR, as
*       calculated below. HSWORK is computed assuming ILO=1 and IHI=N,
*       the worst case.)
*
      MINWRK = 1
      IF( INFO.EQ.0 .AND. ( LWORK.GE.1 .OR. LQUERY ) ) THEN
         MAXWRK = N + N*ILAENV( 1, 'DGEHRD', ' ', N, 1, N, 0 )
         IF( ( .NOT.WANTVL ) .AND. ( .NOT.WANTVR ) ) THEN
            MINWRK = MAX( 1, 2*N )
            IF( .NOT.WNTSNN )
     $         MINWRK = MAX( MINWRK, N*N+6*N )
            MAXB = MAX( ILAENV( 8, 'DHSEQR', 'SN', N, 1, N, -1 ), 2 )
            IF( WNTSNN ) THEN
               K = MIN( MAXB, N, MAX( 2, ILAENV( 4, 'DHSEQR', 'EN', N,
     $             1, N, -1 ) ) )
            ELSE
               K = MIN( MAXB, N, MAX( 2, ILAENV( 4, 'DHSEQR', 'SN', N,
     $             1, N, -1 ) ) )
            END IF
            HSWORK = MAX( K*( K+2 ), 2*N )
            MAXWRK = MAX( MAXWRK, 1, HSWORK )
            IF( .NOT.WNTSNN )
     $         MAXWRK = MAX( MAXWRK, N*N+6*N )
         ELSE
            MINWRK = MAX( 1, 3*N )
            IF( ( .NOT.WNTSNN ) .AND. ( .NOT.WNTSNE ) )
```

```
     $         MINWRK = MAX( MINWRK, N*N+6*N )
               MAXB = MAX( ILAENV( 8, 'DHSEQR', 'SN', N, 1, N, -1 ), 2 )
               K = MIN( MAXB, N, MAX( 2, ILAENV( 4, 'DHSEQR', 'EN', N, 1,
     $             N, -1 ) ) )
               HSWORK = MAX( K*( K+2 ), 2*N )
               MAXWRK = MAX( MAXWRK, 1, HSWORK )
               MAXWRK = MAX( MAXWRK, N+( N-1 )*
     $                   ILAENV( 1, 'DORGHR', ' ', N, 1, N, -1 ) )
               IF( ( .NOT.WNTSNN ) .AND. ( .NOT.WNTSNE ) )
     $            MAXWRK = MAX( MAXWRK, N*N+6*N )
               MAXWRK = MAX( MAXWRK, 3*N, 1 )
            END IF
            WORK( 1 ) = MAXWRK
         END IF
         IF( LWORK.LT.MINWRK .AND. .NOT.LQUERY ) THEN
            INFO = -21
         END IF
         IF( INFO.NE.0 ) THEN
            CALL XERBLA( 'DGEEVX', -INFO )
            RETURN
         ELSE IF( LQUERY ) THEN
            RETURN
         END IF
*
*        Quick return if possible
*
         IF( N.EQ.0 )
     $      RETURN
*
*        Get machine constants
*
         EPS = DLAMCH( 'P' )
         SMLNUM = DLAMCH( 'S' )
         BIGNUM = ONE / SMLNUM
         CALL DLABAD( SMLNUM, BIGNUM )
         SMLNUM = SQRT( SMLNUM ) / EPS
         BIGNUM = ONE / SMLNUM
*
*        Scale A if max element outside range [SMLNUM,BIGNUM]
*
         ICOND = 0
         ANRM = DLANGE( 'M', N, N, A, LDA, DUM )
         SCALEA = .FALSE.
         IF( ANRM.GT.ZERO .AND. ANRM.LT.SMLNUM ) THEN
            SCALEA = .TRUE.
            CSCALE = SMLNUM
         ELSE IF( ANRM.GT.BIGNUM ) THEN
            SCALEA = .TRUE.
            CSCALE = BIGNUM
         END IF
```

```
      IF( SCALEA )
     $   CALL DLASCL( 'G', 0, 0, ANRM, CSCALE, N, N, A, LDA, IERR )
*
*     Balance the matrix and compute ABNRM
*
      CALL DGEBAL( BALANC, N, A, LDA, ILO, IHI, SCALE, IERR )
      ABNRM = DLANGE( '1', N, N, A, LDA, DUM )
      IF( SCALEA ) THEN
         DUM( 1 ) = ABNRM
         CALL DLASCL( 'G', 0, 0, CSCALE, ANRM, 1, 1, DUM, 1, IERR )
         ABNRM = DUM( 1 )
      END IF
*
*     Reduce to upper Hessenberg form
*     (Workspace: need 2*N, prefer N+N*NB)
*
      ITAU = 1
      IWRK = ITAU + N
      CALL DGEHRD( N, ILO, IHI, A, LDA, WORK( ITAU ), WORK( IWRK ),
     $             LWORK-IWRK+1, IERR )
*
      IF( WANTVL ) THEN
*
*        Want left eigenvectors
*        Copy Householder vectors to VL
*
         SIDE = 'L'
         CALL DLACPY( 'L', N, N, A, LDA, VL, LDVL )
*
*        Generate orthogonal matrix in VL
*        (Workspace: need 2*N-1, prefer N+(N-1)*NB)
*
         CALL DORGHR( N, ILO, IHI, VL, LDVL, WORK( ITAU ), WORK( IWRK ),
     $                LWORK-IWRK+1, IERR )
*
*        Perform QR iteration, accumulating Schur vectors in VL
*        (Workspace: need 1, prefer HSWORK (see comments) )
*
         IWRK = ITAU
         CALL DHSEQR( 'S', 'V', N, ILO, IHI, A, LDA, WR, WI, VL, LDVL,
     $                WORK( IWRK ), LWORK-IWRK+1, INFO )
*
         IF( WANTVR ) THEN
*
*           Want left and right eigenvectors
*           Copy Schur vectors to VR
*
            SIDE = 'B'
            CALL DLACPY( 'F', N, N, VL, LDVL, VR, LDVR )
         END IF
```

```
*
      ELSE IF( WANTVR ) THEN
*
*        Want right eigenvectors
*        Copy Householder vectors to VR
*
         SIDE = 'R'
         CALL DLACPY( 'L', N, N, A, LDA, VR, LDVR )
*
*        Generate orthogonal matrix in VR
*        (Workspace: need 2*N-1, prefer N+(N-1)*NB)
*
         CALL DORGHR( N, ILO, IHI, VR, LDVR, WORK( ITAU ), WORK( IWRK ),
     $                LWORK-IWRK+1, IERR )
*
*        Perform QR iteration, accumulating Schur vectors in VR
*        (Workspace: need 1, prefer HSWORK (see comments) )
*
         IWRK = ITAU
         CALL DHSEQR( 'S', 'V', N, ILO, IHI, A, LDA, WR, WI, VR, LDVR,
     $                WORK( IWRK ), LWORK-IWRK+1, INFO )
*
      ELSE
*
*        Compute eigenvalues only
*        If condition numbers desired, compute Schur form
*
         IF( WNTSNN ) THEN
            JOB = 'E'
         ELSE
            JOB = 'S'
         END IF
*
*        (Workspace: need 1, prefer HSWORK (see comments) )
*
         IWRK = ITAU
         CALL DHSEQR( JOB, 'N', N, ILO, IHI, A, LDA, WR, WI, VR, LDVR,
     $                WORK( IWRK ), LWORK-IWRK+1, INFO )
      END IF
*
*     If INFO > 0 from DHSEQR, then quit
*
      IF( INFO.GT.0 )
     $   GO TO 50
*
      IF( WANTVL .OR. WANTVR ) THEN
*
*        Compute left and/or right eigenvectors
*        (Workspace: need 3*N)
*
```

```
         CALL DTREVC( SIDE, 'B', SELECT, N, A, LDA, VL, LDVL, VR, LDVR,
     $                N, NOUT, WORK( IWRK ), IERR )
      END IF
*
*     Compute condition numbers if desired
*     (Workspace: need N*N+6*N unless SENSE = 'E')
*
      IF( .NOT.WNTSNN ) THEN
         CALL DTRSNA( SENSE, 'A', SELECT, N, A, LDA, VL, LDVL, VR, LDVR,
     $                RCONDE, RCONDV, N, NOUT, WORK( IWRK ), N, IWORK,
     $                ICOND )
      END IF
*
      IF( WANTVL ) THEN
*
*        Undo balancing of left eigenvectors
*
         CALL DGEBAK( BALANC, 'L', N, ILO, IHI, SCALE, N, VL, LDVL,
     $                IERR )
*
*        Normalize left eigenvectors and make largest component real
*
         DO 20 I = 1, N
            IF( WI( I ).EQ.ZERO ) THEN
               SCL = ONE / DNRM2( N, VL( 1, I ), 1 )
               CALL DSCAL( N, SCL, VL( 1, I ), 1 )
            ELSE IF( WI( I ).GT.ZERO ) THEN
               SCL = ONE / DLAPY2( DNRM2( N, VL( 1, I ), 1 ),
     $               DNRM2( N, VL( 1, I+1 ), 1 ) )
               CALL DSCAL( N, SCL, VL( 1, I ), 1 )
               CALL DSCAL( N, SCL, VL( 1, I+1 ), 1 )
               DO 10 K = 1, N
                  WORK( K ) = VL( K, I )**2 + VL( K, I+1 )**2
   10          CONTINUE
               K = IDAMAX( N, WORK, 1 )
               CALL DLARTG( VL( K, I ), VL( K, I+1 ), CS, SN, R )
               CALL DROT( N, VL( 1, I ), 1, VL( 1, I+1 ), 1, CS, SN )
               VL( K, I+1 ) = ZERO
            END IF
   20    CONTINUE
      END IF
*
      IF( WANTVR ) THEN
*
*        Undo balancing of right eigenvectors
*
         CALL DGEBAK( BALANC, 'R', N, ILO, IHI, SCALE, N, VR, LDVR,
     $                IERR )
*
*        Normalize right eigenvectors and make largest component real
```

```
*
         DO 40 I = 1, N
            IF( WI( I ).EQ.ZERO ) THEN
               SCL = ONE / DNRM2( N, VR( 1, I ), 1 )
               CALL DSCAL( N, SCL, VR( 1, I ), 1 )
            ELSE IF( WI( I ).GT.ZERO ) THEN
               SCL = ONE / DLAPY2( DNRM2( N, VR( 1, I ), 1 ),
     $               DNRM2( N, VR( 1, I+1 ), 1 ) )
               CALL DSCAL( N, SCL, VR( 1, I ), 1 )
               CALL DSCAL( N, SCL, VR( 1, I+1 ), 1 )
               DO 30 K = 1, N
                  WORK( K ) = VR( K, I )**2 + VR( K, I+1 )**2
   30          CONTINUE
               K = IDAMAX( N, WORK, 1 )
               CALL DLARTG( VR( K, I ), VR( K, I+1 ), CS, SN, R )
               CALL DROT( N, VR( 1, I ), 1, VR( 1, I+1 ), 1, CS, SN )
               VR( K, I+1 ) = ZERO
            END IF
   40    CONTINUE
      END IF
*
*     Undo scaling if necessary
*
   50 CONTINUE
      IF( SCALEA ) THEN
         CALL DLASCL( 'G', 0, 0, CSCALE, ANRM, N-INFO, 1, WR( INFO+1 ),
     $                MAX( N-INFO, 1 ), IERR )
         CALL DLASCL( 'G', 0, 0, CSCALE, ANRM, N-INFO, 1, WI( INFO+1 ),
     $                MAX( N-INFO, 1 ), IERR )
         IF( INFO.EQ.0 ) THEN
            IF( ( WNTSNV .OR. WNTSNB ) .AND. ICOND.EQ.0 )
     $         CALL DLASCL( 'G', 0, 0, CSCALE, ANRM, N, 1, RCONDV, N,
     $                      IERR )
         ELSE
            CALL DLASCL( 'G', 0, 0, CSCALE, ANRM, ILO-1, 1, WR, N,
     $                   IERR )
            CALL DLASCL( 'G', 0, 0, CSCALE, ANRM, ILO-1, 1, WI, N,
     $                   IERR )
         END IF
      END IF
*
      WORK( 1 ) = MAXWRK
      RETURN
*
*     End of DGEEVX
*
      END
```

— LAPACK dgeevx —

```
(let* ((zero 0.0) (one 1.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one))
  (defun dgeevx
         (balanc jobvl jobvr sense n a lda wr wi vl ldvl vr ldvr ilo ihi scale
          abnrm rconde rcondv work lwork iwork info)
    (declare (type (simple-array fixnum (*)) iwork)
             (type (double-float) abnrm)
             (type (simple-array double-float (*)) work rcondv rconde scale vr vl wi
                                                   wr a)
             (type fixnum info lwork ihi ilo ldvr ldvl lda n)
             (type character sense jobvr jobvl balanc))
    (f2cl-lib:with-multi-array-data
        ((balanc character balanc-%data% balanc-%offset%)
         (jobvl character jobvl-%data% jobvl-%offset%)
         (jobvr character jobvr-%data% jobvr-%offset%)
         (sense character sense-%data% sense-%offset%)
         (a double-float a-%data% a-%offset%)
         (wr double-float wr-%data% wr-%offset%)
         (wi double-float wi-%data% wi-%offset%)
         (vl double-float vl-%data% vl-%offset%)
         (vr double-float vr-%data% vr-%offset%)
         (scale double-float scale-%data% scale-%offset%)
         (rconde double-float rconde-%data% rconde-%offset%)
         (rcondv double-float rcondv-%data% rcondv-%offset%)
         (work double-float work-%data% work-%offset%)
         (iwork fixnum iwork-%data% iwork-%offset%))
      (prog ((dum (make-array 1 :element-type 'double-float))
             (select (make-array 1 :element-type 't)) (anrm 0.0) (bignum 0.0)
             (cs 0.0) (cscale 0.0) (eps 0.0) (r 0.0) (scl 0.0) (smlnum 0.0)
             (sn 0.0) (hswork 0) (i 0) (icond 0) (ierr 0) (itau 0) (iwrk 0)
             (k 0) (maxb 0) (maxwrk 0) (minwrk 0) (nout 0)
             (job
              (make-array '(1) :element-type 'character :initial-element #\ ))
             (side
              (make-array '(1) :element-type 'character :initial-element #\ ))
             (lquery nil) (scalea nil) (wantvl nil) (wantvr nil) (wntsnb nil)
             (wntsne nil) (wntsnn nil) (wntsnv nil))
        (declare (type (simple-array double-float (1)) dum)
                 (type (simple-array (member t nil) (1)) select)
                 (type (double-float) anrm bignum cs cscale eps r scl smlnum
                                      sn)
                 (type fixnum hswork i icond ierr itau iwrk k maxb
                                           maxwrk minwrk nout)
                 (type (simple-array character (1)) job side)
                 (type (member t nil) lquery scalea wantvl wantvr wntsnb
                                      wntsne wntsnn wntsnv))
```

```
(setf info 0)
(setf lquery (coerce (= lwork -1) '(member t nil)))
(setf wantvl (char-equal jobvl #\V))
(setf wantvr (char-equal jobvr #\V))
(setf wntsnn (char-equal sense #\N))
(setf wntsne (char-equal sense #\E))
(setf wntsnv (char-equal sense #\V))
(setf wntsnb (char-equal sense #\B))
(cond
  ((not
    (or (char-equal balanc #\N)
        (char-equal balanc #\S)
        (char-equal balanc #\P)
        (char-equal balanc #\B)))
   (setf info -1))
  ((and (not wantvl) (not (char-equal jobvl #\N)))
   (setf info -2))
  ((and (not wantvr) (not (char-equal jobvr #\N)))
   (setf info -3))
  ((or (not (or wntsnn wntsne wntsnb wntsnv))
       (and (or wntsne wntsnb) (not (and wantvl wantvr))))
   (setf info -4))
  ((< n 0)
   (setf info -5))
  ((< lda (max (the fixnum 1) (the fixnum n)))
   (setf info -7))
  ((or (< ldvl 1) (and wantvl (< ldvl n)))
   (setf info -11))
  ((or (< ldvr 1) (and wantvr (< ldvr n)))
   (setf info -13)))
(setf minwrk 1)
(cond
  ((and (= info 0) (or (>= lwork 1) lquery))
   (setf maxwrk
           (f2cl-lib:int-add n
                             (f2cl-lib:int-mul n
                                               (ilaenv 1 "DGEHRD" " " n
                                                1 n 0))))
   (cond
     ((and (not wantvl) (not wantvr))
      (setf minwrk
              (max (the fixnum 1)
                   (the fixnum (f2cl-lib:int-mul 2 n))))
      (if (not wntsnn)
          (setf minwrk
                  (max (the fixnum minwrk)
                       (the fixnum
                            (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                                              (f2cl-lib:int-mul 6
                                                                n))))))
```

```
(setf maxb
        (max
         (the fixnum
              (ilaenv 8 "DHSEQR" "SN" n 1 n -1))
         (the fixnum 2)))
(cond
  (wntsnn
   (setf k
           (min (the fixnum maxb)
                (the fixnum n)
                (the fixnum
                     (max (the fixnum 2)
                          (the fixnum
                               (ilaenv 4 "DHSEQR" "EN" n 1 n
                                -1)))))))
  (t
   (setf k
           (min (the fixnum maxb)
                (the fixnum n)
                (the fixnum
                     (max (the fixnum 2)
                          (the fixnum
                               (ilaenv 4 "DHSEQR" "SN" n 1 n
                                -1))))))))
(setf hswork
        (max
         (the fixnum
              (f2cl-lib:int-mul k (f2cl-lib:int-add k 2)))
         (the fixnum (f2cl-lib:int-mul 2 n))))
(setf maxwrk
        (max (the fixnum maxwrk)
             (the fixnum 1)
             (the fixnum hswork)))
(if (not wntsnn)
    (setf maxwrk
            (max (the fixnum maxwrk)
                 (the fixnum
                      (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                                        (f2cl-lib:int-mul 6
                                                          n)))))))
(t
 (setf minwrk
        (max (the fixnum 1)
             (the fixnum (f2cl-lib:int-mul 3 n))))
 (if (and (not wntsnn) (not wntsne))
     (setf minwrk
             (max (the fixnum minwrk)
                  (the fixnum
                       (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                                         (f2cl-lib:int-mul 6
```

```
                                                                n))))))
        (setf maxb
                (max
                 (the fixnum
                      (ilaenv 8 "DHSEQR" "SN" n 1 n -1))
                 (the fixnum 2)))
        (setf k
                (min (the fixnum maxb)
                     (the fixnum n)
                     (the fixnum
                          (max (the fixnum 2)
                               (the fixnum
                                    (ilaenv 4 "DHSEQR" "EN" n 1 n -1))))))
        (setf hswork
                (max
                 (the fixnum
                      (f2cl-lib:int-mul k (f2cl-lib:int-add k 2)))
                 (the fixnum (f2cl-lib:int-mul 2 n))))
        (setf maxwrk
                (max (the fixnum maxwrk)
                     (the fixnum 1)
                     (the fixnum hswork)))
        (setf maxwrk
                (max (the fixnum maxwrk)
                     (the fixnum
                          (f2cl-lib:int-add n
                                           (f2cl-lib:int-mul
                                            (f2cl-lib:int-sub n 1)
                                            (ilaenv 1 "DORGHR" " " n 1 n
                                             -1))))))
        (if (and (not wntsnn) (not wntsne))
            (setf maxwrk
                    (max (the fixnum maxwrk)
                         (the fixnum
                              (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                                                (f2cl-lib:int-mul 6
                                                                  n))))))
        (setf maxwrk
                (max (the fixnum maxwrk)
                     (the fixnum (f2cl-lib:int-mul 3 n))
                     (the fixnum 1)))))
    (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
            (coerce (the fixnum maxwrk) 'double-float))))
  (cond
    ((and (< lwork minwrk) (not lquery))
     (setf info -21)))
  (cond
    ((/= info 0)
     (error
      " ** On entry to ~a parameter number ~a had an illegal value~%"
```

```
    "DGEEVX" (f2cl-lib:int-sub info))
   (go end_label))
  (lquery
   (go end_label)))
(if (= n 0) (go end_label))
(setf eps (dlamch "P"))
(setf smlnum (dlamch "S"))
(setf bignum (/ one smlnum))
(multiple-value-bind (var-0 var-1)
    (dlabad smlnum bignum)
  (declare (ignore))
  (setf smlnum var-0)
  (setf bignum var-1))
(setf smlnum (/ (f2cl-lib:fsqrt smlnum) eps))
(setf bignum (/ one smlnum))
(setf icond 0)
(setf anrm (dlange "M" n n a lda dum))
(setf scalea nil)
(cond
  ((and (> anrm zero) (< anrm smlnum))
   (setf scalea t)
   (setf cscale smlnum))
  ((> anrm bignum)
   (setf scalea t)
   (setf cscale bignum)))
(if scalea
    (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
        (dlascl "G" 0 0 anrm cscale n n a lda ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                       var-8))
      (setf ierr var-9)))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgebal balanc n a lda ilo ihi scale ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-6))
  (setf ilo var-4)
  (setf ihi var-5)
  (setf ierr var-7))
(setf abnrm (dlange "1" n n a lda dum))
(cond
  (scalea
   (setf (f2cl-lib:fref dum (1) ((1 1))) abnrm)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
       (dlascl "G" 0 0 cscale anrm 1 1 dum 1 ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                      var-8))
     (setf ierr var-9))
   (setf abnrm (f2cl-lib:fref dum (1) ((1 1))))))
(setf itau 1)
```

```
(setf iwrk (f2cl-lib:int-add itau n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
    (dgehrd n ilo ihi a lda
     (f2cl-lib:array-slice work double-float (itau) ((1 *)))
     (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7))
  (setf ierr var-8))
(cond
  (wantvl
   (f2cl-lib:f2cl-set-string side "L" (string 1))
   (dlacpy "L" n n a lda vl ldvl)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
       (dorghr n ilo ihi vl ldvl
        (f2cl-lib:array-slice work double-float (itau) ((1 *)))
        (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7))
     (setf ierr var-8))
   (setf iwrk itau)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
          var-10 var-11 var-12 var-13)
       (dhseqr "S" "V" n ilo ihi a lda wr wi vl ldvl
        (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) info)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                      var-8 var-9 var-10 var-11 var-12))
     (setf info var-13))
   (cond
     (wantvr
      (f2cl-lib:f2cl-set-string side "B" (string 1))
      (dlacpy "F" n n vl ldvl vr ldvr))))
  (wantvr
   (f2cl-lib:f2cl-set-string side "R" (string 1))
   (dlacpy "L" n n a lda vr ldvr)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
       (dorghr n ilo ihi vr ldvr
        (f2cl-lib:array-slice work double-float (itau) ((1 *)))
        (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7))
     (setf ierr var-8))
   (setf iwrk itau)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
          var-10 var-11 var-12 var-13)
```

```
        (dhseqr "S" "V" n ilo ihi a lda wr wi vr ldvr
         (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
         (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) info)
       (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                        var-8 var-9 var-10 var-11 var-12))
       (setf info var-13)))
   (t
    (cond
      (wntsnn
       (f2cl-lib:f2cl-set-string job "E" (string 1)))
      (t
       (f2cl-lib:f2cl-set-string job "S" (string 1))))
    (setf iwrk itau)
    (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
           var-10 var-11 var-12 var-13)
        (dhseqr job "N" n ilo ihi a lda wr wi vr ldvr
         (f2cl-lib:array-slice work double-float (iwrk) ((1 *)))
         (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                       var-8 var-9 var-10 var-11 var-12))
      (setf info var-13))))
(if (> info 0) (go label50))
(cond
  ((or wantvl wantvr)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
          var-10 var-11 var-12 var-13)
       (dtrevc side "B" select n a lda vl ldvl vr ldvr n nout
        (f2cl-lib:array-slice work double-float (iwrk) ((1 *))) ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                      var-8 var-9 var-10 var-12))
     (setf nout var-11)
     (setf ierr var-13))))
(cond
  ((not wntsnn)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
          var-10 var-11 var-12 var-13 var-14 var-15 var-16 var-17)
       (dtrsna sense "A" select n a lda vl ldvl vr ldvr rconde rcondv n
        nout (f2cl-lib:array-slice work double-float (iwrk) ((1 *))) n
        iwork icond)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                      var-8 var-9 var-10 var-11 var-12 var-14 var-15
                      var-16))
     (setf nout var-13)
     (setf icond var-17))))
(cond
  (wantvl
   (multiple-value-bind
```

```
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
    (dgebak balanc "L" n ilo ihi scale n vl ldvl ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                   var-8))
  (setf ierr var-9))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i n) nil)
  (tagbody
    (cond
      ((= (f2cl-lib:fref wi (i) ((1 *))) zero)
       (setf scl
             (/ one
                (dnrm2 n
                 (f2cl-lib:array-slice vl
                                       double-float
                                       (1 i)
                                       ((1 ldvl) (1 *)))
                 1)))
       (dscal n scl
        (f2cl-lib:array-slice vl
                              double-float
                              (1 i)
                              ((1 ldvl) (1 *)))
        1))
      ((> (f2cl-lib:fref wi (i) ((1 *))) zero)
       (setf scl
             (/ one
                (dlapy2
                 (dnrm2 n
                  (f2cl-lib:array-slice vl
                                        double-float
                                        (1 i)
                                        ((1 ldvl) (1 *)))
                  1)
                 (dnrm2 n
                  (f2cl-lib:array-slice vl
                                        double-float
                                        (1 (f2cl-lib:int-add i 1))
                                        ((1 ldvl) (1 *)))
                  1))))
       (dscal n scl
        (f2cl-lib:array-slice vl
                              double-float
                              (1 i)
                              ((1 ldvl) (1 *)))
        1)
       (dscal n scl
        (f2cl-lib:array-slice vl
                              double-float
                              (1 (f2cl-lib:int-add i 1))
```

```
                      ((1 ldvl) (1 *)))
 1)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
              ((> k n) nil)
  (tagbody
    (setf (f2cl-lib:fref work-%data%
                         (k)
                         ((1 *))
                         work-%offset%)
          (+
           (expt
            (f2cl-lib:fref vl-%data%
                           (k i)
                           ((1 ldvl) (1 *))
                           vl-%offset%)
            2)
           (expt
            (f2cl-lib:fref vl-%data%
                           (k (f2cl-lib:int-add i 1))
                           ((1 ldvl) (1 *))
                           vl-%offset%)
            2)))))
(setf k (idamax n work 1))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
    (dlartg
     (f2cl-lib:fref vl-%data%
                    (k i)
                    ((1 ldvl) (1 *))
                    vl-%offset%)
     (f2cl-lib:fref vl-%data%
                    (k (f2cl-lib:int-add i 1))
                    ((1 ldvl) (1 *))
                    vl-%offset%)
     cs sn r)
  (declare (ignore var-0 var-1))
  (setf cs var-2)
  (setf sn var-3)
  (setf r var-4))
(drot n
 (f2cl-lib:array-slice vl
                       double-float
                       (1 i)
                       ((1 ldvl) (1 *)))
 1
 (f2cl-lib:array-slice vl
                       double-float
                       (1 (f2cl-lib:int-add i 1))
                       ((1 ldvl) (1 *)))
 1 cs sn)
(setf (f2cl-lib:fref vl-%data%
```

```
                                (k (f2cl-lib:int-add i 1))
                                ((1 ldvl) (1 *))
                                vl-%offset%)
                  zero)))))))
(cond
  (wantvr
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
       (dgebak balanc "R" n ilo ihi scale n vr ldvr ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                      var-8))
     (setf ierr var-9))
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i n) nil)
     (tagbody
       (cond
         ((= (f2cl-lib:fref wi (i) ((1 *))) zero)
          (setf scl
                  (/ one
                     (dnrm2 n
                      (f2cl-lib:array-slice vr
                                            double-float
                                            (1 i)
                                            ((1 ldvr) (1 *)))
                      1)))
          (dscal n scl
           (f2cl-lib:array-slice vr
                                 double-float
                                 (1 i)
                                 ((1 ldvr) (1 *)))
           1))
         ((> (f2cl-lib:fref wi (i) ((1 *))) zero)
          (setf scl
                  (/ one
                     (dlapy2
                      (dnrm2 n
                       (f2cl-lib:array-slice vr
                                             double-float
                                             (1 i)
                                             ((1 ldvr) (1 *)))
                       1)
                      (dnrm2 n
                       (f2cl-lib:array-slice vr
                                             double-float
                                             (1 (f2cl-lib:int-add i 1))
                                             ((1 ldvr) (1 *)))
                       1))))
          (dscal n scl
           (f2cl-lib:array-slice vr
                                 double-float
```

```
                      (1 i)
                      ((1 ldvr) (1 *)))
 1)
(dscal n scl
 (f2cl-lib:array-slice vr
                      double-float
                      (1 (f2cl-lib:int-add i 1))
                      ((1 ldvr) (1 *)))
 1)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
              ((> k n) nil)
  (tagbody
    (setf (f2cl-lib:fref work-%data%
                         (k)
                         ((1 *))
                         work-%offset%)
            (+
             (expt
              (f2cl-lib:fref vr-%data%
                             (k i)
                             ((1 ldvr) (1 *))
                             vr-%offset%)
              2)
             (expt
              (f2cl-lib:fref vr-%data%
                             (k (f2cl-lib:int-add i 1))
                             ((1 ldvr) (1 *))
                             vr-%offset%)
              2)))))
(setf k (idamax n work 1))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
    (dlartg
     (f2cl-lib:fref vr-%data%
                    (k i)
                    ((1 ldvr) (1 *))
                    vr-%offset%)
     (f2cl-lib:fref vr-%data%
                    (k (f2cl-lib:int-add i 1))
                    ((1 ldvr) (1 *))
                    vr-%offset%)
     cs sn r)
  (declare (ignore var-0 var-1))
  (setf cs var-2)
  (setf sn var-3)
  (setf r var-4))
(drot n
 (f2cl-lib:array-slice vr
                      double-float
                      (1 i)
                      ((1 ldvr) (1 *)))
```

```
                1
                (f2cl-lib:array-slice vr
                                      double-float
                                      (1 (f2cl-lib:int-add i 1))
                                      ((1 ldvr) (1 *)))
                1 cs sn)
               (setf (f2cl-lib:fref vr-%data%
                                    (k (f2cl-lib:int-add i 1))
                                    ((1 ldvr) (1 *))
                                    vr-%offset%)
                     zero)))))))
label50
       (cond
         (scalea
          (multiple-value-bind
                (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
              (dlascl "G" 0 0 cscale anrm (f2cl-lib:int-sub n info) 1
               (f2cl-lib:array-slice wr double-float ((+ info 1)) ((1 *)))
               (max (the fixnum (f2cl-lib:int-sub n info))
                    (the fixnum 1))
               ierr)
            (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                             var-8))
            (setf ierr var-9))
          (multiple-value-bind
                (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
              (dlascl "G" 0 0 cscale anrm (f2cl-lib:int-sub n info) 1
               (f2cl-lib:array-slice wi double-float ((+ info 1)) ((1 *)))
               (max (the fixnum (f2cl-lib:int-sub n info))
                    (the fixnum 1))
               ierr)
            (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                             var-8))
            (setf ierr var-9))
          (cond
            ((= info 0)
             (if (and (or wntsnv wntsnb) (= icond 0))
                 (multiple-value-bind
                       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                        var-9)
                     (dlascl "G" 0 0 cscale anrm n 1 rcondv n ierr)
                   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                                    var-7 var-8))
                   (setf ierr var-9))))
            (t
             (multiple-value-bind
                   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                    var-9)
                 (dlascl "G" 0 0 cscale anrm (f2cl-lib:int-sub ilo 1) 1 wr n
                  ierr)
```

```
              (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                               var-7 var-8))
              (setf ierr var-9))
             (multiple-value-bind
                  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                   var-9)
                (dlascl "G" 0 0 cscale anrm (f2cl-lib:int-sub ilo 1) 1 wi n
                 ierr)
              (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                               var-7 var-8))
              (setf ierr var-9))))))
       (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
              (coerce (the fixnum maxwrk) 'double-float))
end_label
       (return
        (values nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                ilo
                ihi
                nil
                abnrm
                nil
                nil
                nil
                nil
                nil
                info))))))
```

———-

6.10 dgehd2 LAPACK

— dgehd2.input —

```
)set break resume
```

```
)sys rm -f dgehd2.output
)spool dgehd2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dgehd2.help —

```
=====================================================================
dgehd2 examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DGEHD2  -  a  real  general  matrix  A to upper Hessenberg form H by an
       orthogonal similarity transformation

SYNOPSIS
       SUBROUTINE DGEHD2( N, ILO, IHI, A, LDA, TAU, WORK, INFO )

           INTEGER        IHI, ILO, INFO, LDA, N

           DOUBLE         PRECISION A( LDA, * ), TAU( * ), WORK( * )

PURPOSE
       DGEHD2 reduces a real general matrix A to upper Hessenberg form H by an
       orthogonal similarity transformation:  Q' * A * Q = H .


ARGUMENTS
       N       (input) INTEGER
               The order of the matrix A.  N >= 0.

       ILO     (input) INTEGER
               IHI      (input)  INTEGER It is assumed that A is already upper
               triangular in rows and columns 1:ILO-1 and IHI+1:N. ILO and IHI
               are  normally  set by a previous call to DGEBAL; otherwise they
               should be set to 1 and N respectively. See Further Details.

       A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
               On entry, the n by n general matrix to be  reduced.   On  exit,
```

```
          the upper triangle and the first subdiagonal of A are overwrit-
          ten with the upper Hessenberg matrix H, and the elements  below
          the  first  subdiagonal,  with  the  array  TAU,  represent the
          orthogonal matrix Q as a product of elementary reflectors.  See
          Further Details.  LDA     (input) INTEGER The leading dimension
          of the array A.  LDA >= max(1,N).

      TAU     (output) DOUBLE PRECISION array, dimension (N-1)
          The scalar factors of the elementary  reflectors  (see  Further
          Details).

      WORK    (workspace) DOUBLE PRECISION array, dimension (N)

      INFO    (output) INTEGER
          = 0:  successful exit.
          < 0:  if INFO = -i, the i-th argument had an illegal value.

FURTHER DETAILS
      The  matrix  Q  is  represented  as  a  product of (ihi-ilo) elementary
      reflectors

         Q = H(ilo) H(ilo+1) . . . H(ihi-1).

      Each H(i) has the form

         H(i) = I - tau * v * v'

      where tau is a real scalar, and v is a real vector with
      v(1:i) = 0, v(i+1) = 1 and v(ihi+1:n) = 0; v(i+2:ihi) is stored on exit
      in A(i+2:ihi,i), and tau in TAU(i).

      The contents of A are illustrated by the following example, with n = 7,
      ilo = 2 and ihi = 6:

      on entry,                         on exit,

      ( a   a   a   a   a   a   a )     (  a   a   h   h   h   h   a )
      (     a   a   a   a   a   a )     (      a   h   h   h   h   a )
      (     a   a   a   a   a   a )     (      h   h   h   h   h   h )
      (     a   a   a   a   a   a )     (      v2  h   h   h   h   h )
      (     a   a   a   a   a   a )     (      v2  v3  h   h   h   h )
      (     a   a   a   a   a   a )     (      v2  v3  v4  h   h   h )
      (                     a   )     (                      a   )

      where a denotes an element of the original matrix A, h denotes a  modi-
      fied  element  of the upper Hessenberg matrix H, and vi denotes an ele-
      ment of the vector defining H(i).
```

— dgehd2.f —

```
      SUBROUTINE DGEHD2( N, ILO, IHI, A, LDA, TAU, WORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1992
*
*     .. Scalar Arguments ..
      INTEGER            IHI, ILO, INFO, LDA, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE
      PARAMETER          ( ONE = 1.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I
      DOUBLE PRECISION   AII
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLARF, DLARFG, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters
*
      INFO = 0
      IF( N.LT.0 ) THEN
         INFO = -1
      ELSE IF( ILO.LT.1 .OR. ILO.GT.MAX( 1, N ) ) THEN
         INFO = -2
      ELSE IF( IHI.LT.MIN( ILO, N ) .OR. IHI.GT.N ) THEN
         INFO = -3
      ELSE IF( LDA.LT.MAX( 1, N ) ) THEN
         INFO = -5
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DGEHD2', -INFO )
         RETURN
```

```
      END IF
*
      DO 10 I = ILO, IHI - 1
*
*        Compute elementary reflector H(i) to annihilate A(i+2:ihi,i)
*
         CALL DLARFG( IHI-I, A( I+1, I ), A( MIN( I+2, N ), I ), 1,
     $                TAU( I ) )
         AII = A( I+1, I )
         A( I+1, I ) = ONE
*
*        Apply H(i) to A(1:ihi,i+1:ihi) from the right
*
         CALL DLARF( 'Right', IHI, IHI-I, A( I+1, I ), 1, TAU( I ),
     $               A( 1, I+1 ), LDA, WORK )
*
*        Apply H(i) to A(i+1:ihi,i+1:n) from the left
*
         CALL DLARF( 'Left', IHI-I, N-I, A( I+1, I ), 1, TAU( I ),
     $               A( I+1, I+1 ), LDA, WORK )
*
         A( I+1, I ) = AII
   10 CONTINUE
*
      RETURN
*
*     End of DGEHD2
*
      END
```

— LAPACK dgehd2 —

```
(let* ((one 1.0))
  (declare (type (double-float 1.0 1.0) one))
  (defun dgehd2 (n ilo ihi a lda tau work info)
    (declare (type (simple-array double-float (*)) work tau a)
             (type fixnum info lda ihi ilo n))
    (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((aii 0.0) (i 0))
        (declare (type (double-float) aii) (type fixnum i))
        (setf info 0)
        (cond
          ((< n 0)
```

```
   (setf info -1))
  ((or (< ilo 1)
       (> ilo
          (max (the fixnum 1) (the fixnum n))))
   (setf info -2))
  ((or
    (< ihi (min (the fixnum ilo) (the fixnum n)))
    (> ihi n))
   (setf info -3))
  ((< lda (max (the fixnum 1) (the fixnum n)))
   (setf info -5)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DGEHD2" (f2cl-lib:int-sub info))
   (go end_label)))
(f2cl-lib:fdo (i ilo (f2cl-lib:int-add i 1))
              ((> i (f2cl-lib:int-add ihi (f2cl-lib:int-sub 1))) nil)
  (tagbody
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
        (dlarfg (f2cl-lib:int-sub ihi i)
         (f2cl-lib:fref a-%data%
                        ((f2cl-lib:int-add i 1) i)
                        ((1 lda) (1 *))
                        a-%offset%)
         (f2cl-lib:array-slice a
                               double-float
                               ((min (f2cl-lib:int-add i 2) n) i)
                               ((1 lda) (1 *)))
         1 (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%))
      (declare (ignore var-0 var-2 var-3))
      (setf (f2cl-lib:fref a-%data%
                           ((f2cl-lib:int-add i 1) i)
                           ((1 lda) (1 *))
                           a-%offset%)
            var-1)
      (setf (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%) var-4))
    (setf aii
          (f2cl-lib:fref a-%data%
                         ((f2cl-lib:int-add i 1) i)
                         ((1 lda) (1 *))
                         a-%offset%))
    (setf (f2cl-lib:fref a-%data%
                         ((f2cl-lib:int-add i 1) i)
                         ((1 lda) (1 *))
                         a-%offset%)
          one)
    (dlarf "Right" ihi (f2cl-lib:int-sub ihi i)
     (f2cl-lib:array-slice a double-float ((+ i 1) i) ((1 lda) (1 *)))
```

```
            1 (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)
            (f2cl-lib:array-slice a
                                  double-float
                                  (1 (f2cl-lib:int-add i 1))
                                  ((1 lda) (1 *)))
            lda work)
           (dlarf "Left" (f2cl-lib:int-sub ihi i) (f2cl-lib:int-sub n i)
            (f2cl-lib:array-slice a double-float ((+ i 1) i) ((1 lda) (1 *)))
            1 (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)
            (f2cl-lib:array-slice a
                                  double-float
                                  ((+ i 1) (f2cl-lib:int-add i 1))
                                  ((1 lda) (1 *)))
            lda work)
           (setf (f2cl-lib:fref a-%data%
                                ((f2cl-lib:int-add i 1) i)
                                ((1 lda) (1 *))
                                a-%offset%)
                 aii)))
 end_label
        (return (values nil nil nil nil nil nil nil info))))))
```

———-

6.11 dgehrd LAPACK

— **dgehrd.input** —

```
)set break resume
)sys rm -f dgehrd.output
)spool dgehrd.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dgehrd.help** —

```
==========================================================================
dgehrd examples
==========================================================================
```

```
=====================================================================
Man Page Details
=====================================================================

NAME
       DGEHRD  -  Reduce a real general matrix A to upper Hessenberg form H by
       an orthogonal similarity transformation

SYNOPSIS
       SUBROUTINE DGEHRD( N, ILO, IHI, A, LDA, TAU, WORK, LWORK, INFO )

           INTEGER        IHI, ILO, INFO, LDA, LWORK, N

           DOUBLE         PRECISION A( LDA, * ), TAU( * ), WORK( * )

PURPOSE
       DGEHRD reduces a real general matrix A to upper Hessenberg form H by an
       orthogonal similarity transformation:  Q' * A * Q = H .


ARGUMENTS
       N       (input) INTEGER
               The order of the matrix A.  N >= 0.

       ILO     (input) INTEGER
               IHI      (input)  INTEGER It is assumed that A is already upper
               triangular in rows and columns 1:ILO-1 and IHI+1:N. ILO and IHI
               are  normally  set by a previous call to DGEBAL; otherwise they
               should be set to 1 and N respectively. See Further Details.

       A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
               On entry, the N-by-N general matrix to be  reduced.   On  exit,
               the upper triangle and the first subdiagonal of A are overwrit-
               ten with the upper Hessenberg matrix H, and the elements  below
               the  first  subdiagonal,  with  the  array  TAU,  represent the
               orthogonal matrix Q as a product of elementary reflectors.  See
               Further Details.  LDA     (input) INTEGER The leading dimension
               of the array A.  LDA >= max(1,N).

       TAU     (output) DOUBLE PRECISION array, dimension (N-1)
               The scalar factors of the elementary  reflectors  (see  Further
               Details).  Elements 1:ILO-1 and IHI:N-1 of TAU are set to zero.

       WORK    (workspace/output) DOUBLE PRECISION array, dimension (LWORK)
               On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

       LWORK   (input) INTEGER
               The length of the array WORK.  LWORK >= max(1,N).  For  optimum
               performance LWORK >= N*NB, where NB is the optimal blocksize.
```

```
            If  LWORK  = -1, then a workspace query is assumed; the routine
            only calculates the optimal size of  the  WORK  array,  returns
            this  value  as the first entry of the WORK array, and no error
            message related to LWORK is issued by XERBLA.

      INFO  (output) INTEGER
            = 0:  successful exit
            < 0:  if INFO = -i, the i-th argument had an illegal value.

FURTHER DETAILS
      The matrix Q is  represented  as  a  product  of  (ihi-ilo)  elementary
      reflectors

         Q = H(ilo) H(ilo+1) . . . H(ihi-1).

      Each H(i) has the form

         H(i) = I - tau * v * v'

      where tau is a real scalar, and v is a real vector with
      v(1:i) = 0, v(i+1) = 1 and v(ihi+1:n) = 0; v(i+2:ihi) is stored on exit
      in A(i+2:ihi,i), and tau in TAU(i).

      The contents of A are illustrated by the following example, with n = 7,
      ilo = 2 and ihi = 6:

      on entry,                        on exit,

      ( a   a   a   a   a   a   a )    (  a   a   h   h   h   h   a )
      (     a   a   a   a   a   a )    (      a   h   h   h   h   a )
      (     a   a   a   a   a   a )    (      h   h   h   h   h   h )
      (     a   a   a   a   a   a )    (      v2  h   h   h   h   h )
      (     a   a   a   a   a   a )    (      v2  v3  h   h   h   h )
      (     a   a   a   a   a   a )    (      v2  v3  v4  h   h   h )
      (                     a   )      (                      a   )

      where  a denotes an element of the original matrix A, h denotes a modi-
      fied element of the upper Hessenberg matrix H, and vi denotes  an  ele-
      ment of the vector defining H(i).

      See Quintana-Orti and Van  de  Geijn (2005).
```

— dgehrd.f —

```
     SUBROUTINE DGEHRD( N, ILO, IHI, A, LDA, TAU, WORK, LWORK, INFO )
```

```
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      INTEGER            IHI, ILO, INFO, LDA, LWORK, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      INTEGER            NBMAX, LDT
      PARAMETER          ( NBMAX = 64, LDT = NBMAX+1 )
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            LQUERY
      INTEGER            I, IB, IINFO, IWS, LDWORK, LWKOPT, NB, NBMIN,
     $                   NH, NX
      DOUBLE PRECISION   EI
*     ..
*     .. Local Arrays ..
      DOUBLE PRECISION   T( LDT, NBMAX )
*     ..
*     .. External Subroutines ..
      EXTERNAL           DGEHD2, DGEMM, DLAHRD, DLARFB, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. External Functions ..
      INTEGER            ILAENV
      EXTERNAL           ILAENV
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters
*
      INFO = 0
      NB = MIN( NBMAX, ILAENV( 1, 'DGEHRD', ' ', N, ILO, IHI, -1 ) )
      LWKOPT = N*NB
      WORK( 1 ) = LWKOPT
      LQUERY = ( LWORK.EQ.-1 )
      IF( N.LT.0 ) THEN
```

```
         INFO = -1
      ELSE IF( ILO.LT.1 .OR. ILO.GT.MAX( 1, N ) ) THEN
         INFO = -2
      ELSE IF( IHI.LT.MIN( ILO, N ) .OR. IHI.GT.N ) THEN
         INFO = -3
      ELSE IF( LDA.LT.MAX( 1, N ) ) THEN
         INFO = -5
      ELSE IF( LWORK.LT.MAX( 1, N ) .AND. .NOT.LQUERY ) THEN
         INFO = -8
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DGEHRD', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Set elements 1:ILO-1 and IHI:N-1 of TAU to zero
*
      DO 10 I = 1, ILO - 1
         TAU( I ) = ZERO
   10 CONTINUE
      DO 20 I = MAX( 1, IHI ), N - 1
         TAU( I ) = ZERO
   20 CONTINUE
*
*     Quick return if possible
*
      NH = IHI - ILO + 1
      IF( NH.LE.1 ) THEN
         WORK( 1 ) = 1
         RETURN
      END IF
*
*     Determine the block size.
*
      NB = MIN( NBMAX, ILAENV( 1, 'DGEHRD', ' ', N, ILO, IHI, -1 ) )
      NBMIN = 2
      IWS = 1
      IF( NB.GT.1 .AND. NB.LT.NH ) THEN
*
*        Determine when to cross over from blocked to unblocked code
*        (last block is always handled by unblocked code).
*
         NX = MAX( NB, ILAENV( 3, 'DGEHRD', ' ', N, ILO, IHI, -1 ) )
         IF( NX.LT.NH ) THEN
*
*           Determine if workspace is large enough for blocked code.
*
            IWS = N*NB
```

```
            IF( LWORK.LT.IWS ) THEN
*
*              Not enough workspace to use optimal NB:  determine the
*              minimum value of NB, and reduce NB or force use of
*              unblocked code.
*
               NBMIN = MAX( 2, ILAENV( 2, 'DGEHRD', ' ', N, ILO, IHI,
     $                 -1 ) )
               IF( LWORK.GE.N*NBMIN ) THEN
                  NB = LWORK / N
               ELSE
                  NB = 1
               END IF
            END IF
         END IF
         LDWORK = N
*
         IF( NB.LT.NBMIN .OR. NB.GE.NH ) THEN
*
*           Use unblocked code below
*
            I = ILO
*
         ELSE
*
*           Use blocked code
*
            DO 30 I = ILO, IHI - 1 - NX, NB
               IB = MIN( NB, IHI-I )
*
*              Reduce columns i:i+ib-1 to Hessenberg form, returning the
*              matrices V and T of the block reflector H = I - V*T*V'
*              which performs the reduction, and also the matrix Y = A*V*T
*
               CALL DLAHRD( IHI, I, IB, A( 1, I ), LDA, TAU( I ), T, LDT,
     $                      WORK, LDWORK )
*
*              Apply the block reflector H to A(1:ihi,i+ib:ihi) from the
*              right, computing  A := A - Y * V'. V(i+ib,ib-1) must be set
*              to 1.
*
               EI = A( I+IB, I+IB-1 )
               A( I+IB, I+IB-1 ) = ONE
               CALL DGEMM( 'No transpose', 'Transpose', IHI, IHI-I-IB+1,
     $                     IB, -ONE, WORK, LDWORK, A( I+IB, I ), LDA, ONE,
     $                     A( 1, I+IB ), LDA )
               A( I+IB, I+IB-1 ) = EI
*
*              Apply the block reflector H to A(i+1:ihi,i+ib:n) from the
```

```
*           left
*
            CALL DLARFB( 'Left', 'Transpose', 'Forward', 'Columnwise',
     $                   IHI-I, N-I-IB+1, IB, A( I+1, I ), LDA, T, LDT,
     $                   A( I+1, I+IB ), LDA, WORK, LDWORK )
   30    CONTINUE
      END IF
*
*     Use unblocked code to reduce the rest of the matrix
*
      CALL DGEHD2( N, I, IHI, A, LDA, TAU, WORK, IINFO )
      WORK( 1 ) = IWS
*
      RETURN
*
*     End of DGEHRD
*
      END
```

———-

— LAPACK dgehrd —

```
(let* ((nbmax 64) (ldt (+ nbmax 1)) (zero 0.0) (one 1.0))
  (declare (type (fixnum 64 64) nbmax)
           (type fixnum ldt)
           (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one))
  (defun dgehrd (n ilo ihi a lda tau work lwork info)
    (declare (type (simple-array double-float (*)) work tau a)
             (type fixnum info lwork lda ihi ilo n))
    (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((ei 0.0) (i 0) (ib 0) (iinfo 0) (iws 0) (ldwork 0) (lwkopt 0)
             (nb 0) (nbmin 0) (nh 0) (nx 0) (lquery nil)
             (t$
              (make-array (the fixnum (reduce #'* (list ldt nbmax)))
                          :element-type 'double-float)))
        (declare (type (simple-array double-float (*)) t$)
                 (type (double-float) ei)
                 (type fixnum i ib iinfo iws ldwork lwkopt nb
                                          nbmin nh nx)
                 (type (member t nil) lquery))
        (setf info 0)
        (setf nb
                (min (the fixnum nbmax)
```

```
             (the fixnum
                  (ilaenv 1 "DGEHRD" " " n ilo ihi -1))))
(setf lwkopt (f2cl-lib:int-mul n nb))
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
        (coerce (the fixnum lwkopt) 'double-float))
(setf lquery (coerce (= lwork -1) '(member t nil)))
(cond
  ((< n 0)
   (setf info -1))
  ((or (< ilo 1)
       (> ilo
          (max (the fixnum 1) (the fixnum n))))
   (setf info -2))
  ((or
    (< ihi (min (the fixnum ilo) (the fixnum n)))
    (> ihi n))
   (setf info -3))
  ((< lda (max (the fixnum 1) (the fixnum n)))
   (setf info -5))
  ((and
    (< lwork (max (the fixnum 1) (the fixnum n)))
    (not lquery))
   (setf info -8)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DGEHRD" (f2cl-lib:int-sub info))
   (go end_label))
  (lquery
   (go end_label)))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i (f2cl-lib:int-add ilo (f2cl-lib:int-sub 1))) nil)
  (tagbody
    (setf (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%) zero)))
(f2cl-lib:fdo (i
               (max (the fixnum 1)
                    (the fixnum ihi))
               (f2cl-lib:int-add i 1))
              ((> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
  (tagbody
    (setf (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%) zero)))
(setf nh (f2cl-lib:int-add (f2cl-lib:int-sub ihi ilo) 1))
(cond
  ((<= nh 1)
   (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
           (coerce (the fixnum 1) 'double-float))
   (go end_label)))
(setf nb
        (min (the fixnum nbmax)
```

```
             (the fixnum
                  (ilaenv 1 "DGEHRD" " " n ilo ihi -1))))
(setf nbmin 2)
(setf iws 1)
(cond
  ((and (> nb 1) (< nb nh))
   (setf nx
           (max (the fixnum nb)
                (the fixnum
                     (ilaenv 3 "DGEHRD" " " n ilo ihi -1))))
   (cond
     ((< nx nh)
      (setf iws (f2cl-lib:int-mul n nb))
      (cond
        ((< lwork iws)
         (setf nbmin
                 (max (the fixnum 2)
                      (the fixnum
                           (ilaenv 2 "DGEHRD" " " n ilo ihi -1))))
         (cond
           ((>= lwork (f2cl-lib:int-mul n nbmin))
            (setf nb (the fixnum (truncate lwork n))))
           (t
            (setf nb 1)))))))))
(setf ldwork n)
(cond
  ((or (< nb nbmin) (>= nb nh))
   (setf i ilo))
  (t
   (f2cl-lib:fdo (i ilo (f2cl-lib:int-add i nb))
                 ((> i
                     (f2cl-lib:int-add ihi
                                       (f2cl-lib:int-sub 1)
                                       (f2cl-lib:int-sub nx)))
                  nil)
     (tagbody
       (setf ib
               (min (the fixnum nb)
                    (the fixnum (f2cl-lib:int-sub ihi i))))
       (dlahrd ihi i ib
        (f2cl-lib:array-slice a double-float (1 i) ((1 lda) (1 *))) lda
        (f2cl-lib:array-slice tau double-float (i) ((1 *))) t$ ldt work
        ldwork)
       (setf ei
               (f2cl-lib:fref a-%data%
                              ((f2cl-lib:int-add i ib)
                               (f2cl-lib:int-sub
                                (f2cl-lib:int-add i ib)
                                1))
                              ((1 lda) (1 *))
```

```
                                a-%offset%))
                (setf (f2cl-lib:fref a-%data%
                                     ((f2cl-lib:int-add i ib)
                                      (f2cl-lib:int-sub (f2cl-lib:int-add i ib)
                                                        1))
                                     ((1 lda) (1 *))
                                     a-%offset%)
                      one)
                (dgemm "No transpose" "Transpose" ihi
                 (f2cl-lib:int-add (f2cl-lib:int-sub ihi i ib) 1) ib (- one)
                 work ldwork
                 (f2cl-lib:array-slice a
                                       double-float
                                       ((+ i ib) i)
                                       ((1 lda) (1 *)))
                 lda one
                 (f2cl-lib:array-slice a
                                       double-float
                                       (1 (f2cl-lib:int-add i ib))
                                       ((1 lda) (1 *)))
                 lda)
                (setf (f2cl-lib:fref a-%data%
                                     ((f2cl-lib:int-add i ib)
                                      (f2cl-lib:int-sub (f2cl-lib:int-add i ib)
                                                        1))
                                     ((1 lda) (1 *))
                                     a-%offset%)
                      ei)
                (dlarfb "Left" "Transpose" "Forward" "Columnwise"
                 (f2cl-lib:int-sub ihi i)
                 (f2cl-lib:int-add (f2cl-lib:int-sub n i ib) 1) ib
                 (f2cl-lib:array-slice a
                                       double-float
                                       ((+ i 1) i)
                                       ((1 lda) (1 *)))
                 lda t$ ldt
                 (f2cl-lib:array-slice a
                                       double-float
                                       ((+ i 1) (f2cl-lib:int-add i ib))
                                       ((1 lda) (1 *)))
                 lda work ldwork)))))
       (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
           (dgehd2 n i ihi a lda tau work iinfo)
         (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
         (setf iinfo var-7))
       (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
             (coerce (the fixnum iws) 'double-float))
end_label
       (return (values nil nil nil nil nil nil nil nil info))))))
```

———-

6.12 dgelq2 LAPACK

— **dgelq2.input** —

```
)set break resume
)sys rm -f dgelq2.output
)spool dgelq2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dgelq2.help** —

```
=====================================================================
dgelq2 examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DGELQ2 - an LQ factorization of a real m by n matrix A

SYNOPSIS
       SUBROUTINE DGELQ2( M, N, A, LDA, TAU, WORK, INFO )

           INTEGER        INFO, LDA, M, N

           DOUBLE         PRECISION A( LDA, * ), TAU( * ), WORK( * )

PURPOSE
       DGELQ2  computes an LQ factorization of a real m by n matrix A: A = L *
       Q.


ARGUMENTS
       M       (input) INTEGER
               The number of rows of the matrix A.  M >= 0.
```

```
       N       (input) INTEGER
               The number of columns of the matrix A.  N >= 0.

       A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
               On entry, the m by n matrix A.  On exit, the  elements  on  and
               below the diagonal of the array contain the m by min(m,n) lower
               trapezoidal matrix L (L is lower triangular if  m  <=  n);  the
               elements  above the diagonal, with the array TAU, represent the
               orthogonal matrix Q as a product of elementary reflectors  (see
               Further  Details).   LDA     (input) INTEGER The leading dimen-
               sion of the array A.  LDA >= max(1,M).

       TAU     (output) DOUBLE PRECISION array, dimension (min(M,N))
               The scalar factors of the elementary  reflectors  (see  Further
               Details).

       WORK    (workspace) DOUBLE PRECISION array, dimension (M)

       INFO    (output) INTEGER
               = 0: successful exit
               < 0: if INFO = -i, the i-th argument had an illegal value

FURTHER DETAILS
       The matrix Q is represented as a product of elementary reflectors

          Q = H(k) . . . H(2) H(1), where k = min(m,n).

       Each H(i) has the form

          H(i) = I - tau * v * v'

       where tau is a real scalar, and v is a real vector with
       v(1:i-1)  =  0  and v(i) = 1; v(i+1:n) is stored on exit in A(i,i+1:n),
       and tau in TAU(i).
```

———-

— dgelq2.f —

```
      SUBROUTINE DGELQ2( M, N, A, LDA, TAU, WORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     February 29, 1992
*
*     .. Scalar Arguments ..
```

```
      INTEGER            INFO, LDA, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE
      PARAMETER          ( ONE = 1.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I, K
      DOUBLE PRECISION   AII
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLARF, DLARFG, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      IF( M.LT.0 ) THEN
         INFO = -1
      ELSE IF( N.LT.0 ) THEN
         INFO = -2
      ELSE IF( LDA.LT.MAX( 1, M ) ) THEN
         INFO = -4
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DGELQ2', -INFO )
         RETURN
      END IF
*
      K = MIN( M, N )
*
      DO 10 I = 1, K
*
*        Generate elementary reflector H(i) to annihilate A(i,i+1:n)
*
         CALL DLARFG( N-I+1, A( I, I ), A( I, MIN( I+1, N ) ), LDA,
     $                TAU( I ) )
         IF( I.LT.M ) THEN
*
*           Apply H(i) to A(i+1:m,i:n) from the right
```

```
*
            AII = A( I, I )
            A( I, I ) = ONE
            CALL DLARF( 'Right', M-I, N-I+1, A( I, I ), LDA, TAU( I ),
     $                  A( I+1, I ), LDA, WORK )
            A( I, I ) = AII
         END IF
   10 CONTINUE
      RETURN
*
*     End of DGELQ2
*
      END
```

———-

— **LAPACK dgelq2** —

```
(let* ((one 1.0))
  (declare (type (double-float 1.0 1.0) one))
  (defun dgelq2 (m n a lda tau work info)
    (declare (type (simple-array double-float (*)) work tau a)
             (type fixnum info lda n m))
    (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((aii 0.0) (i 0) (k 0))
        (declare (type (double-float) aii) (type fixnum i k))
        (setf info 0)
        (cond
          ((< m 0)
           (setf info -1))
          ((< n 0)
           (setf info -2))
          ((< lda (max (the fixnum 1) (the fixnum m)))
           (setf info -4)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DGELQ2" (f2cl-lib:int-sub info))
           (go end_label)))
        (setf k (min (the fixnum m) (the fixnum n)))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i k) nil)
          (tagbody
            (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
```

```
               (dlarfg (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
                (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
                (f2cl-lib:array-slice a
                                      double-float
                                      (i
                                       (min
                                        (the fixnum
                                             (f2cl-lib:int-add i 1))
                                        (the fixnum n)))
                                      ((1 lda) (1 *)))
                lda (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%))
              (declare (ignore var-0 var-2 var-3))
              (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
                    var-1)
              (setf (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%) var-4))
            (cond
              ((< i m)
               (setf aii
                     (f2cl-lib:fref a-%data%
                                    (i i)
                                    ((1 lda) (1 *))
                                    a-%offset%))
               (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
                     one)
               (dlarf "Right" (f2cl-lib:int-sub m i)
                (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
                (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
                (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)
                (f2cl-lib:array-slice a
                                      double-float
                                      ((+ i 1) i)
                                      ((1 lda) (1 *)))
                lda work)
               (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
                     aii)))))
 end_label
        (return (values nil nil nil nil nil nil info))))))
```

———-

6.13 dgelqf LAPACK

— dgelqf.input —

```
)set break resume
)sys rm -f dgelqf.output
```

```
)spool dgelqf.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dgelqf.help —

```
==========================================================================
dgelqf examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

NAME
       DGELQF - an LQ factorization of a real M-by-N matrix A

SYNOPSIS
       SUBROUTINE DGELQF( M, N, A, LDA, TAU, WORK, LWORK, INFO )

           INTEGER        INFO, LDA, LWORK, M, N

           DOUBLE         PRECISION A( LDA, * ), TAU( * ), WORK( * )

PURPOSE
       DGELQF  computes an LQ factorization of a real M-by-N matrix A: A = L *
       Q.


ARGUMENTS
       M       (input) INTEGER
               The number of rows of the matrix A.  M >= 0.

       N       (input) INTEGER
               The number of columns of the matrix A.  N >= 0.

       A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
               On entry, the M-by-N matrix A.  On exit, the  elements  on  and
               below the diagonal of the array contain the m-by-min(m,n) lower
               trapezoidal matrix L (L is lower triangular if  m  <=  n);  the
               elements  above the diagonal, with the array TAU, represent the
               orthogonal matrix Q as a product of elementary reflectors  (see
               Further  Details).   LDA     (input) INTEGER The leading dimen-
```

```
              sion of the array A.  LDA >= max(1,M).

       TAU     (output) DOUBLE PRECISION array, dimension (min(M,N))
              The scalar factors of the elementary  reflectors  (see  Further
              Details).

       WORK       (workspace/output)   DOUBLE   PRECISION   array,   dimension
       (MAX(1,LWORK))
              On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

       LWORK   (input) INTEGER
              The dimension of the array WORK.  LWORK >= max(1,M).  For opti-
              mum performance LWORK >= M*NB, where NB is the  optimal  block-
              size.

              If  LWORK  = -1, then a workspace query is assumed; the routine
              only calculates the optimal size of  the  WORK  array,  returns
              this  value  as the first entry of the WORK array, and no error
              message related to LWORK is issued by XERBLA.

       INFO    (output) INTEGER
              = 0:  successful exit
              < 0:  if INFO = -i, the i-th argument had an illegal value

FURTHER DETAILS
       The matrix Q is represented as a product of elementary reflectors

          Q = H(k) . . . H(2) H(1), where k = min(m,n).

       Each H(i) has the form

          H(i) = I - tau * v * v'

       where tau is a real scalar, and v is a real vector with
       v(1:i-1) = 0 and v(i) = 1; v(i+1:n) is stored on  exit  in  A(i,i+1:n),
       and tau in TAU(i).
```

— dgelqf.f —

```
      SUBROUTINE DGELQF( M, N, A, LDA, TAU, WORK, LWORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
```

```
*     .. Scalar Arguments ..
      INTEGER            INFO, LDA, LWORK, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Local Scalars ..
      LOGICAL            LQUERY
      INTEGER            I, IB, IINFO, IWS, K, LDWORK, LWKOPT, NB,
     $                   NBMIN, NX
*     ..
*     .. External Subroutines ..
      EXTERNAL           DGELQ2, DLARFB, DLARFT, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. External Functions ..
      INTEGER            ILAENV
      EXTERNAL           ILAENV
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      NB = ILAENV( 1, 'DGELQF', ' ', M, N, -1, -1 )
      LWKOPT = M*NB
      WORK( 1 ) = LWKOPT
      LQUERY = ( LWORK.EQ.-1 )
      IF( M.LT.0 ) THEN
         INFO = -1
      ELSE IF( N.LT.0 ) THEN
         INFO = -2
      ELSE IF( LDA.LT.MAX( 1, M ) ) THEN
         INFO = -4
      ELSE IF( LWORK.LT.MAX( 1, M ) .AND. .NOT.LQUERY ) THEN
         INFO = -7
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DGELQF', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Quick return if possible
```

```
*
      K = MIN( M, N )
      IF( K.EQ.0 ) THEN
         WORK( 1 ) = 1
         RETURN
      END IF
*
      NBMIN = 2
      NX = 0
      IWS = M
      IF( NB.GT.1 .AND. NB.LT.K ) THEN
*
*        Determine when to cross over from blocked to unblocked code.
*
         NX = MAX( 0, ILAENV( 3, 'DGELQF', ' ', M, N, -1, -1 ) )
         IF( NX.LT.K ) THEN
*
*           Determine if workspace is large enough for blocked code.
*
            LDWORK = M
            IWS = LDWORK*NB
            IF( LWORK.LT.IWS ) THEN
*
*              Not enough workspace to use optimal NB:  reduce NB and
*              determine the minimum value of NB.
*
               NB = LWORK / LDWORK
               NBMIN = MAX( 2, ILAENV( 2, 'DGELQF', ' ', M, N, -1,
     $                 -1 ) )
            END IF
         END IF
      END IF
*
      IF( NB.GE.NBMIN .AND. NB.LT.K .AND. NX.LT.K ) THEN
*
*        Use blocked code initially
*
         DO 10 I = 1, K - NX, NB
            IB = MIN( K-I+1, NB )
*
*           Compute the LQ factorization of the current block
*           A(i:i+ib-1,i:n)
*
            CALL DGELQ2( IB, N-I+1, A( I, I ), LDA, TAU( I ), WORK,
     $                   IINFO )
            IF( I+IB.LE.M ) THEN
*
*              Form the triangular factor of the block reflector
*              H = H(i) H(i+1) . . . H(i+ib-1)
*
```

```
               CALL DLARFT( 'Forward', 'Rowwise', N-I+1, IB, A( I, I ),
     $                      LDA, TAU( I ), WORK, LDWORK )
*
*              Apply H to A(i+ib:m,i:n) from the right
*
               CALL DLARFB( 'Right', 'No transpose', 'Forward',
     $                      'Rowwise', M-I-IB+1, N-I+1, IB, A( I, I ),
     $                      LDA, WORK, LDWORK, A( I+IB, I ), LDA,
     $                      WORK( IB+1 ), LDWORK )
            END IF
   10    CONTINUE
         ELSE
            I = 1
         END IF
*
*     Use unblocked code to factor the last or only block.
*
         IF( I.LE.K )
     $   CALL DGELQ2( M-I+1, N-I+1, A( I, I ), LDA, TAU( I ), WORK,
     $                IINFO )
*
         WORK( 1 ) = IWS
         RETURN
*
*     End of DGELQF
*
         END
```

———-

— LAPACK dgelqf —

```
(defun dgelqf (m n a lda tau work lwork info)
  (declare (type (simple-array double-float (*)) work tau a)
           (type fixnum info lwork lda n m))
  (f2cl-lib:with-multi-array-data
      ((a double-float a-%data% a-%offset%)
       (tau double-float tau-%data% tau-%offset%)
       (work double-float work-%data% work-%offset%))
    (prog ((i 0) (ib 0) (iinfo 0) (iws 0) (k 0) (ldwork 0) (lwkopt 0) (nb 0)
           (nbmin 0) (nx 0) (lquery nil))
      (declare (type (member t nil) lquery)
               (type fixnum nx nbmin nb lwkopt ldwork k iws iinfo
                                       ib i))
      (setf info 0)
      (setf nb (ilaenv 1 "DGELQF" " " m n -1 -1))
      (setf lwkopt (f2cl-lib:int-mul m nb))
      (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
```

```
       (coerce (the fixnum lwkopt) 'double-float))
(setf lquery (coerce (= lwork -1) '(member t nil)))
(cond
  ((< m 0)
   (setf info -1))
  ((< n 0)
   (setf info -2))
  ((< lda (max (the fixnum 1) (the fixnum m)))
   (setf info -4))
  ((and
    (< lwork (max (the fixnum 1) (the fixnum m)))
    (not lquery))
   (setf info -7)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DGELQF" (f2cl-lib:int-sub info))
   (go end_label))
  (lquery
   (go end_label)))
(setf k (min (the fixnum m) (the fixnum n)))
(cond
  ((= k 0)
   (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
           (coerce (the fixnum 1) 'double-float))
   (go end_label)))
(setf nbmin 2)
(setf nx 0)
(setf iws m)
(cond
  ((and (> nb 1) (< nb k))
   (setf nx
           (max (the fixnum 0)
                (the fixnum
                     (ilaenv 3 "DGELQF" " " m n -1 -1))))
   (cond
     ((< nx k)
      (setf ldwork m)
      (setf iws (f2cl-lib:int-mul ldwork nb))
      (cond
        ((< lwork iws)
         (setf nb (the fixnum (truncate lwork ldwork)))
         (setf nbmin
                 (max (the fixnum 2)
                      (the fixnum
                           (ilaenv 2 "DGELQF" " " m n -1 -1)))))))))
(cond
  ((and (>= nb nbmin) (< nb k) (< nx k))
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i nb))
```

```
                    ((> i (f2cl-lib:int-add k (f2cl-lib:int-sub nx))) nil)
          (tagbody
            (setf ib
                  (min
                   (the fixnum
                        (f2cl-lib:int-add (f2cl-lib:int-sub k i) 1))
                   (the fixnum nb)))
            (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
                (dgelq2 ib (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
                 (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
                 lda (f2cl-lib:array-slice tau double-float (i) ((1 *))) work
                 iinfo)
              (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5))
              (setf iinfo var-6))
            (cond
              ((<= (f2cl-lib:int-add i ib) m)
               (dlarft "Forward" "Rowwise"
                (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1) ib
                (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
                lda (f2cl-lib:array-slice tau double-float (i) ((1 *))) work
                ldwork)
               (dlarfb "Right" "No transpose" "Forward" "Rowwise"
                (f2cl-lib:int-add (f2cl-lib:int-sub m i ib) 1)
                (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1) ib
                (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
                lda work ldwork
                (f2cl-lib:array-slice a
                                      double-float
                                      ((+ i ib) i)
                                      ((1 lda) (1 *)))
                lda
                (f2cl-lib:array-slice work double-float ((+ ib 1)) ((1 *)))
                ldwork))))))
        (t
         (setf i 1)))
      (if (<= i k)
          (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
              (dgelq2 (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
               (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
               (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
               (f2cl-lib:array-slice tau double-float (i) ((1 *))) work iinfo)
            (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5))
            (setf iinfo var-6)))
      (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
            (coerce (the fixnum iws) 'double-float))
 end_label
      (return (values nil nil nil nil nil nil nil info)))))
```

6.14 dgeqr2 LAPACK

— **dgeqr2.input** —

```
)set break resume
)sys rm -f dgeqr2.output
)spool dgeqr2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dgeqr2.help** —

```
=======================================================================
dgeqr2 examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

NAME
       DGEQR2 - a QR factorization of a real m by n matrix A

SYNOPSIS
       SUBROUTINE DGEQR2( M, N, A, LDA, TAU, WORK, INFO )

           INTEGER        INFO, LDA, M, N

           DOUBLE         PRECISION A( LDA, * ), TAU( * ), WORK( * )

PURPOSE
       DGEQR2  computes  a QR factorization of a real m by n matrix A: A = Q *
       R.


ARGUMENTS
       M       (input) INTEGER
               The number of rows of the matrix A.  M >= 0.

       N       (input) INTEGER
               The number of columns of the matrix A.  N >= 0.
```

```
       A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
               On entry, the m by n matrix A.  On exit, the  elements  on  and
               above the diagonal of the array contain the min(m,n) by n upper
               trapezoidal matrix R (R is upper triangular if  m  >=  n);  the
               elements  below the diagonal, with the array TAU, represent the
               orthogonal matrix Q as a product of elementary reflectors  (see
               Further  Details).   LDA     (input) INTEGER The leading dimen-
               sion of the array A.  LDA >= max(1,M).

       TAU     (output) DOUBLE PRECISION array, dimension (min(M,N))
               The scalar factors of the elementary  reflectors  (see  Further
               Details).

       WORK    (workspace) DOUBLE PRECISION array, dimension (N)

       INFO    (output) INTEGER
               = 0: successful exit
               < 0: if INFO = -i, the i-th argument had an illegal value

FURTHER DETAILS
       The matrix Q is represented as a product of elementary reflectors

          Q = H(1) H(2) . . . H(k), where k = min(m,n).

       Each H(i) has the form

          H(i) = I - tau * v * v'

       where tau is a real scalar, and v is a real vector with
       v(1:i-1)  =  0  and v(i) = 1; v(i+1:m) is stored on exit in A(i+1:m,i),
       and tau in TAU(i).
```

———-

— dgeqr2.f —

```
      SUBROUTINE DGEQR2( M, N, A, LDA, TAU, WORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     February 29, 1992
*
*     .. Scalar Arguments ..
      INTEGER            INFO, LDA, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), TAU( * ), WORK( * )
```

```
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE
      PARAMETER          ( ONE = 1.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I, K
      DOUBLE PRECISION   AII
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLARF, DLARFG, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      IF( M.LT.0 ) THEN
         INFO = -1
      ELSE IF( N.LT.0 ) THEN
         INFO = -2
      ELSE IF( LDA.LT.MAX( 1, M ) ) THEN
         INFO = -4
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DGEQR2', -INFO )
         RETURN
      END IF
*
      K = MIN( M, N )
*
      DO 10 I = 1, K
*
*        Generate elementary reflector H(i) to annihilate A(i+1:m,i)
*
         CALL DLARFG( M-I+1, A( I, I ), A( MIN( I+1, M ), I ), 1,
     $                TAU( I ) )
         IF( I.LT.N ) THEN
*
*           Apply H(i) to A(i:m,i+1:n) from the left
*
            AII = A( I, I )
            A( I, I ) = ONE
            CALL DLARF( 'Left', M-I+1, N-I, A( I, I ), 1, TAU( I ),
```

```
     $                  A( I, I+1 ), LDA, WORK )
            A( I, I ) = AII
         END IF
   10 CONTINUE
      RETURN
*
*     End of DGEQR2
*
      END
```

———-

— LAPACK dgeqr2 —

```
(let* ((one 1.0))
  (declare (type (double-float 1.0 1.0) one))
  (defun dgeqr2 (m n a lda tau work info)
    (declare (type (simple-array double-float (*)) work tau a)
             (type fixnum info lda n m))
    (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((aii 0.0) (i 0) (k 0))
        (declare (type (double-float) aii) (type fixnum i k))
        (setf info 0)
        (cond
          ((< m 0)
           (setf info -1))
          ((< n 0)
           (setf info -2))
          ((< lda (max (the fixnum 1) (the fixnum m)))
           (setf info -4)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DGEQR2" (f2cl-lib:int-sub info))
           (go end_label)))
        (setf k (min (the fixnum m) (the fixnum n)))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i k) nil)
          (tagbody
            (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
                (dlarfg (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
                 (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
                 (f2cl-lib:array-slice a
                                       double-float
```

```
                                    ((min (f2cl-lib:int-add i 1) m) i)
                                    ((1 lda) (1 *)))
                1 (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%))
              (declare (ignore var-0 var-2 var-3))
              (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
                     var-1)
              (setf (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%) var-4))
            (cond
              ((< i n)
               (setf aii
                      (f2cl-lib:fref a-%data%
                                     (i i)
                                     ((1 lda) (1 *))
                                     a-%offset%))
               (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
                      one)
               (dlarf "Left" (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
                (f2cl-lib:int-sub n i)
                (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) 1
                (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)
                (f2cl-lib:array-slice a
                                     double-float
                                     (i (f2cl-lib:int-add i 1))
                                     ((1 lda) (1 *)))
                lda work)
               (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
                      aii)))))
 end_label
        (return (values nil nil nil nil nil nil info))))))
```

———-

6.15 dgeqrf LAPACK

— dgeqrf.input —

```
)set break resume
)sys rm -f dgeqrf.output
)spool dgeqrf.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dgeqrf.help** —

```
========================================================================
dgeqrf examples
========================================================================

========================================================================
Man Page Details
========================================================================

NAME
       DGEQRF - a QR factorization of a real M-by-N matrix A

SYNOPSIS
       SUBROUTINE DGEQRF( M, N, A, LDA, TAU, WORK, LWORK, INFO )

           INTEGER        INFO, LDA, LWORK, M, N

           DOUBLE         PRECISION A( LDA, * ), TAU( * ), WORK( * )

PURPOSE
       DGEQRF  computes  a QR factorization of a real M-by-N matrix A: A = Q *
       R.


ARGUMENTS
       M       (input) INTEGER
               The number of rows of the matrix A.  M >= 0.

       N       (input) INTEGER
               The number of columns of the matrix A.  N >= 0.

       A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
               On entry, the M-by-N matrix A.  On exit, the  elements  on  and
               above the diagonal of the array contain the min(M,N)-by-N upper
               trapezoidal matrix R (R is upper triangular if  m  >=  n);  the
               elements  below the diagonal, with the array TAU, represent the
               orthogonal matrix Q as a product of min(m,n) elementary reflec-
               tors (see Further Details).

       LDA     (input) INTEGER
               The leading dimension of the array A.  LDA >= max(1,M).

       TAU     (output) DOUBLE PRECISION array, dimension (min(M,N))
               The  scalar  factors  of the elementary reflectors (see Further
               Details).
```

```
       WORK      (workspace/output)  DOUBLE  PRECISION  array,  dimension
       (MAX(1,LWORK))
               On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

       LWORK   (input) INTEGER
               The dimension of the array WORK.  LWORK >= max(1,N).  For opti-
               mum  performance  LWORK >= N*NB, where NB is the optimal block-
               size.

               If LWORK = -1, then a workspace query is assumed;  the  routine
               only  calculates  the  optimal  size of the WORK array, returns
               this value as the first entry of the WORK array, and  no  error
               message related to LWORK is issued by XERBLA.

       INFO    (output) INTEGER
               = 0:  successful exit
               < 0:  if INFO = -i, the i-th argument had an illegal value

FURTHER DETAILS
       The matrix Q is represented as a product of elementary reflectors

          Q = H(1) H(2) . . . H(k), where k = min(m,n).

       Each H(i) has the form

          H(i) = I - tau * v * v'

       where tau is a real scalar, and v is a real vector with
       v(1:i-1)  =  0  and v(i) = 1; v(i+1:m) is stored on exit in A(i+1:m,i),
       and tau in TAU(i).
```

— dgeqrf.f —

```
      SUBROUTINE DGEQRF( M, N, A, LDA, TAU, WORK, LWORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      INTEGER            INFO, LDA, LWORK, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), TAU( * ), WORK( * )
*     ..
```

```
*
*  =====================================================================
*
*     .. Local Scalars ..
      LOGICAL            LQUERY
      INTEGER            I, IB, IINFO, IWS, K, LDWORK, LWKOPT, NB,
     $                   NBMIN, NX
*     ..
*     .. External Subroutines ..
      EXTERNAL           DGEQR2, DLARFB, DLARFT, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. External Functions ..
      INTEGER            ILAENV
      EXTERNAL           ILAENV
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      NB = ILAENV( 1, 'DGEQRF', ' ', M, N, -1, -1 )
      LWKOPT = N*NB
      WORK( 1 ) = LWKOPT
      LQUERY = ( LWORK.EQ.-1 )
      IF( M.LT.0 ) THEN
         INFO = -1
      ELSE IF( N.LT.0 ) THEN
         INFO = -2
      ELSE IF( LDA.LT.MAX( 1, M ) ) THEN
         INFO = -4
      ELSE IF( LWORK.LT.MAX( 1, N ) .AND. .NOT.LQUERY ) THEN
         INFO = -7
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DGEQRF', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Quick return if possible
*
      K = MIN( M, N )
      IF( K.EQ.0 ) THEN
         WORK( 1 ) = 1
         RETURN
      END IF
```

```
*
      NBMIN = 2
      NX = 0
      IWS = N
      IF( NB.GT.1 .AND. NB.LT.K ) THEN
*
*        Determine when to cross over from blocked to unblocked code.
*
         NX = MAX( 0, ILAENV( 3, 'DGEQRF', ' ', M, N, -1, -1 ) )
         IF( NX.LT.K ) THEN
*
*           Determine if workspace is large enough for blocked code.
*
            LDWORK = N
            IWS = LDWORK*NB
            IF( LWORK.LT.IWS ) THEN
*
*              Not enough workspace to use optimal NB:  reduce NB and
*              determine the minimum value of NB.
*
               NB = LWORK / LDWORK
               NBMIN = MAX( 2, ILAENV( 2, 'DGEQRF', ' ', M, N, -1,
     $                 -1 ) )
            END IF
         END IF
      END IF
*
      IF( NB.GE.NBMIN .AND. NB.LT.K .AND. NX.LT.K ) THEN
*
*        Use blocked code initially
*
         DO 10 I = 1, K - NX, NB
            IB = MIN( K-I+1, NB )
*
*           Compute the QR factorization of the current block
*           A(i:m,i:i+ib-1)
*
            CALL DGEQR2( M-I+1, IB, A( I, I ), LDA, TAU( I ), WORK,
     $                   IINFO )
            IF( I+IB.LE.N ) THEN
*
*              Form the triangular factor of the block reflector
*              H = H(i) H(i+1) . . . H(i+ib-1)
*
               CALL DLARFT( 'Forward', 'Columnwise', M-I+1, IB,
     $                      A( I, I ), LDA, TAU( I ), WORK, LDWORK )
*
*              Apply H' to A(i:m,i+ib:n) from the left
*
               CALL DLARFB( 'Left', 'Transpose', 'Forward',
```

```
     $                     'Columnwise', M-I+1, N-I-IB+1, IB,
     $                     A( I, I ), LDA, WORK, LDWORK, A( I, I+IB ),
     $                     LDA, WORK( IB+1 ), LDWORK )
           END IF
   10    CONTINUE
      ELSE
         I = 1
      END IF
*
*     Use unblocked code to factor the last or only block.
*
      IF( I.LE.K )
     $   CALL DGEQR2( M-I+1, N-I+1, A( I, I ), LDA, TAU( I ), WORK,
     $                IINFO )
*
      WORK( 1 ) = IWS
      RETURN
*
*     End of DGEQRF
*
      END
```

———-

— LAPACK dgeqrf —

```
(defun dgeqrf (m n a lda tau work lwork info)
  (declare (type (simple-array double-float (*)) work tau a)
           (type fixnum info lwork lda n m))
  (f2cl-lib:with-multi-array-data
      ((a double-float a-%data% a-%offset%)
       (tau double-float tau-%data% tau-%offset%)
       (work double-float work-%data% work-%offset%))
    (prog ((i 0) (ib 0) (iinfo 0) (iws 0) (k 0) (ldwork 0) (lwkopt 0) (nb 0)
           (nbmin 0) (nx 0) (lquery nil))
      (declare (type (member t nil) lquery)
               (type fixnum nx nbmin nb lwkopt ldwork k iws iinfo
                                    ib i))
      (setf info 0)
      (setf nb (ilaenv 1 "DGEQRF" " " m n -1 -1))
      (setf lwkopt (f2cl-lib:int-mul n nb))
      (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
              (coerce (the fixnum lwkopt) 'double-float))
      (setf lquery (coerce (= lwork -1) '(member t nil)))
      (cond
        ((< m 0)
         (setf info -1))
        ((< n 0)
```

```
   (setf info -2))
  ((< lda (max (the fixnum 1) (the fixnum m)))
   (setf info -4))
  ((and
    (< lwork (max (the fixnum 1) (the fixnum n)))
    (not lquery))
   (setf info -7)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DGEQRF" (f2cl-lib:int-sub info))
   (go end_label))
  (lquery
   (go end_label)))
(setf k (min (the fixnum m) (the fixnum n)))
(cond
  ((= k 0)
   (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
           (coerce (the fixnum 1) 'double-float))
   (go end_label)))
(setf nbmin 2)
(setf nx 0)
(setf iws n)
(cond
  ((and (> nb 1) (< nb k))
   (setf nx
           (max (the fixnum 0)
                (the fixnum
                     (ilaenv 3 "DGEQRF" " " m n -1 -1))))
   (cond
     ((< nx k)
      (setf ldwork n)
      (setf iws (f2cl-lib:int-mul ldwork nb))
      (cond
        ((< lwork iws)
         (setf nb (the fixnum (truncate lwork ldwork)))
         (setf nbmin
                 (max (the fixnum 2)
                      (the fixnum
                           (ilaenv 2 "DGEQRF" " " m n -1 -1)))))))))))
(cond
  ((and (>= nb nbmin) (< nb k) (< nx k))
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i nb))
                 ((> i (f2cl-lib:int-add k (f2cl-lib:int-sub nx))) nil)
     (tagbody
       (setf ib
               (min
                (the fixnum
                     (f2cl-lib:int-add (f2cl-lib:int-sub k i) 1))
```

```
                (the fixnum nb)))
          (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
              (dgeqr2 (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1) ib
               (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
               lda (f2cl-lib:array-slice tau double-float (i) ((1 *))) work
               iinfo)
            (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5))
            (setf iinfo var-6))
          (cond
            ((<= (f2cl-lib:int-add i ib) n)
             (dlarft "Forward" "Columnwise"
              (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1) ib
              (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
              lda (f2cl-lib:array-slice tau double-float (i) ((1 *))) work
              ldwork)
             (dlarfb "Left" "Transpose" "Forward" "Columnwise"
              (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
              (f2cl-lib:int-add (f2cl-lib:int-sub n i ib) 1) ib
              (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
              lda work ldwork
              (f2cl-lib:array-slice a
                                    double-float
                                    (i (f2cl-lib:int-add i ib))
                                    ((1 lda) (1 *)))
              lda
              (f2cl-lib:array-slice work double-float ((+ ib 1)) ((1 *)))
              ldwork))))))
      (t
       (setf i 1)))
    (if (<= i k)
        (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
            (dgeqr2 (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
             (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
             (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
             (f2cl-lib:array-slice tau double-float (i) ((1 *))) work iinfo)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5))
          (setf iinfo var-6)))
    (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
          (coerce (the fixnum iws) 'double-float))
end_label
    (return (values nil nil nil nil nil nil nil info)))))
```

6.16 dgesdd LAPACK

— dgesdd.input —

```
)set break resume
)sys rm -f dgesdd.output
)spool dgesdd.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

————-

— dgesdd.help —

```
=======================================================================
dgesdd examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

NAME
       DGESDD - the singular value decomposition (SVD) of a real M-by-N matrix
       A, optionally computing the left and right singular vectors

SYNOPSIS
       SUBROUTINE DGESDD( JOBZ, M, N, A, LDA,  S,  U,  LDU,  VT,  LDVT,  WORK,
                          LWORK, IWORK, INFO )

           CHARACTER      JOBZ

           INTEGER        INFO, LDA, LDU, LDVT, LWORK, M, N

           INTEGER        IWORK( * )

           DOUBLE         PRECISION  A(  LDA,  *  ),  S( * ), U( LDU, * ), VT(
                          LDVT, * ), WORK( * )

PURPOSE
       DGESDD computes the singular value decomposition (SVD) of a real M-by-N
       matrix A, optionally computing the left and right singular vectors.  If
       singular vectors are desired, it uses a divide-and-conquer algorithm.

       The SVD is written

            A = U * SIGMA * transpose(V)
```

```
       where SIGMA is an M-by-N matrix which is zero except for  its  min(m,n)
       diagonal elements, U is an M-by-M orthogonal matrix, and V is an N-by-N
       orthogonal matrix.  The diagonal elements of  SIGMA  are  the  singular
       values  of  A;  they  are  real  and  non-negative, and are returned in
       descending order.  The first min(m,n) columns of U and V are  the  left
       and right singular vectors of A.

       Note that the routine returns VT = V**T, not V.

       The  divide  and  conquer  algorithm  makes very mild assumptions about
       floating point arithmetic. It will work on machines with a guard  digit
       in add/subtract, or on those binary machines without guard digits which
       subtract like the Cray X-MP, Cray Y-MP, Cray C-90, or Cray-2. It  could
       conceivably  fail on hexadecimal or decimal machines without guard dig-
       its, but we know of none.


ARGUMENTS
       JOBZ    (input) CHARACTER*1
               Specifies options for computing all or part of the matrix U:
               = 'A':  all M columns of U and all N rows of V**T are  returned
               in the arrays U and VT; = 'S':  the first min(M,N) columns of U
               and the first min(M,N) rows of V**T are returned in the  arrays
               U and VT; = 'O':  If M >= N, the first N columns of U are over-
               written on the array A and all rows of V**T are returned in the
               array VT; otherwise, all columns of U are returned in the array
               U and the first M rows of V**T are overwritten in the array  A;
               = 'N':  no columns of U or rows of V**T are computed.

       M       (input) INTEGER
               The number of rows of the input matrix A.  M >= 0.

       N       (input) INTEGER
               The number of columns of the input matrix A.  N >= 0.

       A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
               On  entry,  the M-by-N matrix A.  On exit, if JOBZ = 'O',  A is
               overwritten with the first N columns of U  (the  left  singular
               vectors,  stored  columnwise)  if M >= N; A is overwritten with
               the first M rows of V**T (the right  singular  vectors,  stored
               rowwise)  otherwise.   if  JOBZ .ne. 'O', the contents of A are
               destroyed.

       LDA     (input) INTEGER
               The leading dimension of the array A.  LDA >= max(1,M).

       S       (output) DOUBLE PRECISION array, dimension (min(M,N))
               The singular values of A, sorted so that S(i) >= S(i+1).
```

```
      U       (output) DOUBLE PRECISION array, dimension (LDU,UCOL)
              UCOL = M if JOBZ = 'A' or JOBZ = 'O' and M < N; UCOL = min(M,N)
              if  JOBZ  = 'S'.  If JOBZ = 'A' or JOBZ = 'O' and M < N, U con-
              tains the M-by-M orthogonal matrix U; if JOBZ = 'S', U contains
              the  first  min(M,N)  columns  of U (the left singular vectors,
              stored columnwise); if JOBZ = 'O' and M >= N, or JOBZ = 'N',  U
              is not referenced.

      LDU     (input) INTEGER
              The  leading dimension of the array U.  LDU >= 1; if JOBZ = 'S'
              or 'A' or JOBZ = 'O' and M < N, LDU >= M.

      VT      (output) DOUBLE PRECISION array, dimension (LDVT,N)
              If JOBZ = 'A' or JOBZ = 'O' and M >= N, VT contains the  N-by-N
              orthogonal  matrix  V**T;  if JOBZ = 'S', VT contains the first
              min(M,N) rows of V**T (the right singular vectors, stored  row-
              wise); if JOBZ = 'O' and M < N, or JOBZ = 'N', VT is not refer-
              enced.

      LDVT    (input) INTEGER
              The leading dimension of the array VT.  LDVT >= 1;  if  JOBZ  =
              'A' or JOBZ = 'O' and M >= N, LDVT >= N; if JOBZ = 'S', LDVT >=
              min(M,N).

      WORK      (workspace/output)   DOUBLE   PRECISION   array,    dimension
      (MAX(1,LWORK))
              On exit, if INFO = 0, WORK(1) returns the optimal LWORK;

      LWORK   (input) INTEGER
              The dimension of the array WORK. LWORK >= 1.  If  JOBZ  =  'N',
              LWORK >= 3*min(M,N) + max(max(M,N),7*min(M,N)).  If JOBZ = 'O',
              LWORK            >=            3*min(M,N)*min(M,N)            +
              max(max(M,N),5*min(M,N)*min(M,N)+4*min(M,N)).  If JOBZ = 'S' or
              'A'        LWORK        >=        3*min(M,N)*min(M,N)         +
              max(max(M,N),4*min(M,N)*min(M,N)+4*min(M,N)).  For good perfor-
              mance, LWORK should generally be larger.  If  LWORK  =  -1  but
              other  input  arguments  are legal, WORK(1) returns the optimal
              LWORK.

      IWORK   (workspace) INTEGER array, dimension (8*min(M,N))

      INFO    (output) INTEGER
              = 0:  successful exit.
              < 0:  if INFO = -i, the i-th argument had an illegal value.
              > 0:  DBDSDC did not converge, updating process failed.

  Further Details
  ===============

  Based on contributions by
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— **dgesdd.f** —

```
      SUBROUTINE DGESDD( JOBZ, M, N, A, LDA, S, U, LDU, VT, LDVT, WORK,
     $                   LWORK, IWORK, INFO )
*
*  -- LAPACK driver routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1999
*
*     .. Scalar Arguments ..
      CHARACTER          JOBZ
      INTEGER            INFO, LDA, LDU, LDVT, LWORK, M, N
*     ..
*     .. Array Arguments ..
      INTEGER            IWORK( * )
      DOUBLE PRECISION   A( LDA, * ), S( * ), U( LDU, * ),
     $                   VT( LDVT, * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D0, ONE = 1.0D0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            LQUERY, WNTQA, WNTQAS, WNTQN, WNTQO, WNTQS
      INTEGER            BDSPAC, BLK, CHUNK, I, IE, IERR, IL,
     $                   IR, ISCL, ITAU, ITAUP, ITAUQ, IU, IVT, LDWKVT,
     $                   LDWRKL, LDWRKR, LDWRKU, MAXWRK, MINMN, MINWRK,
     $                   MNTHR, NWORK, WRKBL
      DOUBLE PRECISION   ANRM, BIGNUM, EPS, SMLNUM
*     ..
*     .. Local Arrays ..
      INTEGER            IDUM( 1 )
      DOUBLE PRECISION   DUM( 1 )
*     ..
*     .. External Subroutines ..
      EXTERNAL           DBDSDC, DGEBRD, DGELQF, DGEMM, DGEQRF, DLACPY,
     $                   DLASCL, DLASET, DORGBR, DORGLQ, DORGQR, DORMBR,
     $                   XERBLA
*     ..
```

```
*     .. External Functions ..
      LOGICAL            LSAME
      INTEGER            ILAENV
      DOUBLE PRECISION   DLAMCH, DLANGE
      EXTERNAL           DLAMCH, DLANGE, ILAENV, LSAME
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          DBLE, INT, MAX, MIN, SQRT
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      MINMN = MIN( M, N )
      MNTHR = INT( MINMN*11.0D0 / 6.0D0 )
      WNTQA = LSAME( JOBZ, 'A' )
      WNTQS = LSAME( JOBZ, 'S' )
      WNTQAS = WNTQA .OR. WNTQS
      WNTQO = LSAME( JOBZ, 'O' )
      WNTQN = LSAME( JOBZ, 'N' )
      MINWRK = 1
      MAXWRK = 1
      LQUERY = ( LWORK.EQ.-1 )
*
      IF( .NOT.( WNTQA .OR. WNTQS .OR. WNTQO .OR. WNTQN ) ) THEN
         INFO = -1
      ELSE IF( M.LT.0 ) THEN
         INFO = -2
      ELSE IF( N.LT.0 ) THEN
         INFO = -3
      ELSE IF( LDA.LT.MAX( 1, M ) ) THEN
         INFO = -5
      ELSE IF( LDU.LT.1 .OR. ( WNTQAS .AND. LDU.LT.M ) .OR.
     $         ( WNTQO .AND. M.LT.N .AND. LDU.LT.M ) ) THEN
         INFO = -8
      ELSE IF( LDVT.LT.1 .OR. ( WNTQA .AND. LDVT.LT.N ) .OR.
     $         ( WNTQS .AND. LDVT.LT.MINMN ) .OR.
     $         ( WNTQO .AND. M.GE.N .AND. LDVT.LT.N ) ) THEN
         INFO = -10
      END IF
*
*     Compute workspace
*      (Note: Comments in the code beginning "Workspace:" describe the
*       minimal amount of workspace needed at that point in the code,
*       as well as the preferred amount for good performance.
*       NB refers to the optimal block size for the immediately
*       following subroutine, as returned by ILAENV.)
*
      IF( INFO.EQ.0 .AND. M.GT.0 .AND. N.GT.0 ) THEN
```

```
         IF( M.GE.N ) THEN
*
*           Compute space needed for DBDSDC
*
            IF( WNTQN ) THEN
               BDSPAC = 7*N
            ELSE
               BDSPAC = 3*N*N + 4*N
            END IF
            IF( M.GE.MNTHR ) THEN
               IF( WNTQN ) THEN
*
*                 Path 1 (M much larger than N, JOBZ='N')
*
                  WRKBL = N + N*ILAENV( 1, 'DGEQRF', ' ', M, N, -1,
     $                    -1 )
                  WRKBL = MAX( WRKBL, 3*N+2*N*
     $                    ILAENV( 1, 'DGEBRD', ' ', N, N, -1, -1 ) )
                  MAXWRK = MAX( WRKBL, BDSPAC+N )
                  MINWRK = BDSPAC + N
               ELSE IF( WNTQO ) THEN
*
*                 Path 2 (M much larger than N, JOBZ='O')
*
                  WRKBL = N + N*ILAENV( 1, 'DGEQRF', ' ', M, N, -1, -1 )
                  WRKBL = MAX( WRKBL, N+N*ILAENV( 1, 'DORGQR', ' ', M,
     $                    N, N, -1 ) )
                  WRKBL = MAX( WRKBL, 3*N+2*N*
     $                    ILAENV( 1, 'DGEBRD', ' ', N, N, -1, -1 ) )
                  WRKBL = MAX( WRKBL, 3*N+N*
     $                    ILAENV( 1, 'DORMBR', 'QLN', N, N, N, -1 ) )
                  WRKBL = MAX( WRKBL, 3*N+N*
     $                    ILAENV( 1, 'DORMBR', 'PRT', N, N, N, -1 ) )
                  WRKBL = MAX( WRKBL, BDSPAC+3*N )
                  MAXWRK = WRKBL + 2*N*N
                  MINWRK = BDSPAC + 2*N*N + 3*N
               ELSE IF( WNTQS ) THEN
*
*                 Path 3 (M much larger than N, JOBZ='S')
*
                  WRKBL = N + N*ILAENV( 1, 'DGEQRF', ' ', M, N, -1, -1 )
                  WRKBL = MAX( WRKBL, N+N*ILAENV( 1, 'DORGQR', ' ', M,
     $                    N, N, -1 ) )
                  WRKBL = MAX( WRKBL, 3*N+2*N*
     $                    ILAENV( 1, 'DGEBRD', ' ', N, N, -1, -1 ) )
                  WRKBL = MAX( WRKBL, 3*N+N*
     $                    ILAENV( 1, 'DORMBR', 'QLN', N, N, N, -1 ) )
                  WRKBL = MAX( WRKBL, 3*N+N*
     $                    ILAENV( 1, 'DORMBR', 'PRT', N, N, N, -1 ) )
                  WRKBL = MAX( WRKBL, BDSPAC+3*N )
```

```
                  MAXWRK = WRKBL + N*N
                  MINWRK = BDSPAC + N*N + 3*N
               ELSE IF( WNTQA ) THEN
*
*                  Path 4 (M much larger than N, JOBZ='A')
*
                  WRKBL = N + N*ILAENV( 1, 'DGEQRF', ' ', M, N, -1, -1 )
                  WRKBL = MAX( WRKBL, N+M*ILAENV( 1, 'DORGQR', ' ', M,
     $                    M, N, -1 ) )
                  WRKBL = MAX( WRKBL, 3*N+2*N*
     $                    ILAENV( 1, 'DGEBRD', ' ', N, N, -1, -1 ) )
                  WRKBL = MAX( WRKBL, 3*N+N*
     $                    ILAENV( 1, 'DORMBR', 'QLN', N, N, N, -1 ) )
                  WRKBL = MAX( WRKBL, 3*N+N*
     $                    ILAENV( 1, 'DORMBR', 'PRT', N, N, N, -1 ) )
                  WRKBL = MAX( WRKBL, BDSPAC+3*N )
                  MAXWRK = WRKBL + N*N
                  MINWRK = BDSPAC + N*N + 3*N
               END IF
            ELSE
*
*              Path 5 (M at least N, but not much larger)
*
               WRKBL = 3*N + ( M+N )*ILAENV( 1, 'DGEBRD', ' ', M, N, -1,
     $                 -1 )
               IF( WNTQN ) THEN
                  MAXWRK = MAX( WRKBL, BDSPAC+3*N )
                  MINWRK = 3*N + MAX( M, BDSPAC )
               ELSE IF( WNTQO ) THEN
                  WRKBL = MAX( WRKBL, 3*N+N*
     $                    ILAENV( 1, 'DORMBR', 'QLN', M, N, N, -1 ) )
                  WRKBL = MAX( WRKBL, 3*N+N*
     $                    ILAENV( 1, 'DORMBR', 'PRT', N, N, N, -1 ) )
                  WRKBL = MAX( WRKBL, BDSPAC+3*N )
                  MAXWRK = WRKBL + M*N
                  MINWRK = 3*N + MAX( M, N*N+BDSPAC )
               ELSE IF( WNTQS ) THEN
                  WRKBL = MAX( WRKBL, 3*N+N*
     $                    ILAENV( 1, 'DORMBR', 'QLN', M, N, N, -1 ) )
                  WRKBL = MAX( WRKBL, 3*N+N*
     $                    ILAENV( 1, 'DORMBR', 'PRT', N, N, N, -1 ) )
                  MAXWRK = MAX( WRKBL, BDSPAC+3*N )
                  MINWRK = 3*N + MAX( M, BDSPAC )
               ELSE IF( WNTQA ) THEN
                  WRKBL = MAX( WRKBL, 3*N+M*
     $                    ILAENV( 1, 'DORMBR', 'QLN', M, M, N, -1 ) )
                  WRKBL = MAX( WRKBL, 3*N+N*
     $                    ILAENV( 1, 'DORMBR', 'PRT', N, N, N, -1 ) )
                  MAXWRK = MAX( MAXWRK, BDSPAC+3*N )
                  MINWRK = 3*N + MAX( M, BDSPAC )
```

```
               END IF
            END IF
         ELSE
*
*           Compute space needed for DBDSDC
*
            IF( WNTQN ) THEN
               BDSPAC = 7*M
            ELSE
               BDSPAC = 3*M*M + 4*M
            END IF
            IF( N.GE.MNTHR ) THEN
               IF( WNTQN ) THEN
*
*                 Path 1t (N much larger than M, JOBZ='N')
*
                  WRKBL = M + M*ILAENV( 1, 'DGELQF', ' ', M, N, -1,
     $                    -1 )
                  WRKBL = MAX( WRKBL, 3*M+2*M*
     $                    ILAENV( 1, 'DGEBRD', ' ', M, M, -1, -1 ) )
                  MAXWRK = MAX( WRKBL, BDSPAC+M )
                  MINWRK = BDSPAC + M
               ELSE IF( WNTQO ) THEN
*
*                 Path 2t (N much larger than M, JOBZ='O')
*
                  WRKBL = M + M*ILAENV( 1, 'DGELQF', ' ', M, N, -1, -1 )
                  WRKBL = MAX( WRKBL, M+M*ILAENV( 1, 'DORGLQ', ' ', M,
     $                    N, M, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+2*M*
     $                    ILAENV( 1, 'DGEBRD', ' ', M, M, -1, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+M*
     $                    ILAENV( 1, 'DORMBR', 'QLN', M, M, M, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+M*
     $                    ILAENV( 1, 'DORMBR', 'PRT', M, M, M, -1 ) )
                  WRKBL = MAX( WRKBL, BDSPAC+3*M )
                  MAXWRK = WRKBL + 2*M*M
                  MINWRK = BDSPAC + 2*M*M + 3*M
               ELSE IF( WNTQS ) THEN
*
*                 Path 3t (N much larger than M, JOBZ='S')
*
                  WRKBL = M + M*ILAENV( 1, 'DGELQF', ' ', M, N, -1, -1 )
                  WRKBL = MAX( WRKBL, M+M*ILAENV( 1, 'DORGLQ', ' ', M,
     $                    N, M, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+2*M*
     $                    ILAENV( 1, 'DGEBRD', ' ', M, M, -1, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+M*
     $                    ILAENV( 1, 'DORMBR', 'QLN', M, M, M, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+M*
```

```
     $                   ILAENV( 1, 'DORMBR', 'PRT', M, M, M, -1 ) )
                  WRKBL = MAX( WRKBL, BDSPAC+3*M )
                  MAXWRK = WRKBL + M*M
                  MINWRK = BDSPAC + M*M + 3*M
               ELSE IF( WNTQA ) THEN
*
*                 Path 4t (N much larger than M, JOBZ='A')
*
                  WRKBL = M + M*ILAENV( 1, 'DGELQF', ' ', M, N, -1, -1 )
                  WRKBL = MAX( WRKBL, M+N*ILAENV( 1, 'DORGLQ', ' ', N,
     $                    N, M, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+2*M*
     $                    ILAENV( 1, 'DGEBRD', ' ', M, M, -1, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+M*
     $                    ILAENV( 1, 'DORMBR', 'QLN', M, M, M, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+M*
     $                    ILAENV( 1, 'DORMBR', 'PRT', M, M, M, -1 ) )
                  WRKBL = MAX( WRKBL, BDSPAC+3*M )
                  MAXWRK = WRKBL + M*M
                  MINWRK = BDSPAC + M*M + 3*M
               END IF
            ELSE
*
*              Path 5t (N greater than M, but not much larger)
*
               WRKBL = 3*M + ( M+N )*ILAENV( 1, 'DGEBRD', ' ', M, N, -1,
     $                 -1 )
               IF( WNTQN ) THEN
                  MAXWRK = MAX( WRKBL, BDSPAC+3*M )
                  MINWRK = 3*M + MAX( N, BDSPAC )
               ELSE IF( WNTQO ) THEN
                  WRKBL = MAX( WRKBL, 3*M+M*
     $                    ILAENV( 1, 'DORMBR', 'QLN', M, M, N, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+M*
     $                    ILAENV( 1, 'DORMBR', 'PRT', M, N, M, -1 ) )
                  WRKBL = MAX( WRKBL, BDSPAC+3*M )
                  MAXWRK = WRKBL + M*N
                  MINWRK = 3*M + MAX( N, M*M+BDSPAC )
               ELSE IF( WNTQS ) THEN
                  WRKBL = MAX( WRKBL, 3*M+M*
     $                    ILAENV( 1, 'DORMBR', 'QLN', M, M, N, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+M*
     $                    ILAENV( 1, 'DORMBR', 'PRT', M, N, M, -1 ) )
                  MAXWRK = MAX( WRKBL, BDSPAC+3*M )
                  MINWRK = 3*M + MAX( N, BDSPAC )
               ELSE IF( WNTQA ) THEN
                  WRKBL = MAX( WRKBL, 3*M+M*
     $                    ILAENV( 1, 'DORMBR', 'QLN', M, M, N, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+M*
     $                    ILAENV( 1, 'DORMBR', 'PRT', N, N, M, -1 ) )
```

```
                  MAXWRK = MAX( WRKBL, BDSPAC+3*M )
                  MINWRK = 3*M + MAX( N, BDSPAC )
               END IF
            END IF
         END IF
         WORK( 1 ) = MAXWRK
      END IF
*
      IF( LWORK.LT.MINWRK .AND. .NOT.LQUERY ) THEN
         INFO = -12
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DGESDD', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( M.EQ.0 .OR. N.EQ.0 ) THEN
         IF( LWORK.GE.1 )
     $      WORK( 1 ) = ONE
         RETURN
      END IF
*
*     Get machine constants
*
      EPS = DLAMCH( 'P' )
      SMLNUM = SQRT( DLAMCH( 'S' ) ) / EPS
      BIGNUM = ONE / SMLNUM
*
*     Scale A if max element outside range [SMLNUM,BIGNUM]
*
      ANRM = DLANGE( 'M', M, N, A, LDA, DUM )
      ISCL = 0
      IF( ANRM.GT.ZERO .AND. ANRM.LT.SMLNUM ) THEN
         ISCL = 1
         CALL DLASCL( 'G', 0, 0, ANRM, SMLNUM, M, N, A, LDA, IERR )
      ELSE IF( ANRM.GT.BIGNUM ) THEN
         ISCL = 1
         CALL DLASCL( 'G', 0, 0, ANRM, BIGNUM, M, N, A, LDA, IERR )
      END IF
*
      IF( M.GE.N ) THEN
*
*        A has at least as many rows as columns. If A has sufficiently
*        more rows than columns, first reduce using the QR
*        decomposition (if sufficient workspace available)
*
```

```
         IF( M.GE.MNTHR ) THEN
*
            IF( WNTQN ) THEN
*
*              Path 1 (M much larger than N, JOBZ='N')
*              No singular vectors to be computed
*
               ITAU = 1
               NWORK = ITAU + N
*
*              Compute A=Q*R
*              (Workspace: need 2*N, prefer N+N*NB)
*
               CALL DGEQRF( M, N, A, LDA, WORK( ITAU ), WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
*
*              Zero out below R
*
               CALL DLASET( 'L', N-1, N-1, ZERO, ZERO, A( 2, 1 ), LDA )
               IE = 1
               ITAUQ = IE + N
               ITAUP = ITAUQ + N
               NWORK = ITAUP + N
*
*              Bidiagonalize R in A
*              (Workspace: need 4*N, prefer 3*N+2*N*NB)
*
               CALL DGEBRD( N, N, A, LDA, S, WORK( IE ), WORK( ITAUQ ),
     $                      WORK( ITAUP ), WORK( NWORK ), LWORK-NWORK+1,
     $                      IERR )
               NWORK = IE + N
*
*              Perform bidiagonal SVD, computing singular values only
*              (Workspace: need N+BDSPAC)
*
               CALL DBDSDC( 'U', 'N', N, S, WORK( IE ), DUM, 1, DUM, 1,
     $                      DUM, IDUM, WORK( NWORK ), IWORK, INFO )
*
            ELSE IF( WNTQO ) THEN
*
*              Path 2 (M much larger than N, JOBZ = 'O')
*              N left singular vectors to be overwritten on A and
*              N right singular vectors to be computed in VT
*
               IR = 1
*
*              WORK(IR) is LDWRKR by N
*
               IF( LWORK.GE.LDA*N+N*N+3*N+BDSPAC ) THEN
                  LDWRKR = LDA
```

```
               ELSE
                  LDWRKR = ( LWORK-N*N-3*N-BDSPAC ) / N
               END IF
               ITAU = IR + LDWRKR*N
               NWORK = ITAU + N
*
*              Compute A=Q*R
*              (Workspace: need N*N+2*N, prefer N*N+N+N*NB)
*
               CALL DGEQRF( M, N, A, LDA, WORK( ITAU ), WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
*
*              Copy R to WORK(IR), zeroing out below it
*
               CALL DLACPY( 'U', N, N, A, LDA, WORK( IR ), LDWRKR )
               CALL DLASET( 'L', N-1, N-1, ZERO, ZERO, WORK( IR+1 ),
     $                      LDWRKR )
*
*              Generate Q in A
*              (Workspace: need N*N+2*N, prefer N*N+N+N*NB)
*
               CALL DORGQR( M, N, N, A, LDA, WORK( ITAU ),
     $                      WORK( NWORK ), LWORK-NWORK+1, IERR )
               IE = ITAU
               ITAUQ = IE + N
               ITAUP = ITAUQ + N
               NWORK = ITAUP + N
*
*              Bidiagonalize R in VT, copying result to WORK(IR)
*              (Workspace: need N*N+4*N, prefer N*N+3*N+2*N*NB)
*
               CALL DGEBRD( N, N, WORK( IR ), LDWRKR, S, WORK( IE ),
     $                      WORK( ITAUQ ), WORK( ITAUP ), WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
*
*              WORK(IU) is N by N
*
               IU = NWORK
               NWORK = IU + N*N
*
*              Perform bidiagonal SVD, computing left singular vectors
*              of bidiagonal matrix in WORK(IU) and computing right
*              singular vectors of bidiagonal matrix in VT
*              (Workspace: need N+N*N+BDSPAC)
*
               CALL DBDSDC( 'U', 'I', N, S, WORK( IE ), WORK( IU ), N,
     $                      VT, LDVT, DUM, IDUM, WORK( NWORK ), IWORK,
     $                      INFO )
*
*              Overwrite WORK(IU) by left singular vectors of R
```

```
*              and VT by right singular vectors of R
*              (Workspace: need 2*N*N+3*N, prefer 2*N*N+2*N+N*NB)
*
               CALL DORMBR( 'Q', 'L', 'N', N, N, N, WORK( IR ), LDWRKR,
     $                      WORK( ITAUQ ), WORK( IU ), N, WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
               CALL DORMBR( 'P', 'R', 'T', N, N, N, WORK( IR ), LDWRKR,
     $                      WORK( ITAUP ), VT, LDVT, WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
*
*              Multiply Q in A by left singular vectors of R in
*              WORK(IU), storing result in WORK(IR) and copying to A
*              (Workspace: need 2*N*N, prefer N*N+M*N)
*
               DO 10 I = 1, M, LDWRKR
                  CHUNK = MIN( M-I+1, LDWRKR )
                  CALL DGEMM( 'N', 'N', CHUNK, N, N, ONE, A( I, 1 ),
     $                        LDA, WORK( IU ), N, ZERO, WORK( IR ),
     $                        LDWRKR )
                  CALL DLACPY( 'F', CHUNK, N, WORK( IR ), LDWRKR,
     $                         A( I, 1 ), LDA )
   10          CONTINUE
*
            ELSE IF( WNTQS ) THEN
*
*              Path 3 (M much larger than N, JOBZ='S')
*              N left singular vectors to be computed in U and
*              N right singular vectors to be computed in VT
*
               IR = 1
*
*              WORK(IR) is N by N
*
               LDWRKR = N
               ITAU = IR + LDWRKR*N
               NWORK = ITAU + N
*
*              Compute A=Q*R
*              (Workspace: need N*N+2*N, prefer N*N+N+N*NB)
*
               CALL DGEQRF( M, N, A, LDA, WORK( ITAU ), WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
*
*              Copy R to WORK(IR), zeroing out below it
*
               CALL DLACPY( 'U', N, N, A, LDA, WORK( IR ), LDWRKR )
               CALL DLASET( 'L', N-1, N-1, ZERO, ZERO, WORK( IR+1 ),
     $                      LDWRKR )
*
*              Generate Q in A
```

```
*              (Workspace: need N*N+2*N, prefer N*N+N+N*NB)
*
               CALL DORGQR( M, N, N, A, LDA, WORK( ITAU ),
     $                      WORK( NWORK ), LWORK-NWORK+1, IERR )
               IE = ITAU
               ITAUQ = IE + N
               ITAUP = ITAUQ + N
               NWORK = ITAUP + N
*
*              Bidiagonalize R in WORK(IR)
*              (Workspace: need N*N+4*N, prefer N*N+3*N+2*N*NB)
*
               CALL DGEBRD( N, N, WORK( IR ), LDWRKR, S, WORK( IE ),
     $                      WORK( ITAUQ ), WORK( ITAUP ), WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
*
*              Perform bidiagonal SVD, computing left singular vectors
*              of bidiagoal matrix in U and computing right singular
*              vectors of bidiagonal matrix in VT
*              (Workspace: need N+BDSPAC)
*
               CALL DBDSDC( 'U', 'I', N, S, WORK( IE ), U, LDU, VT,
     $                      LDVT, DUM, IDUM, WORK( NWORK ), IWORK,
     $                      INFO )
*
*              Overwrite U by left singular vectors of R and VT
*              by right singular vectors of R
*              (Workspace: need N*N+3*N, prefer N*N+2*N+N*NB)
*
               CALL DORMBR( 'Q', 'L', 'N', N, N, N, WORK( IR ), LDWRKR,
     $                      WORK( ITAUQ ), U, LDU, WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
*
               CALL DORMBR( 'P', 'R', 'T', N, N, N, WORK( IR ), LDWRKR,
     $                      WORK( ITAUP ), VT, LDVT, WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
*
*              Multiply Q in A by left singular vectors of R in
*              WORK(IR), storing result in U
*              (Workspace: need N*N)
*
               CALL DLACPY( 'F', N, N, U, LDU, WORK( IR ), LDWRKR )
               CALL DGEMM( 'N', 'N', M, N, N, ONE, A, LDA, WORK( IR ),
     $                     LDWRKR, ZERO, U, LDU )
*
            ELSE IF( WNTQA ) THEN
*
*              Path 4 (M much larger than N, JOBZ='A')
*              M left singular vectors to be computed in U and
*              N right singular vectors to be computed in VT
```

```
*
                IU = 1
*
*               WORK(IU) is N by N
*
                LDWRKU = N
                ITAU = IU + LDWRKU*N
                NWORK = ITAU + N
*
*               Compute A=Q*R, copying result to U
*               (Workspace: need N*N+2*N, prefer N*N+N+N*NB)
*
                CALL DGEQRF( M, N, A, LDA, WORK( ITAU ), WORK( NWORK ),
     $                       LWORK-NWORK+1, IERR )
                CALL DLACPY( 'L', M, N, A, LDA, U, LDU )
*
*               Generate Q in U
*               (Workspace: need N*N+2*N, prefer N*N+N+N*NB)
                CALL DORGQR( M, M, N, U, LDU, WORK( ITAU ),
     $                       WORK( NWORK ), LWORK-NWORK+1, IERR )
*
*               Produce R in A, zeroing out other entries
*
                CALL DLASET( 'L', N-1, N-1, ZERO, ZERO, A( 2, 1 ), LDA )
                IE = ITAU
                ITAUQ = IE + N
                ITAUP = ITAUQ + N
                NWORK = ITAUP + N
*
*               Bidiagonalize R in A
*               (Workspace: need N*N+4*N, prefer N*N+3*N+2*N*NB)
*
                CALL DGEBRD( N, N, A, LDA, S, WORK( IE ), WORK( ITAUQ ),
     $                       WORK( ITAUP ), WORK( NWORK ), LWORK-NWORK+1,
     $                       IERR )
*
*               Perform bidiagonal SVD, computing left singular vectors
*               of bidiagonal matrix in WORK(IU) and computing right
*               singular vectors of bidiagonal matrix in VT
*               (Workspace: need N+N*N+BDSPAC)
*
                CALL DBDSDC( 'U', 'I', N, S, WORK( IE ), WORK( IU ), N,
     $                       VT, LDVT, DUM, IDUM, WORK( NWORK ), IWORK,
     $                       INFO )
*
*               Overwrite WORK(IU) by left singular vectors of R and VT
*               by right singular vectors of R
*               (Workspace: need N*N+3*N, prefer N*N+2*N+N*NB)
*
                CALL DORMBR( 'Q', 'L', 'N', N, N, N, A, LDA,
```

```
     $                     WORK( ITAUQ ), WORK( IU ), LDWRKU,
     $                     WORK( NWORK ), LWORK-NWORK+1, IERR )
               CALL DORMBR( 'P', 'R', 'T', N, N, N, A, LDA,
     $                     WORK( ITAUP ), VT, LDVT, WORK( NWORK ),
     $                     LWORK-NWORK+1, IERR )
*
*              Multiply Q in U by left singular vectors of R in
*              WORK(IU), storing result in A
*              (Workspace: need N*N)
*
               CALL DGEMM( 'N', 'N', M, N, N, ONE, U, LDU, WORK( IU ),
     $                    LDWRKU, ZERO, A, LDA )
*
*              Copy left singular vectors of A from A to U
*
               CALL DLACPY( 'F', M, N, A, LDA, U, LDU )
*
            END IF
*
         ELSE
*
*           M .LT. MNTHR
*
*           Path 5 (M at least N, but not much larger)
*           Reduce to bidiagonal form without QR decomposition
*
            IE = 1
            ITAUQ = IE + N
            ITAUP = ITAUQ + N
            NWORK = ITAUP + N
*
*           Bidiagonalize A
*           (Workspace: need 3*N+M, prefer 3*N+(M+N)*NB)
*
            CALL DGEBRD( M, N, A, LDA, S, WORK( IE ), WORK( ITAUQ ),
     $                   WORK( ITAUP ), WORK( NWORK ), LWORK-NWORK+1,
     $                   IERR )
            IF( WNTQN ) THEN
*
*              Perform bidiagonal SVD, only computing singular values
*              (Workspace: need N+BDSPAC)
*
               CALL DBDSDC( 'U', 'N', N, S, WORK( IE ), DUM, 1, DUM, 1,
     $                      DUM, IDUM, WORK( NWORK ), IWORK, INFO )
            ELSE IF( WNTQO ) THEN
               IU = NWORK
               IF( LWORK.GE.M*N+3*N+BDSPAC ) THEN
*
*                 WORK( IU ) is M by N
*
```

```
                  LDWRKU = M
                  NWORK = IU + LDWRKU*N
                  CALL DLASET( 'F', M, N, ZERO, ZERO, WORK( IU ),
     $                         LDWRKU )
               ELSE
*
*                 WORK( IU ) is N by N
*
                  LDWRKU = N
                  NWORK = IU + LDWRKU*N
*
*                 WORK(IR) is LDWRKR by N
*
                  IR = NWORK
                  LDWRKR = ( LWORK-N*N-3*N ) / N
               END IF
               NWORK = IU + LDWRKU*N
*
*              Perform bidiagonal SVD, computing left singular vectors
*              of bidiagonal matrix in WORK(IU) and computing right
*              singular vectors of bidiagonal matrix in VT
*              (Workspace: need N+N*N+BDSPAC)
*
               CALL DBDSDC( 'U', 'I', N, S, WORK( IE ), WORK( IU ),
     $                      LDWRKU, VT, LDVT, DUM, IDUM, WORK( NWORK ),
     $                      IWORK, INFO )
*
*              Overwrite VT by right singular vectors of A
*              (Workspace: need N*N+2*N, prefer N*N+N+N*NB)
*
               CALL DORMBR( 'P', 'R', 'T', N, N, N, A, LDA,
     $                      WORK( ITAUP ), VT, LDVT, WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
*
               IF( LWORK.GE.M*N+3*N+BDSPAC ) THEN
*
*                 Overwrite WORK(IU) by left singular vectors of A
*                 (Workspace: need N*N+2*N, prefer N*N+N+N*NB)
*
                  CALL DORMBR( 'Q', 'L', 'N', M, N, N, A, LDA,
     $                         WORK( ITAUQ ), WORK( IU ), LDWRKU,
     $                         WORK( NWORK ), LWORK-NWORK+1, IERR )
*
*                 Copy left singular vectors of A from WORK(IU) to A
*
                  CALL DLACPY( 'F', M, N, WORK( IU ), LDWRKU, A, LDA )
               ELSE
*
*                 Generate Q in A
*                 (Workspace: need N*N+2*N, prefer N*N+N+N*NB)
```

```
*
                  CALL DORGBR( 'Q', M, N, N, A, LDA, WORK( ITAUQ ),
     $                         WORK( NWORK ), LWORK-NWORK+1, IERR )
*
*                 Multiply Q in A by left singular vectors of
*                 bidiagonal matrix in WORK(IU), storing result in
*                 WORK(IR) and copying to A
*                 (Workspace: need 2*N*N, prefer N*N+M*N)
*
                  DO 20 I = 1, M, LDWRKR
                     CHUNK = MIN( M-I+1, LDWRKR )
                     CALL DGEMM( 'N', 'N', CHUNK, N, N, ONE, A( I, 1 ),
     $                           LDA, WORK( IU ), LDWRKU, ZERO,
     $                           WORK( IR ), LDWRKR )
                     CALL DLACPY( 'F', CHUNK, N, WORK( IR ), LDWRKR,
     $                            A( I, 1 ), LDA )
   20             CONTINUE
               END IF
*
            ELSE IF( WNTQS ) THEN
*
*              Perform bidiagonal SVD, computing left singular vectors
*              of bidiagonal matrix in U and computing right singular
*              vectors of bidiagonal matrix in VT
*              (Workspace: need N+BDSPAC)
*
               CALL DLASET( 'F', M, N, ZERO, ZERO, U, LDU )
               CALL DBDSDC( 'U', 'I', N, S, WORK( IE ), U, LDU, VT,
     $                      LDVT, DUM, IDUM, WORK( NWORK ), IWORK,
     $                      INFO )
*
*              Overwrite U by left singular vectors of A and VT
*              by right singular vectors of A
*              (Workspace: need 3*N, prefer 2*N+N*NB)
*
               CALL DORMBR( 'Q', 'L', 'N', M, N, N, A, LDA,
     $                      WORK( ITAUQ ), U, LDU, WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
               CALL DORMBR( 'P', 'R', 'T', N, N, N, A, LDA,
     $                      WORK( ITAUP ), VT, LDVT, WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
            ELSE IF( WNTQA ) THEN
*
*              Perform bidiagonal SVD, computing left singular vectors
*              of bidiagonal matrix in U and computing right singular
*              vectors of bidiagonal matrix in VT
*              (Workspace: need N+BDSPAC)
*
               CALL DLASET( 'F', M, M, ZERO, ZERO, U, LDU )
               CALL DBDSDC( 'U', 'I', N, S, WORK( IE ), U, LDU, VT,
```

```
     $                     LDVT, DUM, IDUM, WORK( NWORK ), IWORK,
     $                     INFO )
*
*              Set the right corner of U to identity matrix
*
               CALL DLASET( 'F', M-N, M-N, ZERO, ONE, U( N+1, N+1 ),
     $                      LDU )
*
*              Overwrite U by left singular vectors of A and VT
*              by right singular vectors of A
*              (Workspace: need N*N+2*N+M, prefer N*N+2*N+M*NB)
*
               CALL DORMBR( 'Q', 'L', 'N', M, M, N, A, LDA,
     $                      WORK( ITAUQ ), U, LDU, WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
               CALL DORMBR( 'P', 'R', 'T', N, N, M, A, LDA,
     $                      WORK( ITAUP ), VT, LDVT, WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
            END IF
*
         END IF
*
      ELSE
*
*        A has more columns than rows. If A has sufficiently more
*        columns than rows, first reduce using the LQ decomposition (if
*        sufficient workspace available)
*
         IF( N.GE.MNTHR ) THEN
*
            IF( WNTQN ) THEN
*
*              Path 1t (N much larger than M, JOBZ='N')
*              No singular vectors to be computed
*
               ITAU = 1
               NWORK = ITAU + M
*
*              Compute A=L*Q
*              (Workspace: need 2*M, prefer M+M*NB)
*
               CALL DGELQF( M, N, A, LDA, WORK( ITAU ), WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
*
*              Zero out above L
*
               CALL DLASET( 'U', M-1, M-1, ZERO, ZERO, A( 1, 2 ), LDA )
               IE = 1
               ITAUQ = IE + M
               ITAUP = ITAUQ + M
```

```
               NWORK = ITAUP + M
*
*              Bidiagonalize L in A
*              (Workspace: need 4*M, prefer 3*M+2*M*NB)
*
               CALL DGEBRD( M, M, A, LDA, S, WORK( IE ), WORK( ITAUQ ),
     $                      WORK( ITAUP ), WORK( NWORK ), LWORK-NWORK+1,
     $                      IERR )
               NWORK = IE + M
*
*              Perform bidiagonal SVD, computing singular values only
*              (Workspace: need M+BDSPAC)
*
               CALL DBDSDC( 'U', 'N', M, S, WORK( IE ), DUM, 1, DUM, 1,
     $                      DUM, IDUM, WORK( NWORK ), IWORK, INFO )
*
            ELSE IF( WNTQO ) THEN
*
*              Path 2t (N much larger than M, JOBZ='O')
*              M right singular vectors to be overwritten on A and
*              M left singular vectors to be computed in U
*
               IVT = 1
*
*              IVT is M by M
*
               IL = IVT + M*M
               IF( LWORK.GE.M*N+M*M+3*M+BDSPAC ) THEN
*
*                 WORK(IL) is M by N
*
                  LDWRKL = M
                  CHUNK = N
               ELSE
                  LDWRKL = M
                  CHUNK = ( LWORK-M*M ) / M
               END IF
               ITAU = IL + LDWRKL*M
               NWORK = ITAU + M
*
*              Compute A=L*Q
*              (Workspace: need M*M+2*M, prefer M*M+M+M*NB)
*
               CALL DGELQF( M, N, A, LDA, WORK( ITAU ), WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
*
*              Copy L to WORK(IL), zeroing about above it
*
               CALL DLACPY( 'L', M, M, A, LDA, WORK( IL ), LDWRKL )
               CALL DLASET( 'U', M-1, M-1, ZERO, ZERO,
```

```
     $                    WORK( IL+LDWRKL ), LDWRKL )
*
*             Generate Q in A
*             (Workspace: need M*M+2*M, prefer M*M+M+M*NB)
*
              CALL DORGLQ( M, N, M, A, LDA, WORK( ITAU ),
     $                     WORK( NWORK ), LWORK-NWORK+1, IERR )
              IE = ITAU
              ITAUQ = IE + M
              ITAUP = ITAUQ + M
              NWORK = ITAUP + M
*
*             Bidiagonalize L in WORK(IL)
*             (Workspace: need M*M+4*M, prefer M*M+3*M+2*M*NB)
*
              CALL DGEBRD( M, M, WORK( IL ), LDWRKL, S, WORK( IE ),
     $                     WORK( ITAUQ ), WORK( ITAUP ), WORK( NWORK ),
     $                     LWORK-NWORK+1, IERR )
*
*             Perform bidiagonal SVD, computing left singular vectors
*             of bidiagonal matrix in U, and computing right singular
*             vectors of bidiagonal matrix in WORK(IVT)
*             (Workspace: need M+M*M+BDSPAC)
*
              CALL DBDSDC( 'U', 'I', M, S, WORK( IE ), U, LDU,
     $                     WORK( IVT ), M, DUM, IDUM, WORK( NWORK ),
     $                     IWORK, INFO )
*
*             Overwrite U by left singular vectors of L and WORK(IVT)
*             by right singular vectors of L
*             (Workspace: need 2*M*M+3*M, prefer 2*M*M+2*M+M*NB)
*
              CALL DORMBR( 'Q', 'L', 'N', M, M, M, WORK( IL ), LDWRKL,
     $                     WORK( ITAUQ ), U, LDU, WORK( NWORK ),
     $                     LWORK-NWORK+1, IERR )
              CALL DORMBR( 'P', 'R', 'T', M, M, M, WORK( IL ), LDWRKL,
     $                     WORK( ITAUP ), WORK( IVT ), M,
     $                     WORK( NWORK ), LWORK-NWORK+1, IERR )
*
*             Multiply right singular vectors of L in WORK(IVT) by Q
*             in A, storing result in WORK(IL) and copying to A
*             (Workspace: need 2*M*M, prefer M*M+M*N)
*
              DO 30 I = 1, N, CHUNK
                 BLK = MIN( N-I+1, CHUNK )
                 CALL DGEMM( 'N', 'N', M, BLK, M, ONE, WORK( IVT ), M,
     $                       A( 1, I ), LDA, ZERO, WORK( IL ), LDWRKL )
                 CALL DLACPY( 'F', M, BLK, WORK( IL ), LDWRKL,
     $                        A( 1, I ), LDA )
   30         CONTINUE
```

```
*
            ELSE IF( WNTQS ) THEN
*
*              Path 3t (N much larger than M, JOBZ='S')
*              M right singular vectors to be computed in VT and
*              M left singular vectors to be computed in U
*
               IL = 1
*
*              WORK(IL) is M by M
*
               LDWRKL = M
               ITAU = IL + LDWRKL*M
               NWORK = ITAU + M
*
*              Compute A=L*Q
*              (Workspace: need M*M+2*M, prefer M*M+M+M*NB)
*
               CALL DGELQF( M, N, A, LDA, WORK( ITAU ), WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
*
*              Copy L to WORK(IL), zeroing out above it
*
               CALL DLACPY( 'L', M, M, A, LDA, WORK( IL ), LDWRKL )
               CALL DLASET( 'U', M-1, M-1, ZERO, ZERO,
     $                      WORK( IL+LDWRKL ), LDWRKL )
*
*              Generate Q in A
*              (Workspace: need M*M+2*M, prefer M*M+M+M*NB)
*
               CALL DORGLQ( M, N, M, A, LDA, WORK( ITAU ),
     $                      WORK( NWORK ), LWORK-NWORK+1, IERR )
               IE = ITAU
               ITAUQ = IE + M
               ITAUP = ITAUQ + M
               NWORK = ITAUP + M
*
*              Bidiagonalize L in WORK(IU), copying result to U
*              (Workspace: need M*M+4*M, prefer M*M+3*M+2*M*NB)
*
               CALL DGEBRD( M, M, WORK( IL ), LDWRKL, S, WORK( IE ),
     $                      WORK( ITAUQ ), WORK( ITAUP ), WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
*
*              Perform bidiagonal SVD, computing left singular vectors
*              of bidiagonal matrix in U and computing right singular
*              vectors of bidiagonal matrix in VT
*              (Workspace: need M+BDSPAC)
*
               CALL DBDSDC( 'U', 'I', M, S, WORK( IE ), U, LDU, VT,
```

```
     $                    LDVT, DUM, IDUM, WORK( NWORK ), IWORK,
     $                    INFO )
*
*            Overwrite U by left singular vectors of L and VT
*            by right singular vectors of L
*            (Workspace: need M*M+3*M, prefer M*M+2*M+M*NB)
*
             CALL DORMBR( 'Q', 'L', 'N', M, M, M, WORK( IL ), LDWRKL,
     $                    WORK( ITAUQ ), U, LDU, WORK( NWORK ),
     $                    LWORK-NWORK+1, IERR )
             CALL DORMBR( 'P', 'R', 'T', M, M, M, WORK( IL ), LDWRKL,
     $                    WORK( ITAUP ), VT, LDVT, WORK( NWORK ),
     $                    LWORK-NWORK+1, IERR )
*
*            Multiply right singular vectors of L in WORK(IL) by
*            Q in A, storing result in VT
*            (Workspace: need M*M)
*
             CALL DLACPY( 'F', M, M, VT, LDVT, WORK( IL ), LDWRKL )
             CALL DGEMM( 'N', 'N', M, N, M, ONE, WORK( IL ), LDWRKL,
     $                   A, LDA, ZERO, VT, LDVT )
*
          ELSE IF( WNTQA ) THEN
*
*            Path 4t (N much larger than M, JOBZ='A')
*            N right singular vectors to be computed in VT and
*            M left singular vectors to be computed in U
*
             IVT = 1
*
*            WORK(IVT) is M by M
*
             LDWKVT = M
             ITAU = IVT + LDWKVT*M
             NWORK = ITAU + M
*
*            Compute A=L*Q, copying result to VT
*            (Workspace: need M*M+2*M, prefer M*M+M+M*NB)
*
             CALL DGELQF( M, N, A, LDA, WORK( ITAU ), WORK( NWORK ),
     $                    LWORK-NWORK+1, IERR )
             CALL DLACPY( 'U', M, N, A, LDA, VT, LDVT )
*
*            Generate Q in VT
*            (Workspace: need M*M+2*M, prefer M*M+M+M*NB)
*
             CALL DORGLQ( N, N, M, VT, LDVT, WORK( ITAU ),
     $                    WORK( NWORK ), LWORK-NWORK+1, IERR )
*
*            Produce L in A, zeroing out other entries
```

```
*
               CALL DLASET( 'U', M-1, M-1, ZERO, ZERO, A( 1, 2 ), LDA )
               IE = ITAU
               ITAUQ = IE + M
               ITAUP = ITAUQ + M
               NWORK = ITAUP + M
*
*              Bidiagonalize L in A
*              (Workspace: need M*M+4*M, prefer M*M+3*M+2*M*NB)
*
               CALL DGEBRD( M, M, A, LDA, S, WORK( IE ), WORK( ITAUQ ),
     $                      WORK( ITAUP ), WORK( NWORK ), LWORK-NWORK+1,
     $                      IERR )
*
*              Perform bidiagonal SVD, computing left singular vectors
*              of bidiagonal matrix in U and computing right singular
*              vectors of bidiagonal matrix in WORK(IVT)
*              (Workspace: need M+M*M+BDSPAC)
*
               CALL DBDSDC( 'U', 'I', M, S, WORK( IE ), U, LDU,
     $                      WORK( IVT ), LDWKVT, DUM, IDUM,
     $                      WORK( NWORK ), IWORK, INFO )
*
*              Overwrite U by left singular vectors of L and WORK(IVT)
*              by right singular vectors of L
*              (Workspace: need M*M+3*M, prefer M*M+2*M+M*NB)
*
               CALL DORMBR( 'Q', 'L', 'N', M, M, M, A, LDA,
     $                      WORK( ITAUQ ), U, LDU, WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
               CALL DORMBR( 'P', 'R', 'T', M, M, M, A, LDA,
     $                      WORK( ITAUP ), WORK( IVT ), LDWKVT,
     $                      WORK( NWORK ), LWORK-NWORK+1, IERR )
*
*              Multiply right singular vectors of L in WORK(IVT) by
*              Q in VT, storing result in A
*              (Workspace: need M*M)
*
               CALL DGEMM( 'N', 'N', M, N, M, ONE, WORK( IVT ), LDWKVT,
     $                     VT, LDVT, ZERO, A, LDA )
*
*              Copy right singular vectors of A from A to VT
*
               CALL DLACPY( 'F', M, N, A, LDA, VT, LDVT )
*
            END IF
*
         ELSE
*
*           N .LT. MNTHR
```

```
*
*           Path 5t (N greater than M, but not much larger)
*           Reduce to bidiagonal form without LQ decomposition
*
            IE = 1
            ITAUQ = IE + M
            ITAUP = ITAUQ + M
            NWORK = ITAUP + M
*
*           Bidiagonalize A
*           (Workspace: need 3*M+N, prefer 3*M+(M+N)*NB)
*
            CALL DGEBRD( M, N, A, LDA, S, WORK( IE ), WORK( ITAUQ ),
     $                   WORK( ITAUP ), WORK( NWORK ), LWORK-NWORK+1,
     $                   IERR )
            IF( WNTQN ) THEN
*
*              Perform bidiagonal SVD, only computing singular values
*              (Workspace: need M+BDSPAC)
*
               CALL DBDSDC( 'L', 'N', M, S, WORK( IE ), DUM, 1, DUM, 1,
     $                      DUM, IDUM, WORK( NWORK ), IWORK, INFO )
            ELSE IF( WNTQO ) THEN
               LDWKVT = M
               IVT = NWORK
               IF( LWORK.GE.M*N+3*M+BDSPAC ) THEN
*
*                 WORK( IVT ) is M by N
*
                  CALL DLASET( 'F', M, N, ZERO, ZERO, WORK( IVT ),
     $                         LDWKVT )
                  NWORK = IVT + LDWKVT*N
               ELSE
*
*                 WORK( IVT ) is M by M
*
                  NWORK = IVT + LDWKVT*M
                  IL = NWORK
*
*                 WORK(IL) is M by CHUNK
*
                  CHUNK = ( LWORK-M*M-3*M ) / M
               END IF
*
*              Perform bidiagonal SVD, computing left singular vectors
*              of bidiagonal matrix in U and computing right singular
*              vectors of bidiagonal matrix in WORK(IVT)
*              (Workspace: need M*M+BDSPAC)
*
               CALL DBDSDC( 'L', 'I', M, S, WORK( IE ), U, LDU,
```

```
     $                     WORK( IVT ), LDWKVT, DUM, IDUM,
     $                     WORK( NWORK ), IWORK, INFO )
*
*              Overwrite U by left singular vectors of A
*              (Workspace: need M*M+2*M, prefer M*M+M+M*NB)
*
               CALL DORMBR( 'Q', 'L', 'N', M, M, N, A, LDA,
     $                      WORK( ITAUQ ), U, LDU, WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
*
               IF( LWORK.GE.M*N+3*M+BDSPAC ) THEN
*
*                 Overwrite WORK(IVT) by left singular vectors of A
*                 (Workspace: need M*M+2*M, prefer M*M+M+M*NB)
*
                  CALL DORMBR( 'P', 'R', 'T', M, N, M, A, LDA,
     $                         WORK( ITAUP ), WORK( IVT ), LDWKVT,
     $                         WORK( NWORK ), LWORK-NWORK+1, IERR )
*
*                 Copy right singular vectors of A from WORK(IVT) to A
*
                  CALL DLACPY( 'F', M, N, WORK( IVT ), LDWKVT, A, LDA )
               ELSE
*
*                 Generate P**T in A
*                 (Workspace: need M*M+2*M, prefer M*M+M+M*NB)
*
                  CALL DORGBR( 'P', M, N, M, A, LDA, WORK( ITAUP ),
     $                         WORK( NWORK ), LWORK-NWORK+1, IERR )
*
*                 Multiply Q in A by right singular vectors of
*                 bidiagonal matrix in WORK(IVT), storing result in
*                 WORK(IL) and copying to A
*                 (Workspace: need 2*M*M, prefer M*M+M*N)
*
                  DO 40 I = 1, N, CHUNK
                     BLK = MIN( N-I+1, CHUNK )
                     CALL DGEMM( 'N', 'N', M, BLK, M, ONE, WORK( IVT ),
     $                           LDWKVT, A( 1, I ), LDA, ZERO,
     $                           WORK( IL ), M )
                     CALL DLACPY( 'F', M, BLK, WORK( IL ), M, A( 1, I ),
     $                            LDA )
   40             CONTINUE
               END IF
            ELSE IF( WNTQS ) THEN
*
*              Perform bidiagonal SVD, computing left singular vectors
*              of bidiagonal matrix in U and computing right singular
*              vectors of bidiagonal matrix in VT
*              (Workspace: need M+BDSPAC)
```

```
*
               CALL DLASET( 'F', M, N, ZERO, ZERO, VT, LDVT )
               CALL DBDSDC( 'L', 'I', M, S, WORK( IE ), U, LDU, VT,
     $                      LDVT, DUM, IDUM, WORK( NWORK ), IWORK,
     $                      INFO )
*
*              Overwrite U by left singular vectors of A and VT
*              by right singular vectors of A
*              (Workspace: need 3*M, prefer 2*M+M*NB)
*
               CALL DORMBR( 'Q', 'L', 'N', M, M, N, A, LDA,
     $                      WORK( ITAUQ ), U, LDU, WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
               CALL DORMBR( 'P', 'R', 'T', M, N, M, A, LDA,
     $                      WORK( ITAUP ), VT, LDVT, WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
            ELSE IF( WNTQA ) THEN
*
*              Perform bidiagonal SVD, computing left singular vectors
*              of bidiagonal matrix in U and computing right singular
*              vectors of bidiagonal matrix in VT
*              (Workspace: need M+BDSPAC)
*
               CALL DLASET( 'F', N, N, ZERO, ZERO, VT, LDVT )
               CALL DBDSDC( 'L', 'I', M, S, WORK( IE ), U, LDU, VT,
     $                      LDVT, DUM, IDUM, WORK( NWORK ), IWORK,
     $                      INFO )
*
*              Set the right corner of VT to identity matrix
*
               CALL DLASET( 'F', N-M, N-M, ZERO, ONE, VT( M+1, M+1 ),
     $                      LDVT )
*
*              Overwrite U by left singular vectors of A and VT
*              by right singular vectors of A
*              (Workspace: need 2*M+N, prefer 2*M+N*NB)
*
               CALL DORMBR( 'Q', 'L', 'N', M, M, N, A, LDA,
     $                      WORK( ITAUQ ), U, LDU, WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
               CALL DORMBR( 'P', 'R', 'T', N, N, M, A, LDA,
     $                      WORK( ITAUP ), VT, LDVT, WORK( NWORK ),
     $                      LWORK-NWORK+1, IERR )
            END IF
*
         END IF
*
      END IF
*
*     Undo scaling if necessary
```

```
*
      IF( ISCL.EQ.1 ) THEN
         IF( ANRM.GT.BIGNUM )
     $      CALL DLASCL( 'G', 0, 0, BIGNUM, ANRM, MINMN, 1, S, MINMN,
     $                   IERR )
         IF( ANRM.LT.SMLNUM )
     $      CALL DLASCL( 'G', 0, 0, SMLNUM, ANRM, MINMN, 1, S, MINMN,
     $                   IERR )
      END IF
*
*     Return optimal workspace in WORK(1)
*
      WORK( 1 ) = DBLE( MAXWRK )
*
      RETURN
*
*     End of DGESDD
*
      END
```

———-

— LAPACK dgesdd —

```
(let* ((zero 0.0) (one 1.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one))
  (defun dgesdd (jobz m n a lda s u ldu vt ldvt work lwork iwork info)
    (declare (type (simple-array fixnum (*)) iwork)
             (type (simple-array double-float (*)) work vt u s a)
             (type fixnum info lwork ldvt ldu lda n m)
             (type character jobz))
    (f2cl-lib:with-multi-array-data
        ((jobz character jobz-%data% jobz-%offset%)
         (a double-float a-%data% a-%offset%)
         (s double-float s-%data% s-%offset%)
         (u double-float u-%data% u-%offset%)
         (vt double-float vt-%data% vt-%offset%)
         (work double-float work-%data% work-%offset%)
         (iwork fixnum iwork-%data% iwork-%offset%))
      (prog ((dum (make-array 1 :element-type 'double-float))
             (idum (make-array 1 :element-type 'fixnum)) (anrm 0.0)
             (bignum 0.0) (eps 0.0) (smlnum 0.0) (bdspac 0) (blk 0) (chunk 0)
             (i 0) (ie 0) (ierr 0) (il 0) (ir 0) (iscl 0) (itau 0) (itaup 0)
             (itauq 0) (iu 0) (ivt 0) (ldwkvt 0) (ldwrkl 0) (ldwrkr 0)
             (ldwrku 0) (maxwrk 0) (minmn 0) (minwrk 0) (mnthr 0) (nwork 0)
             (wrkbl 0) (lquery nil) (wntqa nil) (wntqas nil) (wntqn nil)
             (wntqo nil) (wntqs nil))
```

```
(declare (type (simple-array double-float (1)) dum)
         (type (simple-array fixnum (1)) idum)
         (type (double-float) anrm bignum eps smlnum)
         (type fixnum bdspac blk chunk i ie ierr il ir
                                  iscl itau itaup itauq iu ivt ldwkvt
                                  ldwrkl ldwrkr ldwrku maxwrk minmn
                                  minwrk mnthr nwork wrkbl)
         (type (member t nil) lquery wntqa wntqas wntqn wntqo wntqs))
(setf info 0)
(setf minmn (min (the fixnum m) (the fixnum n)))
(setf mnthr (f2cl-lib:int (/ (* minmn 11.0) 6.0)))
(setf wntqa (char-equal jobz #\A))
(setf wntqs (char-equal jobz #\S))
(setf wntqas (or wntqa wntqs))
(setf wntqo (char-equal jobz #\O))
(setf wntqn (char-equal jobz #\N))
(setf minwrk 1)
(setf maxwrk 1)
(setf lquery (coerce (= lwork -1) '(member t nil)))
(cond
  ((not (or wntqa wntqs wntqo wntqn))
   (setf info -1))
  ((< m 0)
   (setf info -2))
  ((< n 0)
   (setf info -3))
  ((< lda (max (the fixnum 1) (the fixnum m)))
   (setf info -5))
  ((or (< ldu 1) (and wntqas (< ldu m)) (and wntqo (< m n) (< ldu m)))
   (setf info -8))
  ((or (< ldvt 1)
       (and wntqa (< ldvt n))
       (and wntqs (< ldvt minmn))
       (and wntqo (>= m n) (< ldvt n)))
   (setf info -10)))
(cond
  ((and (= info 0) (> m 0) (> n 0))
   (cond
     ((>= m n)
      (cond
        (wntqn
         (setf bdspac (f2cl-lib:int-mul 7 n)))
        (t
         (setf bdspac
                 (f2cl-lib:int-add (f2cl-lib:int-mul 3 n n)
                                   (f2cl-lib:int-mul 4 n)))))
      (cond
        ((>= m mnthr)
         (cond
           (wntqn
```

```
 (setf wrkbl
         (f2cl-lib:int-add n
                           (f2cl-lib:int-mul n
                                             (ilaenv 1
                                              "DGEQRF" " " m
                                              n -1 -1))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                     (f2cl-lib:int-mul 2
                                                       n
                                                       (ilaenv
                                                        1
                                                        "DGEBRD"
                                                        " "
                                                        n n
                                                        -1
                                                        -1))))))
 (setf maxwrk
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add bdspac n))))
 (setf minwrk (f2cl-lib:int-add bdspac n)))
(wntqo
 (setf wrkbl
         (f2cl-lib:int-add n
                           (f2cl-lib:int-mul n
                                             (ilaenv 1
                                              "DGEQRF" " " m
                                              n -1 -1))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add n
                                     (f2cl-lib:int-mul n
                                                       (ilaenv
                                                        1
                                                        "DORGQR"
                                                        " "
                                                        m n
                                                        n
                                                        -1))))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                     (f2cl-lib:int-mul 2
                                                       n
                                                       (ilaenv
```

```
                                                                1
                                                                "DGEBRD"
                                                                " "
                                                                n n
                                                                -1
                                                                -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                                  (f2cl-lib:int-mul n
                                                                    (ilaenv
                                                                     1
                                                                     "DORMBR"
                                                                     "QLN"
                                                                     n n
                                                                     n
                                                                     -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                                  (f2cl-lib:int-mul n
                                                                    (ilaenv
                                                                     1
                                                                     "DORMBR"
                                                                     "PRT"
                                                                     n n
                                                                     n
                                                                     -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add bdspac
                                                  (f2cl-lib:int-mul 3
                                                                    n)))))
                (setf maxwrk
                      (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul 2 n n)))
                (setf minwrk
                      (f2cl-lib:int-add bdspac
                                        (f2cl-lib:int-mul 2 n n)
                                        (f2cl-lib:int-mul 3 n))))
               (wntqs
                (setf wrkbl
                      (f2cl-lib:int-add n
                                        (f2cl-lib:int-mul n
                                                          (ilaenv 1
                                                           "DGEQRF" " " m
                                                           n -1 -1))))
                (setf wrkbl
```

```
          (max (the fixnum wrkbl)
               (the fixnum
                    (f2cl-lib:int-add n
                                      (f2cl-lib:int-mul n
                                                        (ilaenv
                                                         1
                                                         "DORGQR"
                                                         " "
                                                         m n
                                                         n
                                                         -1))))))
    (setf wrkbl
          (max (the fixnum wrkbl)
               (the fixnum
                    (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                      (f2cl-lib:int-mul 2
                                                        n
                                                        (ilaenv
                                                         1
                                                         "DGEBRD"
                                                         " "
                                                         n n
                                                         -1
                                                         -1))))))
    (setf wrkbl
          (max (the fixnum wrkbl)
               (the fixnum
                    (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                      (f2cl-lib:int-mul n
                                                        (ilaenv
                                                         1
                                                         "DORMBR"
                                                         "QLN"
                                                         n n
                                                         n
                                                         -1))))))
    (setf wrkbl
          (max (the fixnum wrkbl)
               (the fixnum
                    (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                      (f2cl-lib:int-mul n
                                                        (ilaenv
                                                         1
                                                         "DORMBR"
                                                         "PRT"
                                                         n n
                                                         n
                                                         -1))))))
    (setf wrkbl
          (max (the fixnum wrkbl)
```

```
                (the fixnum
                     (f2cl-lib:int-add bdspac
                                       (f2cl-lib:int-mul 3
                                                         n)))))
 (setf maxwrk
         (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul n n)))
 (setf minwrk
         (f2cl-lib:int-add bdspac
                           (f2cl-lib:int-mul n n)
                           (f2cl-lib:int-mul 3 n))))
(wntqa
 (setf wrkbl
         (f2cl-lib:int-add n
                           (f2cl-lib:int-mul n
                                             (ilaenv 1
                                              "DGEQRF" " " m
                                              n -1 -1))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add n
                                     (f2cl-lib:int-mul m
                                                       (ilaenv
                                                        1
                                                        "DORGQR"
                                                        " "
                                                        m m
                                                        n
                                                        -1))))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                     (f2cl-lib:int-mul 2
                                                       n
                                                       (ilaenv
                                                        1
                                                        "DGEBRD"
                                                        " "
                                                        n n
                                                        -1
                                                        -1))))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                     (f2cl-lib:int-mul n
                                                       (ilaenv
                                                        1
                                                        "DORMBR"
```

```
                                                                  "QLN"
                                                                  n n
                                                                  n
                                                                  -1))))))
        (setf wrkbl
                (max (the fixnum wrkbl)
                     (the fixnum
                          (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                            (f2cl-lib:int-mul n
                                                              (ilaenv
                                                               1
                                                               "DORMBR"
                                                               "PRT"
                                                               n n
                                                               n
                                                               -1))))))
        (setf wrkbl
                (max (the fixnum wrkbl)
                     (the fixnum
                          (f2cl-lib:int-add bdspac
                                            (f2cl-lib:int-mul 3
                                                              n)))))
        (setf maxwrk
                (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul n n)))
        (setf minwrk
                (f2cl-lib:int-add bdspac
                                  (f2cl-lib:int-mul n n)
                                  (f2cl-lib:int-mul 3 n))))))
    (t
     (setf wrkbl
             (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                               (f2cl-lib:int-mul
                                (f2cl-lib:int-add m n)
                                (ilaenv 1 "DGEBRD" " " m n -1 -1))))
     (cond
       (wntqn
        (setf maxwrk
                (max (the fixnum wrkbl)
                     (the fixnum
                          (f2cl-lib:int-add bdspac
                                            (f2cl-lib:int-mul 3
                                                              n)))))
        (setf minwrk
                (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                  (max (the fixnum m)
                                       (the fixnum
                                            bdspac)))))
       (wntqo
        (setf wrkbl
                (max (the fixnum wrkbl)
```

```
                    (the fixnum
                         (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                           (f2cl-lib:int-mul n
                                                             (ilaenv
                                                              1
                                                              "DORMBR"
                                                              "QLN"
                                                              m n
                                                              n
                                                              -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                                  (f2cl-lib:int-mul n
                                                                    (ilaenv
                                                                     1
                                                                     "DORMBR"
                                                                     "PRT"
                                                                     n n
                                                                     n
                                                                     -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add bdspac
                                                  (f2cl-lib:int-mul 3
                                                                    n)))))
                (setf maxwrk
                      (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul m n)))
                (setf minwrk
                      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                        (max (the fixnum m)
                                             (the fixnum
                                                  (f2cl-lib:int-add
                                                   (f2cl-lib:int-mul n n)
                                                   bdspac))))))
               (wntqs
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                                  (f2cl-lib:int-mul n
                                                                    (ilaenv
                                                                     1
                                                                     "DORMBR"
                                                                     "QLN"
                                                                     m n
                                                                     n
                                                                     -1))))))
```

```
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                     (f2cl-lib:int-mul n
                                                       (ilaenv
                                                        1
                                                        "DORMBR"
                                                        "PRT"
                                                        n n
                                                        n
                                                        -1))))))
 (setf maxwrk
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add bdspac
                                     (f2cl-lib:int-mul 3
                                                       n)))))
 (setf minwrk
         (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                           (max (the fixnum m)
                                (the fixnum
                                     bdspac)))))
(wntqa
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                     (f2cl-lib:int-mul m
                                                       (ilaenv
                                                        1
                                                        "DORMBR"
                                                        "QLN"
                                                        m m
                                                        n
                                                        -1))))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                     (f2cl-lib:int-mul n
                                                       (ilaenv
                                                        1
                                                        "DORMBR"
                                                        "PRT"
                                                        n n
                                                        n
                                                        -1))))))
 (setf maxwrk
         (max (the fixnum maxwrk)
```

```
                        (the fixnum
                             (f2cl-lib:int-add bdspac
                                               (f2cl-lib:int-mul 3
                                                                 n)))))
               (setf minwrk
                       (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                         (max (the fixnum m)
                                              (the fixnum
                                                   bdspac)))))))))
          (t
           (cond
             (wntqn
              (setf bdspac (f2cl-lib:int-mul 7 m)))
             (t
              (setf bdspac
                      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m m)
                                        (f2cl-lib:int-mul 4 m)))))
           (cond
             ((>= n mnthr)
              (cond
                (wntqn
                 (setf wrkbl
                         (f2cl-lib:int-add m
                                           (f2cl-lib:int-mul m
                                                             (ilaenv 1
                                                              "DGELQF" " " m
                                                              n -1 -1))))
                 (setf wrkbl
                         (max (the fixnum wrkbl)
                              (the fixnum
                                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                                     (f2cl-lib:int-mul 2
                                                                       m
                                                                       (ilaenv
                                                                        1
                                                                        "DGEBRD"
                                                                        " "
                                                                        m m
                                                                        -1
                                                                        -1))))))
                 (setf maxwrk
                         (max (the fixnum wrkbl)
                              (the fixnum
                                   (f2cl-lib:int-add bdspac m))))
                 (setf minwrk (f2cl-lib:int-add bdspac m)))
                (wntqo
                 (setf wrkbl
                         (f2cl-lib:int-add m
                                           (f2cl-lib:int-mul m
                                                             (ilaenv 1
```

```
                                                "DGELQF" " " m
                                                n -1 -1))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add m
                                                  (f2cl-lib:int-mul m
                                                                    (ilaenv
                                                                     1
                                                                     "DORGLQ"
                                                                     " "
                                                                     m n
                                                                     m
                                                                     -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                                  (f2cl-lib:int-mul 2
                                                                    m
                                                                    (ilaenv
                                                                     1
                                                                     "DGEBRD"
                                                                     " "
                                                                     m m
                                                                     -1
                                                                     -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                                  (f2cl-lib:int-mul m
                                                                    (ilaenv
                                                                     1
                                                                     "DORMBR"
                                                                     "QLN"
                                                                     m m
                                                                     m
                                                                     -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                                  (f2cl-lib:int-mul m
                                                                    (ilaenv
                                                                     1
                                                                     "DORMBR"
                                                                     "PRT"
                                                                     m m
                                                                     m
```

```
                                                                -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add bdspac
                                                  (f2cl-lib:int-mul 3
                                                                    m)))))
                (setf maxwrk
                      (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul 2 m m)))
                (setf minwrk
                      (f2cl-lib:int-add bdspac
                                        (f2cl-lib:int-mul 2 m m)
                                        (f2cl-lib:int-mul 3 m))))
               (wntqs
                (setf wrkbl
                      (f2cl-lib:int-add m
                                        (f2cl-lib:int-mul m
                                                          (ilaenv 1
                                                           "DGELQF" " " m
                                                           n -1 -1))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add m
                                                  (f2cl-lib:int-mul m
                                                                    (ilaenv
                                                                     1
                                                                     "DORGLQ"
                                                                     " "
                                                                     m n
                                                                     m
                                                                     -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                                  (f2cl-lib:int-mul 2
                                                                    m
                                                                    (ilaenv
                                                                     1
                                                                     "DGEBRD"
                                                                     " "
                                                                     m m
                                                                     -1
                                                                     -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                                  (f2cl-lib:int-mul m
```

```
                                                                (ilaenv
                                                                 1
                                                                 "DORMBR"
                                                                 "QLN"
                                                                 m m
                                                                 m
                                                                 -1))))))
                 (setf wrkbl
                         (max (the fixnum wrkbl)
                              (the fixnum
                                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                                     (f2cl-lib:int-mul m
                                                                       (ilaenv
                                                                        1
                                                                        "DORMBR"
                                                                        "PRT"
                                                                        m m
                                                                        m
                                                                        -1))))))
                 (setf wrkbl
                         (max (the fixnum wrkbl)
                              (the fixnum
                                   (f2cl-lib:int-add bdspac
                                                     (f2cl-lib:int-mul 3
                                                                       m)))))
                 (setf maxwrk
                         (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul m m)))
                 (setf minwrk
                         (f2cl-lib:int-add bdspac
                                           (f2cl-lib:int-mul m m)
                                           (f2cl-lib:int-mul 3 m))))
                (wntqa
                 (setf wrkbl
                         (f2cl-lib:int-add m
                                           (f2cl-lib:int-mul m
                                                             (ilaenv 1
                                                              "DGELQF" " " m
                                                              n -1 -1))))
                 (setf wrkbl
                         (max (the fixnum wrkbl)
                              (the fixnum
                                   (f2cl-lib:int-add m
                                                     (f2cl-lib:int-mul n
                                                                       (ilaenv
                                                                        1
                                                                        "DORGLQ"
                                                                        " "
                                                                        n n
                                                                        m
                                                                        -1))))))
```

```
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                                  (f2cl-lib:int-mul 2
                                                                    m
                                                                    (ilaenv
                                                                     1
                                                                     "DGEBRD"
                                                                     " "
                                                                     m m
                                                                     -1
                                                                     -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                                  (f2cl-lib:int-mul m
                                                                    (ilaenv
                                                                     1
                                                                     "DORMBR"
                                                                     "QLN"
                                                                     m m
                                                                     m
                                                                     -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                                  (f2cl-lib:int-mul m
                                                                    (ilaenv
                                                                     1
                                                                     "DORMBR"
                                                                     "PRT"
                                                                     m m
                                                                     m
                                                                     -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add bdspac
                                                  (f2cl-lib:int-mul 3
                                                                    m)))))
                (setf maxwrk
                      (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul m m)))
                (setf minwrk
                      (f2cl-lib:int-add bdspac
                                        (f2cl-lib:int-mul m m)
                                        (f2cl-lib:int-mul 3 m))))))
               (t
```

```
(setf wrkbl
        (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                          (f2cl-lib:int-mul
                           (f2cl-lib:int-add m n)
                           (ilaenv 1 "DGEBRD" " " m n -1 -1))))
(cond
  (wntqn
   (setf maxwrk
           (max (the fixnum wrkbl)
                (the fixnum
                     (f2cl-lib:int-add bdspac
                                       (f2cl-lib:int-mul 3
                                                         m)))))
   (setf minwrk
           (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                             (max (the fixnum n)
                                  (the fixnum
                                       bdspac)))))
  (wntqo
   (setf wrkbl
           (max (the fixnum wrkbl)
                (the fixnum
                     (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                       (f2cl-lib:int-mul m
                                                         (ilaenv
                                                          1
                                                          "DORMBR"
                                                          "QLN"
                                                          m m
                                                          n
                                                          -1))))))
   (setf wrkbl
           (max (the fixnum wrkbl)
                (the fixnum
                     (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                       (f2cl-lib:int-mul m
                                                         (ilaenv
                                                          1
                                                          "DORMBR"
                                                          "PRT"
                                                          m n
                                                          m
                                                          -1))))))
   (setf wrkbl
           (max (the fixnum wrkbl)
                (the fixnum
                     (f2cl-lib:int-add bdspac
                                       (f2cl-lib:int-mul 3
                                                         m)))))
   (setf maxwrk
```

```
        (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul m n)))
 (setf minwrk
        (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                          (max (the fixnum n)
                               (the fixnum
                                    (f2cl-lib:int-add
                                     (f2cl-lib:int-mul m m)
                                     bdspac))))))
(wntqs
 (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                    (f2cl-lib:int-mul m
                                                      (ilaenv
                                                       1
                                                       "DORMBR"
                                                       "QLN"
                                                       m m
                                                       n
                                                       -1))))))
 (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                    (f2cl-lib:int-mul m
                                                      (ilaenv
                                                       1
                                                       "DORMBR"
                                                       "PRT"
                                                       m n
                                                       m
                                                       -1))))))
 (setf maxwrk
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add bdspac
                                    (f2cl-lib:int-mul 3
                                                      m)))))
 (setf minwrk
        (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                          (max (the fixnum n)
                               (the fixnum
                                    bdspac)))))
(wntqa
 (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                    (f2cl-lib:int-mul m
```

```
                                                                    (ilaenv
                                                                     1
                                                                     "DORMBR"
                                                                     "QLN"
                                                                     m m
                                                                     n
                                                                     -1))))))
              (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                                  (f2cl-lib:int-mul m
                                                                    (ilaenv
                                                                     1
                                                                     "DORMBR"
                                                                     "PRT"
                                                                     n n
                                                                     m
                                                                     -1))))))
              (setf maxwrk
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add bdspac
                                                  (f2cl-lib:int-mul 3
                                                                    m)))))
              (setf minwrk
                      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                        (max (the fixnum n)
                                             (the fixnum
                                                  bdspac))))))))))
     (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
             (coerce (the fixnum maxwrk) 'double-float))))
  (cond
    ((and (< lwork minwrk) (not lquery))
     (setf info -12)))
  (cond
    ((/= info 0)
     (error
      " ** On entry to ~a parameter number ~a had an illegal value~%"
      "DGESDD" (f2cl-lib:int-sub info))
     (go end_label))
    (lquery
     (go end_label)))
  (cond
    ((or (= m 0) (= n 0))
     (if (>= lwork 1)
         (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%) one))
     (go end_label)))
  (setf eps (dlamch "P"))
  (setf smlnum (/ (f2cl-lib:fsqrt (dlamch "S")) eps))
```

```
(setf bignum (/ one smlnum))
(setf anrm (dlange "M" m n a lda dum))
(setf iscl 0)
(cond
  ((and (> anrm zero) (< anrm smlnum))
   (setf iscl 1)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
       (dlascl "G" 0 0 anrm smlnum m n a lda ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                      var-8))
     (setf ierr var-9)))
  ((> anrm bignum)
   (setf iscl 1)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
       (dlascl "G" 0 0 anrm bignum m n a lda ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                      var-8))
     (setf ierr var-9))))
(cond
  ((>= m n)
   (cond
     ((>= m mnthr)
      (cond
        (wntqn
         (setf itau 1)
         (setf nwork (f2cl-lib:int-add itau n))
         (multiple-value-bind
               (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
             (dgeqrf m n a lda
              (f2cl-lib:array-slice work double-float (itau) ((1 *)))
              (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
              (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
           (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
           (setf ierr var-7))
         (dlaset "L" (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1) zero
          zero
          (f2cl-lib:array-slice a double-float (2 1) ((1 lda) (1 *)))
          lda)
         (setf ie 1)
         (setf itauq (f2cl-lib:int-add ie n))
         (setf itaup (f2cl-lib:int-add itauq n))
         (setf nwork (f2cl-lib:int-add itaup n))
         (multiple-value-bind
               (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                var-9 var-10)
             (dgebrd n n a lda s
              (f2cl-lib:array-slice work double-float (ie) ((1 *)))
              (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
```

```
      (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9))
   (setf ierr var-10))
 (setf nwork (f2cl-lib:int-add ie n))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9 var-10 var-11 var-12 var-13)
     (dbdsdc "U" "N" n s
      (f2cl-lib:array-slice work double-float (ie) ((1 *))) dum
      1 dum 1 dum idum
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      iwork info)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12))
   (setf info var-13)))
(wntqo
 (setf ir 1)
 (cond
   ((>= lwork
        (f2cl-lib:int-add (f2cl-lib:int-mul lda n)
                          (f2cl-lib:int-mul n n)
                          (f2cl-lib:int-mul 3 n)
                          bdspac))
    (setf ldwrkr lda))
   (t
    (setf ldwrkr
          (the fixnum
               (truncate (- lwork (* n n) (* 3 n) bdspac)
                         n)))))
 (setf itau (f2cl-lib:int-add ir (f2cl-lib:int-mul ldwrkr n)))
 (setf nwork (f2cl-lib:int-add itau n))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
     (dgeqrf m n a lda
      (f2cl-lib:array-slice work double-float (itau) ((1 *)))
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
   (setf ierr var-7))
 (dlacpy "U" n n a lda
  (f2cl-lib:array-slice work double-float (ir) ((1 *))) ldwrkr)
 (dlaset "L" (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1) zero
  zero
  (f2cl-lib:array-slice work double-float ((+ ir 1)) ((1 *)))
  ldwrkr)
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
```

```
    (dorgqr m n n a lda
     (f2cl-lib:array-slice work double-float (itau) ((1 *)))
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf nwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10)
    (dgebrd n n
     (f2cl-lib:array-slice work double-float (ir) ((1 *)))
     ldwrkr s
     (f2cl-lib:array-slice work double-float (ie) ((1 *)))
     (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
     (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9))
  (setf ierr var-10))
(setf iu nwork)
(setf nwork (f2cl-lib:int-add iu (f2cl-lib:int-mul n n)))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
    (dbdsdc "U" "I" n s
     (f2cl-lib:array-slice work double-float (ie) ((1 *)))
     (f2cl-lib:array-slice work double-float (iu) ((1 *))) n
     vt ldvt dum idum
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     iwork info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf info var-13))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
    (dormbr "Q" "L" "N" n n n
     (f2cl-lib:array-slice work double-float (ir) ((1 *)))
     ldwrkr
     (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
     (f2cl-lib:array-slice work double-float (iu) ((1 *))) n
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
```

```
                    var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9 var-10 var-11 var-12 var-13)
     (dormbr "P" "R" "T" n n n
      (f2cl-lib:array-slice work double-float (ir) ((1 *)))
      ldwrkr
      (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
      vt ldvt
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12))
   (setf ierr var-13))
 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i ldwrkr))
               ((> i m) nil)
   (tagbody
     (setf chunk
             (min
              (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1))
              (the fixnum ldwrkr)))
     (dgemm "N" "N" chunk n n one
      (f2cl-lib:array-slice a
                            double-float
                            (i 1)
                            ((1 lda) (1 *)))
      lda (f2cl-lib:array-slice work double-float (iu) ((1 *)))
      n zero
      (f2cl-lib:array-slice work double-float (ir) ((1 *)))
      ldwrkr)
     (dlacpy "F" chunk n
      (f2cl-lib:array-slice work double-float (ir) ((1 *)))
      ldwrkr
      (f2cl-lib:array-slice a
                            double-float
                            (i 1)
                            ((1 lda) (1 *)))
      lda))))
(wntqs
 (setf ir 1)
 (setf ldwrkr n)
 (setf itau (f2cl-lib:int-add ir (f2cl-lib:int-mul ldwrkr n)))
 (setf nwork (f2cl-lib:int-add itau n))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
     (dgeqrf m n a lda
      (f2cl-lib:array-slice work double-float (itau) ((1 *)))
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
```

```
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
  (setf ierr var-7))
(dlacpy "U" n n a lda
 (f2cl-lib:array-slice work double-float (ir) ((1 *))) ldwrkr)
(dlaset "L" (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1) zero
 zero
 (f2cl-lib:array-slice work double-float ((+ ir 1)) ((1 *)))
 ldwrkr)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
    (dorgqr m n n a lda
     (f2cl-lib:array-slice work double-float (itau) ((1 *)))
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf nwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10)
    (dgebrd n n
     (f2cl-lib:array-slice work double-float (ir) ((1 *)))
     ldwrkr s
     (f2cl-lib:array-slice work double-float (ie) ((1 *)))
     (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
     (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
    (dbdsdc "U" "I" n s
     (f2cl-lib:array-slice work double-float (ie) ((1 *))) u
     ldu vt ldvt dum idum
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     iwork info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf info var-13))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
```

```
    (dormbr "Q" "L" "N" n n n
     (f2cl-lib:array-slice work double-float (ir) ((1 *)))
     ldwrkr
     (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
     u ldu
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12))
   (setf ierr var-13))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9 var-10 var-11 var-12 var-13)
     (dormbr "P" "R" "T" n n n
      (f2cl-lib:array-slice work double-float (ir) ((1 *)))
      ldwrkr
      (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
      vt ldvt
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12))
   (setf ierr var-13))
 (dlacpy "F" n n u ldu
  (f2cl-lib:array-slice work double-float (ir) ((1 *))) ldwrkr)
 (dgemm "N" "N" m n n one a lda
  (f2cl-lib:array-slice work double-float (ir) ((1 *))) ldwrkr
  zero u ldu))
(wntqa
 (setf iu 1)
 (setf ldwrku n)
 (setf itau (f2cl-lib:int-add iu (f2cl-lib:int-mul ldwrku n)))
 (setf nwork (f2cl-lib:int-add itau n))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
     (dgeqrf m n a lda
      (f2cl-lib:array-slice work double-float (itau) ((1 *)))
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
   (setf ierr var-7))
 (dlacpy "L" m n a lda u ldu)
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
     (dorgqr m m n u ldu
      (f2cl-lib:array-slice work double-float (itau) ((1 *)))
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7))
```

```
  (setf ierr var-8))
(dlaset "L" (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1) zero
 zero
 (f2cl-lib:array-slice a double-float (2 1) ((1 lda) (1 *)))
 lda)
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf nwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10)
    (dgebrd n n a lda s
     (f2cl-lib:array-slice work double-float (ie) ((1 *)))
     (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
     (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
    (dbdsdc "U" "I" n s
     (f2cl-lib:array-slice work double-float (ie) ((1 *)))
     (f2cl-lib:array-slice work double-float (iu) ((1 *))) n
     vt ldvt dum idum
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     iwork info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf info var-13))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
    (dormbr "Q" "L" "N" n n n a lda
     (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
     (f2cl-lib:array-slice work double-float (iu) ((1 *)))
     ldwrku
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
    (dormbr "P" "R" "T" n n n a lda
     (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
```

```
          vt ldvt
          (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
          (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                         var-7 var-8 var-9 var-10 var-11 var-12))
        (setf ierr var-13))
      (dgemm "N" "N" m n n one u ldu
       (f2cl-lib:array-slice work double-float (iu) ((1 *))) ldwrku
       zero a lda)
      (dlacpy "F" m n a lda u ldu))))
  (t
   (setf ie 1)
   (setf itauq (f2cl-lib:int-add ie n))
   (setf itaup (f2cl-lib:int-add itauq n))
   (setf nwork (f2cl-lib:int-add itaup n))
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
          var-9 var-10)
       (dgebrd m n a lda s
        (f2cl-lib:array-slice work double-float (ie) ((1 *)))
        (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
        (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
        (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                      var-7 var-8 var-9))
     (setf ierr var-10))
   (cond
     (wntqn
      (multiple-value-bind
            (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
             var-9 var-10 var-11 var-12 var-13)
          (dbdsdc "U" "N" n s
           (f2cl-lib:array-slice work double-float (ie) ((1 *))) dum
           1 dum 1 dum idum
           (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
           iwork info)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                         var-7 var-8 var-9 var-10 var-11 var-12))
        (setf info var-13)))
     (wntqo
      (setf iu nwork)
      (cond
        ((>= lwork
             (f2cl-lib:int-add (f2cl-lib:int-mul m n)
                               (f2cl-lib:int-mul 3 n)
                               bdspac))
         (setf ldwrku m)
         (setf nwork
                 (f2cl-lib:int-add iu (f2cl-lib:int-mul ldwrku n)))
```

```
   (dlaset "F" m n zero zero
    (f2cl-lib:array-slice work double-float (iu) ((1 *)))
    ldwrku))
  (t
   (setf ldwrku n)
   (setf nwork
         (f2cl-lib:int-add iu (f2cl-lib:int-mul ldwrku n)))
   (setf ir nwork)
   (setf ldwrkr
         (the fixnum
              (truncate (- lwork (* n n) (* 3 n)) n)))))
(setf nwork (f2cl-lib:int-add iu (f2cl-lib:int-mul ldwrku n)))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
    (dbdsdc "U" "I" n s
     (f2cl-lib:array-slice work double-float (ie) ((1 *)))
     (f2cl-lib:array-slice work double-float (iu) ((1 *)))
     ldwrku vt ldvt dum idum
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     iwork info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf info var-13))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
    (dormbr "P" "R" "T" n n n a lda
     (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
     vt ldvt
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
(cond
  ((>= lwork
       (f2cl-lib:int-add (f2cl-lib:int-mul m n)
                         (f2cl-lib:int-mul 3 n)
                         bdspac))
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
          var-8 var-9 var-10 var-11 var-12 var-13)
       (dormbr "Q" "L" "N" m n n a lda
        (f2cl-lib:array-slice work
                              double-float
                              (itauq)
                              ((1 *)))
        (f2cl-lib:array-slice work double-float (iu) ((1 *)))
        ldwrku
```

```
      (f2cl-lib:array-slice work
                            double-float
                            (nwork)
                            ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1)
      ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9 var-10 var-11
                    var-12))
   (setf ierr var-13))
 (dlacpy "F" m n
  (f2cl-lib:array-slice work double-float (iu) ((1 *)))
  ldwrku a lda))
(t
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8 var-9)
     (dorgbr "Q" m n n a lda
      (f2cl-lib:array-slice work
                            double-float
                            (itauq)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (nwork)
                            ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1)
      ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8))
   (setf ierr var-9))
 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i ldwrkr))
               ((> i m) nil)
   (tagbody
     (setf chunk
             (min
              (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-sub m i)
                                     1))
              (the fixnum ldwrkr)))
     (dgemm "N" "N" chunk n n one
      (f2cl-lib:array-slice a
                            double-float
                            (i 1)
                            ((1 lda) (1 *)))
      lda
      (f2cl-lib:array-slice work double-float (iu) ((1 *)))
      ldwrku zero
      (f2cl-lib:array-slice work double-float (ir) ((1 *)))
      ldwrkr)
```

```
        (dlacpy "F" chunk n
         (f2cl-lib:array-slice work double-float (ir) ((1 *)))
         ldwrkr
         (f2cl-lib:array-slice a
                               double-float
                               (i 1)
                               ((1 lda) (1 *)))
         lda))))))
(wntqs
 (dlaset "F" m n zero zero u ldu)
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9 var-10 var-11 var-12 var-13)
     (dbdsdc "U" "I" n s
      (f2cl-lib:array-slice work double-float (ie) ((1 *))) u
      ldu vt ldvt dum idum
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      iwork info)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12))
   (setf info var-13))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9 var-10 var-11 var-12 var-13)
     (dormbr "Q" "L" "N" m n n a lda
      (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
      u ldu
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12))
   (setf ierr var-13))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9 var-10 var-11 var-12 var-13)
     (dormbr "P" "R" "T" n n n a lda
      (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
      vt ldvt
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12))
   (setf ierr var-13)))
(wntqa
 (dlaset "F" m m zero zero u ldu)
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9 var-10 var-11 var-12 var-13)
     (dbdsdc "U" "I" n s
      (f2cl-lib:array-slice work double-float (ie) ((1 *))) u
```

```
              ldu vt ldvt dum idum
              (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
              iwork info)
            (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                             var-7 var-8 var-9 var-10 var-11 var-12))
            (setf info var-13))
           (dlaset "F" (f2cl-lib:int-sub m n) (f2cl-lib:int-sub m n) zero
            one
            (f2cl-lib:array-slice u
                                  double-float
                                  ((+ n 1) (f2cl-lib:int-add n 1))
                                  ((1 ldu) (1 *)))
            ldu)
           (multiple-value-bind
                 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                  var-9 var-10 var-11 var-12 var-13)
               (dormbr "Q" "L" "N" m m n a lda
                (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
                u ldu
                (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
                (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
             (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                              var-7 var-8 var-9 var-10 var-11 var-12))
             (setf ierr var-13))
           (multiple-value-bind
                 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                  var-9 var-10 var-11 var-12 var-13)
               (dormbr "P" "R" "T" n n m a lda
                (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
                vt ldvt
                (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
                (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
             (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                              var-7 var-8 var-9 var-10 var-11 var-12))
             (setf ierr var-13)))))))
      (t
       (cond
         ((>= n mnthr)
          (cond
            (wntqn
             (setf itau 1)
             (setf nwork (f2cl-lib:int-add itau m))
             (multiple-value-bind
                   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
                 (dgelqf m n a lda
                  (f2cl-lib:array-slice work double-float (itau) ((1 *)))
                  (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
                  (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
               (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
               (setf ierr var-7))
```

```
 (dlaset "U" (f2cl-lib:int-sub m 1) (f2cl-lib:int-sub m 1) zero
  zero
  (f2cl-lib:array-slice a double-float (1 2) ((1 lda) (1 *)))
  lda)
 (setf ie 1)
 (setf itauq (f2cl-lib:int-add ie m))
 (setf itaup (f2cl-lib:int-add itauq m))
 (setf nwork (f2cl-lib:int-add itaup m))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9 var-10)
     (dgebrd m m a lda s
      (f2cl-lib:array-slice work double-float (ie) ((1 *)))
      (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
      (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9))
   (setf ierr var-10))
 (setf nwork (f2cl-lib:int-add ie m))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9 var-10 var-11 var-12 var-13)
     (dbdsdc "U" "N" m s
      (f2cl-lib:array-slice work double-float (ie) ((1 *))) dum
      1 dum 1 dum idum
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      iwork info)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12))
   (setf info var-13)))
(wntqo
 (setf ivt 1)
 (setf il (f2cl-lib:int-add ivt (f2cl-lib:int-mul m m)))
 (cond
   ((>= lwork
        (f2cl-lib:int-add (f2cl-lib:int-mul m n)
                          (f2cl-lib:int-mul m m)
                          (f2cl-lib:int-mul 3 m)
                          bdspac))
    (setf ldwrkl m)
    (setf chunk n))
   (t
    (setf ldwrkl m)
    (setf chunk
            (the fixnum
                 (truncate (- lwork (* m m)) m)))))
 (setf itau (f2cl-lib:int-add il (f2cl-lib:int-mul ldwrkl m)))
 (setf nwork (f2cl-lib:int-add itau m))
```

```
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgelqf m n a lda
     (f2cl-lib:array-slice work double-float (itau) ((1 *)))
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
  (setf ierr var-7))
(dlacpy "L" m m a lda
 (f2cl-lib:array-slice work double-float (il) ((1 *))) ldwrkl)
(dlaset "U" (f2cl-lib:int-sub m 1) (f2cl-lib:int-sub m 1) zero
 zero
 (f2cl-lib:array-slice work
                       double-float
                       ((+ il ldwrkl))
                       ((1 *)))
 ldwrkl)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
    (dorglq m n m a lda
     (f2cl-lib:array-slice work double-float (itau) ((1 *)))
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf nwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10)
    (dgebrd m m
     (f2cl-lib:array-slice work double-float (il) ((1 *)))
     ldwrkl s
     (f2cl-lib:array-slice work double-float (ie) ((1 *)))
     (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
     (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
    (dbdsdc "U" "I" m s
     (f2cl-lib:array-slice work double-float (ie) ((1 *))) u
     ldu
```

```
     (f2cl-lib:array-slice work double-float (ivt) ((1 *))) m
     dum idum
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     iwork info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf info var-13))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
    (dormbr "Q" "L" "N" m m m
     (f2cl-lib:array-slice work double-float (il) ((1 *)))
     ldwrkl
     (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
     u ldu
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
    (dormbr "P" "R" "T" m m m
     (f2cl-lib:array-slice work double-float (il) ((1 *)))
     ldwrkl
     (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
     (f2cl-lib:array-slice work double-float (ivt) ((1 *))) m
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i chunk))
              ((> i n) nil)
  (tagbody
    (setf blk
            (min
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1))
             (the fixnum chunk)))
    (dgemm "N" "N" m blk m one
     (f2cl-lib:array-slice work double-float (ivt) ((1 *))) m
     (f2cl-lib:array-slice a
                           double-float
                           (1 i)
                           ((1 lda) (1 *)))
     lda zero
     (f2cl-lib:array-slice work double-float (il) ((1 *)))
     ldwrkl)
```

```
      (dlacpy "F" m blk
       (f2cl-lib:array-slice work double-float (il) ((1 *)))
       ldwrkl
       (f2cl-lib:array-slice a
                             double-float
                             (1 i)
                             ((1 lda) (1 *)))
       lda))))
  (wntqs
   (setf il 1)
   (setf ldwrkl m)
   (setf itau (f2cl-lib:int-add il (f2cl-lib:int-mul ldwrkl m)))
   (setf nwork (f2cl-lib:int-add itau m))
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
       (dgelqf m n a lda
        (f2cl-lib:array-slice work double-float (itau) ((1 *)))
        (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
     (setf ierr var-7))
   (dlacpy "L" m m a lda
    (f2cl-lib:array-slice work double-float (il) ((1 *))) ldwrkl)
   (dlaset "U" (f2cl-lib:int-sub m 1) (f2cl-lib:int-sub m 1) zero
    zero
    (f2cl-lib:array-slice work
                          double-float
                          ((+ il ldwrkl))
                          ((1 *)))
    ldwrkl)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
       (dorglq m n m a lda
        (f2cl-lib:array-slice work double-float (itau) ((1 *)))
        (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                      var-7))
     (setf ierr var-8))
   (setf ie itau)
   (setf itauq (f2cl-lib:int-add ie m))
   (setf itaup (f2cl-lib:int-add itauq m))
   (setf nwork (f2cl-lib:int-add itaup m))
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
          var-9 var-10)
       (dgebrd m m
        (f2cl-lib:array-slice work double-float (il) ((1 *)))
        ldwrkl s
        (f2cl-lib:array-slice work double-float (ie) ((1 *)))
```

```
     (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
     (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9))
  (setf ierr var-10))
 (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
    (dbdsdc "U" "I" m s
     (f2cl-lib:array-slice work double-float (ie) ((1 *))) u
     ldu vt ldvt dum idum
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     iwork info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf info var-13))
 (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
    (dormbr "Q" "L" "N" m m m
     (f2cl-lib:array-slice work double-float (il) ((1 *)))
     ldwrkl
     (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
     u ldu
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
 (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
    (dormbr "P" "R" "T" m m m
     (f2cl-lib:array-slice work double-float (il) ((1 *)))
     ldwrkl
     (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
     vt ldvt
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
 (dlacpy "F" m m vt ldvt
  (f2cl-lib:array-slice work double-float (il) ((1 *))) ldwrkl)
 (dgemm "N" "N" m n m one
  (f2cl-lib:array-slice work double-float (il) ((1 *))) ldwrkl
  a lda zero vt ldvt))
(wntqa
```

```
(setf ivt 1)
(setf ldwkvt m)
(setf itau (f2cl-lib:int-add ivt (f2cl-lib:int-mul ldwkvt m)))
(setf nwork (f2cl-lib:int-add itau m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgelqf m n a lda
     (f2cl-lib:array-slice work double-float (itau) ((1 *)))
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
  (setf ierr var-7))
(dlacpy "U" m n a lda vt ldvt)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
    (dorglq n n m vt ldvt
     (f2cl-lib:array-slice work double-float (itau) ((1 *)))
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7))
  (setf ierr var-8))
(dlaset "U" (f2cl-lib:int-sub m 1) (f2cl-lib:int-sub m 1) zero
 zero
 (f2cl-lib:array-slice a double-float (1 2) ((1 lda) (1 *)))
 lda)
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf nwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10)
    (dgebrd m m a lda s
     (f2cl-lib:array-slice work double-float (ie) ((1 *)))
     (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
     (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
    (dbdsdc "U" "I" m s
     (f2cl-lib:array-slice work double-float (ie) ((1 *))) u
     ldu
     (f2cl-lib:array-slice work double-float (ivt) ((1 *)))
     ldwkvt dum idum
```

```
          (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
          iwork info)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                         var-7 var-8 var-9 var-10 var-11 var-12))
        (setf info var-13))
      (multiple-value-bind
           (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
            var-9 var-10 var-11 var-12 var-13)
          (dormbr "Q" "L" "N" m m m a lda
           (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
           u ldu
           (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
           (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                         var-7 var-8 var-9 var-10 var-11 var-12))
        (setf ierr var-13))
      (multiple-value-bind
           (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
            var-9 var-10 var-11 var-12 var-13)
          (dormbr "P" "R" "T" m m m a lda
           (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
           (f2cl-lib:array-slice work double-float (ivt) ((1 *)))
           ldwkvt
           (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
           (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                         var-7 var-8 var-9 var-10 var-11 var-12))
        (setf ierr var-13))
      (dgemm "N" "N" m n m one
       (f2cl-lib:array-slice work double-float (ivt) ((1 *))) ldwkvt
       vt ldvt zero a lda)
      (dlacpy "F" m n a lda vt ldvt))))
  (t
   (setf ie 1)
   (setf itauq (f2cl-lib:int-add ie m))
   (setf itaup (f2cl-lib:int-add itauq m))
   (setf nwork (f2cl-lib:int-add itaup m))
   (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
         var-9 var-10)
       (dgebrd m n a lda s
        (f2cl-lib:array-slice work double-float (ie) ((1 *)))
        (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
        (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
        (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                      var-7 var-8 var-9))
     (setf ierr var-10))
   (cond
```

```
(wntqn
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9 var-10 var-11 var-12 var-13)
     (dbdsdc "L" "N" m s
      (f2cl-lib:array-slice work double-float (ie) ((1 *))) dum
      1 dum 1 dum idum
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      iwork info)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12))
   (setf info var-13)))
(wntqo
 (setf ldwkvt m)
 (setf ivt nwork)
 (cond
   ((>= lwork
        (f2cl-lib:int-add (f2cl-lib:int-mul m n)
                          (f2cl-lib:int-mul 3 m)
                          bdspac))
    (dlaset "F" m n zero zero
     (f2cl-lib:array-slice work double-float (ivt) ((1 *)))
     ldwkvt)
    (setf nwork
            (f2cl-lib:int-add ivt (f2cl-lib:int-mul ldwkvt n))))
   (t
    (setf nwork
            (f2cl-lib:int-add ivt (f2cl-lib:int-mul ldwkvt m)))
    (setf il nwork)
    (setf chunk
            (the fixnum
                 (truncate (- lwork (* m m) (* 3 m)) m)))))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9 var-10 var-11 var-12 var-13)
     (dbdsdc "L" "I" m s
      (f2cl-lib:array-slice work double-float (ie) ((1 *))) u
      ldu
      (f2cl-lib:array-slice work double-float (ivt) ((1 *)))
      ldwkvt dum idum
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      iwork info)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12))
   (setf info var-13))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9 var-10 var-11 var-12 var-13)
     (dormbr "Q" "L" "N" m m n a lda
      (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
```

```
      u ldu
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                     var-7 var-8 var-9 var-10 var-11 var-12))
    (setf ierr var-13))
  (cond
    ((>= lwork
         (f2cl-lib:int-add (f2cl-lib:int-mul m n)
                           (f2cl-lib:int-mul 3 m)
                           bdspac))
     (multiple-value-bind
           (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
            var-8 var-9 var-10 var-11 var-12 var-13)
         (dormbr "P" "R" "T" m n m a lda
          (f2cl-lib:array-slice work
                                double-float
                                (itaup)
                                ((1 *)))
          (f2cl-lib:array-slice work double-float (ivt) ((1 *)))
          ldwkvt
          (f2cl-lib:array-slice work
                                double-float
                                (nwork)
                                ((1 *)))
          (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1)
          ierr)
       (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                        var-6 var-7 var-8 var-9 var-10 var-11
                        var-12))
       (setf ierr var-13))
     (dlacpy "F" m n
      (f2cl-lib:array-slice work double-float (ivt) ((1 *)))
      ldwkvt a lda))
    (t
     (multiple-value-bind
           (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
            var-8 var-9)
         (dorgbr "P" m n m a lda
          (f2cl-lib:array-slice work
                                double-float
                                (itaup)
                                ((1 *)))
          (f2cl-lib:array-slice work
                                double-float
                                (nwork)
                                ((1 *)))
          (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1)
          ierr)
       (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
```

```
                        var-6 var-7 var-8))
      (setf ierr var-9))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i chunk))
                  ((> i n) nil)
      (tagbody
        (setf blk
                (min
                 (the fixnum
                      (f2cl-lib:int-add (f2cl-lib:int-sub n i)
                                        1))
                 (the fixnum chunk)))
        (dgemm "N" "N" m blk m one
         (f2cl-lib:array-slice work double-float (ivt) ((1 *)))
         ldwkvt
         (f2cl-lib:array-slice a
                               double-float
                               (1 i)
                               ((1 lda) (1 *)))
         lda zero
         (f2cl-lib:array-slice work double-float (il) ((1 *)))
         m)
        (dlacpy "F" m blk
         (f2cl-lib:array-slice work double-float (il) ((1 *)))
         m
         (f2cl-lib:array-slice a
                               double-float
                               (1 i)
                               ((1 lda) (1 *)))
         lda))))))
(wntqs
 (dlaset "F" m n zero zero vt ldvt)
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9 var-10 var-11 var-12 var-13)
     (dbdsdc "L" "I" m s
      (f2cl-lib:array-slice work double-float (ie) ((1 *))) u
      ldu vt ldvt dum idum
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      iwork info)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12))
   (setf info var-13))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9 var-10 var-11 var-12 var-13)
     (dormbr "Q" "L" "N" m m n a lda
      (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
      u ldu
      (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
```

```
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
 (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
    (dormbr "P" "R" "T" m n m a lda
     (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
     vt ldvt
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13)))
(wntqa
 (dlaset "F" n n zero zero vt ldvt)
 (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
    (dbdsdc "L" "I" m s
     (f2cl-lib:array-slice work double-float (ie) ((1 *))) u
     ldu vt ldvt dum idum
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     iwork info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf info var-13))
 (dlaset "F" (f2cl-lib:int-sub n m) (f2cl-lib:int-sub n m) zero
  one
  (f2cl-lib:array-slice vt
                        double-float
                        ((+ m 1) (f2cl-lib:int-add m 1))
                        ((1 ldvt) (1 *)))
  ldvt)
 (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
    (dormbr "Q" "L" "N" m m n a lda
     (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
     u ldu
     (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12))
  (setf ierr var-13))
 (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13)
    (dormbr "P" "R" "T" n n m a lda
     (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
```

```
                    vt ldvt
                    (f2cl-lib:array-slice work double-float (nwork) ((1 *)))
                    (f2cl-lib:int-add (f2cl-lib:int-sub lwork nwork) 1) ierr)
                  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                                   var-7 var-8 var-9 var-10 var-11 var-12))
                  (setf ierr var-13))))))))
       (cond
         ((= iscl 1)
          (if (> anrm bignum)
              (multiple-value-bind
                    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                     var-9)
                  (dlascl "G" 0 0 bignum anrm minmn 1 s minmn ierr)
                (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                                 var-7 var-8))
                (setf ierr var-9)))
          (if (< anrm smlnum)
              (multiple-value-bind
                    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                     var-9)
                  (dlascl "G" 0 0 smlnum anrm minmn 1 s minmn ierr)
                (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                                 var-7 var-8))
                (setf ierr var-9)))))
       (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
             (coerce (realpart maxwrk) 'double-float))
end_label
       (return
        (values nil nil nil nil nil nil nil nil nil nil nil nil info))))))
```

———-

6.17 dgesvd LAPACK

— **dgesvd.input** —

```
)set break resume
)sys rm -f dgesvd.output
)spool dgesvd.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dgesvd.help —

```
========================================================================
dgesvd examples
========================================================================

========================================================================
Man Page Details
========================================================================

NAME
       DGESVD - the singular value decomposition (SVD) of a real M-by-N matrix
       A, optionally computing the left and/or right singular vectors

SYNOPSIS
       SUBROUTINE DGESVD( JOBU, JOBVT, M, N, A, LDA,  S,  U,  LDU,  VT,  LDVT,
                          WORK, LWORK, INFO )

           CHARACTER      JOBU, JOBVT

           INTEGER        INFO, LDA, LDU, LDVT, LWORK, M, N

           DOUBLE         PRECISION  A(  LDA,  *  ),  S( * ), U( LDU, * ), VT(
                          LDVT, * ), WORK( * )

  Purpose
  =======

  DGESVD computes the singular value decomposition (SVD) of a real
  M-by-N matrix A, optionally computing the left and/or right singular
  vectors. The SVD is written

       A = U * SIGMA * transpose(V)

  where SIGMA is an M-by-N matrix which is zero except for its
  min(m,n) diagonal elements, U is an M-by-M orthogonal matrix, and
  V is an N-by-N orthogonal matrix.  The diagonal elements of SIGMA
  are the singular values of A; they are real and non-negative, and
  are returned in descending order.  The first min(m,n) columns of
  U and V are the left and right singular vectors of A.

  Note that the routine returns V**T, not V.

  Arguments
  =========

  JOBU    (input) CHARACTER*1
```

```
          Specifies options for computing all or part of the matrix U:
          = 'A':  all M columns of U are returned in array U:
          = 'S':  the first min(m,n) columns of U (the left singular
                  vectors) are returned in the array U;
          = 'O':  the first min(m,n) columns of U (the left singular
                  vectors) are overwritten on the array A;
          = 'N':  no columns of U (no left singular vectors) are
                  computed.

  JOBVT   (input) CHARACTER*1
          Specifies options for computing all or part of the matrix
          V**T:
          = 'A':  all N rows of V**T are returned in the array VT;
          = 'S':  the first min(m,n) rows of V**T (the right singular
                  vectors) are returned in the array VT;
          = 'O':  the first min(m,n) rows of V**T (the right singular
                  vectors) are overwritten on the array A;
          = 'N':  no rows of V**T (no right singular vectors) are
                  computed.

          JOBVT and JOBU cannot both be 'O'.

  M       (input) INTEGER
          The number of rows of the input matrix A.  M >= 0.

  N       (input) INTEGER
          The number of columns of the input matrix A.  N >= 0.

  A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
          On entry, the M-by-N matrix A.
          On exit,
          if JOBU = 'O',  A is overwritten with the first min(m,n)
                          columns of U (the left singular vectors,
                          stored columnwise);
          if JOBVT = 'O', A is overwritten with the first min(m,n)
                          rows of V**T (the right singular vectors,
                          stored rowwise);
          if JOBU .ne. 'O' and JOBVT .ne. 'O', the contents of A
                          are destroyed.

  LDA     (input) INTEGER
          The leading dimension of the array A.  LDA >= max(1,M).

  S       (output) DOUBLE PRECISION array, dimension (min(M,N))
          The singular values of A, sorted so that S(i) >= S(i+1).

  U       (output) DOUBLE PRECISION array, dimension (LDU,UCOL)
          (LDU,M) if JOBU = 'A' or (LDU,min(M,N)) if JOBU = 'S'.
          If JOBU = 'A', U contains the M-by-M orthogonal matrix U;
          if JOBU = 'S', U contains the first min(m,n) columns of U
```

```
        (the left singular vectors, stored columnwise);
        if JOBU = 'N' or 'O', U is not referenced.

LDU     (input) INTEGER
        The leading dimension of the array U.  LDU >= 1; if
        JOBU = 'S' or 'A', LDU >= M.

VT      (output) DOUBLE PRECISION array, dimension (LDVT,N)
        If JOBVT = 'A', VT contains the N-by-N orthogonal matrix
        V**T;
        if JOBVT = 'S', VT contains the first min(m,n) rows of
        V**T (the right singular vectors, stored rowwise);
        if JOBVT = 'N' or 'O', VT is not referenced.

LDVT    (input) INTEGER
        The leading dimension of the array VT.  LDVT >= 1; if
        JOBVT = 'A', LDVT >= N; if JOBVT = 'S', LDVT >= min(M,N).

WORK    (workspace/output) DOUBLE PRECISION array, dimension (LWORK)
        On exit, if INFO = 0, WORK(1) returns the optimal LWORK;
        if INFO > 0, WORK(2:MIN(M,N)) contains the unconverged
        superdiagonal elements of an upper bidiagonal matrix B
        whose diagonal is in S (not necessarily sorted). B
        satisfies A = U * B * VT, so it has the same singular values
        as A, and singular vectors related by U and VT.

LWORK   (input) INTEGER
        The dimension of the array WORK. LWORK >= 1.
        LWORK >= MAX(3*MIN(M,N)+MAX(M,N),5*MIN(M,N)).
        For good performance, LWORK should generally be larger.

        If LWORK = -1, then a workspace query is assumed; the routine
        only calculates the optimal size of the WORK array, returns
        this value as the first entry of the WORK array, and no error
        message related to LWORK is issued by XERBLA.

INFO    (output) INTEGER
        = 0:  successful exit.
        < 0:  if INFO = -i, the i-th argument had an illegal value.
        > 0:  if DBDSQR did not converge, INFO specifies how many
              superdiagonals of an intermediate bidiagonal form B
              did not converge to zero. See the description of WORK
              above for details.
```

———-

— dgesvd.f —

```
      SUBROUTINE DGESVD( JOBU, JOBVT, M, N, A, LDA, S, U, LDU, VT, LDVT,
     $                   WORK, LWORK, INFO )
*
*  -- LAPACK driver routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1999
*
*     .. Scalar Arguments ..
      CHARACTER          JOBU, JOBVT
      INTEGER            INFO, LDA, LDU, LDVT, LWORK, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), S( * ), U( LDU, * ),
     $                   VT( LDVT, * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D0, ONE = 1.0D0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            LQUERY, WNTUA, WNTUAS, WNTUN, WNTUO, WNTUS,
     $                   WNTVA, WNTVAS, WNTVN, WNTVO, WNTVS
      INTEGER            BDSPAC, BLK, CHUNK, I, IE, IERR, IR, ISCL,
     $                   ITAU, ITAUP, ITAUQ, IU, IWORK, LDWRKR, LDWRKU,
     $                   MAXWRK, MINMN, MINWRK, MNTHR, NCU, NCVT, NRU,
     $                   NRVT, WRKBL
      DOUBLE PRECISION   ANRM, BIGNUM, EPS, SMLNUM
*     ..
*     .. Local Arrays ..
      DOUBLE PRECISION   DUM( 1 )
*     ..
*     .. External Subroutines ..
      EXTERNAL           DBDSQR, DGEBRD, DGELQF, DGEMM, DGEQRF, DLACPY,
     $                   DLASCL, DLASET, DORGBR, DORGLQ, DORGQR, DORMBR,
     $                   XERBLA
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      INTEGER            ILAENV
      DOUBLE PRECISION   DLAMCH, DLANGE
      EXTERNAL           LSAME, ILAENV, DLAMCH, DLANGE
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN, SQRT
*     ..
*     .. Executable Statements ..
```

```
*
*     Test the input arguments
*
      INFO = 0
      MINMN = MIN( M, N )
      MNTHR = ILAENV( 6, 'DGESVD', JOBU // JOBVT, M, N, 0, 0 )
      WNTUA = LSAME( JOBU, 'A' )
      WNTUS = LSAME( JOBU, 'S' )
      WNTUAS = WNTUA .OR. WNTUS
      WNTUO = LSAME( JOBU, 'O' )
      WNTUN = LSAME( JOBU, 'N' )
      WNTVA = LSAME( JOBVT, 'A' )
      WNTVS = LSAME( JOBVT, 'S' )
      WNTVAS = WNTVA .OR. WNTVS
      WNTVO = LSAME( JOBVT, 'O' )
      WNTVN = LSAME( JOBVT, 'N' )
      MINWRK = 1
      LQUERY = ( LWORK.EQ.-1 )
*
      IF( .NOT.( WNTUA .OR. WNTUS .OR. WNTUO .OR. WNTUN ) ) THEN
         INFO = -1
      ELSE IF( .NOT.( WNTVA .OR. WNTVS .OR. WNTVO .OR. WNTVN ) .OR.
     $         ( WNTVO .AND. WNTUO ) ) THEN
         INFO = -2
      ELSE IF( M.LT.0 ) THEN
         INFO = -3
      ELSE IF( N.LT.0 ) THEN
         INFO = -4
      ELSE IF( LDA.LT.MAX( 1, M ) ) THEN
         INFO = -6
      ELSE IF( LDU.LT.1 .OR. ( WNTUAS .AND. LDU.LT.M ) ) THEN
         INFO = -9
      ELSE IF( LDVT.LT.1 .OR. ( WNTVA .AND. LDVT.LT.N ) .OR.
     $         ( WNTVS .AND. LDVT.LT.MINMN ) ) THEN
         INFO = -11
      END IF
*
*     Compute workspace
*      (Note: Comments in the code beginning "Workspace:" describe the
*       minimal amount of workspace needed at that point in the code,
*       as well as the preferred amount for good performance.
*       NB refers to the optimal block size for the immediately
*       following subroutine, as returned by ILAENV.)
*
      IF( INFO.EQ.0 .AND. ( LWORK.GE.1 .OR. LQUERY ) .AND. M.GT.0 .AND.
     $    N.GT.0 ) THEN
         IF( M.GE.N ) THEN
*
*           Compute space needed for DBDSQR
*
```

```
            BDSPAC = 5*N
            IF( M.GE.MNTHR ) THEN
               IF( WNTUN ) THEN
*
*                 Path 1 (M much larger than N, JOBU='N')
*
                  MAXWRK = N + N*ILAENV( 1, 'DGEQRF', ' ', M, N, -1,
     $                     -1 )
                  MAXWRK = MAX( MAXWRK, 3*N+2*N*
     $                     ILAENV( 1, 'DGEBRD', ' ', N, N, -1, -1 ) )
                  IF( WNTVO .OR. WNTVAS )
     $               MAXWRK = MAX( MAXWRK, 3*N+( N-1 )*
     $                        ILAENV( 1, 'DORGBR', 'P', N, N, N, -1 ) )
                  MAXWRK = MAX( MAXWRK, BDSPAC )
                  MINWRK = MAX( 4*N, BDSPAC )
                  MAXWRK = MAX( MAXWRK, MINWRK )
               ELSE IF( WNTUO .AND. WNTVN ) THEN
*
*                 Path 2 (M much larger than N, JOBU='O', JOBVT='N')
*
                  WRKBL = N + N*ILAENV( 1, 'DGEQRF', ' ', M, N, -1, -1 )
                  WRKBL = MAX( WRKBL, N+N*ILAENV( 1, 'DORGQR', ' ', M,
     $                    N, N, -1 ) )
                  WRKBL = MAX( WRKBL, 3*N+2*N*
     $                    ILAENV( 1, 'DGEBRD', ' ', N, N, -1, -1 ) )
                  WRKBL = MAX( WRKBL, 3*N+N*
     $                    ILAENV( 1, 'DORGBR', 'Q', N, N, N, -1 ) )
                  WRKBL = MAX( WRKBL, BDSPAC )
                  MAXWRK = MAX( N*N+WRKBL, N*N+M*N+N )
                  MINWRK = MAX( 3*N+M, BDSPAC )
                  MAXWRK = MAX( MAXWRK, MINWRK )
               ELSE IF( WNTUO .AND. WNTVAS ) THEN
*
*                 Path 3 (M much larger than N, JOBU='O', JOBVT='S' or
*                 'A')
*
                  WRKBL = N + N*ILAENV( 1, 'DGEQRF', ' ', M, N, -1, -1 )
                  WRKBL = MAX( WRKBL, N+N*ILAENV( 1, 'DORGQR', ' ', M,
     $                    N, N, -1 ) )
                  WRKBL = MAX( WRKBL, 3*N+2*N*
     $                    ILAENV( 1, 'DGEBRD', ' ', N, N, -1, -1 ) )
                  WRKBL = MAX( WRKBL, 3*N+N*
     $                    ILAENV( 1, 'DORGBR', 'Q', N, N, N, -1 ) )
                  WRKBL = MAX( WRKBL, 3*N+( N-1 )*
     $                    ILAENV( 1, 'DORGBR', 'P', N, N, N, -1 ) )
                  WRKBL = MAX( WRKBL, BDSPAC )
                  MAXWRK = MAX( N*N+WRKBL, N*N+M*N+N )
                  MINWRK = MAX( 3*N+M, BDSPAC )
                  MAXWRK = MAX( MAXWRK, MINWRK )
               ELSE IF( WNTUS .AND. WNTVN ) THEN
```

```
*
*                Path 4 (M much larger than N, JOBU='S', JOBVT='N')
*
                 WRKBL = N + N*ILAENV( 1, 'DGEQRF', ' ', M, N, -1, -1 )
                 WRKBL = MAX( WRKBL, N+N*ILAENV( 1, 'DORGQR', ' ', M,
     $                   N, N, -1 ) )
                 WRKBL = MAX( WRKBL, 3*N+2*N*
     $                   ILAENV( 1, 'DGEBRD', ' ', N, N, -1, -1 ) )
                 WRKBL = MAX( WRKBL, 3*N+N*
     $                   ILAENV( 1, 'DORGBR', 'Q', N, N, N, -1 ) )
                 WRKBL = MAX( WRKBL, BDSPAC )
                 MAXWRK = N*N + WRKBL
                 MINWRK = MAX( 3*N+M, BDSPAC )
                 MAXWRK = MAX( MAXWRK, MINWRK )
               ELSE IF( WNTUS .AND. WNTVO ) THEN
*
*                Path 5 (M much larger than N, JOBU='S', JOBVT='O')
*
                 WRKBL = N + N*ILAENV( 1, 'DGEQRF', ' ', M, N, -1, -1 )
                 WRKBL = MAX( WRKBL, N+N*ILAENV( 1, 'DORGQR', ' ', M,
     $                   N, N, -1 ) )
                 WRKBL = MAX( WRKBL, 3*N+2*N*
     $                   ILAENV( 1, 'DGEBRD', ' ', N, N, -1, -1 ) )
                 WRKBL = MAX( WRKBL, 3*N+N*
     $                   ILAENV( 1, 'DORGBR', 'Q', N, N, N, -1 ) )
                 WRKBL = MAX( WRKBL, 3*N+( N-1 )*
     $                   ILAENV( 1, 'DORGBR', 'P', N, N, N, -1 ) )
                 WRKBL = MAX( WRKBL, BDSPAC )
                 MAXWRK = 2*N*N + WRKBL
                 MINWRK = MAX( 3*N+M, BDSPAC )
                 MAXWRK = MAX( MAXWRK, MINWRK )
               ELSE IF( WNTUS .AND. WNTVAS ) THEN
*
*                Path 6 (M much larger than N, JOBU='S', JOBVT='S' or
*                'A')
*
                 WRKBL = N + N*ILAENV( 1, 'DGEQRF', ' ', M, N, -1, -1 )
                 WRKBL = MAX( WRKBL, N+N*ILAENV( 1, 'DORGQR', ' ', M,
     $                   N, N, -1 ) )
                 WRKBL = MAX( WRKBL, 3*N+2*N*
     $                   ILAENV( 1, 'DGEBRD', ' ', N, N, -1, -1 ) )
                 WRKBL = MAX( WRKBL, 3*N+N*
     $                   ILAENV( 1, 'DORGBR', 'Q', N, N, N, -1 ) )
                 WRKBL = MAX( WRKBL, 3*N+( N-1 )*
     $                   ILAENV( 1, 'DORGBR', 'P', N, N, N, -1 ) )
                 WRKBL = MAX( WRKBL, BDSPAC )
                 MAXWRK = N*N + WRKBL
                 MINWRK = MAX( 3*N+M, BDSPAC )
                 MAXWRK = MAX( MAXWRK, MINWRK )
               ELSE IF( WNTUA .AND. WNTVN ) THEN
```

```
*
*                Path 7 (M much larger than N, JOBU='A', JOBVT='N')
*
                 WRKBL = N + N*ILAENV( 1, 'DGEQRF', ' ', M, N, -1, -1 )
                 WRKBL = MAX( WRKBL, N+M*ILAENV( 1, 'DORGQR', ' ', M,
     $                   M, N, -1 ) )
                 WRKBL = MAX( WRKBL, 3*N+2*N*
     $                   ILAENV( 1, 'DGEBRD', ' ', N, N, -1, -1 ) )
                 WRKBL = MAX( WRKBL, 3*N+N*
     $                   ILAENV( 1, 'DORGBR', 'Q', N, N, N, -1 ) )
                 WRKBL = MAX( WRKBL, BDSPAC )
                 MAXWRK = N*N + WRKBL
                 MINWRK = MAX( 3*N+M, BDSPAC )
                 MAXWRK = MAX( MAXWRK, MINWRK )
              ELSE IF( WNTUA .AND. WNTVO ) THEN
*
*                Path 8 (M much larger than N, JOBU='A', JOBVT='O')
*
                 WRKBL = N + N*ILAENV( 1, 'DGEQRF', ' ', M, N, -1, -1 )
                 WRKBL = MAX( WRKBL, N+M*ILAENV( 1, 'DORGQR', ' ', M,
     $                   M, N, -1 ) )
                 WRKBL = MAX( WRKBL, 3*N+2*N*
     $                   ILAENV( 1, 'DGEBRD', ' ', N, N, -1, -1 ) )
                 WRKBL = MAX( WRKBL, 3*N+N*
     $                   ILAENV( 1, 'DORGBR', 'Q', N, N, N, -1 ) )
                 WRKBL = MAX( WRKBL, 3*N+( N-1 )*
     $                   ILAENV( 1, 'DORGBR', 'P', N, N, N, -1 ) )
                 WRKBL = MAX( WRKBL, BDSPAC )
                 MAXWRK = 2*N*N + WRKBL
                 MINWRK = MAX( 3*N+M, BDSPAC )
                 MAXWRK = MAX( MAXWRK, MINWRK )
              ELSE IF( WNTUA .AND. WNTVAS ) THEN
*
*                Path 9 (M much larger than N, JOBU='A', JOBVT='S' or
*                'A')
*
                 WRKBL = N + N*ILAENV( 1, 'DGEQRF', ' ', M, N, -1, -1 )
                 WRKBL = MAX( WRKBL, N+M*ILAENV( 1, 'DORGQR', ' ', M,
     $                   M, N, -1 ) )
                 WRKBL = MAX( WRKBL, 3*N+2*N*
     $                   ILAENV( 1, 'DGEBRD', ' ', N, N, -1, -1 ) )
                 WRKBL = MAX( WRKBL, 3*N+N*
     $                   ILAENV( 1, 'DORGBR', 'Q', N, N, N, -1 ) )
                 WRKBL = MAX( WRKBL, 3*N+( N-1 )*
     $                   ILAENV( 1, 'DORGBR', 'P', N, N, N, -1 ) )
                 WRKBL = MAX( WRKBL, BDSPAC )
                 MAXWRK = N*N + WRKBL
                 MINWRK = MAX( 3*N+M, BDSPAC )
                 MAXWRK = MAX( MAXWRK, MINWRK )
              END IF
```

```
            ELSE
*
*              Path 10 (M at least N, but not much larger)
*
               MAXWRK = 3*N + ( M+N )*ILAENV( 1, 'DGEBRD', ' ', M, N,
     $                   -1, -1 )
               IF( WNTUS .OR. WNTUO )
     $            MAXWRK = MAX( MAXWRK, 3*N+N*
     $                     ILAENV( 1, 'DORGBR', 'Q', M, N, N, -1 ) )
               IF( WNTUA )
     $            MAXWRK = MAX( MAXWRK, 3*N+M*
     $                     ILAENV( 1, 'DORGBR', 'Q', M, M, N, -1 ) )
               IF( .NOT.WNTVN )
     $            MAXWRK = MAX( MAXWRK, 3*N+( N-1 )*
     $                     ILAENV( 1, 'DORGBR', 'P', N, N, N, -1 ) )
               MAXWRK = MAX( MAXWRK, BDSPAC )
               MINWRK = MAX( 3*N+M, BDSPAC )
               MAXWRK = MAX( MAXWRK, MINWRK )
            END IF
         ELSE
*
*           Compute space needed for DBDSQR
*
            BDSPAC = 5*M
            IF( N.GE.MNTHR ) THEN
               IF( WNTVN ) THEN
*
*                 Path 1t(N much larger than M, JOBVT='N')
*
                  MAXWRK = M + M*ILAENV( 1, 'DGELQF', ' ', M, N, -1,
     $                     -1 )
                  MAXWRK = MAX( MAXWRK, 3*M+2*M*
     $                     ILAENV( 1, 'DGEBRD', ' ', M, M, -1, -1 ) )
                  IF( WNTUO .OR. WNTUAS )
     $               MAXWRK = MAX( MAXWRK, 3*M+M*
     $                        ILAENV( 1, 'DORGBR', 'Q', M, M, M, -1 ) )
                  MAXWRK = MAX( MAXWRK, BDSPAC )
                  MINWRK = MAX( 4*M, BDSPAC )
                  MAXWRK = MAX( MAXWRK, MINWRK )
               ELSE IF( WNTVO .AND. WNTUN ) THEN
*
*                 Path 2t(N much larger than M, JOBU='N', JOBVT='O')
*
                  WRKBL = M + M*ILAENV( 1, 'DGELQF', ' ', M, N, -1, -1 )
                  WRKBL = MAX( WRKBL, M+M*ILAENV( 1, 'DORGLQ', ' ', M,
     $                    N, M, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+2*M*
     $                    ILAENV( 1, 'DGEBRD', ' ', M, M, -1, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+( M-1 )*
     $                    ILAENV( 1, 'DORGBR', 'P', M, M, M, -1 ) )
```

```
                  WRKBL = MAX( WRKBL, BDSPAC )
                  MAXWRK = MAX( M*M+WRKBL, M*M+M*N+M )
                  MINWRK = MAX( 3*M+N, BDSPAC )
                  MAXWRK = MAX( MAXWRK, MINWRK )
               ELSE IF( WNTVO .AND. WNTUAS ) THEN
*
*                  Path 3t(N much larger than M, JOBU='S' or 'A',
*                  JOBVT='O')
*
                  WRKBL = M + M*ILAENV( 1, 'DGELQF', ' ', M, N, -1, -1 )
                  WRKBL = MAX( WRKBL, M+M*ILAENV( 1, 'DORGLQ', ' ', M,
     $                    N, M, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+2*M*
     $                    ILAENV( 1, 'DGEBRD', ' ', M, M, -1, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+( M-1 )*
     $                    ILAENV( 1, 'DORGBR', 'P', M, M, M, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+M*
     $                    ILAENV( 1, 'DORGBR', 'Q', M, M, M, -1 ) )
                  WRKBL = MAX( WRKBL, BDSPAC )
                  MAXWRK = MAX( M*M+WRKBL, M*M+M*N+M )
                  MINWRK = MAX( 3*M+N, BDSPAC )
                  MAXWRK = MAX( MAXWRK, MINWRK )
               ELSE IF( WNTVS .AND. WNTUN ) THEN
*
*                  Path 4t(N much larger than M, JOBU='N', JOBVT='S')
*
                  WRKBL = M + M*ILAENV( 1, 'DGELQF', ' ', M, N, -1, -1 )
                  WRKBL = MAX( WRKBL, M+M*ILAENV( 1, 'DORGLQ', ' ', M,
     $                    N, M, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+2*M*
     $                    ILAENV( 1, 'DGEBRD', ' ', M, M, -1, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+( M-1 )*
     $                    ILAENV( 1, 'DORGBR', 'P', M, M, M, -1 ) )
                  WRKBL = MAX( WRKBL, BDSPAC )
                  MAXWRK = M*M + WRKBL
                  MINWRK = MAX( 3*M+N, BDSPAC )
                  MAXWRK = MAX( MAXWRK, MINWRK )
               ELSE IF( WNTVS .AND. WNTUO ) THEN
*
*                  Path 5t(N much larger than M, JOBU='O', JOBVT='S')
*
                  WRKBL = M + M*ILAENV( 1, 'DGELQF', ' ', M, N, -1, -1 )
                  WRKBL = MAX( WRKBL, M+M*ILAENV( 1, 'DORGLQ', ' ', M,
     $                    N, M, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+2*M*
     $                    ILAENV( 1, 'DGEBRD', ' ', M, M, -1, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+( M-1 )*
     $                    ILAENV( 1, 'DORGBR', 'P', M, M, M, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+M*
     $                    ILAENV( 1, 'DORGBR', 'Q', M, M, M, -1 ) )
```

```
                  WRKBL = MAX( WRKBL, BDSPAC )
                  MAXWRK = 2*M*M + WRKBL
                  MINWRK = MAX( 3*M+N, BDSPAC )
                  MAXWRK = MAX( MAXWRK, MINWRK )
               ELSE IF( WNTVS .AND. WNTUAS ) THEN
*
*                  Path 6t(N much larger than M, JOBU='S' or 'A',
*                  JOBVT='S')
*
                  WRKBL = M + M*ILAENV( 1, 'DGELQF', ' ', M, N, -1, -1 )
                  WRKBL = MAX( WRKBL, M+M*ILAENV( 1, 'DORGLQ', ' ', M,
     $                    N, M, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+2*M*
     $                    ILAENV( 1, 'DGEBRD', ' ', M, M, -1, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+( M-1 )*
     $                    ILAENV( 1, 'DORGBR', 'P', M, M, M, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+M*
     $                    ILAENV( 1, 'DORGBR', 'Q', M, M, M, -1 ) )
                  WRKBL = MAX( WRKBL, BDSPAC )
                  MAXWRK = M*M + WRKBL
                  MINWRK = MAX( 3*M+N, BDSPAC )
                  MAXWRK = MAX( MAXWRK, MINWRK )
               ELSE IF( WNTVA .AND. WNTUN ) THEN
*
*                  Path 7t(N much larger than M, JOBU='N', JOBVT='A')
*
                  WRKBL = M + M*ILAENV( 1, 'DGELQF', ' ', M, N, -1, -1 )
                  WRKBL = MAX( WRKBL, M+N*ILAENV( 1, 'DORGLQ', ' ', N,
     $                    N, M, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+2*M*
     $                    ILAENV( 1, 'DGEBRD', ' ', M, M, -1, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+( M-1 )*
     $                    ILAENV( 1, 'DORGBR', 'P', M, M, M, -1 ) )
                  WRKBL = MAX( WRKBL, BDSPAC )
                  MAXWRK = M*M + WRKBL
                  MINWRK = MAX( 3*M+N, BDSPAC )
                  MAXWRK = MAX( MAXWRK, MINWRK )
               ELSE IF( WNTVA .AND. WNTUO ) THEN
*
*                  Path 8t(N much larger than M, JOBU='O', JOBVT='A')
*
                  WRKBL = M + M*ILAENV( 1, 'DGELQF', ' ', M, N, -1, -1 )
                  WRKBL = MAX( WRKBL, M+N*ILAENV( 1, 'DORGLQ', ' ', N,
     $                    N, M, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+2*M*
     $                    ILAENV( 1, 'DGEBRD', ' ', M, M, -1, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+( M-1 )*
     $                    ILAENV( 1, 'DORGBR', 'P', M, M, M, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+M*
     $                    ILAENV( 1, 'DORGBR', 'Q', M, M, M, -1 ) )
```

```
                  WRKBL = MAX( WRKBL, BDSPAC )
                  MAXWRK = 2*M*M + WRKBL
                  MINWRK = MAX( 3*M+N, BDSPAC )
                  MAXWRK = MAX( MAXWRK, MINWRK )
               ELSE IF( WNTVA .AND. WNTUAS ) THEN
*
*                  Path 9t(N much larger than M, JOBU='S' or 'A',
*                  JOBVT='A')
*
                  WRKBL = M + M*ILAENV( 1, 'DGELQF', ' ', M, N, -1, -1 )
                  WRKBL = MAX( WRKBL, M+N*ILAENV( 1, 'DORGLQ', ' ', N,
     $                    N, M, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+2*M*
     $                    ILAENV( 1, 'DGEBRD', ' ', M, M, -1, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+( M-1 )*
     $                    ILAENV( 1, 'DORGBR', 'P', M, M, M, -1 ) )
                  WRKBL = MAX( WRKBL, 3*M+M*
     $                    ILAENV( 1, 'DORGBR', 'Q', M, M, M, -1 ) )
                  WRKBL = MAX( WRKBL, BDSPAC )
                  MAXWRK = M*M + WRKBL
                  MINWRK = MAX( 3*M+N, BDSPAC )
                  MAXWRK = MAX( MAXWRK, MINWRK )
               END IF
            ELSE
*
*              Path 10t(N greater than M, but not much larger)
*
               MAXWRK = 3*M + ( M+N )*ILAENV( 1, 'DGEBRD', ' ', M, N,
     $                  -1, -1 )
               IF( WNTVS .OR. WNTVO )
     $            MAXWRK = MAX( MAXWRK, 3*M+M*
     $                     ILAENV( 1, 'DORGBR', 'P', M, N, M, -1 ) )
               IF( WNTVA )
     $            MAXWRK = MAX( MAXWRK, 3*M+N*
     $                     ILAENV( 1, 'DORGBR', 'P', N, N, M, -1 ) )
               IF( .NOT.WNTUN )
     $            MAXWRK = MAX( MAXWRK, 3*M+( M-1 )*
     $                     ILAENV( 1, 'DORGBR', 'Q', M, M, M, -1 ) )
               MAXWRK = MAX( MAXWRK, BDSPAC )
               MINWRK = MAX( 3*M+N, BDSPAC )
               MAXWRK = MAX( MAXWRK, MINWRK )
            END IF
         END IF
         WORK( 1 ) = MAXWRK
      END IF
*
      IF( LWORK.LT.MINWRK .AND. .NOT.LQUERY ) THEN
         INFO = -13
      END IF
      IF( INFO.NE.0 ) THEN
```

```
         CALL XERBLA( 'DGESVD', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( M.EQ.0 .OR. N.EQ.0 ) THEN
         IF( LWORK.GE.1 )
     $      WORK( 1 ) = ONE
         RETURN
      END IF
*
*     Get machine constants
*
      EPS = DLAMCH( 'P' )
      SMLNUM = SQRT( DLAMCH( 'S' ) ) / EPS
      BIGNUM = ONE / SMLNUM
*
*     Scale A if max element outside range [SMLNUM,BIGNUM]
*
      ANRM = DLANGE( 'M', M, N, A, LDA, DUM )
      ISCL = 0
      IF( ANRM.GT.ZERO .AND. ANRM.LT.SMLNUM ) THEN
         ISCL = 1
         CALL DLASCL( 'G', 0, 0, ANRM, SMLNUM, M, N, A, LDA, IERR )
      ELSE IF( ANRM.GT.BIGNUM ) THEN
         ISCL = 1
         CALL DLASCL( 'G', 0, 0, ANRM, BIGNUM, M, N, A, LDA, IERR )
      END IF
*
      IF( M.GE.N ) THEN
*
*        A has at least as many rows as columns. If A has sufficiently
*        more rows than columns, first reduce using the QR
*        decomposition (if sufficient workspace available)
*
         IF( M.GE.MNTHR ) THEN
*
            IF( WNTUN ) THEN
*
*              Path 1 (M much larger than N, JOBU='N')
*              No left singular vectors to be computed
*
               ITAU = 1
               IWORK = ITAU + N
*
*              Compute A=Q*R
*              (Workspace: need 2*N, prefer N+N*NB)
```

```
*
               CALL DGEQRF( M, N, A, LDA, WORK( ITAU ), WORK( IWORK ),
     $                      LWORK-IWORK+1, IERR )
*
*              Zero out below R
*
               CALL DLASET( 'L', N-1, N-1, ZERO, ZERO, A( 2, 1 ), LDA )
               IE = 1
               ITAUQ = IE + N
               ITAUP = ITAUQ + N
               IWORK = ITAUP + N
*
*              Bidiagonalize R in A
*              (Workspace: need 4*N, prefer 3*N+2*N*NB)
*
               CALL DGEBRD( N, N, A, LDA, S, WORK( IE ), WORK( ITAUQ ),
     $                      WORK( ITAUP ), WORK( IWORK ), LWORK-IWORK+1,
     $                      IERR )
               NCVT = 0
               IF( WNTVO .OR. WNTVAS ) THEN
*
*                 If right singular vectors desired, generate P'.
*                 (Workspace: need 4*N-1, prefer 3*N+(N-1)*NB)
*
                  CALL DORGBR( 'P', N, N, N, A, LDA, WORK( ITAUP ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  NCVT = N
               END IF
               IWORK = IE + N
*
*              Perform bidiagonal QR iteration, computing right
*              singular vectors of A in A if desired
*              (Workspace: need BDSPAC)
*
               CALL DBDSQR( 'U', N, NCVT, 0, 0, S, WORK( IE ), A, LDA,
     $                      DUM, 1, DUM, 1, WORK( IWORK ), INFO )
*
*              If right singular vectors desired in VT, copy them there
*
               IF( WNTVAS )
     $            CALL DLACPY( 'F', N, N, A, LDA, VT, LDVT )
*
            ELSE IF( WNTUO .AND. WNTVN ) THEN
*
*              Path 2 (M much larger than N, JOBU='O', JOBVT='N')
*              N left singular vectors to be overwritten on A and
*              no right singular vectors to be computed
*
               IF( LWORK.GE.N*N+MAX( 4*N, BDSPAC ) ) THEN
*
```

```
*                Sufficient workspace for a fast algorithm
*
                 IR = 1
                 IF( LWORK.GE.MAX( WRKBL, LDA*N+N )+LDA*N ) THEN
*
*                   WORK(IU) is LDA by N, WORK(IR) is LDA by N
*
                    LDWRKU = LDA
                    LDWRKR = LDA
                 ELSE IF( LWORK.GE.MAX( WRKBL, LDA*N+N )+N*N ) THEN
*
*                   WORK(IU) is LDA by N, WORK(IR) is N by N
*
                    LDWRKU = LDA
                    LDWRKR = N
                 ELSE
*
*                   WORK(IU) is LDWRKU by N, WORK(IR) is N by N
*
                    LDWRKU = ( LWORK-N*N-N ) / N
                    LDWRKR = N
                 END IF
                 ITAU = IR + LDWRKR*N
                 IWORK = ITAU + N
*
*                Compute A=Q*R
*                (Workspace: need N*N+2*N, prefer N*N+N+N*NB)
*
                 CALL DGEQRF( M, N, A, LDA, WORK( ITAU ),
     $                        WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                Copy R to WORK(IR) and zero out below it
*
                 CALL DLACPY( 'U', N, N, A, LDA, WORK( IR ), LDWRKR )
                 CALL DLASET( 'L', N-1, N-1, ZERO, ZERO, WORK( IR+1 ),
     $                        LDWRKR )
*
*                Generate Q in A
*                (Workspace: need N*N+2*N, prefer N*N+N+N*NB)
*
                 CALL DORGQR( M, N, N, A, LDA, WORK( ITAU ),
     $                        WORK( IWORK ), LWORK-IWORK+1, IERR )
                 IE = ITAU
                 ITAUQ = IE + N
                 ITAUP = ITAUQ + N
                 IWORK = ITAUP + N
*
*                Bidiagonalize R in WORK(IR)
*                (Workspace: need N*N+4*N, prefer N*N+3*N+2*N*NB)
*
```

```
                  CALL DGEBRD( N, N, WORK( IR ), LDWRKR, S, WORK( IE ),
     $                         WORK( ITAUQ ), WORK( ITAUP ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                 Generate left vectors bidiagonalizing R
*                 (Workspace: need N*N+4*N, prefer N*N+3*N+N*NB)
*
                  CALL DORGBR( 'Q', N, N, N, WORK( IR ), LDWRKR,
     $                         WORK( ITAUQ ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
                  IWORK = IE + N
*
*                 Perform bidiagonal QR iteration, computing left
*                 singular vectors of R in WORK(IR)
*                 (Workspace: need N*N+BDSPAC)
*
                  CALL DBDSQR( 'U', N, 0, N, 0, S, WORK( IE ), DUM, 1,
     $                         WORK( IR ), LDWRKR, DUM, 1,
     $                         WORK( IWORK ), INFO )
                  IU = IE + N
*
*                 Multiply Q in A by left singular vectors of R in
*                 WORK(IR), storing result in WORK(IU) and copying to A
*                 (Workspace: need N*N+2*N, prefer N*N+M*N+N)
*
                  DO 10 I = 1, M, LDWRKU
                     CHUNK = MIN( M-I+1, LDWRKU )
                     CALL DGEMM( 'N', 'N', CHUNK, N, N, ONE, A( I, 1 ),
     $                           LDA, WORK( IR ), LDWRKR, ZERO,
     $                           WORK( IU ), LDWRKU )
                     CALL DLACPY( 'F', CHUNK, N, WORK( IU ), LDWRKU,
     $                            A( I, 1 ), LDA )
   10             CONTINUE
*
               ELSE
*
*                 Insufficient workspace for a fast algorithm
*
                  IE = 1
                  ITAUQ = IE + N
                  ITAUP = ITAUQ + N
                  IWORK = ITAUP + N
*
*                 Bidiagonalize A
*                 (Workspace: need 3*N+M, prefer 3*N+(M+N)*NB)
*
                  CALL DGEBRD( M, N, A, LDA, S, WORK( IE ),
     $                         WORK( ITAUQ ), WORK( ITAUP ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
*
```

```
*                Generate left vectors bidiagonalizing A
*                (Workspace: need 4*N, prefer 3*N+N*NB)
*
                 CALL DORGBR( 'Q', M, N, N, A, LDA, WORK( ITAUQ ),
     $                        WORK( IWORK ), LWORK-IWORK+1, IERR )
                 IWORK = IE + N
*
*                Perform bidiagonal QR iteration, computing left
*                singular vectors of A in A
*                (Workspace: need BDSPAC)
*
                 CALL DBDSQR( 'U', N, 0, M, 0, S, WORK( IE ), DUM, 1,
     $                        A, LDA, DUM, 1, WORK( IWORK ), INFO )
*
              END IF
*
            ELSE IF( WNTUO .AND. WNTVAS ) THEN
*
*             Path 3 (M much larger than N, JOBU='O', JOBVT='S' or 'A')
*             N left singular vectors to be overwritten on A and
*             N right singular vectors to be computed in VT
*
              IF( LWORK.GE.N*N+MAX( 4*N, BDSPAC ) ) THEN
*
*                Sufficient workspace for a fast algorithm
*
                 IR = 1
                 IF( LWORK.GE.MAX( WRKBL, LDA*N+N )+LDA*N ) THEN
*
*                   WORK(IU) is LDA by N and WORK(IR) is LDA by N
*
                    LDWRKU = LDA
                    LDWRKR = LDA
                 ELSE IF( LWORK.GE.MAX( WRKBL, LDA*N+N )+N*N ) THEN
*
*                   WORK(IU) is LDA by N and WORK(IR) is N by N
*
                    LDWRKU = LDA
                    LDWRKR = N
                 ELSE
*
*                   WORK(IU) is LDWRKU by N and WORK(IR) is N by N
*
                    LDWRKU = ( LWORK-N*N-N ) / N
                    LDWRKR = N
                 END IF
                 ITAU = IR + LDWRKR*N
                 IWORK = ITAU + N
*
*                Compute A=Q*R
```

```
*                 (Workspace: need N*N+2*N, prefer N*N+N+N*NB)
*
                  CALL DGEQRF( M, N, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                 Copy R to VT, zeroing out below it
*
                  CALL DLACPY( 'U', N, N, A, LDA, VT, LDVT )
                  CALL DLASET( 'L', N-1, N-1, ZERO, ZERO, VT( 2, 1 ),
     $                         LDVT )
*
*                 Generate Q in A
*                 (Workspace: need N*N+2*N, prefer N*N+N+N*NB)
*
                  CALL DORGQR( M, N, N, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IE = ITAU
                  ITAUQ = IE + N
                  ITAUP = ITAUQ + N
                  IWORK = ITAUP + N
*
*                 Bidiagonalize R in VT, copying result to WORK(IR)
*                 (Workspace: need N*N+4*N, prefer N*N+3*N+2*N*NB)
*
                  CALL DGEBRD( N, N, VT, LDVT, S, WORK( IE ),
     $                         WORK( ITAUQ ), WORK( ITAUP ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  CALL DLACPY( 'L', N, N, VT, LDVT, WORK( IR ), LDWRKR )
*
*                 Generate left vectors bidiagonalizing R in WORK(IR)
*                 (Workspace: need N*N+4*N, prefer N*N+3*N+N*NB)
*
                  CALL DORGBR( 'Q', N, N, N, WORK( IR ), LDWRKR,
     $                         WORK( ITAUQ ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
*
*                 Generate right vectors bidiagonalizing R in VT
*                 (Workspace: need N*N+4*N-1, prefer N*N+3*N+(N-1)*NB)
*
                  CALL DORGBR( 'P', N, N, N, VT, LDVT, WORK( ITAUP ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IWORK = IE + N
*
*                 Perform bidiagonal QR iteration, computing left
*                 singular vectors of R in WORK(IR) and computing right
*                 singular vectors of R in VT
*                 (Workspace: need N*N+BDSPAC)
*
                  CALL DBDSQR( 'U', N, N, N, 0, S, WORK( IE ), VT, LDVT,
     $                         WORK( IR ), LDWRKR, DUM, 1,
```

```
     $                        WORK( IWORK ), INFO )
                  IU = IE + N
*
*                 Multiply Q in A by left singular vectors of R in
*                 WORK(IR), storing result in WORK(IU) and copying to A
*                 (Workspace: need N*N+2*N, prefer N*N+M*N+N)
*
                  DO 20 I = 1, M, LDWRKU
                     CHUNK = MIN( M-I+1, LDWRKU )
                     CALL DGEMM( 'N', 'N', CHUNK, N, N, ONE, A( I, 1 ),
     $                           LDA, WORK( IR ), LDWRKR, ZERO,
     $                           WORK( IU ), LDWRKU )
                     CALL DLACPY( 'F', CHUNK, N, WORK( IU ), LDWRKU,
     $                            A( I, 1 ), LDA )
   20             CONTINUE
*
               ELSE
*
*                 Insufficient workspace for a fast algorithm
*
                  ITAU = 1
                  IWORK = ITAU + N
*
*                 Compute A=Q*R
*                 (Workspace: need 2*N, prefer N+N*NB)
*
                  CALL DGEQRF( M, N, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                 Copy R to VT, zeroing out below it
*
                  CALL DLACPY( 'U', N, N, A, LDA, VT, LDVT )
                  CALL DLASET( 'L', N-1, N-1, ZERO, ZERO, VT( 2, 1 ),
     $                         LDVT )
*
*                 Generate Q in A
*                 (Workspace: need 2*N, prefer N+N*NB)
*
                  CALL DORGQR( M, N, N, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IE = ITAU
                  ITAUQ = IE + N
                  ITAUP = ITAUQ + N
                  IWORK = ITAUP + N
*
*                 Bidiagonalize R in VT
*                 (Workspace: need 4*N, prefer 3*N+2*N*NB)
*
                  CALL DGEBRD( N, N, VT, LDVT, S, WORK( IE ),
     $                         WORK( ITAUQ ), WORK( ITAUP ),
```

```
     $                        WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                Multiply Q in A by left vectors bidiagonalizing R
*                (Workspace: need 3*N+M, prefer 3*N+M*NB)
*
                 CALL DORMBR( 'Q', 'R', 'N', M, N, N, VT, LDVT,
     $                        WORK( ITAUQ ), A, LDA, WORK( IWORK ),
     $                        LWORK-IWORK+1, IERR )
*
*                Generate right vectors bidiagonalizing R in VT
*                (Workspace: need 4*N-1, prefer 3*N+(N-1)*NB)
*
                 CALL DORGBR( 'P', N, N, N, VT, LDVT, WORK( ITAUP ),
     $                        WORK( IWORK ), LWORK-IWORK+1, IERR )
                 IWORK = IE + N
*
*                Perform bidiagonal QR iteration, computing left
*                singular vectors of A in A and computing right
*                singular vectors of A in VT
*                (Workspace: need BDSPAC)
*
                 CALL DBDSQR( 'U', N, N, M, 0, S, WORK( IE ), VT, LDVT,
     $                        A, LDA, DUM, 1, WORK( IWORK ), INFO )
*
              END IF
*
            ELSE IF( WNTUS ) THEN
*
              IF( WNTVN ) THEN
*
*                Path 4 (M much larger than N, JOBU='S', JOBVT='N')
*                N left singular vectors to be computed in U and
*                no right singular vectors to be computed
*
                 IF( LWORK.GE.N*N+MAX( 4*N, BDSPAC ) ) THEN
*
*                   Sufficient workspace for a fast algorithm
*
                    IR = 1
                    IF( LWORK.GE.WRKBL+LDA*N ) THEN
*
*                      WORK(IR) is LDA by N
*
                       LDWRKR = LDA
                    ELSE
*
*                      WORK(IR) is N by N
*
                       LDWRKR = N
                    END IF
```

```
                  ITAU = IR + LDWRKR*N
                  IWORK = ITAU + N
*
*                 Compute A=Q*R
*                 (Workspace: need N*N+2*N, prefer N*N+N+N*NB)
*
                  CALL DGEQRF( M, N, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                 Copy R to WORK(IR), zeroing out below it
*
                  CALL DLACPY( 'U', N, N, A, LDA, WORK( IR ),
     $                         LDWRKR )
                  CALL DLASET( 'L', N-1, N-1, ZERO, ZERO,
     $                         WORK( IR+1 ), LDWRKR )
*
*                 Generate Q in A
*                 (Workspace: need N*N+2*N, prefer N*N+N+N*NB)
*
                  CALL DORGQR( M, N, N, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IE = ITAU
                  ITAUQ = IE + N
                  ITAUP = ITAUQ + N
                  IWORK = ITAUP + N
*
*                 Bidiagonalize R in WORK(IR)
*                 (Workspace: need N*N+4*N, prefer N*N+3*N+2*N*NB)
*
                  CALL DGEBRD( N, N, WORK( IR ), LDWRKR, S,
     $                         WORK( IE ), WORK( ITAUQ ),
     $                         WORK( ITAUP ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
*
*                 Generate left vectors bidiagonalizing R in WORK(IR)
*                 (Workspace: need N*N+4*N, prefer N*N+3*N+N*NB)
*
                  CALL DORGBR( 'Q', N, N, N, WORK( IR ), LDWRKR,
     $                         WORK( ITAUQ ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
                  IWORK = IE + N
*
*                 Perform bidiagonal QR iteration, computing left
*                 singular vectors of R in WORK(IR)
*                 (Workspace: need N*N+BDSPAC)
*
                  CALL DBDSQR( 'U', N, 0, N, 0, S, WORK( IE ), DUM,
     $                         1, WORK( IR ), LDWRKR, DUM, 1,
     $                         WORK( IWORK ), INFO )
*
```

```
*                    Multiply Q in A by left singular vectors of R in
*                    WORK(IR), storing result in U
*                    (Workspace: need N*N)
*
                     CALL DGEMM( 'N', 'N', M, N, N, ONE, A, LDA,
     $                           WORK( IR ), LDWRKR, ZERO, U, LDU )
*
                  ELSE
*
*                    Insufficient workspace for a fast algorithm
*
                     ITAU = 1
                     IWORK = ITAU + N
*
*                    Compute A=Q*R, copying result to U
*                    (Workspace: need 2*N, prefer N+N*NB)
*
                     CALL DGEQRF( M, N, A, LDA, WORK( ITAU ),
     $                           WORK( IWORK ), LWORK-IWORK+1, IERR )
                     CALL DLACPY( 'L', M, N, A, LDA, U, LDU )
*
*                    Generate Q in U
*                    (Workspace: need 2*N, prefer N+N*NB)
*
                     CALL DORGQR( M, N, N, U, LDU, WORK( ITAU ),
     $                           WORK( IWORK ), LWORK-IWORK+1, IERR )
                     IE = ITAU
                     ITAUQ = IE + N
                     ITAUP = ITAUQ + N
                     IWORK = ITAUP + N
*
*                    Zero out below R in A
*
                     CALL DLASET( 'L', N-1, N-1, ZERO, ZERO, A( 2, 1 ),
     $                           LDA )
*
*                    Bidiagonalize R in A
*                    (Workspace: need 4*N, prefer 3*N+2*N*NB)
*
                     CALL DGEBRD( N, N, A, LDA, S, WORK( IE ),
     $                           WORK( ITAUQ ), WORK( ITAUP ),
     $                           WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                    Multiply Q in U by left vectors bidiagonalizing R
*                    (Workspace: need 3*N+M, prefer 3*N+M*NB)
*
                     CALL DORMBR( 'Q', 'R', 'N', M, N, N, A, LDA,
     $                           WORK( ITAUQ ), U, LDU, WORK( IWORK ),
     $                           LWORK-IWORK+1, IERR )
                     IWORK = IE + N
```

```
*
*                    Perform bidiagonal QR iteration, computing left
*                    singular vectors of A in U
*                    (Workspace: need BDSPAC)
*
                     CALL DBDSQR( 'U', N, 0, M, 0, S, WORK( IE ), DUM,
     $                           1, U, LDU, DUM, 1, WORK( IWORK ),
     $                           INFO )
*
                  END IF
*
               ELSE IF( WNTVO ) THEN
*
*                  Path 5 (M much larger than N, JOBU='S', JOBVT='O')
*                  N left singular vectors to be computed in U and
*                  N right singular vectors to be overwritten on A
*
                  IF( LWORK.GE.2*N*N+MAX( 4*N, BDSPAC ) ) THEN
*
*                     Sufficient workspace for a fast algorithm
*
                     IU = 1
                     IF( LWORK.GE.WRKBL+2*LDA*N ) THEN
*
*                        WORK(IU) is LDA by N and WORK(IR) is LDA by N
*
                        LDWRKU = LDA
                        IR = IU + LDWRKU*N
                        LDWRKR = LDA
                     ELSE IF( LWORK.GE.WRKBL+( LDA+N )*N ) THEN
*
*                        WORK(IU) is LDA by N and WORK(IR) is N by N
*
                        LDWRKU = LDA
                        IR = IU + LDWRKU*N
                        LDWRKR = N
                     ELSE
*
*                        WORK(IU) is N by N and WORK(IR) is N by N
*
                        LDWRKU = N
                        IR = IU + LDWRKU*N
                        LDWRKR = N
                     END IF
                     ITAU = IR + LDWRKR*N
                     IWORK = ITAU + N
*
*                     Compute A=Q*R
*                     (Workspace: need 2*N*N+2*N, prefer 2*N*N+N+N*NB)
*
```

```
                  CALL DGEQRF( M, N, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                 Copy R to WORK(IU), zeroing out below it
*
                  CALL DLACPY( 'U', N, N, A, LDA, WORK( IU ),
     $                         LDWRKU )
                  CALL DLASET( 'L', N-1, N-1, ZERO, ZERO,
     $                         WORK( IU+1 ), LDWRKU )
*
*                 Generate Q in A
*                 (Workspace: need 2*N*N+2*N, prefer 2*N*N+N+N*NB)
*
                  CALL DORGQR( M, N, N, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IE = ITAU
                  ITAUQ = IE + N
                  ITAUP = ITAUQ + N
                  IWORK = ITAUP + N
*
*                 Bidiagonalize R in WORK(IU), copying result to
*                 WORK(IR)
*                 (Workspace: need 2*N*N+4*N,
*                             prefer 2*N*N+3*N+2*N*NB)
*
                  CALL DGEBRD( N, N, WORK( IU ), LDWRKU, S,
     $                         WORK( IE ), WORK( ITAUQ ),
     $                         WORK( ITAUP ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
                  CALL DLACPY( 'U', N, N, WORK( IU ), LDWRKU,
     $                         WORK( IR ), LDWRKR )
*
*                 Generate left bidiagonalizing vectors in WORK(IU)
*                 (Workspace: need 2*N*N+4*N, prefer 2*N*N+3*N+N*NB)
*
                  CALL DORGBR( 'Q', N, N, N, WORK( IU ), LDWRKU,
     $                         WORK( ITAUQ ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
*
*                 Generate right bidiagonalizing vectors in WORK(IR)
*                 (Workspace: need 2*N*N+4*N-1,
*                             prefer 2*N*N+3*N+(N-1)*NB)
*
                  CALL DORGBR( 'P', N, N, N, WORK( IR ), LDWRKR,
     $                         WORK( ITAUP ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
                  IWORK = IE + N
*
*                 Perform bidiagonal QR iteration, computing left
*                 singular vectors of R in WORK(IU) and computing
```

```
*                    right singular vectors of R in WORK(IR)
*                    (Workspace: need 2*N*N+BDSPAC)
*
                     CALL DBDSQR( 'U', N, N, N, 0, S, WORK( IE ),
     $                             WORK( IR ), LDWRKR, WORK( IU ),
     $                             LDWRKU, DUM, 1, WORK( IWORK ), INFO )
*
*                    Multiply Q in A by left singular vectors of R in
*                    WORK(IU), storing result in U
*                    (Workspace: need N*N)
*
                     CALL DGEMM( 'N', 'N', M, N, N, ONE, A, LDA,
     $                           WORK( IU ), LDWRKU, ZERO, U, LDU )
*
*                    Copy right singular vectors of R to A
*                    (Workspace: need N*N)
*
                     CALL DLACPY( 'F', N, N, WORK( IR ), LDWRKR, A,
     $                             LDA )
*
                  ELSE
*
*                    Insufficient workspace for a fast algorithm
*
                     ITAU = 1
                     IWORK = ITAU + N
*
*                    Compute A=Q*R, copying result to U
*                    (Workspace: need 2*N, prefer N+N*NB)
*
                     CALL DGEQRF( M, N, A, LDA, WORK( ITAU ),
     $                            WORK( IWORK ), LWORK-IWORK+1, IERR )
                     CALL DLACPY( 'L', M, N, A, LDA, U, LDU )
*
*                    Generate Q in U
*                    (Workspace: need 2*N, prefer N+N*NB)
*
                     CALL DORGQR( M, N, N, U, LDU, WORK( ITAU ),
     $                            WORK( IWORK ), LWORK-IWORK+1, IERR )
                     IE = ITAU
                     ITAUQ = IE + N
                     ITAUP = ITAUQ + N
                     IWORK = ITAUP + N
*
*                    Zero out below R in A
*
                     CALL DLASET( 'L', N-1, N-1, ZERO, ZERO, A( 2, 1 ),
     $                            LDA )
*
*                    Bidiagonalize R in A
```

```
*                    (Workspace: need 4*N, prefer 3*N+2*N*NB)
*
                     CALL DGEBRD( N, N, A, LDA, S, WORK( IE ),
     $                             WORK( ITAUQ ), WORK( ITAUP ),
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                    Multiply Q in U by left vectors bidiagonalizing R
*                    (Workspace: need 3*N+M, prefer 3*N+M*NB)
*
                     CALL DORMBR( 'Q', 'R', 'N', M, N, N, A, LDA,
     $                             WORK( ITAUQ ), U, LDU, WORK( IWORK ),
     $                             LWORK-IWORK+1, IERR )
*
*                    Generate right vectors bidiagonalizing R in A
*                    (Workspace: need 4*N-1, prefer 3*N+(N-1)*NB)
*
                     CALL DORGBR( 'P', N, N, N, A, LDA, WORK( ITAUP ),
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
                     IWORK = IE + N
*
*                    Perform bidiagonal QR iteration, computing left
*                    singular vectors of A in U and computing right
*                    singular vectors of A in A
*                    (Workspace: need BDSPAC)
*
                     CALL DBDSQR( 'U', N, N, M, 0, S, WORK( IE ), A,
     $                             LDA, U, LDU, DUM, 1, WORK( IWORK ),
     $                             INFO )
*
                  END IF
*
               ELSE IF( WNTVAS ) THEN
*
*                 Path 6 (M much larger than N, JOBU='S', JOBVT='S'
*                         or 'A')
*                 N left singular vectors to be computed in U and
*                 N right singular vectors to be computed in VT
*
                  IF( LWORK.GE.N*N+MAX( 4*N, BDSPAC ) ) THEN
*
*                    Sufficient workspace for a fast algorithm
*
                     IU = 1
                     IF( LWORK.GE.WRKBL+LDA*N ) THEN
*
*                       WORK(IU) is LDA by N
*
                        LDWRKU = LDA
                     ELSE
*
```

```
*                     WORK(IU) is N by N
*
                      LDWRKU = N
                    END IF
                    ITAU = IU + LDWRKU*N
                    IWORK = ITAU + N
*
*                   Compute A=Q*R
*                   (Workspace: need N*N+2*N, prefer N*N+N+N*NB)
*
                    CALL DGEQRF( M, N, A, LDA, WORK( ITAU ),
     $                          WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                   Copy R to WORK(IU), zeroing out below it
*
                    CALL DLACPY( 'U', N, N, A, LDA, WORK( IU ),
     $                          LDWRKU )
                    CALL DLASET( 'L', N-1, N-1, ZERO, ZERO,
     $                          WORK( IU+1 ), LDWRKU )
*
*                   Generate Q in A
*                   (Workspace: need N*N+2*N, prefer N*N+N+N*NB)
*
                    CALL DORGQR( M, N, N, A, LDA, WORK( ITAU ),
     $                          WORK( IWORK ), LWORK-IWORK+1, IERR )
                    IE = ITAU
                    ITAUQ = IE + N
                    ITAUP = ITAUQ + N
                    IWORK = ITAUP + N
*
*                   Bidiagonalize R in WORK(IU), copying result to VT
*                   (Workspace: need N*N+4*N, prefer N*N+3*N+2*N*NB)
*
                    CALL DGEBRD( N, N, WORK( IU ), LDWRKU, S,
     $                          WORK( IE ), WORK( ITAUQ ),
     $                          WORK( ITAUP ), WORK( IWORK ),
     $                          LWORK-IWORK+1, IERR )
                    CALL DLACPY( 'U', N, N, WORK( IU ), LDWRKU, VT,
     $                          LDVT )
*
*                   Generate left bidiagonalizing vectors in WORK(IU)
*                   (Workspace: need N*N+4*N, prefer N*N+3*N+N*NB)
*
                    CALL DORGBR( 'Q', N, N, N, WORK( IU ), LDWRKU,
     $                          WORK( ITAUQ ), WORK( IWORK ),
     $                          LWORK-IWORK+1, IERR )
*
*                   Generate right bidiagonalizing vectors in VT
*                   (Workspace: need N*N+4*N-1,
*                               prefer N*N+3*N+(N-1)*NB)
```

```
*
                     CALL DORGBR( 'P', N, N, N, VT, LDVT, WORK( ITAUP ),
     $                           WORK( IWORK ), LWORK-IWORK+1, IERR )
                     IWORK = IE + N
*
*                    Perform bidiagonal QR iteration, computing left
*                    singular vectors of R in WORK(IU) and computing
*                    right singular vectors of R in VT
*                    (Workspace: need N*N+BDSPAC)
*
                     CALL DBDSQR( 'U', N, N, N, 0, S, WORK( IE ), VT,
     $                           LDVT, WORK( IU ), LDWRKU, DUM, 1,
     $                           WORK( IWORK ), INFO )
*
*                    Multiply Q in A by left singular vectors of R in
*                    WORK(IU), storing result in U
*                    (Workspace: need N*N)
*
                     CALL DGEMM( 'N', 'N', M, N, N, ONE, A, LDA,
     $                           WORK( IU ), LDWRKU, ZERO, U, LDU )
*
                  ELSE
*
*                    Insufficient workspace for a fast algorithm
*
                     ITAU = 1
                     IWORK = ITAU + N
*
*                    Compute A=Q*R, copying result to U
*                    (Workspace: need 2*N, prefer N+N*NB)
*
                     CALL DGEQRF( M, N, A, LDA, WORK( ITAU ),
     $                           WORK( IWORK ), LWORK-IWORK+1, IERR )
                     CALL DLACPY( 'L', M, N, A, LDA, U, LDU )
*
*                    Generate Q in U
*                    (Workspace: need 2*N, prefer N+N*NB)
*
                     CALL DORGQR( M, N, N, U, LDU, WORK( ITAU ),
     $                           WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                    Copy R to VT, zeroing out below it
*
                     CALL DLACPY( 'U', N, N, A, LDA, VT, LDVT )
                     CALL DLASET( 'L', N-1, N-1, ZERO, ZERO, VT( 2, 1 ),
     $                           LDVT )
                     IE = ITAU
                     ITAUQ = IE + N
                     ITAUP = ITAUQ + N
                     IWORK = ITAUP + N
```

```
*
*                    Bidiagonalize R in VT
*                    (Workspace: need 4*N, prefer 3*N+2*N*NB)
*
                     CALL DGEBRD( N, N, VT, LDVT, S, WORK( IE ),
     $                             WORK( ITAUQ ), WORK( ITAUP ),
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                    Multiply Q in U by left bidiagonalizing vectors
*                    in VT
*                    (Workspace: need 3*N+M, prefer 3*N+M*NB)
*
                     CALL DORMBR( 'Q', 'R', 'N', M, N, N, VT, LDVT,
     $                             WORK( ITAUQ ), U, LDU, WORK( IWORK ),
     $                             LWORK-IWORK+1, IERR )
*
*                    Generate right bidiagonalizing vectors in VT
*                    (Workspace: need 4*N-1, prefer 3*N+(N-1)*NB)
*
                     CALL DORGBR( 'P', N, N, N, VT, LDVT, WORK( ITAUP ),
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
                     IWORK = IE + N
*
*                    Perform bidiagonal QR iteration, computing left
*                    singular vectors of A in U and computing right
*                    singular vectors of A in VT
*                    (Workspace: need BDSPAC)
*
                     CALL DBDSQR( 'U', N, N, M, 0, S, WORK( IE ), VT,
     $                             LDVT, U, LDU, DUM, 1, WORK( IWORK ),
     $                             INFO )
*
                  END IF
*
               END IF
*
            ELSE IF( WNTUA ) THEN
*
               IF( WNTVN ) THEN
*
*                 Path 7 (M much larger than N, JOBU='A', JOBVT='N')
*                 M left singular vectors to be computed in U and
*                 no right singular vectors to be computed
*
                  IF( LWORK.GE.N*N+MAX( N+M, 4*N, BDSPAC ) ) THEN
*
*                    Sufficient workspace for a fast algorithm
*
                     IR = 1
                     IF( LWORK.GE.WRKBL+LDA*N ) THEN
```

```
*
*                       WORK(IR) is LDA by N
*
                        LDWRKR = LDA
                     ELSE
*
*                       WORK(IR) is N by N
*
                        LDWRKR = N
                     END IF
                     ITAU = IR + LDWRKR*N
                     IWORK = ITAU + N
*
*                    Compute A=Q*R, copying result to U
*                    (Workspace: need N*N+2*N, prefer N*N+N+N*NB)
*
                     CALL DGEQRF( M, N, A, LDA, WORK( ITAU ),
     $                            WORK( IWORK ), LWORK-IWORK+1, IERR )
                     CALL DLACPY( 'L', M, N, A, LDA, U, LDU )
*
*                    Copy R to WORK(IR), zeroing out below it
*
                     CALL DLACPY( 'U', N, N, A, LDA, WORK( IR ),
     $                            LDWRKR )
                     CALL DLASET( 'L', N-1, N-1, ZERO, ZERO,
     $                            WORK( IR+1 ), LDWRKR )
*
*                    Generate Q in U
*                    (Workspace: need N*N+N+M, prefer N*N+N+M*NB)
*
                     CALL DORGQR( M, M, N, U, LDU, WORK( ITAU ),
     $                            WORK( IWORK ), LWORK-IWORK+1, IERR )
                     IE = ITAU
                     ITAUQ = IE + N
                     ITAUP = ITAUQ + N
                     IWORK = ITAUP + N
*
*                    Bidiagonalize R in WORK(IR)
*                    (Workspace: need N*N+4*N, prefer N*N+3*N+2*N*NB)
*
                     CALL DGEBRD( N, N, WORK( IR ), LDWRKR, S,
     $                            WORK( IE ), WORK( ITAUQ ),
     $                            WORK( ITAUP ), WORK( IWORK ),
     $                            LWORK-IWORK+1, IERR )
*
*                    Generate left bidiagonalizing vectors in WORK(IR)
*                    (Workspace: need N*N+4*N, prefer N*N+3*N+N*NB)
*
                     CALL DORGBR( 'Q', N, N, N, WORK( IR ), LDWRKR,
     $                            WORK( ITAUQ ), WORK( IWORK ),
```

```
     $                        LWORK-IWORK+1, IERR )
                      IWORK = IE + N
*
*                     Perform bidiagonal QR iteration, computing left
*                     singular vectors of R in WORK(IR)
*                     (Workspace: need N*N+BDSPAC)
*
                      CALL DBDSQR( 'U', N, 0, N, 0, S, WORK( IE ), DUM,
     $                             1, WORK( IR ), LDWRKR, DUM, 1,
     $                             WORK( IWORK ), INFO )
*
*                     Multiply Q in U by left singular vectors of R in
*                     WORK(IR), storing result in A
*                     (Workspace: need N*N)
*
                      CALL DGEMM( 'N', 'N', M, N, N, ONE, U, LDU,
     $                           WORK( IR ), LDWRKR, ZERO, A, LDA )
*
*                     Copy left singular vectors of A from A to U
*
                      CALL DLACPY( 'F', M, N, A, LDA, U, LDU )
*
                   ELSE
*
*                     Insufficient workspace for a fast algorithm
*
                      ITAU = 1
                      IWORK = ITAU + N
*
*                     Compute A=Q*R, copying result to U
*                     (Workspace: need 2*N, prefer N+N*NB)
*
                      CALL DGEQRF( M, N, A, LDA, WORK( ITAU ),
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
                      CALL DLACPY( 'L', M, N, A, LDA, U, LDU )
*
*                     Generate Q in U
*                     (Workspace: need N+M, prefer N+M*NB)
*
                      CALL DORGQR( M, M, N, U, LDU, WORK( ITAU ),
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
                      IE = ITAU
                      ITAUQ = IE + N
                      ITAUP = ITAUQ + N
                      IWORK = ITAUP + N
*
*                     Zero out below R in A
*
                      CALL DLASET( 'L', N-1, N-1, ZERO, ZERO, A( 2, 1 ),
     $                             LDA )
```

```
*
*                    Bidiagonalize R in A
*                    (Workspace: need 4*N, prefer 3*N+2*N*NB)
*
                     CALL DGEBRD( N, N, A, LDA, S, WORK( IE ),
     $                             WORK( ITAUQ ), WORK( ITAUP ),
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                    Multiply Q in U by left bidiagonalizing vectors
*                    in A
*                    (Workspace: need 3*N+M, prefer 3*N+M*NB)
*
                     CALL DORMBR( 'Q', 'R', 'N', M, N, N, A, LDA,
     $                             WORK( ITAUQ ), U, LDU, WORK( IWORK ),
     $                             LWORK-IWORK+1, IERR )
                     IWORK = IE + N
*
*                    Perform bidiagonal QR iteration, computing left
*                    singular vectors of A in U
*                    (Workspace: need BDSPAC)
*
                     CALL DBDSQR( 'U', N, 0, M, 0, S, WORK( IE ), DUM,
     $                             1, U, LDU, DUM, 1, WORK( IWORK ),
     $                             INFO )
*
                  END IF
*
               ELSE IF( WNTVO ) THEN
*
*                  Path 8 (M much larger than N, JOBU='A', JOBVT='O')
*                  M left singular vectors to be computed in U and
*                  N right singular vectors to be overwritten on A
*
                  IF( LWORK.GE.2*N*N+MAX( N+M, 4*N, BDSPAC ) ) THEN
*
*                     Sufficient workspace for a fast algorithm
*
                     IU = 1
                     IF( LWORK.GE.WRKBL+2*LDA*N ) THEN
*
*                        WORK(IU) is LDA by N and WORK(IR) is LDA by N
*
                        LDWRKU = LDA
                        IR = IU + LDWRKU*N
                        LDWRKR = LDA
                     ELSE IF( LWORK.GE.WRKBL+( LDA+N )*N ) THEN
*
*                        WORK(IU) is LDA by N and WORK(IR) is N by N
*
                        LDWRKU = LDA
```

```
                     IR = IU + LDWRKU*N
                     LDWRKR = N
                  ELSE
*
*                    WORK(IU) is N by N and WORK(IR) is N by N
*
                     LDWRKU = N
                     IR = IU + LDWRKU*N
                     LDWRKR = N
                  END IF
                  ITAU = IR + LDWRKR*N
                  IWORK = ITAU + N
*
*                 Compute A=Q*R, copying result to U
*                 (Workspace: need 2*N*N+2*N, prefer 2*N*N+N+N*NB)
*
                  CALL DGEQRF( M, N, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  CALL DLACPY( 'L', M, N, A, LDA, U, LDU )
*
*                 Generate Q in U
*                 (Workspace: need 2*N*N+N+M, prefer 2*N*N+N+M*NB)
*
                  CALL DORGQR( M, M, N, U, LDU, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                 Copy R to WORK(IU), zeroing out below it
*
                  CALL DLACPY( 'U', N, N, A, LDA, WORK( IU ),
     $                         LDWRKU )
                  CALL DLASET( 'L', N-1, N-1, ZERO, ZERO,
     $                         WORK( IU+1 ), LDWRKU )
                  IE = ITAU
                  ITAUQ = IE + N
                  ITAUP = ITAUQ + N
                  IWORK = ITAUP + N
*
*                 Bidiagonalize R in WORK(IU), copying result to
*                 WORK(IR)
*                 (Workspace: need 2*N*N+4*N,
*                             prefer 2*N*N+3*N+2*N*NB)
*
                  CALL DGEBRD( N, N, WORK( IU ), LDWRKU, S,
     $                         WORK( IE ), WORK( ITAUQ ),
     $                         WORK( ITAUP ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
                  CALL DLACPY( 'U', N, N, WORK( IU ), LDWRKU,
     $                         WORK( IR ), LDWRKR )
*
*                 Generate left bidiagonalizing vectors in WORK(IU)
```

```
*                    (Workspace: need 2*N*N+4*N, prefer 2*N*N+3*N+N*NB)
*
                     CALL DORGBR( 'Q', N, N, N, WORK( IU ), LDWRKU,
     $                             WORK( ITAUQ ), WORK( IWORK ),
     $                             LWORK-IWORK+1, IERR )
*
*                    Generate right bidiagonalizing vectors in WORK(IR)
*                    (Workspace: need 2*N*N+4*N-1,
*                                prefer 2*N*N+3*N+(N-1)*NB)
*
                     CALL DORGBR( 'P', N, N, N, WORK( IR ), LDWRKR,
     $                             WORK( ITAUP ), WORK( IWORK ),
     $                             LWORK-IWORK+1, IERR )
                     IWORK = IE + N
*
*                    Perform bidiagonal QR iteration, computing left
*                    singular vectors of R in WORK(IU) and computing
*                    right singular vectors of R in WORK(IR)
*                    (Workspace: need 2*N*N+BDSPAC)
*
                     CALL DBDSQR( 'U', N, N, N, 0, S, WORK( IE ),
     $                             WORK( IR ), LDWRKR, WORK( IU ),
     $                             LDWRKU, DUM, 1, WORK( IWORK ), INFO )
*
*                    Multiply Q in U by left singular vectors of R in
*                    WORK(IU), storing result in A
*                    (Workspace: need N*N)
*
                     CALL DGEMM( 'N', 'N', M, N, N, ONE, U, LDU,
     $                           WORK( IU ), LDWRKU, ZERO, A, LDA )
*
*                    Copy left singular vectors of A from A to U
*
                     CALL DLACPY( 'F', M, N, A, LDA, U, LDU )
*
*                    Copy right singular vectors of R from WORK(IR) to A
*
                     CALL DLACPY( 'F', N, N, WORK( IR ), LDWRKR, A,
     $                             LDA )
*
                  ELSE
*
*                    Insufficient workspace for a fast algorithm
*
                     ITAU = 1
                     IWORK = ITAU + N
*
*                    Compute A=Q*R, copying result to U
*                    (Workspace: need 2*N, prefer N+N*NB)
*
```

```
                  CALL DGEQRF( M, N, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  CALL DLACPY( 'L', M, N, A, LDA, U, LDU )
*
*                 Generate Q in U
*                 (Workspace: need N+M, prefer N+M*NB)
*
                  CALL DORGQR( M, M, N, U, LDU, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IE = ITAU
                  ITAUQ = IE + N
                  ITAUP = ITAUQ + N
                  IWORK = ITAUP + N
*
*                 Zero out below R in A
*
                  CALL DLASET( 'L', N-1, N-1, ZERO, ZERO, A( 2, 1 ),
     $                         LDA )
*
*                 Bidiagonalize R in A
*                 (Workspace: need 4*N, prefer 3*N+2*N*NB)
*
                  CALL DGEBRD( N, N, A, LDA, S, WORK( IE ),
     $                         WORK( ITAUQ ), WORK( ITAUP ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                 Multiply Q in U by left bidiagonalizing vectors
*                 in A
*                 (Workspace: need 3*N+M, prefer 3*N+M*NB)
*
                  CALL DORMBR( 'Q', 'R', 'N', M, N, N, A, LDA,
     $                         WORK( ITAUQ ), U, LDU, WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
*
*                 Generate right bidiagonalizing vectors in A
*                 (Workspace: need 4*N-1, prefer 3*N+(N-1)*NB)
*
                  CALL DORGBR( 'P', N, N, N, A, LDA, WORK( ITAUP ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IWORK = IE + N
*
*                 Perform bidiagonal QR iteration, computing left
*                 singular vectors of A in U and computing right
*                 singular vectors of A in A
*                 (Workspace: need BDSPAC)
*
                  CALL DBDSQR( 'U', N, N, M, 0, S, WORK( IE ), A,
     $                         LDA, U, LDU, DUM, 1, WORK( IWORK ),
     $                         INFO )
*
```

```
                  END IF
*
               ELSE IF( WNTVAS ) THEN
*
*                 Path 9 (M much larger than N, JOBU='A', JOBVT='S'
*                         or 'A')
*                 M left singular vectors to be computed in U and
*                 N right singular vectors to be computed in VT
*
                  IF( LWORK.GE.N*N+MAX( N+M, 4*N, BDSPAC ) ) THEN
*
*                    Sufficient workspace for a fast algorithm
*
                     IU = 1
                     IF( LWORK.GE.WRKBL+LDA*N ) THEN
*
*                       WORK(IU) is LDA by N
*
                        LDWRKU = LDA
                     ELSE
*
*                       WORK(IU) is N by N
*
                        LDWRKU = N
                     END IF
                     ITAU = IU + LDWRKU*N
                     IWORK = ITAU + N
*
*                    Compute A=Q*R, copying result to U
*                    (Workspace: need N*N+2*N, prefer N*N+N+N*NB)
*
                     CALL DGEQRF( M, N, A, LDA, WORK( ITAU ),
     $                           WORK( IWORK ), LWORK-IWORK+1, IERR )
                     CALL DLACPY( 'L', M, N, A, LDA, U, LDU )
*
*                    Generate Q in U
*                    (Workspace: need N*N+N+M, prefer N*N+N+M*NB)
*
                     CALL DORGQR( M, M, N, U, LDU, WORK( ITAU ),
     $                           WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                    Copy R to WORK(IU), zeroing out below it
*
                     CALL DLACPY( 'U', N, N, A, LDA, WORK( IU ),
     $                           LDWRKU )
                     CALL DLASET( 'L', N-1, N-1, ZERO, ZERO,
     $                           WORK( IU+1 ), LDWRKU )
                     IE = ITAU
                     ITAUQ = IE + N
                     ITAUP = ITAUQ + N
```

```
                  IWORK = ITAUP + N
*
*                 Bidiagonalize R in WORK(IU), copying result to VT
*                 (Workspace: need N*N+4*N, prefer N*N+3*N+2*N*NB)
*
                  CALL DGEBRD( N, N, WORK( IU ), LDWRKU, S,
     $                         WORK( IE ), WORK( ITAUQ ),
     $                         WORK( ITAUP ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
                  CALL DLACPY( 'U', N, N, WORK( IU ), LDWRKU, VT,
     $                         LDVT )
*
*                 Generate left bidiagonalizing vectors in WORK(IU)
*                 (Workspace: need N*N+4*N, prefer N*N+3*N+N*NB)
*
                  CALL DORGBR( 'Q', N, N, N, WORK( IU ), LDWRKU,
     $                         WORK( ITAUQ ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
*
*                 Generate right bidiagonalizing vectors in VT
*                 (Workspace: need N*N+4*N-1,
*                             prefer N*N+3*N+(N-1)*NB)
*
                  CALL DORGBR( 'P', N, N, N, VT, LDVT, WORK( ITAUP ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IWORK = IE + N
*
*                 Perform bidiagonal QR iteration, computing left
*                 singular vectors of R in WORK(IU) and computing
*                 right singular vectors of R in VT
*                 (Workspace: need N*N+BDSPAC)
*
                  CALL DBDSQR( 'U', N, N, N, 0, S, WORK( IE ), VT,
     $                         LDVT, WORK( IU ), LDWRKU, DUM, 1,
     $                         WORK( IWORK ), INFO )
*
*                 Multiply Q in U by left singular vectors of R in
*                 WORK(IU), storing result in A
*                 (Workspace: need N*N)
*
                  CALL DGEMM( 'N', 'N', M, N, N, ONE, U, LDU,
     $                        WORK( IU ), LDWRKU, ZERO, A, LDA )
*
*                 Copy left singular vectors of A from A to U
*
                  CALL DLACPY( 'F', M, N, A, LDA, U, LDU )
*
               ELSE
*
*                 Insufficient workspace for a fast algorithm
```

```
*
                  ITAU = 1
                  IWORK = ITAU + N
*
*                 Compute A=Q*R, copying result to U
*                 (Workspace: need 2*N, prefer N+N*NB)
*
                  CALL DGEQRF( M, N, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  CALL DLACPY( 'L', M, N, A, LDA, U, LDU )
*
*                 Generate Q in U
*                 (Workspace: need N+M, prefer N+M*NB)
*
                  CALL DORGQR( M, M, N, U, LDU, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                 Copy R from A to VT, zeroing out below it
*
                  CALL DLACPY( 'U', N, N, A, LDA, VT, LDVT )
                  CALL DLASET( 'L', N-1, N-1, ZERO, ZERO, VT( 2, 1 ),
     $                         LDVT )
                  IE = ITAU
                  ITAUQ = IE + N
                  ITAUP = ITAUQ + N
                  IWORK = ITAUP + N
*
*                 Bidiagonalize R in VT
*                 (Workspace: need 4*N, prefer 3*N+2*N*NB)
*
                  CALL DGEBRD( N, N, VT, LDVT, S, WORK( IE ),
     $                         WORK( ITAUQ ), WORK( ITAUP ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                 Multiply Q in U by left bidiagonalizing vectors
*                 in VT
*                 (Workspace: need 3*N+M, prefer 3*N+M*NB)
*
                  CALL DORMBR( 'Q', 'R', 'N', M, N, N, VT, LDVT,
     $                         WORK( ITAUQ ), U, LDU, WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
*
*                 Generate right bidiagonalizing vectors in VT
*                 (Workspace: need 4*N-1, prefer 3*N+(N-1)*NB)
*
                  CALL DORGBR( 'P', N, N, N, VT, LDVT, WORK( ITAUP ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IWORK = IE + N
*
*                 Perform bidiagonal QR iteration, computing left
```

```
*                    singular vectors of A in U and computing right
*                    singular vectors of A in VT
*                    (Workspace: need BDSPAC)
*
                     CALL DBDSQR( 'U', N, N, M, 0, S, WORK( IE ), VT,
     $                           LDVT, U, LDU, DUM, 1, WORK( IWORK ),
     $                           INFO )
*
                  END IF
*
               END IF
*
            END IF
*
         ELSE
*
*           M .LT. MNTHR
*
*           Path 10 (M at least N, but not much larger)
*           Reduce to bidiagonal form without QR decomposition
*
            IE = 1
            ITAUQ = IE + N
            ITAUP = ITAUQ + N
            IWORK = ITAUP + N
*
*           Bidiagonalize A
*           (Workspace: need 3*N+M, prefer 3*N+(M+N)*NB)
*
            CALL DGEBRD( M, N, A, LDA, S, WORK( IE ), WORK( ITAUQ ),
     $                   WORK( ITAUP ), WORK( IWORK ), LWORK-IWORK+1,
     $                   IERR )
            IF( WNTUAS ) THEN
*
*              If left singular vectors desired in U, copy result to U
*              and generate left bidiagonalizing vectors in U
*              (Workspace: need 3*N+NCU, prefer 3*N+NCU*NB)
*
               CALL DLACPY( 'L', M, N, A, LDA, U, LDU )
               IF( WNTUS )
     $            NCU = N
               IF( WNTUA )
     $            NCU = M
               CALL DORGBR( 'Q', M, NCU, N, U, LDU, WORK( ITAUQ ),
     $                      WORK( IWORK ), LWORK-IWORK+1, IERR )
            END IF
            IF( WNTVAS ) THEN
*
*              If right singular vectors desired in VT, copy result to
*              VT and generate right bidiagonalizing vectors in VT
```

```
*              (Workspace: need 4*N-1, prefer 3*N+(N-1)*NB)
*
               CALL DLACPY( 'U', N, N, A, LDA, VT, LDVT )
               CALL DORGBR( 'P', N, N, N, VT, LDVT, WORK( ITAUP ),
     $                      WORK( IWORK ), LWORK-IWORK+1, IERR )
            END IF
            IF( WNTUO ) THEN
*
*              If left singular vectors desired in A, generate left
*              bidiagonalizing vectors in A
*              (Workspace: need 4*N, prefer 3*N+N*NB)
*
               CALL DORGBR( 'Q', M, N, N, A, LDA, WORK( ITAUQ ),
     $                      WORK( IWORK ), LWORK-IWORK+1, IERR )
            END IF
            IF( WNTVO ) THEN
*
*              If right singular vectors desired in A, generate right
*              bidiagonalizing vectors in A
*              (Workspace: need 4*N-1, prefer 3*N+(N-1)*NB)
*
               CALL DORGBR( 'P', N, N, N, A, LDA, WORK( ITAUP ),
     $                      WORK( IWORK ), LWORK-IWORK+1, IERR )
            END IF
            IWORK = IE + N
            IF( WNTUAS .OR. WNTUO )
     $         NRU = M
            IF( WNTUN )
     $         NRU = 0
            IF( WNTVAS .OR. WNTVO )
     $         NCVT = N
            IF( WNTVN )
     $         NCVT = 0
            IF( ( .NOT.WNTUO ) .AND. ( .NOT.WNTVO ) ) THEN
*
*              Perform bidiagonal QR iteration, if desired, computing
*              left singular vectors in U and computing right singular
*              vectors in VT
*              (Workspace: need BDSPAC)
*
               CALL DBDSQR( 'U', N, NCVT, NRU, 0, S, WORK( IE ), VT,
     $                      LDVT, U, LDU, DUM, 1, WORK( IWORK ), INFO )
            ELSE IF( ( .NOT.WNTUO ) .AND. WNTVO ) THEN
*
*              Perform bidiagonal QR iteration, if desired, computing
*              left singular vectors in U and computing right singular
*              vectors in A
*              (Workspace: need BDSPAC)
*
               CALL DBDSQR( 'U', N, NCVT, NRU, 0, S, WORK( IE ), A, LDA,
```

```
     $                     U, LDU, DUM, 1, WORK( IWORK ), INFO )
            ELSE
*
*              Perform bidiagonal QR iteration, if desired, computing
*              left singular vectors in A and computing right singular
*              vectors in VT
*              (Workspace: need BDSPAC)
*
               CALL DBDSQR( 'U', N, NCVT, NRU, 0, S, WORK( IE ), VT,
     $                      LDVT, A, LDA, DUM, 1, WORK( IWORK ), INFO )
            END IF
*
         END IF
*
      ELSE
*
*        A has more columns than rows. If A has sufficiently more
*        columns than rows, first reduce using the LQ decomposition (if
*        sufficient workspace available)
*
         IF( N.GE.MNTHR ) THEN
*
            IF( WNTVN ) THEN
*
*              Path 1t(N much larger than M, JOBVT='N')
*              No right singular vectors to be computed
*
               ITAU = 1
               IWORK = ITAU + M
*
*              Compute A=L*Q
*              (Workspace: need 2*M, prefer M+M*NB)
*
               CALL DGELQF( M, N, A, LDA, WORK( ITAU ), WORK( IWORK ),
     $                      LWORK-IWORK+1, IERR )
*
*              Zero out above L
*
               CALL DLASET( 'U', M-1, M-1, ZERO, ZERO, A( 1, 2 ), LDA )
               IE = 1
               ITAUQ = IE + M
               ITAUP = ITAUQ + M
               IWORK = ITAUP + M
*
*              Bidiagonalize L in A
*              (Workspace: need 4*M, prefer 3*M+2*M*NB)
*
               CALL DGEBRD( M, M, A, LDA, S, WORK( IE ), WORK( ITAUQ ),
     $                      WORK( ITAUP ), WORK( IWORK ), LWORK-IWORK+1,
     $                      IERR )
```

```
               IF( WNTUO .OR. WNTUAS ) THEN
*
*                 If left singular vectors desired, generate Q
*                 (Workspace: need 4*M, prefer 3*M+M*NB)
*
                  CALL DORGBR( 'Q', M, M, M, A, LDA, WORK( ITAUQ ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
               END IF
               IWORK = IE + M
               NRU = 0
               IF( WNTUO .OR. WNTUAS )
     $            NRU = M
*
*              Perform bidiagonal QR iteration, computing left singular
*              vectors of A in A if desired
*              (Workspace: need BDSPAC)
*
               CALL DBDSQR( 'U', M, 0, NRU, 0, S, WORK( IE ), DUM, 1, A,
     $                      LDA, DUM, 1, WORK( IWORK ), INFO )
*
*              If left singular vectors desired in U, copy them there
*
               IF( WNTUAS )
     $            CALL DLACPY( 'F', M, M, A, LDA, U, LDU )
*
            ELSE IF( WNTVO .AND. WNTUN ) THEN
*
*              Path 2t(N much larger than M, JOBU='N', JOBVT='O')
*              M right singular vectors to be overwritten on A and
*              no left singular vectors to be computed
*
               IF( LWORK.GE.M*M+MAX( 4*M, BDSPAC ) ) THEN
*
*                 Sufficient workspace for a fast algorithm
*
                  IR = 1
                  IF( LWORK.GE.MAX( WRKBL, LDA*N+M )+LDA*M ) THEN
*
*                    WORK(IU) is LDA by N and WORK(IR) is LDA by M
*
                     LDWRKU = LDA
                     CHUNK = N
                     LDWRKR = LDA
                  ELSE IF( LWORK.GE.MAX( WRKBL, LDA*N+M )+M*M ) THEN
*
*                    WORK(IU) is LDA by N and WORK(IR) is M by M
*
                     LDWRKU = LDA
                     CHUNK = N
                     LDWRKR = M
```

```
                  ELSE
*
*                    WORK(IU) is M by CHUNK and WORK(IR) is M by M
*
                     LDWRKU = M
                     CHUNK = ( LWORK-M*M-M ) / M
                     LDWRKR = M
                  END IF
                  ITAU = IR + LDWRKR*M
                  IWORK = ITAU + M
*
*                 Compute A=L*Q
*                 (Workspace: need M*M+2*M, prefer M*M+M+M*NB)
*
                  CALL DGELQF( M, N, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                 Copy L to WORK(IR) and zero out above it
*
                  CALL DLACPY( 'L', M, M, A, LDA, WORK( IR ), LDWRKR )
                  CALL DLASET( 'U', M-1, M-1, ZERO, ZERO,
     $                         WORK( IR+LDWRKR ), LDWRKR )
*
*                 Generate Q in A
*                 (Workspace: need M*M+2*M, prefer M*M+M+M*NB)
*
                  CALL DORGLQ( M, N, M, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IE = ITAU
                  ITAUQ = IE + M
                  ITAUP = ITAUQ + M
                  IWORK = ITAUP + M
*
*                 Bidiagonalize L in WORK(IR)
*                 (Workspace: need M*M+4*M, prefer M*M+3*M+2*M*NB)
*
                  CALL DGEBRD( M, M, WORK( IR ), LDWRKR, S, WORK( IE ),
     $                         WORK( ITAUQ ), WORK( ITAUP ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                 Generate right vectors bidiagonalizing L
*                 (Workspace: need M*M+4*M-1, prefer M*M+3*M+(M-1)*NB)
*
                  CALL DORGBR( 'P', M, M, M, WORK( IR ), LDWRKR,
     $                         WORK( ITAUP ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
                  IWORK = IE + M
*
*                 Perform bidiagonal QR iteration, computing right
*                 singular vectors of L in WORK(IR)
```

```
*                 (Workspace: need M*M+BDSPAC)
*
                  CALL DBDSQR( 'U', M, M, 0, 0, S, WORK( IE ),
     $                         WORK( IR ), LDWRKR, DUM, 1, DUM, 1,
     $                         WORK( IWORK ), INFO )
                  IU = IE + M
*
*                 Multiply right singular vectors of L in WORK(IR) by Q
*                 in A, storing result in WORK(IU) and copying to A
*                 (Workspace: need M*M+2*M, prefer M*M+M*N+M)
*
                  DO 30 I = 1, N, CHUNK
                     BLK = MIN( N-I+1, CHUNK )
                     CALL DGEMM( 'N', 'N', M, BLK, M, ONE, WORK( IR ),
     $                           LDWRKR, A( 1, I ), LDA, ZERO,
     $                           WORK( IU ), LDWRKU )
                     CALL DLACPY( 'F', M, BLK, WORK( IU ), LDWRKU,
     $                            A( 1, I ), LDA )
   30             CONTINUE
*
               ELSE
*
*                 Insufficient workspace for a fast algorithm
*
                  IE = 1
                  ITAUQ = IE + M
                  ITAUP = ITAUQ + M
                  IWORK = ITAUP + M
*
*                 Bidiagonalize A
*                 (Workspace: need 3*M+N, prefer 3*M+(M+N)*NB)
*
                  CALL DGEBRD( M, N, A, LDA, S, WORK( IE ),
     $                         WORK( ITAUQ ), WORK( ITAUP ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                 Generate right vectors bidiagonalizing A
*                 (Workspace: need 4*M, prefer 3*M+M*NB)
*
                  CALL DORGBR( 'P', M, N, M, A, LDA, WORK( ITAUP ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IWORK = IE + M
*
*                 Perform bidiagonal QR iteration, computing right
*                 singular vectors of A in A
*                 (Workspace: need BDSPAC)
*
                  CALL DBDSQR( 'L', M, N, 0, 0, S, WORK( IE ), A, LDA,
     $                         DUM, 1, DUM, 1, WORK( IWORK ), INFO )
*
```

```
               END IF
*
            ELSE IF( WNTVO .AND. WNTUAS ) THEN
*
*              Path 3t(N much larger than M, JOBU='S' or 'A', JOBVT='O')
*              M right singular vectors to be overwritten on A and
*              M left singular vectors to be computed in U
*
               IF( LWORK.GE.M*M+MAX( 4*M, BDSPAC ) ) THEN
*
*                 Sufficient workspace for a fast algorithm
*
                  IR = 1
                  IF( LWORK.GE.MAX( WRKBL, LDA*N+M )+LDA*M ) THEN
*
*                    WORK(IU) is LDA by N and WORK(IR) is LDA by M
*
                     LDWRKU = LDA
                     CHUNK = N
                     LDWRKR = LDA
                  ELSE IF( LWORK.GE.MAX( WRKBL, LDA*N+M )+M*M ) THEN
*
*                    WORK(IU) is LDA by N and WORK(IR) is M by M
*
                     LDWRKU = LDA
                     CHUNK = N
                     LDWRKR = M
                  ELSE
*
*                    WORK(IU) is M by CHUNK and WORK(IR) is M by M
*
                     LDWRKU = M
                     CHUNK = ( LWORK-M*M-M ) / M
                     LDWRKR = M
                  END IF
                  ITAU = IR + LDWRKR*M
                  IWORK = ITAU + M
*
*                 Compute A=L*Q
*                 (Workspace: need M*M+2*M, prefer M*M+M+M*NB)
*
                  CALL DGELQF( M, N, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                 Copy L to U, zeroing about above it
*
                  CALL DLACPY( 'L', M, M, A, LDA, U, LDU )
                  CALL DLASET( 'U', M-1, M-1, ZERO, ZERO, U( 1, 2 ),
     $                         LDU )
*
```

```
*                 Generate Q in A
*                 (Workspace: need M*M+2*M, prefer M*M+M+M*NB)
*
                  CALL DORGLQ( M, N, M, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IE = ITAU
                  ITAUQ = IE + M
                  ITAUP = ITAUQ + M
                  IWORK = ITAUP + M
*
*                 Bidiagonalize L in U, copying result to WORK(IR)
*                 (Workspace: need M*M+4*M, prefer M*M+3*M+2*M*NB)
*
                  CALL DGEBRD( M, M, U, LDU, S, WORK( IE ),
     $                         WORK( ITAUQ ), WORK( ITAUP ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  CALL DLACPY( 'U', M, M, U, LDU, WORK( IR ), LDWRKR )
*
*                 Generate right vectors bidiagonalizing L in WORK(IR)
*                 (Workspace: need M*M+4*M-1, prefer M*M+3*M+(M-1)*NB)
*
                  CALL DORGBR( 'P', M, M, M, WORK( IR ), LDWRKR,
     $                         WORK( ITAUP ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
*
*                 Generate left vectors bidiagonalizing L in U
*                 (Workspace: need M*M+4*M, prefer M*M+3*M+M*NB)
*
                  CALL DORGBR( 'Q', M, M, M, U, LDU, WORK( ITAUQ ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IWORK = IE + M
*
*                 Perform bidiagonal QR iteration, computing left
*                 singular vectors of L in U, and computing right
*                 singular vectors of L in WORK(IR)
*                 (Workspace: need M*M+BDSPAC)
*
                  CALL DBDSQR( 'U', M, M, M, 0, S, WORK( IE ),
     $                         WORK( IR ), LDWRKR, U, LDU, DUM, 1,
     $                         WORK( IWORK ), INFO )
                  IU = IE + M
*
*                 Multiply right singular vectors of L in WORK(IR) by Q
*                 in A, storing result in WORK(IU) and copying to A
*                 (Workspace: need M*M+2*M, prefer M*M+M*N+M))
*
                  DO 40 I = 1, N, CHUNK
                     BLK = MIN( N-I+1, CHUNK )
                     CALL DGEMM( 'N', 'N', M, BLK, M, ONE, WORK( IR ),
     $                           LDWRKR, A( 1, I ), LDA, ZERO,
```

```
     $                        WORK( IU ), LDWRKU )
                     CALL DLACPY( 'F', M, BLK, WORK( IU ), LDWRKU,
     $                         A( 1, I ), LDA )
   40             CONTINUE
*
              ELSE
*
*                Insufficient workspace for a fast algorithm
*
                 ITAU = 1
                 IWORK = ITAU + M
*
*                Compute A=L*Q
*                (Workspace: need 2*M, prefer M+M*NB)
*
                 CALL DGELQF( M, N, A, LDA, WORK( ITAU ),
     $                        WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                Copy L to U, zeroing out above it
*
                 CALL DLACPY( 'L', M, M, A, LDA, U, LDU )
                 CALL DLASET( 'U', M-1, M-1, ZERO, ZERO, U( 1, 2 ),
     $                        LDU )
*
*                Generate Q in A
*                (Workspace: need 2*M, prefer M+M*NB)
*
                 CALL DORGLQ( M, N, M, A, LDA, WORK( ITAU ),
     $                        WORK( IWORK ), LWORK-IWORK+1, IERR )
                 IE = ITAU
                 ITAUQ = IE + M
                 ITAUP = ITAUQ + M
                 IWORK = ITAUP + M
*
*                Bidiagonalize L in U
*                (Workspace: need 4*M, prefer 3*M+2*M*NB)
*
                 CALL DGEBRD( M, M, U, LDU, S, WORK( IE ),
     $                        WORK( ITAUQ ), WORK( ITAUP ),
     $                        WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                Multiply right vectors bidiagonalizing L by Q in A
*                (Workspace: need 3*M+N, prefer 3*M+N*NB)
*
                 CALL DORMBR( 'P', 'L', 'T', M, N, M, U, LDU,
     $                        WORK( ITAUP ), A, LDA, WORK( IWORK ),
     $                        LWORK-IWORK+1, IERR )
*
*                Generate left vectors bidiagonalizing L in U
*                (Workspace: need 4*M, prefer 3*M+M*NB)
```

```
*
                  CALL DORGBR( 'Q', M, M, M, U, LDU, WORK( ITAUQ ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IWORK = IE + M
*
*                 Perform bidiagonal QR iteration, computing left
*                 singular vectors of A in U and computing right
*                 singular vectors of A in A
*                 (Workspace: need BDSPAC)
*
                  CALL DBDSQR( 'U', M, N, M, 0, S, WORK( IE ), A, LDA,
     $                         U, LDU, DUM, 1, WORK( IWORK ), INFO )
*
               END IF
*
            ELSE IF( WNTVS ) THEN
*
               IF( WNTUN ) THEN
*
*                 Path 4t(N much larger than M, JOBU='N', JOBVT='S')
*                 M right singular vectors to be computed in VT and
*                 no left singular vectors to be computed
*
                  IF( LWORK.GE.M*M+MAX( 4*M, BDSPAC ) ) THEN
*
*                    Sufficient workspace for a fast algorithm
*
                     IR = 1
                     IF( LWORK.GE.WRKBL+LDA*M ) THEN
*
*                       WORK(IR) is LDA by M
*
                        LDWRKR = LDA
                     ELSE
*
*                       WORK(IR) is M by M
*
                        LDWRKR = M
                     END IF
                     ITAU = IR + LDWRKR*M
                     IWORK = ITAU + M
*
*                    Compute A=L*Q
*                    (Workspace: need M*M+2*M, prefer M*M+M+M*NB)
*
                     CALL DGELQF( M, N, A, LDA, WORK( ITAU ),
     $                            WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                    Copy L to WORK(IR), zeroing out above it
*
```

```
                  CALL DLACPY( 'L', M, M, A, LDA, WORK( IR ),
     $                         LDWRKR )
                  CALL DLASET( 'U', M-1, M-1, ZERO, ZERO,
     $                         WORK( IR+LDWRKR ), LDWRKR )
*
*                 Generate Q in A
*                 (Workspace: need M*M+2*M, prefer M*M+M+M*NB)
*
                  CALL DORGLQ( M, N, M, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IE = ITAU
                  ITAUQ = IE + M
                  ITAUP = ITAUQ + M
                  IWORK = ITAUP + M
*
*                 Bidiagonalize L in WORK(IR)
*                 (Workspace: need M*M+4*M, prefer M*M+3*M+2*M*NB)
*
                  CALL DGEBRD( M, M, WORK( IR ), LDWRKR, S,
     $                         WORK( IE ), WORK( ITAUQ ),
     $                         WORK( ITAUP ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
*
*                 Generate right vectors bidiagonalizing L in
*                 WORK(IR)
*                 (Workspace: need M*M+4*M, prefer M*M+3*M+(M-1)*NB)
*
                  CALL DORGBR( 'P', M, M, M, WORK( IR ), LDWRKR,
     $                         WORK( ITAUP ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
                  IWORK = IE + M
*
*                 Perform bidiagonal QR iteration, computing right
*                 singular vectors of L in WORK(IR)
*                 (Workspace: need M*M+BDSPAC)
*
                  CALL DBDSQR( 'U', M, M, 0, 0, S, WORK( IE ),
     $                         WORK( IR ), LDWRKR, DUM, 1, DUM, 1,
     $                         WORK( IWORK ), INFO )
*
*                 Multiply right singular vectors of L in WORK(IR) by
*                 Q in A, storing result in VT
*                 (Workspace: need M*M)
*
                  CALL DGEMM( 'N', 'N', M, N, M, ONE, WORK( IR ),
     $                        LDWRKR, A, LDA, ZERO, VT, LDVT )
*
               ELSE
*
*                 Insufficient workspace for a fast algorithm
```

```
*
                  ITAU = 1
                  IWORK = ITAU + M
*
*                 Compute A=L*Q
*                 (Workspace: need 2*M, prefer M+M*NB)
*
                  CALL DGELQF( M, N, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                 Copy result to VT
*
                  CALL DLACPY( 'U', M, N, A, LDA, VT, LDVT )
*
*                 Generate Q in VT
*                 (Workspace: need 2*M, prefer M+M*NB)
*
                  CALL DORGLQ( M, N, M, VT, LDVT, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IE = ITAU
                  ITAUQ = IE + M
                  ITAUP = ITAUQ + M
                  IWORK = ITAUP + M
*
*                 Zero out above L in A
*
                  CALL DLASET( 'U', M-1, M-1, ZERO, ZERO, A( 1, 2 ),
     $                         LDA )
*
*                 Bidiagonalize L in A
*                 (Workspace: need 4*M, prefer 3*M+2*M*NB)
*
                  CALL DGEBRD( M, M, A, LDA, S, WORK( IE ),
     $                         WORK( ITAUQ ), WORK( ITAUP ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                 Multiply right vectors bidiagonalizing L by Q in VT
*                 (Workspace: need 3*M+N, prefer 3*M+N*NB)
*
                  CALL DORMBR( 'P', 'L', 'T', M, N, M, A, LDA,
     $                         WORK( ITAUP ), VT, LDVT,
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IWORK = IE + M
*
*                 Perform bidiagonal QR iteration, computing right
*                 singular vectors of A in VT
*                 (Workspace: need BDSPAC)
*
                  CALL DBDSQR( 'U', M, N, 0, 0, S, WORK( IE ), VT,
     $                         LDVT, DUM, 1, DUM, 1, WORK( IWORK ),
```

```
     $                          INFO )
*
                  END IF
*
               ELSE IF( WNTUO ) THEN
*
*                 Path 5t(N much larger than M, JOBU='O', JOBVT='S')
*                 M right singular vectors to be computed in VT and
*                 M left singular vectors to be overwritten on A
*
                  IF( LWORK.GE.2*M*M+MAX( 4*M, BDSPAC ) ) THEN
*
*                    Sufficient workspace for a fast algorithm
*
                     IU = 1
                     IF( LWORK.GE.WRKBL+2*LDA*M ) THEN
*
*                       WORK(IU) is LDA by M and WORK(IR) is LDA by M
*
                        LDWRKU = LDA
                        IR = IU + LDWRKU*M
                        LDWRKR = LDA
                     ELSE IF( LWORK.GE.WRKBL+( LDA+M )*M ) THEN
*
*                       WORK(IU) is LDA by M and WORK(IR) is M by M
*
                        LDWRKU = LDA
                        IR = IU + LDWRKU*M
                        LDWRKR = M
                     ELSE
*
*                       WORK(IU) is M by M and WORK(IR) is M by M
*
                        LDWRKU = M
                        IR = IU + LDWRKU*M
                        LDWRKR = M
                     END IF
                     ITAU = IR + LDWRKR*M
                     IWORK = ITAU + M
*
*                    Compute A=L*Q
*                    (Workspace: need 2*M*M+2*M, prefer 2*M*M+M+M*NB)
*
                     CALL DGELQF( M, N, A, LDA, WORK( ITAU ),
     $                            WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                    Copy L to WORK(IU), zeroing out below it
*
                     CALL DLACPY( 'L', M, M, A, LDA, WORK( IU ),
     $                            LDWRKU )
```

```
                  CALL DLASET( 'U', M-1, M-1, ZERO, ZERO,
     $                         WORK( IU+LDWRKU ), LDWRKU )
*
*                 Generate Q in A
*                 (Workspace: need 2*M*M+2*M, prefer 2*M*M+M+M*NB)
*
                  CALL DORGLQ( M, N, M, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IE = ITAU
                  ITAUQ = IE + M
                  ITAUP = ITAUQ + M
                  IWORK = ITAUP + M
*
*                 Bidiagonalize L in WORK(IU), copying result to
*                 WORK(IR)
*                 (Workspace: need 2*M*M+4*M,
*                            prefer 2*M*M+3*M+2*M*NB)
*
                  CALL DGEBRD( M, M, WORK( IU ), LDWRKU, S,
     $                         WORK( IE ), WORK( ITAUQ ),
     $                         WORK( ITAUP ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
                  CALL DLACPY( 'L', M, M, WORK( IU ), LDWRKU,
     $                         WORK( IR ), LDWRKR )
*
*                 Generate right bidiagonalizing vectors in WORK(IU)
*                 (Workspace: need 2*M*M+4*M-1,
*                            prefer 2*M*M+3*M+(M-1)*NB)
*
                  CALL DORGBR( 'P', M, M, M, WORK( IU ), LDWRKU,
     $                         WORK( ITAUP ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
*
*                 Generate left bidiagonalizing vectors in WORK(IR)
*                 (Workspace: need 2*M*M+4*M, prefer 2*M*M+3*M+M*NB)
*
                  CALL DORGBR( 'Q', M, M, M, WORK( IR ), LDWRKR,
     $                         WORK( ITAUQ ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
                  IWORK = IE + M
*
*                 Perform bidiagonal QR iteration, computing left
*                 singular vectors of L in WORK(IR) and computing
*                 right singular vectors of L in WORK(IU)
*                 (Workspace: need 2*M*M+BDSPAC)
*
                  CALL DBDSQR( 'U', M, M, M, 0, S, WORK( IE ),
     $                         WORK( IU ), LDWRKU, WORK( IR ),
     $                         LDWRKR, DUM, 1, WORK( IWORK ), INFO )
*
```

```
*                    Multiply right singular vectors of L in WORK(IU) by
*                    Q in A, storing result in VT
*                    (Workspace: need M*M)
*
                     CALL DGEMM( 'N', 'N', M, N, M, ONE, WORK( IU ),
     $                            LDWRKU, A, LDA, ZERO, VT, LDVT )
*
*                    Copy left singular vectors of L to A
*                    (Workspace: need M*M)
*
                     CALL DLACPY( 'F', M, M, WORK( IR ), LDWRKR, A,
     $                            LDA )
*
                  ELSE
*
*                    Insufficient workspace for a fast algorithm
*
                     ITAU = 1
                     IWORK = ITAU + M
*
*                    Compute A=L*Q, copying result to VT
*                    (Workspace: need 2*M, prefer M+M*NB)
*
                     CALL DGELQF( M, N, A, LDA, WORK( ITAU ),
     $                            WORK( IWORK ), LWORK-IWORK+1, IERR )
                     CALL DLACPY( 'U', M, N, A, LDA, VT, LDVT )
*
*                    Generate Q in VT
*                    (Workspace: need 2*M, prefer M+M*NB)
*
                     CALL DORGLQ( M, N, M, VT, LDVT, WORK( ITAU ),
     $                            WORK( IWORK ), LWORK-IWORK+1, IERR )
                     IE = ITAU
                     ITAUQ = IE + M
                     ITAUP = ITAUQ + M
                     IWORK = ITAUP + M
*
*                    Zero out above L in A
*
                     CALL DLASET( 'U', M-1, M-1, ZERO, ZERO, A( 1, 2 ),
     $                            LDA )
*
*                    Bidiagonalize L in A
*                    (Workspace: need 4*M, prefer 3*M+2*M*NB)
*
                     CALL DGEBRD( M, M, A, LDA, S, WORK( IE ),
     $                            WORK( ITAUQ ), WORK( ITAUP ),
     $                            WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                    Multiply right vectors bidiagonalizing L by Q in VT
```

```
*                    (Workspace: need 3*M+N, prefer 3*M+N*NB)
*
                     CALL DORMBR( 'P', 'L', 'T', M, N, M, A, LDA,
     $                             WORK( ITAUP ), VT, LDVT,
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                    Generate left bidiagonalizing vectors of L in A
*                    (Workspace: need 4*M, prefer 3*M+M*NB)
*
                     CALL DORGBR( 'Q', M, M, M, A, LDA, WORK( ITAUQ ),
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
                     IWORK = IE + M
*
*                    Perform bidiagonal QR iteration, compute left
*                    singular vectors of A in A and compute right
*                    singular vectors of A in VT
*                    (Workspace: need BDSPAC)
*
                     CALL DBDSQR( 'U', M, N, M, 0, S, WORK( IE ), VT,
     $                             LDVT, A, LDA, DUM, 1, WORK( IWORK ),
     $                             INFO )
*
                  END IF
*
               ELSE IF( WNTUAS ) THEN
*
*                  Path 6t(N much larger than M, JOBU='S' or 'A',
*                          JOBVT='S')
*                  M right singular vectors to be computed in VT and
*                  M left singular vectors to be computed in U
*
                  IF( LWORK.GE.M*M+MAX( 4*M, BDSPAC ) ) THEN
*
*                     Sufficient workspace for a fast algorithm
*
                     IU = 1
                     IF( LWORK.GE.WRKBL+LDA*M ) THEN
*
*                        WORK(IU) is LDA by N
*
                        LDWRKU = LDA
                     ELSE
*
*                        WORK(IU) is LDA by M
*
                        LDWRKU = M
                     END IF
                     ITAU = IU + LDWRKU*M
                     IWORK = ITAU + M
*
```

```
*                    Compute A=L*Q
*                    (Workspace: need M*M+2*M, prefer M*M+M+M*NB)
*
                     CALL DGELQF( M, N, A, LDA, WORK( ITAU ),
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                    Copy L to WORK(IU), zeroing out above it
*
                     CALL DLACPY( 'L', M, M, A, LDA, WORK( IU ),
     $                             LDWRKU )
                     CALL DLASET( 'U', M-1, M-1, ZERO, ZERO,
     $                             WORK( IU+LDWRKU ), LDWRKU )
*
*                    Generate Q in A
*                    (Workspace: need M*M+2*M, prefer M*M+M+M*NB)
*
                     CALL DORGLQ( M, N, M, A, LDA, WORK( ITAU ),
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
                     IE = ITAU
                     ITAUQ = IE + M
                     ITAUP = ITAUQ + M
                     IWORK = ITAUP + M
*
*                    Bidiagonalize L in WORK(IU), copying result to U
*                    (Workspace: need M*M+4*M, prefer M*M+3*M+2*M*NB)
*
                     CALL DGEBRD( M, M, WORK( IU ), LDWRKU, S,
     $                             WORK( IE ), WORK( ITAUQ ),
     $                             WORK( ITAUP ), WORK( IWORK ),
     $                             LWORK-IWORK+1, IERR )
                     CALL DLACPY( 'L', M, M, WORK( IU ), LDWRKU, U,
     $                             LDU )
*
*                    Generate right bidiagonalizing vectors in WORK(IU)
*                    (Workspace: need M*M+4*M-1,
*                                prefer M*M+3*M+(M-1)*NB)
*
                     CALL DORGBR( 'P', M, M, M, WORK( IU ), LDWRKU,
     $                             WORK( ITAUP ), WORK( IWORK ),
     $                             LWORK-IWORK+1, IERR )
*
*                    Generate left bidiagonalizing vectors in U
*                    (Workspace: need M*M+4*M, prefer M*M+3*M+M*NB)
*
                     CALL DORGBR( 'Q', M, M, M, U, LDU, WORK( ITAUQ ),
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
                     IWORK = IE + M
*
*                    Perform bidiagonal QR iteration, computing left
*                    singular vectors of L in U and computing right
```

```
*                    singular vectors of L in WORK(IU)
*                    (Workspace: need M*M+BDSPAC)
*
                     CALL DBDSQR( 'U', M, M, M, 0, S, WORK( IE ),
     $                             WORK( IU ), LDWRKU, U, LDU, DUM, 1,
     $                             WORK( IWORK ), INFO )
*
*                    Multiply right singular vectors of L in WORK(IU) by
*                    Q in A, storing result in VT
*                    (Workspace: need M*M)
*
                     CALL DGEMM( 'N', 'N', M, N, M, ONE, WORK( IU ),
     $                           LDWRKU, A, LDA, ZERO, VT, LDVT )
*
                  ELSE
*
*                    Insufficient workspace for a fast algorithm
*
                     ITAU = 1
                     IWORK = ITAU + M
*
*                    Compute A=L*Q, copying result to VT
*                    (Workspace: need 2*M, prefer M+M*NB)
*
                     CALL DGELQF( M, N, A, LDA, WORK( ITAU ),
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
                     CALL DLACPY( 'U', M, N, A, LDA, VT, LDVT )
*
*                    Generate Q in VT
*                    (Workspace: need 2*M, prefer M+M*NB)
*
                     CALL DORGLQ( M, N, M, VT, LDVT, WORK( ITAU ),
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                    Copy L to U, zeroing out above it
*
                     CALL DLACPY( 'L', M, M, A, LDA, U, LDU )
                     CALL DLASET( 'U', M-1, M-1, ZERO, ZERO, U( 1, 2 ),
     $                             LDU )
                     IE = ITAU
                     ITAUQ = IE + M
                     ITAUP = ITAUQ + M
                     IWORK = ITAUP + M
*
*                    Bidiagonalize L in U
*                    (Workspace: need 4*M, prefer 3*M+2*M*NB)
*
                     CALL DGEBRD( M, M, U, LDU, S, WORK( IE ),
     $                             WORK( ITAUQ ), WORK( ITAUP ),
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
```

```
*
*                    Multiply right bidiagonalizing vectors in U by Q
*                    in VT
*                    (Workspace: need 3*M+N, prefer 3*M+N*NB)
*
                     CALL DORMBR( 'P', 'L', 'T', M, N, M, U, LDU,
     $                             WORK( ITAUP ), VT, LDVT,
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                    Generate left bidiagonalizing vectors in U
*                    (Workspace: need 4*M, prefer 3*M+M*NB)
*
                     CALL DORGBR( 'Q', M, M, M, U, LDU, WORK( ITAUQ ),
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
                     IWORK = IE + M
*
*                    Perform bidiagonal QR iteration, computing left
*                    singular vectors of A in U and computing right
*                    singular vectors of A in VT
*                    (Workspace: need BDSPAC)
*
                     CALL DBDSQR( 'U', M, N, M, 0, S, WORK( IE ), VT,
     $                             LDVT, U, LDU, DUM, 1, WORK( IWORK ),
     $                             INFO )
*
                  END IF
*
               END IF
*
            ELSE IF( WNTVA ) THEN
*
               IF( WNTUN ) THEN
*
*                 Path 7t(N much larger than M, JOBU='N', JOBVT='A')
*                 N right singular vectors to be computed in VT and
*                 no left singular vectors to be computed
*
                  IF( LWORK.GE.M*M+MAX( N+M, 4*M, BDSPAC ) ) THEN
*
*                    Sufficient workspace for a fast algorithm
*
                     IR = 1
                     IF( LWORK.GE.WRKBL+LDA*M ) THEN
*
*                       WORK(IR) is LDA by M
*
                        LDWRKR = LDA
                     ELSE
*
*                       WORK(IR) is M by M
```

```
*
                     LDWRKR = M
                  END IF
                  ITAU = IR + LDWRKR*M
                  IWORK = ITAU + M
*
*                 Compute A=L*Q, copying result to VT
*                 (Workspace: need M*M+2*M, prefer M*M+M+M*NB)
*
                  CALL DGELQF( M, N, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  CALL DLACPY( 'U', M, N, A, LDA, VT, LDVT )
*
*                 Copy L to WORK(IR), zeroing out above it
*
                  CALL DLACPY( 'L', M, M, A, LDA, WORK( IR ),
     $                         LDWRKR )
                  CALL DLASET( 'U', M-1, M-1, ZERO, ZERO,
     $                         WORK( IR+LDWRKR ), LDWRKR )
*
*                 Generate Q in VT
*                 (Workspace: need M*M+M+N, prefer M*M+M+N*NB)
*
                  CALL DORGLQ( N, N, M, VT, LDVT, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IE = ITAU
                  ITAUQ = IE + M
                  ITAUP = ITAUQ + M
                  IWORK = ITAUP + M
*
*                 Bidiagonalize L in WORK(IR)
*                 (Workspace: need M*M+4*M, prefer M*M+3*M+2*M*NB)
*
                  CALL DGEBRD( M, M, WORK( IR ), LDWRKR, S,
     $                         WORK( IE ), WORK( ITAUQ ),
     $                         WORK( ITAUP ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
*
*                 Generate right bidiagonalizing vectors in WORK(IR)
*                 (Workspace: need M*M+4*M-1,
*                             prefer M*M+3*M+(M-1)*NB)
*
                  CALL DORGBR( 'P', M, M, M, WORK( IR ), LDWRKR,
     $                         WORK( ITAUP ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
                  IWORK = IE + M
*
*                 Perform bidiagonal QR iteration, computing right
*                 singular vectors of L in WORK(IR)
*                 (Workspace: need M*M+BDSPAC)
```

```
*
                  CALL DBDSQR( 'U', M, M, 0, 0, S, WORK( IE ),
     $                         WORK( IR ), LDWRKR, DUM, 1, DUM, 1,
     $                         WORK( IWORK ), INFO )
*
*                 Multiply right singular vectors of L in WORK(IR) by
*                 Q in VT, storing result in A
*                 (Workspace: need M*M)
*
                  CALL DGEMM( 'N', 'N', M, N, M, ONE, WORK( IR ),
     $                        LDWRKR, VT, LDVT, ZERO, A, LDA )
*
*                 Copy right singular vectors of A from A to VT
*
                  CALL DLACPY( 'F', M, N, A, LDA, VT, LDVT )
*
               ELSE
*
*                 Insufficient workspace for a fast algorithm
*
                  ITAU = 1
                  IWORK = ITAU + M
*
*                 Compute A=L*Q, copying result to VT
*                 (Workspace: need 2*M, prefer M+M*NB)
*
                  CALL DGELQF( M, N, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  CALL DLACPY( 'U', M, N, A, LDA, VT, LDVT )
*
*                 Generate Q in VT
*                 (Workspace: need M+N, prefer M+N*NB)
*
                  CALL DORGLQ( N, N, M, VT, LDVT, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IE = ITAU
                  ITAUQ = IE + M
                  ITAUP = ITAUQ + M
                  IWORK = ITAUP + M
*
*                 Zero out above L in A
*
                  CALL DLASET( 'U', M-1, M-1, ZERO, ZERO, A( 1, 2 ),
     $                         LDA )
*
*                 Bidiagonalize L in A
*                 (Workspace: need 4*M, prefer 3*M+2*M*NB)
*
                  CALL DGEBRD( M, M, A, LDA, S, WORK( IE ),
     $                         WORK( ITAUQ ), WORK( ITAUP ),
```

```
     $                           WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                    Multiply right bidiagonalizing vectors in A by Q
*                    in VT
*                    (Workspace: need 3*M+N, prefer 3*M+N*NB)
*
                     CALL DORMBR( 'P', 'L', 'T', M, N, M, A, LDA,
     $                           WORK( ITAUP ), VT, LDVT,
     $                           WORK( IWORK ), LWORK-IWORK+1, IERR )
                     IWORK = IE + M
*
*                    Perform bidiagonal QR iteration, computing right
*                    singular vectors of A in VT
*                    (Workspace: need BDSPAC)
*
                     CALL DBDSQR( 'U', M, N, 0, 0, S, WORK( IE ), VT,
     $                           LDVT, DUM, 1, DUM, 1, WORK( IWORK ),
     $                           INFO )
*
                  END IF
*
               ELSE IF( WNTUO ) THEN
*
*                  Path 8t(N much larger than M, JOBU='O', JOBVT='A')
*                  N right singular vectors to be computed in VT and
*                  M left singular vectors to be overwritten on A
*
                  IF( LWORK.GE.2*M*M+MAX( N+M, 4*M, BDSPAC ) ) THEN
*
*                     Sufficient workspace for a fast algorithm
*
                     IU = 1
                     IF( LWORK.GE.WRKBL+2*LDA*M ) THEN
*
*                        WORK(IU) is LDA by M and WORK(IR) is LDA by M
*
                        LDWRKU = LDA
                        IR = IU + LDWRKU*M
                        LDWRKR = LDA
                     ELSE IF( LWORK.GE.WRKBL+( LDA+M )*M ) THEN
*
*                        WORK(IU) is LDA by M and WORK(IR) is M by M
*
                        LDWRKU = LDA
                        IR = IU + LDWRKU*M
                        LDWRKR = M
                     ELSE
*
*                        WORK(IU) is M by M and WORK(IR) is M by M
*
```

```
                     LDWRKU = M
                     IR = IU + LDWRKU*M
                     LDWRKR = M
                  END IF
                  ITAU = IR + LDWRKR*M
                  IWORK = ITAU + M
*
*                 Compute A=L*Q, copying result to VT
*                 (Workspace: need 2*M*M+2*M, prefer 2*M*M+M+M*NB)
*
                  CALL DGELQF( M, N, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  CALL DLACPY( 'U', M, N, A, LDA, VT, LDVT )
*
*                 Generate Q in VT
*                 (Workspace: need 2*M*M+M+N, prefer 2*M*M+M+N*NB)
*
                  CALL DORGLQ( N, N, M, VT, LDVT, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                 Copy L to WORK(IU), zeroing out above it
*
                  CALL DLACPY( 'L', M, M, A, LDA, WORK( IU ),
     $                         LDWRKU )
                  CALL DLASET( 'U', M-1, M-1, ZERO, ZERO,
     $                         WORK( IU+LDWRKU ), LDWRKU )
                  IE = ITAU
                  ITAUQ = IE + M
                  ITAUP = ITAUQ + M
                  IWORK = ITAUP + M
*
*                 Bidiagonalize L in WORK(IU), copying result to
*                 WORK(IR)
*                 (Workspace: need 2*M*M+4*M,
*                             prefer 2*M*M+3*M+2*M*NB)
*
                  CALL DGEBRD( M, M, WORK( IU ), LDWRKU, S,
     $                         WORK( IE ), WORK( ITAUQ ),
     $                         WORK( ITAUP ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
                  CALL DLACPY( 'L', M, M, WORK( IU ), LDWRKU,
     $                         WORK( IR ), LDWRKR )
*
*                 Generate right bidiagonalizing vectors in WORK(IU)
*                 (Workspace: need 2*M*M+4*M-1,
*                             prefer 2*M*M+3*M+(M-1)*NB)
*
                  CALL DORGBR( 'P', M, M, M, WORK( IU ), LDWRKU,
     $                         WORK( ITAUP ), WORK( IWORK ),
     $                         LWORK-IWORK+1, IERR )
```

```
*
*                    Generate left bidiagonalizing vectors in WORK(IR)
*                    (Workspace: need 2*M*M+4*M, prefer 2*M*M+3*M+M*NB)
*
                     CALL DORGBR( 'Q', M, M, M, WORK( IR ), LDWRKR,
     $                             WORK( ITAUQ ), WORK( IWORK ),
     $                             LWORK-IWORK+1, IERR )
                     IWORK = IE + M
*
*                    Perform bidiagonal QR iteration, computing left
*                    singular vectors of L in WORK(IR) and computing
*                    right singular vectors of L in WORK(IU)
*                    (Workspace: need 2*M*M+BDSPAC)
*
                     CALL DBDSQR( 'U', M, M, M, 0, S, WORK( IE ),
     $                             WORK( IU ), LDWRKU, WORK( IR ),
     $                             LDWRKR, DUM, 1, WORK( IWORK ), INFO )
*
*                    Multiply right singular vectors of L in WORK(IU) by
*                    Q in VT, storing result in A
*                    (Workspace: need M*M)
*
                     CALL DGEMM( 'N', 'N', M, N, M, ONE, WORK( IU ),
     $                           LDWRKU, VT, LDVT, ZERO, A, LDA )
*
*                    Copy right singular vectors of A from A to VT
*
                     CALL DLACPY( 'F', M, N, A, LDA, VT, LDVT )
*
*                    Copy left singular vectors of A from WORK(IR) to A
*
                     CALL DLACPY( 'F', M, M, WORK( IR ), LDWRKR, A,
     $                             LDA )
*
                  ELSE
*
*                    Insufficient workspace for a fast algorithm
*
                     ITAU = 1
                     IWORK = ITAU + M
*
*                    Compute A=L*Q, copying result to VT
*                    (Workspace: need 2*M, prefer M+M*NB)
*
                     CALL DGELQF( M, N, A, LDA, WORK( ITAU ),
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
                     CALL DLACPY( 'U', M, N, A, LDA, VT, LDVT )
*
*                    Generate Q in VT
*                    (Workspace: need M+N, prefer M+N*NB)
```

```
*
                     CALL DORGLQ( N, N, M, VT, LDVT, WORK( ITAU ),
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
                     IE = ITAU
                     ITAUQ = IE + M
                     ITAUP = ITAUQ + M
                     IWORK = ITAUP + M
*
*                    Zero out above L in A
*
                     CALL DLASET( 'U', M-1, M-1, ZERO, ZERO, A( 1, 2 ),
     $                             LDA )
*
*                    Bidiagonalize L in A
*                    (Workspace: need 4*M, prefer 3*M+2*M*NB)
*
                     CALL DGEBRD( M, M, A, LDA, S, WORK( IE ),
     $                             WORK( ITAUQ ), WORK( ITAUP ),
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                    Multiply right bidiagonalizing vectors in A by Q
*                    in VT
*                    (Workspace: need 3*M+N, prefer 3*M+N*NB)
*
                     CALL DORMBR( 'P', 'L', 'T', M, N, M, A, LDA,
     $                             WORK( ITAUP ), VT, LDVT,
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                    Generate left bidiagonalizing vectors in A
*                    (Workspace: need 4*M, prefer 3*M+M*NB)
*
                     CALL DORGBR( 'Q', M, M, M, A, LDA, WORK( ITAUQ ),
     $                             WORK( IWORK ), LWORK-IWORK+1, IERR )
                     IWORK = IE + M
*
*                    Perform bidiagonal QR iteration, computing left
*                    singular vectors of A in A and computing right
*                    singular vectors of A in VT
*                    (Workspace: need BDSPAC)
*
                     CALL DBDSQR( 'U', M, N, M, 0, S, WORK( IE ), VT,
     $                             LDVT, A, LDA, DUM, 1, WORK( IWORK ),
     $                             INFO )
*
                  END IF
*
               ELSE IF( WNTUAS ) THEN
*
*                  Path 9t(N much larger than M, JOBU='S' or 'A',
*                          JOBVT='A')
```

```
*                 N right singular vectors to be computed in VT and
*                 M left singular vectors to be computed in U
*
                  IF( LWORK.GE.M*M+MAX( N+M, 4*M, BDSPAC ) ) THEN
*
*                    Sufficient workspace for a fast algorithm
*
                     IU = 1
                     IF( LWORK.GE.WRKBL+LDA*M ) THEN
*
*                       WORK(IU) is LDA by M
*
                        LDWRKU = LDA
                     ELSE
*
*                       WORK(IU) is M by M
*
                        LDWRKU = M
                     END IF
                     ITAU = IU + LDWRKU*M
                     IWORK = ITAU + M
*
*                    Compute A=L*Q, copying result to VT
*                    (Workspace: need M*M+2*M, prefer M*M+M+M*NB)
*
                     CALL DGELQF( M, N, A, LDA, WORK( ITAU ),
     $                           WORK( IWORK ), LWORK-IWORK+1, IERR )
                     CALL DLACPY( 'U', M, N, A, LDA, VT, LDVT )
*
*                    Generate Q in VT
*                    (Workspace: need M*M+M+N, prefer M*M+M+N*NB)
*
                     CALL DORGLQ( N, N, M, VT, LDVT, WORK( ITAU ),
     $                           WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                    Copy L to WORK(IU), zeroing out above it
*
                     CALL DLACPY( 'L', M, M, A, LDA, WORK( IU ),
     $                           LDWRKU )
                     CALL DLASET( 'U', M-1, M-1, ZERO, ZERO,
     $                           WORK( IU+LDWRKU ), LDWRKU )
                     IE = ITAU
                     ITAUQ = IE + M
                     ITAUP = ITAUQ + M
                     IWORK = ITAUP + M
*
*                    Bidiagonalize L in WORK(IU), copying result to U
*                    (Workspace: need M*M+4*M, prefer M*M+3*M+2*M*NB)
*
                     CALL DGEBRD( M, M, WORK( IU ), LDWRKU, S,
```

```
     $                        WORK( IE ), WORK( ITAUQ ),
     $                        WORK( ITAUP ), WORK( IWORK ),
     $                        LWORK-IWORK+1, IERR )
                      CALL DLACPY( 'L', M, M, WORK( IU ), LDWRKU, U,
     $                        LDU )
*
*                     Generate right bidiagonalizing vectors in WORK(IU)
*                     (Workspace: need M*M+4*M, prefer M*M+3*M+(M-1)*NB)
*
                      CALL DORGBR( 'P', M, M, M, WORK( IU ), LDWRKU,
     $                        WORK( ITAUP ), WORK( IWORK ),
     $                        LWORK-IWORK+1, IERR )
*
*                     Generate left bidiagonalizing vectors in U
*                     (Workspace: need M*M+4*M, prefer M*M+3*M+M*NB)
*
                      CALL DORGBR( 'Q', M, M, M, U, LDU, WORK( ITAUQ ),
     $                        WORK( IWORK ), LWORK-IWORK+1, IERR )
                      IWORK = IE + M
*
*                     Perform bidiagonal QR iteration, computing left
*                     singular vectors of L in U and computing right
*                     singular vectors of L in WORK(IU)
*                     (Workspace: need M*M+BDSPAC)
*
                      CALL DBDSQR( 'U', M, M, M, 0, S, WORK( IE ),
     $                        WORK( IU ), LDWRKU, U, LDU, DUM, 1,
     $                        WORK( IWORK ), INFO )
*
*                     Multiply right singular vectors of L in WORK(IU) by
*                     Q in VT, storing result in A
*                     (Workspace: need M*M)
*
                      CALL DGEMM( 'N', 'N', M, N, M, ONE, WORK( IU ),
     $                           LDWRKU, VT, LDVT, ZERO, A, LDA )
*
*                     Copy right singular vectors of A from A to VT
*
                      CALL DLACPY( 'F', M, N, A, LDA, VT, LDVT )
*
                    ELSE
*
*                     Insufficient workspace for a fast algorithm
*
                      ITAU = 1
                      IWORK = ITAU + M
*
*                     Compute A=L*Q, copying result to VT
*                     (Workspace: need 2*M, prefer M+M*NB)
*
```

```
                  CALL DGELQF( M, N, A, LDA, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  CALL DLACPY( 'U', M, N, A, LDA, VT, LDVT )
*
*                 Generate Q in VT
*                 (Workspace: need M+N, prefer M+N*NB)
*
                  CALL DORGLQ( N, N, M, VT, LDVT, WORK( ITAU ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                 Copy L to U, zeroing out above it
*
                  CALL DLACPY( 'L', M, M, A, LDA, U, LDU )
                  CALL DLASET( 'U', M-1, M-1, ZERO, ZERO, U( 1, 2 ),
     $                         LDU )
                  IE = ITAU
                  ITAUQ = IE + M
                  ITAUP = ITAUQ + M
                  IWORK = ITAUP + M
*
*                 Bidiagonalize L in U
*                 (Workspace: need 4*M, prefer 3*M+2*M*NB)
*
                  CALL DGEBRD( M, M, U, LDU, S, WORK( IE ),
     $                         WORK( ITAUQ ), WORK( ITAUP ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                 Multiply right bidiagonalizing vectors in U by Q
*                 in VT
*                 (Workspace: need 3*M+N, prefer 3*M+N*NB)
*
                  CALL DORMBR( 'P', 'L', 'T', M, N, M, U, LDU,
     $                         WORK( ITAUP ), VT, LDVT,
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
*
*                 Generate left bidiagonalizing vectors in U
*                 (Workspace: need 4*M, prefer 3*M+M*NB)
*
                  CALL DORGBR( 'Q', M, M, M, U, LDU, WORK( ITAUQ ),
     $                         WORK( IWORK ), LWORK-IWORK+1, IERR )
                  IWORK = IE + M
*
*                 Perform bidiagonal QR iteration, computing left
*                 singular vectors of A in U and computing right
*                 singular vectors of A in VT
*                 (Workspace: need BDSPAC)
*
                  CALL DBDSQR( 'U', M, N, M, 0, S, WORK( IE ), VT,
     $                         LDVT, U, LDU, DUM, 1, WORK( IWORK ),
     $                         INFO )
```

```
*
                  END IF
*
               END IF
*
            END IF
*
         ELSE
*
*           N .LT. MNTHR
*
*           Path 10t(N greater than M, but not much larger)
*           Reduce to bidiagonal form without LQ decomposition
*
            IE = 1
            ITAUQ = IE + M
            ITAUP = ITAUQ + M
            IWORK = ITAUP + M
*
*           Bidiagonalize A
*           (Workspace: need 3*M+N, prefer 3*M+(M+N)*NB)
*
            CALL DGEBRD( M, N, A, LDA, S, WORK( IE ), WORK( ITAUQ ),
     $                   WORK( ITAUP ), WORK( IWORK ), LWORK-IWORK+1,
     $                   IERR )
            IF( WNTUAS ) THEN
*
*              If left singular vectors desired in U, copy result to U
*              and generate left bidiagonalizing vectors in U
*              (Workspace: need 4*M-1, prefer 3*M+(M-1)*NB)
*
               CALL DLACPY( 'L', M, M, A, LDA, U, LDU )
               CALL DORGBR( 'Q', M, M, N, U, LDU, WORK( ITAUQ ),
     $                      WORK( IWORK ), LWORK-IWORK+1, IERR )
            END IF
            IF( WNTVAS ) THEN
*
*              If right singular vectors desired in VT, copy result to
*              VT and generate right bidiagonalizing vectors in VT
*              (Workspace: need 3*M+NRVT, prefer 3*M+NRVT*NB)
*
               CALL DLACPY( 'U', M, N, A, LDA, VT, LDVT )
               IF( WNTVA )
     $            NRVT = N
               IF( WNTVS )
     $            NRVT = M
               CALL DORGBR( 'P', NRVT, N, M, VT, LDVT, WORK( ITAUP ),
     $                      WORK( IWORK ), LWORK-IWORK+1, IERR )
            END IF
            IF( WNTUO ) THEN
```

```
*
*             If left singular vectors desired in A, generate left
*             bidiagonalizing vectors in A
*             (Workspace: need 4*M-1, prefer 3*M+(M-1)*NB)
*
              CALL DORGBR( 'Q', M, M, N, A, LDA, WORK( ITAUQ ),
     $                     WORK( IWORK ), LWORK-IWORK+1, IERR )
            END IF
            IF( WNTVO ) THEN
*
*             If right singular vectors desired in A, generate right
*             bidiagonalizing vectors in A
*             (Workspace: need 4*M, prefer 3*M+M*NB)
*
              CALL DORGBR( 'P', M, N, M, A, LDA, WORK( ITAUP ),
     $                     WORK( IWORK ), LWORK-IWORK+1, IERR )
            END IF
            IWORK = IE + M
            IF( WNTUAS .OR. WNTUO )
     $         NRU = M
            IF( WNTUN )
     $         NRU = 0
            IF( WNTVAS .OR. WNTVO )
     $         NCVT = N
            IF( WNTVN )
     $         NCVT = 0
            IF( ( .NOT.WNTUO ) .AND. ( .NOT.WNTVO ) ) THEN
*
*             Perform bidiagonal QR iteration, if desired, computing
*             left singular vectors in U and computing right singular
*             vectors in VT
*             (Workspace: need BDSPAC)
*
              CALL DBDSQR( 'L', M, NCVT, NRU, 0, S, WORK( IE ), VT,
     $                     LDVT, U, LDU, DUM, 1, WORK( IWORK ), INFO )
            ELSE IF( ( .NOT.WNTUO ) .AND. WNTVO ) THEN
*
*             Perform bidiagonal QR iteration, if desired, computing
*             left singular vectors in U and computing right singular
*             vectors in A
*             (Workspace: need BDSPAC)
*
              CALL DBDSQR( 'L', M, NCVT, NRU, 0, S, WORK( IE ), A, LDA,
     $                     U, LDU, DUM, 1, WORK( IWORK ), INFO )
            ELSE
*
*             Perform bidiagonal QR iteration, if desired, computing
*             left singular vectors in A and computing right singular
*             vectors in VT
*             (Workspace: need BDSPAC)
```

```
*
               CALL DBDSQR( 'L', M, NCVT, NRU, 0, S, WORK( IE ), VT,
     $                      LDVT, A, LDA, DUM, 1, WORK( IWORK ), INFO )
            END IF
*
         END IF
*
      END IF
*
*     If DBDSQR failed to converge, copy unconverged superdiagonals
*     to WORK( 2:MINMN )
*
      IF( INFO.NE.0 ) THEN
         IF( IE.GT.2 ) THEN
            DO 50 I = 1, MINMN - 1
               WORK( I+1 ) = WORK( I+IE-1 )
   50       CONTINUE
         END IF
         IF( IE.LT.2 ) THEN
            DO 60 I = MINMN - 1, 1, -1
               WORK( I+1 ) = WORK( I+IE-1 )
   60       CONTINUE
         END IF
      END IF
*
*     Undo scaling if necessary
*
      IF( ISCL.EQ.1 ) THEN
         IF( ANRM.GT.BIGNUM )
     $      CALL DLASCL( 'G', 0, 0, BIGNUM, ANRM, MINMN, 1, S, MINMN,
     $                   IERR )
         IF( INFO.NE.0 .AND. ANRM.GT.BIGNUM )
     $      CALL DLASCL( 'G', 0, 0, BIGNUM, ANRM, MINMN-1, 1, WORK( 2 ),
     $                   MINMN, IERR )
         IF( ANRM.LT.SMLNUM )
     $      CALL DLASCL( 'G', 0, 0, SMLNUM, ANRM, MINMN, 1, S, MINMN,
     $                   IERR )
         IF( INFO.NE.0 .AND. ANRM.LT.SMLNUM )
     $      CALL DLASCL( 'G', 0, 0, SMLNUM, ANRM, MINMN-1, 1, WORK( 2 ),
     $                   MINMN, IERR )
      END IF
*
*     Return optimal workspace in WORK(1)
*
      WORK( 1 ) = MAXWRK
*
      RETURN
*
*     End of DGESVD
*
```

```
      END
```

———-

— LAPACK dgesvd —

```
(let* ((zero 0.0) (one 1.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one))
  (defun dgesvd (jobu jobvt m n a lda s u ldu vt ldvt work lwork info)
    (declare (type (simple-array double-float (*)) work vt u s a)
             (type fixnum info lwork ldvt ldu lda n m)
             (type character jobvt jobu))
    (f2cl-lib:with-multi-array-data
        ((jobu character jobu-%data% jobu-%offset%)
         (jobvt character jobvt-%data% jobvt-%offset%)
         (a double-float a-%data% a-%offset%)
         (s double-float s-%data% s-%offset%)
         (u double-float u-%data% u-%offset%)
         (vt double-float vt-%data% vt-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((dum (make-array 1 :element-type 'double-float)) (anrm 0.0)
             (bignum 0.0) (eps 0.0) (smlnum 0.0) (bdspac 0) (blk 0) (chunk 0)
             (i 0) (ie 0) (ierr 0) (ir 0) (iscl 0) (itau 0) (itaup 0) (itauq 0)
             (iu 0) (iwork 0) (ldwrkr 0) (ldwrku 0) (maxwrk 0) (minmn 0)
             (minwrk 0) (mnthr 0) (ncu 0) (ncvt 0) (nru 0) (nrvt 0) (wrkbl 0)
             (lquery nil) (wntua nil) (wntuas nil) (wntun nil) (wntuo nil)
             (wntus nil) (wntva nil) (wntvas nil) (wntvn nil) (wntvo nil)
             (wntvs nil))
        (declare (type (simple-array double-float (1)) dum)
                 (type (double-float) anrm bignum eps smlnum)
                 (type fixnum bdspac blk chunk i ie ierr ir iscl
                                        itau itaup itauq iu iwork ldwrkr
                                        ldwrku maxwrk minmn minwrk mnthr ncu
                                        ncvt nru nrvt wrkbl)
                 (type (member t nil) lquery wntua wntuas wntun wntuo wntus
                                      wntva wntvas wntvn wntvo wntvs))
        (setf info 0)
        (setf minmn (min (the fixnum m) (the fixnum n)))
        (setf mnthr (ilaenv 6 "DGESVD" (f2cl-lib:f2cl-// jobu jobvt) m n 0 0))
        (setf wntua (char-equal jobu #\A))
        (setf wntus (char-equal jobu #\S))
        (setf wntuas (or wntua wntus))
        (setf wntuo (char-equal jobu #\O))
        (setf wntun (char-equal jobu #\N))
        (setf wntva (char-equal jobvt #\A))
        (setf wntvs (char-equal jobvt #\S))
        (setf wntvas (or wntva wntvs))
```

```
(setf wntvo (char-equal jobvt #\O))
(setf wntvn (char-equal jobvt #\N))
(setf minwrk 1)
(setf lquery (coerce (= lwork -1) '(member t nil)))
(cond
  ((not (or wntua wntus wntuo wntun))
   (setf info -1))
  ((or (not (or wntva wntvs wntvo wntvn)) (and wntvo wntuo))
   (setf info -2))
  ((< m 0)
   (setf info -3))
  ((< n 0)
   (setf info -4))
  ((< lda (max (the fixnum 1) (the fixnum m)))
   (setf info -6))
  ((or (< ldu 1) (and wntuas (< ldu m)))
   (setf info -9))
  ((or (< ldvt 1) (and wntva (< ldvt n)) (and wntvs (< ldvt minmn)))
   (setf info -11)))
(cond
  ((and (= info 0) (or (>= lwork 1) lquery) (> m 0) (> n 0))
   (cond
     ((>= m n)
      (setf bdspac (f2cl-lib:int-mul 5 n))
      (cond
        ((>= m mnthr)
         (cond
           (wntun
            (setf maxwrk
                    (f2cl-lib:int-add n
                                      (f2cl-lib:int-mul n
                                                        (ilaenv 1
                                                         "DGEQRF" " " m
                                                         n -1 -1))))
            (setf maxwrk
                    (max (the fixnum maxwrk)
                         (the fixnum
                              (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                                (f2cl-lib:int-mul 2
                                                  n
                                                  (ilaenv
                                                   1
                                                   "DGEBRD"
                                                   " "
                                                   n n
                                                   -1
                                                   -1))))))
            (if (or wntvo wntvas)
                (setf maxwrk
                        (max (the fixnum maxwrk)
```

```
                    (the fixnum
                         (f2cl-lib:int-add
                          (f2cl-lib:int-mul 3 n)
                          (f2cl-lib:int-mul
                           (f2cl-lib:int-sub n 1)
                           (ilaenv 1 "DORGBR" "P" n n n
                            -1)))))))
 (setf maxwrk
         (max (the fixnum maxwrk)
              (the fixnum bdspac)))
 (setf minwrk
         (max (the fixnum (f2cl-lib:int-mul 4 n))
              (the fixnum bdspac)))
 (setf maxwrk
         (max (the fixnum maxwrk)
              (the fixnum minwrk))))
((and wntuo wntvn)
 (setf wrkbl
         (f2cl-lib:int-add n
                           (f2cl-lib:int-mul n
                                             (ilaenv 1
                                              "DGEQRF" " " m
                                              n -1 -1))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add n
                                     (f2cl-lib:int-mul n
                                       (ilaenv
                                         1
                                         "DORGQR"
                                         " "
                                         m n
                                         n
                                         -1))))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                     (f2cl-lib:int-mul 2
                                       n
                                       (ilaenv
                                         1
                                         "DGEBRD"
                                         " "
                                         n n
                                         -1
                                         -1))))))
 (setf wrkbl
         (max (the fixnum wrkbl)
```

```
                    (the fixnum
                         (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                           (f2cl-lib:int-mul n
                                             (ilaenv
                                              1
                                              "DORGBR"
                                              "Q"
                                              n n
                                              n
                                              -1))))))
               (setf wrkbl
                     (max (the fixnum wrkbl)
                          (the fixnum bdspac)))
               (setf maxwrk
                     (max
                      (the fixnum
                           (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                                             wrkbl))
                      (the fixnum
                           (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                                             (f2cl-lib:int-mul m n)
                                             n))))
               (setf minwrk
                     (max
                      (the fixnum
                           (f2cl-lib:int-add (f2cl-lib:int-mul 3 n) m))
                      (the fixnum bdspac)))
               (setf maxwrk
                     (max (the fixnum maxwrk)
                          (the fixnum minwrk))))
              ((and wntuo wntvas)
               (setf wrkbl
                     (f2cl-lib:int-add n
                                       (f2cl-lib:int-mul n
                                                         (ilaenv 1
                                                          "DGEQRF" " " m
                                                          n -1 -1))))
               (setf wrkbl
                     (max (the fixnum wrkbl)
                          (the fixnum
                               (f2cl-lib:int-add n
                                                 (f2cl-lib:int-mul n
                                                  (ilaenv
                                                    1
                                                    "DORGQR"
                                                    " "
                                                    m n
                                                    n
                                                    -1))))))
               (setf wrkbl
```

```
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                    (f2cl-lib:int-mul 2
                                      n
                                      (ilaenv
                                       1
                                       "DGEBRD"
                                       " "
                                       n n
                                       -1
                                       -1))))))
(setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                    (f2cl-lib:int-mul n
                                      (ilaenv
                                        1
                                        "DORGBR"
                                        "Q"
                                        n n
                                        n
                                        -1))))))
(setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                    (f2cl-lib:int-mul
                                     (f2cl-lib:int-sub n 1)
                                     (ilaenv 1 "DORGBR" "P"
                                      n n n -1))))))
(setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum bdspac)))
(setf maxwrk
        (max
         (the fixnum
              (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                                wrkbl))
         (the fixnum
              (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                                (f2cl-lib:int-mul m n)
                                n))))
(setf minwrk
        (max
         (the fixnum
              (f2cl-lib:int-add (f2cl-lib:int-mul 3 n) m))
         (the fixnum bdspac)))
(setf maxwrk
```

```
        (max (the fixnum maxwrk)
             (the fixnum minwrk))))
   ((and wntus wntvn)
    (setf wrkbl
        (f2cl-lib:int-add n
                          (f2cl-lib:int-mul n
                                            (ilaenv 1
                                             "DGEQRF" " " m
                                             n -1 -1))))
    (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add n
                                    (f2cl-lib:int-mul n
                                      (ilaenv
                                       1
                                       "DORGQR"
                                       " "
                                       m n
                                       n
                                       -1))))))
    (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                    (f2cl-lib:int-mul 2
                                      n
                                      (ilaenv
                                       1
                                       "DGEBRD"
                                       " "
                                       n n
                                       -1
                                       -1))))))
    (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                    (f2cl-lib:int-mul n
                                      (ilaenv
                                       1
                                       "DORGBR"
                                       "Q"
                                       n n
                                       n
                                       -1))))))
    (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum bdspac)))
    (setf maxwrk
```

```
        (f2cl-lib:int-add (f2cl-lib:int-mul n n) wrkbl))
 (setf minwrk
        (max
         (the fixnum
              (f2cl-lib:int-add (f2cl-lib:int-mul 3 n) m))
         (the fixnum bdspac)))
 (setf maxwrk
        (max (the fixnum maxwrk)
             (the fixnum minwrk))))
((and wntus wntvo)
 (setf wrkbl
        (f2cl-lib:int-add n
                          (f2cl-lib:int-mul n
                                            (ilaenv 1
                                             "DGEQRF" " " m
                                             n -1 -1))))
 (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add n
                                    (f2cl-lib:int-mul n
                                     (ilaenv
                                      1
                                      "DORGQR"
                                      " "
                                      m n
                                      n
                                      -1))))))
 (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                    (f2cl-lib:int-mul 2
                                       n
                                       (ilaenv
                                        1
                                        "DGEBRD"
                                        " "
                                        n n
                                        -1
                                        -1))))))
 (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                    (f2cl-lib:int-mul n
                                      (ilaenv
                                       1
                                       "DORGBR"
                                       "Q"
```

```
                                        n n
                                        n
                                        -1))))))
 (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                    (f2cl-lib:int-mul
                                     (f2cl-lib:int-sub n 1)
                                     (ilaenv 1 "DORGBR" "P"
                                      n n n -1))))))
 (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum bdspac)))
 (setf maxwrk
        (f2cl-lib:int-add (f2cl-lib:int-mul 2 n n) wrkbl))
 (setf minwrk
        (max
         (the fixnum
              (f2cl-lib:int-add (f2cl-lib:int-mul 3 n) m))
         (the fixnum bdspac)))
 (setf maxwrk
        (max (the fixnum maxwrk)
             (the fixnum minwrk))))
((and wntus wntvas)
 (setf wrkbl
        (f2cl-lib:int-add n
                          (f2cl-lib:int-mul n
                                            (ilaenv 1
                                             "DGEQRF" " " m
                                             n -1 -1))))
 (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add n
                                    (f2cl-lib:int-mul n
                                      (ilaenv
                                       1
                                       "DORGQR"
                                       " "
                                       m n
                                       n
                                       -1))))))
 (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                    (f2cl-lib:int-mul 2
                                      n
                                      (ilaenv
```

```
                                        1
                                        "DGEBRD"
                                        " "
                                        n n
                                        -1
                                        -1))))))
 (setf wrkbl
       (max (the fixnum wrkbl)
            (the fixnum
                 (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                   (f2cl-lib:int-mul n
                                    (ilaenv
                                     1
                                     "DORGBR"
                                     "Q"
                                     n n
                                     n
                                     -1))))))
 (setf wrkbl
       (max (the fixnum wrkbl)
            (the fixnum
                 (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                   (f2cl-lib:int-mul
                                    (f2cl-lib:int-sub n 1)
                                    (ilaenv 1 "DORGBR" "P"
                                     n n n -1))))))
 (setf wrkbl
       (max (the fixnum wrkbl)
            (the fixnum bdspac)))
 (setf maxwrk
       (f2cl-lib:int-add (f2cl-lib:int-mul n n) wrkbl))
 (setf minwrk
       (max
        (the fixnum
             (f2cl-lib:int-add (f2cl-lib:int-mul 3 n) m))
        (the fixnum bdspac)))
 (setf maxwrk
       (max (the fixnum maxwrk)
            (the fixnum minwrk))))
((and wntua wntvn)
 (setf wrkbl
       (f2cl-lib:int-add n
                         (f2cl-lib:int-mul n
                                           (ilaenv 1
                                            "DGEQRF" " " m
                                            n -1 -1))))
 (setf wrkbl
       (max (the fixnum wrkbl)
            (the fixnum
                 (f2cl-lib:int-add n
```

```
                                        (f2cl-lib:int-mul m
                                          (ilaenv
                                           1
                                           "DORGQR"
                                           " "
                                           m m
                                           n
                                           -1))))))
                 (setf wrkbl
                       (max (the fixnum wrkbl)
                            (the fixnum
                                 (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                                   (f2cl-lib:int-mul 2
                                                      n
                                                      (ilaenv
                                                        1
                                                        "DGEBRD"
                                                        " "
                                                        n n
                                                        -1
                                                        -1))))))
                 (setf wrkbl
                       (max (the fixnum wrkbl)
                            (the fixnum
                                 (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                                   (f2cl-lib:int-mul n
                                                     (ilaenv
                                                       1
                                                       "DORGBR"
                                                       "Q"
                                                       n n
                                                       n
                                                        -1))))))
                 (setf wrkbl
                       (max (the fixnum wrkbl)
                            (the fixnum bdspac)))
                 (setf maxwrk
                       (f2cl-lib:int-add (f2cl-lib:int-mul n n) wrkbl))
                 (setf minwrk
                       (max
                        (the fixnum
                             (f2cl-lib:int-add (f2cl-lib:int-mul 3 n) m))
                        (the fixnum bdspac)))
                 (setf maxwrk
                       (max (the fixnum maxwrk)
                            (the fixnum minwrk))))
                ((and wntua wntvo)
                 (setf wrkbl
                       (f2cl-lib:int-add n
                                         (f2cl-lib:int-mul n
```

```
                                                (ilaenv 1
                                                 "DGEQRF" " " m
                                                 n -1 -1))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add n
                                                  (f2cl-lib:int-mul m
                                                    (ilaenv
                                                     1
                                                     "DORGQR"
                                                     " "
                                                     m m
                                                     n
                                                     -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                                  (f2cl-lib:int-mul 2
                                                   n
                                                   (ilaenv
                                                    1
                                                    "DGEBRD"
                                                    " "
                                                    n n
                                                    -1
                                                    -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                                  (f2cl-lib:int-mul n
                                                   (ilaenv
                                                    1
                                                    "DORGBR"
                                                    "Q"
                                                    n n
                                                    n
                                                    -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                                  (f2cl-lib:int-mul
                                                   (f2cl-lib:int-sub n 1)
                                                   (ilaenv 1 "DORGBR" "P"
                                                    n n n -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
```

```
             (the fixnum bdspac)))
 (setf maxwrk
        (f2cl-lib:int-add (f2cl-lib:int-mul 2 n n) wrkbl))
 (setf minwrk
        (max
         (the fixnum
              (f2cl-lib:int-add (f2cl-lib:int-mul 3 n) m))
         (the fixnum bdspac)))
 (setf maxwrk
        (max (the fixnum maxwrk)
             (the fixnum minwrk))))
((and wntua wntvas)
 (setf wrkbl
        (f2cl-lib:int-add n
                          (f2cl-lib:int-mul n
                                            (ilaenv 1
                                             "DGEQRF" " " m
                                             n -1 -1))))
 (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add n
                                    (f2cl-lib:int-mul m
                                     (ilaenv
                                      1
                                      "DORGQR"
                                      " "
                                      m m
                                      n
                                      -1))))))
 (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                    (f2cl-lib:int-mul 2
                                      n
                                      (ilaenv
                                       1
                                       "DGEBRD"
                                       " "
                                       n n
                                       -1
                                       -1))))))
 (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                    (f2cl-lib:int-mul n
                                     (ilaenv
                                       1
```

```
                                          "DORGBR"
                                          "Q"
                                          n n
                                          n
                                          -1))))))
    (setf wrkbl
            (max (the fixnum wrkbl)
                 (the fixnum
                      (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                        (f2cl-lib:int-mul
                                         (f2cl-lib:int-sub n 1)
                                         (ilaenv 1 "DORGBR" "P"
                                          n n n -1))))))
    (setf wrkbl
            (max (the fixnum wrkbl)
                 (the fixnum bdspac)))
    (setf maxwrk
            (f2cl-lib:int-add (f2cl-lib:int-mul n n) wrkbl))
    (setf minwrk
            (max
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-mul 3 n) m))
             (the fixnum bdspac)))
    (setf maxwrk
            (max (the fixnum maxwrk)
                 (the fixnum minwrk))))))
(t
 (setf maxwrk
        (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                          (f2cl-lib:int-mul
                           (f2cl-lib:int-add m n)
                          (ilaenv 1 "DGEBRD" " " m n -1 -1))))
 (if (or wntus wntuo)
     (setf maxwrk
             (max (the fixnum maxwrk)
                  (the fixnum
                       (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                         (f2cl-lib:int-mul n
                                           (ilaenv
                                            1
                                            "DORGBR"
                                            "Q"
                                            m n
                                            n
                                            -1)))))))
 (if wntua
     (setf maxwrk
             (max (the fixnum maxwrk)
                  (the fixnum
                       (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
```

```
                                                  (f2cl-lib:int-mul m
                                                   (ilaenv
                                                    1
                                                    "DORGBR"
                                                    "Q"
                                                    m m
                                                    n
                                                     -1)))))))
          (if (not wntvn)
              (setf maxwrk
                      (max (the fixnum maxwrk)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-mul 3 n)
                                                  (f2cl-lib:int-mul
                                                   (f2cl-lib:int-sub n
                                                                     1)
                                                   (ilaenv 1 "DORGBR"
                                                    "P" n n n -1)))))))
          (setf maxwrk
                  (max (the fixnum maxwrk)
                       (the fixnum bdspac)))
          (setf minwrk
                  (max
                   (the fixnum
                        (f2cl-lib:int-add (f2cl-lib:int-mul 3 n) m))
                   (the fixnum bdspac)))
          (setf maxwrk
                  (max (the fixnum maxwrk)
                       (the fixnum minwrk))))))
      (t
       (setf bdspac (f2cl-lib:int-mul 5 m))
       (cond
         ((>= n mnthr)
          (cond
            (wntvn
             (setf maxwrk
                     (f2cl-lib:int-add m
                                       (f2cl-lib:int-mul m
                                                         (ilaenv 1
                                                          "DGELQF" " " m
                                                          n -1 -1))))
             (setf maxwrk
                     (max (the fixnum maxwrk)
                          (the fixnum
                               (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                                 (f2cl-lib:int-mul 2
                                                  m
                                                  (ilaenv
                                                    1
                                                    "DGEBRD"
```

```
                                        " "
                                        m m
                                        -1
                                        -1))))))
 (if (or wntuo wntuas)
     (setf maxwrk
             (max (the fixnum maxwrk)
                  (the fixnum
                       (f2cl-lib:int-add
                        (f2cl-lib:int-mul 3 m)
                        (f2cl-lib:int-mul m
                                          (ilaenv 1 "DORGBR"
                                           "Q" m m m
                                           -1)))))))
 (setf maxwrk
         (max (the fixnum maxwrk)
              (the fixnum bdspac)))
 (setf minwrk
         (max (the fixnum (f2cl-lib:int-mul 4 m))
              (the fixnum bdspac)))
 (setf maxwrk
         (max (the fixnum maxwrk)
              (the fixnum minwrk))))
((and wntvo wntun)
 (setf wrkbl
         (f2cl-lib:int-add m
                           (f2cl-lib:int-mul m
                                             (ilaenv 1
                                              "DGELQF" " " m
                                              n -1 -1))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add m
                                     (f2cl-lib:int-mul m
                                      (ilaenv
                                       1
                                       "DORGLQ"
                                       " "
                                       m n
                                       m
                                       -1))))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                     (f2cl-lib:int-mul 2
                                       m
                                       (ilaenv
                                        1
```

```
                                        "DGEBRD"
                                        " "
                                        m m
                                        -1
                                        -1))))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                     (f2cl-lib:int-mul
                                      (f2cl-lib:int-sub m 1)
                                      (ilaenv 1 "DORGBR" "P"
                                       m m m -1))))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum bdspac)))
 (setf maxwrk
         (max
          (the fixnum
               (f2cl-lib:int-add (f2cl-lib:int-mul m m)
                                 wrkbl))
          (the fixnum
               (f2cl-lib:int-add (f2cl-lib:int-mul m m)
                                 (f2cl-lib:int-mul m n)
                                 m))))
 (setf minwrk
         (max
          (the fixnum
               (f2cl-lib:int-add (f2cl-lib:int-mul 3 m) n))
          (the fixnum bdspac)))
 (setf maxwrk
         (max (the fixnum maxwrk)
              (the fixnum minwrk))))
((and wntvo wntuas)
 (setf wrkbl
         (f2cl-lib:int-add m
                           (f2cl-lib:int-mul m
                                             (ilaenv 1
                                              "DGELQF" " " m
                                              n -1 -1))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add m
                                     (f2cl-lib:int-mul m
                                       (ilaenv
                                        1
                                        "DORGLQ"
                                        " "
                                        m n
```

```
                                        m
                                        -1))))))
(setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                    (f2cl-lib:int-mul 2
                                     m
                                     (ilaenv
                                      1
                                      "DGEBRD"
                                      " "
                                      m m
                                      -1
                                      -1))))))
(setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                    (f2cl-lib:int-mul
                                     (f2cl-lib:int-sub m 1)
                                     (ilaenv 1 "DORGBR" "P"
                                      m m m -1))))))
(setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                    (f2cl-lib:int-mul m
                                     (ilaenv
                                       1
                                       "DORGBR"
                                       "Q"
                                       m m
                                       m
                                       -1))))))
(setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum bdspac)))
(setf maxwrk
        (max
         (the fixnum
              (f2cl-lib:int-add (f2cl-lib:int-mul m m)
                                wrkbl))
         (the fixnum
              (f2cl-lib:int-add (f2cl-lib:int-mul m m)
                                (f2cl-lib:int-mul m n)
                                m))))
(setf minwrk
        (max
         (the fixnum
```

```
              (f2cl-lib:int-add (f2cl-lib:int-mul 3 m) n))
          (the fixnum bdspac)))
 (setf maxwrk
         (max (the fixnum maxwrk)
              (the fixnum minwrk))))
((and wntvs wntun)
 (setf wrkbl
         (f2cl-lib:int-add m
                           (f2cl-lib:int-mul m
                                             (ilaenv 1
                                              "DGELQF" " " m
                                              n -1 -1))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add m
                                     (f2cl-lib:int-mul m
                                       (ilaenv
                                        1
                                        "DORGLQ"
                                        " "
                                        m n
                                        m
                                        -1))))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                     (f2cl-lib:int-mul 2
                                       m
                                       (ilaenv
                                        1
                                        "DGEBRD"
                                        " "
                                        m m
                                        -1
                                        -1))))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                     (f2cl-lib:int-mul
                                      (f2cl-lib:int-sub m 1)
                                      (ilaenv 1 "DORGBR" "P"
                                       m m m -1))))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum bdspac)))
 (setf maxwrk
         (f2cl-lib:int-add (f2cl-lib:int-mul m m) wrkbl))
```

```
 (setf minwrk
         (max
          (the fixnum
               (f2cl-lib:int-add (f2cl-lib:int-mul 3 m) n))
          (the fixnum bdspac)))
 (setf maxwrk
         (max (the fixnum maxwrk)
              (the fixnum minwrk))))
((and wntvs wntuo)
 (setf wrkbl
         (f2cl-lib:int-add m
                           (f2cl-lib:int-mul m
                                             (ilaenv 1
                                              "DGELQF" " " m
                                              n -1 -1))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add m
                                     (f2cl-lib:int-mul m
                                      (ilaenv
                                       1
                                       "DORGLQ"
                                       " "
                                       m n
                                       m
                                       -1))))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                     (f2cl-lib:int-mul 2
                                       m
                                       (ilaenv
                                         1
                                         "DGEBRD"
                                         " "
                                         m m
                                         -1
                                         -1))))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                     (f2cl-lib:int-mul
                                      (f2cl-lib:int-sub m 1)
                                      (ilaenv 1 "DORGBR" "P"
                                       m m m -1))))))
 (setf wrkbl
         (max (the fixnum wrkbl)
```

```
                    (the fixnum
                         (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                           (f2cl-lib:int-mul m
                                            (ilaenv
                                             1
                                             "DORGBR"
                                             "Q"
                                             m m
                                             m
                                             -1))))))
               (setf wrkbl
                     (max (the fixnum wrkbl)
                          (the fixnum bdspac)))
               (setf maxwrk
                     (f2cl-lib:int-add (f2cl-lib:int-mul 2 m m) wrkbl))
               (setf minwrk
                     (max
                      (the fixnum
                           (f2cl-lib:int-add (f2cl-lib:int-mul 3 m) n))
                      (the fixnum bdspac)))
               (setf maxwrk
                     (max (the fixnum maxwrk)
                          (the fixnum minwrk))))
              ((and wntvs wntuas)
               (setf wrkbl
                     (f2cl-lib:int-add m
                                       (f2cl-lib:int-mul m
                                                         (ilaenv 1
                                                          "DGELQF" " " m
                                                          n -1 -1))))
               (setf wrkbl
                     (max (the fixnum wrkbl)
                          (the fixnum
                               (f2cl-lib:int-add m
                                                 (f2cl-lib:int-mul m
                                                  (ilaenv
                                                   1
                                                   "DORGLQ"
                                                   " "
                                                   m n
                                                   m
                                                   -1))))))
               (setf wrkbl
                     (max (the fixnum wrkbl)
                          (the fixnum
                               (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                                 (f2cl-lib:int-mul 2
                                                   m
                                                   (ilaenv
                                                    1
```

```
                                        "DGEBRD"
                                        " "
                                        m m
                                        -1
                                        -1))))))
 (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                    (f2cl-lib:int-mul
                                     (f2cl-lib:int-sub m 1)
                                     (ilaenv 1 "DORGBR" "P"
                                      m m m -1))))))
 (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                    (f2cl-lib:int-mul m
                                     (ilaenv
                                      1
                                      "DORGBR"
                                      "Q"
                                      m m
                                      m
                                      -1))))))
 (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum bdspac)))
 (setf maxwrk
        (f2cl-lib:int-add (f2cl-lib:int-mul m m) wrkbl))
 (setf minwrk
        (max
         (the fixnum
              (f2cl-lib:int-add (f2cl-lib:int-mul 3 m) n))
         (the fixnum bdspac)))
 (setf maxwrk
        (max (the fixnum maxwrk)
             (the fixnum minwrk))))
((and wntva wntun)
 (setf wrkbl
        (f2cl-lib:int-add m
                          (f2cl-lib:int-mul m
                                            (ilaenv 1
                                             "DGELQF" " " m
                                             n -1 -1))))
 (setf wrkbl
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add m
                                    (f2cl-lib:int-mul n
```

```
                                        (ilaenv
                                          1
                                          "DORGLQ"
                                          " "
                                          n n
                                          m
                                          -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                                  (f2cl-lib:int-mul 2
                                                   m
                                                   (ilaenv
                                                     1
                                                     "DGEBRD"
                                                     " "
                                                     m m
                                                     -1
                                                     -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                                  (f2cl-lib:int-mul
                                                   (f2cl-lib:int-sub m 1)
                                                   (ilaenv 1 "DORGBR" "P"
                                                    m m m -1))))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
                           (the fixnum bdspac)))
                (setf maxwrk
                      (f2cl-lib:int-add (f2cl-lib:int-mul m m) wrkbl))
                (setf minwrk
                      (max
                       (the fixnum
                            (f2cl-lib:int-add (f2cl-lib:int-mul 3 m) n))
                       (the fixnum bdspac)))
                (setf maxwrk
                      (max (the fixnum maxwrk)
                           (the fixnum minwrk))))
               ((and wntva wntuo)
                (setf wrkbl
                      (f2cl-lib:int-add m
                                        (f2cl-lib:int-mul m
                                                          (ilaenv 1
                                                           "DGELQF" " " m
                                                           n -1 -1))))
                (setf wrkbl
                      (max (the fixnum wrkbl)
```

```
                    (the fixnum
                         (f2cl-lib:int-add m
                                           (f2cl-lib:int-mul n
                                             (ilaenv
                                               1
                                               "DORGLQ"
                                               " "
                                               n n
                                               m
                                               -1))))))
              (setf wrkbl
                    (max (the fixnum wrkbl)
                         (the fixnum
                              (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                                (f2cl-lib:int-mul 2
                                                  m
                                                  (ilaenv
                                                    1
                                                    "DGEBRD"
                                                    " "
                                                    m m
                                                    -1
                                                    -1))))))
              (setf wrkbl
                    (max (the fixnum wrkbl)
                         (the fixnum
                              (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                                (f2cl-lib:int-mul
                                                 (f2cl-lib:int-sub m 1)
                                                 (ilaenv 1 "DORGBR" "P"
                                                  m m m -1))))))
              (setf wrkbl
                    (max (the fixnum wrkbl)
                         (the fixnum
                              (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                                (f2cl-lib:int-mul m
                                                  (ilaenv
                                                    1
                                                    "DORGBR"
                                                    "Q"
                                                    m m
                                                    m
                                                    -1))))))
              (setf wrkbl
                    (max (the fixnum wrkbl)
                         (the fixnum bdspac)))
              (setf maxwrk
                    (f2cl-lib:int-add (f2cl-lib:int-mul 2 m m) wrkbl))
              (setf minwrk
                    (max
```

```
          (the fixnum
               (f2cl-lib:int-add (f2cl-lib:int-mul 3 m) n))
          (the fixnum bdspac)))
 (setf maxwrk
         (max (the fixnum maxwrk)
              (the fixnum minwrk))))
((and wntva wntuas)
 (setf wrkbl
         (f2cl-lib:int-add m
                           (f2cl-lib:int-mul m
                                             (ilaenv 1
                                              "DGELQF" " " m
                                              n -1 -1))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add m
                                     (f2cl-lib:int-mul n
                                       (ilaenv
                                        1
                                        "DORGLQ"
                                        " "
                                        n n
                                        m
                                        -1))))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                     (f2cl-lib:int-mul 2
                                       m
                                       (ilaenv
                                         1
                                         "DGEBRD"
                                         " "
                                         m m
                                         -1
                                         -1))))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                     (f2cl-lib:int-mul
                                      (f2cl-lib:int-sub m 1)
                                      (ilaenv 1 "DORGBR" "P"
                                       m m m -1))))))
 (setf wrkbl
         (max (the fixnum wrkbl)
              (the fixnum
                   (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
```

```
                                          (f2cl-lib:int-mul m
                                           (ilaenv
                                            1
                                            "DORGBR"
                                            "Q"
                                            m m
                                            m
                                            -1))))))
          (setf wrkbl
                (max (the fixnum wrkbl)
                     (the fixnum bdspac)))
          (setf maxwrk
                (f2cl-lib:int-add (f2cl-lib:int-mul m m) wrkbl))
          (setf minwrk
                (max
                 (the fixnum
                      (f2cl-lib:int-add (f2cl-lib:int-mul 3 m) n))
                 (the fixnum bdspac)))
          (setf maxwrk
                (max (the fixnum maxwrk)
                     (the fixnum minwrk))))))
        (t
         (setf maxwrk
               (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                 (f2cl-lib:int-mul
                                  (f2cl-lib:int-add m n)
                                 (ilaenv 1 "DGEBRD" " " m n -1 -1))))
         (if (or wntvs wntvo)
             (setf maxwrk
                   (max (the fixnum maxwrk)
                        (the fixnum
                             (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                               (f2cl-lib:int-mul m
                                                (ilaenv
                                                  1
                                                  "DORGBR"
                                                  "P"
                                                  m n
                                                  m
                                                  -1)))))))
         (if wntva
             (setf maxwrk
                   (max (the fixnum maxwrk)
                        (the fixnum
                             (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                               (f2cl-lib:int-mul n
                                                (ilaenv
                                                 1
                                                 "DORGBR"
                                                 "P"
```

```
                                                  n n
                                                  m
                                                  -1)))))))
          (if (not wntun)
              (setf maxwrk
                      (max (the fixnum maxwrk)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-mul 3 m)
                                                  (f2cl-lib:int-mul
                                                   (f2cl-lib:int-sub m
                                                                     1)
                                                   (ilaenv 1 "DORGBR"
                                                    "Q" m m m -1)))))))
          (setf maxwrk
                  (max (the fixnum maxwrk)
                       (the fixnum bdspac)))
          (setf minwrk
                  (max
                   (the fixnum
                        (f2cl-lib:int-add (f2cl-lib:int-mul 3 m) n))
                   (the fixnum bdspac)))
          (setf maxwrk
                  (max (the fixnum maxwrk)
                       (the fixnum minwrk)))))))
   (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
           (coerce (the fixnum maxwrk) 'double-float))))
(cond
  ((and (< lwork minwrk) (not lquery))
   (setf info -13)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DGESVD" (f2cl-lib:int-sub info))
   (go end_label))
  (lquery
   (go end_label)))
(cond
  ((or (= m 0) (= n 0))
   (if (>= lwork 1)
      (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%) one))
   (go end_label)))
(setf eps (dlamch "P"))
(setf smlnum (/ (f2cl-lib:fsqrt (dlamch "S")) eps))
(setf bignum (/ one smlnum))
(setf anrm (dlange "M" m n a lda dum))
(setf iscl 0)
(cond
  ((and (> anrm zero) (< anrm smlnum))
   (setf iscl 1)
```

```
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
       (dlascl "G" 0 0 anrm smlnum m n a lda ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                      var-8))
     (setf ierr var-9)))
  ((> anrm bignum)
   (setf iscl 1)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
       (dlascl "G" 0 0 anrm bignum m n a lda ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                      var-8))
     (setf ierr var-9))))
(cond
  ((>= m n)
   (cond
     ((>= m mnthr)
      (cond
        (wntun
         (setf itau 1)
         (setf iwork (f2cl-lib:int-add itau n))
         (multiple-value-bind
               (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
             (dgeqrf m n a lda
              (f2cl-lib:array-slice work double-float (itau) ((1 *)))
              (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
              (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
           (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
           (setf ierr var-7))
         (dlaset "L" (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1) zero
          zero
          (f2cl-lib:array-slice a double-float (2 1) ((1 lda) (1 *)))
          lda)
         (setf ie 1)
         (setf itauq (f2cl-lib:int-add ie n))
         (setf itaup (f2cl-lib:int-add itauq n))
         (setf iwork (f2cl-lib:int-add itaup n))
         (multiple-value-bind
               (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                var-9 var-10)
             (dgebrd n n a lda s
              (f2cl-lib:array-slice work double-float (ie) ((1 *)))
              (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
              (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
              (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
              (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
           (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                            var-7 var-8 var-9))
           (setf ierr var-10))
```

```
(setf ncvt 0)
(cond
  ((or wntvo wntvas)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
          var-8 var-9)
       (dorgbr "P" n n n a lda
        (f2cl-lib:array-slice work
                              double-float
                              (itaup)
                              ((1 *)))
        (f2cl-lib:array-slice work
                              double-float
                              (iwork)
                              ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
        ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                      var-6 var-7 var-8))
     (setf ierr var-9))
   (setf ncvt n)))
(setf iwork (f2cl-lib:int-add ie n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
       var-9 var-10 var-11 var-12 var-13 var-14)
    (dbdsqr "U" n ncvt 0 0 s
     (f2cl-lib:array-slice work double-float (ie) ((1 *))) a
     lda dum 1 dum 1
     (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
     info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12
                   var-13))
  (setf info var-14))
(if wntvas (dlacpy "F" n n a lda vt ldvt)))
((and wntuo wntvn)
(cond
  ((>= lwork
       (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                         (max
                          (the fixnum
                               (f2cl-lib:int-mul 4 n))
                          (the fixnum bdspac))))
   (setf ir 1)
   (cond
     ((>= lwork
          (f2cl-lib:int-add
           (max (the fixnum wrkbl)
                (the fixnum
                     (f2cl-lib:int-add
```

```
                    (f2cl-lib:int-mul lda n)
                    n)))
         (f2cl-lib:int-mul lda n)))
   (setf ldwrku lda)
   (setf ldwrkr lda))
  ((>= lwork
       (f2cl-lib:int-add
        (max (the fixnum wrkbl)
             (the fixnum
                  (f2cl-lib:int-add
                   (f2cl-lib:int-mul lda n)
                   n)))
        (f2cl-lib:int-mul n n)))
   (setf ldwrku lda)
   (setf ldwrkr n))
  (t
   (setf ldwrku
           (the fixnum
                (truncate (- lwork (* n n) n) n)))
   (setf ldwrkr n)))
(setf itau
       (f2cl-lib:int-add ir (f2cl-lib:int-mul ldwrkr n)))
(setf iwork (f2cl-lib:int-add itau n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgeqrf m n a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6))
  (setf ierr var-7))
(dlacpy "U" n n a lda
 (f2cl-lib:array-slice work double-float (ir) ((1 *)))
 ldwrkr)
(dlaset "L" (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1)
 zero zero
 (f2cl-lib:array-slice work
                       double-float
                       ((+ ir 1))
                       ((1 *)))
 ldwrkr)
(multiple-value-bind
```

```
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorgqr m n n a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd n n
     (f2cl-lib:array-slice work double-float (ir) ((1 *)))
     ldwrkr s
     (f2cl-lib:array-slice work double-float (ie) ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "Q" n n n
     (f2cl-lib:array-slice work double-float (ir) ((1 *)))
     ldwrkr
```

```
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14)
    (dbdsqr "U" n 0 n 0 s
     (f2cl-lib:array-slice work double-float (ie) ((1 *)))
     dum 1
     (f2cl-lib:array-slice work double-float (ir) ((1 *)))
     ldwrkr dum 1
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9 var-10 var-11
                   var-12 var-13))
  (setf info var-14))
(setf iu (f2cl-lib:int-add ie n))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i ldwrku))
              ((> i m) nil)
  (tagbody
    (setf chunk
            (min
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-sub m i)
                                    1))
             (the fixnum ldwrku)))
    (dgemm "N" "N" chunk n n one
     (f2cl-lib:array-slice a
                           double-float
                           (i 1)
                           ((1 lda) (1 *)))
     lda
     (f2cl-lib:array-slice work double-float (ir) ((1 *)))
     ldwrkr zero
     (f2cl-lib:array-slice work double-float (iu) ((1 *)))
```

```
      ldwrku)
     (dlacpy "F" chunk n
      (f2cl-lib:array-slice work double-float (iu) ((1 *)))
      ldwrku
      (f2cl-lib:array-slice a
                            double-float
                            (i 1)
                            ((1 lda) (1 *)))
      lda))))
(t
 (setf ie 1)
 (setf itauq (f2cl-lib:int-add ie n))
 (setf itaup (f2cl-lib:int-add itauq n))
 (setf iwork (f2cl-lib:int-add itaup n))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8 var-9 var-10)
     (dgebrd m n a lda s
      (f2cl-lib:array-slice work double-float (ie) ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (itauq)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (itaup)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9))
   (setf ierr var-10))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8 var-9)
     (dorgbr "Q" m n n a lda
      (f2cl-lib:array-slice work
                            double-float
                            (itauq)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
```

```
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                       var-6 var-7 var-8))
      (setf ierr var-9))
    (setf iwork (f2cl-lib:int-add ie n))
    (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
          var-8 var-9 var-10 var-11 var-12 var-13 var-14)
       (dbdsqr "U" n 0 m 0 s
        (f2cl-lib:array-slice work double-float (ie) ((1 *)))
        dum 1 a lda dum 1
        (f2cl-lib:array-slice work
                              double-float
                              (iwork)
                              ((1 *)))
        info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                       var-6 var-7 var-8 var-9 var-10 var-11
                       var-12 var-13))
      (setf info var-14)))))
((and wntuo wntvas)
 (cond
   ((>= lwork
        (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                          (max
                           (the fixnum
                                (f2cl-lib:int-mul 4 n))
                           (the fixnum bdspac))))
    (setf ir 1)
    (cond
      ((>= lwork
           (f2cl-lib:int-add
            (max (the fixnum wrkbl)
                 (the fixnum
                      (f2cl-lib:int-add
                       (f2cl-lib:int-mul lda n)
                       n)))
            (f2cl-lib:int-mul lda n)))
       (setf ldwrku lda)
       (setf ldwrkr lda))
      ((>= lwork
           (f2cl-lib:int-add
            (max (the fixnum wrkbl)
                 (the fixnum
                      (f2cl-lib:int-add
                       (f2cl-lib:int-mul lda n)
                       n)))
            (f2cl-lib:int-mul n n)))
       (setf ldwrku lda)
       (setf ldwrkr n))
      (t
```

```
   (setf ldwrku
          (the fixnum
               (truncate (- lwork (* n n) n) n)))
   (setf ldwrkr n)))
(setf itau
       (f2cl-lib:int-add ir (f2cl-lib:int-mul ldwrkr n)))
(setf iwork (f2cl-lib:int-add itau n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgeqrf m n a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6))
  (setf ierr var-7))
(dlacpy "U" n n a lda vt ldvt)
(dlaset "L" (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1)
 zero zero
 (f2cl-lib:array-slice vt
                       double-float
                       (2 1)
                       ((1 ldvt) (1 *)))
 ldvt)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorgqr m n n a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
```

```
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd n n vt ldvt s
     (f2cl-lib:array-slice work double-float (ie) ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(dlacpy "L" n n vt ldvt
 (f2cl-lib:array-slice work double-float (ir) ((1 *)))
 ldwrkr)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "Q" n n n
     (f2cl-lib:array-slice work double-float (ir) ((1 *)))
     ldwrkr
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "P" n n n vt ldvt
```

```
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14)
    (dbdsqr "U" n n n 0 s
     (f2cl-lib:array-slice work double-float (ie) ((1 *)))
     vt ldvt
     (f2cl-lib:array-slice work double-float (ir) ((1 *)))
     ldwrkr dum 1
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9 var-10 var-11
                   var-12 var-13))
  (setf info var-14))
(setf iu (f2cl-lib:int-add ie n))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i ldwrku))
              ((> i m) nil)
  (tagbody
    (setf chunk
            (min
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-sub m i)
                                    1))
             (the fixnum ldwrku)))
    (dgemm "N" "N" chunk n n one
     (f2cl-lib:array-slice a
                           double-float
                           (i 1)
                           ((1 lda) (1 *)))
     lda
     (f2cl-lib:array-slice work double-float (ir) ((1 *)))
     ldwrkr zero
     (f2cl-lib:array-slice work double-float (iu) ((1 *)))
```

```
      ldwrku)
     (dlacpy "F" chunk n
      (f2cl-lib:array-slice work double-float (iu) ((1 *)))
      ldwrku
      (f2cl-lib:array-slice a
                            double-float
                            (i 1)
                            ((1 lda) (1 *)))
      lda))))
(t
 (setf itau 1)
 (setf iwork (f2cl-lib:int-add itau n))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
     (dgeqrf m n a lda
      (f2cl-lib:array-slice work
                            double-float
                            (itau)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6))
   (setf ierr var-7))
 (dlacpy "U" n n a lda vt ldvt)
 (dlaset "L" (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1)
  zero zero
  (f2cl-lib:array-slice vt
                        double-float
                        (2 1)
                        ((1 ldvt) (1 *)))
  ldvt)
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8)
     (dorgqr m n n a lda
      (f2cl-lib:array-slice work
                            double-float
                            (itau)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
```

```
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd n n vt ldvt s
     (f2cl-lib:array-slice work double-float (ie) ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13)
    (dormbr "Q" "R" "N" m n n vt ldvt
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     a lda
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9 var-10 var-11
                   var-12))
  (setf ierr var-13))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
```

```
                var-8 var-9)
               (dorgbr "P" n n n vt ldvt
                (f2cl-lib:array-slice work
                                      double-float
                                      (itaup)
                                      ((1 *)))
                (f2cl-lib:array-slice work
                                      double-float
                                      (iwork)
                                      ((1 *)))
                (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
                ierr)
              (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                               var-6 var-7 var-8))
              (setf ierr var-9))
            (setf iwork (f2cl-lib:int-add ie n))
            (multiple-value-bind
                 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                  var-8 var-9 var-10 var-11 var-12 var-13 var-14)
               (dbdsqr "U" n n m 0 s
                (f2cl-lib:array-slice work double-float (ie) ((1 *)))
                vt ldvt a lda dum 1
                (f2cl-lib:array-slice work
                                      double-float
                                      (iwork)
                                      ((1 *)))
                info)
              (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                               var-6 var-7 var-8 var-9 var-10 var-11
                               var-12 var-13))
              (setf info var-14)))))
        (wntus
         (cond
           (wntvn
            (cond
              ((>= lwork
                   (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                                     (max
                                      (the fixnum
                                           (f2cl-lib:int-mul 4 n))
                                      (the fixnum bdspac))))
               (setf ir 1)
               (cond
                 ((>= lwork
                      (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul lda n)))
                  (setf ldwrkr lda))
                 (t
                  (setf ldwrkr n)))
               (setf itau
                       (f2cl-lib:int-add ir
```

```
                          (f2cl-lib:int-mul ldwrkr n)))
(setf iwork (f2cl-lib:int-add itau n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgeqrf m n a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6))
  (setf ierr var-7))
(dlacpy "U" n n a lda
 (f2cl-lib:array-slice work double-float (ir) ((1 *)))
 ldwrkr)
(dlaset "L" (f2cl-lib:int-sub n 1)
 (f2cl-lib:int-sub n 1) zero zero
 (f2cl-lib:array-slice work
                       double-float
                       ((+ ir 1))
                       ((1 *)))
 ldwrkr)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorgqr m n n a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
```

```
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8 var-9 var-10)
      (dgebrd n n
       (f2cl-lib:array-slice work
                             double-float
                             (ir)
                             ((1 *)))
       ldwrkr s
       (f2cl-lib:array-slice work
                             double-float
                             (ie)
                             ((1 *)))
       (f2cl-lib:array-slice work
                             double-float
                             (itauq)
                             ((1 *)))
       (f2cl-lib:array-slice work
                             double-float
                             (itaup)
                             ((1 *)))
       (f2cl-lib:array-slice work
                             double-float
                             (iwork)
                             ((1 *)))
       (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
       ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8 var-9))
    (setf ierr var-10))
  (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8 var-9)
      (dorgbr "Q" n n n
       (f2cl-lib:array-slice work
                             double-float
                             (ir)
                             ((1 *)))
       ldwrkr
       (f2cl-lib:array-slice work
                             double-float
                             (itauq)
                             ((1 *)))
       (f2cl-lib:array-slice work
                             double-float
                             (iwork)
                             ((1 *)))
       (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
       ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8))
```

```
  (setf ierr var-9))
 (setf iwork (f2cl-lib:int-add ie n))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8 var-9 var-10 var-11 var-12 var-13 var-14)
     (dbdsqr "U" n 0 n 0 s
      (f2cl-lib:array-slice work
                            double-float
                            (ie)
                            ((1 *)))
      dum 1
      (f2cl-lib:array-slice work
                            double-float
                            (ir)
                            ((1 *)))
      ldwrkr dum 1
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      info)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9 var-10 var-11
                    var-12 var-13))
   (setf info var-14))
 (dgemm "N" "N" m n n one a lda
  (f2cl-lib:array-slice work double-float (ir) ((1 *)))
  ldwrkr zero u ldu))
(t
 (setf itau 1)
 (setf iwork (f2cl-lib:int-add itau n))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
     (dgeqrf m n a lda
      (f2cl-lib:array-slice work
                            double-float
                            (itau)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6))
   (setf ierr var-7))
 (dlacpy "L" m n a lda u ldu)
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
```

```
      var-8)
    (dorgqr m n n u ldu
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(dlaset "L" (f2cl-lib:int-sub n 1)
 (f2cl-lib:int-sub n 1) zero zero
 (f2cl-lib:array-slice a
                       double-float
                       (2 1)
                       ((1 lda) (1 *)))
 lda)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd n n a lda s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
```

```
      (setf ierr var-10))
    (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
          var-8 var-9 var-10 var-11 var-12 var-13)
        (dormbr "Q" "R" "N" m n n a lda
         (f2cl-lib:array-slice work
                               double-float
                               (itauq)
                               ((1 *)))
         u ldu
         (f2cl-lib:array-slice work
                               double-float
                               (iwork)
                               ((1 *)))
         (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
         ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                       var-6 var-7 var-8 var-9 var-10 var-11
                       var-12))
      (setf ierr var-13))
    (setf iwork (f2cl-lib:int-add ie n))
    (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
          var-8 var-9 var-10 var-11 var-12 var-13 var-14)
        (dbdsqr "U" n 0 m 0 s
         (f2cl-lib:array-slice work
                               double-float
                               (ie)
                               ((1 *)))
         dum 1 u ldu dum 1
         (f2cl-lib:array-slice work
                               double-float
                               (iwork)
                               ((1 *)))
         info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                       var-6 var-7 var-8 var-9 var-10 var-11
                       var-12 var-13))
      (setf info var-14)))))
(wntvo
 (cond
   ((>= lwork
        (f2cl-lib:int-add (f2cl-lib:int-mul 2 n n)
                          (max
                           (the fixnum
                                (f2cl-lib:int-mul 4 n))
                           (the fixnum bdspac))))
    (setf iu 1)
    (cond
      ((>= lwork
```

```
        (f2cl-lib:int-add wrkbl
                          (f2cl-lib:int-mul 2 lda n)))
    (setf ldwrku lda)
    (setf ir
          (f2cl-lib:int-add iu
                            (f2cl-lib:int-mul ldwrku
                                              n)))
    (setf ldwrkr lda))
   ((>= lwork
        (f2cl-lib:int-add wrkbl
                          (f2cl-lib:int-mul
                           (f2cl-lib:int-add lda n)
                           n)))
    (setf ldwrku lda)
    (setf ir
          (f2cl-lib:int-add iu
                            (f2cl-lib:int-mul ldwrku
                                              n)))
    (setf ldwrkr n))
   (t
    (setf ldwrku n)
    (setf ir
          (f2cl-lib:int-add iu
                            (f2cl-lib:int-mul ldwrku
                                              n)))
    (setf ldwrkr n)))
(setf itau
      (f2cl-lib:int-add ir
                        (f2cl-lib:int-mul ldwrkr n)))
(setf iwork (f2cl-lib:int-add itau n))
(multiple-value-bind
     (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
   (dgeqrf m n a lda
    (f2cl-lib:array-slice work
                          double-float
                          (itau)
                          ((1 *)))
    (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6))
  (setf ierr var-7))
(dlacpy "U" n n a lda
 (f2cl-lib:array-slice work double-float (iu) ((1 *)))
 ldwrku)
(dlaset "L" (f2cl-lib:int-sub n 1)
```

```
 (f2cl-lib:int-sub n 1) zero zero
 (f2cl-lib:array-slice work
                       double-float
                       ((+ iu 1))
                       ((1 *)))
 ldwrku)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorgqr m n n a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd n n
     (f2cl-lib:array-slice work
                           double-float
                           (iu)
                           ((1 *)))
     ldwrku s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
```

```
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(dlacpy "U" n n
 (f2cl-lib:array-slice work double-float (iu) ((1 *)))
 ldwrku
 (f2cl-lib:array-slice work double-float (ir) ((1 *)))
 ldwrkr)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "Q" n n n
     (f2cl-lib:array-slice work
                           double-float
                           (iu)
                           ((1 *)))
     ldwrku
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "P" n n n
     (f2cl-lib:array-slice work
                           double-float
                           (ir)
                           ((1 *)))
     ldwrkr
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
```

```
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
 (setf iwork (f2cl-lib:int-add ie n))
 (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14)
    (dbdsqr "U" n n n 0 s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (ir)
                           ((1 *)))
     ldwrkr
     (f2cl-lib:array-slice work
                           double-float
                           (iu)
                           ((1 *)))
     ldwrku dum 1
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9 var-10 var-11
                   var-12 var-13))
  (setf info var-14))
 (dgemm "N" "N" m n n one a lda
  (f2cl-lib:array-slice work double-float (iu) ((1 *)))
  ldwrku zero u ldu)
 (dlacpy "F" n n
  (f2cl-lib:array-slice work double-float (ir) ((1 *)))
  ldwrkr a lda))
(t
 (setf itau 1)
 (setf iwork (f2cl-lib:int-add itau n))
 (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgeqrf m n a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
```

```
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6))
  (setf ierr var-7))
(dlacpy "L" m n a lda u ldu)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorgqr m n n u ldu
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(dlaset "L" (f2cl-lib:int-sub n 1)
 (f2cl-lib:int-sub n 1) zero zero
 (f2cl-lib:array-slice a
                       double-float
                       (2 1)
                       ((1 lda) (1 *)))
 lda)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd n n a lda s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
```

```
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13)
    (dormbr "Q" "R" "N" m n n a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     u ldu
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9 var-10 var-11
                   var-12))
  (setf ierr var-13))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "P" n n n a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie n))
```

```
    (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
           var-8 var-9 var-10 var-11 var-12 var-13 var-14)
        (dbdsqr "U" n n m 0 s
         (f2cl-lib:array-slice work
                               double-float
                               (ie)
                               ((1 *)))
         a lda u ldu dum 1
         (f2cl-lib:array-slice work
                               double-float
                               (iwork)
                               ((1 *)))
         info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                       var-6 var-7 var-8 var-9 var-10 var-11
                       var-12 var-13))
      (setf info var-14)))))
(wntvas
 (cond
   ((>= lwork
        (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                          (max
                           (the fixnum
                                (f2cl-lib:int-mul 4 n))
                           (the fixnum bdspac))))
    (setf iu 1)
    (cond
      ((>= lwork
           (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul lda n)))
       (setf ldwrku lda))
      (t
       (setf ldwrku n)))
    (setf itau
            (f2cl-lib:int-add iu
                              (f2cl-lib:int-mul ldwrku n)))
    (setf iwork (f2cl-lib:int-add itau n))
    (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
        (dgeqrf m n a lda
         (f2cl-lib:array-slice work
                               double-float
                               (itau)
                               ((1 *)))
         (f2cl-lib:array-slice work
                               double-float
                               (iwork)
                               ((1 *)))
         (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
         ierr)
```

```
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6))
  (setf ierr var-7))
(dlacpy "U" n n a lda
 (f2cl-lib:array-slice work double-float (iu) ((1 *)))
 ldwrku)
(dlaset "L" (f2cl-lib:int-sub n 1)
 (f2cl-lib:int-sub n 1) zero zero
 (f2cl-lib:array-slice work
                       double-float
                       ((+ iu 1))
                       ((1 *)))
 ldwrku)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorgqr m n n a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd n n
     (f2cl-lib:array-slice work
                           double-float
                           (iu)
                           ((1 *)))
     ldwrku s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
```

```
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(dlacpy "U" n n
 (f2cl-lib:array-slice work double-float (iu) ((1 *)))
 ldwrku vt ldvt)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "Q" n n n
     (f2cl-lib:array-slice work
                          double-float
                          (iu)
                          ((1 *)))
     ldwrku
     (f2cl-lib:array-slice work
                          double-float
                          (itauq)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "P" n n n vt ldvt
     (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
```

```
                              ((1 *)))
       (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
       ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8))
    (setf ierr var-9))
  (setf iwork (f2cl-lib:int-add ie n))
  (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
         var-8 var-9 var-10 var-11 var-12 var-13 var-14)
      (dbdsqr "U" n n n 0 s
       (f2cl-lib:array-slice work
                             double-float
                             (ie)
                             ((1 *)))
       vt ldvt
       (f2cl-lib:array-slice work
                             double-float
                             (iu)
                             ((1 *)))
       ldwrku dum 1
       (f2cl-lib:array-slice work
                             double-float
                             (iwork)
                             ((1 *)))
       info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8 var-9 var-10 var-11
                     var-12 var-13))
    (setf info var-14))
  (dgemm "N" "N" m n n one a lda
   (f2cl-lib:array-slice work double-float (iu) ((1 *)))
   ldwrku zero u ldu))
 (t
  (setf itau 1)
  (setf iwork (f2cl-lib:int-add itau n))
  (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
      (dgeqrf m n a lda
       (f2cl-lib:array-slice work
                             double-float
                             (itau)
                             ((1 *)))
       (f2cl-lib:array-slice work
                             double-float
                             (iwork)
                             ((1 *)))
       (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
       ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
```

```
                  var-6))
  (setf ierr var-7))
(dlacpy "L" m n a lda u ldu)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorgqr m n n u ldu
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(dlacpy "U" n n a lda vt ldvt)
(dlaset "L" (f2cl-lib:int-sub n 1)
 (f2cl-lib:int-sub n 1) zero zero
 (f2cl-lib:array-slice vt
                       double-float
                       (2 1)
                       ((1 ldvt) (1 *)))
 ldvt)
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd n n vt ldvt s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
```

```
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13)
    (dormbr "Q" "R" "N" m n n vt ldvt
     (f2cl-lib:array-slice work
                          double-float
                          (itauq)
                          ((1 *)))
     u ldu
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9 var-10 var-11
                   var-12))
  (setf ierr var-13))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "P" n n n vt ldvt
     (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14)
    (dbdsqr "U" n n m 0 s
     (f2cl-lib:array-slice work
                          double-float
```

```
                                    (ie)
                                    ((1 *)))
                vt ldvt u ldu dum 1
                (f2cl-lib:array-slice work
                                    double-float
                                    (iwork)
                                    ((1 *)))
                info)
              (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                               var-6 var-7 var-8 var-9 var-10 var-11
                               var-12 var-13))
              (setf info var-14)))))))
    (wntua
     (cond
       (wntvn
        (cond
          ((>= lwork
               (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                                 (max
                                  (the fixnum
                                       (f2cl-lib:int-add n m))
                                  (the fixnum
                                       (f2cl-lib:int-mul 4 n))
                                  (the fixnum bdspac))))
           (setf ir 1)
           (cond
             ((>= lwork
                  (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul lda n)))
              (setf ldwrkr lda))
             (t
              (setf ldwrkr n)))
           (setf itau
                 (f2cl-lib:int-add ir
                                   (f2cl-lib:int-mul ldwrkr n)))
           (setf iwork (f2cl-lib:int-add itau n))
           (multiple-value-bind
                 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
               (dgeqrf m n a lda
                (f2cl-lib:array-slice work
                                    double-float
                                    (itau)
                                    ((1 *)))
                (f2cl-lib:array-slice work
                                    double-float
                                    (iwork)
                                    ((1 *)))
                (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
                ierr)
             (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                              var-6))
```

```
  (setf ierr var-7))
(dlacpy "L" m n a lda u ldu)
(dlacpy "U" n n a lda
 (f2cl-lib:array-slice work double-float (ir) ((1 *)))
 ldwrkr)
(dlaset "L" (f2cl-lib:int-sub n 1)
 (f2cl-lib:int-sub n 1) zero zero
 (f2cl-lib:array-slice work
                       double-float
                       ((+ ir 1))
                       ((1 *)))
 ldwrkr)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorgqr m m n u ldu
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd n n
     (f2cl-lib:array-slice work
                           double-float
                           (ir)
                           ((1 *)))
     ldwrkr s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
```

```
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "Q" n n n
     (f2cl-lib:array-slice work
                           double-float
                           (ir)
                           ((1 *)))
     ldwrkr
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14)
    (dbdsqr "U" n 0 n 0 s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     dum 1
     (f2cl-lib:array-slice work
                           double-float
                           (ir)
                           ((1 *)))
     ldwrkr dum 1
```

```
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      info)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9 var-10 var-11
                    var-12 var-13))
   (setf info var-14))
 (dgemm "N" "N" m n n one u ldu
  (f2cl-lib:array-slice work double-float (ir) ((1 *)))
  ldwrkr zero a lda)
 (dlacpy "F" m n a lda u ldu))
(t
 (setf itau 1)
 (setf iwork (f2cl-lib:int-add itau n))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
     (dgeqrf m n a lda
      (f2cl-lib:array-slice work
                            double-float
                            (itau)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6))
   (setf ierr var-7))
 (dlacpy "L" m n a lda u ldu)
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8)
     (dorgqr m m n u ldu
      (f2cl-lib:array-slice work
                            double-float
                            (itau)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7))
   (setf ierr var-8))
```

```
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(dlaset "L" (f2cl-lib:int-sub n 1)
 (f2cl-lib:int-sub n 1) zero zero
 (f2cl-lib:array-slice a
                       double-float
                       (2 1)
                       ((1 lda) (1 *)))
 lda)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd n n a lda s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13)
    (dormbr "Q" "R" "N" m n n a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     u ldu
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
```

```
           ierr)
         (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                          var-6 var-7 var-8 var-9 var-10 var-11
                          var-12))
         (setf ierr var-13))
       (setf iwork (f2cl-lib:int-add ie n))
       (multiple-value-bind
            (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
             var-8 var-9 var-10 var-11 var-12 var-13 var-14)
           (dbdsqr "U" n 0 m 0 s
            (f2cl-lib:array-slice work
                                  double-float
                                  (ie)
                                  ((1 *)))
            dum 1 u ldu dum 1
            (f2cl-lib:array-slice work
                                  double-float
                                  (iwork)
                                  ((1 *)))
            info)
         (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                          var-6 var-7 var-8 var-9 var-10 var-11
                          var-12 var-13))
         (setf info var-14)))))
  (wntvo
   (cond
     ((>= lwork
          (f2cl-lib:int-add (f2cl-lib:int-mul 2 n n)
                            (max
                             (the fixnum
                                  (f2cl-lib:int-add n m))
                             (the fixnum
                                  (f2cl-lib:int-mul 4 n))
                             (the fixnum bdspac))))
       (setf iu 1)
       (cond
         ((>= lwork
              (f2cl-lib:int-add wrkbl
                                (f2cl-lib:int-mul 2 lda n)))
          (setf ldwrku lda)
          (setf ir
                (f2cl-lib:int-add iu
                                  (f2cl-lib:int-mul ldwrku
                                                    n)))
          (setf ldwrkr lda))
         ((>= lwork
              (f2cl-lib:int-add wrkbl
                                (f2cl-lib:int-mul
                                 (f2cl-lib:int-add lda n)
                                 n)))
```

```
   (setf ldwrku lda)
   (setf ir
           (f2cl-lib:int-add iu
                             (f2cl-lib:int-mul ldwrku
                                               n)))
   (setf ldwrkr n))
  (t
   (setf ldwrku n)
   (setf ir
           (f2cl-lib:int-add iu
                             (f2cl-lib:int-mul ldwrku
                                               n)))
   (setf ldwrkr n)))
(setf itau
       (f2cl-lib:int-add ir
                         (f2cl-lib:int-mul ldwrkr n)))
(setf iwork (f2cl-lib:int-add itau n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgeqrf m n a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6))
  (setf ierr var-7))
(dlacpy "L" m n a lda u ldu)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorgqr m m n u ldu
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
```

```
  (setf ierr var-8))
(dlacpy "U" n n a lda
 (f2cl-lib:array-slice work double-float (iu) ((1 *)))
 ldwrku)
(dlaset "L" (f2cl-lib:int-sub n 1)
 (f2cl-lib:int-sub n 1) zero zero
 (f2cl-lib:array-slice work
                       double-float
                       ((+ iu 1))
                       ((1 *)))
 ldwrku)
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd n n
     (f2cl-lib:array-slice work
                           double-float
                           (iu)
                           ((1 *)))
     ldwrku s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(dlacpy "U" n n
 (f2cl-lib:array-slice work double-float (iu) ((1 *)))
 ldwrku
 (f2cl-lib:array-slice work double-float (ir) ((1 *)))
 ldwrkr)
```

```
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "Q" n n n
     (f2cl-lib:array-slice work
                           double-float
                           (iu)
                           ((1 *)))
     ldwrku
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "P" n n n
     (f2cl-lib:array-slice work
                           double-float
                           (ir)
                           ((1 *)))
     ldwrkr
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14)
    (dbdsqr "U" n n n 0 s
     (f2cl-lib:array-slice work
```

```
                              double-float
                              (ie)
                              ((1 *)))
        (f2cl-lib:array-slice work
                              double-float
                              (ir)
                              ((1 *)))
        ldwrkr
        (f2cl-lib:array-slice work
                              double-float
                              (iu)
                              ((1 *)))
        ldwrku dum 1
        (f2cl-lib:array-slice work
                              double-float
                              (iwork)
                              ((1 *)))
        info)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                      var-6 var-7 var-8 var-9 var-10 var-11
                      var-12 var-13))
     (setf info var-14))
   (dgemm "N" "N" m n n one u ldu
    (f2cl-lib:array-slice work double-float (iu) ((1 *)))
    ldwrku zero a lda)
   (dlacpy "F" m n a lda u ldu)
   (dlacpy "F" n n
    (f2cl-lib:array-slice work double-float (ir) ((1 *)))
    ldwrkr a lda))
  (t
   (setf itau 1)
   (setf iwork (f2cl-lib:int-add itau n))
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
       (dgeqrf m n a lda
        (f2cl-lib:array-slice work
                              double-float
                              (itau)
                              ((1 *)))
        (f2cl-lib:array-slice work
                              double-float
                              (iwork)
                              ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
        ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                      var-6))
     (setf ierr var-7))
   (dlacpy "L" m n a lda u ldu)
   (multiple-value-bind
```

```
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorgqr m m n u ldu
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(dlaset "L" (f2cl-lib:int-sub n 1)
 (f2cl-lib:int-sub n 1) zero zero
 (f2cl-lib:array-slice a
                       double-float
                       (2 1)
                       ((1 lda) (1 *)))
 lda)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd n n a lda s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
```

```
                  var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
     (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
      var-8 var-9 var-10 var-11 var-12 var-13)
   (dormbr "Q" "R" "N" m n n a lda
    (f2cl-lib:array-slice work
                          double-float
                          (itauq)
                          ((1 *)))
    u ldu
    (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                  var-6 var-7 var-8 var-9 var-10 var-11
                  var-12))
  (setf ierr var-13))
(multiple-value-bind
     (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
      var-8 var-9)
   (dorgbr "P" n n n a lda
    (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))
    (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
    ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                  var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie n))
(multiple-value-bind
     (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
      var-8 var-9 var-10 var-11 var-12 var-13 var-14)
   (dbdsqr "U" n n m 0 s
    (f2cl-lib:array-slice work
                          double-float
                          (ie)
                          ((1 *)))
    a lda u ldu dum 1
    (f2cl-lib:array-slice work
                          double-float
```

```
                                (iwork)
                                ((1 *)))
          info)
       (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                        var-6 var-7 var-8 var-9 var-10 var-11
                        var-12 var-13))
       (setf info var-14)))))
(wntvas
 (cond
   ((>= lwork
        (f2cl-lib:int-add (f2cl-lib:int-mul n n)
                          (max
                           (the fixnum
                                (f2cl-lib:int-add n m))
                           (the fixnum
                                (f2cl-lib:int-mul 4 n))
                           (the fixnum bdspac))))
    (setf iu 1)
    (cond
      ((>= lwork
           (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul lda n)))
       (setf ldwrku lda))
      (t
       (setf ldwrku n)))
    (setf itau
          (f2cl-lib:int-add iu
                            (f2cl-lib:int-mul ldwrku n)))
    (setf iwork (f2cl-lib:int-add itau n))
    (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
        (dgeqrf m n a lda
         (f2cl-lib:array-slice work
                               double-float
                               (itau)
                               ((1 *)))
         (f2cl-lib:array-slice work
                               double-float
                               (iwork)
                               ((1 *)))
         (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
         ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                       var-6))
      (setf ierr var-7))
    (dlacpy "L" m n a lda u ldu)
    (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
           var-8)
        (dorgqr m m n u ldu
         (f2cl-lib:array-slice work
```

```
                          double-float
                          (itau)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(dlacpy "U" n n a lda
 (f2cl-lib:array-slice work double-float (iu) ((1 *)))
 ldwrku)
(dlaset "L" (f2cl-lib:int-sub n 1)
 (f2cl-lib:int-sub n 1) zero zero
 (f2cl-lib:array-slice work
                       double-float
                       ((+ iu 1))
                       ((1 *)))
 ldwrku)
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd n n
     (f2cl-lib:array-slice work
                          double-float
                          (iu)
                          ((1 *)))
     ldwrku s
     (f2cl-lib:array-slice work
                          double-float
                          (ie)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (itauq)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
```

```
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(dlacpy "U" n n
 (f2cl-lib:array-slice work double-float (iu) ((1 *)))
 ldwrku vt ldvt)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "Q" n n n
     (f2cl-lib:array-slice work
                           double-float
                           (iu)
                           ((1 *)))
     ldwrku
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "P" n n n vt ldvt
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie n))
(multiple-value-bind
```

```
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8 var-9 var-10 var-11 var-12 var-13 var-14)
      (dbdsqr "U" n n n 0 s
       (f2cl-lib:array-slice work
                             double-float
                             (ie)
                             ((1 *)))
       vt ldvt
       (f2cl-lib:array-slice work
                             double-float
                             (iu)
                             ((1 *)))
       ldwrku dum 1
       (f2cl-lib:array-slice work
                             double-float
                             (iwork)
                             ((1 *)))
       info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8 var-9 var-10 var-11
                     var-12 var-13))
    (setf info var-14))
  (dgemm "N" "N" m n n one u ldu
   (f2cl-lib:array-slice work double-float (iu) ((1 *)))
   ldwrku zero a lda)
  (dlacpy "F" m n a lda u ldu))
 (t
  (setf itau 1)
  (setf iwork (f2cl-lib:int-add itau n))
  (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
      (dgeqrf m n a lda
       (f2cl-lib:array-slice work
                             double-float
                             (itau)
                             ((1 *)))
       (f2cl-lib:array-slice work
                             double-float
                             (iwork)
                             ((1 *)))
       (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
       ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6))
    (setf ierr var-7))
  (dlacpy "L" m n a lda u ldu)
  (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
         var-8)
      (dorgqr m m n u ldu
```

```
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(dlacpy "U" n n a lda vt ldvt)
(dlaset "L" (f2cl-lib:int-sub n 1)
 (f2cl-lib:int-sub n 1) zero zero
 (f2cl-lib:array-slice vt
                       double-float
                       (2 1)
                       ((1 ldvt) (1 *)))
 ldvt)
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie n))
(setf itaup (f2cl-lib:int-add itauq n))
(setf iwork (f2cl-lib:int-add itaup n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd n n vt ldvt s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
```

```
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13)
    (dormbr "Q" "R" "N" m n n vt ldvt
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     u ldu
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9 var-10 var-11
                   var-12))
  (setf ierr var-13))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "P" n n n vt ldvt
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie n))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14)
    (dbdsqr "U" n n m 0 s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     vt ldvt u ldu dum 1
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
```

```
                info)
              (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                               var-6 var-7 var-8 var-9 var-10 var-11
                               var-12 var-13))
              (setf info var-14)))))))))
  (t
   (setf ie 1)
   (setf itauq (f2cl-lib:int-add ie n))
   (setf itaup (f2cl-lib:int-add itauq n))
   (setf iwork (f2cl-lib:int-add itaup n))
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
          var-9 var-10)
       (dgebrd m n a lda s
        (f2cl-lib:array-slice work double-float (ie) ((1 *)))
        (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
        (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
        (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                      var-7 var-8 var-9))
     (setf ierr var-10))
   (cond
     (wntuas
      (dlacpy "L" m n a lda u ldu)
      (if wntus (setf ncu n))
      (if wntua (setf ncu m))
      (multiple-value-bind
            (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
             var-9)
          (dorgbr "Q" m ncu n u ldu
           (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
           (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
           (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                         var-7 var-8))
        (setf ierr var-9))))
   (cond
     (wntvas
      (dlacpy "U" n n a lda vt ldvt)
      (multiple-value-bind
            (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
             var-9)
          (dorgbr "P" n n n vt ldvt
           (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
           (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
           (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                         var-7 var-8))
        (setf ierr var-9))))
```

```
(cond
  (wntuo
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
          var-9)
       (dorgbr "Q" m n n a lda
        (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
        (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                      var-7 var-8))
     (setf ierr var-9))))
(cond
  (wntvo
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
          var-9)
       (dorgbr "P" n n n a lda
        (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
        (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                      var-7 var-8))
     (setf ierr var-9))))
(setf iwork (f2cl-lib:int-add ie n))
(if (or wntuas wntuo) (setf nru m))
(if wntun (setf nru 0))
(if (or wntvas wntvo) (setf ncvt n))
(if wntvn (setf ncvt 0))
(cond
  ((and (not wntuo) (not wntvo))
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
          var-9 var-10 var-11 var-12 var-13 var-14)
       (dbdsqr "U" n ncvt nru 0 s
        (f2cl-lib:array-slice work double-float (ie) ((1 *))) vt
        ldvt u ldu dum 1
        (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
        info)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                      var-7 var-8 var-9 var-10 var-11 var-12
                      var-13))
     (setf info var-14)))
  ((and (not wntuo) wntvo)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
          var-9 var-10 var-11 var-12 var-13 var-14)
       (dbdsqr "U" n ncvt nru 0 s
        (f2cl-lib:array-slice work double-float (ie) ((1 *))) a
        lda u ldu dum 1
```

```
                (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
                info)
              (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                               var-7 var-8 var-9 var-10 var-11 var-12
                               var-13))
              (setf info var-14)))
            (t
             (multiple-value-bind
                   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                    var-9 var-10 var-11 var-12 var-13 var-14)
                 (dbdsqr "U" n ncvt nru 0 s
                  (f2cl-lib:array-slice work double-float (ie) ((1 *))) vt
                  ldvt a lda dum 1
                  (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
                  info)
               (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                                var-7 var-8 var-9 var-10 var-11 var-12
                                var-13))
               (setf info var-14)))))))
    (t
     (cond
       ((>= n mnthr)
        (cond
          (wntvn
           (setf itau 1)
           (setf iwork (f2cl-lib:int-add itau m))
           (multiple-value-bind
                 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
               (dgelqf m n a lda
                (f2cl-lib:array-slice work double-float (itau) ((1 *)))
                (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
                (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
             (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
             (setf ierr var-7))
           (dlaset "U" (f2cl-lib:int-sub m 1) (f2cl-lib:int-sub m 1) zero
            zero
            (f2cl-lib:array-slice a double-float (1 2) ((1 lda) (1 *)))
            lda)
           (setf ie 1)
           (setf itauq (f2cl-lib:int-add ie m))
           (setf itaup (f2cl-lib:int-add itauq m))
           (setf iwork (f2cl-lib:int-add itaup m))
           (multiple-value-bind
                 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                  var-9 var-10)
               (dgebrd m m a lda s
                (f2cl-lib:array-slice work double-float (ie) ((1 *)))
                (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
                (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
                (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
```

```
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9))
  (setf ierr var-10))
 (cond
  ((or wntuo wntuas)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
          var-8 var-9)
       (dorgbr "Q" m m m a lda
        (f2cl-lib:array-slice work
                              double-float
                              (itauq)
                              ((1 *)))
        (f2cl-lib:array-slice work
                              double-float
                              (iwork)
                              ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
        ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                       var-6 var-7 var-8))
      (setf ierr var-9))))
 (setf iwork (f2cl-lib:int-add ie m))
 (setf nru 0)
 (if (or wntuo wntuas) (setf nru m))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9 var-10 var-11 var-12 var-13 var-14)
     (dbdsqr "U" m 0 nru 0 s
      (f2cl-lib:array-slice work double-float (ie) ((1 *))) dum
      1 a lda dum 1
      (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
      info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10 var-11 var-12
                   var-13))
  (setf info var-14))
 (if wntuas (dlacpy "F" m m a lda u ldu)))
((and wntvo wntun)
 (cond
  ((>= lwork
       (f2cl-lib:int-add (f2cl-lib:int-mul m m)
                         (max
                          (the fixnum
                               (f2cl-lib:int-mul 4 m))
                          (the fixnum bdspac))))
   (setf ir 1)
   (cond
     ((>= lwork
```

```
          (f2cl-lib:int-add
           (max (the fixnum wrkbl)
                (the fixnum
                     (f2cl-lib:int-add
                      (f2cl-lib:int-mul lda n)
                      m)))
           (f2cl-lib:int-mul lda m)))
    (setf ldwrku lda)
    (setf chunk n)
    (setf ldwrkr lda))
   ((>= lwork
          (f2cl-lib:int-add
           (max (the fixnum wrkbl)
                (the fixnum
                     (f2cl-lib:int-add
                      (f2cl-lib:int-mul lda n)
                      m)))
           (f2cl-lib:int-mul m m)))
    (setf ldwrku lda)
    (setf chunk n)
    (setf ldwrkr m))
   (t
    (setf ldwrku m)
    (setf chunk
            (the fixnum
                 (truncate (- lwork (* m m) m) m)))
    (setf ldwrkr m)))
(setf itau
        (f2cl-lib:int-add ir (f2cl-lib:int-mul ldwrkr m)))
(setf iwork (f2cl-lib:int-add itau m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgelqf m n a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6))
  (setf ierr var-7))
(dlacpy "L" m m a lda
 (f2cl-lib:array-slice work double-float (ir) ((1 *)))
 ldwrkr)
(dlaset "U" (f2cl-lib:int-sub m 1) (f2cl-lib:int-sub m 1)
```

```
 zero zero
 (f2cl-lib:array-slice work
                       double-float
                       ((+ ir ldwrkr))
                       ((1 *)))
 ldwrkr)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorglq m n m a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd m m
     (f2cl-lib:array-slice work double-float (ir) ((1 *)))
     ldwrkr s
     (f2cl-lib:array-slice work double-float (ie) ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
```

```
  (setf ierr var-10))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "P" m m m
     (f2cl-lib:array-slice work double-float (ir) ((1 *)))
     ldwrkr
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14)
    (dbdsqr "U" m m 0 0 s
     (f2cl-lib:array-slice work double-float (ie) ((1 *)))
     (f2cl-lib:array-slice work double-float (ir) ((1 *)))
     ldwrkr dum 1 dum 1
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9 var-10 var-11
                   var-12 var-13))
  (setf info var-14))
(setf iu (f2cl-lib:int-add ie m))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i chunk))
              ((> i n) nil)
  (tagbody
    (setf blk
            (min
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-sub n i)
                                    1))
             (the fixnum chunk)))
    (dgemm "N" "N" m blk m one
     (f2cl-lib:array-slice work double-float (ir) ((1 *)))
     ldwrkr
```

```
      (f2cl-lib:array-slice a
                            double-float
                            (1 i)
                            ((1 lda) (1 *)))
      lda zero
      (f2cl-lib:array-slice work double-float (iu) ((1 *)))
      ldwrku)
     (dlacpy "F" m blk
      (f2cl-lib:array-slice work double-float (iu) ((1 *)))
      ldwrku
      (f2cl-lib:array-slice a
                            double-float
                            (1 i)
                            ((1 lda) (1 *)))
      lda))))
(t
 (setf ie 1)
 (setf itauq (f2cl-lib:int-add ie m))
 (setf itaup (f2cl-lib:int-add itauq m))
 (setf iwork (f2cl-lib:int-add itaup m))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8 var-9 var-10)
     (dgebrd m n a lda s
      (f2cl-lib:array-slice work double-float (ie) ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (itauq)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (itaup)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9))
   (setf ierr var-10))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8 var-9)
     (dorgbr "P" m n m a lda
      (f2cl-lib:array-slice work
                            double-float
                            (itaup)
                            ((1 *)))
```

```
          (f2cl-lib:array-slice work
                                double-float
                                (iwork)
                                ((1 *)))
          (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
          ierr)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                         var-6 var-7 var-8))
        (setf ierr var-9))
      (setf iwork (f2cl-lib:int-add ie m))
      (multiple-value-bind
            (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
             var-8 var-9 var-10 var-11 var-12 var-13 var-14)
          (dbdsqr "L" m n 0 0 s
           (f2cl-lib:array-slice work double-float (ie) ((1 *)))
           a lda dum 1 dum 1
           (f2cl-lib:array-slice work
                                 double-float
                                 (iwork)
                                 ((1 *)))
           info)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                         var-6 var-7 var-8 var-9 var-10 var-11
                         var-12 var-13))
        (setf info var-14)))))
((and wntvo wntuas)
 (cond
   ((>= lwork
        (f2cl-lib:int-add (f2cl-lib:int-mul m m)
                          (max
                           (the fixnum
                                (f2cl-lib:int-mul 4 m))
                           (the fixnum bdspac))))
    (setf ir 1)
    (cond
      ((>= lwork
           (f2cl-lib:int-add
            (max (the fixnum wrkbl)
                 (the fixnum
                      (f2cl-lib:int-add
                       (f2cl-lib:int-mul lda n)
                       m)))
            (f2cl-lib:int-mul lda m)))
       (setf ldwrku lda)
       (setf chunk n)
       (setf ldwrkr lda))
      ((>= lwork
           (f2cl-lib:int-add
            (max (the fixnum wrkbl)
                 (the fixnum
```

```
                  (f2cl-lib:int-add
                   (f2cl-lib:int-mul lda n)
                   m)))
         (f2cl-lib:int-mul m m)))
   (setf ldwrku lda)
   (setf chunk n)
   (setf ldwrkr m))
  (t
   (setf ldwrku m)
   (setf chunk
           (the fixnum
                (truncate (- lwork (* m m) m) m)))
   (setf ldwrkr m)))
(setf itau
       (f2cl-lib:int-add ir (f2cl-lib:int-mul ldwrkr m)))
(setf iwork (f2cl-lib:int-add itau m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgelqf m n a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6))
  (setf ierr var-7))
(dlacpy "L" m m a lda u ldu)
(dlaset "U" (f2cl-lib:int-sub m 1) (f2cl-lib:int-sub m 1)
 zero zero
 (f2cl-lib:array-slice u
                       double-float
                       (1 2)
                       ((1 ldu) (1 *)))
 ldu)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorglq m n m a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
```

```
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd m m u ldu s
     (f2cl-lib:array-slice work double-float (ie) ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (itauq)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(dlacpy "U" m m u ldu
 (f2cl-lib:array-slice work double-float (ir) ((1 *)))
 ldwrkr)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "P" m m m
     (f2cl-lib:array-slice work double-float (ir) ((1 *)))
     ldwrkr
     (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
```

```
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "Q" m m m u ldu
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14)
    (dbdsqr "U" m m m 0 s
     (f2cl-lib:array-slice work double-float (ie) ((1 *)))
     (f2cl-lib:array-slice work double-float (ir) ((1 *)))
     ldwrkr u ldu dum 1
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9 var-10 var-11
                   var-12 var-13))
  (setf info var-14))
(setf iu (f2cl-lib:int-add ie m))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i chunk))
              ((> i n) nil)
  (tagbody
    (setf blk
            (min
             (the fixnum
                  (f2cl-lib:int-add (f2cl-lib:int-sub n i)
                                    1))
             (the fixnum chunk)))
    (dgemm "N" "N" m blk m one
```

```
      (f2cl-lib:array-slice work double-float (ir) ((1 *)))
      ldwrkr
      (f2cl-lib:array-slice a
                            double-float
                            (1 i)
                            ((1 lda) (1 *)))
      lda zero
      (f2cl-lib:array-slice work double-float (iu) ((1 *)))
      ldwrku)
     (dlacpy "F" m blk
      (f2cl-lib:array-slice work double-float (iu) ((1 *)))
      ldwrku
      (f2cl-lib:array-slice a
                            double-float
                            (1 i)
                            ((1 lda) (1 *)))
      lda))))
(t
 (setf itau 1)
 (setf iwork (f2cl-lib:int-add itau m))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
     (dgelqf m n a lda
      (f2cl-lib:array-slice work
                            double-float
                            (itau)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6))
   (setf ierr var-7))
 (dlacpy "L" m m a lda u ldu)
 (dlaset "U" (f2cl-lib:int-sub m 1) (f2cl-lib:int-sub m 1)
  zero zero
  (f2cl-lib:array-slice u
                        double-float
                        (1 2)
                        ((1 ldu) (1 *)))
  ldu)
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8)
     (dorglq m n m a lda
      (f2cl-lib:array-slice work
                            double-float
```

```
                          (itau)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd m m u ldu s
     (f2cl-lib:array-slice work double-float (ie) ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (itauq)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13)
    (dormbr "P" "L" "T" m n m u ldu
     (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))
     a lda
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
```

```
          (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
          ierr)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                         var-6 var-7 var-8 var-9 var-10 var-11
                         var-12))
        (setf ierr var-13))
      (multiple-value-bind
           (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
            var-8 var-9)
          (dorgbr "Q" m m m u ldu
           (f2cl-lib:array-slice work
                                 double-float
                                 (itauq)
                                 ((1 *)))
           (f2cl-lib:array-slice work
                                 double-float
                                 (iwork)
                                 ((1 *)))
           (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
           ierr)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                         var-6 var-7 var-8))
        (setf ierr var-9))
      (setf iwork (f2cl-lib:int-add ie m))
      (multiple-value-bind
           (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
            var-8 var-9 var-10 var-11 var-12 var-13 var-14)
          (dbdsqr "U" m n m 0 s
           (f2cl-lib:array-slice work double-float (ie) ((1 *)))
           a lda u ldu dum 1
           (f2cl-lib:array-slice work
                                 double-float
                                 (iwork)
                                 ((1 *)))
           info)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                         var-6 var-7 var-8 var-9 var-10 var-11
                         var-12 var-13))
        (setf info var-14)))))
  (wntvs
   (cond
     (wntun
      (cond
        ((>= lwork
             (f2cl-lib:int-add (f2cl-lib:int-mul m m)
                               (max
                                (the fixnum
                                     (f2cl-lib:int-mul 4 m))
                                (the fixnum bdspac))))
         (setf ir 1)
```

```
(cond
  ((>= lwork
      (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul lda m)))
   (setf ldwrkr lda))
  (t
   (setf ldwrkr m)))
(setf itau
        (f2cl-lib:int-add ir
                          (f2cl-lib:int-mul ldwrkr m)))
(setf iwork (f2cl-lib:int-add itau m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgelqf m n a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6))
  (setf ierr var-7))
(dlacpy "L" m m a lda
 (f2cl-lib:array-slice work double-float (ir) ((1 *)))
 ldwrkr)
(dlaset "U" (f2cl-lib:int-sub m 1)
 (f2cl-lib:int-sub m 1) zero zero
 (f2cl-lib:array-slice work
                       double-float
                       ((+ ir ldwrkr))
                       ((1 *)))
 ldwrkr)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorglq m n m a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
```

```
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd m m
     (f2cl-lib:array-slice work
                           double-float
                           (ir)
                           ((1 *)))
     ldwrkr s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "P" m m m
     (f2cl-lib:array-slice work
                           double-float
                           (ir)
                           ((1 *)))
     ldwrkr
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
```

```
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8))
    (setf ierr var-9))
  (setf iwork (f2cl-lib:int-add ie m))
  (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
         var-8 var-9 var-10 var-11 var-12 var-13 var-14)
      (dbdsqr "U" m m 0 0 s
       (f2cl-lib:array-slice work
                             double-float
                             (ie)
                             ((1 *)))
       (f2cl-lib:array-slice work
                             double-float
                             (ir)
                             ((1 *)))
       ldwrkr dum 1 dum 1
       (f2cl-lib:array-slice work
                             double-float
                             (iwork)
                             ((1 *)))
       info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8 var-9 var-10 var-11
                     var-12 var-13))
    (setf info var-14))
  (dgemm "N" "N" m n m one
   (f2cl-lib:array-slice work double-float (ir) ((1 *)))
   ldwrkr a lda zero vt ldvt))
 (t
  (setf itau 1)
  (setf iwork (f2cl-lib:int-add itau m))
  (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
      (dgelqf m n a lda
       (f2cl-lib:array-slice work
                             double-float
                             (itau)
                             ((1 *)))
       (f2cl-lib:array-slice work
                             double-float
                             (iwork)
                             ((1 *)))
       (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
```

```
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6))
  (setf ierr var-7))
(dlacpy "U" m n a lda vt ldvt)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorglq m n m vt ldvt
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(dlaset "U" (f2cl-lib:int-sub m 1)
 (f2cl-lib:int-sub m 1) zero zero
 (f2cl-lib:array-slice a
                       double-float
                       (1 2)
                       ((1 lda) (1 *)))
 lda)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd m m a lda s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
```

```
                                  double-float
                                  (iwork)
                                  ((1 *)))
                (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
                ierr)
              (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                               var-6 var-7 var-8 var-9))
              (setf ierr var-10))
            (multiple-value-bind
                 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                  var-8 var-9 var-10 var-11 var-12 var-13)
                (dormbr "P" "L" "T" m n m a lda
                 (f2cl-lib:array-slice work
                                  double-float
                                  (itaup)
                                  ((1 *)))
                 vt ldvt
                 (f2cl-lib:array-slice work
                                  double-float
                                  (iwork)
                                  ((1 *)))
                 (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
                 ierr)
              (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                               var-6 var-7 var-8 var-9 var-10 var-11
                               var-12))
              (setf ierr var-13))
            (setf iwork (f2cl-lib:int-add ie m))
            (multiple-value-bind
                 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                  var-8 var-9 var-10 var-11 var-12 var-13 var-14)
                (dbdsqr "U" m n 0 0 s
                 (f2cl-lib:array-slice work
                                  double-float
                                  (ie)
                                  ((1 *)))
                 vt ldvt dum 1 dum 1
                 (f2cl-lib:array-slice work
                                  double-float
                                  (iwork)
                                  ((1 *)))
                 info)
              (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                               var-6 var-7 var-8 var-9 var-10 var-11
                               var-12 var-13))
              (setf info var-14)))))
        (wntuo
         (cond
           ((>= lwork
                (f2cl-lib:int-add (f2cl-lib:int-mul 2 m m)
```

```
                      (max
                       (the fixnum
                            (f2cl-lib:int-mul 4 m))
                       (the fixnum bdspac))))
(setf iu 1)
(cond
  ((>= lwork
       (f2cl-lib:int-add wrkbl
                         (f2cl-lib:int-mul 2 lda m)))
   (setf ldwrku lda)
   (setf ir
           (f2cl-lib:int-add iu
                             (f2cl-lib:int-mul ldwrku
                                               m)))
   (setf ldwrkr lda))
  ((>= lwork
       (f2cl-lib:int-add wrkbl
                         (f2cl-lib:int-mul
                          (f2cl-lib:int-add lda m)
                          m)))
   (setf ldwrku lda)
   (setf ir
           (f2cl-lib:int-add iu
                             (f2cl-lib:int-mul ldwrku
                                               m)))
   (setf ldwrkr m))
  (t
   (setf ldwrku m)
   (setf ir
           (f2cl-lib:int-add iu
                             (f2cl-lib:int-mul ldwrku
                                               m)))
   (setf ldwrkr m)))
(setf itau
        (f2cl-lib:int-add ir
                          (f2cl-lib:int-mul ldwrkr m)))
(setf iwork (f2cl-lib:int-add itau m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgelqf m n a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
```

```
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6))
  (setf ierr var-7))
(dlacpy "L" m m a lda
 (f2cl-lib:array-slice work double-float (iu) ((1 *)))
 ldwrku)
(dlaset "U" (f2cl-lib:int-sub m 1)
 (f2cl-lib:int-sub m 1) zero zero
 (f2cl-lib:array-slice work
                       double-float
                       ((+ iu ldwrku))
                       ((1 *)))
 ldwrku)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorglq m n m a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd m m
     (f2cl-lib:array-slice work
                           double-float
                           (iu)
                           ((1 *)))
     ldwrku s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
```

```
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(dlacpy "L" m m
 (f2cl-lib:array-slice work double-float (iu) ((1 *)))
 ldwrku
 (f2cl-lib:array-slice work double-float (ir) ((1 *)))
 ldwrkr)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "P" m m m
     (f2cl-lib:array-slice work
                          double-float
                          (iu)
                          ((1 *)))
     ldwrku
     (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "Q" m m m
     (f2cl-lib:array-slice work
                          double-float
                          (ir)
                          ((1 *)))
     ldwrkr
```

```
      (f2cl-lib:array-slice work
                            double-float
                            (itauq)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8))
    (setf ierr var-9))
   (setf iwork (f2cl-lib:int-add ie m))
   (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
         var-8 var-9 var-10 var-11 var-12 var-13 var-14)
       (dbdsqr "U" m m m 0 s
      (f2cl-lib:array-slice work
                            double-float
                            (ie)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (iu)
                            ((1 *)))
      ldwrku
      (f2cl-lib:array-slice work
                            double-float
                            (ir)
                            ((1 *)))
      ldwrkr dum 1
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8 var-9 var-10 var-11
                     var-12 var-13))
    (setf info var-14))
   (dgemm "N" "N" m n m one
    (f2cl-lib:array-slice work double-float (iu) ((1 *)))
    ldwrku a lda zero vt ldvt)
   (dlacpy "F" m m
    (f2cl-lib:array-slice work double-float (ir) ((1 *)))
    ldwrkr a lda))
  (t
   (setf itau 1)
   (setf iwork (f2cl-lib:int-add itau m))
```

```
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgelqf m n a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6))
  (setf ierr var-7))
(dlacpy "U" m n a lda vt ldvt)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorglq m n m vt ldvt
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(dlaset "U" (f2cl-lib:int-sub m 1)
 (f2cl-lib:int-sub m 1) zero zero
 (f2cl-lib:array-slice a
                       double-float
                       (1 2)
                       ((1 lda) (1 *)))
 lda)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd m m a lda s
     (f2cl-lib:array-slice work
```

```
                          double-float
                          (ie)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (itauq)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13)
    (dormbr "P" "L" "T" m n m a lda
     (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))
     vt ldvt
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9 var-10 var-11
                   var-12))
  (setf ierr var-13))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "Q" m m m a lda
     (f2cl-lib:array-slice work
                          double-float
                          (itauq)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
```

```
                                ((1 *)))
             (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
             ierr)
           (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                            var-6 var-7 var-8))
           (setf ierr var-9))
         (setf iwork (f2cl-lib:int-add ie m))
         (multiple-value-bind
               (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                var-8 var-9 var-10 var-11 var-12 var-13 var-14)
             (dbdsqr "U" m n m 0 s
              (f2cl-lib:array-slice work
                                    double-float
                                    (ie)
                                    ((1 *)))
              vt ldvt a lda dum 1
              (f2cl-lib:array-slice work
                                    double-float
                                    (iwork)
                                    ((1 *)))
              info)
           (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                            var-6 var-7 var-8 var-9 var-10 var-11
                            var-12 var-13))
           (setf info var-14)))))
(wntuas
 (cond
   ((>= lwork
        (f2cl-lib:int-add (f2cl-lib:int-mul m m)
                          (max
                           (the fixnum
                                (f2cl-lib:int-mul 4 m))
                           (the fixnum bdspac))))
    (setf iu 1)
    (cond
      ((>= lwork
           (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul lda m)))
       (setf ldwrku lda))
      (t
       (setf ldwrku m)))
    (setf itau
            (f2cl-lib:int-add iu
                              (f2cl-lib:int-mul ldwrku m)))
    (setf iwork (f2cl-lib:int-add itau m))
    (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
        (dgelqf m n a lda
         (f2cl-lib:array-slice work
                               double-float
                               (itau)
```

```
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6))
  (setf ierr var-7))
(dlacpy "L" m m a lda
 (f2cl-lib:array-slice work double-float (iu) ((1 *)))
 ldwrku)
(dlaset "U" (f2cl-lib:int-sub m 1)
 (f2cl-lib:int-sub m 1) zero zero
 (f2cl-lib:array-slice work
                       double-float
                       ((+ iu ldwrku))
                       ((1 *)))
 ldwrku)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorglq m n m a lda
     (f2cl-lib:array-slice work
                          double-float
                          (itau)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd m m
     (f2cl-lib:array-slice work
                          double-float
                          (iu)
                          ((1 *)))
     ldwrku s
```

```
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(dlacpy "L" m m
 (f2cl-lib:array-slice work double-float (iu) ((1 *)))
 ldwrku u ldu)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "P" m m m
     (f2cl-lib:array-slice work
                           double-float
                           (iu)
                           ((1 *)))
     ldwrku
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "Q" m m m u ldu
```

```
      (f2cl-lib:array-slice work
                            double-float
                            (itauq)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8))
    (setf ierr var-9))
  (setf iwork (f2cl-lib:int-add ie m))
  (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8 var-9 var-10 var-11 var-12 var-13 var-14)
      (dbdsqr "U" m m m 0 s
       (f2cl-lib:array-slice work
                             double-float
                             (ie)
                             ((1 *)))
       (f2cl-lib:array-slice work
                             double-float
                             (iu)
                             ((1 *)))
       ldwrku u ldu dum 1
       (f2cl-lib:array-slice work
                             double-float
                             (iwork)
                             ((1 *)))
       info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8 var-9 var-10 var-11
                     var-12 var-13))
    (setf info var-14))
  (dgemm "N" "N" m n m one
   (f2cl-lib:array-slice work double-float (iu) ((1 *)))
   ldwrku a lda zero vt ldvt))
 (t
  (setf itau 1)
  (setf iwork (f2cl-lib:int-add itau m))
  (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
      (dgelqf m n a lda
       (f2cl-lib:array-slice work
                             double-float
                             (itau)
                             ((1 *)))
       (f2cl-lib:array-slice work
```

```
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6))
  (setf ierr var-7))
(dlacpy "U" m n a lda vt ldvt)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorglq m n m vt ldvt
     (f2cl-lib:array-slice work
                          double-float
                          (itau)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(dlacpy "L" m m a lda u ldu)
(dlaset "U" (f2cl-lib:int-sub m 1)
 (f2cl-lib:int-sub m 1) zero zero
 (f2cl-lib:array-slice u
                       double-float
                       (1 2)
                       ((1 ldu) (1 *)))
 ldu)
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd m m u ldu s
     (f2cl-lib:array-slice work
                          double-float
                          (ie)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (itauq)
                          ((1 *)))
```

```
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13)
    (dormbr "P" "L" "T" m n m u ldu
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     vt ldvt
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9 var-10 var-11
                   var-12))
  (setf ierr var-13))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "Q" m m m u ldu
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie m))
```

```
        (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
               var-8 var-9 var-10 var-11 var-12 var-13 var-14)
            (dbdsqr "U" m n m 0 s
             (f2cl-lib:array-slice work
                                   double-float
                                   (ie)
                                   ((1 *)))
             vt ldvt u ldu dum 1
             (f2cl-lib:array-slice work
                                   double-float
                                   (iwork)
                                   ((1 *)))
             info)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                           var-6 var-7 var-8 var-9 var-10 var-11
                           var-12 var-13))
          (setf info var-14)))))))
(wntva
 (cond
   (wntun
    (cond
      ((>= lwork
           (f2cl-lib:int-add (f2cl-lib:int-mul m m)
                             (max
                              (the fixnum
                                   (f2cl-lib:int-add n m))
                              (the fixnum
                                   (f2cl-lib:int-mul 4 m))
                              (the fixnum bdspac))))
       (setf ir 1)
       (cond
         ((>= lwork
              (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul lda m)))
          (setf ldwrkr lda))
         (t
          (setf ldwrkr m)))
       (setf itau
             (f2cl-lib:int-add ir
                               (f2cl-lib:int-mul ldwrkr m)))
       (setf iwork (f2cl-lib:int-add itau m))
       (multiple-value-bind
             (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
           (dgelqf m n a lda
            (f2cl-lib:array-slice work
                                  double-float
                                  (itau)
                                  ((1 *)))
            (f2cl-lib:array-slice work
                                  double-float
```

```
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6))
  (setf ierr var-7))
(dlacpy "U" m n a lda vt ldvt)
(dlacpy "L" m m a lda
 (f2cl-lib:array-slice work double-float (ir) ((1 *)))
 ldwrkr)
(dlaset "U" (f2cl-lib:int-sub m 1)
 (f2cl-lib:int-sub m 1) zero zero
 (f2cl-lib:array-slice work
                       double-float
                       ((+ ir ldwrkr))
                       ((1 *)))
 ldwrkr)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorglq n n m vt ldvt
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd m m
     (f2cl-lib:array-slice work
                           double-float
                           (ir)
                           ((1 *)))
     ldwrkr s
     (f2cl-lib:array-slice work
                           double-float
```

```
                          (ie)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (itauq)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "P" m m m
     (f2cl-lib:array-slice work
                          double-float
                          (ir)
                          ((1 *)))
     ldwrkr
     (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14)
    (dbdsqr "U" m m 0 0 s
     (f2cl-lib:array-slice work
                          double-float
                          (ie)
                          ((1 *)))
```

```
      (f2cl-lib:array-slice work
                            double-float
                            (ir)
                            ((1 *)))
      ldwrkr dum 1 dum 1
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8 var-9 var-10 var-11
                     var-12 var-13))
    (setf info var-14))
  (dgemm "N" "N" m n m one
   (f2cl-lib:array-slice work double-float (ir) ((1 *)))
   ldwrkr vt ldvt zero a lda)
  (dlacpy "F" m n a lda vt ldvt))
 (t
  (setf itau 1)
  (setf iwork (f2cl-lib:int-add itau m))
  (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
      (dgelqf m n a lda
       (f2cl-lib:array-slice work
                             double-float
                             (itau)
                             ((1 *)))
       (f2cl-lib:array-slice work
                             double-float
                             (iwork)
                             ((1 *)))
       (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
       ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6))
    (setf ierr var-7))
  (dlacpy "U" m n a lda vt ldvt)
  (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
         var-8)
      (dorglq n n m vt ldvt
       (f2cl-lib:array-slice work
                             double-float
                             (itau)
                             ((1 *)))
       (f2cl-lib:array-slice work
                             double-float
                             (iwork)
                             ((1 *)))
```

```
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(dlaset "U" (f2cl-lib:int-sub m 1)
 (f2cl-lib:int-sub m 1) zero zero
 (f2cl-lib:array-slice a
                       double-float
                       (1 2)
                       ((1 lda) (1 *)))
 lda)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd m m a lda s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13)
    (dormbr "P" "L" "T" m n m a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     vt ldvt
```

```
          (f2cl-lib:array-slice work
                                double-float
                                (iwork)
                                ((1 *)))
          (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
          ierr)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                         var-6 var-7 var-8 var-9 var-10 var-11
                         var-12))
        (setf ierr var-13))
      (setf iwork (f2cl-lib:int-add ie m))
      (multiple-value-bind
           (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
            var-8 var-9 var-10 var-11 var-12 var-13 var-14)
          (dbdsqr "U" m n 0 0 s
           (f2cl-lib:array-slice work
                                 double-float
                                 (ie)
                                 ((1 *)))
           vt ldvt dum 1 dum 1
           (f2cl-lib:array-slice work
                                 double-float
                                 (iwork)
                                 ((1 *)))
           info)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                         var-6 var-7 var-8 var-9 var-10 var-11
                         var-12 var-13))
        (setf info var-14)))))
(wntuo
 (cond
   ((>= lwork
        (f2cl-lib:int-add (f2cl-lib:int-mul 2 m m)
                          (max
                           (the fixnum
                                (f2cl-lib:int-add n m))
                           (the fixnum
                                (f2cl-lib:int-mul 4 m))
                           (the fixnum bdspac))))
    (setf iu 1)
    (cond
      ((>= lwork
           (f2cl-lib:int-add wrkbl
                             (f2cl-lib:int-mul 2 lda m)))
       (setf ldwrku lda)
       (setf ir
             (f2cl-lib:int-add iu
                               (f2cl-lib:int-mul ldwrku
                                                 m)))
       (setf ldwrkr lda))
```

```
  ((>= lwork
       (f2cl-lib:int-add wrkbl
                         (f2cl-lib:int-mul
                          (f2cl-lib:int-add lda m)
                          m)))
   (setf ldwrku lda)
   (setf ir
           (f2cl-lib:int-add iu
                             (f2cl-lib:int-mul ldwrku
                                               m)))
   (setf ldwrkr m))
  (t
   (setf ldwrku m)
   (setf ir
           (f2cl-lib:int-add iu
                             (f2cl-lib:int-mul ldwrku
                                               m)))
   (setf ldwrkr m)))
(setf itau
        (f2cl-lib:int-add ir
                          (f2cl-lib:int-mul ldwrkr m)))
(setf iwork (f2cl-lib:int-add itau m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
    (dgelqf m n a lda
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6))
  (setf ierr var-7))
(dlacpy "U" m n a lda vt ldvt)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorglq n n m vt ldvt
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
```

```
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(dlacpy "L" m m a lda
 (f2cl-lib:array-slice work double-float (iu) ((1 *)))
 ldwrku)
(dlaset "U" (f2cl-lib:int-sub m 1)
 (f2cl-lib:int-sub m 1) zero zero
 (f2cl-lib:array-slice work
                       double-float
                       ((+ iu ldwrku))
                       ((1 *)))
 ldwrku)
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd m m
     (f2cl-lib:array-slice work
                           double-float
                           (iu)
                           ((1 *)))
     ldwrku s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
```

```
(dlacpy "L" m m
 (f2cl-lib:array-slice work double-float (iu) ((1 *)))
 ldwrku
 (f2cl-lib:array-slice work double-float (ir) ((1 *)))
 ldwrkr)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "P" m m m
     (f2cl-lib:array-slice work
                           double-float
                           (iu)
                           ((1 *)))
     ldwrku
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "Q" m m m
     (f2cl-lib:array-slice work
                           double-float
                           (ir)
                           ((1 *)))
     ldwrkr
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie m))
```

```
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14)
    (dbdsqr "U" m m m 0 s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iu)
                           ((1 *)))
     ldwrku
     (f2cl-lib:array-slice work
                           double-float
                           (ir)
                           ((1 *)))
     ldwrkr dum 1
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9 var-10 var-11
                   var-12 var-13))
  (setf info var-14))
 (dgemm "N" "N" m n m one
  (f2cl-lib:array-slice work double-float (iu) ((1 *)))
  ldwrku vt ldvt zero a lda)
 (dlacpy "F" m n a lda vt ldvt)
 (dlacpy "F" m m
  (f2cl-lib:array-slice work double-float (ir) ((1 *)))
  ldwrkr a lda))
(t
 (setf itau 1)
 (setf iwork (f2cl-lib:int-add itau m))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
     (dgelqf m n a lda
      (f2cl-lib:array-slice work
                            double-float
                            (itau)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
```

```
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6))
  (setf ierr var-7))
(dlacpy "U" m n a lda vt ldvt)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorglq n n m vt ldvt
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(dlaset "U" (f2cl-lib:int-sub m 1)
 (f2cl-lib:int-sub m 1) zero zero
 (f2cl-lib:array-slice a
                       double-float
                       (1 2)
                       ((1 lda) (1 *)))
 lda)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd m m a lda s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
```

```
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13)
    (dormbr "P" "L" "T" m n m a lda
     (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))
     vt ldvt
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9 var-10 var-11
                   var-12))
  (setf ierr var-13))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "Q" m m m a lda
     (f2cl-lib:array-slice work
                          double-float
                          (itauq)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14)
    (dbdsqr "U" m n m 0 s
     (f2cl-lib:array-slice work
                          double-float
```

```
                                (ie)
                                ((1 *)))
            vt ldvt a lda dum 1
            (f2cl-lib:array-slice work
                                double-float
                                (iwork)
                                ((1 *)))
            info)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                           var-6 var-7 var-8 var-9 var-10 var-11
                           var-12 var-13))
          (setf info var-14)))))
    (wntuas
     (cond
       ((>= lwork
            (f2cl-lib:int-add (f2cl-lib:int-mul m m)
                              (max
                               (the fixnum
                                    (f2cl-lib:int-add n m))
                               (the fixnum
                                    (f2cl-lib:int-mul 4 m))
                               (the fixnum bdspac))))
        (setf iu 1)
        (cond
          ((>= lwork
               (f2cl-lib:int-add wrkbl (f2cl-lib:int-mul lda m)))
           (setf ldwrku lda))
          (t
           (setf ldwrku m)))
        (setf itau
                (f2cl-lib:int-add iu
                                  (f2cl-lib:int-mul ldwrku m)))
        (setf iwork (f2cl-lib:int-add itau m))
        (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
            (dgelqf m n a lda
             (f2cl-lib:array-slice work
                                   double-float
                                   (itau)
                                   ((1 *)))
             (f2cl-lib:array-slice work
                                   double-float
                                   (iwork)
                                   ((1 *)))
             (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
             ierr)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                           var-6))
          (setf ierr var-7))
        (dlacpy "U" m n a lda vt ldvt)
```

```
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorglq n n m vt ldvt
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(dlacpy "L" m m a lda
 (f2cl-lib:array-slice work double-float (iu) ((1 *)))
 ldwrku)
(dlaset "U" (f2cl-lib:int-sub m 1)
 (f2cl-lib:int-sub m 1) zero zero
 (f2cl-lib:array-slice work
                       double-float
                       ((+ iu ldwrku))
                       ((1 *)))
 ldwrku)
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd m m
     (f2cl-lib:array-slice work
                           double-float
                           (iu)
                           ((1 *)))
     ldwrku s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
```

```
                          (itaup)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(dlacpy "L" m m
 (f2cl-lib:array-slice work double-float (iu) ((1 *)))
 ldwrku u ldu)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "P" m m m
     (f2cl-lib:array-slice work
                          double-float
                          (iu)
                          ((1 *)))
     ldwrku
     (f2cl-lib:array-slice work
                          double-float
                          (itaup)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "Q" m m m u ldu
     (f2cl-lib:array-slice work
                          double-float
                          (itauq)
                          ((1 *)))
     (f2cl-lib:array-slice work
                          double-float
                          (iwork)
                          ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
```

```
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
 (setf iwork (f2cl-lib:int-add ie m))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8 var-9 var-10 var-11 var-12 var-13 var-14)
     (dbdsqr "U" m m m 0 s
      (f2cl-lib:array-slice work
                            double-float
                            (ie)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (iu)
                            ((1 *)))
      ldwrku u ldu dum 1
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9 var-10 var-11
                   var-12 var-13))
  (setf info var-14))
 (dgemm "N" "N" m n m one
  (f2cl-lib:array-slice work double-float (iu) ((1 *)))
  ldwrku vt ldvt zero a lda)
 (dlacpy "F" m n a lda vt ldvt))
(t
 (setf itau 1)
 (setf iwork (f2cl-lib:int-add itau m))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
     (dgelqf m n a lda
      (f2cl-lib:array-slice work
                            double-float
                            (itau)
                            ((1 *)))
      (f2cl-lib:array-slice work
                            double-float
                            (iwork)
                            ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
      ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6))
  (setf ierr var-7))
 (dlacpy "U" m n a lda vt ldvt)
```

```
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8)
    (dorglq n n m vt ldvt
     (f2cl-lib:array-slice work
                           double-float
                           (itau)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7))
  (setf ierr var-8))
(dlacpy "L" m m a lda u ldu)
(dlaset "U" (f2cl-lib:int-sub m 1)
 (f2cl-lib:int-sub m 1) zero zero
 (f2cl-lib:array-slice u
                       double-float
                       (1 2)
                       ((1 ldu) (1 *)))
 ldu)
(setf ie itau)
(setf itauq (f2cl-lib:int-add ie m))
(setf itaup (f2cl-lib:int-add itauq m))
(setf iwork (f2cl-lib:int-add itaup m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
    (dgebrd m m u ldu s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
```

```
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9))
  (setf ierr var-10))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13)
    (dormbr "P" "L" "T" m n m u ldu
     (f2cl-lib:array-slice work
                           double-float
                           (itaup)
                           ((1 *)))
     vt ldvt
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9 var-10 var-11
                   var-12))
  (setf ierr var-13))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9)
    (dorgbr "Q" m m m u ldu
     (f2cl-lib:array-slice work
                           double-float
                           (itauq)
                           ((1 *)))
     (f2cl-lib:array-slice work
                           double-float
                           (iwork)
                           ((1 *)))
     (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1)
     ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8))
  (setf ierr var-9))
(setf iwork (f2cl-lib:int-add ie m))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14)
    (dbdsqr "U" m n m 0 s
     (f2cl-lib:array-slice work
                           double-float
                           (ie)
                           ((1 *)))
     vt ldvt u ldu dum 1
```

```
                (f2cl-lib:array-slice work
                                      double-float
                                      (iwork)
                                      ((1 *)))
                info)
               (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                                var-6 var-7 var-8 var-9 var-10 var-11
                                var-12 var-13))
               (setf info var-14)))))))))
(t
 (setf ie 1)
 (setf itauq (f2cl-lib:int-add ie m))
 (setf itaup (f2cl-lib:int-add itauq m))
 (setf iwork (f2cl-lib:int-add itaup m))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9 var-10)
     (dgebrd m n a lda s
      (f2cl-lib:array-slice work double-float (ie) ((1 *)))
      (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
      (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
      (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
      (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9))
   (setf ierr var-10))
 (cond
   (wntuas
    (dlacpy "L" m m a lda u ldu)
    (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
           var-9)
        (dorgbr "Q" m m n u ldu
         (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
         (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
         (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                       var-7 var-8))
      (setf ierr var-9))))
 (cond
   (wntvas
    (dlacpy "U" m n a lda vt ldvt)
    (if wntva (setf nrvt n))
    (if wntvs (setf nrvt m))
    (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
           var-9)
        (dorgbr "P" nrvt n m vt ldvt
         (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
         (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
```

```
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                      var-7 var-8))
     (setf ierr var-9))))
(cond
  (wntuo
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
          var-9)
       (dorgbr "Q" m m n a lda
        (f2cl-lib:array-slice work double-float (itauq) ((1 *)))
        (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                      var-7 var-8))
     (setf ierr var-9))))
(cond
  (wntvo
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
          var-9)
       (dorgbr "P" m n m a lda
        (f2cl-lib:array-slice work double-float (itaup) ((1 *)))
        (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
        (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwork) 1) ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                      var-7 var-8))
     (setf ierr var-9))))
(setf iwork (f2cl-lib:int-add ie m))
(if (or wntuas wntuo) (setf nru m))
(if wntun (setf nru 0))
(if (or wntvas wntvo) (setf ncvt n))
(if wntvn (setf ncvt 0))
(cond
  ((and (not wntuo) (not wntvo))
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
          var-9 var-10 var-11 var-12 var-13 var-14)
       (dbdsqr "L" m ncvt nru 0 s
        (f2cl-lib:array-slice work double-float (ie) ((1 *))) vt
        ldvt u ldu dum 1
        (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
        info)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                      var-7 var-8 var-9 var-10 var-11 var-12
                      var-13))
     (setf info var-14)))
  ((and (not wntuo) wntvo)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
```

```
                  var-9 var-10 var-11 var-12 var-13 var-14)
                (dbdsqr "L" m ncvt nru 0 s
                 (f2cl-lib:array-slice work double-float (ie) ((1 *))) a
                 lda u ldu dum 1
                 (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
                 info)
               (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                                var-7 var-8 var-9 var-10 var-11 var-12
                                var-13))
               (setf info var-14)))
             (t
              (multiple-value-bind
                    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                     var-9 var-10 var-11 var-12 var-13 var-14)
                  (dbdsqr "L" m ncvt nru 0 s
                   (f2cl-lib:array-slice work double-float (ie) ((1 *))) vt
                   ldvt a lda dum 1
                   (f2cl-lib:array-slice work double-float (iwork) ((1 *)))
                   info)
                 (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                                  var-7 var-8 var-9 var-10 var-11 var-12
                                  var-13))
                 (setf info var-14))))))))
    (cond
      ((/= info 0)
       (cond
         ((> ie 2)
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i
                            (f2cl-lib:int-add minmn (f2cl-lib:int-sub 1)))
                         nil)
            (tagbody
              (setf (f2cl-lib:fref work-%data%
                                   ((f2cl-lib:int-add i 1))
                                   ((1 *))
                                   work-%offset%)
                    (f2cl-lib:fref work-%data%
                                   ((f2cl-lib:int-sub
                                     (f2cl-lib:int-add i ie)
                                     1))
                                   ((1 *))
                                   work-%offset%))))))
         (cond
           ((< ie 2)
            (f2cl-lib:fdo (i (f2cl-lib:int-add minmn (f2cl-lib:int-sub 1))
                           (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                          ((> i 1) nil)
              (tagbody
                (setf (f2cl-lib:fref work-%data%
                                     ((f2cl-lib:int-add i 1))
```

```
                                        ((1 *))
                                        work-%offset%)
                                (f2cl-lib:fref work-%data%
                                               ((f2cl-lib:int-sub
                                                 (f2cl-lib:int-add i ie)
                                                 1))
                                               ((1 *))
                                               work-%offset%))))))))
        (cond
          ((= iscl 1)
           (if (> anrm bignum)
               (multiple-value-bind
                     (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                      var-9)
                   (dlascl "G" 0 0 bignum anrm minmn 1 s minmn ierr)
                 (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                                  var-7 var-8))
                 (setf ierr var-9)))
           (if (and (/= info 0) (> anrm bignum))
               (multiple-value-bind
                     (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                      var-9)
                   (dlascl "G" 0 0 bignum anrm (f2cl-lib:int-sub minmn 1) 1
                    (f2cl-lib:array-slice work double-float (2) ((1 *))) minmn
                    ierr)
                 (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                                  var-7 var-8))
                 (setf ierr var-9)))
           (if (< anrm smlnum)
               (multiple-value-bind
                     (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                      var-9)
                   (dlascl "G" 0 0 smlnum anrm minmn 1 s minmn ierr)
                 (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                                  var-7 var-8))
                 (setf ierr var-9)))
           (if (and (/= info 0) (< anrm smlnum))
               (multiple-value-bind
                     (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                      var-9)
                   (dlascl "G" 0 0 smlnum anrm (f2cl-lib:int-sub minmn 1) 1
                    (f2cl-lib:array-slice work double-float (2) ((1 *))) minmn
                    ierr)
                 (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                                  var-7 var-8))
                 (setf ierr var-9)))))
        (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
                (coerce (the fixnum maxwrk) 'double-float))
 end_label
        (return
```

```
        (values nil nil nil nil nil nil nil nil nil nil nil nil info))))))
```

———-

6.18 dgesv LAPACK

— **dgesv.input** —

```
)set break resume
)sys rm -f dgesv.output
)spool dgesv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dgesv.help** —

```
========================================================================
dgesv examples
========================================================================

========================================================================
Man Page Details
========================================================================

NAME
       DGESV - the solution to a real system of linear equations  A * X = B,

SYNOPSIS
       SUBROUTINE DGESV( N, NRHS, A, LDA, IPIV, B, LDB, INFO )

           INTEGER       INFO, LDA, LDB, N, NRHS

           INTEGER       IPIV( * )

           DOUBLE        PRECISION A( LDA, * ), B( LDB, * )

PURPOSE
       DGESV computes the solution to a real system of linear equations
          A  *  X  =  B, where A is an N-by-N matrix and X and B are N-by-NRHS
```

```
       matrices.

       The LU decomposition with partial pivoting and row interchanges is used
       to factor A as
          A = P * L * U,
       where  P  is a permutation matrix, L is unit lower triangular, and U is
       upper triangular.  The factored form of A is then  used  to  solve  the
       system of equations A * X = B.


ARGUMENTS
       N       (input) INTEGER
               The  number  of linear equations, i.e., the order of the matrix
               A.  N >= 0.

       NRHS    (input) INTEGER
               The number of right hand sides, i.e., the number of columns  of
               the matrix B.  NRHS >= 0.

       A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
               On  entry,  the N-by-N coefficient matrix A.  On exit, the fac-
               tors L and U from the factorization A = P*L*U; the unit  diago-
               nal elements of L are not stored.

       LDA     (input) INTEGER
               The leading dimension of the array A.  LDA >= max(1,N).

       IPIV    (output) INTEGER array, dimension (N)
               The  pivot  indices that define the permutation matrix P; row i
               of the matrix was interchanged with row IPIV(i).

       B       (input/output) DOUBLE PRECISION array, dimension (LDB,NRHS)
               On entry, the N-by-NRHS matrix of right hand side matrix B.  On
               exit, if INFO = 0, the N-by-NRHS solution matrix X.

       LDB     (input) INTEGER
               The leading dimension of the array B.  LDB >= max(1,N).

       INFO    (output) INTEGER
               = 0:  successful exit
               < 0:  if INFO = -i, the i-th argument had an illegal value
               >  0:   if INFO = i, U(i,i) is exactly zero.  The factorization
               has been completed, but the factor U is  exactly  singular,  so
               the solution could not be computed.
```

— dgesv.f —

```
      SUBROUTINE DGESV( N, NRHS, A, LDA, IPIV, B, LDB, INFO )
*
*  -- LAPACK driver routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     March 31, 1993
*
*     .. Scalar Arguments ..
      INTEGER            INFO, LDA, LDB, N, NRHS
*     ..
*     .. Array Arguments ..
      INTEGER            IPIV( * )
      DOUBLE PRECISION   A( LDA, * ), B( LDB, * )
*     ..
*
*  =====================================================================
*
*     .. External Subroutines ..
      EXTERNAL           DGETRF, DGETRS, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF( N.LT.0 ) THEN
         INFO = -1
      ELSE IF( NRHS.LT.0 ) THEN
         INFO = -2
      ELSE IF( LDA.LT.MAX( 1, N ) ) THEN
         INFO = -4
      ELSE IF( LDB.LT.MAX( 1, N ) ) THEN
         INFO = -7
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DGESV ', -INFO )
         RETURN
      END IF
*
*     Compute the LU factorization of A.
*
      CALL DGETRF( N, N, A, LDA, IPIV, INFO )
      IF( INFO.EQ.0 ) THEN
*
*        Solve the system A*X = B, overwriting B with X.
*
         CALL DGETRS( 'No transpose', N, NRHS, A, LDA, IPIV, B, LDB,
```

```
     $                INFO )
      END IF
      RETURN
*
*     End of DGESV
*
      END
```

———-

— LAPACK dgesv —

```
(defun dgesv (n nrhs a lda ipiv b ldb$ info)
  (declare (type (simple-array fixnum (*)) ipiv)
           (type (simple-array double-float (*)) b a)
           (type fixnum info ldb$ lda nrhs n))
  (f2cl-lib:with-multi-array-data
      ((a double-float a-%data% a-%offset%)
       (b double-float b-%data% b-%offset%)
       (ipiv fixnum ipiv-%data% ipiv-%offset%))
    (prog ()
      (declare)
      (setf info 0)
      (cond
        ((< n 0)
         (setf info -1))
        ((< nrhs 0)
         (setf info -2))
        ((< lda (max (the fixnum 1) (the fixnum n)))
         (setf info -4))
        ((< ldb$ (max (the fixnum 1) (the fixnum n)))
         (setf info -7)))
      (cond
        ((/= info 0)
         (error
          " ** On entry to ~a parameter number ~a had an illegal value~%"
          "DGESV " (f2cl-lib:int-sub info))
         (go end_label)))
      (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5)
          (dgetrf n n a lda ipiv info)
        (declare (ignore var-0 var-1 var-2 var-3 var-4))
        (setf info var-5))
      (cond
        ((= info 0)
         (multiple-value-bind
               (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
             (dgetrs "No transpose" n nrhs a lda ipiv b ldb$ info)
           (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7))
```

```
          (setf info var-8))))
      (go end_label)
 end_label
      (return (values nil nil nil nil nil nil nil info)))))
```

———-

6.19 dgetf2 LAPACK

— **dgetf2.input** —

```
)set break resume
)sys rm -f dgetf2.output
)spool dgetf2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dgetf2.help** —

```
=======================================================================
dgetf2 examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

NAME
       DGETF2 - an LU factorization of a general m-by-n matrix A using partial
       pivoting with row interchanges

SYNOPSIS
       SUBROUTINE DGETF2( M, N, A, LDA, IPIV, INFO )

           INTEGER        INFO, LDA, M, N

           INTEGER        IPIV( * )

           DOUBLE         PRECISION A( LDA, * )
```

```
PURPOSE
       DGETF2 computes an LU factorization of a general m-by-n matrix A  using
       partial pivoting with row interchanges.

       The factorization has the form
          A = P * L * U
       where P is a permutation matrix, L is lower triangular with unit diago-
       nal elements (lower trapezoidal if m > n), and U  is  upper  triangular
       (upper trapezoidal if m < n).

       This is the right-looking Level 2 BLAS version of the algorithm.


ARGUMENTS
       M       (input) INTEGER
               The number of rows of the matrix A.  M >= 0.

       N       (input) INTEGER
               The number of columns of the matrix A.  N >= 0.

       A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
               On  entry, the m by n matrix to be factored.  On exit, the fac-
               tors L and U from the factorization A = P*L*U; the unit  diago-
               nal elements of L are not stored.

       LDA     (input) INTEGER
               The leading dimension of the array A.  LDA >= max(1,M).

       IPIV    (output) INTEGER array, dimension (min(M,N))
               The  pivot indices; for 1 <= i <= min(M,N), row i of the matrix
               was interchanged with row IPIV(i).

       INFO    (output) INTEGER
               = 0: successful exit
               < 0: if INFO = -k, the k-th argument had an illegal value
               > 0: if INFO = k, U(k,k) is exactly zero. The factorization has
               been completed, but the factor U is exactly singular, and divi-
               sion by zero will occur if it is used  to  solve  a  system  of
               equations.
```

———-

— dgetf2.f —

```
      SUBROUTINE DGETF2( M, N, A, LDA, IPIV, INFO )
*
*  -- LAPACK routine (version 3.0) --
```

```
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1992
*
*     .. Scalar Arguments ..
      INTEGER            INFO, LDA, M, N
*     ..
*     .. Array Arguments ..
      INTEGER            IPIV( * )
      DOUBLE PRECISION   A( LDA, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE, ZERO
      PARAMETER          ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            J, JP
*     ..
*     .. External Functions ..
      INTEGER            IDAMAX
      EXTERNAL           IDAMAX
*     ..
*     .. External Subroutines ..
      EXTERNAL           DGER, DSCAL, DSWAP, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF( M.LT.0 ) THEN
         INFO = -1
      ELSE IF( N.LT.0 ) THEN
         INFO = -2
      ELSE IF( LDA.LT.MAX( 1, M ) ) THEN
         INFO = -4
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DGETF2', -INFO )
         RETURN
      END IF
*
*     Quick return if possible
*
```

```
      IF( M.EQ.0 .OR. N.EQ.0 )
     $   RETURN
*
      DO 10 J = 1, MIN( M, N )
*
*        Find pivot and test for singularity.
*
         JP = J - 1 + IDAMAX( M-J+1, A( J, J ), 1 )
         IPIV( J ) = JP
         IF( A( JP, J ).NE.ZERO ) THEN
*
*           Apply the interchange to columns 1:N.
*
            IF( JP.NE.J )
     $         CALL DSWAP( N, A( J, 1 ), LDA, A( JP, 1 ), LDA )
*
*           Compute elements J+1:M of J-th column.
*
            IF( J.LT.M )
     $         CALL DSCAL( M-J, ONE / A( J, J ), A( J+1, J ), 1 )
*
         ELSE IF( INFO.EQ.0 ) THEN
*
            INFO = J
         END IF
*
         IF( J.LT.MIN( M, N ) ) THEN
*
*           Update trailing submatrix.
*
            CALL DGER( M-J, N-J, -ONE, A( J+1, J ), 1, A( J, J+1 ), LDA,
     $                 A( J+1, J+1 ), LDA )
         END IF
   10 CONTINUE
      RETURN
*
*     End of DGETF2
*
      END
```

— LAPACK dgetf2 —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dgetf2 (m n a lda ipiv info)
```

```
(declare (type (simple-array fixnum (*)) ipiv)
         (type (simple-array double-float (*)) a)
         (type fixnum info lda n m))
(f2cl-lib:with-multi-array-data
    ((a double-float a-%data% a-%offset%)
     (ipiv fixnum ipiv-%data% ipiv-%offset%))
  (prog ((j 0) (jp 0))
    (declare (type fixnum j jp))
    (setf info 0)
    (cond
      ((< m 0)
       (setf info -1))
      ((< n 0)
       (setf info -2))
      ((< lda (max (the fixnum 1) (the fixnum m)))
       (setf info -4)))
    (cond
      ((/= info 0)
       (error
        " ** On entry to ~a parameter number ~a had an illegal value~%"
        "DGETF2" (f2cl-lib:int-sub info))
       (go end_label)))
    (if (or (= m 0) (= n 0)) (go end_label))
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j
                      (min (the fixnum m)
                           (the fixnum n)))
                   nil)
      (tagbody
        (setf jp
                (f2cl-lib:int-add (f2cl-lib:int-sub j 1)
                                  (idamax
                                   (f2cl-lib:int-add (f2cl-lib:int-sub m j)
                                                     1)
                                   (f2cl-lib:array-slice a
                                                         double-float
                                                         (j j)
                                                         ((1 lda) (1 *)))
                                   1)))
        (setf (f2cl-lib:fref ipiv-%data% (j) ((1 *)) ipiv-%offset%) jp)
        (cond
          ((/= (f2cl-lib:fref a (jp j) ((1 lda) (1 *))) zero)
           (if (/= jp j)
               (dswap n
                (f2cl-lib:array-slice a double-float (j 1) ((1 lda) (1 *)))
                lda
                (f2cl-lib:array-slice a
                                      double-float
                                      (jp 1)
                                      ((1 lda) (1 *)))
```

```
                lda))
             (if (< j m)
                 (dscal (f2cl-lib:int-sub m j)
                  (/ one
                     (f2cl-lib:fref a-%data%
                                    (j j)
                                    ((1 lda) (1 *))
                                    a-%offset%))
                  (f2cl-lib:array-slice a
                                        double-float
                                        ((+ j 1) j)
                                        ((1 lda) (1 *)))
                  1)))
           ((= info 0)
            (setf info j)))
          (cond
            ((< j (min (the fixnum m) (the fixnum n)))
             (dger (f2cl-lib:int-sub m j) (f2cl-lib:int-sub n j) (- one)
              (f2cl-lib:array-slice a
                                    double-float
                                    ((+ j 1) j)
                                    ((1 lda) (1 *)))
              1
              (f2cl-lib:array-slice a
                                    double-float
                                    (j (f2cl-lib:int-add j 1))
                                    ((1 lda) (1 *)))
              lda
              (f2cl-lib:array-slice a
                                    double-float
                                    ((+ j 1) (f2cl-lib:int-add j 1))
                                    ((1 lda) (1 *)))
              lda)))))
       (go end_label)
end_label
       (return (values nil nil nil nil nil info))))))
```

———-

6.20 dgetrf LAPACK

— **dgetrf.input** —

```
)set break resume
)sys rm -f dgetrf.output
)spool dgetrf.output
```

```
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dgetrf.help —

```
==========================================================================
dgetrf examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

NAME
       DGETRF - an LU factorization of a general M-by-N matrix A using partial
       pivoting with row interchanges

SYNOPSIS
       SUBROUTINE DGETRF( M, N, A, LDA, IPIV, INFO )

           INTEGER        INFO, LDA, M, N

           INTEGER        IPIV( * )

           DOUBLE         PRECISION A( LDA, * )

PURPOSE
       DGETRF computes an LU factorization of a general M-by-N matrix A  using
       partial pivoting with row interchanges.

       The factorization has the form
          A = P * L * U
       where P is a permutation matrix, L is lower triangular with unit diago-
       nal elements (lower trapezoidal if m > n), and U  is  upper  triangular
       (upper trapezoidal if m < n).

       This is the right-looking Level 3 BLAS version of the algorithm.


ARGUMENTS
       M       (input) INTEGER
               The number of rows of the matrix A.  M >= 0.
```

```
       N       (input) INTEGER
               The number of columns of the matrix A.  N >= 0.

       A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
               On  entry, the M-by-N matrix to be factored.  On exit, the fac-
               tors L and U from the factorization A = P*L*U; the unit  diago-
               nal elements of L are not stored.

       LDA     (input) INTEGER
               The leading dimension of the array A.  LDA >= max(1,M).

       IPIV    (output) INTEGER array, dimension (min(M,N))
               The  pivot indices; for 1 <= i <= min(M,N), row i of the matrix
               was interchanged with row IPIV(i).

       INFO    (output) INTEGER
               = 0:  successful exit
               < 0:  if INFO = -i, the i-th argument had an illegal value
               > 0:  if INFO = i, U(i,i) is exactly  zero.  The  factorization
               has  been  completed, but the factor U is exactly singular, and
               division by zero will occur if it is used to solve a system  of
               equations.
```

———-

— dgetrf.f —

```
      SUBROUTINE DGETRF( M, N, A, LDA, IPIV, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     March 31, 1993
*
*     .. Scalar Arguments ..
      INTEGER            INFO, LDA, M, N
*     ..
*     .. Array Arguments ..
      INTEGER            IPIV( * )
      DOUBLE PRECISION   A( LDA, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE
      PARAMETER          ( ONE = 1.0D+0 )
*     ..
```

```
*     .. Local Scalars ..
      INTEGER            I, IINFO, J, JB, NB
*     ..
*     .. External Subroutines ..
      EXTERNAL           DGEMM, DGETF2, DLASWP, DTRSM, XERBLA
*     ..
*     .. External Functions ..
      INTEGER            ILAENV
      EXTERNAL           ILAENV
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IF( M.LT.0 ) THEN
         INFO = -1
      ELSE IF( N.LT.0 ) THEN
         INFO = -2
      ELSE IF( LDA.LT.MAX( 1, M ) ) THEN
         INFO = -4
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DGETRF', -INFO )
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( M.EQ.0 .OR. N.EQ.0 )
     $   RETURN
*
*     Determine the block size for this environment.
*
      NB = ILAENV( 1, 'DGETRF', ' ', M, N, -1, -1 )
      IF( NB.LE.1 .OR. NB.GE.MIN( M, N ) ) THEN
*
*        Use unblocked code.
*
         CALL DGETF2( M, N, A, LDA, IPIV, INFO )
      ELSE
*
*        Use blocked code.
*
         DO 20 J = 1, MIN( M, N ), NB
            JB = MIN( MIN( M, N )-J+1, NB )
*
```

```
*           Factor diagonal and subdiagonal blocks and test for exact
*           singularity.
*
            CALL DGETF2( M-J+1, JB, A( J, J ), LDA, IPIV( J ), IINFO )
*
*           Adjust INFO and the pivot indices.
*
            IF( INFO.EQ.0 .AND. IINFO.GT.0 )
     $         INFO = IINFO + J - 1
            DO 10 I = J, MIN( M, J+JB-1 )
               IPIV( I ) = J - 1 + IPIV( I )
   10       CONTINUE
*
*           Apply interchanges to columns 1:J-1.
*
            CALL DLASWP( J-1, A, LDA, J, J+JB-1, IPIV, 1 )
*
            IF( J+JB.LE.N ) THEN
*
*              Apply interchanges to columns J+JB:N.
*
               CALL DLASWP( N-J-JB+1, A( 1, J+JB ), LDA, J, J+JB-1,
     $                      IPIV, 1 )
*
*              Compute block row of U.
*
               CALL DTRSM( 'Left', 'Lower', 'No transpose', 'Unit', JB,
     $                     N-J-JB+1, ONE, A( J, J ), LDA, A( J, J+JB ),
     $                     LDA )
               IF( J+JB.LE.M ) THEN
*
*                 Update trailing submatrix.
*
                  CALL DGEMM( 'No transpose', 'No transpose', M-J-JB+1,
     $                        N-J-JB+1, JB, -ONE, A( J+JB, J ), LDA,
     $                        A( J, J+JB ), LDA, ONE, A( J+JB, J+JB ),
     $                        LDA )
               END IF
            END IF
   20    CONTINUE
      END IF
      RETURN
*
*     End of DGETRF
*
      END
```

— LAPACK dgetrf —

```
(let* ((one 1.0))
  (declare (type (double-float 1.0 1.0) one))
  (defun dgetrf (m n a lda ipiv info)
    (declare (type (simple-array fixnum (*)) ipiv)
             (type (simple-array double-float (*)) a)
             (type fixnum info lda n m))
    (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (ipiv fixnum ipiv-%data% ipiv-%offset%))
      (prog ((i 0) (iinfo 0) (j 0) (jb 0) (nb 0))
        (declare (type fixnum i iinfo j jb nb))
        (setf info 0)
        (cond
          ((< m 0)
           (setf info -1))
          ((< n 0)
           (setf info -2))
          ((< lda (max (the fixnum 1) (the fixnum m)))
           (setf info -4)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DGETRF" (f2cl-lib:int-sub info))
           (go end_label)))
        (if (or (= m 0) (= n 0)) (go end_label))
        (setf nb (ilaenv 1 "DGETRF" " " m n -1 -1))
        (cond
          ((or (<= nb 1)
               (>= nb
                   (min (the fixnum m) (the fixnum n))))
           (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5)
               (dgetf2 m n a lda ipiv info)
             (declare (ignore var-0 var-1 var-2 var-3 var-4))
             (setf info var-5)))
          (t
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j nb))
                         ((> j
                             (min (the fixnum m)
                                  (the fixnum n)))
                          nil)
             (tagbody
               (setf jb
                       (min
                        (the fixnum
                             (f2cl-lib:int-add
                              (f2cl-lib:int-sub
```

```
                (min (the fixnum m)
                     (the fixnum n))
                j)
               1))
          (the fixnum nb)))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5)
    (dgetf2 (f2cl-lib:int-add (f2cl-lib:int-sub m j) 1) jb
     (f2cl-lib:array-slice a double-float (j j) ((1 lda) (1 *)))
     lda
     (f2cl-lib:array-slice ipiv fixnum (j) ((1 *)))
     iinfo)
  (declare (ignore var-0 var-1 var-2 var-3 var-4))
  (setf iinfo var-5))
(if (and (= info 0) (> iinfo 0))
    (setf info (f2cl-lib:int-sub (f2cl-lib:int-add iinfo j) 1)))
(f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
              ((> i
                  (min (the fixnum m)
                       (the fixnum
                            (f2cl-lib:int-add j
                                              jb
                                              (f2cl-lib:int-sub
                                               1)))))
               nil)
  (tagbody
    (setf (f2cl-lib:fref ipiv-%data% (i) ((1 *)) ipiv-%offset%)
            (f2cl-lib:int-add (f2cl-lib:int-sub j 1)
                              (f2cl-lib:fref ipiv-%data%
                                             (i)
                                             ((1 *))
                                             ipiv-%offset%)))))
(dlaswp (f2cl-lib:int-sub j 1) a lda j
 (f2cl-lib:int-sub (f2cl-lib:int-add j jb) 1) ipiv 1)
(cond
  ((<= (f2cl-lib:int-add j jb) n)
   (dlaswp (f2cl-lib:int-add (f2cl-lib:int-sub n j jb) 1)
    (f2cl-lib:array-slice a
                          double-float
                          (1 (f2cl-lib:int-add j jb))
                          ((1 lda) (1 *)))
    lda j (f2cl-lib:int-sub (f2cl-lib:int-add j jb) 1) ipiv 1)
   (dtrsm "Left" "Lower" "No transpose" "Unit" jb
    (f2cl-lib:int-add (f2cl-lib:int-sub n j jb) 1) one
    (f2cl-lib:array-slice a double-float (j j) ((1 lda) (1 *)))
    lda
    (f2cl-lib:array-slice a
                          double-float
                          (j (f2cl-lib:int-add j jb))
                          ((1 lda) (1 *)))
    lda)
```

```
                (cond
                  ((<= (f2cl-lib:int-add j jb) m)
                   (dgemm "No transpose" "No transpose"
                    (f2cl-lib:int-add (f2cl-lib:int-sub m j jb) 1)
                    (f2cl-lib:int-add (f2cl-lib:int-sub n j jb) 1) jb (- one)
                    (f2cl-lib:array-slice a
                                          double-float
                                          ((+ j jb) j)
                                          ((1 lda) (1 *)))
                    lda
                    (f2cl-lib:array-slice a
                                          double-float
                                          (j (f2cl-lib:int-add j jb))
                                          ((1 lda) (1 *)))
                    lda one
                    (f2cl-lib:array-slice a
                                          double-float
                                          ((+ j jb) (f2cl-lib:int-add j jb))
                                          ((1 lda) (1 *)))
                    lda)))))))))
 end_label
        (return (values nil nil nil nil nil info))))))
```

———-

6.21 dgetrs LAPACK

— **dgetrs.input** —

```
)set break resume
)sys rm -f dgetrs.output
)spool dgetrs.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dgetrs.help** —

```
==========================================================================
dgetrs examples
```

```
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DGETRS  -  a system of linear equations  A * X = B or A' * X = B with a
       general N-by-N matrix A using the LU factorization computed by DGETRF

SYNOPSIS
       SUBROUTINE DGETRS( TRANS, N, NRHS, A, LDA, IPIV, B, LDB, INFO )

           CHARACTER      TRANS

           INTEGER        INFO, LDA, LDB, N, NRHS

           INTEGER        IPIV( * )

           DOUBLE         PRECISION A( LDA, * ), B( LDB, * )

PURPOSE
       DGETRS solves a system of linear equations
          A * X = B  or  A' * X = B with a general N-by-N matrix A  using  the
       LU factorization computed by DGETRF.


ARGUMENTS
       TRANS   (input) CHARACTER*1
               Specifies the form of the system of equations:
               = 'N':  A * X = B  (No transpose)
               = 'T':  A'* X = B  (Transpose)
               = 'C':  A'* X = B  (Conjugate transpose = Transpose)

       N       (input) INTEGER
               The order of the matrix A.  N >= 0.

       NRHS    (input) INTEGER
               The  number of right hand sides, i.e., the number of columns of
               the matrix B.  NRHS >= 0.

       A       (input) DOUBLE PRECISION array, dimension (LDA,N)
               The factors L and U from the factorization A =  P*L*U  as  com-
               puted by DGETRF.

       LDA     (input) INTEGER
               The leading dimension of the array A.  LDA >= max(1,N).

       IPIV    (input) INTEGER array, dimension (N)
               The pivot indices from DGETRF; for 1<=i<=N, row i of the matrix
```

```
              was interchanged with row IPIV(i).

       B      (input/output) DOUBLE PRECISION array, dimension (LDB,NRHS)
              On entry, the right hand side matrix B.  On exit, the  solution
              matrix X.

       LDB    (input) INTEGER
              The leading dimension of the array B.  LDB >= max(1,N).

       INFO   (output) INTEGER
              = 0:  successful exit
              < 0:  if INFO = -i, the i-th argument had an illegal value
```

———-

— dgetrs.f —

```
      SUBROUTINE DGETRS( TRANS, N, NRHS, A, LDA, IPIV, B, LDB, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     March 31, 1993
*
*     .. Scalar Arguments ..
      CHARACTER          TRANS
      INTEGER            INFO, LDA, LDB, N, NRHS
*     ..
*     .. Array Arguments ..
      INTEGER            IPIV( * )
      DOUBLE PRECISION   A( LDA, * ), B( LDB, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE
      PARAMETER          ( ONE = 1.0D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            NOTRAN
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLASWP, DTRSM, XERBLA
```

```
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      NOTRAN = LSAME( TRANS, 'N' )
      IF( .NOT.NOTRAN .AND. .NOT.LSAME( TRANS, 'T' ) .AND. .NOT.
     $    LSAME( TRANS, 'C' ) ) THEN
         INFO = -1
      ELSE IF( N.LT.0 ) THEN
         INFO = -2
      ELSE IF( NRHS.LT.0 ) THEN
         INFO = -3
      ELSE IF( LDA.LT.MAX( 1, N ) ) THEN
         INFO = -5
      ELSE IF( LDB.LT.MAX( 1, N ) ) THEN
         INFO = -8
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DGETRS', -INFO )
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( N.EQ.0 .OR. NRHS.EQ.0 )
     $   RETURN
*
      IF( NOTRAN ) THEN
*
*        Solve A * X = B.
*
*        Apply row interchanges to the right hand sides.
*
         CALL DLASWP( NRHS, B, LDB, 1, N, IPIV, 1 )
*
*        Solve L*X = B, overwriting B with X.
*
         CALL DTRSM( 'Left', 'Lower', 'No transpose', 'Unit', N, NRHS,
     $               ONE, A, LDA, B, LDB )
*
*        Solve U*X = B, overwriting B with X.
*
         CALL DTRSM( 'Left', 'Upper', 'No transpose', 'Non-unit', N,
     $               NRHS, ONE, A, LDA, B, LDB )
      ELSE
```

```
*
*        Solve A' * X = B.
*
*        Solve U'*X = B, overwriting B with X.
*
         CALL DTRSM( 'Left', 'Upper', 'Transpose', 'Non-unit', N, NRHS,
     $               ONE, A, LDA, B, LDB )
*
*        Solve L'*X = B, overwriting B with X.
*
         CALL DTRSM( 'Left', 'Lower', 'Transpose', 'Unit', N, NRHS, ONE,
     $               A, LDA, B, LDB )
*
*        Apply row interchanges to the solution vectors.
*
         CALL DLASWP( NRHS, B, LDB, 1, N, IPIV, -1 )
      END IF
*
      RETURN
*
*     End of DGETRS
*
      END
```

———-

— LAPACK dgetrs —

```
(let* ((one 1.0))
  (declare (type (double-float 1.0 1.0) one))
  (defun dgetrs (trans n nrhs a lda ipiv b ldb$ info)
    (declare (type (simple-array fixnum (*)) ipiv)
             (type (simple-array double-float (*)) b a)
             (type fixnum info ldb$ lda nrhs n)
             (type character trans))
    (f2cl-lib:with-multi-array-data
        ((trans character trans-%data% trans-%offset%)
         (a double-float a-%data% a-%offset%)
         (b double-float b-%data% b-%offset%)
         (ipiv fixnum ipiv-%data% ipiv-%offset%))
      (prog ((notran nil))
        (declare (type (member t nil) notran))
        (setf info 0)
        (setf notran (char-equal trans #\N))
        (cond
          ((and (not notran) (not (char-equal trans #\T))
                (not (char-equal trans #\C)))
           (setf info -1))
```

```
          ((< n 0)
           (setf info -2))
          ((< nrhs 0)
           (setf info -3))
          ((< lda (max (the fixnum 1) (the fixnum n)))
           (setf info -5))
          ((< ldb$ (max (the fixnum 1) (the fixnum n)))
           (setf info -8)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DGETRS" (f2cl-lib:int-sub info))
           (go end_label)))
        (if (or (= n 0) (= nrhs 0)) (go end_label))
        (cond
          (notran
           (dlaswp nrhs b ldb$ 1 n ipiv 1)
           (dtrsm "Left" "Lower" "No transpose" "Unit" n nrhs one a lda b ldb$)
           (dtrsm "Left" "Upper" "No transpose" "Non-unit" n nrhs one a lda b
            ldb$))
          (t
           (dtrsm "Left" "Upper" "Transpose" "Non-unit" n nrhs one a lda b ldb$)
           (dtrsm "Left" "Lower" "Transpose" "Unit" n nrhs one a lda b ldb$)
           (dlaswp nrhs b ldb$ 1 n ipiv -1)))
        (go end_label)
 end_label
        (return (values nil nil nil nil nil nil nil nil info))))))
```

———-

6.22 dhseqr LAPACK

— dhseqr.input —

```
)set break resume
)sys rm -f dhseqr.output
)spool dhseqr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dhseqr.help —

```
=====================================================================
dhseqr examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DHSEQR - compute the eigenvalues of a Hessenberg matrix H  and, option-
       ally, the matrices T and Z from the Schur decomposition  H = Z T  Z**T,
       where T is an upper quasi-triangular matrix (the  Schur form), and Z is
       the orthogonal matrix of Schur vectors

       Optionally Z may be postmultiplied into an input orthogonal matrix Q,
       so that this routine can give the Schur factorization of a matrix A
       which has been reduced to the Hessenberg form H by the orthogonal
       matrix Q:  A = Q*H*Q**T = (QZ)*T*(QZ)**T.

SYNOPSIS
       SUBROUTINE DHSEQR( JOB, COMPZ, N, ILO, IHI, H, LDH,  WR,  WI,  Z,  LDZ,
                          WORK, LWORK, INFO )

           INTEGER        IHI, ILO, INFO, LDH, LDZ, LWORK, N

           CHARACTER      COMPZ, JOB

           DOUBLE         PRECISION  H( LDH, * ), WI( * ), WORK( * ), WR( * ),
                          Z( LDZ, * )

PURPOSE
          DHSEQR computes the eigenvalues of a Hessenberg matrix H
          and, optionally, the matrices T and Z from the Schur decomposition
          H = Z T Z**T, where T is an upper quasi-triangular matrix (the
          Schur form), and Z is the orthogonal matrix of Schur vectors.

          Optionally Z may be postmultiplied into an input orthogonal
          matrix Q so that this routine can give the Schur factorization
          of a matrix A which has been reduced to the Hessenberg form H
          by the orthogonal matrix Q:  A = Q*H*Q**T = (QZ)*T*(QZ)**T.


ARGUMENTS
  JOB     (input) CHARACTER*1
          = 'E':  compute eigenvalues only;
          = 'S':  compute eigenvalues and the Schur form T.
```

```
COMPZ   (input) CHARACTER*1
        = 'N':  no Schur vectors are computed;
        = 'I':  Z is initialized to the unit matrix and the matrix Z
                of Schur vectors of H is returned;
        = 'V':  Z must contain an orthogonal matrix Q on entry, and
                the product Q*Z is returned.

N       (input) INTEGER
        The order of the matrix H.  N >= 0.

ILO     (input) INTEGER
IHI     (input) INTEGER
        It is assumed that H is already upper triangular in rows
        and columns 1:ILO-1 and IHI+1:N. ILO and IHI are normally
        set by a previous call to DGEBAL, and then passed to SGEHRD
        when the matrix output by DGEBAL is reduced to Hessenberg
        form. Otherwise ILO and IHI should be set to 1 and N
        respectively.
        1 <= ILO <= IHI <= N, if N > 0; ILO=1 and IHI=0, if N=0.

H       (input/output) DOUBLE PRECISION array, dimension (LDH,N)
        On entry, the upper Hessenberg matrix H.
        On exit, if JOB = 'S', H contains the upper quasi-triangular
        matrix T from the Schur decomposition (the Schur form);
        2-by-2 diagonal blocks (corresponding to complex conjugate
        pairs of eigenvalues) are returned in standard form, with
        H(i,i) = H(i+1,i+1) and H(i+1,i)*H(i,i+1) < 0. If JOB = 'E',
        the contents of H are unspecified on exit.

LDH     (input) INTEGER
        The leading dimension of the array H. LDH >= max(1,N).

WR      (output) DOUBLE PRECISION array, dimension (N)
WI      (output) DOUBLE PRECISION array, dimension (N)
        The real and imaginary parts, respectively, of the computed
        eigenvalues. If two eigenvalues are computed as a complex
        conjugate pair, they are stored in consecutive elements of
        WR and WI, say the i-th and (i+1)th, with WI(i) > 0 and
        WI(i+1) < 0. If JOB = 'S', the eigenvalues are stored in the
        same order as on the diagonal of the Schur form returned in
        H, with WR(i) = H(i,i) and, if H(i:i+1,i:i+1) is a 2-by-2
        diagonal block, WI(i) = sqrt(H(i+1,i)*H(i,i+1)) and
        WI(i+1) = -WI(i).

Z       (input/output) DOUBLE PRECISION array, dimension (LDZ,N)
        If COMPZ = 'N': Z is not referenced.
        If COMPZ = 'I': on entry, Z need not be set, and on exit, Z
        contains the orthogonal matrix Z of the Schur vectors of H.
        If COMPZ = 'V': on entry Z must contain an N-by-N matrix Q,
        which is assumed to be equal to the unit matrix except for
```

```
          the submatrix Z(ILO:IHI,ILO:IHI); on exit Z contains Q*Z.
          Normally Q is the orthogonal matrix generated by DORGHR after
          the call to DGEHRD which formed the Hessenberg matrix H.

  LDZ     (input) INTEGER
          The leading dimension of the array Z.
          LDZ >= max(1,N) if COMPZ = 'I' or 'V'; LDZ >= 1 otherwise.

  WORK    (workspace/output) DOUBLE PRECISION array, dimension (LWORK)
          On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

  LWORK   (input) INTEGER
          The dimension of the array WORK.  LWORK >= max(1,N).

          If LWORK = -1, then a workspace query is assumed; the routine
          only calculates the optimal size of the WORK array, returns
          this value as the first entry of the WORK array, and no error
          message related to LWORK is issued by XERBLA.

  INFO    (output) INTEGER
          = 0:  successful exit
          < 0:  if INFO = -i, the i-th argument had an illegal value
          > 0:  if INFO = i, DHSEQR failed to compute all of the
                eigenvalues in a total of 30*(IHI-ILO+1) iterations;
                elements 1:ilo-1 and i+1:n of WR and WI contain those
                eigenvalues which have been successfully computed.
```

— dhseqr.f —

```
      SUBROUTINE DHSEQR( JOB, COMPZ, N, ILO, IHI, H, LDH, WR, WI, Z,
     $                   LDZ, WORK, LWORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      CHARACTER          COMPZ, JOB
      INTEGER            IHI, ILO, INFO, LDH, LDZ, LWORK, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   H( LDH, * ), WI( * ), WORK( * ), WR( * ),
     $                   Z( LDZ, * )
*     ..
*
```

```
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE, TWO
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0, TWO = 2.0D+0 )
      DOUBLE PRECISION   CONST
      PARAMETER          ( CONST = 1.5D+0 )
      INTEGER            NSMAX, LDS
      PARAMETER          ( NSMAX = 15, LDS = NSMAX )
*     ..
*     .. Local Scalars ..
      LOGICAL            INITZ, LQUERY, WANTT, WANTZ
      INTEGER            I, I1, I2, IERR, II, ITEMP, ITN, ITS, J, K, L,
     $                   MAXB, NH, NR, NS, NV
      DOUBLE PRECISION   ABSW, OVFL, SMLNUM, TAU, TEMP, TST1, ULP, UNFL
*     ..
*     .. Local Arrays ..
      DOUBLE PRECISION   S( LDS, NSMAX ), V( NSMAX+1 ), VV( NSMAX+1 )
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      INTEGER            IDAMAX, ILAENV
      DOUBLE PRECISION   DLAMCH, DLANHS, DLAPY2
      EXTERNAL           LSAME, IDAMAX, ILAENV, DLAMCH, DLANHS, DLAPY2
*     ..
*     .. External Subroutines ..
      EXTERNAL           DCOPY, DGEMV, DLACPY, DLAHQR, DLARFG, DLARFX,
     $                   DLASET, DSCAL, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Decode and test the input parameters
*
      WANTT = LSAME( JOB, 'S' )
      INITZ = LSAME( COMPZ, 'I' )
      WANTZ = INITZ .OR. LSAME( COMPZ, 'V' )
*
      INFO = 0
      WORK( 1 ) = MAX( 1, N )
      LQUERY = ( LWORK.EQ.-1 )
      IF( .NOT.LSAME( JOB, 'E' ) .AND. .NOT.WANTT ) THEN
         INFO = -1
      ELSE IF( .NOT.LSAME( COMPZ, 'N' ) .AND. .NOT.WANTZ ) THEN
         INFO = -2
      ELSE IF( N.LT.0 ) THEN
         INFO = -3
      ELSE IF( ILO.LT.1 .OR. ILO.GT.MAX( 1, N ) ) THEN
```

```
         INFO = -4
      ELSE IF( IHI.LT.MIN( ILO, N ) .OR. IHI.GT.N ) THEN
         INFO = -5
      ELSE IF( LDH.LT.MAX( 1, N ) ) THEN
         INFO = -7
      ELSE IF( LDZ.LT.1 .OR. WANTZ .AND. LDZ.LT.MAX( 1, N ) ) THEN
         INFO = -11
      ELSE IF( LWORK.LT.MAX( 1, N ) .AND. .NOT.LQUERY ) THEN
         INFO = -13
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DHSEQR', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Initialize Z, if necessary
*
      IF( INITZ )
     $   CALL DLASET( 'Full', N, N, ZERO, ONE, Z, LDZ )
*
*     Store the eigenvalues isolated by DGEBAL.
*
      DO 10 I = 1, ILO - 1
         WR( I ) = H( I, I )
         WI( I ) = ZERO
   10 CONTINUE
      DO 20 I = IHI + 1, N
         WR( I ) = H( I, I )
         WI( I ) = ZERO
   20 CONTINUE
*
*     Quick return if possible.
*
      IF( N.EQ.0 )
     $   RETURN
      IF( ILO.EQ.IHI ) THEN
         WR( ILO ) = H( ILO, ILO )
         WI( ILO ) = ZERO
         RETURN
      END IF
*
*     Set rows and columns ILO to IHI to zero below the first
*     subdiagonal.
*
      DO 40 J = ILO, IHI - 2
         DO 30 I = J + 2, N
            H( I, J ) = ZERO
   30    CONTINUE
```

```
   40 CONTINUE
      NH = IHI - ILO + 1
*
*     Determine the order of the multi-shift QR algorithm to be used.
*
      NS = ILAENV( 4, 'DHSEQR', JOB // COMPZ, N, ILO, IHI, -1 )
      MAXB = ILAENV( 8, 'DHSEQR', JOB // COMPZ, N, ILO, IHI, -1 )
      IF( NS.LE.2 .OR. NS.GT.NH .OR. MAXB.GE.NH ) THEN
*
*        Use the standard double-shift algorithm
*
         CALL DLAHQR( WANTT, WANTZ, N, ILO, IHI, H, LDH, WR, WI, ILO,
     $                IHI, Z, LDZ, INFO )
         RETURN
      END IF
      MAXB = MAX( 3, MAXB )
      NS = MIN( NS, MAXB, NSMAX )
*
*     Now 2 < NS <= MAXB < NH.
*
*     Set machine-dependent constants for the stopping criterion.
*     If norm(H) <= sqrt(OVFL), overflow should not occur.
*
      UNFL = DLAMCH( 'Safe minimum' )
      OVFL = ONE / UNFL
      CALL DLABAD( UNFL, OVFL )
      ULP = DLAMCH( 'Precision' )
      SMLNUM = UNFL*( NH / ULP )
*
*     I1 and I2 are the indices of the first row and last column of H
*     to which transformations must be applied. If eigenvalues only are
*     being computed, I1 and I2 are set inside the main loop.
*
      IF( WANTT ) THEN
         I1 = 1
         I2 = N
      END IF
*
*     ITN is the total number of multiple-shift QR iterations allowed.
*
      ITN = 30*NH
*
*     The main loop begins here. I is the loop index and decreases from
*     IHI to ILO in steps of at most MAXB. Each iteration of the loop
*     works with the active submatrix in rows and columns L to I.
*     Eigenvalues I+1 to IHI have already converged. Either L = ILO or
*     H(L,L-1) is negligible so that the matrix splits.
*
      I = IHI
   50 CONTINUE
```

```
      L = ILO
      IF( I.LT.ILO )
     $   GO TO 170
*
*     Perform multiple-shift QR iterations on rows and columns ILO to I
*     until a submatrix of order at most MAXB splits off at the bottom
*     because a subdiagonal element has become negligible.
*
      DO 150 ITS = 0, ITN
*
*        Look for a single small subdiagonal element.
*
         DO 60 K = I, L + 1, -1
            TST1 = ABS( H( K-1, K-1 ) ) + ABS( H( K, K ) )
            IF( TST1.EQ.ZERO )
     $         TST1 = DLANHS( '1', I-L+1, H( L, L ), LDH, WORK )
            IF( ABS( H( K, K-1 ) ).LE.MAX( ULP*TST1, SMLNUM ) )
     $         GO TO 70
   60    CONTINUE
   70    CONTINUE
         L = K
         IF( L.GT.ILO ) THEN
*
*           H(L,L-1) is negligible.
*
            H( L, L-1 ) = ZERO
         END IF
*
*        Exit from loop if a submatrix of order <= MAXB has split off.
*
         IF( L.GE.I-MAXB+1 )
     $      GO TO 160
*
*        Now the active submatrix is in rows and columns L to I. If
*        eigenvalues only are being computed, only the active submatrix
*        need be transformed.
*
         IF( .NOT.WANTT ) THEN
            I1 = L
            I2 = I
         END IF
*
         IF( ITS.EQ.20 .OR. ITS.EQ.30 ) THEN
*
*           Exceptional shifts.
*
            DO 80 II = I - NS + 1, I
               WR( II ) = CONST*( ABS( H( II, II-1 ) )+
     $                    ABS( H( II, II ) ) )
               WI( II ) = ZERO
```

```
   80       CONTINUE
         ELSE
*
*           Use eigenvalues of trailing submatrix of order NS as shifts.
*
            CALL DLACPY( 'Full', NS, NS, H( I-NS+1, I-NS+1 ), LDH, S,
     $                   LDS )
            CALL DLAHQR( .FALSE., .FALSE., NS, 1, NS, S, LDS,
     $                   WR( I-NS+1 ), WI( I-NS+1 ), 1, NS, Z, LDZ,
     $                   IERR )
            IF( IERR.GT.0 ) THEN
*
*              If DLAHQR failed to compute all NS eigenvalues, use the
*              unconverged diagonal elements as the remaining shifts.
*
               DO 90 II = 1, IERR
                  WR( I-NS+II ) = S( II, II )
                  WI( I-NS+II ) = ZERO
   90          CONTINUE
            END IF
         END IF
*
*        Form the first column of (G-w(1)) (G-w(2)) . . . (G-w(ns))
*        where G is the Hessenberg submatrix H(L:I,L:I) and w is
*        the vector of shifts (stored in WR and WI). The result is
*        stored in the local array V.
*
         V( 1 ) = ONE
         DO 100 II = 2, NS + 1
            V( II ) = ZERO
  100    CONTINUE
         NV = 1
         DO 120 J = I - NS + 1, I
            IF( WI( J ).GE.ZERO ) THEN
               IF( WI( J ).EQ.ZERO ) THEN
*
*                 real shift
*
                  CALL DCOPY( NV+1, V, 1, VV, 1 )
                  CALL DGEMV( 'No transpose', NV+1, NV, ONE, H( L, L ),
     $                        LDH, VV, 1, -WR( J ), V, 1 )
                  NV = NV + 1
               ELSE IF( WI( J ).GT.ZERO ) THEN
*
*                 complex conjugate pair of shifts
*
                  CALL DCOPY( NV+1, V, 1, VV, 1 )
                  CALL DGEMV( 'No transpose', NV+1, NV, ONE, H( L, L ),
     $                        LDH, V, 1, -TWO*WR( J ), VV, 1 )
                  ITEMP = IDAMAX( NV+1, VV, 1 )
```

```
                  TEMP = ONE / MAX( ABS( VV( ITEMP ) ), SMLNUM )
                  CALL DSCAL( NV+1, TEMP, VV, 1 )
                  ABSW = DLAPY2( WR( J ), WI( J ) )
                  TEMP = ( TEMP*ABSW )*ABSW
                  CALL DGEMV( 'No transpose', NV+2, NV+1, ONE,
     $                        H( L, L ), LDH, VV, 1, TEMP, V, 1 )
                  NV = NV + 2
               END IF
*
*              Scale V(1:NV) so that max(abs(V(i))) = 1. If V is zero,
*              reset it to the unit vector.
*
               ITEMP = IDAMAX( NV, V, 1 )
               TEMP = ABS( V( ITEMP ) )
               IF( TEMP.EQ.ZERO ) THEN
                  V( 1 ) = ONE
                  DO 110 II = 2, NV
                     V( II ) = ZERO
  110             CONTINUE
               ELSE
                  TEMP = MAX( TEMP, SMLNUM )
                  CALL DSCAL( NV, ONE / TEMP, V, 1 )
               END IF
            END IF
  120    CONTINUE
*
*        Multiple-shift QR step
*
         DO 140 K = L, I - 1
*
*           The first iteration of this loop determines a reflection G
*           from the vector V and applies it from left and right to H,
*           thus creating a nonzero bulge below the subdiagonal.
*
*           Each subsequent iteration determines a reflection G to
*           restore the Hessenberg form in the (K-1)th column, and thus
*           chases the bulge one step toward the bottom of the active
*           submatrix. NR is the order of G.
*
            NR = MIN( NS+1, I-K+1 )
            IF( K.GT.L )
     $         CALL DCOPY( NR, H( K, K-1 ), 1, V, 1 )
            CALL DLARFG( NR, V( 1 ), V( 2 ), 1, TAU )
            IF( K.GT.L ) THEN
               H( K, K-1 ) = V( 1 )
               DO 130 II = K + 1, I
                  H( II, K-1 ) = ZERO
  130          CONTINUE
            END IF
            V( 1 ) = ONE
```

```
*
*           Apply G from the left to transform the rows of the matrix in
*           columns K to I2.
*
            CALL DLARFX( 'Left', NR, I2-K+1, V, TAU, H( K, K ), LDH,
     $                   WORK )
*
*           Apply G from the right to transform the columns of the
*           matrix in rows I1 to min(K+NR,I).
*
            CALL DLARFX( 'Right', MIN( K+NR, I )-I1+1, NR, V, TAU,
     $                   H( I1, K ), LDH, WORK )
*
            IF( WANTZ ) THEN
*
*              Accumulate transformations in the matrix Z
*
               CALL DLARFX( 'Right', NH, NR, V, TAU, Z( ILO, K ), LDZ,
     $                      WORK )
            END IF
  140    CONTINUE
*
  150 CONTINUE
*
*     Failure to converge in remaining number of iterations
*
      INFO = I
      RETURN
*
  160 CONTINUE
*
*     A submatrix of order <= MAXB in rows and columns L to I has split
*     off. Use the double-shift QR algorithm to handle it.
*
      CALL DLAHQR( WANTT, WANTZ, N, L, I, H, LDH, WR, WI, ILO, IHI, Z,
     $             LDZ, INFO )
      IF( INFO.GT.0 )
     $   RETURN
*
*     Decrement number of remaining iterations, and return to start of
*     the main loop with a new value of I.
*
      ITN = ITN - ITS
      I = L - 1
      GO TO 50
*
  170 CONTINUE
      WORK( 1 ) = MAX( 1, N )
      RETURN
*
```

```
*     End of DHSEQR
*
      END
```

———-

— LAPACK dhseqr —

```
(let* ((zero 0.0) (one 1.0) (two 2.0) (const 1.5) (nsmax 15) (lds nsmax))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one)
           (type (double-float 2.0 2.0) two)
           (type (double-float 1.5 1.5) const)
           (type (fixnum 15 15) nsmax)
           (type fixnum lds))
  (defun dhseqr (job compz n ilo ihi h ldh wr wi z ldz work lwork info)
    (declare (type (simple-array double-float (*)) work z wi wr h)
             (type fixnum info lwork ldz ldh ihi ilo n)
             (type character compz job))
    (f2cl-lib:with-multi-array-data
        ((job character job-%data% job-%offset%)
         (compz character compz-%data% compz-%offset%)
         (h double-float h-%data% h-%offset%)
         (wr double-float wr-%data% wr-%offset%)
         (wi double-float wi-%data% wi-%offset%)
         (z double-float z-%data% z-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((s
              (make-array (the fixnum (reduce #'* (list lds nsmax)))
                          :element-type 'double-float))
             (v
              (make-array (f2cl-lib:int-add nsmax 1)
                          :element-type 'double-float))
             (vv
              (make-array (f2cl-lib:int-add nsmax 1)
                          :element-type 'double-float))
             (absw 0.0) (ovfl 0.0) (smlnum 0.0) (tau 0.0) (temp 0.0) (tst1 0.0)
             (ulp 0.0) (unfl 0.0) (i 0) (i1 0) (i2 0) (ierr 0) (ii 0) (itemp 0)
             (itn 0) (its 0) (j 0) (k 0) (l 0) (maxb 0) (nh 0) (nr 0) (ns 0)
             (nv 0) (initz nil) (lquery nil) (wantt nil) (wantz nil))
        (declare (type (simple-array double-float (*)) s v vv)
                 (type (double-float) absw ovfl smlnum tau temp tst1 ulp unfl)
                 (type fixnum i i1 i2 ierr ii itemp itn its j k l
                                          maxb nh nr ns nv)
                 (type (member t nil) initz lquery wantt wantz))
        (setf wantt (char-equal job #\S))
        (setf initz (char-equal compz #\I))
        (setf wantz (or initz (char-equal compz #\V)))
```

```
(setf info 0)
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
        (coerce
         (the fixnum
              (max (the fixnum 1)
                   (the fixnum n)))
         'double-float))
(setf lquery (coerce (= lwork -1) '(member t nil)))
(cond
  ((and (not (char-equal job #\E)) (not wantt))
   (setf info -1))
  ((and (not (char-equal compz #\N)) (not wantz))
   (setf info -2))
  ((< n 0)
   (setf info -3))
  ((or (< ilo 1)
       (> ilo
          (max (the fixnum 1) (the fixnum n))))
   (setf info -4))
  ((or
    (< ihi (min (the fixnum ilo) (the fixnum n)))
    (> ihi n))
   (setf info -5))
  ((< ldh (max (the fixnum 1) (the fixnum n)))
   (setf info -7))
  ((or (< ldz 1)
       (and wantz
            (< ldz
               (max (the fixnum 1)
                    (the fixnum n)))))
   (setf info -11))
  ((and
    (< lwork (max (the fixnum 1) (the fixnum n)))
    (not lquery))
   (setf info -13)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DHSEQR" (f2cl-lib:int-sub info))
   (go end_label))
  (lquery
   (go end_label)))
(if initz (dlaset "Full" n n zero one z ldz))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i (f2cl-lib:int-add ilo (f2cl-lib:int-sub 1))) nil)
  (tagbody
    (setf (f2cl-lib:fref wr-%data% (i) ((1 *)) wr-%offset%)
            (f2cl-lib:fref h-%data% (i i) ((1 ldh) (1 *)) h-%offset%))
    (setf (f2cl-lib:fref wi-%data% (i) ((1 *)) wi-%offset%) zero)))
```

```
(f2cl-lib:fdo (i (f2cl-lib:int-add ihi 1) (f2cl-lib:int-add i 1))
              ((> i n) nil)
  (tagbody
    (setf (f2cl-lib:fref wr-%data% (i) ((1 *)) wr-%offset%)
            (f2cl-lib:fref h-%data% (i i) ((1 ldh) (1 *)) h-%offset%))
    (setf (f2cl-lib:fref wi-%data% (i) ((1 *)) wi-%offset%) zero)))
(if (= n 0) (go end_label))
(cond
  ((= ilo ihi)
   (setf (f2cl-lib:fref wr-%data% (ilo) ((1 *)) wr-%offset%)
           (f2cl-lib:fref h-%data%
                          (ilo ilo)
                          ((1 ldh) (1 *))
                          h-%offset%))
   (setf (f2cl-lib:fref wi-%data% (ilo) ((1 *)) wi-%offset%) zero)
   (go end_label)))
(f2cl-lib:fdo (j ilo (f2cl-lib:int-add j 1))
              ((> j (f2cl-lib:int-add ihi (f2cl-lib:int-sub 2))) nil)
  (tagbody
    (f2cl-lib:fdo (i (f2cl-lib:int-add j 2) (f2cl-lib:int-add i 1))
                  ((> i n) nil)
      (tagbody
        (setf (f2cl-lib:fref h-%data% (i j) ((1 ldh) (1 *)) h-%offset%)
                zero)))))
(setf nh (f2cl-lib:int-add (f2cl-lib:int-sub ihi ilo) 1))
(setf ns (ilaenv 4 "DHSEQR" (f2cl-lib:f2cl-// job compz) n ilo ihi -1))
(setf maxb
        (ilaenv 8 "DHSEQR" (f2cl-lib:f2cl-// job compz) n ilo ihi -1))
(cond
  ((or (<= ns 2) (> ns nh) (>= maxb nh))
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
          var-10 var-11 var-12 var-13)
       (dlahqr wantt wantz n ilo ihi h ldh wr wi ilo ihi z ldz info)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                      var-8 var-9 var-10 var-11 var-12))
     (setf info var-13))
   (go end_label)))
(setf maxb
        (max (the fixnum 3) (the fixnum maxb)))
(setf ns
        (min (the fixnum ns)
             (the fixnum maxb)
             (the fixnum nsmax)))
(setf unfl (dlamch "Safe minimum"))
(setf ovfl (/ one unfl))
(multiple-value-bind (var-0 var-1)
    (dlabad unfl ovfl)
  (declare (ignore))
  (setf unfl var-0)
```

```
          (setf ovfl var-1))
        (setf ulp (dlamch "Precision"))
        (setf smlnum (* unfl (/ nh ulp)))
        (cond
          (wantt
           (setf i1 1)
           (setf i2 n)))
        (setf itn (f2cl-lib:int-mul 30 nh))
        (setf i ihi)
label50
        (setf l ilo)
        (if (< i ilo) (go label170))
        (f2cl-lib:fdo (its 0 (f2cl-lib:int-add its 1))
                      ((> its itn) nil)
          (tagbody
            (f2cl-lib:fdo (k i (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
                          ((> k (f2cl-lib:int-add l 1)) nil)
              (tagbody
                (setf tst1
                        (+
                         (abs
                          (f2cl-lib:fref h-%data%
                                         ((f2cl-lib:int-sub k 1)
                                          (f2cl-lib:int-sub k 1))
                                         ((1 ldh) (1 *))
                                         h-%offset%))
                         (abs
                          (f2cl-lib:fref h-%data%
                                         (k k)
                                         ((1 ldh) (1 *))
                                         h-%offset%))))
                (if (= tst1 zero)
                    (setf tst1
                            (dlanhs "1"
                             (f2cl-lib:int-add (f2cl-lib:int-sub i l) 1)
                             (f2cl-lib:array-slice h
                                                   double-float
                                                   (l l)
                                                   ((1 ldh) (1 *)))
                             ldh work)))
                (if
                 (<=
                  (abs
                   (f2cl-lib:fref h-%data%
                                  (k (f2cl-lib:int-sub k 1))
                                  ((1 ldh) (1 *))
                                  h-%offset%))
                  (max (* ulp tst1) smlnum))
                 (go label70))))
label70
```

```
(setf l k)
(cond
  ((> l ilo)
   (setf (f2cl-lib:fref h-%data%
                        (l (f2cl-lib:int-sub l 1))
                        ((1 ldh) (1 *))
                        h-%offset%)
          zero)))
(if (>= l (f2cl-lib:int-add (f2cl-lib:int-sub i maxb) 1))
    (go label160))
(cond
  ((not wantt)
   (setf i1 l)
   (setf i2 i)))
(cond
  ((or (= its 20) (= its 30))
   (f2cl-lib:fdo (ii (f2cl-lib:int-add i (f2cl-lib:int-sub ns) 1)
                  (f2cl-lib:int-add ii 1))
                 ((> ii i) nil)
     (tagbody
       (setf (f2cl-lib:fref wr-%data% (ii) ((1 *)) wr-%offset%)
             (* const
                (+
                 (abs
                  (f2cl-lib:fref h-%data%
                                 (ii (f2cl-lib:int-sub ii 1))
                                 ((1 ldh) (1 *))
                                 h-%offset%))
                 (abs
                  (f2cl-lib:fref h-%data%
                                 (ii ii)
                                 ((1 ldh) (1 *))
                                 h-%offset%)))))
       (setf (f2cl-lib:fref wi-%data% (ii) ((1 *)) wi-%offset%)
             zero))))
  (t
   (dlacpy "Full" ns ns
    (f2cl-lib:array-slice h
                          double-float
                          ((+ i (f2cl-lib:int-sub ns) 1)
                           (f2cl-lib:int-add
                            (f2cl-lib:int-sub i ns)
                            1))
                          ((1 ldh) (1 *)))
    ldh s lds)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
          var-9 var-10 var-11 var-12 var-13)
       (dlahqr nil nil ns 1 ns s lds
        (f2cl-lib:array-slice wr
```

```
                                double-float
                                ((+ i (f2cl-lib:int-sub ns) 1))
                                ((1 *)))
          (f2cl-lib:array-slice wi
                                double-float
                                ((+ i (f2cl-lib:int-sub ns) 1))
                                ((1 *)))
          1 ns z ldz ierr)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                         var-7 var-8 var-9 var-10 var-11 var-12))
        (setf ierr var-13))
       (cond
        ((> ierr 0)
         (f2cl-lib:fdo (ii 1 (f2cl-lib:int-add ii 1))
                       ((> ii ierr) nil)
           (tagbody
             (setf (f2cl-lib:fref wr-%data%
                                  ((f2cl-lib:int-add
                                    (f2cl-lib:int-sub i ns)
                                    ii))
                                  ((1 *))
                                  wr-%offset%)
                   (f2cl-lib:fref s (ii ii) ((1 lds) (1 nsmax))))
             (setf (f2cl-lib:fref wi-%data%
                                  ((f2cl-lib:int-add
                                    (f2cl-lib:int-sub i ns)
                                    ii))
                                  ((1 *))
                                  wi-%offset%)
                   zero)))))))
    (setf (f2cl-lib:fref v (1) ((1 (f2cl-lib:int-add nsmax 1)))) one)
    (f2cl-lib:fdo (ii 2 (f2cl-lib:int-add ii 1))
                  ((> ii (f2cl-lib:int-add ns 1)) nil)
      (tagbody
        (setf (f2cl-lib:fref v (ii) ((1 (f2cl-lib:int-add nsmax 1))))
              zero)))
    (setf nv 1)
    (f2cl-lib:fdo (j (f2cl-lib:int-add i (f2cl-lib:int-sub ns) 1)
                     (f2cl-lib:int-add j 1))
                  ((> j i) nil)
      (tagbody
        (cond
          ((>= (f2cl-lib:fref wi (j) ((1 *))) zero)
           (cond
             ((= (f2cl-lib:fref wi (j) ((1 *))) zero)
              (dcopy (f2cl-lib:int-add nv 1) v 1 vv 1)
              (dgemv "No transpose" (f2cl-lib:int-add nv 1) nv one
                     (f2cl-lib:array-slice h
                                           double-float
                                           (1 1)
```

```
                          ((1 ldh) (1 *)))
     ldh vv 1
     (- (f2cl-lib:fref wr-%data% (j) ((1 *)) wr-%offset%)) v
     1)
    (setf nv (f2cl-lib:int-add nv 1)))
   ((> (f2cl-lib:fref wi (j) ((1 *))) zero)
    (dcopy (f2cl-lib:int-add nv 1) v 1 vv 1)
    (dgemv "No transpose" (f2cl-lib:int-add nv 1) nv one
     (f2cl-lib:array-slice h
                           double-float
                           (1 1)
                           ((1 ldh) (1 *)))
     ldh v 1
     (* (- two)
        (f2cl-lib:fref wr-%data% (j) ((1 *)) wr-%offset%))
     vv 1)
    (setf itemp (idamax (f2cl-lib:int-add nv 1) vv 1))
    (setf temp
            (/ one
               (max
                (abs
                 (f2cl-lib:fref vv
                                (itemp)
                                ((1
                                  (f2cl-lib:int-add nsmax
                                                    1)))))
                smlnum)))
    (dscal (f2cl-lib:int-add nv 1) temp vv 1)
    (setf absw
            (dlapy2
             (f2cl-lib:fref wr-%data%
                            (j)
                            ((1 *))
                            wr-%offset%)
             (f2cl-lib:fref wi-%data%
                            (j)
                            ((1 *))
                            wi-%offset%)))
    (setf temp (* temp absw absw))
    (dgemv "No transpose" (f2cl-lib:int-add nv 2)
     (f2cl-lib:int-add nv 1) one
     (f2cl-lib:array-slice h
                           double-float
                           (1 1)
                           ((1 ldh) (1 *)))
     ldh vv 1 temp v 1)
    (setf nv (f2cl-lib:int-add nv 2))))
(setf itemp (idamax nv v 1))
(setf temp
        (abs
```

```
                    (f2cl-lib:fref v
                                  (itemp)
                                  ((1 (f2cl-lib:int-add nsmax 1))))))
          (cond
            ((= temp zero)
             (setf (f2cl-lib:fref v
                                  (1)
                                  ((1 (f2cl-lib:int-add nsmax 1))))
                   one)
             (f2cl-lib:fdo (ii 2 (f2cl-lib:int-add ii 1))
                           ((> ii nv) nil)
               (tagbody
                 (setf (f2cl-lib:fref v
                                      (ii)
                                      ((1
                                        (f2cl-lib:int-add nsmax 1))))
                       zero))))
            (t
             (setf temp (max temp smlnum))
             (dscal nv (/ one temp) v 1)))))
(f2cl-lib:fdo (k l (f2cl-lib:int-add k 1))
              ((> k (f2cl-lib:int-add i (f2cl-lib:int-sub 1))) nil)
  (tagbody
    (setf nr
            (min (the fixnum (f2cl-lib:int-add ns 1))
                 (the fixnum
                      (f2cl-lib:int-add (f2cl-lib:int-sub i k)
                                        1))))
    (if (> k l)
        (dcopy nr
         (f2cl-lib:array-slice h
                               double-float
                               (k (f2cl-lib:int-sub k 1))
                               ((1 ldh) (1 *)))
         1 v 1))
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
        (dlarfg nr
         (f2cl-lib:fref v (1) ((1 (f2cl-lib:int-add nsmax 1))))
         (f2cl-lib:array-slice v
                               double-float
                               (2)
                               ((1 (f2cl-lib:int-add nsmax 1))))
         1 tau)
      (declare (ignore var-0 var-2 var-3))
      (setf (f2cl-lib:fref v (1) ((1 (f2cl-lib:int-add nsmax 1))))
            var-1)
      (setf tau var-4))
    (cond
      ((> k l)
       (setf (f2cl-lib:fref h-%data%
```

```
                                    (k (f2cl-lib:int-sub k 1))
                                    ((1 ldh) (1 *))
                                    h-%offset%)
                            (f2cl-lib:fref v
                                           (1)
                                           ((1 (f2cl-lib:int-add nsmax 1)))))
                       (f2cl-lib:fdo (ii (f2cl-lib:int-add k 1)
                                         (f2cl-lib:int-add ii 1))
                                     ((> ii i) nil)
                         (tagbody
                           (setf (f2cl-lib:fref h-%data%
                                                (ii (f2cl-lib:int-sub k 1))
                                                ((1 ldh) (1 *))
                                                h-%offset%)
                                 zero)))))
                     (setf (f2cl-lib:fref v (1) ((1 (f2cl-lib:int-add nsmax 1))))
                           one)
                     (dlarfx "Left" nr (f2cl-lib:int-add (f2cl-lib:int-sub i2 k) 1)
                      v tau
                      (f2cl-lib:array-slice h double-float (k k) ((1 ldh) (1 *)))
                      ldh work)
                     (dlarfx "Right"
                      (f2cl-lib:int-add
                       (f2cl-lib:int-sub
                        (min (the fixnum (f2cl-lib:int-add k nr))
                             (the fixnum i))
                        i1)
                       1)
                      nr v tau
                      (f2cl-lib:array-slice h double-float (i1 k) ((1 ldh) (1 *)))
                      ldh work)
                     (cond
                       (wantz
                        (dlarfx "Right" nh nr v tau
                         (f2cl-lib:array-slice z
                                               double-float
                                               (ilo k)
                                               ((1 ldz) (1 *)))
                         ldz work)))))))
              (setf info i)
              (go end_label)
label160
              (multiple-value-bind
                    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
                     var-10 var-11 var-12 var-13)
                  (dlahqr wantt wantz n l i h ldh wr wi ilo ihi z ldz info)
                (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                                 var-8 var-9 var-10 var-11 var-12))
                (setf info var-13))
              (if (> info 0) (go end_label))
```

```
        (setf itn (f2cl-lib:int-sub itn its))
        (setf i (f2cl-lib:int-sub l 1))
        (go label50)
 label170
        (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
                (coerce
                 (the fixnum
                      (max (the fixnum 1)
                           (the fixnum n)))
                 'double-float))
 end_label
        (return
         (values nil nil nil nil nil nil nil nil nil nil nil nil nil info))))))
```

———-

6.23 disnan LAPACK

— **disnan.input** —

```
)set break resume
)sys rm -f disnan.output
)spool disnan.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **disnan.help** —

```
==========================================================================
dhseqr examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

Online html documentation available at
           http://www.netlib.org/lapack/explore-html/
```

```
 Definition:
 ===========

     LOGICAL FUNCTION DISNAN( DIN )

     .. Scalar Arguments ..
     DOUBLE PRECISION   DIN
     ..


 Purpose:
 =============

 DISNAN returns .TRUE. if its argument is NaN, and .FALSE.
 otherwise.  To be replaced by the Fortran 2003 intrinsic in the
 future.


 Arguments:
 ==========

 [in] DIN
       DIN is DOUBLE PRECISION
       Input to test for NaN.

 Authors:
 ========

 Univ. of Tennessee
 Univ. of California Berkeley
 Univ. of Colorado Denver
 NAG Ltd.

 November 2011
```

———-

— disnan.f —

```
*  =====================================================================
      LOGICAL FUNCTION DISNAN( DIN )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
```

```
      DOUBLE PRECISION   DIN
*     ..
*
*  =====================================================================
*
*  .. External Functions ..
      LOGICAL DLAISNAN
      EXTERNAL DLAISNAN
*  ..
*  .. Executable Statements ..
      DISNAN = DLAISNAN(DIN,DIN)
      RETURN
      END
```

———-

— LAPACK disnan —

———-

6.24 dlabad LAPACK

— dlabad.input —

```
)set break resume
)sys rm -f dlabad.output
)spool dlabad.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dlabad.help —

```
=====================================================================
dlabad examples
=====================================================================
```

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=====================================================================
Man Page Details
=====================================================================

NAME
       DLABAD  - a input the values computed by DLAMCH for underflow and over-
       flow, and returns the square root of each of these values if the log of
       LARGE is sufficiently large

SYNOPSIS
       SUBROUTINE DLABAD( SMALL, LARGE )

           DOUBLE         PRECISION LARGE, SMALL

PURPOSE
       DLABAD  takes  as input the values computed by DLAMCH for underflow and
       overflow, and returns the square root of each of these  values  if  the
       log  of  LARGE  is  sufficiently large.  This subroutine is intended to
       identify machines with a large exponent range, such as the  Crays,  and
       redefine  the  underflow  and overflow limits to be the square roots of
       the values computed by  DLAMCH.   This  subroutine  is  needed  because
       DLAMCH does not compensate for poor arithmetic in the upper half of the
       exponent range, as is found on a Cray.


ARGUMENTS
       SMALL   (input/output) DOUBLE PRECISION
               On entry, the underflow threshold as computed  by  DLAMCH.   On
               exit, if LOG10(LARGE) is sufficiently large, the square root of
               SMALL, otherwise unchanged.

       LARGE   (input/output) DOUBLE PRECISION
               On entry, the overflow threshold as  computed  by  DLAMCH.   On
               exit, if LOG10(LARGE) is sufficiently large, the square root of
               LARGE, otherwise unchanged.
```

———-

— dlabad.f —

```
      SUBROUTINE DLABAD( SMALL, LARGE )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1992
*
*     .. Scalar Arguments ..
```

```
      DOUBLE PRECISION   LARGE, SMALL
*     ..
*
*  =====================================================================
*
*     .. Intrinsic Functions ..
      INTRINSIC          LOG10, SQRT
*     ..
*     .. Executable Statements ..
*
*     If it looks like we're on a Cray, take the square root of
*     SMALL and LARGE to avoid overflow and underflow problems.
*
      IF( LOG10( LARGE ).GT.2000.D0 ) THEN
         SMALL = SQRT( SMALL )
         LARGE = SQRT( LARGE )
      END IF
*
      RETURN
*
*     End of DLABAD
*
      END
```

———-

— LAPACK dlabad —

```
(defun dlabad (small large)
  (declare (type (double-float) large small))
  (prog ()
    (declare)
    (cond
      ((> (f2cl-lib:log10 large) 2000.0)
       (setf small (f2cl-lib:fsqrt small))
       (setf large (f2cl-lib:fsqrt large))))
    (return (values small large))))
```

———-

6.25 dlabrd LAPACK

— dlabrd.input —

```
)set break resume
)sys rm -f dlabrd.output
)spool dlabrd.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dlabrd.help —

```
====================================================================
dlabrd examples
====================================================================

====================================================================
Man Page Details
====================================================================

NAME
       DLABRD  - the first NB rows and columns of a real general m by n matrix
       A to upper or lower bidiagonal form by an orthogonal transformation  Q'
       * A * P, and returns the matrices X and Y which are needed to apply the
       transformation to the unreduced part of A

SYNOPSIS
       SUBROUTINE DLABRD( M, N, NB, A, LDA, D, E, TAUQ, TAUP, X, LDX, Y, LDY )

           INTEGER        LDA, LDX, LDY, M, N, NB

           DOUBLE         PRECISION  A(  LDA,  * ), D( * ), E( * ), TAUP( * ),
                          TAUQ( * ), X( LDX, * ), Y( LDY, * )

PURPOSE
       DLABRD reduces the first NB rows and columns of a real general m  by  n
       matrix A to upper or lower bidiagonal form by an orthogonal transforma-
       tion Q' * A * P, and returns the matrices X and Y which are  needed  to
       apply the transformation to the unreduced part of A.

       If  m  >=  n, A is reduced to upper bidiagonal form; if m < n, to lower
       bidiagonal form.

       This is an auxiliary routine called by DGEBRD


ARGUMENTS
```

M (input) INTEGER
The number of rows in the matrix A.

N (input) INTEGER
The number of columns in the matrix A.

NB (input) INTEGER
The number of leading rows and columns of A to be reduced.

A (input/output) DOUBLE PRECISION array, dimension (LDA,N)
On entry, the m by n general matrix to be reduced. On exit, the first NB rows and columns of the matrix are overwritten; the rest of the array is unchanged. If m >= n, elements on and below the diagonal in the first NB columns, with the array TAUQ, represent the orthogonal matrix Q as a product of elementary reflectors; and elements above the diagonal in the first NB rows, with the array TAUP, represent the orthogonal matrix P as a product of elementary reflectors. If m < n, elements below the diagonal in the first NB columns, with the array TAUQ, represent the orthogonal matrix Q as a product of elementary reflectors, and elements on and above the diagonal in the first NB rows, with the array TAUP, represent the orthogonal matrix P as a product of elementary reflectors. See Further Details. LDA (input) INTEGER The leading dimension of the array A. LDA >= max(1,M).

D (output) DOUBLE PRECISION array, dimension (NB)
The diagonal elements of the first NB rows and columns of the reduced matrix. D(i) = A(i,i).

E (output) DOUBLE PRECISION array, dimension (NB)
The off-diagonal elements of the first NB rows and columns of the reduced matrix.

TAUQ (output) DOUBLE PRECISION array dimension (NB)
The scalar factors of the elementary reflectors which represent the orthogonal matrix Q. See Further Details. TAUP (output) DOUBLE PRECISION array, dimension (NB) The scalar factors of the elementary reflectors which represent the orthogonal matrix P. See Further Details. X (output) DOUBLE PRECISION array, dimension (LDX,NB) The m-by-nb matrix X required to update the unreduced part of A.

LDX (input) INTEGER
The leading dimension of the array X. LDX >= M.

Y (output) DOUBLE PRECISION array, dimension (LDY,NB)
The n-by-nb matrix Y required to update the unreduced part of A.

```
       LDY     (input) INTEGER
               The leading dimension of the array Y. LDY >= N.

FURTHER DETAILS
       The  matrices Q and P are represented as products of elementary reflec-
       tors:

          Q = H(1) H(2) . . . H(nb)  and  P = G(1) G(2) . . . G(nb)

       Each H(i) and G(i) has the form:

          H(i) = I - tauq * v * v'  and G(i) = I - taup * u * u'

       where tauq and taup are real scalars, and v and u are real vectors.

       If m >= n, v(1:i-1) = 0, v(i) = 1, and v(i:m)  is  stored  on  exit  in
       A(i:m,i);  u(1:i)  =  0,  u(i+1) = 1, and u(i+1:n) is stored on exit in
       A(i,i+1:n); tauq is stored in TAUQ(i) and taup in TAUP(i).

       If m < n, v(1:i) = 0, v(i+1) = 1, and v(i+1:m) is  stored  on  exit  in
       A(i+2:m,i);  u(1:i-1)  =  0,  u(i) = 1, and u(i:n) is stored on exit in
       A(i,i+1:n); tauq is stored in TAUQ(i) and taup in TAUP(i).

       The elements of the vectors v and u together form the m-by-nb matrix  V
       and  the nb-by-n matrix U' which are needed, with X and Y, to apply the
       transformation to the unreduced part  of  the  matrix,  using  a  block
       update of the form:  A := A - V*Y' - X*U'.

       The  contents  of  A  on exit are illustrated by the following examples
       with nb = 2:

       m = 6 and n = 5 (m > n):          m = 5 and n = 6 (m < n):

         (  1   1   u1  u1  u1 )           (  1   u1  u1  u1  u1  u1 )
         (  v1  1   1   u2  u2 )           (  1   1   u2  u2  u2  u2 )
         (  v1  v2  a   a   a  )           (  v1  1   a   a   a   a  )
         (  v1  v2  a   a   a  )           (  v1  v2  a   a   a   a  )
         (  v1  v2  a   a   a  )           (  v1  v2  a   a   a   a  )
         (  v1  v2  a   a   a  )
```

— dlabrd.f —

```
      SUBROUTINE DLABRD( M, N, NB, A, LDA, D, E, TAUQ, TAUP, X, LDX, Y,
     $                   LDY )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     February 29, 1992
*
*     .. Scalar Arguments ..
      INTEGER            LDA, LDX, LDY, M, N, NB
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), D( * ), E( * ), TAUP( * ),
     $                   TAUQ( * ), X( LDX, * ), Y( LDY, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D0, ONE = 1.0D0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I
*     ..
*     .. External Subroutines ..
      EXTERNAL           DGEMV, DLARFG, DSCAL
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MIN
*     ..
*     .. Executable Statements ..
*
*     Quick return if possible
*
      IF( M.LE.0 .OR. N.LE.0 )
     $   RETURN
*
      IF( M.GE.N ) THEN
*
*        Reduce to upper bidiagonal form
*
         DO 10 I = 1, NB
*
*           Update A(i:m,i)
*
            CALL DGEMV( 'No transpose', M-I+1, I-1, -ONE, A( I, 1 ),
     $                  LDA, Y( I, 1 ), LDY, ONE, A( I, I ), 1 )
            CALL DGEMV( 'No transpose', M-I+1, I-1, -ONE, X( I, 1 ),
     $                  LDX, A( 1, I ), 1, ONE, A( I, I ), 1 )
```

```
*
*           Generate reflection Q(i) to annihilate A(i+1:m,i)
*
            CALL DLARFG( M-I+1, A( I, I ), A( MIN( I+1, M ), I ), 1,
     $                   TAUQ( I ) )
            D( I ) = A( I, I )
            IF( I.LT.N ) THEN
               A( I, I ) = ONE
*
*              Compute Y(i+1:n,i)
*
               CALL DGEMV( 'Transpose', M-I+1, N-I, ONE, A( I, I+1 ),
     $                     LDA, A( I, I ), 1, ZERO, Y( I+1, I ), 1 )
               CALL DGEMV( 'Transpose', M-I+1, I-1, ONE, A( I, 1 ), LDA,
     $                     A( I, I ), 1, ZERO, Y( 1, I ), 1 )
               CALL DGEMV( 'No transpose', N-I, I-1, -ONE, Y( I+1, 1 ),
     $                     LDY, Y( 1, I ), 1, ONE, Y( I+1, I ), 1 )
               CALL DGEMV( 'Transpose', M-I+1, I-1, ONE, X( I, 1 ), LDX,
     $                     A( I, I ), 1, ZERO, Y( 1, I ), 1 )
               CALL DGEMV( 'Transpose', I-1, N-I, -ONE, A( 1, I+1 ),
     $                     LDA, Y( 1, I ), 1, ONE, Y( I+1, I ), 1 )
               CALL DSCAL( N-I, TAUQ( I ), Y( I+1, I ), 1 )
*
*              Update A(i,i+1:n)
*
               CALL DGEMV( 'No transpose', N-I, I, -ONE, Y( I+1, 1 ),
     $                     LDY, A( I, 1 ), LDA, ONE, A( I, I+1 ), LDA )
               CALL DGEMV( 'Transpose', I-1, N-I, -ONE, A( 1, I+1 ),
     $                     LDA, X( I, 1 ), LDX, ONE, A( I, I+1 ), LDA )
*
*              Generate reflection P(i) to annihilate A(i,i+2:n)
*
               CALL DLARFG( N-I, A( I, I+1 ), A( I, MIN( I+2, N ) ),
     $                      LDA, TAUP( I ) )
               E( I ) = A( I, I+1 )
               A( I, I+1 ) = ONE
*
*              Compute X(i+1:m,i)
*
               CALL DGEMV( 'No transpose', M-I, N-I, ONE, A( I+1, I+1 ),
     $                     LDA, A( I, I+1 ), LDA, ZERO, X( I+1, I ), 1 )
               CALL DGEMV( 'Transpose', N-I, I, ONE, Y( I+1, 1 ), LDY,
     $                     A( I, I+1 ), LDA, ZERO, X( 1, I ), 1 )
               CALL DGEMV( 'No transpose', M-I, I, -ONE, A( I+1, 1 ),
     $                     LDA, X( 1, I ), 1, ONE, X( I+1, I ), 1 )
               CALL DGEMV( 'No transpose', I-1, N-I, ONE, A( 1, I+1 ),
     $                     LDA, A( I, I+1 ), LDA, ZERO, X( 1, I ), 1 )
               CALL DGEMV( 'No transpose', M-I, I-1, -ONE, X( I+1, 1 ),
     $                     LDX, X( 1, I ), 1, ONE, X( I+1, I ), 1 )
               CALL DSCAL( M-I, TAUP( I ), X( I+1, I ), 1 )
```

```
            END IF
   10    CONTINUE
         ELSE
*
*           Reduce to lower bidiagonal form
*
            DO 20 I = 1, NB
*
*              Update A(i,i:n)
*
               CALL DGEMV( 'No transpose', N-I+1, I-1, -ONE, Y( I, 1 ),
     $                     LDY, A( I, 1 ), LDA, ONE, A( I, I ), LDA )
               CALL DGEMV( 'Transpose', I-1, N-I+1, -ONE, A( 1, I ), LDA,
     $                     X( I, 1 ), LDX, ONE, A( I, I ), LDA )
*
*              Generate reflection P(i) to annihilate A(i,i+1:n)
*
               CALL DLARFG( N-I+1, A( I, I ), A( I, MIN( I+1, N ) ), LDA,
     $                      TAUP( I ) )
               D( I ) = A( I, I )
               IF( I.LT.M ) THEN
                  A( I, I ) = ONE
*
*                 Compute X(i+1:m,i)
*
                  CALL DGEMV( 'No transpose', M-I, N-I+1, ONE, A( I+1, I ),
     $                        LDA, A( I, I ), LDA, ZERO, X( I+1, I ), 1 )
                  CALL DGEMV( 'Transpose', N-I+1, I-1, ONE, Y( I, 1 ), LDY,
     $                        A( I, I ), LDA, ZERO, X( 1, I ), 1 )
                  CALL DGEMV( 'No transpose', M-I, I-1, -ONE, A( I+1, 1 ),
     $                        LDA, X( 1, I ), 1, ONE, X( I+1, I ), 1 )
                  CALL DGEMV( 'No transpose', I-1, N-I+1, ONE, A( 1, I ),
     $                        LDA, A( I, I ), LDA, ZERO, X( 1, I ), 1 )
                  CALL DGEMV( 'No transpose', M-I, I-1, -ONE, X( I+1, 1 ),
     $                        LDX, X( 1, I ), 1, ONE, X( I+1, I ), 1 )
                  CALL DSCAL( M-I, TAUP( I ), X( I+1, I ), 1 )
*
*                 Update A(i+1:m,i)
*
                  CALL DGEMV( 'No transpose', M-I, I-1, -ONE, A( I+1, 1 ),
     $                        LDA, Y( I, 1 ), LDY, ONE, A( I+1, I ), 1 )
                  CALL DGEMV( 'No transpose', M-I, I, -ONE, X( I+1, 1 ),
     $                        LDX, A( 1, I ), 1, ONE, A( I+1, I ), 1 )
*
*                 Generate reflection Q(i) to annihilate A(i+2:m,i)
*
                  CALL DLARFG( M-I, A( I+1, I ), A( MIN( I+2, M ), I ), 1,
     $                         TAUQ( I ) )
                  E( I ) = A( I+1, I )
                  A( I+1, I ) = ONE
```

```
*
*              Compute Y(i+1:n,i)
*
               CALL DGEMV( 'Transpose', M-I, N-I, ONE, A( I+1, I+1 ),
     $                     LDA, A( I+1, I ), 1, ZERO, Y( I+1, I ), 1 )
               CALL DGEMV( 'Transpose', M-I, I-1, ONE, A( I+1, 1 ), LDA,
     $                     A( I+1, I ), 1, ZERO, Y( 1, I ), 1 )
               CALL DGEMV( 'No transpose', N-I, I-1, -ONE, Y( I+1, 1 ),
     $                     LDY, Y( 1, I ), 1, ONE, Y( I+1, I ), 1 )
               CALL DGEMV( 'Transpose', M-I, I, ONE, X( I+1, 1 ), LDX,
     $                     A( I+1, I ), 1, ZERO, Y( 1, I ), 1 )
               CALL DGEMV( 'Transpose', I, N-I, -ONE, A( 1, I+1 ), LDA,
     $                     Y( 1, I ), 1, ONE, Y( I+1, I ), 1 )
               CALL DSCAL( N-I, TAUQ( I ), Y( I+1, I ), 1 )
            END IF
   20    CONTINUE
      END IF
      RETURN
*
*     End of DLABRD
*
      END
```

— LAPACK dlabrd —

```
(let* ((zero 0.0) (one 1.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one))
  (defun dlabrd (m n nb a lda d e tauq taup x ldx y ldy)
    (declare (type (simple-array double-float (*)) y x taup tauq e d a)
             (type fixnum ldy ldx lda nb n m))
    (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (d double-float d-%data% d-%offset%)
         (e double-float e-%data% e-%offset%)
         (tauq double-float tauq-%data% tauq-%offset%)
         (taup double-float taup-%data% taup-%offset%)
         (x double-float x-%data% x-%offset%)
         (y double-float y-%data% y-%offset%))
      (prog ((i 0))
        (declare (type fixnum i))
        (if (or (<= m 0) (<= n 0)) (go end_label))
        (cond
          ((>= m n)
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i nb) nil)
```

```
(tagbody
  (dgemv "No transpose"
   (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
   (f2cl-lib:int-sub i 1) (- one)
   (f2cl-lib:array-slice a double-float (i 1) ((1 lda) (1 *))) lda
   (f2cl-lib:array-slice y double-float (i 1) ((1 ldy) (1 *))) ldy
   one (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
   1)
  (dgemv "No transpose"
   (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
   (f2cl-lib:int-sub i 1) (- one)
   (f2cl-lib:array-slice x double-float (i 1) ((1 ldx) (1 *))) ldx
   (f2cl-lib:array-slice a double-float (1 i) ((1 lda) (1 *))) 1
   one (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
   1)
  (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
      (dlarfg (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
       (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
       (f2cl-lib:array-slice a
                             double-float
                             ((min (f2cl-lib:int-add i 1) m) i)
                             ((1 lda) (1 *)))
       1 (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%))
    (declare (ignore var-0 var-2 var-3))
    (setf (f2cl-lib:fref a-%data%
                         (i i)
                         ((1 lda) (1 *))
                         a-%offset%)
          var-1)
    (setf (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%)
          var-4))
  (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
        (f2cl-lib:fref a-%data%
                       (i i)
                       ((1 lda) (1 *))
                       a-%offset%))
  (cond
    ((< i n)
     (setf (f2cl-lib:fref a-%data%
                          (i i)
                          ((1 lda) (1 *))
                          a-%offset%)
           one)
     (dgemv "Transpose"
      (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
      (f2cl-lib:int-sub n i) one
      (f2cl-lib:array-slice a
                            double-float
                            (i (f2cl-lib:int-add i 1))
                            ((1 lda) (1 *)))
```

```
 lda
 (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
 1 zero
 (f2cl-lib:array-slice y
                       double-float
                       ((+ i 1) i)
                       ((1 ldy) (1 *)))
 1)
(dgemv "Transpose"
 (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
 (f2cl-lib:int-sub i 1) one
 (f2cl-lib:array-slice a double-float (i 1) ((1 lda) (1 *)))
 lda
 (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
 1 zero
 (f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 *)))
 1)
(dgemv "No transpose" (f2cl-lib:int-sub n i)
 (f2cl-lib:int-sub i 1) (- one)
 (f2cl-lib:array-slice y
                       double-float
                       ((+ i 1) 1)
                       ((1 ldy) (1 *)))
 ldy
 (f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 *)))
 1 one
 (f2cl-lib:array-slice y
                       double-float
                       ((+ i 1) i)
                       ((1 ldy) (1 *)))
 1)
(dgemv "Transpose"
 (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
 (f2cl-lib:int-sub i 1) one
 (f2cl-lib:array-slice x double-float (i 1) ((1 ldx) (1 *)))
 ldx
 (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
 1 zero
 (f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 *)))
 1)
(dgemv "Transpose" (f2cl-lib:int-sub i 1)
 (f2cl-lib:int-sub n i) (- one)
 (f2cl-lib:array-slice a
                       double-float
                       (1 (f2cl-lib:int-add i 1))
                       ((1 lda) (1 *)))
 lda
 (f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 *)))
 1 one
 (f2cl-lib:array-slice y
```

```
                      double-float
                      ((+ i 1) i)
                      ((1 ldy) (1 *)))
 1)
(dscal (f2cl-lib:int-sub n i)
 (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%)
 (f2cl-lib:array-slice y
                      double-float
                      ((+ i 1) i)
                      ((1 ldy) (1 *)))
 1)
(dgemv "No transpose" (f2cl-lib:int-sub n i) i (- one)
 (f2cl-lib:array-slice y
                      double-float
                      ((+ i 1) 1)
                      ((1 ldy) (1 *)))
 ldy
 (f2cl-lib:array-slice a double-float (i 1) ((1 lda) (1 *)))
 lda one
 (f2cl-lib:array-slice a
                      double-float
                      (i (f2cl-lib:int-add i 1))
                      ((1 lda) (1 *)))
 lda)
(dgemv "Transpose" (f2cl-lib:int-sub i 1)
 (f2cl-lib:int-sub n i) (- one)
 (f2cl-lib:array-slice a
                      double-float
                      (1 (f2cl-lib:int-add i 1))
                      ((1 lda) (1 *)))
 lda
 (f2cl-lib:array-slice x double-float (i 1) ((1 ldx) (1 *)))
 ldx one
 (f2cl-lib:array-slice a
                      double-float
                      (i (f2cl-lib:int-add i 1))
                      ((1 lda) (1 *)))
 lda)
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
    (dlarfg (f2cl-lib:int-sub n i)
     (f2cl-lib:fref a-%data%
                    (i (f2cl-lib:int-add i 1))
                    ((1 lda) (1 *))
                    a-%offset%)
     (f2cl-lib:array-slice a
                           double-float
                           (i
                            (min
                             (the fixnum
                                  (f2cl-lib:int-add i 2))
```

```
                              (the fixnum n)))
                            ((1 lda) (1 *)))
     lda
     (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%))
  (declare (ignore var-0 var-2 var-3))
  (setf (f2cl-lib:fref a-%data%
                       (i (f2cl-lib:int-add i 1))
                       ((1 lda) (1 *))
                       a-%offset%)
        var-1)
  (setf (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%)
        var-4))
(setf (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)
       (f2cl-lib:fref a-%data%
                      (i (f2cl-lib:int-add i 1))
                      ((1 lda) (1 *))
                      a-%offset%))
(setf (f2cl-lib:fref a-%data%
                     (i (f2cl-lib:int-add i 1))
                     ((1 lda) (1 *))
                     a-%offset%)
       one)
(dgemv "No transpose" (f2cl-lib:int-sub m i)
 (f2cl-lib:int-sub n i) one
 (f2cl-lib:array-slice a
                       double-float
                       ((+ i 1) (f2cl-lib:int-add i 1))
                       ((1 lda) (1 *)))
 lda
 (f2cl-lib:array-slice a
                       double-float
                       (i (f2cl-lib:int-add i 1))
                       ((1 lda) (1 *)))
 lda zero
 (f2cl-lib:array-slice x
                       double-float
                       ((+ i 1) i)
                       ((1 ldx) (1 *)))
 1)
(dgemv "Transpose" (f2cl-lib:int-sub n i) i one
 (f2cl-lib:array-slice y
                       double-float
                       ((+ i 1) 1)
                       ((1 ldy) (1 *)))
 ldy
 (f2cl-lib:array-slice a
                       double-float
                       (i (f2cl-lib:int-add i 1))
                       ((1 lda) (1 *)))
 lda zero
```

```
 (f2cl-lib:array-slice x double-float (1 i) ((1 ldx) (1 *)))
 1)
(dgemv "No transpose" (f2cl-lib:int-sub m i) i (- one)
 (f2cl-lib:array-slice a
                       double-float
                       ((+ i 1) 1)
                       ((1 lda) (1 *)))
 lda
 (f2cl-lib:array-slice x double-float (1 i) ((1 ldx) (1 *)))
 1 one
 (f2cl-lib:array-slice x
                       double-float
                       ((+ i 1) i)
                       ((1 ldx) (1 *)))
 1)
(dgemv "No transpose" (f2cl-lib:int-sub i 1)
 (f2cl-lib:int-sub n i) one
 (f2cl-lib:array-slice a
                       double-float
                       (1 (f2cl-lib:int-add i 1))
                       ((1 lda) (1 *)))
 lda
 (f2cl-lib:array-slice a
                       double-float
                       (i (f2cl-lib:int-add i 1))
                       ((1 lda) (1 *)))
 lda zero
 (f2cl-lib:array-slice x double-float (1 i) ((1 ldx) (1 *)))
 1)
(dgemv "No transpose" (f2cl-lib:int-sub m i)
 (f2cl-lib:int-sub i 1) (- one)
 (f2cl-lib:array-slice x
                       double-float
                       ((+ i 1) 1)
                       ((1 ldx) (1 *)))
 ldx
 (f2cl-lib:array-slice x double-float (1 i) ((1 ldx) (1 *)))
 1 one
 (f2cl-lib:array-slice x
                       double-float
                       ((+ i 1) i)
                       ((1 ldx) (1 *)))
 1)
(dscal (f2cl-lib:int-sub m i)
 (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%)
 (f2cl-lib:array-slice x
                       double-float
                       ((+ i 1) i)
                       ((1 ldx) (1 *)))
 1))))))
```

```
(t
 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
               ((> i nb) nil)
   (tagbody
     (dgemv "No transpose"
      (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
      (f2cl-lib:int-sub i 1) (- one)
      (f2cl-lib:array-slice y double-float (i 1) ((1 ldy) (1 *))) ldy
      (f2cl-lib:array-slice a double-float (i 1) ((1 lda) (1 *))) lda
      one (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
      lda)
     (dgemv "Transpose" (f2cl-lib:int-sub i 1)
      (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1) (- one)
      (f2cl-lib:array-slice a double-float (1 i) ((1 lda) (1 *))) lda
      (f2cl-lib:array-slice x double-float (i 1) ((1 ldx) (1 *))) ldx
      one (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
      lda)
     (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
         (dlarfg (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
          (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
          (f2cl-lib:array-slice a
                                double-float
                                (i
                                 (min
                                  (the fixnum
                                       (f2cl-lib:int-add i 1))
                                  (the fixnum n)))
                                ((1 lda) (1 *)))
          lda (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%))
       (declare (ignore var-0 var-2 var-3))
       (setf (f2cl-lib:fref a-%data%
                            (i i)
                            ((1 lda) (1 *))
                            a-%offset%)
             var-1)
       (setf (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%)
             var-4))
     (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
           (f2cl-lib:fref a-%data%
                          (i i)
                          ((1 lda) (1 *))
                          a-%offset%))
     (cond
       ((< i m)
        (setf (f2cl-lib:fref a-%data%
                             (i i)
                             ((1 lda) (1 *))
                             a-%offset%)
              one)
        (dgemv "No transpose" (f2cl-lib:int-sub m i)
```

```
 (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1) one
 (f2cl-lib:array-slice a
                       double-float
                       ((+ i 1) i)
                       ((1 lda) (1 *)))
 lda
 (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
 lda zero
 (f2cl-lib:array-slice x
                       double-float
                       ((+ i 1) i)
                       ((1 ldx) (1 *)))
 1)
(dgemv "Transpose"
 (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
 (f2cl-lib:int-sub i 1) one
 (f2cl-lib:array-slice y double-float (i 1) ((1 ldy) (1 *)))
 ldy
 (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
 lda zero
 (f2cl-lib:array-slice x double-float (1 i) ((1 ldx) (1 *)))
 1)
(dgemv "No transpose" (f2cl-lib:int-sub m i)
 (f2cl-lib:int-sub i 1) (- one)
 (f2cl-lib:array-slice a
                       double-float
                       ((+ i 1) 1)
                       ((1 lda) (1 *)))
 lda
 (f2cl-lib:array-slice x double-float (1 i) ((1 ldx) (1 *)))
 1 one
 (f2cl-lib:array-slice x
                       double-float
                       ((+ i 1) i)
                       ((1 ldx) (1 *)))
 1)
(dgemv "No transpose" (f2cl-lib:int-sub i 1)
 (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1) one
 (f2cl-lib:array-slice a double-float (1 i) ((1 lda) (1 *)))
 lda
 (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
 lda zero
 (f2cl-lib:array-slice x double-float (1 i) ((1 ldx) (1 *)))
 1)
(dgemv "No transpose" (f2cl-lib:int-sub m i)
 (f2cl-lib:int-sub i 1) (- one)
 (f2cl-lib:array-slice x
                       double-float
                       ((+ i 1) 1)
                       ((1 ldx) (1 *)))
```

```
 ldx
 (f2cl-lib:array-slice x double-float (1 i) ((1 ldx) (1 *)))
 1 one
 (f2cl-lib:array-slice x
                       double-float
                       ((+ i 1) i)
                       ((1 ldx) (1 *)))
 1)
(dscal (f2cl-lib:int-sub m i)
 (f2cl-lib:fref taup-%data% (i) ((1 *)) taup-%offset%)
 (f2cl-lib:array-slice x
                       double-float
                       ((+ i 1) i)
                       ((1 ldx) (1 *)))
 1)
(dgemv "No transpose" (f2cl-lib:int-sub m i)
 (f2cl-lib:int-sub i 1) (- one)
 (f2cl-lib:array-slice a
                       double-float
                       ((+ i 1) 1)
                       ((1 lda) (1 *)))
 lda
 (f2cl-lib:array-slice y double-float (i 1) ((1 ldy) (1 *)))
 ldy one
 (f2cl-lib:array-slice a
                       double-float
                       ((+ i 1) i)
                       ((1 lda) (1 *)))
 1)
(dgemv "No transpose" (f2cl-lib:int-sub m i) i (- one)
 (f2cl-lib:array-slice x
                       double-float
                       ((+ i 1) 1)
                       ((1 ldx) (1 *)))
 ldx
 (f2cl-lib:array-slice a double-float (1 i) ((1 lda) (1 *)))
 1 one
 (f2cl-lib:array-slice a
                       double-float
                       ((+ i 1) i)
                       ((1 lda) (1 *)))
 1)
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
    (dlarfg (f2cl-lib:int-sub m i)
     (f2cl-lib:fref a-%data%
                    ((f2cl-lib:int-add i 1) i)
                    ((1 lda) (1 *))
                    a-%offset%)
     (f2cl-lib:array-slice a
                           double-float
```

```
                          ((min (f2cl-lib:int-add i 2) m) i)
                          ((1 lda) (1 *)))
     1 (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%))
  (declare (ignore var-0 var-2 var-3))
  (setf (f2cl-lib:fref a-%data%
                       ((f2cl-lib:int-add i 1) i)
                       ((1 lda) (1 *))
                       a-%offset%)
          var-1)
  (setf (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%)
          var-4))
(setf (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)
        (f2cl-lib:fref a-%data%
                       ((f2cl-lib:int-add i 1) i)
                       ((1 lda) (1 *))
                       a-%offset%))
(setf (f2cl-lib:fref a-%data%
                     ((f2cl-lib:int-add i 1) i)
                     ((1 lda) (1 *))
                     a-%offset%)
        one)
(dgemv "Transpose" (f2cl-lib:int-sub m i)
 (f2cl-lib:int-sub n i) one
 (f2cl-lib:array-slice a
                       double-float
                       ((+ i 1) (f2cl-lib:int-add i 1))
                       ((1 lda) (1 *)))
 lda
 (f2cl-lib:array-slice a
                       double-float
                       ((+ i 1) i)
                       ((1 lda) (1 *)))
 1 zero
 (f2cl-lib:array-slice y
                       double-float
                       ((+ i 1) i)
                       ((1 ldy) (1 *)))
 1)
(dgemv "Transpose" (f2cl-lib:int-sub m i)
 (f2cl-lib:int-sub i 1) one
 (f2cl-lib:array-slice a
                       double-float
                       ((+ i 1) 1)
                       ((1 lda) (1 *)))
 lda
 (f2cl-lib:array-slice a
                       double-float
                       ((+ i 1) i)
                       ((1 lda) (1 *)))
 1 zero
```

```
                    (f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 *)))
                    1)
                   (dgemv "No transpose" (f2cl-lib:int-sub n i)
                    (f2cl-lib:int-sub i 1) (- one)
                    (f2cl-lib:array-slice y
                                          double-float
                                          ((+ i 1) 1)
                                          ((1 ldy) (1 *)))
                    ldy
                    (f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 *)))
                    1 one
                    (f2cl-lib:array-slice y
                                          double-float
                                          ((+ i 1) i)
                                          ((1 ldy) (1 *)))
                    1)
                   (dgemv "Transpose" (f2cl-lib:int-sub m i) i one
                    (f2cl-lib:array-slice x
                                          double-float
                                          ((+ i 1) 1)
                                          ((1 ldx) (1 *)))
                    ldx
                    (f2cl-lib:array-slice a
                                          double-float
                                          ((+ i 1) i)
                                          ((1 lda) (1 *)))
                    1 zero
                    (f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 *)))
                    1)
                   (dgemv "Transpose" i (f2cl-lib:int-sub n i) (- one)
                    (f2cl-lib:array-slice a
                                          double-float
                                          (1 (f2cl-lib:int-add i 1))
                                          ((1 lda) (1 *)))
                    lda
                    (f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 *)))
                    1 one
                    (f2cl-lib:array-slice y
                                          double-float
                                          ((+ i 1) i)
                                          ((1 ldy) (1 *)))
                    1)
                   (dscal (f2cl-lib:int-sub n i)
                    (f2cl-lib:fref tauq-%data% (i) ((1 *)) tauq-%offset%)
                    (f2cl-lib:array-slice y
                                          double-float
                                          ((+ i 1) i)
                                          ((1 ldy) (1 *)))
                    1)))))))
 end_label
```

```
        (return
         (values nil nil nil nil nil nil nil nil nil nil nil nil nil))))))
```

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6.26 dlacon LAPACK

— **dlacon.input** —

```
)set break resume
)sys rm -f dlacon.output
)spool dlacon.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlacon.help** —

```
========================================================================
dlacon examples
========================================================================

========================================================================
Man Page Details
========================================================================

NAME
       DLACON - the 1-norm of a square, real matrix A

SYNOPSIS
       SUBROUTINE DLACON( N, V, X, ISGN, EST, KASE )

           INTEGER        KASE, N

           DOUBLE         PRECISION EST

           INTEGER        ISGN( * )

           DOUBLE         PRECISION V( * ), X( * )
```

```
PURPOSE
       DLACON estimates the 1-norm of a square, real matrix A.  Reverse commu-
       nication is used for evaluating matrix-vector products.


ARGUMENTS
       N      (input) INTEGER
              The order of the matrix.  N >= 1.

       V      (workspace) DOUBLE PRECISION array, dimension (N)
              On the final return, V = A*W,  where  EST =  norm(V)/norm(W)  (W
              is not returned).

       X      (input/output) DOUBLE PRECISION array, dimension (N)
              On  an  intermediate  return,  X should be overwritten by A * X,
              if KASE=1, A' * X,  if KASE=2, and DLACON must be re-called with
              all the other parameters unchanged.

       ISGN   (workspace) INTEGER array, dimension (N)

       EST    (input/output) DOUBLE PRECISION
              On  entry  with  KASE  =  1  or  2  and  JUMP = 3, EST should be
              unchanged from the previous call to DLACON.  On exit, EST is  an
              estimate (a lower bound) for norm(A).

       KASE   (input/output) INTEGER
              On the initial call to DLACON, KASE should be 0.  On an interme-
              diate return, KASE will be 1 or 2, indicating whether  X  should
              be  overwritten  by  A * X  or A' * X.  On the final return from
              DLACON, KASE will again be 0.

FURTHER DETAILS
       Reference: N.J. Higham, "FORTRAN codes for estimating the one-norm of a
       real or complex matrix, with applications to condition estimation", ACM
       Trans. Math. Soft., vol. 14, no. 4, pp. 381-396, December 1988.
```

———-

— dlacon.f —

```
      SUBROUTINE DLACON( N, V, X, ISGN, EST, KASE )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     February 29, 1992
*
*     .. Scalar Arguments ..
```

```
      INTEGER            KASE, N
      DOUBLE PRECISION   EST
*     ..
*     .. Array Arguments ..
      INTEGER            ISGN( * )
      DOUBLE PRECISION   V( * ), X( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      INTEGER            ITMAX
      PARAMETER          ( ITMAX = 5 )
      DOUBLE PRECISION   ZERO, ONE, TWO
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0, TWO = 2.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I, ITER, J, JLAST, JUMP
      DOUBLE PRECISION   ALTSGN, ESTOLD, TEMP
*     ..
*     .. External Functions ..
      INTEGER            IDAMAX
      DOUBLE PRECISION   DASUM
      EXTERNAL           IDAMAX, DASUM
*     ..
*     .. External Subroutines ..
      EXTERNAL           DCOPY
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, DBLE, NINT, SIGN
*     ..
*     .. Save statement ..
      SAVE
*     ..
*     .. Executable Statements ..
*
      IF( KASE.EQ.0 ) THEN
         DO 10 I = 1, N
            X( I ) = ONE / DBLE( N )
   10    CONTINUE
         KASE = 1
         JUMP = 1
         RETURN
      END IF
*
      GO TO ( 20, 40, 70, 110, 140 )JUMP
*
*     ................ ENTRY   (JUMP = 1)
*     FIRST ITERATION.  X HAS BEEN OVERWRITTEN BY A*X.
*
```

```
   20 CONTINUE
      IF( N.EQ.1 ) THEN
         V( 1 ) = X( 1 )
         EST = ABS( V( 1 ) )
*        ... QUIT
         GO TO 150
      END IF
      EST = DASUM( N, X, 1 )
*
      DO 30 I = 1, N
         X( I ) = SIGN( ONE, X( I ) )
         ISGN( I ) = NINT( X( I ) )
   30 CONTINUE
      KASE = 2
      JUMP = 2
      RETURN
*
*     ..... ENTRY   (JUMP = 2)
*     FIRST ITERATION.  X HAS BEEN OVERWRITTEN BY TRANDPOSE(A)*X.
*
   40 CONTINUE
      J = IDAMAX( N, X, 1 )
      ITER = 2
*
*     MAIN LOOP - ITERATIONS 2,3,...,ITMAX.
*
   50 CONTINUE
      DO 60 I = 1, N
         X( I ) = ZERO
   60 CONTINUE
      X( J ) = ONE
      KASE = 1
      JUMP = 3
      RETURN
*
*     ..... ENTRY   (JUMP = 3)
*     X HAS BEEN OVERWRITTEN BY A*X.
*
   70 CONTINUE
      CALL DCOPY( N, X, 1, V, 1 )
      ESTOLD = EST
      EST = DASUM( N, V, 1 )
      DO 80 I = 1, N
         IF( NINT( SIGN( ONE, X( I ) ) ).NE.ISGN( I ) )
     $      GO TO 90
   80 CONTINUE
*     REPEATED SIGN VECTOR DETECTED, HENCE ALGORITHM HAS CONVERGED.
      GO TO 120
*
   90 CONTINUE
```

```
*     TEST FOR CYCLING.
      IF( EST.LE.ESTOLD )
     $   GO TO 120
*
      DO 100 I = 1, N
         X( I ) = SIGN( ONE, X( I ) )
         ISGN( I ) = NINT( X( I ) )
  100 CONTINUE
      KASE = 2
      JUMP = 4
      RETURN
*
*     ..... ENTRY   (JUMP = 4)
*     X HAS BEEN OVERWRITTEN BY TRANDPOSE(A)*X.
*
  110 CONTINUE
      JLAST = J
      J = IDAMAX( N, X, 1 )
      IF( ( X( JLAST ).NE.ABS( X( J ) ) ) .AND. ( ITER.LT.ITMAX ) ) THEN
         ITER = ITER + 1
         GO TO 50
      END IF
*
*     ITERATION COMPLETE.  FINAL STAGE.
*
  120 CONTINUE
      ALTSGN = ONE
      DO 130 I = 1, N
         X( I ) = ALTSGN*( ONE+DBLE( I-1 ) / DBLE( N-1 ) )
         ALTSGN = -ALTSGN
  130 CONTINUE
      KASE = 1
      JUMP = 5
      RETURN
*
*     ..... ENTRY   (JUMP = 5)
*     X HAS BEEN OVERWRITTEN BY A*X.
*
  140 CONTINUE
      TEMP = TWO*( DASUM( N, X, 1 ) / DBLE( 3*N ) )
      IF( TEMP.GT.EST ) THEN
         CALL DCOPY( N, X, 1, V, 1 )
         EST = TEMP
      END IF
*
  150 CONTINUE
      KASE = 0
      RETURN
*
*     End of DLACON
```

```
*
      END
```

———-

— LAPACK dlacon —

```
(let* ((itmax 5) (zero 0.0) (one 1.0) (two 2.0))
  (declare (type (fixnum 5 5) itmax)
           (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one)
           (type (double-float 2.0 2.0) two))
  (let ((altsgn 0.0)
        (estold 0.0)
        (temp 0.0)
        (i 0)
        (iter 0)
        (j 0)
        (jlast 0)
        (jump 0))
    (declare (type fixnum itmax jump jlast j iter i)
             (type (double-float) two one zero temp estold altsgn))
    (defun dlacon (n v x isgn est kase)
      (declare (type (double-float) est)
               (type (simple-array fixnum (*)) isgn)
               (type (simple-array double-float (*)) x v)
               (type fixnum kase n))
      (f2cl-lib:with-multi-array-data
          ((v double-float v-%data% v-%offset%)
           (x double-float x-%data% x-%offset%)
           (isgn fixnum isgn-%data% isgn-%offset%))
        (prog ()
          (declare)
          (cond
            ((= kase 0)
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i n) nil)
               (tagbody
                 (setf (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%)
                         (/ one (coerce (realpart n) 'double-float)))))
             (setf kase 1)
             (setf jump 1)
             (go end_label)))
          (f2cl-lib:computed-goto (label20 label40 label70 label110 label140)
                                  jump)
 label20
          (cond
            ((= n 1)
```

```
           (setf (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%)
                   (f2cl-lib:fref x-%data% (1) ((1 *)) x-%offset%))
           (setf est (abs (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%)))
           (go label150)))
         (setf est (dasum n x 1))
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i n) nil)
           (tagbody
             (setf (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%)
                     (f2cl-lib:sign one
                                    (f2cl-lib:fref x-%data%
                                                   (i)
                                                   ((1 *))
                                                   x-%offset%)))
             (setf (f2cl-lib:fref isgn-%data% (i) ((1 *)) isgn-%offset%)
                     (values (round
                              (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%))))))
         (setf kase 2)
         (setf jump 2)
         (go end_label)
label40
         (setf j (idamax n x 1))
         (setf iter 2)
label50
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i n) nil)
           (tagbody
             (setf (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%) zero)))
         (setf (f2cl-lib:fref x-%data% (j) ((1 *)) x-%offset%) one)
         (setf kase 1)
         (setf jump 3)
         (go end_label)
label70
         (dcopy n x 1 v 1)
         (setf estold est)
         (setf est (dasum n v 1))
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i n) nil)
           (tagbody
             (if
              (/=
               (values (round
                        (f2cl-lib:sign one
                                       (f2cl-lib:fref x-%data%
                                                      (i)
                                                      ((1 *))
                                                      x-%offset%))))
               (f2cl-lib:fref isgn-%data% (i) ((1 *)) isgn-%offset%))
              (go label90))))
         (go label120)
```

```
label90
         (if (<= est estold) (go label120))
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i n) nil)
           (tagbody
             (setf (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%)
                     (f2cl-lib:sign one
                                    (f2cl-lib:fref x-%data%
                                                   (i)
                                                   ((1 *))
                                                   x-%offset%)))
             (setf (f2cl-lib:fref isgn-%data% (i) ((1 *)) isgn-%offset%)
                     (values (round
                      (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%))))))
         (setf kase 2)
         (setf jump 4)
         (go end_label)
label110
         (setf jlast j)
         (setf j (idamax n x 1))
         (cond
           ((and
             (/= (f2cl-lib:fref x (jlast) ((1 *)))
                 (abs (f2cl-lib:fref x (j) ((1 *)))))
             (< iter itmax))
            (setf iter (f2cl-lib:int-add iter 1))
            (go label50)))
label120
         (setf altsgn one)
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i n) nil)
           (tagbody
             (setf (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%)
               (* altsgn
                (+ one
                 (/
                  (coerce (realpart (f2cl-lib:int-sub i 1)) 'double-float)
                  (coerce (realpart (f2cl-lib:int-sub n 1)) 'double-float)))))
             (setf altsgn (- altsgn))))
         (setf kase 1)
         (setf jump 5)
         (go end_label)
label140
         (setf temp
          (* two
           (/ (dasum n x 1)
              (coerce (realpart (f2cl-lib:int-mul 3 n)) 'double-float))))
         (cond
           ((> temp est)
            (dcopy n x 1 v 1)
```

```
            (setf est temp)))
 label150
         (setf kase 0)
 end_label
         (return (values nil nil nil nil est kase)))))))
```

———-

6.27 dlacpy LAPACK

— **dlacpy.input** —

```
)set break resume
)sys rm -f dlacpy.output
)spool dlacpy.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlacpy.help** —

```
========================================================================
dlacpy examples
========================================================================

========================================================================
Man Page Details
========================================================================

NAME
       DLACPY - all or part of a two-dimensional matrix A to another matrix B

SYNOPSIS
       SUBROUTINE DLACPY( UPLO, M, N, A, LDA, B, LDB )

           CHARACTER      UPLO

           INTEGER        LDA, LDB, M, N

           DOUBLE         PRECISION A( LDA, * ), B( LDB, * )
```

```
PURPOSE
       DLACPY  copies  all  or  part  of a two-dimensional matrix A to another
       matrix B.


ARGUMENTS
       UPLO    (input) CHARACTER*1
               Specifies the part of the matrix A to be copied to B.   =  'U':
               Upper triangular part
               = 'L':      Lower triangular part
               Otherwise:  All of the matrix A

       M       (input) INTEGER
               The number of rows of the matrix A.  M >= 0.

       N       (input) INTEGER
               The number of columns of the matrix A.  N >= 0.

       A       (input) DOUBLE PRECISION array, dimension (LDA,N)
               The m by n matrix A.  If UPLO = 'U', only the upper triangle or
               trapezoid is accessed; if UPLO = 'L', only the  lower  triangle
               or trapezoid is accessed.

       LDA     (input) INTEGER
               The leading dimension of the array A.  LDA >= max(1,M).

       B       (output) DOUBLE PRECISION array, dimension (LDB,N)
               On exit, B = A in the locations specified by UPLO.

       LDB     (input) INTEGER
               The leading dimension of the array B.  LDB >= max(1,M).
```

———-

— **dlacpy.f** —

```
      SUBROUTINE DLACPY( UPLO, M, N, A, LDA, B, LDB )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     February 29, 1992
*
*     .. Scalar Arguments ..
      CHARACTER          UPLO
      INTEGER            LDA, LDB, M, N
*     ..
```

```
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), B( LDB, * )
*     ..
*
*  =====================================================================
*
*     .. Local Scalars ..
      INTEGER            I, J
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MIN
*     ..
*     .. Executable Statements ..
*
      IF( LSAME( UPLO, 'U' ) ) THEN
         DO 20 J = 1, N
            DO 10 I = 1, MIN( J, M )
               B( I, J ) = A( I, J )
   10       CONTINUE
   20    CONTINUE
      ELSE IF( LSAME( UPLO, 'L' ) ) THEN
         DO 40 J = 1, N
            DO 30 I = J, M
               B( I, J ) = A( I, J )
   30       CONTINUE
   40    CONTINUE
      ELSE
         DO 60 J = 1, N
            DO 50 I = 1, M
               B( I, J ) = A( I, J )
   50       CONTINUE
   60    CONTINUE
      END IF
      RETURN
*
*     End of DLACPY
*
      END
```

———-

— LAPACK dlacpy —

```
(defun dlacpy (uplo m n a lda b ldb$)
```

```
(declare (type (simple-array double-float (*)) b a)
         (type fixnum ldb$ lda n m)
         (type character uplo))
(f2cl-lib:with-multi-array-data
    ((uplo character uplo-%data% uplo-%offset%)
     (a double-float a-%data% a-%offset%)
     (b double-float b-%data% b-%offset%))
  (prog ((i 0) (j 0))
    (declare (type fixnum j i))
    (cond
      ((char-equal uplo #\U)
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i
                             (min (the fixnum j)
                                  (the fixnum m)))
                          nil)
             (tagbody
               (setf (f2cl-lib:fref b-%data%
                                    (i j)
                                    ((1 ldb$) (1 *))
                                    b-%offset%)
                     (f2cl-lib:fref a-%data%
                                    (i j)
                                    ((1 lda) (1 *))
                                    a-%offset%)))))))
      ((char-equal uplo #\L)
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                         ((> i m) nil)
             (tagbody
               (setf (f2cl-lib:fref b-%data%
                                    (i j)
                                    ((1 ldb$) (1 *))
                                    b-%offset%)
                     (f2cl-lib:fref a-%data%
                                    (i j)
                                    ((1 lda) (1 *))
                                    a-%offset%)))))))
      (t
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i m) nil)
             (tagbody
```

```
                (setf (f2cl-lib:fref b-%data%
                                     (i j)
                                     ((1 ldb$) (1 *))
                                     b-%offset%)
                      (f2cl-lib:fref a-%data%
                                     (i j)
                                     ((1 lda) (1 *))
                                     a-%offset%))))))))
 end_label
      (return (values nil nil nil nil nil nil nil)))))
```

———-

6.28 dladiv LAPACK

— dladiv.input —

```
)set break resume
)sys rm -f dladiv.output
)spool dladiv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dladiv.help —

```
=======================================================================
dladiv examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

NAME
  DLADIV performs complex division in  real arithmetic

                        a + i*b
              p + i*q = ---------
                        c + i*d
```

```
  The algorithm is due to Robert L. Smith and can be found
  in D. Knuth, The art of Computer Programming, Vol.2, p.195

 Arguments
 =========

  A       (input) DOUBLE PRECISION
  B       (input) DOUBLE PRECISION
  C       (input) DOUBLE PRECISION
  D       (input) DOUBLE PRECISION
          The scalars a, b, c, and d in the above expression.

  P       (output) DOUBLE PRECISION
  Q       (output) DOUBLE PRECISION
          The scalars p and q in the above expression.
```

———-

— dladiv.f —

```
      SUBROUTINE DLADIV( A, B, C, D, P, Q )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1992
*
*     .. Scalar Arguments ..
      DOUBLE PRECISION   A, B, C, D, P, Q
*     ..
*
*  =====================================================================
*
*     .. Local Scalars ..
      DOUBLE PRECISION   E, F
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS
*     ..
*     .. Executable Statements ..
*
      IF( ABS( D ).LT.ABS( C ) ) THEN
         E = D / C
         F = C + D*E
         P = ( A+B*E ) / F
         Q = ( B-A*E ) / F
      ELSE
```

```
         E = C / D
         F = D + C*E
         P = ( B+A*E ) / F
         Q = ( -A+B*E ) / F
      END IF
*
      RETURN
*
*     End of DLADIV
*
      END
```

———-

— LAPACK dladiv —

```
(defun dladiv (a b c d p q)
  (declare (type (double-float) q p d c b a))
  (prog ((e 0.0) (f 0.0))
    (declare (type (double-float) f e))
    (cond
      ((< (abs d) (abs c))
       (setf e (/ d c))
       (setf f (+ c (* d e)))
       (setf p (/ (+ a (* b e)) f))
       (setf q (/ (- b (* a e)) f)))
      (t
       (setf e (/ c d))
       (setf f (+ d (* c e)))
       (setf p (/ (+ b (* a e)) f))
       (setf q (/ (- (* b e) a) f))))
    (return (values nil nil nil nil p q))))
```

———-

6.29 dlaed6 LAPACK

— dlaed6.input —

```
)set break resume
)sys rm -f dlaed6.output
)spool dlaed6.output
)set message test on
)set message auto off
```

```
)clear all

)spool
)lisp (bye)
```

———-

— dlaed6.help —

```
==========================================================================
dlaed6 examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 Purpose
 =======

  DLAED6 computes the positive or negative root (closest to the origin)
  of
                   z(1)        z(2)        z(3)
  f(x) =   rho + --------- + ---------- + ---------
                  d(1)-x      d(2)-x      d(3)-x

  It is assumed that

        if ORGATI = .true. the root is between d(2) and d(3);
        otherwise it is between d(1) and d(2)

  This routine will be called by DLAED4 when necessary. In most cases,
  the root sought is the smallest in magnitude, though it might not be
  in some extremely rare situations.

  Arguments
  =========

  KNITER       (input) INTEGER
               Refer to DLAED4 for its significance.

  ORGATI       (input) LOGICAL
               If ORGATI is true, the needed root is between d(2) and
               d(3); otherwise it is between d(1) and d(2).  See
               DLAED4 for further details.

  RHO          (input) DOUBLE PRECISION
               Refer to the equation f(x) above.
```

```
  D            (input) DOUBLE PRECISION array, dimension (3)
               D satisfies d(1) < d(2) < d(3).

  Z            (input) DOUBLE PRECISION array, dimension (3)
               Each of the elements in z must be positive.

  FINIT        (input) DOUBLE PRECISION
               The value of f at 0. It is more accurate than the one
               evaluated inside this routine (if someone wants to do
               so).

  TAU          (output) DOUBLE PRECISION
               The root of the equation f(x).

  INFO         (output) INTEGER
               = 0: successful exit
               > 0: if INFO = 1, failure to converge

 Further Details
 ===============

  Based on contributions by
     Ren-Cang Li, Computer Science Division, University of California
     at Berkeley, USA
```

———-

— dlaed6.f —

```
      SUBROUTINE DLAED6( KNITER, ORGATI, RHO, D, Z, FINIT, TAU, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Oak Ridge National Lab, Argonne National Lab,
*     Courant Institute, NAG Ltd., and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      LOGICAL            ORGATI
      INTEGER            INFO, KNITER
      DOUBLE PRECISION   FINIT, RHO, TAU
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   D( 3 ), Z( 3 )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
```

```
      INTEGER            MAXIT
      PARAMETER          ( MAXIT = 20 )
      DOUBLE PRECISION   ZERO, ONE, TWO, THREE, FOUR, EIGHT
      PARAMETER          ( ZERO = 0.0D0, ONE = 1.0D0, TWO = 2.0D0,
     $                   THREE = 3.0D0, FOUR = 4.0D0, EIGHT = 8.0D0 )
*     ..
*     .. External Functions ..
      DOUBLE PRECISION   DLAMCH
      EXTERNAL           DLAMCH
*     ..
*     .. Local Arrays ..
      DOUBLE PRECISION   DSCALE( 3 ), ZSCALE( 3 )
*     ..
*     .. Local Scalars ..
      LOGICAL            FIRST, SCALE
      INTEGER            I, ITER, NITER
      DOUBLE PRECISION   A, B, BASE, C, DDF, DF, EPS, ERRETM, ETA, F,
     $                   FC, SCLFAC, SCLINV, SMALL1, SMALL2, SMINV1,
     $                   SMINV2, TEMP, TEMP1, TEMP2, TEMP3, TEMP4
*     ..
*     .. Save statement ..
      SAVE               FIRST, SMALL1, SMINV1, SMALL2, SMINV2, EPS
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, INT, LOG, MAX, MIN, SQRT
*     ..
*     .. Data statements ..
      DATA               FIRST / .TRUE. /
*     ..
*     .. Executable Statements ..
*
      INFO = 0
*
      NITER = 1
      TAU = ZERO
      IF( KNITER.EQ.2 ) THEN
         IF( ORGATI ) THEN
            TEMP = ( D( 3 )-D( 2 ) ) / TWO
            C = RHO + Z( 1 ) / ( ( D( 1 )-D( 2 ) )-TEMP )
            A = C*( D( 2 )+D( 3 ) ) + Z( 2 ) + Z( 3 )
            B = C*D( 2 )*D( 3 ) + Z( 2 )*D( 3 ) + Z( 3 )*D( 2 )
         ELSE
            TEMP = ( D( 1 )-D( 2 ) ) / TWO
            C = RHO + Z( 3 ) / ( ( D( 3 )-D( 2 ) )-TEMP )
            A = C*( D( 1 )+D( 2 ) ) + Z( 1 ) + Z( 2 )
            B = C*D( 1 )*D( 2 ) + Z( 1 )*D( 2 ) + Z( 2 )*D( 1 )
         END IF
         TEMP = MAX( ABS( A ), ABS( B ), ABS( C ) )
         A = A / TEMP
         B = B / TEMP
```

```
         C = C / TEMP
         IF( C.EQ.ZERO ) THEN
            TAU = B / A
         ELSE IF( A.LE.ZERO ) THEN
            TAU = ( A-SQRT( ABS( A*A-FOUR*B*C ) ) ) / ( TWO*C )
         ELSE
            TAU = TWO*B / ( A+SQRT( ABS( A*A-FOUR*B*C ) ) )
         END IF
         TEMP = RHO + Z( 1 ) / ( D( 1 )-TAU ) +
     $          Z( 2 ) / ( D( 2 )-TAU ) + Z( 3 ) / ( D( 3 )-TAU )
         IF( ABS( FINIT ).LE.ABS( TEMP ) )
     $      TAU = ZERO
      END IF
*
*     On first call to routine, get machine parameters for
*     possible scaling to avoid overflow
*
      IF( FIRST ) THEN
         EPS = DLAMCH( 'Epsilon' )
         BASE = DLAMCH( 'Base' )
         SMALL1 = BASE**( INT( LOG( DLAMCH( 'SafMin' ) ) / LOG( BASE ) /
     $            THREE ) )
         SMINV1 = ONE / SMALL1
         SMALL2 = SMALL1*SMALL1
         SMINV2 = SMINV1*SMINV1
         FIRST = .FALSE.
      END IF
*
*     Determine if scaling of inputs necessary to avoid overflow
*     when computing 1/TEMP**3
*
      IF( ORGATI ) THEN
         TEMP = MIN( ABS( D( 2 )-TAU ), ABS( D( 3 )-TAU ) )
      ELSE
         TEMP = MIN( ABS( D( 1 )-TAU ), ABS( D( 2 )-TAU ) )
      END IF
      SCALE = .FALSE.
      IF( TEMP.LE.SMALL1 ) THEN
         SCALE = .TRUE.
         IF( TEMP.LE.SMALL2 ) THEN
*
*        Scale up by power of radix nearest 1/SAFMIN**(2/3)
*
            SCLFAC = SMINV2
            SCLINV = SMALL2
         ELSE
*
*        Scale up by power of radix nearest 1/SAFMIN**(1/3)
*
            SCLFAC = SMINV1
```

```
            SCLINV = SMALL1
         END IF
*
*        Scaling up safe because D, Z, TAU scaled elsewhere to be O(1)
*
         DO 10 I = 1, 3
            DSCALE( I ) = D( I )*SCLFAC
            ZSCALE( I ) = Z( I )*SCLFAC
   10    CONTINUE
         TAU = TAU*SCLFAC
      ELSE
*
*        Copy D and Z to DSCALE and ZSCALE
*
         DO 20 I = 1, 3
            DSCALE( I ) = D( I )
            ZSCALE( I ) = Z( I )
   20    CONTINUE
      END IF
*
      FC = ZERO
      DF = ZERO
      DDF = ZERO
      DO 30 I = 1, 3
         TEMP = ONE / ( DSCALE( I )-TAU )
         TEMP1 = ZSCALE( I )*TEMP
         TEMP2 = TEMP1*TEMP
         TEMP3 = TEMP2*TEMP
         FC = FC + TEMP1 / DSCALE( I )
         DF = DF + TEMP2
         DDF = DDF + TEMP3
   30 CONTINUE
      F = FINIT + TAU*FC
*
      IF( ABS( F ).LE.ZERO )
     $   GO TO 60
*
*        Iteration begins
*
*     It is not hard to see that
*
*           1) Iterations will go up monotonically
*              if FINIT < 0;
*
*           2) Iterations will go down monotonically
*              if FINIT > 0.
*
      ITER = NITER + 1
*
      DO 50 NITER = ITER, MAXIT
```

```
*
         IF( ORGATI ) THEN
            TEMP1 = DSCALE( 2 ) - TAU
            TEMP2 = DSCALE( 3 ) - TAU
         ELSE
            TEMP1 = DSCALE( 1 ) - TAU
            TEMP2 = DSCALE( 2 ) - TAU
         END IF
         A = ( TEMP1+TEMP2 )*F - TEMP1*TEMP2*DF
         B = TEMP1*TEMP2*F
         C = F - ( TEMP1+TEMP2 )*DF + TEMP1*TEMP2*DDF
         TEMP = MAX( ABS( A ), ABS( B ), ABS( C ) )
         A = A / TEMP
         B = B / TEMP
         C = C / TEMP
         IF( C.EQ.ZERO ) THEN
            ETA = B / A
         ELSE IF( A.LE.ZERO ) THEN
            ETA = ( A-SQRT( ABS( A*A-FOUR*B*C ) ) ) / ( TWO*C )
         ELSE
            ETA = TWO*B / ( A+SQRT( ABS( A*A-FOUR*B*C ) ) )
         END IF
         IF( F*ETA.GE.ZERO ) THEN
            ETA = -F / DF
         END IF
*
         TEMP = ETA + TAU
         IF( ORGATI ) THEN
            IF( ETA.GT.ZERO .AND. TEMP.GE.DSCALE( 3 ) )
     $         ETA = ( DSCALE( 3 )-TAU ) / TWO
            IF( ETA.LT.ZERO .AND. TEMP.LE.DSCALE( 2 ) )
     $         ETA = ( DSCALE( 2 )-TAU ) / TWO
         ELSE
            IF( ETA.GT.ZERO .AND. TEMP.GE.DSCALE( 2 ) )
     $         ETA = ( DSCALE( 2 )-TAU ) / TWO
            IF( ETA.LT.ZERO .AND. TEMP.LE.DSCALE( 1 ) )
     $         ETA = ( DSCALE( 1 )-TAU ) / TWO
         END IF
         TAU = TAU + ETA
*
         FC = ZERO
         ERRETM = ZERO
         DF = ZERO
         DDF = ZERO
         DO 40 I = 1, 3
            TEMP = ONE / ( DSCALE( I )-TAU )
            TEMP1 = ZSCALE( I )*TEMP
            TEMP2 = TEMP1*TEMP
            TEMP3 = TEMP2*TEMP
            TEMP4 = TEMP1 / DSCALE( I )
```

```
            FC = FC + TEMP4
            ERRETM = ERRETM + ABS( TEMP4 )
            DF = DF + TEMP2
            DDF = DDF + TEMP3
   40    CONTINUE
         F = FINIT + TAU*FC
         ERRETM = EIGHT*( ABS( FINIT )+ABS( TAU )*ERRETM ) +
     $            ABS( TAU )*DF
         IF( ABS( F ).LE.EPS*ERRETM )
     $      GO TO 60
   50 CONTINUE
      INFO = 1
   60 CONTINUE
*
*     Undo scaling
*
      IF( SCALE )
     $   TAU = TAU*SCLINV
      RETURN
*
*     End of DLAED6
*
      END
```

———-

— LAPACK dlaed6 —

```
(let* ((maxit 20)
       (zero 0.0)
       (one 1.0)
       (two 2.0)
       (three 3.0)
       (four 4.0)
       (eight 8.0))
  (declare (type (fixnum 20 20) maxit)
           (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one)
           (type (double-float 2.0 2.0) two)
           (type (double-float 3.0 3.0) three)
           (type (double-float 4.0 4.0) four)
           (type (double-float 8.0 8.0) eight))
  (let ((small1 0.0)
        (sminv1 0.0)
        (small2 0.0)
        (sminv2 0.0)
        (eps 0.0)
        (first$ nil))
```

```
(declare (type (member t nil) first$)
         (type (double-float) eps sminv2 small2 sminv1 small1))
(setq first$ t)
(defun dlaed6 (kniter orgati rho d z finit tau info)
  (declare (type (simple-array double-float (*)) z d)
           (type (double-float) tau finit rho)
           (type (member t nil) orgati)
           (type fixnum info kniter))
  (f2cl-lib:with-multi-array-data
      ((d double-float d-%data% d-%offset%)
       (z double-float z-%data% z-%offset%))
    (prog ((a 0.0) (b 0.0) (base 0.0) (c 0.0) (ddf 0.0) (df 0.0)
           (erretm 0.0) (eta 0.0) (f 0.0) (fc 0.0) (sclfac 0.0)
           (sclinv 0.0) (temp 0.0) (temp1 0.0) (temp2 0.0) (temp3 0.0)
           (temp4 0.0) (i 0) (iter 0) (niter 0) (scale nil)
           (dscale (make-array 3 :element-type 'double-float))
           (zscale (make-array 3 :element-type 'double-float)))
      (declare (type (double-float) a b base c ddf df erretm eta f fc
                                    sclfac sclinv temp temp1 temp2 temp3
                                    temp4)
               (type fixnum i iter niter)
               (type (member t nil) scale)
               (type (simple-array double-float (3)) dscale zscale))
      (setf info 0)
      (setf niter 1)
      (setf tau zero)
      (cond
        ((= kniter 2)
         (cond
           (orgati
            (setf temp
                    (/
                     (- (f2cl-lib:fref d-%data% (3) ((1 3)) d-%offset%)
                        (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%))
                     two))
            (setf c
                    (+ rho
                       (/ (f2cl-lib:fref z-%data% (1) ((1 3)) z-%offset%)
                          (-
                           (f2cl-lib:fref d-%data% (1) ((1 3)) d-%offset%)
                           (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%)
                           temp))))
            (setf a
                    (+
                     (* c
                        (+ (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%)
                           (f2cl-lib:fref d-%data%
                                          (3)
                                          ((1 3))
                                          d-%offset%)))
```

```
                (f2cl-lib:fref z-%data% (2) ((1 3)) z-%offset%)
                (f2cl-lib:fref z-%data% (3) ((1 3)) z-%offset%)))
          (setf b
                (+
                 (* c
                    (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%)
                    (f2cl-lib:fref d-%data% (3) ((1 3)) d-%offset%))
                 (* (f2cl-lib:fref z-%data% (2) ((1 3)) z-%offset%)
                    (f2cl-lib:fref d-%data% (3) ((1 3)) d-%offset%))
                 (* (f2cl-lib:fref z-%data% (3) ((1 3)) z-%offset%)
                    (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%)))))
         (t
          (setf temp
                (/
                 (- (f2cl-lib:fref d-%data% (1) ((1 3)) d-%offset%)
                    (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%))
                 two))
          (setf c
                (+ rho
                   (/ (f2cl-lib:fref z-%data% (3) ((1 3)) z-%offset%)
                      (-
                       (f2cl-lib:fref d-%data% (3) ((1 3)) d-%offset%)
                       (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%)
                       temp))))
          (setf a
                (+
                 (* c
                    (+ (f2cl-lib:fref d-%data% (1) ((1 3)) d-%offset%)
                       (f2cl-lib:fref d-%data%
                                      (2)
                                      ((1 3))
                                      d-%offset%)))
                 (f2cl-lib:fref z-%data% (1) ((1 3)) z-%offset%)
                 (f2cl-lib:fref z-%data% (2) ((1 3)) z-%offset%)))
          (setf b
                (+
                 (* c
                    (f2cl-lib:fref d-%data% (1) ((1 3)) d-%offset%)
                    (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%))
                 (* (f2cl-lib:fref z-%data% (1) ((1 3)) z-%offset%)
                    (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%))
                 (* (f2cl-lib:fref z-%data% (2) ((1 3)) z-%offset%)
                    (f2cl-lib:fref d-%data% (1) ((1 3)) d-%offset%))))))
    (setf temp (max (abs a) (abs b) (abs c)))
    (setf a (/ a temp))
    (setf b (/ b temp))
    (setf c (/ c temp))
    (cond
      ((= c zero)
       (setf tau (/ b a)))
```

```
      ((<= a zero)
       (setf tau
             (/
              (- a
                 (f2cl-lib:fsqrt
                  (abs (+ (* a a) (* (- four) b c)))))
              (* two c))))
      (t
       (setf tau
             (/ (* two b)
                (+ a
                   (f2cl-lib:fsqrt
                    (abs (+ (* a a) (* (- four) b c)))))))))
   (setf temp
         (+ rho
            (/ (f2cl-lib:fref z-%data% (1) ((1 3)) z-%offset%)
               (- (f2cl-lib:fref d-%data% (1) ((1 3)) d-%offset%)
                  tau))
            (/ (f2cl-lib:fref z-%data% (2) ((1 3)) z-%offset%)
               (- (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%)
                  tau))
            (/ (f2cl-lib:fref z-%data% (3) ((1 3)) z-%offset%)
               (- (f2cl-lib:fref d-%data% (3) ((1 3)) d-%offset%)
                  tau))))
   (if (<= (abs finit) (abs temp)) (setf tau zero))))
(cond
  (first$
   (setf eps (dlamch "Epsilon"))
   (setf base (dlamch "Base"))
   (setf small1
         (expt base
               (f2cl-lib:int
                (/
                 (/ (f2cl-lib:flog (dlamch "SafMin"))
                    (f2cl-lib:flog base))
                 three))))
   (setf sminv1 (/ one small1))
   (setf small2 (* small1 small1))
   (setf sminv2 (* sminv1 sminv1))
   (setf first$ nil)))
(cond
  (orgati
   (setf temp
         (min
          (abs
           (- (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%) tau))
          (abs
           (- (f2cl-lib:fref d-%data% (3) ((1 3)) d-%offset%)
              tau)))))
  (t
```

```
   (setf temp
           (min
            (abs
             (- (f2cl-lib:fref d-%data% (1) ((1 3)) d-%offset%) tau))
            (abs
             (- (f2cl-lib:fref d-%data% (2) ((1 3)) d-%offset%)
                tau))))))
(setf scale nil)
(cond
  ((<= temp small1)
   (setf scale t)
   (cond
     ((<= temp small2)
      (setf sclfac sminv2)
      (setf sclinv small2))
     (t
      (setf sclfac sminv1)
      (setf sclinv small1)))
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i 3) nil)
     (tagbody
       (setf (f2cl-lib:fref dscale (i) ((1 3)))
               (* (f2cl-lib:fref d-%data% (i) ((1 3)) d-%offset%)
                  sclfac))
       (setf (f2cl-lib:fref zscale (i) ((1 3)))
               (* (f2cl-lib:fref z-%data% (i) ((1 3)) z-%offset%)
                  sclfac))))
   (setf tau (* tau sclfac)))
  (t
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i 3) nil)
     (tagbody
       (setf (f2cl-lib:fref dscale (i) ((1 3)))
               (f2cl-lib:fref d-%data% (i) ((1 3)) d-%offset%))
       (setf (f2cl-lib:fref zscale (i) ((1 3)))
               (f2cl-lib:fref z-%data% (i) ((1 3)) z-%offset%))))))
(setf fc zero)
(setf df zero)
(setf ddf zero)
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i 3) nil)
  (tagbody
    (setf temp (/ one (- (f2cl-lib:fref dscale (i) ((1 3))) tau)))
    (setf temp1 (* (f2cl-lib:fref zscale (i) ((1 3))) temp))
    (setf temp2 (* temp1 temp))
    (setf temp3 (* temp2 temp))
    (setf fc (+ fc (/ temp1 (f2cl-lib:fref dscale (i) ((1 3))))))
    (setf df (+ df temp2))
    (setf ddf (+ ddf temp3))))
(setf f (+ finit (* tau fc)))
```

```
(if (<= (abs f) zero) (go label60))
(setf iter (f2cl-lib:int-add niter 1))
(f2cl-lib:fdo (niter iter (f2cl-lib:int-add niter 1))
              ((> niter maxit) nil)
  (tagbody
    (cond
      (orgati
       (setf temp1 (- (f2cl-lib:fref dscale (2) ((1 3))) tau))
       (setf temp2 (- (f2cl-lib:fref dscale (3) ((1 3))) tau)))
      (t
       (setf temp1 (- (f2cl-lib:fref dscale (1) ((1 3))) tau))
       (setf temp2 (- (f2cl-lib:fref dscale (2) ((1 3))) tau))))
    (setf a (+ (* (+ temp1 temp2) f) (* (- temp1) temp2 df)))
    (setf b (* temp1 temp2 f))
    (setf c (+ (- f (* (+ temp1 temp2) df)) (* temp1 temp2 ddf)))
    (setf temp (max (abs a) (abs b) (abs c)))
    (setf a (/ a temp))
    (setf b (/ b temp))
    (setf c (/ c temp))
    (cond
      ((= c zero)
       (setf eta (/ b a)))
      ((<= a zero)
       (setf eta
               (/
                (- a
                   (f2cl-lib:fsqrt
                    (abs (+ (* a a) (* (- four) b c)))))
                (* two c))))
      (t
       (setf eta
               (/ (* two b)
                  (+ a
                     (f2cl-lib:fsqrt
                      (abs (+ (* a a) (* (- four) b c)))))))))
    (cond
      ((>= (* f eta) zero)
       (setf eta (/ (- f) df))))
    (setf temp (+ eta tau))
    (cond
      (orgati
       (if
        (and (> eta zero)
             (>= temp (f2cl-lib:fref dscale (3) ((1 3)))))
        (setf eta (/ (- (f2cl-lib:fref dscale (3) ((1 3))) tau) two)))
       (if
        (and (< eta zero)
             (<= temp (f2cl-lib:fref dscale (2) ((1 3)))))
        (setf eta
                (/ (- (f2cl-lib:fref dscale (2) ((1 3))) tau) two))))
```

```
              (t
               (if
                (and (> eta zero)
                     (>= temp (f2cl-lib:fref dscale (2) ((1 3)))))
                (setf eta (/ (- (f2cl-lib:fref dscale (2) ((1 3))) tau) two)))
               (if
                (and (< eta zero)
                     (<= temp (f2cl-lib:fref dscale (1) ((1 3)))))
                (setf eta
                        (/ (- (f2cl-lib:fref dscale (1) ((1 3))) tau)
                           two)))))
            (setf tau (+ tau eta))
            (setf fc zero)
            (setf erretm zero)
            (setf df zero)
            (setf ddf zero)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          ((> i 3) nil)
              (tagbody
                (setf temp
                        (/ one (- (f2cl-lib:fref dscale (i) ((1 3))) tau)))
                (setf temp1 (* (f2cl-lib:fref zscale (i) ((1 3))) temp))
                (setf temp2 (* temp1 temp))
                (setf temp3 (* temp2 temp))
                (setf temp4 (/ temp1 (f2cl-lib:fref dscale (i) ((1 3)))))
                (setf fc (+ fc temp4))
                (setf erretm (+ erretm (abs temp4)))
                (setf df (+ df temp2))
                (setf ddf (+ ddf temp3))))
            (setf f (+ finit (* tau fc)))
            (setf erretm
                    (+ (* eight (+ (abs finit) (* (abs tau) erretm)))
                       (* (abs tau) df)))
            (if (<= (abs f) (* eps erretm)) (go label60))))
          (setf info 1)
label60
          (if scale (setf tau (* tau sclinv)))
end_label
          (return (values nil nil nil nil nil nil tau info)))))))
```

———-

6.30 dlaexc LAPACK

— dlaexc.input —

```
)set break resume
)sys rm -f dlaexc.output
)spool dlaexc.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dlaexc.help —

```
=====================================================================
dlaexc examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DLAEXC  -  adjacent  diagonal  blocks T11 and T22 of order 1 or 2 in an
       upper quasi-triangular matrix T by an orthogonal similarity transforma-
       tion

SYNOPSIS
       SUBROUTINE DLAEXC( WANTQ, N, T, LDT, Q, LDQ, J1, N1, N2, WORK, INFO )

           LOGICAL        WANTQ

           INTEGER        INFO, J1, LDQ, LDT, N, N1, N2

           DOUBLE         PRECISION Q( LDQ, * ), T( LDT, * ), WORK( * )

PURPOSE
       DLAEXC swaps adjacent diagonal blocks T11 and T22 of order 1 or 2 in an
       upper quasi-triangular matrix T by an orthogonal similarity transforma-
       tion.

       T must be in Schur canonical form, that is, block upper triangular with
       1-by-1 and 2-by-2 diagonal blocks; each 2-by-2 diagonal block  has  its
       diagonal  elemnts equal and its off-diagonal elements of opposite sign.


ARGUMENTS
       WANTQ   (input) LOGICAL
               = .TRUE. : accumulate the transformation in the matrix Q;
```

```
              = .FALSE.: do not accumulate the transformation.

       N      (input) INTEGER
              The order of the matrix T. N >= 0.

       T      (input/output) DOUBLE PRECISION array, dimension (LDT,N)
              On entry, the upper quasi-triangular matrix T, in Schur canoni-
              cal form.  On exit, the updated matrix T, again in Schur canon-
              ical form.

       LDT    (input)  INTEGER
              The leading dimension of the array T. LDT >= max(1,N).

       Q      (input/output) DOUBLE PRECISION array, dimension (LDQ,N)
              On entry, if WANTQ is .TRUE., the orthogonal matrix Q.  On
              exit, if WANTQ is .TRUE., the updated matrix Q.  If WANTQ is
              .FALSE., Q is not referenced.

       LDQ    (input) INTEGER
              The leading dimension of the array Q.  LDQ >= 1; and  if  WANTQ
              is .TRUE., LDQ >= N.

       J1     (input) INTEGER
              The index of the first row of the first block T11.

       N1     (input) INTEGER
              The order of the first block T11. N1 = 0, 1 or 2.

       N2     (input) INTEGER
              The order of the second block T22. N2 = 0, 1 or 2.

       WORK   (workspace) DOUBLE PRECISION array, dimension (N)

       INFO   (output) INTEGER
              = 0: successful exit
              = 1: the transformed matrix T would be too far from Schur form;
              the blocks are not swapped and T and Q are unchanged.
```

———-

— dlaexc.f —

```
      SUBROUTINE DLAEXC( WANTQ, N, T, LDT, Q, LDQ, J1, N1, N2, WORK,
     $                   INFO )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
```

```
*     February 29, 1992
*
*     .. Scalar Arguments ..
      LOGICAL            WANTQ
      INTEGER            INFO, J1, LDQ, LDT, N, N1, N2
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   Q( LDQ, * ), T( LDT, * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0 )
      DOUBLE PRECISION   TEN
      PARAMETER          ( TEN = 1.0D+1 )
      INTEGER            LDD, LDX
      PARAMETER          ( LDD = 4, LDX = 2 )
*     ..
*     .. Local Scalars ..
      INTEGER            IERR, J2, J3, J4, K, ND
      DOUBLE PRECISION   CS, DNORM, EPS, SCALE, SMLNUM, SN, T11, T22,
     $                   T33, TAU, TAU1, TAU2, TEMP, THRESH, WI1, WI2,
     $                   WR1, WR2, XNORM
*     ..
*     .. Local Arrays ..
      DOUBLE PRECISION   D( LDD, 4 ), U( 3 ), U1( 3 ), U2( 3 ),
     $                   X( LDX, 2 )
*     ..
*     .. External Functions ..
      DOUBLE PRECISION   DLAMCH, DLANGE
      EXTERNAL           DLAMCH, DLANGE
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLACPY, DLANV2, DLARFG, DLARFX, DLARTG, DLASY2,
     $                   DROT
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX
*     ..
*     .. Executable Statements ..
*
      INFO = 0
*
*     Quick return if possible
*
      IF( N.EQ.0 .OR. N1.EQ.0 .OR. N2.EQ.0 )
     $   RETURN
      IF( J1+N1.GT.N )
```

```
     $   RETURN
*
      J2 = J1 + 1
      J3 = J1 + 2
      J4 = J1 + 3
*
      IF( N1.EQ.1 .AND. N2.EQ.1 ) THEN
*
*        Swap two 1-by-1 blocks.
*
         T11 = T( J1, J1 )
         T22 = T( J2, J2 )
*
*        Determine the transformation to perform the interchange.
*
         CALL DLARTG( T( J1, J2 ), T22-T11, CS, SN, TEMP )
*
*        Apply transformation to the matrix T.
*
         IF( J3.LE.N )
     $      CALL DROT( N-J1-1, T( J1, J3 ), LDT, T( J2, J3 ), LDT, CS,
     $                 SN )
         CALL DROT( J1-1, T( 1, J1 ), 1, T( 1, J2 ), 1, CS, SN )
*
         T( J1, J1 ) = T22
         T( J2, J2 ) = T11
*
         IF( WANTQ ) THEN
*
*           Accumulate transformation in the matrix Q.
*
            CALL DROT( N, Q( 1, J1 ), 1, Q( 1, J2 ), 1, CS, SN )
         END IF
*
      ELSE
*
*        Swapping involves at least one 2-by-2 block.
*
*        Copy the diagonal block of order N1+N2 to the local array D
*        and compute its norm.
*
         ND = N1 + N2
         CALL DLACPY( 'Full', ND, ND, T( J1, J1 ), LDT, D, LDD )
         DNORM = DLANGE( 'Max', ND, ND, D, LDD, WORK )
*
*        Compute machine-dependent threshold for test for accepting
*        swap.
*
         EPS = DLAMCH( 'P' )
         SMLNUM = DLAMCH( 'S' ) / EPS
```

```
         THRESH = MAX( TEN*EPS*DNORM, SMLNUM )
*
*        Solve T11*X - X*T22 = scale*T12 for X.
*
         CALL DLASY2( .FALSE., .FALSE., -1, N1, N2, D, LDD,
     $                D( N1+1, N1+1 ), LDD, D( 1, N1+1 ), LDD, SCALE, X,
     $                LDX, XNORM, IERR )
*
*        Swap the adjacent diagonal blocks.
*
         K = N1 + N1 + N2 - 3
         GO TO ( 10, 20, 30 )K
*
   10    CONTINUE
*
*        N1 = 1, N2 = 2: generate elementary reflector H so that:
*
*        ( scale, X11, X12 ) H = ( 0, 0, * )
*
         U( 1 ) = SCALE
         U( 2 ) = X( 1, 1 )
         U( 3 ) = X( 1, 2 )
         CALL DLARFG( 3, U( 3 ), U, 1, TAU )
         U( 3 ) = ONE
         T11 = T( J1, J1 )
*
*        Perform swap provisionally on diagonal block in D.
*
         CALL DLARFX( 'L', 3, 3, U, TAU, D, LDD, WORK )
         CALL DLARFX( 'R', 3, 3, U, TAU, D, LDD, WORK )
*
*        Test whether to reject swap.
*
         IF( MAX( ABS( D( 3, 1 ) ), ABS( D( 3, 2 ) ), ABS( D( 3,
     $       3 )-T11 ) ).GT.THRESH )GO TO 50
*
*        Accept swap: apply transformation to the entire matrix T.
*
         CALL DLARFX( 'L', 3, N-J1+1, U, TAU, T( J1, J1 ), LDT, WORK )
         CALL DLARFX( 'R', J2, 3, U, TAU, T( 1, J1 ), LDT, WORK )
*
         T( J3, J1 ) = ZERO
         T( J3, J2 ) = ZERO
         T( J3, J3 ) = T11
*
         IF( WANTQ ) THEN
*
*           Accumulate transformation in the matrix Q.
*
            CALL DLARFX( 'R', N, 3, U, TAU, Q( 1, J1 ), LDQ, WORK )
```

```
         END IF
         GO TO 40
*
   20    CONTINUE
*
*        N1 = 2, N2 = 1: generate elementary reflector H so that:
*
*        H (  -X11 ) = ( * )
*          (  -X21 ) = ( 0 )
*          ( scale ) = ( 0 )
*
         U( 1 ) = -X( 1, 1 )
         U( 2 ) = -X( 2, 1 )
         U( 3 ) = SCALE
         CALL DLARFG( 3, U( 1 ), U( 2 ), 1, TAU )
         U( 1 ) = ONE
         T33 = T( J3, J3 )
*
*        Perform swap provisionally on diagonal block in D.
*
         CALL DLARFX( 'L', 3, 3, U, TAU, D, LDD, WORK )
         CALL DLARFX( 'R', 3, 3, U, TAU, D, LDD, WORK )
*
*        Test whether to reject swap.
*
         IF( MAX( ABS( D( 2, 1 ) ), ABS( D( 3, 1 ) ), ABS( D( 1,
     $       1 )-T33 ) ).GT.THRESH )GO TO 50
*
*        Accept swap: apply transformation to the entire matrix T.
*
         CALL DLARFX( 'R', J3, 3, U, TAU, T( 1, J1 ), LDT, WORK )
         CALL DLARFX( 'L', 3, N-J1, U, TAU, T( J1, J2 ), LDT, WORK )
*
         T( J1, J1 ) = T33
         T( J2, J1 ) = ZERO
         T( J3, J1 ) = ZERO
*
         IF( WANTQ ) THEN
*
*           Accumulate transformation in the matrix Q.
*
            CALL DLARFX( 'R', N, 3, U, TAU, Q( 1, J1 ), LDQ, WORK )
         END IF
         GO TO 40
*
   30    CONTINUE
*
*        N1 = 2, N2 = 2: generate elementary reflectors H(1) and H(2) so
*        that:
*
```

```
*        H(2) H(1) (  -X11  -X12 ) = (  *  * )
*                  (  -X21  -X22 )   (  0  * )
*                  ( scale    0  )   (  0  0 )
*                  (    0  scale )   (  0  0 )
*
         U1( 1 ) = -X( 1, 1 )
         U1( 2 ) = -X( 2, 1 )
         U1( 3 ) = SCALE
         CALL DLARFG( 3, U1( 1 ), U1( 2 ), 1, TAU1 )
         U1( 1 ) = ONE
*
         TEMP = -TAU1*( X( 1, 2 )+U1( 2 )*X( 2, 2 ) )
         U2( 1 ) = -TEMP*U1( 2 ) - X( 2, 2 )
         U2( 2 ) = -TEMP*U1( 3 )
         U2( 3 ) = SCALE
         CALL DLARFG( 3, U2( 1 ), U2( 2 ), 1, TAU2 )
         U2( 1 ) = ONE
*
*        Perform swap provisionally on diagonal block in D.
*
         CALL DLARFX( 'L', 3, 4, U1, TAU1, D, LDD, WORK )
         CALL DLARFX( 'R', 4, 3, U1, TAU1, D, LDD, WORK )
         CALL DLARFX( 'L', 3, 4, U2, TAU2, D( 2, 1 ), LDD, WORK )
         CALL DLARFX( 'R', 4, 3, U2, TAU2, D( 1, 2 ), LDD, WORK )
*
*        Test whether to reject swap.
*
         IF( MAX( ABS( D( 3, 1 ) ), ABS( D( 3, 2 ) ), ABS( D( 4, 1 ) ),
     $       ABS( D( 4, 2 ) ) ).GT.THRESH )GO TO 50
*
*        Accept swap: apply transformation to the entire matrix T.
*
         CALL DLARFX( 'L', 3, N-J1+1, U1, TAU1, T( J1, J1 ), LDT, WORK )
         CALL DLARFX( 'R', J4, 3, U1, TAU1, T( 1, J1 ), LDT, WORK )
         CALL DLARFX( 'L', 3, N-J1+1, U2, TAU2, T( J2, J1 ), LDT, WORK )
         CALL DLARFX( 'R', J4, 3, U2, TAU2, T( 1, J2 ), LDT, WORK )
*
         T( J3, J1 ) = ZERO
         T( J3, J2 ) = ZERO
         T( J4, J1 ) = ZERO
         T( J4, J2 ) = ZERO
*
         IF( WANTQ ) THEN
*
*           Accumulate transformation in the matrix Q.
*
            CALL DLARFX( 'R', N, 3, U1, TAU1, Q( 1, J1 ), LDQ, WORK )
            CALL DLARFX( 'R', N, 3, U2, TAU2, Q( 1, J2 ), LDQ, WORK )
         END IF
*
```

```
   40    CONTINUE
*
         IF( N2.EQ.2 ) THEN
*
*           Standardize new 2-by-2 block T11
*
            CALL DLANV2( T( J1, J1 ), T( J1, J2 ), T( J2, J1 ),
     $                   T( J2, J2 ), WR1, WI1, WR2, WI2, CS, SN )
            CALL DROT( N-J1-1, T( J1, J1+2 ), LDT, T( J2, J1+2 ), LDT,
     $                 CS, SN )
            CALL DROT( J1-1, T( 1, J1 ), 1, T( 1, J2 ), 1, CS, SN )
            IF( WANTQ )
     $         CALL DROT( N, Q( 1, J1 ), 1, Q( 1, J2 ), 1, CS, SN )
         END IF
*
         IF( N1.EQ.2 ) THEN
*
*           Standardize new 2-by-2 block T22
*
            J3 = J1 + N2
            J4 = J3 + 1
            CALL DLANV2( T( J3, J3 ), T( J3, J4 ), T( J4, J3 ),
     $                   T( J4, J4 ), WR1, WI1, WR2, WI2, CS, SN )
            IF( J3+2.LE.N )
     $         CALL DROT( N-J3-1, T( J3, J3+2 ), LDT, T( J4, J3+2 ),
     $                    LDT, CS, SN )
            CALL DROT( J3-1, T( 1, J3 ), 1, T( 1, J4 ), 1, CS, SN )
            IF( WANTQ )
     $         CALL DROT( N, Q( 1, J3 ), 1, Q( 1, J4 ), 1, CS, SN )
         END IF
*
      END IF
      RETURN
*
*     Exit with INFO = 1 if swap was rejected.
*
   50 CONTINUE
      INFO = 1
      RETURN
*
*     End of DLAEXC
*
      END
```

— LAPACK dlaexc —

```
(let* ((zero 0.0) (one 1.0) (ten 10.0) (ldd 4) (ldx 2))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one)
           (type (double-float 10.0 10.0) ten)
           (type (fixnum 4 4) ldd)
           (type (fixnum 2 2) ldx))
  (defun dlaexc (wantq n t$ ldt q ldq j1 n1 n2 work info)
    (declare (type (simple-array double-float (*)) work q t$)
             (type fixnum info n2 n1 j1 ldq ldt n)
             (type (member t nil) wantq))
    (f2cl-lib:with-multi-array-data
        ((t$ double-float t$-%data% t$-%offset%)
         (q double-float q-%data% q-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((d
              (make-array (the fixnum (reduce #'* (list ldd 4)))
                          :element-type 'double-float))
             (u (make-array 3 :element-type 'double-float))
             (u1 (make-array 3 :element-type 'double-float))
             (u2 (make-array 3 :element-type 'double-float))
             (x
              (make-array (the fixnum (reduce #'* (list ldx 2)))
                          :element-type 'double-float))
             (cs 0.0) (dnorm 0.0) (eps 0.0) (scale 0.0) (smlnum 0.0) (sn 0.0)
             (t11 0.0) (t22 0.0) (t33 0.0) (tau 0.0) (tau1 0.0) (tau2 0.0)
             (temp 0.0) (thresh 0.0) (wi1 0.0) (wi2 0.0) (wr1 0.0) (wr2 0.0)
             (xnorm 0.0) (ierr 0) (j2 0) (j3 0) (j4 0) (k 0) (nd 0))
        (declare (type (simple-array double-float (3)) u u1 u2)
                 (type (simple-array double-float (*)) d x)
                 (type (double-float) cs dnorm eps scale smlnum sn t11 t22 t33
                                      tau tau1 tau2 temp thresh wi1 wi2 wr1 wr2
                                      xnorm)
                 (type fixnum ierr j2 j3 j4 k nd))
        (setf info 0)
        (if (or (= n 0) (= n1 0) (= n2 0)) (go end_label))
        (if (> (f2cl-lib:int-add j1 n1) n) (go end_label))
        (setf j2 (f2cl-lib:int-add j1 1))
        (setf j3 (f2cl-lib:int-add j1 2))
        (setf j4 (f2cl-lib:int-add j1 3))
        (cond
          ((and (= n1 1) (= n2 1))
           (setf t11
                   (f2cl-lib:fref t$-%data%
                                 (j1 j1)
                                 ((1 ldt) (1 *))
                                 t$-%offset%))
           (setf t22
                   (f2cl-lib:fref t$-%data%
                                 (j2 j2)
                                 ((1 ldt) (1 *))
```

```
                        t$-%offset%))
 (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
     (dlartg
      (f2cl-lib:fref t$-%data% (j1 j2) ((1 ldt) (1 *)) t$-%offset%)
      (- t22 t11) cs sn temp)
   (declare (ignore var-0 var-1))
   (setf cs var-2)
   (setf sn var-3)
   (setf temp var-4))
 (if (<= j3 n)
     (drot (f2cl-lib:int-sub n j1 1)
      (f2cl-lib:array-slice t$ double-float (j1 j3) ((1 ldt) (1 *)))
      ldt
      (f2cl-lib:array-slice t$ double-float (j2 j3) ((1 ldt) (1 *)))
      ldt cs sn))
 (drot (f2cl-lib:int-sub j1 1)
  (f2cl-lib:array-slice t$ double-float (1 j1) ((1 ldt) (1 *))) 1
  (f2cl-lib:array-slice t$ double-float (1 j2) ((1 ldt) (1 *))) 1 cs
  sn)
 (setf (f2cl-lib:fref t$-%data% (j1 j1) ((1 ldt) (1 *)) t$-%offset%)
         t22)
 (setf (f2cl-lib:fref t$-%data% (j2 j2) ((1 ldt) (1 *)) t$-%offset%)
         t11)
 (cond
   (wantq
    (drot n
     (f2cl-lib:array-slice q double-float (1 j1) ((1 ldq) (1 *))) 1
     (f2cl-lib:array-slice q double-float (1 j2) ((1 ldq) (1 *))) 1
     cs sn))))
(t
 (tagbody
   (setf nd (f2cl-lib:int-add n1 n2))
   (dlacpy "Full" nd nd
    (f2cl-lib:array-slice t$ double-float (j1 j1) ((1 ldt) (1 *)))
    ldt d ldd)
   (setf dnorm (dlange "Max" nd nd d ldd work))
   (setf eps (dlamch "P"))
   (setf smlnum (/ (dlamch "S") eps))
   (setf thresh (max (* ten eps dnorm) smlnum))
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
          var-10 var-11 var-12 var-13 var-14 var-15)
       (dlasy2 nil nil -1 n1 n2 d ldd
        (f2cl-lib:array-slice d
                              double-float
                              ((+ n1 1) (f2cl-lib:int-add n1 1))
                              ((1 ldd) (1 4)))
        ldd
        (f2cl-lib:array-slice d
                              double-float
```

```
                                (1 (f2cl-lib:int-add n1 1))
                                ((1 ldd) (1 4)))
                     ldd scale x ldx xnorm ierr)
                  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                                   var-8 var-9 var-10 var-12 var-13))
                  (setf scale var-11)
                  (setf xnorm var-14)
                  (setf ierr var-15))
                (setf k (f2cl-lib:int-sub (f2cl-lib:int-add n1 n1 n2) 3))
                (f2cl-lib:computed-goto (label10 label20 label30) k)
label10
                (setf (f2cl-lib:fref u (1) ((1 3))) scale)
                (setf (f2cl-lib:fref u (2) ((1 3)))
                        (f2cl-lib:fref x (1 1) ((1 ldx) (1 2))))
                (setf (f2cl-lib:fref u (3) ((1 3)))
                        (f2cl-lib:fref x (1 2) ((1 ldx) (1 2))))
                (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
                    (dlarfg 3 (f2cl-lib:fref u (3) ((1 3))) u 1 tau)
                  (declare (ignore var-0 var-2 var-3))
                  (setf (f2cl-lib:fref u (3) ((1 3))) var-1)
                  (setf tau var-4))
                (setf (f2cl-lib:fref u (3) ((1 3))) one)
                (setf t11
                        (f2cl-lib:fref t$-%data%
                                       (j1 j1)
                                       ((1 ldt) (1 *))
                                       t$-%offset%))
                (dlarfx "L" 3 3 u tau d ldd work)
                (dlarfx "R" 3 3 u tau d ldd work)
                (if
                 (>
                  (max (abs (f2cl-lib:fref d (3 1) ((1 ldd) (1 4))))
                       (abs (f2cl-lib:fref d (3 2) ((1 ldd) (1 4))))
                       (abs (- (f2cl-lib:fref d (3 3) ((1 ldd) (1 4))) t11)))
                  thresh)
                 (go label50))
                (dlarfx "L" 3 (f2cl-lib:int-add (f2cl-lib:int-sub n j1) 1) u tau
                 (f2cl-lib:array-slice t$ double-float (j1 j1) ((1 ldt) (1 *)))
                 ldt work)
                (dlarfx "R" j2 3 u tau
                 (f2cl-lib:array-slice t$ double-float (1 j1) ((1 ldt) (1 *))) ldt
                 work)
                (setf (f2cl-lib:fref t$-%data%
                                     (j3 j1)
                                     ((1 ldt) (1 *))
                                     t$-%offset%)
                        zero)
                (setf (f2cl-lib:fref t$-%data%
                                     (j3 j2)
                                     ((1 ldt) (1 *))
```

```
                        t$-%offset%)
               zero)
             (setf (f2cl-lib:fref t$-%data%
                        (j3 j3)
                        ((1 ldt) (1 *))
                        t$-%offset%)
               t11)
             (cond
               (wantq
                (dlarfx "R" n 3 u tau
                 (f2cl-lib:array-slice q double-float (1 j1) ((1 ldq) (1 *)))
                 ldq work)))
             (go label40)
label20
             (setf (f2cl-lib:fref u (1) ((1 3)))
                   (- (f2cl-lib:fref x (1 1) ((1 ldx) (1 2)))))
             (setf (f2cl-lib:fref u (2) ((1 3)))
                   (- (f2cl-lib:fref x (2 1) ((1 ldx) (1 2)))))
             (setf (f2cl-lib:fref u (3) ((1 3))) scale)
             (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
                 (dlarfg 3 (f2cl-lib:fref u (1) ((1 3)))
                  (f2cl-lib:array-slice u double-float (2) ((1 3))) 1 tau)
               (declare (ignore var-0 var-2 var-3))
               (setf (f2cl-lib:fref u (1) ((1 3))) var-1)
               (setf tau var-4))
             (setf (f2cl-lib:fref u (1) ((1 3))) one)
             (setf t33
                   (f2cl-lib:fref t$-%data%
                                  (j3 j3)
                                  ((1 ldt) (1 *))
                                  t$-%offset%))
             (dlarfx "L" 3 3 u tau d ldd work)
             (dlarfx "R" 3 3 u tau d ldd work)
             (if
              (>
               (max (abs (f2cl-lib:fref d (2 1) ((1 ldd) (1 4))))
                    (abs (f2cl-lib:fref d (3 1) ((1 ldd) (1 4))))
                    (abs (- (f2cl-lib:fref d (1 1) ((1 ldd) (1 4))) t33)))
               thresh)
              (go label50))
             (dlarfx "R" j3 3 u tau
              (f2cl-lib:array-slice t$ double-float (1 j1) ((1 ldt) (1 *))) ldt
              work)
             (dlarfx "L" 3 (f2cl-lib:int-sub n j1) u tau
              (f2cl-lib:array-slice t$ double-float (j1 j2) ((1 ldt) (1 *)))
              ldt work)
             (setf (f2cl-lib:fref t$-%data%
                        (j1 j1)
                        ((1 ldt) (1 *))
                        t$-%offset%)
```

```
                t33)
              (setf (f2cl-lib:fref t$-%data%
                                   (j2 j1)
                                   ((1 ldt) (1 *))
                                   t$-%offset%)
                zero)
              (setf (f2cl-lib:fref t$-%data%
                                   (j3 j1)
                                   ((1 ldt) (1 *))
                                   t$-%offset%)
                zero)
              (cond
                (wantq
                 (dlarfx "R" n 3 u tau
                  (f2cl-lib:array-slice q double-float (1 j1) ((1 ldq) (1 *)))
                  ldq work)))
              (go label40)
label30
              (setf (f2cl-lib:fref u1 (1) ((1 3)))
                    (- (f2cl-lib:fref x (1 1) ((1 ldx) (1 2)))))
              (setf (f2cl-lib:fref u1 (2) ((1 3)))
                    (- (f2cl-lib:fref x (2 1) ((1 ldx) (1 2)))))
              (setf (f2cl-lib:fref u1 (3) ((1 3))) scale)
              (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
                  (dlarfg 3 (f2cl-lib:fref u1 (1) ((1 3)))
                   (f2cl-lib:array-slice u1 double-float (2) ((1 3))) 1 tau1)
                (declare (ignore var-0 var-2 var-3))
                (setf (f2cl-lib:fref u1 (1) ((1 3))) var-1)
                (setf tau1 var-4))
              (setf (f2cl-lib:fref u1 (1) ((1 3))) one)
              (setf temp
                    (* (- tau1)
                       (+ (f2cl-lib:fref x (1 2) ((1 ldx) (1 2)))
                          (* (f2cl-lib:fref u1 (2) ((1 3)))
                             (f2cl-lib:fref x (2 2) ((1 ldx) (1 2)))))))
              (setf (f2cl-lib:fref u2 (1) ((1 3)))
                    (- (* (- temp) (f2cl-lib:fref u1 (2) ((1 3))))
                       (f2cl-lib:fref x (2 2) ((1 ldx) (1 2)))))
              (setf (f2cl-lib:fref u2 (2) ((1 3)))
                    (* (- temp) (f2cl-lib:fref u1 (3) ((1 3)))))
              (setf (f2cl-lib:fref u2 (3) ((1 3))) scale)
              (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
                  (dlarfg 3 (f2cl-lib:fref u2 (1) ((1 3)))
                   (f2cl-lib:array-slice u2 double-float (2) ((1 3))) 1 tau2)
                (declare (ignore var-0 var-2 var-3))
                (setf (f2cl-lib:fref u2 (1) ((1 3))) var-1)
                (setf tau2 var-4))
              (setf (f2cl-lib:fref u2 (1) ((1 3))) one)
              (dlarfx "L" 3 4 u1 tau1 d ldd work)
              (dlarfx "R" 4 3 u1 tau1 d ldd work)
```

```
(dlarfx "L" 3 4 u2 tau2
 (f2cl-lib:array-slice d double-float (2 1) ((1 ldd) (1 4))) ldd
 work)
(dlarfx "R" 4 3 u2 tau2
 (f2cl-lib:array-slice d double-float (1 2) ((1 ldd) (1 4))) ldd
 work)
(if
 (>
  (max (abs (f2cl-lib:fref d (3 1) ((1 ldd) (1 4))))
       (abs (f2cl-lib:fref d (3 2) ((1 ldd) (1 4))))
       (abs (f2cl-lib:fref d (4 1) ((1 ldd) (1 4))))
       (abs (f2cl-lib:fref d (4 2) ((1 ldd) (1 4)))))
  thresh)
 (go label50))
(dlarfx "L" 3 (f2cl-lib:int-add (f2cl-lib:int-sub n j1) 1) u1 tau1
 (f2cl-lib:array-slice t$ double-float (j1 j1) ((1 ldt) (1 *)))
 ldt work)
(dlarfx "R" j4 3 u1 tau1
 (f2cl-lib:array-slice t$ double-float (1 j1) ((1 ldt) (1 *))) ldt
 work)
(dlarfx "L" 3 (f2cl-lib:int-add (f2cl-lib:int-sub n j1) 1) u2 tau2
 (f2cl-lib:array-slice t$ double-float (j2 j1) ((1 ldt) (1 *)))
 ldt work)
(dlarfx "R" j4 3 u2 tau2
 (f2cl-lib:array-slice t$ double-float (1 j2) ((1 ldt) (1 *))) ldt
 work)
(setf (f2cl-lib:fref t$-%data%
                     (j3 j1)
                     ((1 ldt) (1 *))
                     t$-%offset%)
        zero)
(setf (f2cl-lib:fref t$-%data%
                     (j3 j2)
                     ((1 ldt) (1 *))
                     t$-%offset%)
        zero)
(setf (f2cl-lib:fref t$-%data%
                     (j4 j1)
                     ((1 ldt) (1 *))
                     t$-%offset%)
        zero)
(setf (f2cl-lib:fref t$-%data%
                     (j4 j2)
                     ((1 ldt) (1 *))
                     t$-%offset%)
        zero)
(cond
  (wantq
   (dlarfx "R" n 3 u1 tau1
    (f2cl-lib:array-slice q double-float (1 j1) ((1 ldq) (1 *)))
```

```
                ldq work)
               (dlarfx "R" n 3 u2 tau2
                (f2cl-lib:array-slice q double-float (1 j2) ((1 ldq) (1 *)))
                ldq work)))
 label40
             (cond
               ((= n2 2)
                (multiple-value-bind
                      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                       var-9)
                    (dlanv2
                     (f2cl-lib:fref t$-%data%
                                    (j1 j1)
                                    ((1 ldt) (1 *))
                                    t$-%offset%)
                     (f2cl-lib:fref t$-%data%
                                    (j1 j2)
                                    ((1 ldt) (1 *))
                                    t$-%offset%)
                     (f2cl-lib:fref t$-%data%
                                    (j2 j1)
                                    ((1 ldt) (1 *))
                                    t$-%offset%)
                     (f2cl-lib:fref t$-%data%
                                    (j2 j2)
                                    ((1 ldt) (1 *))
                                    t$-%offset%)
                     wr1 wi1 wr2 wi2 cs sn)
                  (declare (ignore))
                  (setf (f2cl-lib:fref t$-%data%
                                       (j1 j1)
                                       ((1 ldt) (1 *))
                                       t$-%offset%)
                        var-0)
                  (setf (f2cl-lib:fref t$-%data%
                                       (j1 j2)
                                       ((1 ldt) (1 *))
                                       t$-%offset%)
                        var-1)
                  (setf (f2cl-lib:fref t$-%data%
                                       (j2 j1)
                                       ((1 ldt) (1 *))
                                       t$-%offset%)
                        var-2)
                  (setf (f2cl-lib:fref t$-%data%
                                       (j2 j2)
                                       ((1 ldt) (1 *))
                                       t$-%offset%)
                        var-3)
                  (setf wr1 var-4)
```

```
          (setf wi1 var-5)
          (setf wr2 var-6)
          (setf wi2 var-7)
          (setf cs var-8)
          (setf sn var-9))
        (drot (f2cl-lib:int-sub n j1 1)
         (f2cl-lib:array-slice t$
                               double-float
                               (j1 (f2cl-lib:int-add j1 2))
                               ((1 ldt) (1 *)))
         ldt
         (f2cl-lib:array-slice t$
                               double-float
                               (j2 (f2cl-lib:int-add j1 2))
                               ((1 ldt) (1 *)))
         ldt cs sn)
        (drot (f2cl-lib:int-sub j1 1)
         (f2cl-lib:array-slice t$ double-float (1 j1) ((1 ldt) (1 *)))
         1
         (f2cl-lib:array-slice t$ double-float (1 j2) ((1 ldt) (1 *)))
         1 cs sn)
        (if wantq
            (drot n
             (f2cl-lib:array-slice q
                                   double-float
                                   (1 j1)
                                   ((1 ldq) (1 *)))
             1
             (f2cl-lib:array-slice q
                                   double-float
                                   (1 j2)
                                   ((1 ldq) (1 *)))
             1 cs sn))))
      (cond
        ((= n1 2)
         (setf j3 (f2cl-lib:int-add j1 n2))
         (setf j4 (f2cl-lib:int-add j3 1))
         (multiple-value-bind
               (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                var-9)
             (dlanv2
              (f2cl-lib:fref t$-%data%
                             (j3 j3)
                             ((1 ldt) (1 *))
                             t$-%offset%)
              (f2cl-lib:fref t$-%data%
                             (j3 j4)
                             ((1 ldt) (1 *))
                             t$-%offset%)
              (f2cl-lib:fref t$-%data%
```

```
                    (j4 j3)
                    ((1 ldt) (1 *))
                    t$-%offset%)
      (f2cl-lib:fref t$-%data%
                    (j4 j4)
                    ((1 ldt) (1 *))
                    t$-%offset%)
      wr1 wi1 wr2 wi2 cs sn)
   (declare (ignore))
   (setf (f2cl-lib:fref t$-%data%
                        (j3 j3)
                        ((1 ldt) (1 *))
                        t$-%offset%)
         var-0)
   (setf (f2cl-lib:fref t$-%data%
                        (j3 j4)
                        ((1 ldt) (1 *))
                        t$-%offset%)
         var-1)
   (setf (f2cl-lib:fref t$-%data%
                        (j4 j3)
                        ((1 ldt) (1 *))
                        t$-%offset%)
         var-2)
   (setf (f2cl-lib:fref t$-%data%
                        (j4 j4)
                        ((1 ldt) (1 *))
                        t$-%offset%)
         var-3)
   (setf wr1 var-4)
   (setf wi1 var-5)
   (setf wr2 var-6)
   (setf wi2 var-7)
   (setf cs var-8)
   (setf sn var-9))
 (if (<= (f2cl-lib:int-add j3 2) n)
     (drot (f2cl-lib:int-sub n j3 1)
      (f2cl-lib:array-slice t$
                            double-float
                            (j3 (f2cl-lib:int-add j3 2))
                            ((1 ldt) (1 *)))
      ldt
      (f2cl-lib:array-slice t$
                            double-float
                            (j4 (f2cl-lib:int-add j3 2))
                            ((1 ldt) (1 *)))
      ldt cs sn))
 (drot (f2cl-lib:int-sub j3 1)
  (f2cl-lib:array-slice t$ double-float (1 j3) ((1 ldt) (1 *)))
  1
```

```
                (f2cl-lib:array-slice t$ double-float (1 j4) ((1 ldt) (1 *)))
                1 cs sn)
               (if wantq
                   (drot n
                    (f2cl-lib:array-slice q
                                          double-float
                                          (1 j3)
                                          ((1 ldq) (1 *)))
                    1
                    (f2cl-lib:array-slice q
                                          double-float
                                          (1 j4)
                                          ((1 ldq) (1 *)))
                    1 cs sn)))))))
       (go end_label)
 label50
       (setf info 1)
 end_label
       (return (values nil nil nil nil nil nil nil nil nil nil info))))))
```

———-

6.31 dlahqr LAPACK

— **dlahqr.input** —

```
)set break resume
)sys rm -f dlahqr.output
)spool dlahqr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlahqr.help** —

```
========================================================================
dlahqr examples
========================================================================

========================================================================
```

```
Man Page Details
=================================================================

NAME
       DLAHQR - An auxiliary routine called by DHSEQR to update the  eigenval-
       ues and Schur decomposition already computed  by  DHSEQR,  by   dealing
       with the Hessenberg submatrix in rows and columns ILO to IHI

SYNOPSIS
       SUBROUTINE DLAHQR( WANTT,  WANTZ,  N,  ILO,  IHI, H, LDH, WR, WI, ILOZ,
                          IHIZ, Z, LDZ, INFO )

           INTEGER        IHI, IHIZ, ILO, ILOZ, INFO, LDH, LDZ, N

           LOGICAL        WANTT, WANTZ

           DOUBLE         PRECISION H( LDH, * ), WI( * ), WR( * ), Z( LDZ, * )

 Purpose
 =======

  DLAHQR is an auxiliary routine called by DHSEQR to update the
  eigenvalues and Schur decomposition already computed by DHSEQR, by
  dealing with the Hessenberg submatrix in rows and columns ILO to IHI.

 Arguments
 =========

  WANTT   (input) LOGICAL
          = .TRUE. : the full Schur form T is required;
          = .FALSE.: only eigenvalues are required.

  WANTZ   (input) LOGICAL
          = .TRUE. : the matrix of Schur vectors Z is required;
          = .FALSE.: Schur vectors are not required.

  N       (input) INTEGER
          The order of the matrix H.  N >= 0.

  ILO     (input) INTEGER
  IHI     (input) INTEGER
          It is assumed that H is already upper quasi-triangular in
          rows and columns IHI+1:N, and that H(ILO,ILO-1) = 0 (unless
          ILO = 1). DLAHQR works primarily with the Hessenberg
          submatrix in rows and columns ILO to IHI, but applies
          transformations to all of H if WANTT is .TRUE..
          1 <= ILO <= max(1,IHI); IHI <= N.

  H       (input/output) DOUBLE PRECISION array, dimension (LDH,N)
          On entry, the upper Hessenberg matrix H.
```

```
          On exit, if WANTT is .TRUE., H is upper quasi-triangular in
          rows and columns ILO:IHI, with any 2-by-2 diagonal blocks in
          standard form. If WANTT is .FALSE., the contents of H are
          unspecified on exit.

  LDH     (input) INTEGER
          The leading dimension of the array H. LDH >= max(1,N).

  WR      (output) DOUBLE PRECISION array, dimension (N)
  WI      (output) DOUBLE PRECISION array, dimension (N)
          The real and imaginary parts, respectively, of the computed
          eigenvalues ILO to IHI are stored in the corresponding
          elements of WR and WI. If two eigenvalues are computed as a
          complex conjugate pair, they are stored in consecutive
          elements of WR and WI, say the i-th and (i+1)th, with
          WI(i) > 0 and WI(i+1) < 0. If WANTT is .TRUE., the
          eigenvalues are stored in the same order as on the diagonal
          of the Schur form returned in H, with WR(i) = H(i,i), and, if
          H(i:i+1,i:i+1) is a 2-by-2 diagonal block,
          WI(i) = sqrt(H(i+1,i)*H(i,i+1)) and WI(i+1) = -WI(i).

  ILOZ    (input) INTEGER
  IHIZ    (input) INTEGER
          Specify the rows of Z to which transformations must be
          applied if WANTZ is .TRUE..
          1 <= ILOZ <= ILO; IHI <= IHIZ <= N.

  Z       (input/output) DOUBLE PRECISION array, dimension (LDZ,N)
          If WANTZ is .TRUE., on entry Z must contain the current
          matrix Z of transformations accumulated by DHSEQR, and on
          exit Z has been updated; transformations are applied only to
          the submatrix Z(ILOZ:IHIZ,ILO:IHI).
          If WANTZ is .FALSE., Z is not referenced.

  LDZ     (input) INTEGER
          The leading dimension of the array Z. LDZ >= max(1,N).

  INFO    (output) INTEGER
          = 0: successful exit
          > 0: DLAHQR failed to compute all the eigenvalues ILO to IHI
               in a total of 30*(IHI-ILO+1) iterations; if INFO = i,
               elements i+1:ihi of WR and WI contain those eigenvalues
               which have been successfully computed.

  Further Details
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  2-96 Based on modifications by
     David Day, Sandia National Laboratory, USA
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— dlahqr.f —

```
      SUBROUTINE DLAHQR( WANTT, WANTZ, N, ILO, IHI, H, LDH, WR, WI,
     $                   ILOZ, IHIZ, Z, LDZ, INFO )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      LOGICAL            WANTT, WANTZ
      INTEGER            IHI, IHIZ, ILO, ILOZ, INFO, LDH, LDZ, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   H( LDH, * ), WI( * ), WR( * ), Z( LDZ, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE, HALF
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0, HALF = 0.5D0 )
      DOUBLE PRECISION   DAT1, DAT2
      PARAMETER          ( DAT1 = 0.75D+0, DAT2 = -0.4375D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I, I1, I2, ITN, ITS, J, K, L, M, NH, NR, NZ
      DOUBLE PRECISION   AVE, CS, DISC, H00, H10, H11, H12, H21, H22,
     $                   H33, H33S, H43H34, H44, H44S, OVFL, S, SMLNUM,
     $                   SN, SUM, T1, T2, T3, TST1, ULP, UNFL, V1, V2,
     $                   V3
*     ..
*     .. Local Arrays ..
      DOUBLE PRECISION   V( 3 ), WORK( 1 )
*     ..
*     .. External Functions ..
      DOUBLE PRECISION   DLAMCH, DLANHS
      EXTERNAL           DLAMCH, DLANHS
*     ..
*     .. External Subroutines ..
      EXTERNAL           DCOPY, DLANV2, DLARFG, DROT
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX, MIN, SIGN, SQRT
*     ..
*     .. Executable Statements ..
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```
*
      INFO = 0
*
*     Quick return if possible
*
      IF( N.EQ.0 )
     $   RETURN
      IF( ILO.EQ.IHI ) THEN
         WR( ILO ) = H( ILO, ILO )
         WI( ILO ) = ZERO
         RETURN
      END IF
*
      NH = IHI - ILO + 1
      NZ = IHIZ - ILOZ + 1
*
*     Set machine-dependent constants for the stopping criterion.
*     If norm(H) <= sqrt(OVFL), overflow should not occur.
*
      UNFL = DLAMCH( 'Safe minimum' )
      OVFL = ONE / UNFL
      CALL DLABAD( UNFL, OVFL )
      ULP = DLAMCH( 'Precision' )
      SMLNUM = UNFL*( NH / ULP )
*
*     I1 and I2 are the indices of the first row and last column of H
*     to which transformations must be applied. If eigenvalues only are
*     being computed, I1 and I2 are set inside the main loop.
*
      IF( WANTT ) THEN
         I1 = 1
         I2 = N
      END IF
*
*     ITN is the total number of QR iterations allowed.
*
      ITN = 30*NH
*
*     The main loop begins here. I is the loop index and decreases from
*     IHI to ILO in steps of 1 or 2. Each iteration of the loop works
*     with the active submatrix in rows and columns L to I.
*     Eigenvalues I+1 to IHI have already converged. Either L = ILO or
*     H(L,L-1) is negligible so that the matrix splits.
*
      I = IHI
   10 CONTINUE
      L = ILO
      IF( I.LT.ILO )
     $   GO TO 150
*
```

```
*     Perform QR iterations on rows and columns ILO to I until a
*     submatrix of order 1 or 2 splits off at the bottom because a
*     subdiagonal element has become negligible.
*
      DO 130 ITS = 0, ITN
*
*        Look for a single small subdiagonal element.
*
         DO 20 K = I, L + 1, -1
            TST1 = ABS( H( K-1, K-1 ) ) + ABS( H( K, K ) )
            IF( TST1.EQ.ZERO )
     $         TST1 = DLANHS( '1', I-L+1, H( L, L ), LDH, WORK )
            IF( ABS( H( K, K-1 ) ).LE.MAX( ULP*TST1, SMLNUM ) )
     $         GO TO 30
   20    CONTINUE
   30    CONTINUE
         L = K
         IF( L.GT.ILO ) THEN
*
*           H(L,L-1) is negligible
*
            H( L, L-1 ) = ZERO
         END IF
*
*        Exit from loop if a submatrix of order 1 or 2 has split off.
*
         IF( L.GE.I-1 )
     $      GO TO 140
*
*        Now the active submatrix is in rows and columns L to I. If
*        eigenvalues only are being computed, only the active submatrix
*        need be transformed.
*
         IF( .NOT.WANTT ) THEN
            I1 = L
            I2 = I
         END IF
*
         IF( ITS.EQ.10 .OR. ITS.EQ.20 ) THEN
*
*           Exceptional shift.
*
            S = ABS( H( I, I-1 ) ) + ABS( H( I-1, I-2 ) )
            H44 = DAT1*S + H( I, I )
            H33 = H44
            H43H34 = DAT2*S*S
         ELSE
*
*           Prepare to use Francis' double shift
*           (i.e. 2nd degree generalized Rayleigh quotient)
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```
*
            H44 = H( I, I )
            H33 = H( I-1, I-1 )
            H43H34 = H( I, I-1 )*H( I-1, I )
            S = H( I-1, I-2 )*H( I-1, I-2 )
            DISC = ( H33-H44 )*HALF
            DISC = DISC*DISC + H43H34
            IF( DISC.GT.ZERO ) THEN
*
*              Real roots: use Wilkinson's shift twice
*
               DISC = SQRT( DISC )
               AVE = HALF*( H33+H44 )
               IF( ABS( H33 )-ABS( H44 ).GT.ZERO ) THEN
                  H33 = H33*H44 - H43H34
                  H44 = H33 / ( SIGN( DISC, AVE )+AVE )
               ELSE
                  H44 = SIGN( DISC, AVE ) + AVE
               END IF
               H33 = H44
               H43H34 = ZERO
            END IF
         END IF
*
*        Look for two consecutive small subdiagonal elements.
*
         DO 40 M = I - 2, L, -1
*           Determine the effect of starting the double-shift QR
*           iteration at row M, and see if this would make H(M,M-1)
*           negligible.
*
            H11 = H( M, M )
            H22 = H( M+1, M+1 )
            H21 = H( M+1, M )
            H12 = H( M, M+1 )
            H44S = H44 - H11
            H33S = H33 - H11
            V1 = ( H33S*H44S-H43H34 ) / H21 + H12
            V2 = H22 - H11 - H33S - H44S
            V3 = H( M+2, M+1 )
            S = ABS( V1 ) + ABS( V2 ) + ABS( V3 )
            V1 = V1 / S
            V2 = V2 / S
            V3 = V3 / S
            V( 1 ) = V1
            V( 2 ) = V2
            V( 3 ) = V3
            IF( M.EQ.L )
     $         GO TO 50
            H00 = H( M-1, M-1 )
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```
            H10 = H( M, M-1 )
            TST1 = ABS( V1 )*( ABS( H00 )+ABS( H11 )+ABS( H22 ) )
            IF( ABS( H10 )*( ABS( V2 )+ABS( V3 ) ).LE.ULP*TST1 )
     $         GO TO 50
   40    CONTINUE
   50    CONTINUE
*
*        Double-shift QR step
*
         DO 120 K = M, I - 1
*
*           The first iteration of this loop determines a reflection G
*           from the vector V and applies it from left and right to H,
*           thus creating a nonzero bulge below the subdiagonal.
*
*           Each subsequent iteration determines a reflection G to
*           restore the Hessenberg form in the (K-1)th column, and thus
*           chases the bulge one step toward the bottom of the active
*           submatrix. NR is the order of G.
*
            NR = MIN( 3, I-K+1 )
            IF( K.GT.M )
     $         CALL DCOPY( NR, H( K, K-1 ), 1, V, 1 )
            CALL DLARFG( NR, V( 1 ), V( 2 ), 1, T1 )
            IF( K.GT.M ) THEN
               H( K, K-1 ) = V( 1 )
               H( K+1, K-1 ) = ZERO
               IF( K.LT.I-1 )
     $            H( K+2, K-1 ) = ZERO
            ELSE IF( M.GT.L ) THEN
               H( K, K-1 ) = -H( K, K-1 )
            END IF
            V2 = V( 2 )
            T2 = T1*V2
            IF( NR.EQ.3 ) THEN
               V3 = V( 3 )
               T3 = T1*V3
*
*              Apply G from the left to transform the rows of the matrix
*              in columns K to I2.
*
               DO 60 J = K, I2
                  SUM = H( K, J ) + V2*H( K+1, J ) + V3*H( K+2, J )
                  H( K, J ) = H( K, J ) - SUM*T1
                  H( K+1, J ) = H( K+1, J ) - SUM*T2
                  H( K+2, J ) = H( K+2, J ) - SUM*T3
   60          CONTINUE
*
*              Apply G from the right to transform the columns of the
*              matrix in rows I1 to min(K+3,I).
```

```
*
               DO 70 J = I1, MIN( K+3, I )
                  SUM = H( J, K ) + V2*H( J, K+1 ) + V3*H( J, K+2 )
                  H( J, K ) = H( J, K ) - SUM*T1
                  H( J, K+1 ) = H( J, K+1 ) - SUM*T2
                  H( J, K+2 ) = H( J, K+2 ) - SUM*T3
   70          CONTINUE
*
               IF( WANTZ ) THEN
*
*                 Accumulate transformations in the matrix Z
*
                  DO 80 J = ILOZ, IHIZ
                     SUM = Z( J, K ) + V2*Z( J, K+1 ) + V3*Z( J, K+2 )
                     Z( J, K ) = Z( J, K ) - SUM*T1
                     Z( J, K+1 ) = Z( J, K+1 ) - SUM*T2
                     Z( J, K+2 ) = Z( J, K+2 ) - SUM*T3
   80             CONTINUE
               END IF
            ELSE IF( NR.EQ.2 ) THEN
*
*              Apply G from the left to transform the rows of the matrix
*              in columns K to I2.
*
               DO 90 J = K, I2
                  SUM = H( K, J ) + V2*H( K+1, J )
                  H( K, J ) = H( K, J ) - SUM*T1
                  H( K+1, J ) = H( K+1, J ) - SUM*T2
   90          CONTINUE
*
*              Apply G from the right to transform the columns of the
*              matrix in rows I1 to min(K+3,I).
*
               DO 100 J = I1, I
                  SUM = H( J, K ) + V2*H( J, K+1 )
                  H( J, K ) = H( J, K ) - SUM*T1
                  H( J, K+1 ) = H( J, K+1 ) - SUM*T2
  100          CONTINUE
*
               IF( WANTZ ) THEN
*
*                 Accumulate transformations in the matrix Z
*
                  DO 110 J = ILOZ, IHIZ
                     SUM = Z( J, K ) + V2*Z( J, K+1 )
                     Z( J, K ) = Z( J, K ) - SUM*T1
                     Z( J, K+1 ) = Z( J, K+1 ) - SUM*T2
  110             CONTINUE
               END IF
            END IF
```

```
  120    CONTINUE
*
  130 CONTINUE
*
*     Failure to converge in remaining number of iterations
*
      INFO = I
      RETURN
*
  140 CONTINUE
*
      IF( L.EQ.I ) THEN
*
*        H(I,I-1) is negligible: one eigenvalue has converged.
*
         WR( I ) = H( I, I )
         WI( I ) = ZERO
      ELSE IF( L.EQ.I-1 ) THEN
*
*        H(I-1,I-2) is negligible: a pair of eigenvalues have converged.
*
*        Transform the 2-by-2 submatrix to standard Schur form,
*        and compute and store the eigenvalues.
*
         CALL DLANV2( H( I-1, I-1 ), H( I-1, I ), H( I, I-1 ),
     $                H( I, I ), WR( I-1 ), WI( I-1 ), WR( I ), WI( I ),
     $                CS, SN )
*
         IF( WANTT ) THEN
*
*           Apply the transformation to the rest of H.
*
            IF( I2.GT.I )
     $         CALL DROT( I2-I, H( I-1, I+1 ), LDH, H( I, I+1 ), LDH,
     $                    CS, SN )
            CALL DROT( I-I1-1, H( I1, I-1 ), 1, H( I1, I ), 1, CS, SN )
         END IF
         IF( WANTZ ) THEN
*
*           Apply the transformation to Z.
*
            CALL DROT( NZ, Z( ILOZ, I-1 ), 1, Z( ILOZ, I ), 1, CS, SN )
         END IF
      END IF
*
*     Decrement number of remaining iterations, and return to start of
*     the main loop with new value of I.
*
      ITN = ITN - ITS
      I = L - 1
```

```
      GO TO 10
*
  150 CONTINUE
      RETURN
*
*     End of DLAHQR
*
      END
```

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— LAPACK dlahqr —

```
(let* ((zero 0.0) (one 1.0) (half 0.5) (dat1 0.75) (dat2 (- 0.4375)))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one)
           (type (double-float 0.5 0.5) half)
           (type (double-float 0.75 0.75) dat1)
           (type (double-float) dat2))
  (defun dlahqr (wantt wantz n ilo ihi h ldh wr wi iloz ihiz z ldz info)
    (declare (type (simple-array double-float (*)) z wi wr h)
             (type fixnum info ldz ihiz iloz ldh ihi ilo n)
             (type (member t nil) wantz wantt))
    (f2cl-lib:with-multi-array-data
        ((h double-float h-%data% h-%offset%)
         (wr double-float wr-%data% wr-%offset%)
         (wi double-float wi-%data% wi-%offset%)
         (z double-float z-%data% z-%offset%))
      (prog ((v (make-array 3 :element-type 'double-float))
             (work (make-array 1 :element-type 'double-float)) (ave 0.0)
             (cs 0.0) (disc 0.0) (h00 0.0) (h10 0.0) (h11 0.0) (h12 0.0)
             (h21 0.0) (h22 0.0) (h33 0.0) (h33s 0.0) (h43h34 0.0) (h44 0.0)
             (h44s 0.0) (ovfl 0.0) (s 0.0) (smlnum 0.0) (sn 0.0) (sum 0.0)
             (t1 0.0) (t2 0.0) (t3 0.0) (tst1 0.0) (ulp 0.0) (unfl 0.0)
             (v1 0.0) (v2 0.0) (v3 0.0) (i 0) (i1 0) (i2 0) (itn 0) (its 0)
             (j 0) (k 0) (l 0) (m 0) (nh 0) (nr 0) (nz 0))
        (declare (type (simple-array double-float (3)) v)
                 (type (simple-array double-float (1)) work)
                 (type (double-float) ave cs disc h00 h10 h11 h12 h21 h22 h33
                                      h33s h43h34 h44 h44s ovfl s smlnum sn sum
                                      t1 t2 t3 tst1 ulp unfl v1 v2 v3)
                 (type fixnum i i1 i2 itn its j k l m nh nr nz))
        (setf info 0)
        (if (= n 0) (go end_label))
        (cond
          ((= ilo ihi)
           (setf (f2cl-lib:fref wr-%data% (ilo) ((1 *)) wr-%offset%)
                   (f2cl-lib:fref h-%data%
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```
                                (ilo ilo)
                                ((1 ldh) (1 *))
                                h-%offset%))
           (setf (f2cl-lib:fref wi-%data% (ilo) ((1 *)) wi-%offset%) zero)
           (go end_label)))
        (setf nh (f2cl-lib:int-add (f2cl-lib:int-sub ihi ilo) 1))
        (setf nz (f2cl-lib:int-add (f2cl-lib:int-sub ihiz iloz) 1))
        (setf unfl (dlamch "Safe minimum"))
        (setf ovfl (/ one unfl))
        (multiple-value-bind (var-0 var-1)
            (dlabad unfl ovfl)
          (declare (ignore))
          (setf unfl var-0)
          (setf ovfl var-1))
        (setf ulp (dlamch "Precision"))
        (setf smlnum (* unfl (/ nh ulp)))
        (cond
          (wantt
           (setf i1 1)
           (setf i2 n)))
        (setf itn (f2cl-lib:int-mul 30 nh))
        (setf i ihi)
label10
        (setf l ilo)
        (if (< i ilo) (go end_label))
        (f2cl-lib:fdo (its 0 (f2cl-lib:int-add its 1))
                      ((> its itn) nil)
          (tagbody
            (f2cl-lib:fdo (k i (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
                          ((> k (f2cl-lib:int-add l 1)) nil)
              (tagbody
                (setf tst1
                        (+
                         (abs
                          (f2cl-lib:fref h-%data%
                                         ((f2cl-lib:int-sub k 1)
                                          (f2cl-lib:int-sub k 1))
                                         ((1 ldh) (1 *))
                                         h-%offset%))
                         (abs
                          (f2cl-lib:fref h-%data%
                                         (k k)
                                         ((1 ldh) (1 *))
                                         h-%offset%))))
                (if (= tst1 zero)
                    (setf tst1
                            (dlanhs "1"
                             (f2cl-lib:int-add (f2cl-lib:int-sub i l) 1)
                             (f2cl-lib:array-slice h
                                                   double-float
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```
                                                (l l)
                                                ((1 ldh) (1 *)))
                              ldh work)))
                 (if
                  (<=
                   (abs
                    (f2cl-lib:fref h-%data%
                                   (k (f2cl-lib:int-sub k 1))
                                   ((1 ldh) (1 *))
                                   h-%offset%))
                   (max (* ulp tst1) smlnum))
                  (go label30))))
label30
           (setf l k)
           (cond
             ((> l ilo)
              (setf (f2cl-lib:fref h-%data%
                                   (l (f2cl-lib:int-sub l 1))
                                   ((1 ldh) (1 *))
                                   h-%offset%)
                    zero)))
           (if (>= l (f2cl-lib:int-sub i 1)) (go label140))
           (cond
             ((not wantt)
              (setf i1 l)
              (setf i2 i)))
           (cond
             ((or (= its 10) (= its 20))
              (setf s
                    (+
                     (abs
                      (f2cl-lib:fref h-%data%
                                     (i (f2cl-lib:int-sub i 1))
                                     ((1 ldh) (1 *))
                                     h-%offset%))
                     (abs
                      (f2cl-lib:fref h-%data%
                                     ((f2cl-lib:int-sub i 1)
                                      (f2cl-lib:int-sub i 2))
                                     ((1 ldh) (1 *))
                                     h-%offset%))))
              (setf h44
                    (+ (* dat1 s)
                       (f2cl-lib:fref h-%data%
                                      (i i)
                                      ((1 ldh) (1 *))
                                      h-%offset%)))
              (setf h33 h44)
              (setf h43h34 (* dat2 s s)))
             (t
```

```
      (setf h44
            (f2cl-lib:fref h-%data%
                           (i i)
                           ((1 ldh) (1 *))
                           h-%offset%))
      (setf h33
            (f2cl-lib:fref h-%data%
                           ((f2cl-lib:int-sub i 1)
                            (f2cl-lib:int-sub i 1))
                           ((1 ldh) (1 *))
                           h-%offset%))
      (setf h43h34
            (*
             (f2cl-lib:fref h-%data%
                            (i (f2cl-lib:int-sub i 1))
                            ((1 ldh) (1 *))
                            h-%offset%)
             (f2cl-lib:fref h-%data%
                            ((f2cl-lib:int-sub i 1) i)
                            ((1 ldh) (1 *))
                            h-%offset%)))
      (setf s
            (*
             (f2cl-lib:fref h-%data%
                            ((f2cl-lib:int-sub i 1)
                             (f2cl-lib:int-sub i 2))
                            ((1 ldh) (1 *))
                            h-%offset%)
             (f2cl-lib:fref h-%data%
                            ((f2cl-lib:int-sub i 1)
                             (f2cl-lib:int-sub i 2))
                            ((1 ldh) (1 *))
                            h-%offset%)))
      (setf disc (* (- h33 h44) half))
      (setf disc (+ (* disc disc) h43h34))
      (cond
        ((> disc zero)
         (setf disc (f2cl-lib:fsqrt disc))
         (setf ave (* half (+ h33 h44)))
         (cond
           ((> (+ (abs h33) (- (abs h44))) zero)
            (setf h33 (- (* h33 h44) h43h34))
            (setf h44 (/ h33 (+ (f2cl-lib:sign disc ave) ave))))
           (t
            (setf h44 (+ (f2cl-lib:sign disc ave) ave))))
         (setf h33 h44)
         (setf h43h34 zero)))))
  (f2cl-lib:fdo (m (f2cl-lib:int-add i (f2cl-lib:int-sub 2))
                   (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
                ((> m l) nil)
```

```
(tagbody
  (setf h11
        (f2cl-lib:fref h-%data%
                       (m m)
                       ((1 ldh) (1 *))
                       h-%offset%))
  (setf h22
        (f2cl-lib:fref h-%data%
                       ((f2cl-lib:int-add m 1)
                        (f2cl-lib:int-add m 1))
                       ((1 ldh) (1 *))
                       h-%offset%))
  (setf h21
        (f2cl-lib:fref h-%data%
                       ((f2cl-lib:int-add m 1) m)
                       ((1 ldh) (1 *))
                       h-%offset%))
  (setf h12
        (f2cl-lib:fref h-%data%
                       (m (f2cl-lib:int-add m 1))
                       ((1 ldh) (1 *))
                       h-%offset%))
  (setf h44s (- h44 h11))
  (setf h33s (- h33 h11))
  (setf v1 (+ (/ (- (* h33s h44s) h43h34) h21) h12))
  (setf v2 (- h22 h11 h33s h44s))
  (setf v3
        (f2cl-lib:fref h-%data%
                       ((f2cl-lib:int-add m 2)
                        (f2cl-lib:int-add m 1))
                       ((1 ldh) (1 *))
                       h-%offset%))
  (setf s (+ (abs v1) (abs v2) (abs v3)))
  (setf v1 (/ v1 s))
  (setf v2 (/ v2 s))
  (setf v3 (/ v3 s))
  (setf (f2cl-lib:fref v (1) ((1 3))) v1)
  (setf (f2cl-lib:fref v (2) ((1 3))) v2)
  (setf (f2cl-lib:fref v (3) ((1 3))) v3)
  (if (= m l) (go label50))
  (setf h00
        (f2cl-lib:fref h-%data%
                       ((f2cl-lib:int-sub m 1)
                        (f2cl-lib:int-sub m 1))
                       ((1 ldh) (1 *))
                       h-%offset%))
  (setf h10
        (f2cl-lib:fref h-%data%
                       (m (f2cl-lib:int-sub m 1))
                       ((1 ldh) (1 *))
```

```
                                h-%offset%))
                (setf tst1 (* (abs v1) (+ (abs h00) (abs h11) (abs h22))))
                (if (<= (* (abs h10) (+ (abs v2) (abs v3))) (* ulp tst1))
                    (go label50))))
label50
          (f2cl-lib:fdo (k m (f2cl-lib:int-add k 1))
                        ((> k (f2cl-lib:int-add i (f2cl-lib:int-sub 1))) nil)
            (tagbody
              (setf nr
                      (min (the fixnum 3)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-sub i k)
                                                  1))))
              (if (> k m)
                  (dcopy nr
                   (f2cl-lib:array-slice h
                                         double-float
                                         (k (f2cl-lib:int-sub k 1))
                                         ((1 ldh) (1 *)))
                   1 v 1))
              (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
                  (dlarfg nr (f2cl-lib:fref v (1) ((1 3)))
                   (f2cl-lib:array-slice v double-float (2) ((1 3))) 1 t1)
                (declare (ignore var-0 var-2 var-3))
                (setf (f2cl-lib:fref v (1) ((1 3))) var-1)
                (setf t1 var-4))
              (cond
                ((> k m)
                 (setf (f2cl-lib:fref h-%data%
                                      (k (f2cl-lib:int-sub k 1))
                                      ((1 ldh) (1 *))
                                      h-%offset%)
                       (f2cl-lib:fref v (1) ((1 3))))
                 (setf (f2cl-lib:fref h-%data%
                                      ((f2cl-lib:int-add k 1)
                                       (f2cl-lib:int-sub k 1))
                                      ((1 ldh) (1 *))
                                      h-%offset%)
                       zero)
                 (if (< k (f2cl-lib:int-sub i 1))
                     (setf (f2cl-lib:fref h-%data%
                                          ((f2cl-lib:int-add k 2)
                                           (f2cl-lib:int-sub k 1))
                                          ((1 ldh) (1 *))
                                          h-%offset%)
                           zero)))
                ((> m l)
                 (setf (f2cl-lib:fref h-%data%
                                      (k (f2cl-lib:int-sub k 1))
                                      ((1 ldh) (1 *))
```

```
                          h-%offset%)
                (-
                 (f2cl-lib:fref h-%data%
                                (k (f2cl-lib:int-sub k 1))
                                ((1 ldh) (1 *))
                                h-%offset%)))))
(setf v2 (f2cl-lib:fref v (2) ((1 3))))
(setf t2 (* t1 v2))
(cond
  ((= nr 3)
   (setf v3 (f2cl-lib:fref v (3) ((1 3))))
   (setf t3 (* t1 v3))
   (f2cl-lib:fdo (j k (f2cl-lib:int-add j 1))
                 ((> j i2) nil)
     (tagbody
       (setf sum
               (+
                (f2cl-lib:fref h-%data%
                               (k j)
                               ((1 ldh) (1 *))
                               h-%offset%)
                (* v2
                   (f2cl-lib:fref h-%data%
                                  ((f2cl-lib:int-add k 1) j)
                                  ((1 ldh) (1 *))
                                  h-%offset%))
                (* v3
                   (f2cl-lib:fref h-%data%
                                  ((f2cl-lib:int-add k 2) j)
                                  ((1 ldh) (1 *))
                                  h-%offset%))))
       (setf (f2cl-lib:fref h-%data%
                            (k j)
                            ((1 ldh) (1 *))
                            h-%offset%)
               (-
                (f2cl-lib:fref h-%data%
                               (k j)
                               ((1 ldh) (1 *))
                               h-%offset%)
                (* sum t1)))
       (setf (f2cl-lib:fref h-%data%
                            ((f2cl-lib:int-add k 1) j)
                            ((1 ldh) (1 *))
                            h-%offset%)
               (-
                (f2cl-lib:fref h-%data%
                               ((f2cl-lib:int-add k 1) j)
                               ((1 ldh) (1 *))
                               h-%offset%)
```

```
                (* sum t2)))
    (setf (f2cl-lib:fref h-%data%
                         ((f2cl-lib:int-add k 2) j)
                         ((1 ldh) (1 *))
                         h-%offset%)
                (-
                 (f2cl-lib:fref h-%data%
                                ((f2cl-lib:int-add k 2) j)
                                ((1 ldh) (1 *))
                                h-%offset%)
                 (* sum t3)))))
(f2cl-lib:fdo (j i1 (f2cl-lib:int-add j 1))
              ((> j
                  (min
                   (the fixnum
                        (f2cl-lib:int-add k 3))
                   (the fixnum i)))
               nil)
  (tagbody
    (setf sum
                (+
                 (f2cl-lib:fref h-%data%
                                (j k)
                                ((1 ldh) (1 *))
                                h-%offset%)
                 (* v2
                    (f2cl-lib:fref h-%data%
                                   (j (f2cl-lib:int-add k 1))
                                   ((1 ldh) (1 *))
                                   h-%offset%))
                 (* v3
                    (f2cl-lib:fref h-%data%
                                   (j (f2cl-lib:int-add k 2))
                                   ((1 ldh) (1 *))
                                   h-%offset%))))
    (setf (f2cl-lib:fref h-%data%
                         (j k)
                         ((1 ldh) (1 *))
                         h-%offset%)
                (-
                 (f2cl-lib:fref h-%data%
                                (j k)
                                ((1 ldh) (1 *))
                                h-%offset%)
                 (* sum t1)))
    (setf (f2cl-lib:fref h-%data%
                         (j (f2cl-lib:int-add k 1))
                         ((1 ldh) (1 *))
                         h-%offset%)
                (-
```

```
                (f2cl-lib:fref h-%data%
                               (j (f2cl-lib:int-add k 1))
                               ((1 ldh) (1 *))
                               h-%offset%)
                (* sum t2)))
     (setf (f2cl-lib:fref h-%data%
                          (j (f2cl-lib:int-add k 2))
                          ((1 ldh) (1 *))
                          h-%offset%)
             (-
              (f2cl-lib:fref h-%data%
                             (j (f2cl-lib:int-add k 2))
                             ((1 ldh) (1 *))
                             h-%offset%)
              (* sum t3)))))
(cond
  (wantz
   (f2cl-lib:fdo (j iloz (f2cl-lib:int-add j 1))
                 ((> j ihiz) nil)
     (tagbody
       (setf sum
             (+
              (f2cl-lib:fref z-%data%
                             (j k)
                             ((1 ldz) (1 *))
                             z-%offset%)
              (* v2
                 (f2cl-lib:fref z-%data%
                                (j (f2cl-lib:int-add k 1))
                                ((1 ldz) (1 *))
                                z-%offset%))
              (* v3
                 (f2cl-lib:fref z-%data%
                                (j (f2cl-lib:int-add k 2))
                                ((1 ldz) (1 *))
                                z-%offset%))))
       (setf (f2cl-lib:fref z-%data%
                            (j k)
                            ((1 ldz) (1 *))
                            z-%offset%)
             (-
              (f2cl-lib:fref z-%data%
                             (j k)
                             ((1 ldz) (1 *))
                             z-%offset%)
              (* sum t1)))
       (setf (f2cl-lib:fref z-%data%
                            (j (f2cl-lib:int-add k 1))
                            ((1 ldz) (1 *))
                            z-%offset%)
```

```
                    (-
                     (f2cl-lib:fref z-%data%
                                    (j (f2cl-lib:int-add k 1))
                                    ((1 ldz) (1 *))
                                    z-%offset%)
                     (* sum t2)))
                (setf (f2cl-lib:fref z-%data%
                                     (j (f2cl-lib:int-add k 2))
                                     ((1 ldz) (1 *))
                                     z-%offset%)
                      (-
                       (f2cl-lib:fref z-%data%
                                      (j (f2cl-lib:int-add k 2))
                                      ((1 ldz) (1 *))
                                      z-%offset%)
                       (* sum t3))))))))
      ((= nr 2)
       (f2cl-lib:fdo (j k (f2cl-lib:int-add j 1))
                     ((> j i2) nil)
         (tagbody
           (setf sum
                 (+
                  (f2cl-lib:fref h-%data%
                                 (k j)
                                 ((1 ldh) (1 *))
                                 h-%offset%)
                  (* v2
                     (f2cl-lib:fref h-%data%
                                    ((f2cl-lib:int-add k 1) j)
                                    ((1 ldh) (1 *))
                                    h-%offset%))))
           (setf (f2cl-lib:fref h-%data%
                                (k j)
                                ((1 ldh) (1 *))
                                h-%offset%)
                 (-
                  (f2cl-lib:fref h-%data%
                                 (k j)
                                 ((1 ldh) (1 *))
                                 h-%offset%)
                  (* sum t1)))
           (setf (f2cl-lib:fref h-%data%
                                ((f2cl-lib:int-add k 1) j)
                                ((1 ldh) (1 *))
                                h-%offset%)
                 (-
                  (f2cl-lib:fref h-%data%
                                 ((f2cl-lib:int-add k 1) j)
                                 ((1 ldh) (1 *))
                                 h-%offset%)
```

```
             (* sum t2)))))
(f2cl-lib:fdo (j i1 (f2cl-lib:int-add j 1))
              ((> j i) nil)
  (tagbody
    (setf sum
            (+
             (f2cl-lib:fref h-%data%
                            (j k)
                            ((1 ldh) (1 *))
                            h-%offset%)
             (* v2
                (f2cl-lib:fref h-%data%
                               (j (f2cl-lib:int-add k 1))
                               ((1 ldh) (1 *))
                               h-%offset%))))
    (setf (f2cl-lib:fref h-%data%
                         (j k)
                         ((1 ldh) (1 *))
                         h-%offset%)
            (-
             (f2cl-lib:fref h-%data%
                            (j k)
                            ((1 ldh) (1 *))
                            h-%offset%)
             (* sum t1)))
    (setf (f2cl-lib:fref h-%data%
                         (j (f2cl-lib:int-add k 1))
                         ((1 ldh) (1 *))
                         h-%offset%)
            (-
             (f2cl-lib:fref h-%data%
                            (j (f2cl-lib:int-add k 1))
                            ((1 ldh) (1 *))
                            h-%offset%)
             (* sum t2)))))
(cond
  (wantz
   (f2cl-lib:fdo (j iloz (f2cl-lib:int-add j 1))
                 ((> j ihiz) nil)
     (tagbody
       (setf sum
               (+
                (f2cl-lib:fref z-%data%
                               (j k)
                               ((1 ldz) (1 *))
                               z-%offset%)
                (* v2
                   (f2cl-lib:fref z-%data%
                                  (j (f2cl-lib:int-add k 1))
                                  ((1 ldz) (1 *))
```

```
                                                z-%offset%))))
                              (setf (f2cl-lib:fref z-%data%
                                                   (j k)
                                                   ((1 ldz) (1 *))
                                                   z-%offset%)
                                    (-
                                     (f2cl-lib:fref z-%data%
                                                    (j k)
                                                    ((1 ldz) (1 *))
                                                    z-%offset%)
                                     (* sum t1)))
                              (setf (f2cl-lib:fref z-%data%
                                                   (j (f2cl-lib:int-add k 1))
                                                   ((1 ldz) (1 *))
                                                   z-%offset%)
                                    (-
                                     (f2cl-lib:fref z-%data%
                                                    (j (f2cl-lib:int-add k 1))
                                                    ((1 ldz) (1 *))
                                                    z-%offset%)
                                     (* sum t2))))))))))))
       (setf info i)
       (go end_label)
label140
       (cond
         ((= l i)
          (setf (f2cl-lib:fref wr-%data% (i) ((1 *)) wr-%offset%)
                (f2cl-lib:fref h-%data% (i i) ((1 ldh) (1 *)) h-%offset%))
          (setf (f2cl-lib:fref wi-%data% (i) ((1 *)) wi-%offset%) zero))
         ((= l (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
          (multiple-value-bind
                (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
              (dlanv2
               (f2cl-lib:fref h-%data%
                              ((f2cl-lib:int-sub i 1) (f2cl-lib:int-sub i 1))
                              ((1 ldh) (1 *))
                              h-%offset%)
               (f2cl-lib:fref h-%data%
                              ((f2cl-lib:int-sub i 1) i)
                              ((1 ldh) (1 *))
                              h-%offset%)
               (f2cl-lib:fref h-%data%
                              (i (f2cl-lib:int-sub i 1))
                              ((1 ldh) (1 *))
                              h-%offset%)
               (f2cl-lib:fref h-%data% (i i) ((1 ldh) (1 *)) h-%offset%)
               (f2cl-lib:fref wr-%data%
                              ((f2cl-lib:int-sub i 1))
                              ((1 *))
                              wr-%offset%)
```

```
      (f2cl-lib:fref wi-%data%
                     ((f2cl-lib:int-sub i 1))
                     ((1 *))
                     wi-%offset%)
      (f2cl-lib:fref wr-%data% (i) ((1 *)) wr-%offset%)
      (f2cl-lib:fref wi-%data% (i) ((1 *)) wi-%offset%) cs sn)
    (declare (ignore))
    (setf (f2cl-lib:fref h-%data%
                         ((f2cl-lib:int-sub i 1)
                          (f2cl-lib:int-sub i 1))
                         ((1 ldh) (1 *))
                         h-%offset%)
          var-0)
    (setf (f2cl-lib:fref h-%data%
                         ((f2cl-lib:int-sub i 1) i)
                         ((1 ldh) (1 *))
                         h-%offset%)
          var-1)
    (setf (f2cl-lib:fref h-%data%
                         (i (f2cl-lib:int-sub i 1))
                         ((1 ldh) (1 *))
                         h-%offset%)
          var-2)
    (setf (f2cl-lib:fref h-%data% (i i) ((1 ldh) (1 *)) h-%offset%)
          var-3)
    (setf (f2cl-lib:fref wr-%data%
                         ((f2cl-lib:int-sub i 1))
                         ((1 *))
                         wr-%offset%)
          var-4)
    (setf (f2cl-lib:fref wi-%data%
                         ((f2cl-lib:int-sub i 1))
                         ((1 *))
                         wi-%offset%)
          var-5)
    (setf (f2cl-lib:fref wr-%data% (i) ((1 *)) wr-%offset%) var-6)
    (setf (f2cl-lib:fref wi-%data% (i) ((1 *)) wi-%offset%) var-7)
    (setf cs var-8)
    (setf sn var-9))
  (cond
    (wantt
     (if (> i2 i)
         (drot (f2cl-lib:int-sub i2 i)
          (f2cl-lib:array-slice h
                                double-float
                                ((+ i (f2cl-lib:int-sub 1))
                                 (f2cl-lib:int-add i 1))
                                ((1 ldh) (1 *)))
          ldh
          (f2cl-lib:array-slice h
```

```
                                      double-float
                                      (i (f2cl-lib:int-add i 1))
                                      ((1 ldh) (1 *)))
                  ldh cs sn))
             (drot (f2cl-lib:int-sub i i1 1)
              (f2cl-lib:array-slice h
                                    double-float
                                    (i1 (f2cl-lib:int-sub i 1))
                                    ((1 ldh) (1 *)))
              1 (f2cl-lib:array-slice h double-float (i1 i) ((1 ldh) (1 *))) 1
              cs sn)))
           (cond
             (wantz
              (drot nz
               (f2cl-lib:array-slice z
                                     double-float
                                     (iloz (f2cl-lib:int-sub i 1))
                                     ((1 ldz) (1 *)))
               1 (f2cl-lib:array-slice z double-float (iloz i) ((1 ldz) (1 *)))
               1 cs sn)))))
       (setf itn (f2cl-lib:int-sub itn its))
       (setf i (f2cl-lib:int-sub l 1))
       (go label10)
 end_label
       (return
        (values nil nil nil nil nil nil nil nil nil nil nil nil nil info))))))
```

———-

6.32 dlahrd LAPACK

— **dlahrd.input** —

```
)set break resume
)sys rm -f dlahrd.output
)spool dlahrd.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlahrd.help** —

```
=====================================================================
dlahrd examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DLAHRD  -  the first NB columns of a real general n-by-(n-k+1) matrix A
       so that elements below the k-th subdiagonal are zero

SYNOPSIS
       SUBROUTINE DLAHRD( N, K, NB, A, LDA, TAU, T, LDT, Y, LDY )

           INTEGER        K, LDA, LDT, LDY, N, NB

           DOUBLE         PRECISION A( LDA, * ), T( LDT, NB ), TAU( NB  ),  Y(
                          LDY, NB )

PURPOSE
       DLAHRD  reduces  the  first  NB  columns of a real general n-by-(n-k+1)
       matrix A so that elements below the  k-th  subdiagonal  are  zero.  The
       reduction  is performed by an orthogonal similarity transformation Q' *
       A * Q. The routine returns the matrices V and T which determine Q as  a
       block reflector I - V*T*V', and also the matrix Y = A * V * T.

       This is an OBSOLETE auxiliary routine.
       This routine will be 'deprecated' in a  future release.
       Please use the new routine DLAHR2 instead.


ARGUMENTS
       N       (input) INTEGER
               The order of the matrix A.

       K       (input) INTEGER
               The offset for the reduction. Elements below the k-th subdiago-
               nal in the first NB columns are reduced to zero.

       NB      (input) INTEGER
               The number of columns to be reduced.

       A       (input/output) DOUBLE PRECISION array, dimension (LDA,N-K+1)
               On entry, the n-by-(n-k+1) general matrix A.  On exit, the ele-
               ments on and above the k-th subdiagonal in the first NB columns
               are overwritten with the corresponding elements of the  reduced
               matrix; the elements below the k-th subdiagonal, with the array
               TAU, represent the matrix Q as a product of elementary  reflec-
               tors.  The  other  columns  of  A  are  unchanged.  See Further
```

```
          Details.  LDA     (input) INTEGER The leading dimension of  the
          array A.  LDA >= max(1,N).

      TAU     (output) DOUBLE PRECISION array, dimension (NB)
              The  scalar  factors  of the elementary reflectors. See Further
              Details.

      T       (output) DOUBLE PRECISION array, dimension (LDT,NB)
              The upper triangular matrix T.

      LDT     (input) INTEGER
              The leading dimension of the array T.  LDT >= NB.

      Y       (output) DOUBLE PRECISION array, dimension (LDY,NB)
              The n-by-nb matrix Y.

      LDY     (input) INTEGER
              The leading dimension of the array Y. LDY >= N.

FURTHER DETAILS
      The matrix Q is represented as a product of nb elementary reflectors

         Q = H(1) H(2) . . . H(nb).

      Each H(i) has the form

         H(i) = I - tau * v * v'

      where tau is a real scalar, and v is a real vector with
      v(1:i+k-1)  =  0,  v(i+k)  =  1;  v(i+k+1:n)  is  stored  on  exit  in
      A(i+k+1:n,i), and tau in TAU(i).

      The  elements of the vectors v together form the (n-k+1)-by-nb matrix V
      which is needed, with T and Y, to apply the transformation to the unre-
      duced  part  of  the  matrix,  using  an  update of the form: A := (I -
      V*T*V') * (A - Y*V').

      The contents of A on exit are illustrated by the following example with
      n = 7, k = 3 and nb = 2:

         ( a   h   a   a   a )
         ( a   h   a   a   a )
         ( a   h   a   a   a )
         ( h   h   a   a   a )
         ( v1  h   a   a   a )
         ( v1  v2  a   a   a )
         ( v1  v2  a   a   a )

      where  a denotes an element of the original matrix A, h denotes a modi-
      fied element of the upper Hessenberg matrix H, and vi denotes  an  ele-
```

ment of the vector defining H(i).

———-

— **dlahrd.f** —

```
      SUBROUTINE DLAHRD( N, K, NB, A, LDA, TAU, T, LDT, Y, LDY )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      INTEGER            K, LDA, LDT, LDY, N, NB
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), T( LDT, NB ), TAU( NB ),
     $                   Y( LDY, NB )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I
      DOUBLE PRECISION   EI
*     ..
*     .. External Subroutines ..
      EXTERNAL           DAXPY, DCOPY, DGEMV, DLARFG, DSCAL, DTRMV
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MIN
*     ..
*     .. Executable Statements ..
*
*     Quick return if possible
*
      IF( N.LE.1 )
     $   RETURN
*
      DO 10 I = 1, NB
         IF( I.GT.1 ) THEN
*
*           Update A(1:n,i)
```

```
*
*          Compute i-th column of A - Y * V'
*
           CALL DGEMV( 'No transpose', N, I-1, -ONE, Y, LDY,
     $                 A( K+I-1, 1 ), LDA, ONE, A( 1, I ), 1 )
*
*          Apply I - V * T' * V' to this column (call it b) from the
*          left, using the last column of T as workspace
*
*          Let  V = ( V1 )   and   b = ( b1 )   (first I-1 rows)
*                   ( V2 )             ( b2 )
*
*          where V1 is unit lower triangular
*
*          w := V1' * b1
*
           CALL DCOPY( I-1, A( K+1, I ), 1, T( 1, NB ), 1 )
           CALL DTRMV( 'Lower', 'Transpose', 'Unit', I-1, A( K+1, 1 ),
     $                 LDA, T( 1, NB ), 1 )
*
*          w := w + V2'*b2
*
           CALL DGEMV( 'Transpose', N-K-I+1, I-1, ONE, A( K+I, 1 ),
     $                 LDA, A( K+I, I ), 1, ONE, T( 1, NB ), 1 )
*
*          w := T'*w
*
           CALL DTRMV( 'Upper', 'Transpose', 'Non-unit', I-1, T, LDT,
     $                 T( 1, NB ), 1 )
*
*          b2 := b2 - V2*w
*
           CALL DGEMV( 'No transpose', N-K-I+1, I-1, -ONE, A( K+I, 1 ),
     $                 LDA, T( 1, NB ), 1, ONE, A( K+I, I ), 1 )
*
*          b1 := b1 - V1*w
*
           CALL DTRMV( 'Lower', 'No transpose', 'Unit', I-1,
     $                 A( K+1, 1 ), LDA, T( 1, NB ), 1 )
           CALL DAXPY( I-1, -ONE, T( 1, NB ), 1, A( K+1, I ), 1 )
*
           A( K+I-1, I-1 ) = EI
         END IF
*
*        Generate the elementary reflector H(i) to annihilate
*        A(k+i+1:n,i)
*
         CALL DLARFG( N-K-I+1, A( K+I, I ), A( MIN( K+I+1, N ), I ), 1,
     $                TAU( I ) )
         EI = A( K+I, I )
```

```
         A( K+I, I ) = ONE
*
*        Compute  Y(1:n,i)
*
         CALL DGEMV( 'No transpose', N, N-K-I+1, ONE, A( 1, I+1 ), LDA,
     $               A( K+I, I ), 1, ZERO, Y( 1, I ), 1 )
         CALL DGEMV( 'Transpose', N-K-I+1, I-1, ONE, A( K+I, 1 ), LDA,
     $               A( K+I, I ), 1, ZERO, T( 1, I ), 1 )
         CALL DGEMV( 'No transpose', N, I-1, -ONE, Y, LDY, T( 1, I ), 1,
     $               ONE, Y( 1, I ), 1 )
         CALL DSCAL( N, TAU( I ), Y( 1, I ), 1 )
*
*        Compute T(1:i,i)
*
         CALL DSCAL( I-1, -TAU( I ), T( 1, I ), 1 )
         CALL DTRMV( 'Upper', 'No transpose', 'Non-unit', I-1, T, LDT,
     $               T( 1, I ), 1 )
         T( I, I ) = TAU( I )
*
   10 CONTINUE
      A( K+NB, NB ) = EI
*
      RETURN
*
*     End of DLAHRD
*
      END
```

— LAPACK dlahrd —

```
(let* ((zero 0.0) (one 1.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one))
  (defun dlahrd (n k nb a lda tau t$ ldt y ldy)
    (declare (type (simple-array double-float (*)) y t$ tau a)
             (type fixnum ldy ldt lda nb k n))
    (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (t$ double-float t$-%data% t$-%offset%)
         (y double-float y-%data% y-%offset%))
      (prog ((ei 0.0) (i 0))
        (declare (type (double-float) ei) (type fixnum i))
        (if (<= n 1) (go end_label))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i nb) nil)
```

```
(tagbody
  (cond
    ((> i 1)
     (dgemv "No transpose" n (f2cl-lib:int-sub i 1) (- one) y ldy
      (f2cl-lib:array-slice a
                            double-float
                            ((+ k i (f2cl-lib:int-sub 1)) 1)
                            ((1 lda) (1 *)))
      lda one
      (f2cl-lib:array-slice a double-float (1 i) ((1 lda) (1 *))) 1)
     (dcopy (f2cl-lib:int-sub i 1)
      (f2cl-lib:array-slice a
                            double-float
                            ((+ k 1) i)
                            ((1 lda) (1 *)))
      1
      (f2cl-lib:array-slice t$ double-float (1 nb) ((1 ldt) (1 nb)))
      1)
     (dtrmv "Lower" "Transpose" "Unit" (f2cl-lib:int-sub i 1)
      (f2cl-lib:array-slice a
                            double-float
                            ((+ k 1) 1)
                            ((1 lda) (1 *)))
      lda
      (f2cl-lib:array-slice t$ double-float (1 nb) ((1 ldt) (1 nb)))
      1)
     (dgemv "Transpose" (f2cl-lib:int-add (f2cl-lib:int-sub n k i) 1)
      (f2cl-lib:int-sub i 1) one
      (f2cl-lib:array-slice a
                            double-float
                            ((+ k i) 1)
                            ((1 lda) (1 *)))
      lda
      (f2cl-lib:array-slice a
                            double-float
                            ((+ k i) i)
                            ((1 lda) (1 *)))
      1 one
      (f2cl-lib:array-slice t$ double-float (1 nb) ((1 ldt) (1 nb)))
      1)
     (dtrmv "Upper" "Transpose" "Non-unit" (f2cl-lib:int-sub i 1) t$
      ldt
      (f2cl-lib:array-slice t$ double-float (1 nb) ((1 ldt) (1 nb)))
      1)
     (dgemv "No transpose"
      (f2cl-lib:int-add (f2cl-lib:int-sub n k i) 1)
      (f2cl-lib:int-sub i 1) (- one)
      (f2cl-lib:array-slice a
                            double-float
                            ((+ k i) 1)
```

```
                          ((1 lda) (1 *)))
     lda
     (f2cl-lib:array-slice t$ double-float (1 nb) ((1 ldt) (1 nb)))
     1 one
     (f2cl-lib:array-slice a
                          double-float
                          ((+ k i) i)
                          ((1 lda) (1 *)))
     1)
    (dtrmv "Lower" "No transpose" "Unit" (f2cl-lib:int-sub i 1)
     (f2cl-lib:array-slice a
                          double-float
                          ((+ k 1) 1)
                          ((1 lda) (1 *)))
     lda
     (f2cl-lib:array-slice t$ double-float (1 nb) ((1 ldt) (1 nb)))
     1)
    (daxpy (f2cl-lib:int-sub i 1) (- one)
     (f2cl-lib:array-slice t$ double-float (1 nb) ((1 ldt) (1 nb)))
     1
     (f2cl-lib:array-slice a
                          double-float
                          ((+ k 1) i)
                          ((1 lda) (1 *)))
     1)
    (setf (f2cl-lib:fref a-%data%
                         ((f2cl-lib:int-sub (f2cl-lib:int-add k i)
                                            1)
                          (f2cl-lib:int-sub i 1))
                         ((1 lda) (1 *))
                         a-%offset%)
          ei)))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
    (dlarfg (f2cl-lib:int-add (f2cl-lib:int-sub n k i) 1)
     (f2cl-lib:fref a-%data%
                    ((f2cl-lib:int-add k i) i)
                    ((1 lda) (1 *))
                    a-%offset%)
     (f2cl-lib:array-slice a
                           double-float
                           ((min (f2cl-lib:int-add k i 1) n) i)
                           ((1 lda) (1 *)))
     1 (f2cl-lib:fref tau-%data% (i) ((1 nb)) tau-%offset%))
  (declare (ignore var-0 var-2 var-3))
  (setf (f2cl-lib:fref a-%data%
                       ((f2cl-lib:int-add k i) i)
                       ((1 lda) (1 *))
                       a-%offset%)
        var-1)
  (setf (f2cl-lib:fref tau-%data% (i) ((1 nb)) tau-%offset%)
```

```
                  var-4))
           (setf ei
                 (f2cl-lib:fref a-%data%
                                ((f2cl-lib:int-add k i) i)
                                ((1 lda) (1 *))
                                a-%offset%))
           (setf (f2cl-lib:fref a-%data%
                                ((f2cl-lib:int-add k i) i)
                                ((1 lda) (1 *))
                                a-%offset%)
                 one)
           (dgemv "No transpose" n
            (f2cl-lib:int-add (f2cl-lib:int-sub n k i) 1) one
            (f2cl-lib:array-slice a
                                  double-float
                                  (1 (f2cl-lib:int-add i 1))
                                  ((1 lda) (1 *)))
            lda
            (f2cl-lib:array-slice a double-float ((+ k i) i) ((1 lda) (1 *)))
            1 zero
            (f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 nb))) 1)
           (dgemv "Transpose" (f2cl-lib:int-add (f2cl-lib:int-sub n k i) 1)
            (f2cl-lib:int-sub i 1) one
            (f2cl-lib:array-slice a double-float ((+ k i) 1) ((1 lda) (1 *)))
            lda
            (f2cl-lib:array-slice a double-float ((+ k i) i) ((1 lda) (1 *)))
            1 zero
            (f2cl-lib:array-slice t$ double-float (1 i) ((1 ldt) (1 nb))) 1)
           (dgemv "No transpose" n (f2cl-lib:int-sub i 1) (- one) y ldy
            (f2cl-lib:array-slice t$ double-float (1 i) ((1 ldt) (1 nb))) 1
            one (f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 nb)))
            1)
           (dscal n (f2cl-lib:fref tau-%data% (i) ((1 nb)) tau-%offset%)
            (f2cl-lib:array-slice y double-float (1 i) ((1 ldy) (1 nb))) 1)
           (dscal (f2cl-lib:int-sub i 1)
            (- (f2cl-lib:fref tau-%data% (i) ((1 nb)) tau-%offset%))
            (f2cl-lib:array-slice t$ double-float (1 i) ((1 ldt) (1 nb))) 1)
           (dtrmv "Upper" "No transpose" "Non-unit" (f2cl-lib:int-sub i 1) t$
            ldt (f2cl-lib:array-slice t$ double-float (1 i) ((1 ldt) (1 nb)))
            1)
           (setf (f2cl-lib:fref t$-%data% (i i) ((1 ldt) (1 nb)) t$-%offset%)
                 (f2cl-lib:fref tau-%data% (i) ((1 nb)) tau-%offset%))))
      (setf (f2cl-lib:fref a-%data%
                           ((f2cl-lib:int-add k nb) nb)
                           ((1 lda) (1 *))
                           a-%offset%)
            ei)
end_label
      (return (values nil nil nil nil nil nil nil nil nil nil))))))
```

———-

6.33 dlaisnan LAPACK

— **dlaisnan.input** —

```
)set break resume
)sys rm -f dlaisnan.output
)spool dlaisnan.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlaisnan.help** —

```
=======================================================================
dlaisnan examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

      LOGICAL FUNCTION DLAISNAN( DIN1, DIN2 )

      .. Scalar Arguments ..
      DOUBLE PRECISION   DIN1, DIN2
      ..


 Purpose:
 =============

 This routine is not for general use.  It exists solely to avoid
 over-optimization in DISNAN.
```

```
DLAISNAN checks for NaNs by comparing its two arguments for
inequality.  NaN is the only floating-point value where NaN != NaN
returns .TRUE.  To check for NaNs, pass the same variable as both
arguments.

A compiler must assume that the two arguments are
not the same variable, and the test will not be optimized away.
Interprocedural or whole-program optimization may delete this
test.  The ISNAN functions will be replaced by the correct
Fortran 03 intrinsic once the intrinsic is widely available.

 Arguments:
 ==========

 [in] DIN1
        DIN1 is DOUBLE PRECISION

 [in] DIN2
        DIN2 is DOUBLE PRECISION
        Two numbers to compare for inequality.

Authors:
========
  Univ. of Tennessee
  Univ. of California Berkeley
  Univ. of Colorado Denver
  NAG Ltd.

November 2011
```

———-

— dlaisnan.f —

```
*  =====================================================================
      LOGICAL FUNCTION DLAISNAN( DIN1, DIN2 )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      DOUBLE PRECISION   DIN1, DIN2
*     ..
*
*  =====================================================================
```

```
*
*  .. Executable Statements ..
      DLAISNAN = (DIN1.NE.DIN2)
      RETURN
      END
```

———-

— **LAPACK dlaisnan** —

———-

6.34 dlaln2 LAPACK

— **dlaln2.input** —

```
)set break resume
)sys rm -f dlaln2.output
)spool dlaln2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlaln2.help** —

```
=====================================================================
dlaln2 examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DLALN2  - a system of the form (ca A - w D ) X = s B or (ca A' - w D) X
       = s B with possible scaling ("s") and perturbation of A
```

```
SYNOPSIS
       SUBROUTINE DLALN2( LTRANS, NA, NW, SMIN, CA, A, LDA, D1,  D2,  B,  LDB,
                          WR, WI, X, LDX, SCALE, XNORM, INFO )

           LOGICAL        LTRANS

           INTEGER        INFO, LDA, LDB, LDX, NA, NW

           DOUBLE         PRECISION CA, D1, D2, SCALE, SMIN, WI, WR, XNORM

           DOUBLE         PRECISION A( LDA, * ), B( LDB, * ), X( LDX, * )

 Purpose
 =======

  DLALN2 solves a system of the form  (ca A - w D ) X = s B
  or (ca A' - w D) X = s B   with possible scaling ("s") and
  perturbation of A.  (A' means A-transpose.)

  A is an NA x NA real matrix, ca is a real scalar, D is an NA x NA
  real diagonal matrix, w is a real or complex value, and X and B are
  NA x 1 matrices -- real if w is real, complex if w is complex.  NA
  may be 1 or 2.

  If w is complex, X and B are represented as NA x 2 matrices,
  the first column of each being the real part and the second
  being the imaginary part.

  "s" is a scaling factor (.LE. 1), computed by DLALN2, which is
  so chosen that X can be computed without overflow.  X is further
  scaled if necessary to assure that norm(ca A - w D)*norm(X) is less
  than overflow.

  If both singular values of (ca A - w D) are less than SMIN,
  SMIN*identity will be used instead of (ca A - w D).  If only one
  singular value is less than SMIN, one element of (ca A - w D) will be
  perturbed enough to make the smallest singular value roughly SMIN.
  If both singular values are at least SMIN, (ca A - w D) will not be
  perturbed.  In any case, the perturbation will be at most some small
  multiple of max( SMIN, ulp*norm(ca A - w D) ).  The singular values
  are computed by infinity-norm approximations, and thus will only be
  correct to a factor of 2 or so.

  Note: all input quantities are assumed to be smaller than overflow
  by a reasonable factor.  (See BIGNUM.)

 Arguments
 ==========

  LTRANS  (input) LOGICAL
```

```
        =.TRUE.:  A-transpose will be used.
        =.FALSE.: A will be used (not transposed.)

NA      (input) INTEGER
        The size of the matrix A.  It may (only) be 1 or 2.

NW      (input) INTEGER
        1 if "w" is real, 2 if "w" is complex.  It may only be 1
        or 2.

SMIN    (input) DOUBLE PRECISION
        The desired lower bound on the singular values of A.  This
        should be a safe distance away from underflow or overflow,
        say, between (underflow/machine precision) and  (machine
        precision * overflow ).  (See BIGNUM and ULP.)

CA      (input) DOUBLE PRECISION
        The coefficient c, which A is multiplied by.

A       (input) DOUBLE PRECISION array, dimension (LDA,NA)
        The NA x NA matrix A.

LDA     (input) INTEGER
        The leading dimension of A.  It must be at least NA.

D1      (input) DOUBLE PRECISION
        The 1,1 element in the diagonal matrix D.

D2      (input) DOUBLE PRECISION
        The 2,2 element in the diagonal matrix D.  Not used if NW=1.

B       (input) DOUBLE PRECISION array, dimension (LDB,NW)
        The NA x NW matrix B (right-hand side).  If NW=2 ("w" is
        complex), column 1 contains the real part of B and column 2
        contains the imaginary part.

LDB     (input) INTEGER
        The leading dimension of B.  It must be at least NA.

WR      (input) DOUBLE PRECISION
        The real part of the scalar "w".

WI      (input) DOUBLE PRECISION
        The imaginary part of the scalar "w".  Not used if NW=1.

X       (output) DOUBLE PRECISION array, dimension (LDX,NW)
        The NA x NW matrix X (unknowns), as computed by DLALN2.
        If NW=2 ("w" is complex), on exit, column 1 will contain
        the real part of X and column 2 will contain the imaginary
        part.
```

```
  LDX     (input) INTEGER
          The leading dimension of X.  It must be at least NA.

  SCALE   (output) DOUBLE PRECISION
          The scale factor that B must be multiplied by to insure
          that overflow does not occur when computing X.  Thus,
          (ca A - w D) X  will be SCALE*B, not B (ignoring
          perturbations of A.)  It will be at most 1.

  XNORM   (output) DOUBLE PRECISION
          The infinity-norm of X, when X is regarded as an NA x NW
          real matrix.

  INFO    (output) INTEGER
          An error flag.  It will be set to zero if no error occurs,
          a negative number if an argument is in error, or a positive
          number if  ca A - w D  had to be perturbed.
          The possible values are:
          = 0: No error occurred, and (ca A - w D) did not have to be
                 perturbed.
          = 1: (ca A - w D) had to be perturbed to make its smallest
               (or only) singular value greater than SMIN.
          NOTE: In the interests of speed, this routine does not
                check the inputs for errors.
```

— dlaln2.f —

```
      SUBROUTINE DLALN2( LTRANS, NA, NW, SMIN, CA, A, LDA, D1, D2, B,
     $                   LDB, WR, WI, X, LDX, SCALE, XNORM, INFO )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1992
*
*     .. Scalar Arguments ..
      LOGICAL            LTRANS
      INTEGER            INFO, LDA, LDB, LDX, NA, NW
      DOUBLE PRECISION   CA, D1, D2, SCALE, SMIN, WI, WR, XNORM
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), B( LDB, * ), X( LDX, * )
*     ..
*
* =====================================================================
```

```
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D0, ONE = 1.0D0 )
      DOUBLE PRECISION   TWO
      PARAMETER          ( TWO = 2.0D0 )
*     ..
*     .. Local Scalars ..
      INTEGER            ICMAX, J
      DOUBLE PRECISION   BBND, BI1, BI2, BIGNUM, BNORM, BR1, BR2, CI21,
     $                   CI22, CMAX, CNORM, CR21, CR22, CSI, CSR, LI21,
     $                   LR21, SMINI, SMLNUM, TEMP, U22ABS, UI11, UI11R,
     $                   UI12, UI12S, UI22, UR11, UR11R, UR12, UR12S,
     $                   UR22, XI1, XI2, XR1, XR2
*     ..
*     .. Local Arrays ..
      LOGICAL            RSWAP( 4 ), ZSWAP( 4 )
      INTEGER            IPIVOT( 4, 4 )
      DOUBLE PRECISION   CI( 2, 2 ), CIV( 4 ), CR( 2, 2 ), CRV( 4 )
*     ..
*     .. External Functions ..
      DOUBLE PRECISION   DLAMCH
      EXTERNAL           DLAMCH
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLADIV
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX
*     ..
*     .. Equivalences ..
c
c     *** F2CL cannot currently handle equivalences of arrays
c     *** So we do this by hand.  Since Fortran arrays are column-major
c     *** order, we have the following:
c     ***
c     *** ci(1,1) civ(1)
c     *** ci(2,1) civ(2)
c     *** ci(1,2) civ(3)
c     *** ci(2,2) civ(4)
c     ***
c     *** Similarly for CR.
c      EQUIVALENCE        ( CI( 1, 1 ), CIV( 1 ) ),
c     $                   ( CR( 1, 1 ), CRV( 1 ) )
*     ..
*     .. Data statements ..
      DATA               ZSWAP / .FALSE., .FALSE., .TRUE., .TRUE. /
      DATA               RSWAP / .FALSE., .TRUE., .FALSE., .TRUE. /
      DATA               IPIVOT / 1, 2, 3, 4, 2, 1, 4, 3, 3, 4, 1, 2, 4,
     $                   3, 2, 1 /
```

```
*     ..
*     .. Executable Statements ..
*
*     Compute BIGNUM
*
      SMLNUM = TWO*DLAMCH( 'Safe minimum' )
      BIGNUM = ONE / SMLNUM
      SMINI = MAX( SMIN, SMLNUM )
*
*     Don't check for input errors
*
      INFO = 0
*
*     Standard Initializations
*
      SCALE = ONE
*
      IF( NA.EQ.1 ) THEN
*
*        1 x 1  (i.e., scalar) system   C X = B
*
         IF( NW.EQ.1 ) THEN
*
*           Real 1x1 system.
*
*           C = ca A - w D
*
            CSR = CA*A( 1, 1 ) - WR*D1
            CNORM = ABS( CSR )
*
*           If | C | < SMINI, use C = SMINI
*
            IF( CNORM.LT.SMINI ) THEN
               CSR = SMINI
               CNORM = SMINI
               INFO = 1
            END IF
*
*           Check scaling for  X = B / C
*
            BNORM = ABS( B( 1, 1 ) )
            IF( CNORM.LT.ONE .AND. BNORM.GT.ONE ) THEN
               IF( BNORM.GT.BIGNUM*CNORM )
     $            SCALE = ONE / BNORM
            END IF
*
*           Compute X
*
            X( 1, 1 ) = ( B( 1, 1 )*SCALE ) / CSR
            XNORM = ABS( X( 1, 1 ) )
```

```
         ELSE
*
*           Complex 1x1 system (w is complex)
*
*           C = ca A - w D
*
            CSR = CA*A( 1, 1 ) - WR*D1
            CSI = -WI*D1
            CNORM = ABS( CSR ) + ABS( CSI )
*
*           If | C | < SMINI, use C = SMINI
*
            IF( CNORM.LT.SMINI ) THEN
               CSR = SMINI
               CSI = ZERO
               CNORM = SMINI
               INFO = 1
            END IF
*
*           Check scaling for  X = B / C
*
            BNORM = ABS( B( 1, 1 ) ) + ABS( B( 1, 2 ) )
            IF( CNORM.LT.ONE .AND. BNORM.GT.ONE ) THEN
               IF( BNORM.GT.BIGNUM*CNORM )
     $            SCALE = ONE / BNORM
            END IF
*
*           Compute X
*
            CALL DLADIV( SCALE*B( 1, 1 ), SCALE*B( 1, 2 ), CSR, CSI,
     $                   X( 1, 1 ), X( 1, 2 ) )
            XNORM = ABS( X( 1, 1 ) ) + ABS( X( 1, 2 ) )
         END IF
*
      ELSE
*
*        2x2 System
*
*        Compute the real part of  C = ca A - w D  (or  ca A' - w D )
*
c        *** F2CL original
c         CR( 1, 1 ) = CA*A( 1, 1 ) - WR*D1
c         CR( 2, 2 ) = CA*A( 2, 2 ) - WR*D2
c        *** F2CL replacement
         crv(1)  = CA*A( 1, 1 ) - WR*D1
         crv(4)  = CA*A( 2, 2 ) - WR*D2
         IF( LTRANS ) THEN
c            CR( 1, 2 ) = CA*A( 2, 1 )
c            CR( 2, 1 ) = CA*A( 1, 2 )
            crv( 3 ) = CA*A( 2, 1 )
```

```
            crv( 2 ) = CA*A( 1, 2 )
         ELSE
c            CR( 2, 1 ) = CA*A( 2, 1 )
c            CR( 1, 2 ) = CA*A( 1, 2 )
            crv( 2 ) = CA*A( 2, 1 )
            crv( 3 ) = CA*A( 1, 2 )
         END IF
*
         IF( NW.EQ.1 ) THEN
*
*           Real 2x2 system  (w is real)
*
*           Find the largest element in C
*
            CMAX = ZERO
            ICMAX = 0
*
            DO 10 J = 1, 4
               IF( ABS( CRV( J ) ).GT.CMAX ) THEN
                  CMAX = ABS( CRV( J ) )
                  ICMAX = J
               END IF
   10       CONTINUE
*
*           If norm(C) < SMINI, use SMINI*identity.
*
            IF( CMAX.LT.SMINI ) THEN
               BNORM = MAX( ABS( B( 1, 1 ) ), ABS( B( 2, 1 ) ) )
               IF( SMINI.LT.ONE .AND. BNORM.GT.ONE ) THEN
                  IF( BNORM.GT.BIGNUM*SMINI )
     $               SCALE = ONE / BNORM
               END IF
               TEMP = SCALE / SMINI
               X( 1, 1 ) = TEMP*B( 1, 1 )
               X( 2, 1 ) = TEMP*B( 2, 1 )
               XNORM = TEMP*BNORM
               INFO = 1
               RETURN
            END IF
*
*           Gaussian elimination with complete pivoting.
*
            UR11 = CRV( ICMAX )
            CR21 = CRV( IPIVOT( 2, ICMAX ) )
            UR12 = CRV( IPIVOT( 3, ICMAX ) )
            CR22 = CRV( IPIVOT( 4, ICMAX ) )
            UR11R = ONE / UR11
            LR21 = UR11R*CR21
            UR22 = CR22 - UR12*LR21
*
```

```
*           If smaller pivot < SMINI, use SMINI
*
            IF( ABS( UR22 ).LT.SMINI ) THEN
               UR22 = SMINI
               INFO = 1
            END IF
            IF( RSWAP( ICMAX ) ) THEN
               BR1 = B( 2, 1 )
               BR2 = B( 1, 1 )
            ELSE
               BR1 = B( 1, 1 )
               BR2 = B( 2, 1 )
            END IF
            BR2 = BR2 - LR21*BR1
            BBND = MAX( ABS( BR1*( UR22*UR11R ) ), ABS( BR2 ) )
            IF( BBND.GT.ONE .AND. ABS( UR22 ).LT.ONE ) THEN
               IF( BBND.GE.BIGNUM*ABS( UR22 ) )
     $            SCALE = ONE / BBND
            END IF
*
            XR2 = ( BR2*SCALE ) / UR22
            XR1 = ( SCALE*BR1 )*UR11R - XR2*( UR11R*UR12 )
            IF( ZSWAP( ICMAX ) ) THEN
               X( 1, 1 ) = XR2
               X( 2, 1 ) = XR1
            ELSE
               X( 1, 1 ) = XR1
               X( 2, 1 ) = XR2
            END IF
            XNORM = MAX( ABS( XR1 ), ABS( XR2 ) )
*
*           Further scaling if  norm(A) norm(X) > overflow
*
            IF( XNORM.GT.ONE .AND. CMAX.GT.ONE ) THEN
               IF( XNORM.GT.BIGNUM / CMAX ) THEN
                  TEMP = CMAX / BIGNUM
                  X( 1, 1 ) = TEMP*X( 1, 1 )
                  X( 2, 1 ) = TEMP*X( 2, 1 )
                  XNORM = TEMP*XNORM
                  SCALE = TEMP*SCALE
               END IF
            END IF
         ELSE
*
*           Complex 2x2 system  (w is complex)
*
*           Find the largest element in C
*
c           *** F2CL original
c            CI( 1, 1 ) = -WI*D1
```

```
c            CI( 2, 1 ) = ZERO
c            CI( 1, 2 ) = ZERO
c            CI( 2, 2 ) = -WI*D2
             civ( 1 ) = -WI*D1
             civ( 2 ) = ZERO
             civ( 3 ) = ZERO
             civ( 4 ) = -WI*D2
             CMAX = ZERO
             ICMAX = 0
*
             DO 20 J = 1, 4
                IF( ABS( CRV( J ) )+ABS( CIV( J ) ).GT.CMAX ) THEN
                   CMAX = ABS( CRV( J ) ) + ABS( CIV( J ) )
                   ICMAX = J
                END IF
   20        CONTINUE
*
*            If norm(C) < SMINI, use SMINI*identity.
*
             IF( CMAX.LT.SMINI ) THEN
                BNORM = MAX( ABS( B( 1, 1 ) )+ABS( B( 1, 2 ) ),
     $                  ABS( B( 2, 1 ) )+ABS( B( 2, 2 ) ) )
                IF( SMINI.LT.ONE .AND. BNORM.GT.ONE ) THEN
                   IF( BNORM.GT.BIGNUM*SMINI )
     $                SCALE = ONE / BNORM
                END IF
                TEMP = SCALE / SMINI
                X( 1, 1 ) = TEMP*B( 1, 1 )
                X( 2, 1 ) = TEMP*B( 2, 1 )
                X( 1, 2 ) = TEMP*B( 1, 2 )
                X( 2, 2 ) = TEMP*B( 2, 2 )
                XNORM = TEMP*BNORM
                INFO = 1
                RETURN
             END IF
*
*            Gaussian elimination with complete pivoting.
*
             UR11 = CRV( ICMAX )
             UI11 = CIV( ICMAX )
             CR21 = CRV( IPIVOT( 2, ICMAX ) )
             CI21 = CIV( IPIVOT( 2, ICMAX ) )
             UR12 = CRV( IPIVOT( 3, ICMAX ) )
             UI12 = CIV( IPIVOT( 3, ICMAX ) )
             CR22 = CRV( IPIVOT( 4, ICMAX ) )
             CI22 = CIV( IPIVOT( 4, ICMAX ) )
             IF( ICMAX.EQ.1 .OR. ICMAX.EQ.4 ) THEN
*
*               Code when off-diagonals of pivoted C are real
*
```

```
               IF( ABS( UR11 ).GT.ABS( UI11 ) ) THEN
                  TEMP = UI11 / UR11
                  UR11R = ONE / ( UR11*( ONE+TEMP**2 ) )
                  UI11R = -TEMP*UR11R
               ELSE
                  TEMP = UR11 / UI11
                  UI11R = -ONE / ( UI11*( ONE+TEMP**2 ) )
                  UR11R = -TEMP*UI11R
               END IF
               LR21 = CR21*UR11R
               LI21 = CR21*UI11R
               UR12S = UR12*UR11R
               UI12S = UR12*UI11R
               UR22 = CR22 - UR12*LR21
               UI22 = CI22 - UR12*LI21
            ELSE
*
*              Code when diagonals of pivoted C are real
*
               UR11R = ONE / UR11
               UI11R = ZERO
               LR21 = CR21*UR11R
               LI21 = CI21*UR11R
               UR12S = UR12*UR11R
               UI12S = UI12*UR11R
               UR22 = CR22 - UR12*LR21 + UI12*LI21
               UI22 = -UR12*LI21 - UI12*LR21
            END IF
            U22ABS = ABS( UR22 ) + ABS( UI22 )
*
*           If smaller pivot < SMINI, use SMINI
*
            IF( U22ABS.LT.SMINI ) THEN
               UR22 = SMINI
               UI22 = ZERO
               INFO = 1
            END IF
            IF( RSWAP( ICMAX ) ) THEN
               BR2 = B( 1, 1 )
               BR1 = B( 2, 1 )
               BI2 = B( 1, 2 )
               BI1 = B( 2, 2 )
            ELSE
               BR1 = B( 1, 1 )
               BR2 = B( 2, 1 )
               BI1 = B( 1, 2 )
               BI2 = B( 2, 2 )
            END IF
            BR2 = BR2 - LR21*BR1 + LI21*BI1
            BI2 = BI2 - LI21*BR1 - LR21*BI1
```

```
            BBND = MAX( ( ABS( BR1 )+ABS( BI1 ) )*
     $             ( U22ABS*( ABS( UR11R )+ABS( UI11R ) ) ),
     $             ABS( BR2 )+ABS( BI2 ) )
            IF( BBND.GT.ONE .AND. U22ABS.LT.ONE ) THEN
               IF( BBND.GE.BIGNUM*U22ABS ) THEN
                  SCALE = ONE / BBND
                  BR1 = SCALE*BR1
                  BI1 = SCALE*BI1
                  BR2 = SCALE*BR2
                  BI2 = SCALE*BI2
               END IF
            END IF
*
            CALL DLADIV( BR2, BI2, UR22, UI22, XR2, XI2 )
            XR1 = UR11R*BR1 - UI11R*BI1 - UR12S*XR2 + UI12S*XI2
            XI1 = UI11R*BR1 + UR11R*BI1 - UI12S*XR2 - UR12S*XI2
            IF( ZSWAP( ICMAX ) ) THEN
               X( 1, 1 ) = XR2
               X( 2, 1 ) = XR1
               X( 1, 2 ) = XI2
               X( 2, 2 ) = XI1
            ELSE
               X( 1, 1 ) = XR1
               X( 2, 1 ) = XR2
               X( 1, 2 ) = XI1
               X( 2, 2 ) = XI2
            END IF
            XNORM = MAX( ABS( XR1 )+ABS( XI1 ), ABS( XR2 )+ABS( XI2 ) )
*
*           Further scaling if  norm(A) norm(X) > overflow
*
            IF( XNORM.GT.ONE .AND. CMAX.GT.ONE ) THEN
               IF( XNORM.GT.BIGNUM / CMAX ) THEN
                  TEMP = CMAX / BIGNUM
                  X( 1, 1 ) = TEMP*X( 1, 1 )
                  X( 2, 1 ) = TEMP*X( 2, 1 )
                  X( 1, 2 ) = TEMP*X( 1, 2 )
                  X( 2, 2 ) = TEMP*X( 2, 2 )
                  XNORM = TEMP*XNORM
                  SCALE = TEMP*SCALE
               END IF
            END IF
         END IF
      END IF
*
      RETURN
*
*     End of DLALN2
*
      END
```

———-

— LAPACK dlaln2 —

```
(let* ((zero 0.0) (one 1.0) (two 2.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one)
           (type (double-float 2.0 2.0) two))
  (let ((zswap
         (make-array 4 :element-type 't :initial-contents '(nil nil t t)))
        (rswap
         (make-array 4 :element-type 't :initial-contents '(nil t nil t)))
        (ipivot
         (make-array 16
                     :element-type 'fixnum
                     :initial-contents '(1 2 3 4 2 1 4 3 3 4 1 2 4 3 2 1))))
    (declare (type (simple-array fixnum (16)) ipivot)
             (type (simple-array (member t nil) (4)) rswap zswap))
    (defun dlaln2
           (ltrans na nw smin ca a lda d1 d2 b ldb$ wr wi x ldx scale xnorm
            info)
      (declare (type (simple-array double-float (*)) x b a)
               (type (double-float) xnorm scale wi wr d2 d1 ca smin)
               (type fixnum info ldx ldb$ lda nw na)
               (type (member t nil) ltrans))
      (f2cl-lib:with-multi-array-data
          ((a double-float a-%data% a-%offset%)
           (b double-float b-%data% b-%offset%)
           (x double-float x-%data% x-%offset%))
        (prog ((ci (make-array 4 :element-type 'double-float))
               (civ (make-array 4 :element-type 'double-float))
               (cr (make-array 4 :element-type 'double-float))
               (crv (make-array 4 :element-type 'double-float)) (bbnd 0.0)
               (bi1 0.0) (bi2 0.0) (bignum 0.0) (bnorm 0.0) (br1 0.0) (br2 0.0)
               (ci21 0.0) (ci22 0.0) (cmax 0.0) (cnorm 0.0) (cr21 0.0)
               (cr22 0.0) (csi 0.0) (csr 0.0) (li21 0.0) (lr21 0.0) (smini 0.0)
               (smlnum 0.0) (temp 0.0) (u22abs 0.0) (ui11 0.0) (ui11r 0.0)
               (ui12 0.0) (ui12s 0.0) (ui22 0.0) (ur11 0.0) (ur11r 0.0)
               (ur12 0.0) (ur12s 0.0) (ur22 0.0) (xi1 0.0) (xi2 0.0) (xr1 0.0)
               (xr2 0.0) (icmax 0) (j 0))
          (declare (type (simple-array double-float (4)) ci civ cr crv)
                   (type (double-float) bbnd bi1 bi2 bignum bnorm br1 br2 ci21
                                        ci22 cmax cnorm cr21 cr22 csi csr li21
                                        lr21 smini smlnum temp u22abs ui11
                                        ui11r ui12 ui12s ui22 ur11 ur11r ur12
                                        ur12s ur22 xi1 xi2 xr1 xr2)
                   (type fixnum icmax j))
```

```
(setf smlnum (* two (dlamch "Safe minimum")))
(setf bignum (/ one smlnum))
(setf smini (max smin smlnum))
(setf info 0)
(setf scale one)
(cond
  ((= na 1)
   (cond
     ((= nw 1)
      (setf csr
              (-
               (* ca
                  (f2cl-lib:fref a-%data%
                                 (1 1)
                                 ((1 lda) (1 *))
                                 a-%offset%))
               (* wr d1)))
      (setf cnorm (abs csr))
      (cond
        ((< cnorm smini)
         (setf csr smini)
         (setf cnorm smini)
         (setf info 1)))
      (setf bnorm
              (abs
               (f2cl-lib:fref b-%data%
                              (1 1)
                              ((1 ldb$) (1 *))
                              b-%offset%)))
      (cond
        ((and (< cnorm one) (> bnorm one))
         (if (> bnorm (* bignum cnorm)) (setf scale (/ one bnorm)))))
      (setf (f2cl-lib:fref x-%data% (1 1) ((1 ldx) (1 *)) x-%offset%)
              (/
               (*
                (f2cl-lib:fref b-%data%
                               (1 1)
                               ((1 ldb$) (1 *))
                               b-%offset%)
                scale)
               csr))
      (setf xnorm
              (abs
               (f2cl-lib:fref x-%data%
                              (1 1)
                              ((1 ldx) (1 *))
                              x-%offset%))))
     (t
      (setf csr
              (-
```

```
         (* ca
            (f2cl-lib:fref a-%data%
                           (1 1)
                           ((1 lda) (1 *))
                           a-%offset%))
         (* wr d1)))
(setf csi (* (- wi) d1))
(setf cnorm (+ (abs csr) (abs csi)))
(cond
  ((< cnorm smini)
   (setf csr smini)
   (setf csi zero)
   (setf cnorm smini)
   (setf info 1)))
(setf bnorm
        (+
         (abs
          (f2cl-lib:fref b-%data%
                         (1 1)
                         ((1 ldb$) (1 *))
                         b-%offset%))
         (abs
          (f2cl-lib:fref b-%data%
                         (1 2)
                         ((1 ldb$) (1 *))
                         b-%offset%))))
(cond
  ((and (< cnorm one) (> bnorm one))
   (if (> bnorm (* bignum cnorm)) (setf scale (/ one bnorm)))))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5)
    (dladiv
     (* scale
        (f2cl-lib:fref b-%data%
                       (1 1)
                       ((1 ldb$) (1 *))
                       b-%offset%))
     (* scale
        (f2cl-lib:fref b-%data%
                       (1 2)
                       ((1 ldb$) (1 *))
                       b-%offset%))
     csr csi
     (f2cl-lib:fref x-%data% (1 1) ((1 ldx) (1 *)) x-%offset%)
     (f2cl-lib:fref x-%data% (1 2) ((1 ldx) (1 *)) x-%offset%))
  (declare (ignore var-0 var-1 var-2 var-3))
  (setf (f2cl-lib:fref x-%data%
                       (1 1)
                       ((1 ldx) (1 *))
                       x-%offset%)
         var-4)
```

```
      (setf (f2cl-lib:fref x-%data%
                           (1 2)
                           ((1 ldx) (1 *))
                           x-%offset%)
            var-5))
    (setf xnorm
          (+
           (abs
            (f2cl-lib:fref x-%data%
                           (1 1)
                           ((1 ldx) (1 *))
                           x-%offset%))
           (abs
            (f2cl-lib:fref x-%data%
                           (1 2)
                           ((1 ldx) (1 *))
                           x-%offset%)))))))
(t
 (setf (f2cl-lib:fref crv (1) ((1 4)))
       (-
        (* ca
           (f2cl-lib:fref a-%data%
                          (1 1)
                          ((1 lda) (1 *))
                          a-%offset%))
        (* wr d1)))
 (setf (f2cl-lib:fref crv (4) ((1 4)))
       (-
        (* ca
           (f2cl-lib:fref a-%data%
                          (2 2)
                          ((1 lda) (1 *))
                          a-%offset%))
        (* wr d2)))
 (cond
   (ltrans
    (setf (f2cl-lib:fref crv (3) ((1 4)))
          (* ca
             (f2cl-lib:fref a-%data%
                            (2 1)
                            ((1 lda) (1 *))
                            a-%offset%)))
    (setf (f2cl-lib:fref crv (2) ((1 4)))
          (* ca
             (f2cl-lib:fref a-%data%
                            (1 2)
                            ((1 lda) (1 *))
                            a-%offset%))))
   (t
    (setf (f2cl-lib:fref crv (2) ((1 4)))
```

```
            (* ca
               (f2cl-lib:fref a-%data%
                             (2 1)
                             ((1 lda) (1 *))
                             a-%offset%)))
      (setf (f2cl-lib:fref crv (3) ((1 4)))
            (* ca
               (f2cl-lib:fref a-%data%
                             (1 2)
                             ((1 lda) (1 *))
                             a-%offset%)))))
  (cond
    ((= nw 1)
     (setf cmax zero)
     (setf icmax 0)
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   ((> j 4) nil)
       (tagbody
         (cond
           ((> (abs (f2cl-lib:fref crv (j) ((1 4)))) cmax)
            (setf cmax (abs (f2cl-lib:fref crv (j) ((1 4)))))
            (setf icmax j)))))
     (cond
       ((< cmax smini)
        (setf bnorm
              (max
               (abs
                (f2cl-lib:fref b-%data%
                               (1 1)
                               ((1 ldb$) (1 *))
                               b-%offset%))
               (abs
                (f2cl-lib:fref b-%data%
                               (2 1)
                               ((1 ldb$) (1 *))
                               b-%offset%))))
        (cond
          ((and (< smini one) (> bnorm one))
           (if (> bnorm (* bignum smini))
               (setf scale (/ one bnorm)))))
        (setf temp (/ scale smini))
        (setf (f2cl-lib:fref x-%data%
                             (1 1)
                             ((1 ldx) (1 *))
                             x-%offset%)
              (* temp
                 (f2cl-lib:fref b-%data%
                                (1 1)
                                ((1 ldb$) (1 *))
                                b-%offset%)))
```

```
   (setf (f2cl-lib:fref x-%data%
                        (2 1)
                        ((1 ldx) (1 *))
                        x-%offset%)
         (* temp
            (f2cl-lib:fref b-%data%
                           (2 1)
                           ((1 ldb$) (1 *))
                           b-%offset%)))
   (setf xnorm (* temp bnorm))
   (setf info 1)
   (go end_label)))
(setf ur11 (f2cl-lib:fref crv (icmax) ((1 4))))
(setf cr21
        (f2cl-lib:fref crv
                       ((f2cl-lib:fref ipivot
                                       (2 icmax)
                                       ((1 4) (1 4))))
                       ((1 4))))
(setf ur12
        (f2cl-lib:fref crv
                       ((f2cl-lib:fref ipivot
                                       (3 icmax)
                                       ((1 4) (1 4))))
                       ((1 4))))
(setf cr22
        (f2cl-lib:fref crv
                       ((f2cl-lib:fref ipivot
                                       (4 icmax)
                                       ((1 4) (1 4))))
                       ((1 4))))
(setf ur11r (/ one ur11))
(setf lr21 (* ur11r cr21))
(setf ur22 (- cr22 (* ur12 lr21)))
(cond
  ((< (abs ur22) smini)
   (setf ur22 smini)
   (setf info 1)))
(cond
  ((f2cl-lib:fref rswap (icmax) ((1 4)))
   (setf br1
         (f2cl-lib:fref b-%data%
                        (2 1)
                        ((1 ldb$) (1 *))
                        b-%offset%))
   (setf br2
         (f2cl-lib:fref b-%data%
                        (1 1)
                        ((1 ldb$) (1 *))
                        b-%offset%)))
```

```
  (t
   (setf br1
           (f2cl-lib:fref b-%data%
                         (1 1)
                         ((1 ldb$) (1 *))
                         b-%offset%))
   (setf br2
           (f2cl-lib:fref b-%data%
                         (2 1)
                         ((1 ldb$) (1 *))
                         b-%offset%))))
(setf br2 (- br2 (* lr21 br1)))
(setf bbnd (max (abs (* br1 (* ur22 ur11r))) (abs br2)))
(cond
  ((and (> bbnd one) (< (abs ur22) one))
   (if (>= bbnd (* bignum (abs ur22)))
       (setf scale (/ one bbnd)))))
(setf xr2 (/ (* br2 scale) ur22))
(setf xr1 (- (* scale br1 ur11r) (* xr2 (* ur11r ur12))))
(cond
  ((f2cl-lib:fref zswap (icmax) ((1 4)))
   (setf (f2cl-lib:fref x-%data%
                        (1 1)
                        ((1 ldx) (1 *))
                        x-%offset%)
           xr2)
   (setf (f2cl-lib:fref x-%data%
                        (2 1)
                        ((1 ldx) (1 *))
                        x-%offset%)
           xr1))
  (t
   (setf (f2cl-lib:fref x-%data%
                        (1 1)
                        ((1 ldx) (1 *))
                        x-%offset%)
           xr1)
   (setf (f2cl-lib:fref x-%data%
                        (2 1)
                        ((1 ldx) (1 *))
                        x-%offset%)
           xr2)))
(setf xnorm (max (abs xr1) (abs xr2)))
(cond
  ((and (> xnorm one) (> cmax one))
   (cond
     ((> xnorm (f2cl-lib:f2cl/ bignum cmax))
      (setf temp (/ cmax bignum))
      (setf (f2cl-lib:fref x-%data%
                           (1 1)
```

```
                                ((1 ldx) (1 *))
                                x-%offset%)
                        (* temp
                           (f2cl-lib:fref x-%data%
                                          (1 1)
                                          ((1 ldx) (1 *))
                                          x-%offset%)))
                (setf (f2cl-lib:fref x-%data%
                                     (2 1)
                                     ((1 ldx) (1 *))
                                     x-%offset%)
                        (* temp
                           (f2cl-lib:fref x-%data%
                                          (2 1)
                                          ((1 ldx) (1 *))
                                          x-%offset%)))
                (setf xnorm (* temp xnorm))
                (setf scale (* temp scale)))))))
            (t
             (setf (f2cl-lib:fref civ (1) ((1 4))) (* (- wi) d1))
             (setf (f2cl-lib:fref civ (2) ((1 4))) zero)
             (setf (f2cl-lib:fref civ (3) ((1 4))) zero)
             (setf (f2cl-lib:fref civ (4) ((1 4))) (* (- wi) d2))
             (setf cmax zero)
             (setf icmax 0)
             (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                           ((> j 4) nil)
               (tagbody
                 (cond
                   ((>
                     (+ (abs (f2cl-lib:fref crv (j) ((1 4))))
                        (abs (f2cl-lib:fref civ (j) ((1 4)))))
                     cmax)
                    (setf cmax
                            (+ (abs (f2cl-lib:fref crv (j) ((1 4))))
                               (abs (f2cl-lib:fref civ (j) ((1 4))))))
                    (setf icmax j)))))
             (cond
               ((< cmax smini)
                (setf bnorm
                        (max
                         (+
                          (abs
                           (f2cl-lib:fref b-%data%
                                          (1 1)
                                          ((1 ldb$) (1 *))
                                          b-%offset%))
                          (abs
                           (f2cl-lib:fref b-%data%
                                          (1 2)
```

```
                              ((1 ldb$) (1 *))
                              b-%offset%)))
          (+
           (abs
            (f2cl-lib:fref b-%data%
                           (2 1)
                           ((1 ldb$) (1 *))
                           b-%offset%))
           (abs
            (f2cl-lib:fref b-%data%
                           (2 2)
                           ((1 ldb$) (1 *))
                           b-%offset%)))))
(cond
  ((and (< smini one) (> bnorm one))
   (if (> bnorm (* bignum smini))
       (setf scale (/ one bnorm)))))
(setf temp (/ scale smini))
(setf (f2cl-lib:fref x-%data%
                     (1 1)
                     ((1 ldx) (1 *))
                     x-%offset%)
        (* temp
           (f2cl-lib:fref b-%data%
                          (1 1)
                          ((1 ldb$) (1 *))
                          b-%offset%)))
(setf (f2cl-lib:fref x-%data%
                     (2 1)
                     ((1 ldx) (1 *))
                     x-%offset%)
        (* temp
           (f2cl-lib:fref b-%data%
                          (2 1)
                          ((1 ldb$) (1 *))
                          b-%offset%)))
(setf (f2cl-lib:fref x-%data%
                     (1 2)
                     ((1 ldx) (1 *))
                     x-%offset%)
        (* temp
           (f2cl-lib:fref b-%data%
                          (1 2)
                          ((1 ldb$) (1 *))
                          b-%offset%)))
(setf (f2cl-lib:fref x-%data%
                     (2 2)
                     ((1 ldx) (1 *))
                     x-%offset%)
        (* temp
```

```
                (f2cl-lib:fref b-%data%
                               (2 2)
                               ((1 ldb$) (1 *))
                               b-%offset%)))
   (setf xnorm (* temp bnorm))
   (setf info 1)
   (go end_label)))
(setf ur11 (f2cl-lib:fref crv (icmax) ((1 4))))
(setf ui11 (f2cl-lib:fref civ (icmax) ((1 4))))
(setf cr21
        (f2cl-lib:fref crv
                       ((f2cl-lib:fref ipivot
                                       (2 icmax)
                                       ((1 4) (1 4))))
                       ((1 4))))
(setf ci21
        (f2cl-lib:fref civ
                       ((f2cl-lib:fref ipivot
                                       (2 icmax)
                                       ((1 4) (1 4))))
                       ((1 4))))
(setf ur12
        (f2cl-lib:fref crv
                       ((f2cl-lib:fref ipivot
                                       (3 icmax)
                                       ((1 4) (1 4))))
                       ((1 4))))
(setf ui12
        (f2cl-lib:fref civ
                       ((f2cl-lib:fref ipivot
                                       (3 icmax)
                                       ((1 4) (1 4))))
                       ((1 4))))
(setf cr22
        (f2cl-lib:fref crv
                       ((f2cl-lib:fref ipivot
                                       (4 icmax)
                                       ((1 4) (1 4))))
                       ((1 4))))
(setf ci22
        (f2cl-lib:fref civ
                       ((f2cl-lib:fref ipivot
                                       (4 icmax)
                                       ((1 4) (1 4))))
                       ((1 4))))
(cond
  ((or (= icmax 1) (= icmax 4))
   (cond
     ((> (abs ur11) (abs ui11))
      (setf temp (/ ui11 ur11))
```

```
       (setf ur11r (/ one (* ur11 (+ one (expt temp 2)))))
       (setf ui11r (* (- temp) ur11r)))
      (t
       (setf temp (/ ur11 ui11))
       (setf ui11r (/ (- one) (* ui11 (+ one (expt temp 2)))))
       (setf ur11r (* (- temp) ui11r))))
    (setf lr21 (* cr21 ur11r))
    (setf li21 (* cr21 ui11r))
    (setf ur12s (* ur12 ur11r))
    (setf ui12s (* ur12 ui11r))
    (setf ur22 (- cr22 (* ur12 lr21)))
    (setf ui22 (- ci22 (* ur12 li21))))
   (t
    (setf ur11r (/ one ur11))
    (setf ui11r zero)
    (setf lr21 (* cr21 ur11r))
    (setf li21 (* ci21 ur11r))
    (setf ur12s (* ur12 ur11r))
    (setf ui12s (* ui12 ur11r))
    (setf ur22 (+ (- cr22 (* ur12 lr21)) (* ui12 li21)))
    (setf ui22 (- (* (- ur12) li21) (* ui12 lr21)))))
(setf u22abs (+ (abs ur22) (abs ui22)))
(cond
  ((< u22abs smini)
   (setf ur22 smini)
   (setf ui22 zero)
   (setf info 1)))
(cond
  ((f2cl-lib:fref rswap (icmax) ((1 4)))
   (setf br2
           (f2cl-lib:fref b-%data%
                          (1 1)
                          ((1 ldb$) (1 *))
                          b-%offset%))
   (setf br1
           (f2cl-lib:fref b-%data%
                          (2 1)
                          ((1 ldb$) (1 *))
                          b-%offset%))
   (setf bi2
           (f2cl-lib:fref b-%data%
                          (1 2)
                          ((1 ldb$) (1 *))
                          b-%offset%))
   (setf bi1
           (f2cl-lib:fref b-%data%
                          (2 2)
                          ((1 ldb$) (1 *))
                          b-%offset%)))
  (t
```

```
   (setf br1
           (f2cl-lib:fref b-%data%
                         (1 1)
                         ((1 ldb$) (1 *))
                         b-%offset%))
   (setf br2
           (f2cl-lib:fref b-%data%
                         (2 1)
                         ((1 ldb$) (1 *))
                         b-%offset%))
   (setf bi1
           (f2cl-lib:fref b-%data%
                         (1 2)
                         ((1 ldb$) (1 *))
                         b-%offset%))
   (setf bi2
           (f2cl-lib:fref b-%data%
                         (2 2)
                         ((1 ldb$) (1 *))
                         b-%offset%))))
(setf br2 (+ (- br2 (* lr21 br1)) (* li21 bi1)))
(setf bi2 (- bi2 (* li21 br1) (* lr21 bi1)))
(setf bbnd
        (max
         (* (+ (abs br1) (abs bi1))
            (* u22abs (+ (abs ur11r) (abs ui11r))))
         (+ (abs br2) (abs bi2))))
(cond
  ((and (> bbnd one) (< u22abs one))
   (cond
     ((>= bbnd (* bignum u22abs))
      (setf scale (/ one bbnd))
      (setf br1 (* scale br1))
      (setf bi1 (* scale bi1))
      (setf br2 (* scale br2))
      (setf bi2 (* scale bi2))))))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5)
    (dladiv br2 bi2 ur22 ui22 xr2 xi2)
  (declare (ignore var-0 var-1 var-2 var-3))
  (setf xr2 var-4)
  (setf xi2 var-5))
(setf xr1
        (+ (- (* ur11r br1) (* ui11r bi1) (* ur12s xr2))
           (* ui12s xi2)))
(setf xi1
        (- (+ (* ui11r br1) (* ur11r bi1))
           (* ui12s xr2)
           (* ur12s xi2)))
(cond
  ((f2cl-lib:fref zswap (icmax) ((1 4)))
```

```
    (setf (f2cl-lib:fref x-%data%
                         (1 1)
                         ((1 ldx) (1 *))
                         x-%offset%)
          xr2)
    (setf (f2cl-lib:fref x-%data%
                         (2 1)
                         ((1 ldx) (1 *))
                         x-%offset%)
          xr1)
    (setf (f2cl-lib:fref x-%data%
                         (1 2)
                         ((1 ldx) (1 *))
                         x-%offset%)
          xi2)
    (setf (f2cl-lib:fref x-%data%
                         (2 2)
                         ((1 ldx) (1 *))
                         x-%offset%)
          xi1))
   (t
    (setf (f2cl-lib:fref x-%data%
                         (1 1)
                         ((1 ldx) (1 *))
                         x-%offset%)
          xr1)
    (setf (f2cl-lib:fref x-%data%
                         (2 1)
                         ((1 ldx) (1 *))
                         x-%offset%)
          xr2)
    (setf (f2cl-lib:fref x-%data%
                         (1 2)
                         ((1 ldx) (1 *))
                         x-%offset%)
          xi1)
    (setf (f2cl-lib:fref x-%data%
                         (2 2)
                         ((1 ldx) (1 *))
                         x-%offset%)
          xi2)))
(setf xnorm
        (max (+ (abs xr1) (abs xi1)) (+ (abs xr2) (abs xi2))))
(cond
  ((and (> xnorm one) (> cmax one))
   (cond
     ((> xnorm (f2cl-lib:f2cl/ bignum cmax))
      (setf temp (/ cmax bignum))
      (setf (f2cl-lib:fref x-%data%
                           (1 1)
```

```
                                        ((1 ldx) (1 *))
                                        x-%offset%)
                                (* temp
                                   (f2cl-lib:fref x-%data%
                                                  (1 1)
                                                  ((1 ldx) (1 *))
                                                  x-%offset%)))
                            (setf (f2cl-lib:fref x-%data%
                                                 (2 1)
                                                 ((1 ldx) (1 *))
                                                 x-%offset%)
                                  (* temp
                                     (f2cl-lib:fref x-%data%
                                                    (2 1)
                                                    ((1 ldx) (1 *))
                                                    x-%offset%)))
                            (setf (f2cl-lib:fref x-%data%
                                                 (1 2)
                                                 ((1 ldx) (1 *))
                                                 x-%offset%)
                                  (* temp
                                     (f2cl-lib:fref x-%data%
                                                    (1 2)
                                                    ((1 ldx) (1 *))
                                                    x-%offset%)))
                            (setf (f2cl-lib:fref x-%data%
                                                 (2 2)
                                                 ((1 ldx) (1 *))
                                                 x-%offset%)
                                  (* temp
                                     (f2cl-lib:fref x-%data%
                                                    (2 2)
                                                    ((1 ldx) (1 *))
                                                    x-%offset%)))
                            (setf xnorm (* temp xnorm))
                            (setf scale (* temp scale)))))))))
 end_label
          (return
           (values nil
                   nil
                   nil
                   nil
                   nil
                   nil
                   nil
                   nil
                   nil
                   nil
                   nil
                   nil)
```

```
                nil
                nil
                nil
                scale
                xnorm
                info)))))))
```

———-

6.35 dlamch LAPACK

— **dlamch.input** —

```
)set break resume
)sys rm -f dlamch.output
)spool dlamch.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlamch.help** —

```
========================================================================
dlamch examples
========================================================================

========================================================================
Man Page Details
========================================================================

NAME
       DLAMCH - determine double precision machine parameters

SYNOPSIS
       DOUBLE PRECISION FUNCTION DLAMCH( CMACH )

           CHARACTER    CMACH

 Purpose
 =======
```

```
 DLAMCH determines double precision machine parameters.

Arguments
=========

 CMACH   (input) CHARACTER*1
         Specifies the value to be returned by DLAMCH:
         = 'E' or 'e',   DLAMCH := eps
         = 'S' or 's' ,  DLAMCH := sfmin
         = 'B' or 'b',   DLAMCH := base
         = 'P' or 'p',   DLAMCH := eps*base
         = 'N' or 'n',   DLAMCH := t
         = 'R' or 'r',   DLAMCH := rnd
         = 'M' or 'm',   DLAMCH := emin
         = 'U' or 'u',   DLAMCH := rmin
         = 'L' or 'l',   DLAMCH := emax
         = 'O' or 'o',   DLAMCH := rmax

         where

         eps   = relative machine precision
         sfmin = safe minimum, such that 1/sfmin does not overflow
         base  = base of the machine
         prec  = eps*base
         t     = number of (base) digits in the mantissa
         rnd   = 1.0 when rounding occurs in addition, 0.0 otherwise
         emin  = minimum exponent before (gradual) underflow
         rmin  = underflow threshold - base**(emin-1)
         emax  = largest exponent before overflow
         rmax  = overflow threshold  - (base**emax)*(1-eps)
```

———-

— **dlamch.f** —

```
      DOUBLE PRECISION FUNCTION DLAMCH( CMACH )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1992
*
*     .. Scalar Arguments ..
      CHARACTER          CMACH
*     ..
*
* =====================================================================
```

```
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE, ZERO
      PARAMETER          ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            FIRST, LRND
      INTEGER            BETA, IMAX, IMIN, IT
      DOUBLE PRECISION   BASE, EMAX, EMIN, EPS, PREC, RMACH, RMAX, RMIN,
     $                   RND, SFMIN, SMALL, T
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLAMC2
*     ..
*     .. Save statement ..
      SAVE               FIRST, EPS, SFMIN, BASE, T, RND, EMIN, RMIN,
     $                   EMAX, RMAX, PREC
*     ..
*     .. Data statements ..
      DATA               FIRST / .TRUE. /
*     ..
*     .. Executable Statements ..
*
      IF( FIRST ) THEN
         FIRST = .FALSE.
         CALL DLAMC2( BETA, IT, LRND, EPS, IMIN, RMIN, IMAX, RMAX )
         BASE = BETA
         T = IT
         IF( LRND ) THEN
            RND = ONE
            EPS = ( BASE**( 1-IT ) ) / 2
         ELSE
            RND = ZERO
            EPS = BASE**( 1-IT )
         END IF
         PREC = EPS*BASE
         EMIN = IMIN
         EMAX = IMAX
         SFMIN = RMIN
         SMALL = ONE / RMAX
         IF( SMALL.GE.SFMIN ) THEN
*
*           Use SMALL plus a bit, to avoid the possibility of rounding
*           causing overflow when computing  1/sfmin.
*
            SFMIN = SMALL*( ONE+EPS )
```

```
         END IF
      END IF
*
      IF( LSAME( CMACH, 'E' ) ) THEN
         RMACH = EPS
      ELSE IF( LSAME( CMACH, 'S' ) ) THEN
         RMACH = SFMIN
      ELSE IF( LSAME( CMACH, 'B' ) ) THEN
         RMACH = BASE
      ELSE IF( LSAME( CMACH, 'P' ) ) THEN
         RMACH = PREC
      ELSE IF( LSAME( CMACH, 'N' ) ) THEN
         RMACH = T
      ELSE IF( LSAME( CMACH, 'R' ) ) THEN
         RMACH = RND
      ELSE IF( LSAME( CMACH, 'M' ) ) THEN
         RMACH = EMIN
      ELSE IF( LSAME( CMACH, 'U' ) ) THEN
         RMACH = RMIN
      ELSE IF( LSAME( CMACH, 'L' ) ) THEN
         RMACH = EMAX
      ELSE IF( LSAME( CMACH, 'O' ) ) THEN
         RMACH = RMAX
      END IF
*
      DLAMCH = RMACH
      RETURN
*
*     End of DLAMCH
*
      END
```

———-

— LAPACK dlamch —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (let ((eps 0.0)
        (sfmin 0.0)
        (base 0.0)
        (t$ 0.0f0)
        (rnd 0.0)
        (emin 0.0)
        (rmin 0.0)
        (emax 0.0)
        (rmax 0.0)
```

```
      (prec 0.0)
      (first$ nil))
  (declare (type (member t nil) first$)
           (type (single-float) t$)
           (type (double-float) prec rmax emax rmin emin rnd base sfmin eps))
  (setq first$ t)
  (defun dlamch (cmach)
    (declare (type character cmach))
    (f2cl-lib:with-multi-array-data
        ((cmach character cmach-%data% cmach-%offset%))
      (prog ((rmach 0.0) (small 0.0) (t$ 0.0) (beta 0) (imax 0) (imin 0)
             (it 0) (lrnd nil) (dlamch 0.0))
        (declare (type fixnum beta imax imin it)
                 (type (member t nil) lrnd)
                 (type (double-float) rmach small t$ dlamch))
        (cond
          (first$
           (setf first$ nil)
           (multiple-value-bind
                 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
               (dlamc2 beta it lrnd eps imin rmin imax rmax)
             (declare (ignore))
             (setf beta var-0)
             (setf it var-1)
             (setf lrnd var-2)
             (setf eps var-3)
             (setf imin var-4)
             (setf rmin var-5)
             (setf imax var-6)
             (setf rmax var-7))
           (setf base (coerce (the fixnum beta) 'double-float))
           (setf t$ (coerce (the fixnum it) 'double-float))
           (cond
             (lrnd
              (setf rnd one)
              (setf eps (/ (expt base (f2cl-lib:int-sub 1 it)) 2)))
             (t
              (setf rnd zero)
              (setf eps (expt base (f2cl-lib:int-sub 1 it)))))
           (setf prec (* eps base))
           (setf emin (coerce (the fixnum imin) 'double-float))
           (setf emax (coerce (the fixnum imax) 'double-float))
           (setf sfmin rmin)
           (setf small (/ one rmax))
           (cond
             ((>= small sfmin)
              (setf sfmin (* small (+ one eps)))))))
        (cond
          ((char-equal cmach #\E)
           (setf rmach eps))
```

```
            ((char-equal cmach #\S)
             (setf rmach sfmin))
            ((char-equal cmach #\B)
             (setf rmach base))
            ((char-equal cmach #\P)
             (setf rmach prec))
            ((char-equal cmach #\N)
             (setf rmach t$))
            ((char-equal cmach #\R)
             (setf rmach rnd))
            ((char-equal cmach #\M)
             (setf rmach emin))
            ((char-equal cmach #\U)
             (setf rmach rmin))
            ((char-equal cmach #\L)
             (setf rmach emax))
            ((char-equal cmach #\O)
             (setf rmach rmax)))
          (setf dlamch rmach)
 end_label
          (return (values dlamch nil)))))))
```

———-

6.36 dlamc1 LAPACK

— **dlamc1.input** —

```
)set break resume
)sys rm -f dlamc1.output
)spool dlamc1.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlamc1.help** —

```
====================================================================
dlamc1 examples
====================================================================
```

```
=====================================================================
Man Page Details
=====================================================================

  -- LAPACK auxiliary routine (version 1.1) --
     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
     Courant Institute, Argonne National Lab, and Rice University
     October 31, 1992

     .. Scalar Arguments ..
<       LOGICAL            IEEE1, RND >
<       INTEGER            BETA, T >
     ..

  Purpose
  =======

  DLAMC1 determines the machine parameters given by BETA, T, RND, and
  IEEE1.

  Arguments
  =========

  BETA    (output) INTEGER
          The base of the machine.

  T       (output) INTEGER
          The number of ( BETA ) digits in the mantissa.

  RND     (output) LOGICAL
          Specifies whether proper rounding  ( RND = .TRUE. )  or
          chopping  ( RND = .FALSE. )  occurs in addition. This may not
          be a reliable guide to the way in which the machine performs
          its arithmetic.

  IEEE1   (output) LOGICAL
          Specifies whether rounding appears to be done in the IEEE
          'round to nearest' style.

  Further Details
  ===============

  See Malcolm M. A. (1972) Algorithms to reveal properties of
      floating-point arithmetic. Comms. of the ACM, 15, 949-951.

  See Gentleman W. M. and Marovich S. B. (1974) More on algorithms
      that reveal properties of floating point arithmetic units.
      Comms. of the ACM, 17, 276-277.
```

———-

— dlamc1.f —

```
*****************************************************************************
*
      SUBROUTINE DLAMC1( BETA, T, RND, IEEE1 )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1992
*
*     .. Scalar Arguments ..
      LOGICAL            IEEE1, RND
      INTEGER            BETA, T
*     ..
*
* =====================================================================
*
*     .. Local Scalars ..
      LOGICAL            FIRST, LIEEE1, LRND
      INTEGER            LBETA, LT
      DOUBLE PRECISION   A, B, C, F, ONE, QTR, SAVEC, T1, T2
*     ..
*     .. External Functions ..
      DOUBLE PRECISION   DLAMC3
      EXTERNAL           DLAMC3
*     ..
*     .. Save statement ..
      SAVE               FIRST, LIEEE1, LBETA, LRND, LT
*     ..
*     .. Data statements ..
      DATA               FIRST / .TRUE. /
*     ..
*     .. Executable Statements ..
*
      IF( FIRST ) THEN
         FIRST = .FALSE.
         ONE = 1
*
*        LBETA,  LIEEE1,  LT and  LRND  are the  local values  of  BETA,
*        IEEE1, T and RND.
*
*        Throughout this routine  we use the function  DLAMC3  to ensure
*        that relevant values are  stored and not held in registers,  or
*        are not affected by optimizers.
*
*        Compute  a = 2.0**m  with the  smallest positive integer m such
```

```
*        that
*
*           fl( a + 1.0 ) = a.
*
         A = 1
         C = 1
*
*+       WHILE( C.EQ.ONE )LOOP
   10    CONTINUE
         IF( C.EQ.ONE ) THEN
            A = 2*A
            C = DLAMC3( A, ONE )
            C = DLAMC3( C, -A )
            GO TO 10
         END IF
*+       END WHILE
*
*        Now compute  b = 2.0**m  with the smallest positive integer m
*        such that
*
*           fl( a + b ) .gt. a.
*
         B = 1
         C = DLAMC3( A, B )
*
*+       WHILE( C.EQ.A )LOOP
   20    CONTINUE
         IF( C.EQ.A ) THEN
            B = 2*B
            C = DLAMC3( A, B )
            GO TO 20
         END IF
*+       END WHILE
*
*        Now compute the base.  a and c  are neighbouring floating point
*        numbers  in the  interval  ( beta**t, beta**( t + 1 ) )  and so
*        their difference is beta. Adding 0.25 to c is to ensure that it
*        is truncated to beta and not ( beta - 1 ).
*
         QTR = ONE / 4
         SAVEC = C
         C = DLAMC3( C, -A )
         LBETA = C + QTR
*
*        Now determine whether rounding or chopping occurs,  by adding a
*        bit  less  than  beta/2  and a  bit  more  than  beta/2  to  a.
*
         B = LBETA
         F = DLAMC3( B / 2, -B / 100 )
         C = DLAMC3( F, A )
```

```
         IF( C.EQ.A ) THEN
            LRND = .TRUE.
         ELSE
            LRND = .FALSE.
         END IF
         F = DLAMC3( B / 2, B / 100 )
         C = DLAMC3( F, A )
         IF( ( LRND ) .AND. ( C.EQ.A ) )
     $      LRND = .FALSE.
*
*        Try and decide whether rounding is done in the  IEEE  'round to
*        nearest' style. B/2 is half a unit in the last place of the two
*        numbers A and SAVEC. Furthermore, A is even, i.e. has last  bit
*        zero, and SAVEC is odd. Thus adding B/2 to A should not  change
*        A, but adding B/2 to SAVEC should change SAVEC.
*
         T1 = DLAMC3( B / 2, A )
         T2 = DLAMC3( B / 2, SAVEC )
         LIEEE1 = ( T1.EQ.A ) .AND. ( T2.GT.SAVEC ) .AND. LRND
*
*        Now find  the  mantissa, t.  It should  be the  integer part of
*        log to the base beta of a,  however it is safer to determine  t
*        by powering.  So we find t as the smallest positive integer for
*        which
*
*           fl( beta**t + 1.0 ) = 1.0.
*
         LT = 0
         A = 1
         C = 1
*
*+       WHILE( C.EQ.ONE )LOOP
   30    CONTINUE
         IF( C.EQ.ONE ) THEN
            LT = LT + 1
            A = A*LBETA
            C = DLAMC3( A, ONE )
            C = DLAMC3( C, -A )
            GO TO 30
         END IF
*+       END WHILE
*
      END IF
*
      BETA = LBETA
      T = LT
      RND = LRND
      IEEE1 = LIEEE1
      RETURN
*
```

```
*     End of DLAMC1
*
      END
*
```

———-

— LAPACK dlamc1 —

```
(let ((lieee1 nil) (lbeta 0) (lrnd nil) (f2cl-lib:lt 0) (first$ nil))
  (declare (type fixnum f2cl-lib:lt lbeta)
           (type (member t nil) first$ lrnd lieee1))
  (setq first$ t)
  (defun dlamc1 (beta t$ rnd ieee1)
    (declare (type (member t nil) ieee1 rnd)
             (type fixnum t$ beta))
    (prog ((a 0.0) (b 0.0) (c 0.0) (f 0.0) (one 0.0) (qtr 0.0) (savec 0.0)
           (t1 0.0) (t2 0.0))
      (declare (type (double-float) t2 t1 savec qtr one f c b a))
      (cond
        (first$
         (tagbody
           (setf first$ nil)
           (setf one (coerce (the fixnum 1) 'double-float))
           (setf a (coerce (the fixnum 1) 'double-float))
           (setf c (coerce (the fixnum 1) 'double-float))
 label10
           (cond
             ((= c one)
              (setf a (* 2 a))
              (setf c
                      (multiple-value-bind (ret-val var-0 var-1)
                          (dlamc3 a one)
                        (declare (ignore))
                        (setf a var-0)
                        (setf one var-1)
                        ret-val))
              (setf c
                      (multiple-value-bind (ret-val var-0 var-1)
                          (dlamc3 c (- a))
                        (declare (ignore var-1))
                        (setf c var-0)
                        ret-val))
              (go label10)))
           (setf b (coerce (the fixnum 1) 'double-float))
           (setf c
                  (multiple-value-bind (ret-val var-0 var-1)
                      (dlamc3 a b)
```

```
                    (declare (ignore))
                    (setf a var-0)
                    (setf b var-1)
                    ret-val))
 label20
           (cond
             ((= c a)
              (setf b (* 2 b))
              (setf c
                      (multiple-value-bind (ret-val var-0 var-1)
                          (dlamc3 a b)
                        (declare (ignore))
                        (setf a var-0)
                        (setf b var-1)
                        ret-val))
              (go label20)))
           (setf qtr (/ one 4))
           (setf savec c)
           (setf c
                  (multiple-value-bind (ret-val var-0 var-1)
                      (dlamc3 c (- a))
                    (declare (ignore var-1))
                    (setf c var-0)
                    ret-val))
           (setf lbeta (f2cl-lib:int (+ c qtr)))
           (setf b (coerce (the fixnum lbeta) 'double-float))
           (setf f (dlamc3 (/ b 2) (/ (- b) 100)))
           (setf c
                  (multiple-value-bind (ret-val var-0 var-1)
                      (dlamc3 f a)
                    (declare (ignore))
                    (setf f var-0)
                    (setf a var-1)
                    ret-val))
           (cond
             ((= c a)
              (setf lrnd t))
             (t
              (setf lrnd nil)))
           (setf f (dlamc3 (/ b 2) (/ b 100)))
           (setf c
                  (multiple-value-bind (ret-val var-0 var-1)
                      (dlamc3 f a)
                    (declare (ignore))
                    (setf f var-0)
                    (setf a var-1)
                    ret-val))
           (if (and lrnd (= c a)) (setf lrnd nil))
           (setf t1
                  (multiple-value-bind (ret-val var-0 var-1)
```

```
                    (dlamc3 (/ b 2) a)
                  (declare (ignore var-0))
                  (setf a var-1)
                  ret-val))
          (setf t2
                 (multiple-value-bind (ret-val var-0 var-1)
                     (dlamc3 (/ b 2) savec)
                   (declare (ignore var-0))
                   (setf savec var-1)
                   ret-val))
          (setf lieee1 (and (= t1 a) (> t2 savec) lrnd))
          (setf f2cl-lib:lt 0)
          (setf a (coerce (the fixnum 1) 'double-float))
          (setf c (coerce (the fixnum 1) 'double-float))
label30
          (cond
            ((= c one)
             (setf f2cl-lib:lt (f2cl-lib:int-add f2cl-lib:lt 1))
             (setf a (* a lbeta))
             (setf c
                     (multiple-value-bind (ret-val var-0 var-1)
                         (dlamc3 a one)
                       (declare (ignore))
                       (setf a var-0)
                       (setf one var-1)
                       ret-val))
             (setf c
                     (multiple-value-bind (ret-val var-0 var-1)
                         (dlamc3 c (- a))
                       (declare (ignore var-1))
                       (setf c var-0)
                       ret-val))
             (go label30))))))
     (setf beta lbeta)
     (setf t$ f2cl-lib:lt)
     (setf rnd lrnd)
     (setf ieee1 lieee1)
end_label
     (return (values beta t$ rnd ieee1)))))
```

———-

6.37 dlamc2 LAPACK

— dlamc2.input —

```
)set break resume
)sys rm -f dlamc2.output
)spool dlamc2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dlamc2.help —

```
==========================================================================
dlamc2 examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

  -- LAPACK auxiliary routine (version 1.1) --
     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
     Courant Institute, Argonne National Lab, and Rice University
     October 31, 1992

     .. Scalar Arguments ..
<       LOGICAL            RND >
<       INTEGER            BETA, EMAX, EMIN, T >
<       DOUBLE PRECISION   EPS, RMAX, RMIN >
     ..

  Purpose
  =======

  DLAMC2 determines the machine parameters specified in its argument
  list.

  Arguments
  =========

  BETA    (output) INTEGER
          The base of the machine.

  T       (output) INTEGER
          The number of ( BETA ) digits in the mantissa.

  RND     (output) LOGICAL
```

```
          Specifies whether proper rounding  ( RND = .TRUE. )  or
          chopping  ( RND = .FALSE. )  occurs in addition. This may not
          be a reliable guide to the way in which the machine performs
          its arithmetic.

  EPS     (output) DOUBLE PRECISION
          The smallest positive number such that

             fl( 1.0 - EPS ) .LT. 1.0,

          where fl denotes the computed value.

  EMIN    (output) INTEGER
          The minimum exponent before (gradual) underflow occurs.

  RMIN    (output) DOUBLE PRECISION
          The smallest normalized number for the machine, given by
          BASE**( EMIN - 1 ), where  BASE  is the floating point value
          of BETA.

  EMAX    (output) INTEGER
          The maximum exponent before overflow occurs.

  RMAX    (output) DOUBLE PRECISION
          The largest positive number for the machine, given by
          BASE**EMAX * ( 1 - EPS ), where  BASE  is the floating point
          value of BETA.

  Further Details
  ===============

  The computation of  EPS  is based on a routine PARANOIA by
  W. Kahan of the University of California at Berkeley.
```

———-

— dlamc2.f —

```
*****************************************************************
*
      SUBROUTINE DLAMC2( BETA, T, RND, EPS, EMIN, RMIN, EMAX, RMAX )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1992
*
*     .. Scalar Arguments ..
```

```
      LOGICAL            RND
      INTEGER            BETA, EMAX, EMIN, T
      DOUBLE PRECISION   EPS, RMAX, RMIN
*     ..
*
* =====================================================================
*
*     .. Local Scalars ..
      LOGICAL            FIRST, IEEE, IWARN, LIEEE1, LRND
      INTEGER            GNMIN, GPMIN, I, LBETA, LEMAX, LEMIN, LT,
     $                   NGNMIN, NGPMIN
      DOUBLE PRECISION   A, B, C, HALF, LEPS, LRMAX, LRMIN, ONE, RBASE,
     $                   SIXTH, SMALL, THIRD, TWO, ZERO
*     ..
*     .. External Functions ..
      DOUBLE PRECISION   DLAMC3
      EXTERNAL           DLAMC3
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLAMC1, DLAMC4, DLAMC5
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX, MIN
*     ..
*     .. Save statement ..
      SAVE               FIRST, IWARN, LBETA, LEMAX, LEMIN, LEPS, LRMAX,
     $                   LRMIN, LT
*     ..
*     .. Data statements ..
      DATA               FIRST / .TRUE. / , IWARN / .FALSE. /
*     ..
*     .. Executable Statements ..
*
      IF( FIRST ) THEN
         FIRST = .FALSE.
         ZERO = 0
         ONE = 1
         TWO = 2
*
*        LBETA, LT, LRND, LEPS, LEMIN and LRMIN  are the local values of
*        BETA, T, RND, EPS, EMIN and RMIN.
*
*        Throughout this routine  we use the function  DLAMC3  to ensure
*        that relevant values are stored  and not held in registers,  or
*        are not affected by optimizers.
*
*        DLAMC1 returns the parameters  LBETA, LT, LRND and LIEEE1.
*
         CALL DLAMC1( LBETA, LT, LRND, LIEEE1 )
*
```

```
*        Start to find EPS.
*
         B = LBETA
         A = B**( -LT )
         LEPS = A
*
*        Try some tricks to see whether or not this is the correct  EPS.
*
         B = TWO / 3
         HALF = ONE / 2
         SIXTH = DLAMC3( B, -HALF )
         THIRD = DLAMC3( SIXTH, SIXTH )
         B = DLAMC3( THIRD, -HALF )
         B = DLAMC3( B, SIXTH )
         B = ABS( B )
         IF( B.LT.LEPS )
     $      B = LEPS
*
         LEPS = 1
*
*+       WHILE( ( LEPS.GT.B ).AND.( B.GT.ZERO ) )LOOP
   10    CONTINUE
         IF( ( LEPS.GT.B ) .AND. ( B.GT.ZERO ) ) THEN
            LEPS = B
            C = DLAMC3( HALF*LEPS, ( TWO**5 )*( LEPS**2 ) )
            C = DLAMC3( HALF, -C )
            B = DLAMC3( HALF, C )
            C = DLAMC3( HALF, -B )
            B = DLAMC3( HALF, C )
            GO TO 10
         END IF
*+       END WHILE
*
         IF( A.LT.LEPS )
     $      LEPS = A
*
*        Computation of EPS complete.
*
*        Now find  EMIN.  Let A = + or - 1, and + or - (1 + BASE**(-3)).
*        Keep dividing  A by BETA until (gradual) underflow occurs. This
*        is detected when we cannot recover the previous A.
*
         RBASE = ONE / LBETA
         SMALL = ONE
         DO 20 I = 1, 3
            SMALL = DLAMC3( SMALL*RBASE, ZERO )
   20    CONTINUE
         A = DLAMC3( ONE, SMALL )
         CALL DLAMC4( NGPMIN, ONE, LBETA )
         CALL DLAMC4( NGNMIN, -ONE, LBETA )
```

```
         CALL DLAMC4( GPMIN, A, LBETA )
         CALL DLAMC4( GNMIN, -A, LBETA )
         IEEE = .FALSE.
*
         IF( ( NGPMIN.EQ.NGNMIN ) .AND. ( GPMIN.EQ.GNMIN ) ) THEN
            IF( NGPMIN.EQ.GPMIN ) THEN
               LEMIN = NGPMIN
*            ( Non twos-complement machines, no gradual underflow;
*              e.g.,  VAX )
            ELSE IF( ( GPMIN-NGPMIN ).EQ.3 ) THEN
               LEMIN = NGPMIN - 1 + LT
               IEEE = .TRUE.
*            ( Non twos-complement machines, with gradual underflow;
*              e.g., IEEE standard followers )
            ELSE
               LEMIN = MIN( NGPMIN, GPMIN )
*            ( A guess; no known machine )
               IWARN = .TRUE.
            END IF
*
         ELSE IF( ( NGPMIN.EQ.GPMIN ) .AND. ( NGNMIN.EQ.GNMIN ) ) THEN
            IF( ABS( NGPMIN-NGNMIN ).EQ.1 ) THEN
               LEMIN = MAX( NGPMIN, NGNMIN )
*            ( Twos-complement machines, no gradual underflow;
*              e.g., CYBER 205 )
            ELSE
               LEMIN = MIN( NGPMIN, NGNMIN )
*            ( A guess; no known machine )
               IWARN = .TRUE.
            END IF
*
         ELSE IF( ( ABS( NGPMIN-NGNMIN ).EQ.1 ) .AND.
     $            ( GPMIN.EQ.GNMIN ) ) THEN
            IF( ( GPMIN-MIN( NGPMIN, NGNMIN ) ).EQ.3 ) THEN
               LEMIN = MAX( NGPMIN, NGNMIN ) - 1 + LT
*            ( Twos-complement machines with gradual underflow;
*              no known machine )
            ELSE
               LEMIN = MIN( NGPMIN, NGNMIN )
*            ( A guess; no known machine )
               IWARN = .TRUE.
            END IF
*
         ELSE
            LEMIN = MIN( NGPMIN, NGNMIN, GPMIN, GNMIN )
*         ( A guess; no known machine )
            IWARN = .TRUE.
         END IF
***
* Comment out this if block if EMIN is ok
```

```
         IF( IWARN ) THEN
            FIRST = .TRUE.
            WRITE( 6, FMT = 9999 )LEMIN
         END IF
***
*
*        Assume IEEE arithmetic if we found denormalised  numbers above,
*        or if arithmetic seems to round in the  IEEE style,  determined
*        in routine DLAMC1. A true IEEE machine should have both  things
*        true; however, faulty machines may have one or the other.
*
         IEEE = IEEE .OR. LIEEE1
*
*        Compute  RMIN by successive division by  BETA. We could compute
*        RMIN as BASE**( EMIN - 1 ),  but some machines underflow during
*        this computation.
*
         LRMIN = 1
         DO 30 I = 1, 1 - LEMIN
            LRMIN = DLAMC3( LRMIN*RBASE, ZERO )
   30    CONTINUE
*
*        Finally, call DLAMC5 to compute EMAX and RMAX.
*
         CALL DLAMC5( LBETA, LT, LEMIN, IEEE, LEMAX, LRMAX )
      END IF
*
      BETA = LBETA
      T = LT
      RND = LRND
      EPS = LEPS
      EMIN = LEMIN
      RMIN = LRMIN
      EMAX = LEMAX
      RMAX = LRMAX
*
      RETURN
*
 9999 FORMAT( / / ' WARNING. The value EMIN may be incorrect:-',
     $      '  EMIN = ', I8, /
     $      ' If, after inspection, the value EMIN looks',
     $      ' acceptable please comment out ',
     $      / ' the IF block as marked within the code of routine',
     $      ' DLAMC2,', / ' otherwise supply EMIN explicitly.', / )
*
*     End of DLAMC2
*
      END
```

———-

— LAPACK dlamc2 —

```
(let ((lbeta 0)
      (lemax 0)
      (lemin 0)
      (leps 0.0)
      (lrmax 0.0)
      (lrmin 0.0)
      (f2cl-lib:lt 0)
      (first$ nil)
      (iwarn nil))
  (declare (type (member t nil) iwarn first$)
           (type (double-float) lrmin lrmax leps)
           (type fixnum f2cl-lib:lt lemin lemax lbeta))
  (setq first$ t)
  (setq iwarn nil)
  (defun dlamc2 (beta t$ rnd eps emin rmin emax rmax)
    (declare (type (double-float) rmax rmin eps)
             (type (member t nil) rnd)
             (type fixnum emax emin t$ beta))
    (prog ((a 0.0) (b 0.0) (c 0.0) (half 0.0) (one 0.0) (rbase 0.0)
           (sixth$ 0.0) (small 0.0) (third$ 0.0) (two 0.0) (zero 0.0) (gnmin 0)
           (gpmin 0) (i 0) (ngnmin 0) (ngpmin 0) (ieee nil) (lieee1 nil)
           (lrnd nil))
      (declare (type (member t nil) lrnd lieee1 ieee)
               (type fixnum ngpmin ngnmin i gpmin gnmin)
               (type (double-float) zero two third$ small sixth$ rbase one half
                                    c b a))
      (cond
        (first$
         (tagbody
           (setf first$ nil)
           (setf zero (coerce (the fixnum 0) 'double-float))
           (setf one (coerce (the fixnum 1) 'double-float))
           (setf two (coerce (the fixnum 2) 'double-float))
           (multiple-value-bind (var-0 var-1 var-2 var-3)
               (dlamc1 lbeta f2cl-lib:lt lrnd lieee1)
             (declare (ignore))
             (setf lbeta var-0)
             (setf f2cl-lib:lt var-1)
             (setf lrnd var-2)
             (setf lieee1 var-3))
           (setf b (coerce (the fixnum lbeta) 'double-float))
           (setf a (expt b (f2cl-lib:int-sub f2cl-lib:lt)))
           (setf leps a)
           (setf b (/ two 3))
           (setf half (/ one 2))
           (setf sixth$
                   (multiple-value-bind (ret-val var-0 var-1)
```

```
                    (dlamc3 b (- half))
                  (declare (ignore var-1))
                  (setf b var-0)
                  ret-val))
          (setf third$
                 (multiple-value-bind (ret-val var-0 var-1)
                     (dlamc3 sixth$ sixth$)
                   (declare (ignore))
                   (setf sixth$ var-0)
                   (setf sixth$ var-1)
                   ret-val))
          (setf b
                 (multiple-value-bind (ret-val var-0 var-1)
                     (dlamc3 third$ (- half))
                   (declare (ignore var-1))
                   (setf third$ var-0)
                   ret-val))
          (setf b
                 (multiple-value-bind (ret-val var-0 var-1)
                     (dlamc3 b sixth$)
                   (declare (ignore))
                   (setf b var-0)
                   (setf sixth$ var-1)
                   ret-val))
          (setf b (abs b))
          (if (< b leps) (setf b leps))
          (setf leps (coerce (the fixnum 1) 'double-float))
label10
          (cond
            ((and (> leps b) (> b zero))
             (setf leps b)
             (setf c (dlamc3 (* half leps) (* (expt two 5) (expt leps 2))))
             (setf c
                     (multiple-value-bind (ret-val var-0 var-1)
                         (dlamc3 half (- c))
                       (declare (ignore var-1))
                       (setf half var-0)
                       ret-val))
             (setf b
                     (multiple-value-bind (ret-val var-0 var-1)
                         (dlamc3 half c)
                       (declare (ignore))
                       (setf half var-0)
                       (setf c var-1)
                       ret-val))
             (setf c
                     (multiple-value-bind (ret-val var-0 var-1)
                         (dlamc3 half (- b))
                       (declare (ignore var-1))
                       (setf half var-0)
```

```
            ret-val))
   (setf b
          (multiple-value-bind (ret-val var-0 var-1)
              (dlamc3 half c)
            (declare (ignore))
            (setf half var-0)
            (setf c var-1)
            ret-val))
   (go label10)))
(if (< a leps) (setf leps a))
(setf rbase (/ one lbeta))
(setf small one)
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i 3) nil)
  (tagbody
    (setf small
           (multiple-value-bind (ret-val var-0 var-1)
               (dlamc3 (* small rbase) zero)
             (declare (ignore var-0))
             (setf zero var-1)
             ret-val))))
(setf a
        (multiple-value-bind (ret-val var-0 var-1)
            (dlamc3 one small)
          (declare (ignore))
          (setf one var-0)
          (setf small var-1)
          ret-val))
(multiple-value-bind (var-0 var-1 var-2)
    (dlamc4 ngpmin one lbeta)
  (declare (ignore var-1 var-2))
  (setf ngpmin var-0))
(multiple-value-bind (var-0 var-1 var-2)
    (dlamc4 ngnmin (- one) lbeta)
  (declare (ignore var-1 var-2))
  (setf ngnmin var-0))
(multiple-value-bind (var-0 var-1 var-2)
    (dlamc4 gpmin a lbeta)
  (declare (ignore var-1 var-2))
  (setf gpmin var-0))
(multiple-value-bind (var-0 var-1 var-2)
    (dlamc4 gnmin (- a) lbeta)
  (declare (ignore var-1 var-2))
  (setf gnmin var-0))
(setf ieee nil)
(cond
  ((and (= ngpmin ngnmin) (= gpmin gnmin))
   (cond
     ((= ngpmin gpmin)
      (setf lemin ngpmin))
```

```
   ((= (f2cl-lib:int-add gpmin (f2cl-lib:int-sub ngpmin)) 3)
    (setf lemin
            (f2cl-lib:int-add (f2cl-lib:int-sub ngpmin 1)
                              f2cl-lib:lt))
    (setf ieee t))
   (t
    (setf lemin
            (min (the fixnum ngpmin)
                 (the fixnum gpmin)))
    (setf iwarn t))))
((and (= ngpmin gpmin) (= ngnmin gnmin))
 (cond
   ((= (abs (f2cl-lib:int-add ngpmin (f2cl-lib:int-sub ngnmin))) 1)
    (setf lemin
            (max (the fixnum ngpmin)
                 (the fixnum ngnmin))))
   (t
    (setf lemin
            (min (the fixnum ngpmin)
                 (the fixnum ngnmin)))
    (setf iwarn t))))
((and
  (= (abs (f2cl-lib:int-add ngpmin (f2cl-lib:int-sub ngnmin))) 1)
  (= gpmin gnmin))
 (cond
   ((=
     (f2cl-lib:int-add gpmin
                       (f2cl-lib:int-sub
                        (min (the fixnum ngpmin)
                             (the fixnum ngnmin))))
     3)
    (setf lemin
            (f2cl-lib:int-add
             (f2cl-lib:int-sub
              (max (the fixnum ngpmin)
                   (the fixnum ngnmin))
              1)
             f2cl-lib:lt)))
   (t
    (setf lemin
            (min (the fixnum ngpmin)
                 (the fixnum ngnmin)))
    (setf iwarn t))))
(t
 (setf lemin
         (min (the fixnum ngpmin)
              (the fixnum ngnmin)
              (the fixnum gpmin)
              (the fixnum gnmin)))
 (setf iwarn t)))
```

```
          (cond
            (iwarn
             (setf first$ t)
             (format t "~&~s~a~s~%~s~%~s~s~%"
               "WARNING. The value EMIN may be incorrect:- EMIN = "
               lemin
               " If, after inspection, the value EMIN looks acceptable "
               "please comment out "
               " the IF block as marked within the code of routine DLAMC2,"
               " otherwise supply EMIN explicitly.")))
          (setf ieee (or ieee lieee1))
          (setf lrmin (coerce (the fixnum 1) 'double-float))
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i (f2cl-lib:int-add 1 (f2cl-lib:int-sub lemin)))
                         nil)
            (tagbody
              (setf lrmin
                      (multiple-value-bind (ret-val var-0 var-1)
                          (dlamc3 (* lrmin rbase) zero)
                        (declare (ignore var-0))
                        (setf zero var-1)
                        ret-val))))
          (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5)
              (dlamc5 lbeta f2cl-lib:lt lemin ieee lemax lrmax)
            (declare (ignore var-1))
            (setf lbeta var-0)
            (setf lemin var-2)
            (setf ieee var-3)
            (setf lemax var-4)
            (setf lrmax var-5)))))
     (setf beta lbeta)
     (setf t$ f2cl-lib:lt)
     (setf rnd lrnd)
     (setf eps leps)
     (setf emin lemin)
     (setf rmin lrmin)
     (setf emax lemax)
     (setf rmax lrmax)
 end_label
     (return (values beta t$ rnd eps emin rmin emax rmax)))))
```

———-

6.38 dlamc3 LAPACK

— dlamc3.input —

```
)set break resume
)sys rm -f dlamc3.output
)spool dlamc3.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlamc3.help** —

```
=====================================================================
dlamc3 examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

  -- LAPACK auxiliary routine (version 1.1) --
     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
     Courant Institute, Argonne National Lab, and Rice University
     October 31, 1992

     .. Scalar Arguments ..
<       DOUBLE PRECISION   A, B >
     ..

  Purpose
  =======

  DLAMC3  is intended to force  A  and  B  to be stored prior to doing
  the addition of  A  and  B ,  for use in situations where optimizers
  might hold one of these in a register.

  Arguments
  =========

  A, B    (input) DOUBLE PRECISION
          The values A and B.
```

———-

— **dlamc3.f** —

```
*****************************************************************************
*
      DOUBLE PRECISION FUNCTION DLAMC3( A, B )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1992
*
*     .. Scalar Arguments ..
      DOUBLE PRECISION   A, B
*     ..
*

* =====================================================================
*
*     .. Executable Statements ..
*
      DLAMC3 = A + B
*
      RETURN
*
*     End of DLAMC3
*
      END
*
```

— LAPACK dlamc3 —

```
(defun dlamc3 (a b)
  (declare (type (double-float) b a))
  (prog ((dlamc3 0.0))
    (declare (type (double-float) dlamc3))
    (setf dlamc3 (+ a b))
    (return (values dlamc3 a b))))
```

6.39 dlamc4 LAPACK

— dlamc4.input —

```
)set break resume
)sys rm -f dlamc4.output
)spool dlamc4.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dlamc4.help —

```
=====================================================================
dlamc4 examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

  -- LAPACK auxiliary routine (version 1.1) --
     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
     Courant Institute, Argonne National Lab, and Rice University
     October 31, 1992

     .. Scalar Arguments ..
<       INTEGER            BASE, EMIN >
<       DOUBLE PRECISION   START >
     ..

  Purpose
  =======

  DLAMC4 is a service routine for DLAMC2.

  Arguments
  =========

  EMIN    (output) EMIN
          The minimum exponent before (gradual) underflow, computed by
          setting A = START and dividing by BASE until the previous A
          can not be recovered.

  START   (input) DOUBLE PRECISION
          The starting point for determining EMIN.

  BASE    (input) INTEGER
```

The base of the machine.

———-

— dlamc4.f —

```
*****************************************************************************
*
      SUBROUTINE DLAMC4( EMIN, START, BASE )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1992
*
*     .. Scalar Arguments ..
      INTEGER            BASE, EMIN
      DOUBLE PRECISION   START
*     ..
*
* =====================================================================
*
*     .. Local Scalars ..
      INTEGER            I
      DOUBLE PRECISION   A, B1, B2, C1, C2, D1, D2, ONE, RBASE, ZERO
*     ..
*     .. External Functions ..
      DOUBLE PRECISION   DLAMC3
      EXTERNAL           DLAMC3
*     ..
*     .. Executable Statements ..
*
      A = START
      ONE = 1
      RBASE = ONE / BASE
      ZERO = 0
      EMIN = 1
      B1 = DLAMC3( A*RBASE, ZERO )
      C1 = A
      C2 = A
      D1 = A
      D2 = A
*+    WHILE( ( C1.EQ.A ).AND.( C2.EQ.A ).AND.
*    $       ( D1.EQ.A ).AND.( D2.EQ.A )      )LOOP
   10 CONTINUE
      IF( ( C1.EQ.A ) .AND. ( C2.EQ.A ) .AND. ( D1.EQ.A ) .AND.
     $    ( D2.EQ.A ) ) THEN
         EMIN = EMIN - 1
```

```
         A = B1
         B1 = DLAMC3( A / BASE, ZERO )
         C1 = DLAMC3( B1*BASE, ZERO )
         D1 = ZERO
         DO 20 I = 1, BASE
            D1 = D1 + B1
   20    CONTINUE
         B2 = DLAMC3( A*RBASE, ZERO )
         C2 = DLAMC3( B2 / RBASE, ZERO )
         D2 = ZERO
         DO 30 I = 1, BASE
            D2 = D2 + B2
   30    CONTINUE
         GO TO 10
      END IF
*+    END WHILE
*
      RETURN
*
*     End of DLAMC4
*
      END
*
```

———-

— LAPACK dlamc4 —

```
(defun dlamc4 (emin start base)
  (declare (type (double-float) start) (type fixnum base emin))
  (prog ((a 0.0) (b1 0.0) (b2 0.0) (c1 0.0) (c2 0.0) (d1 0.0) (d2 0.0)
         (one 0.0) (rbase 0.0) (zero 0.0) (i 0))
    (declare (type fixnum i)
             (type (double-float) zero rbase one d2 d1 c2 c1 b2 b1 a))
    (setf a start)
    (setf one (coerce (the fixnum 1) 'double-float))
    (setf rbase (/ one base))
    (setf zero (coerce (the fixnum 0) 'double-float))
    (setf emin 1)
    (setf b1
           (multiple-value-bind (ret-val var-0 var-1)
               (dlamc3 (* a rbase) zero)
             (declare (ignore var-0))
             (setf zero var-1)
             ret-val))
    (setf c1 a)
    (setf c2 a)
    (setf d1 a)
```

```
   (setf d2 a)
 label10
   (cond
     ((and (= c1 a) (= c2 a) (= d1 a) (= d2 a))
      (setf emin (f2cl-lib:int-sub emin 1))
      (setf a b1)
      (setf b1
              (multiple-value-bind (ret-val var-0 var-1)
                  (dlamc3 (/ a base) zero)
                (declare (ignore var-0))
                (setf zero var-1)
                ret-val))
      (setf c1
              (multiple-value-bind (ret-val var-0 var-1)
                  (dlamc3 (* b1 base) zero)
                (declare (ignore var-0))
                (setf zero var-1)
                ret-val))
      (setf d1 zero)
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i base) nil)
        (tagbody (setf d1 (+ d1 b1)) label20))
      (setf b2
              (multiple-value-bind (ret-val var-0 var-1)
                  (dlamc3 (* a rbase) zero)
                (declare (ignore var-0))
                (setf zero var-1)
                ret-val))
      (setf c2
              (multiple-value-bind (ret-val var-0 var-1)
                  (dlamc3 (/ b2 rbase) zero)
                (declare (ignore var-0))
                (setf zero var-1)
                ret-val))
      (setf d2 zero)
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i base) nil)
        (tagbody (setf d2 (+ d2 b2)) label30))
      (go label10)))
 end_label
   (return (values emin nil nil))))
```

6.40 dlamc5 LAPACK

— dlamc5.input —

```
)set break resume
)sys rm -f dlamc5.output
)spool dlamc5.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

————-

— dlamc5.help —

```
========================================================================
dlamc5 examples
========================================================================

========================================================================
Man Page Details
========================================================================

  -- LAPACK auxiliary routine (version 1.1) --
     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
     Courant Institute, Argonne National Lab, and Rice University
     October 31, 1992

     .. Scalar Arguments ..
<       LOGICAL            IEEE >
<       INTEGER            BETA, EMAX, EMIN, P >
<       DOUBLE PRECISION   RMAX >
     ..

  Purpose
  =======

  DLAMC5 attempts to compute RMAX, the largest machine floating-point
  number, without overflow.  It assumes that EMAX + abs(EMIN) sum
  approximately to a power of 2.  It will fail on machines where this
  assumption does not hold, for example, the Cyber 205 (EMIN = -28625,
  EMAX = 28718).  It will also fail if the value supplied for EMIN is
  too large (i.e. too close to zero), probably with overflow.

  Arguments
  =========

  BETA    (input) INTEGER
```

```
          The base of floating-point arithmetic.

  P       (input) INTEGER
          The number of base BETA digits in the mantissa of a
          floating-point value.

  EMIN    (input) INTEGER
          The minimum exponent before (gradual) underflow.

  IEEE    (input) LOGICAL
          A logical flag specifying whether or not the arithmetic
          system is thought to comply with the IEEE standard.

  EMAX    (output) INTEGER
          The largest exponent before overflow

  RMAX    (output) DOUBLE PRECISION
          The largest machine floating-point number.
```

———-

— dlamc5.f —

```
*****************************************************************************
*
      SUBROUTINE DLAMC5( BETA, P, EMIN, IEEE, EMAX, RMAX )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1992
*
*     .. Scalar Arguments ..
      LOGICAL            IEEE
      INTEGER            BETA, EMAX, EMIN, P
      DOUBLE PRECISION   RMAX
*     ..
*
* =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D0, ONE = 1.0D0 )
*     ..
*     .. Local Scalars ..
      INTEGER            EXBITS, EXPSUM, I, LEXP, NBITS, TRY, UEXP
      DOUBLE PRECISION   OLDY, RECBAS, Y, Z
*     ..
```

```
*     .. External Functions ..
      DOUBLE PRECISION   DLAMC3
      EXTERNAL           DLAMC3
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MOD
*     ..
*     .. Executable Statements ..
*
*     First compute LEXP and UEXP, two powers of 2 that bound
*     abs(EMIN). We then assume that EMAX + abs(EMIN) will sum
*     approximately to the bound that is closest to abs(EMIN).
*     (EMAX is the exponent of the required number RMAX).
*
      LEXP = 1
      EXBITS = 1
   10 CONTINUE
      TRY = LEXP*2
      IF( TRY.LE.( -EMIN ) ) THEN
         LEXP = TRY
         EXBITS = EXBITS + 1
         GO TO 10
      END IF
      IF( LEXP.EQ.-EMIN ) THEN
         UEXP = LEXP
      ELSE
         UEXP = TRY
         EXBITS = EXBITS + 1
      END IF
*
*     Now -LEXP is less than or equal to EMIN, and -UEXP is greater
*     than or equal to EMIN. EXBITS is the number of bits needed to
*     store the exponent.
*
      IF( ( UEXP+EMIN ).GT.( -LEXP-EMIN ) ) THEN
         EXPSUM = 2*LEXP
      ELSE
         EXPSUM = 2*UEXP
      END IF
*
*     EXPSUM is the exponent range, approximately equal to
*     EMAX - EMIN + 1 .
*
      EMAX = EXPSUM + EMIN - 1
      NBITS = 1 + EXBITS + P
*
*     NBITS is the total number of bits needed to store a
*     floating-point number.
*
      IF( ( MOD( NBITS, 2 ).EQ.1 ) .AND. ( BETA.EQ.2 ) ) THEN
```

```
*
*        Either there are an odd number of bits used to store a
*        floating-point number, which is unlikely, or some bits are
*        not used in the representation of numbers, which is possible,
*        (e.g. Cray machines) or the mantissa has an implicit bit,
*        (e.g. IEEE machines, Dec Vax machines), which is perhaps the
*        most likely. We have to assume the last alternative.
*        If this is true, then we need to reduce EMAX by one because
*        there must be some way of representing zero in an implicit-bit
*        system. On machines like Cray, we are reducing EMAX by one
*        unnecessarily.
*
         EMAX = EMAX - 1
      END IF
*
      IF( IEEE ) THEN
*
*        Assume we are on an IEEE machine which reserves one exponent
*        for infinity and NaN.
*
         EMAX = EMAX - 1
      END IF
*
*     Now create RMAX, the largest machine number, which should
*     be equal to (1.0 - BETA**(-P)) * BETA**EMAX .
*
*     First compute 1.0 - BETA**(-P), being careful that the
*     result is less than 1.0 .
*
      RECBAS = ONE / BETA
      Z = BETA - ONE
      Y = ZERO
      DO 20 I = 1, P
         Z = Z*RECBAS
         IF( Y.LT.ONE )
     $      OLDY = Y
         Y = DLAMC3( Y, Z )
   20 CONTINUE
      IF( Y.GE.ONE )
     $   Y = OLDY
*
*     Now multiply by BETA**EMAX to get RMAX.
*
      DO 30 I = 1, EMAX
         Y = DLAMC3( Y*BETA, ZERO )
   30 CONTINUE
*
      RMAX = Y
      RETURN
*
```

```
*     End of DLAMC5
*
      END
*
*
```

———-

— LAPACK dlamc5 —

```
(let* ((zero 0.0) (one 1.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one))
  (defun dlamc5 (beta p emin ieee emax rmax)
    (declare (type (double-float) rmax)
             (type (member t nil) ieee)
             (type fixnum emax emin p beta))
    (prog ((oldy 0.0) (recbas 0.0) (y 0.0) (z 0.0) (exbits 0) (expsum 0) (i 0)
           (lexp 0) (nbits 0) (try 0) (uexp 0))
      (declare (type (double-float) oldy recbas y z)
               (type fixnum exbits expsum i lexp nbits try uexp))
      (setf lexp 1)
      (setf exbits 1)
 label10
      (setf try (f2cl-lib:int-mul lexp 2))
      (cond
        ((<= try (f2cl-lib:int-sub emin))
         (setf lexp try)
         (setf exbits (f2cl-lib:int-add exbits 1))
         (go label10)))
      (cond
        ((= lexp (f2cl-lib:int-sub emin))
         (setf uexp lexp))
        (t
         (setf uexp try)
         (setf exbits (f2cl-lib:int-add exbits 1))))
      (cond
        ((> (f2cl-lib:int-add uexp emin)
            (f2cl-lib:int-add (f2cl-lib:int-sub lexp) (f2cl-lib:int-sub emin)))
         (setf expsum (f2cl-lib:int-mul 2 lexp)))
        (t
         (setf expsum (f2cl-lib:int-mul 2 uexp))))
      (setf emax (f2cl-lib:int-sub (f2cl-lib:int-add expsum emin) 1))
      (setf nbits (f2cl-lib:int-add 1 exbits p))
      (cond
        ((and (= (mod nbits 2) 1) (= beta 2))
         (setf emax (f2cl-lib:int-sub emax 1))))
      (cond
```

```
        (ieee
         (setf emax (f2cl-lib:int-sub emax 1))))
      (setf recbas (/ one beta))
      (setf z (- beta one))
      (setf y zero)
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i p) nil)
        (tagbody
          (setf z (* z recbas))
          (if (< y one) (setf oldy y))
          (setf y
                  (multiple-value-bind (ret-val var-0 var-1)
                      (dlamc3 y z)
                    (declare (ignore))
                    (setf y var-0)
                    (setf z var-1)
                    ret-val))))
      (if (>= y one) (setf y oldy))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i emax) nil)
        (tagbody
          (setf y
                  (multiple-value-bind (ret-val var-0 var-1)
                      (dlamc3 (* y beta) zero)
                    (declare (ignore var-0))
                    (setf zero var-1)
                    ret-val))))
      (setf rmax y)
 end_label
      (return (values beta nil emin ieee emax rmax)))))
```

———-

6.41 dlamrg LAPACK

— dlamrg.input —

```
)set break resume
)sys rm -f dlamrg.output
)spool dlamrg.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dlamrg.help —

```
=====================================================================
dlamrg examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DLAMRG  -  create a permutation list which will merge the elements of A
       (which is composed of two independently sorted sets) into a single  set
       which is sorted in ascending order

SYNOPSIS
       SUBROUTINE DLAMRG( N1, N2, A, DTRD1, DTRD2, INDEX )

           INTEGER        DTRD1, DTRD2, N1, N2

           INTEGER        INDEX( * )

           DOUBLE         PRECISION A( * )

 Purpose
 =======

  DLAMRG will create a permutation list which will merge the elements
  of A (which is composed of two independently sorted sets) into a
  single set which is sorted in ascending order.

 Arguments
 =========

  N1     (input) INTEGER
  N2     (input) INTEGER
         These arguements contain the respective lengths of the two
         sorted lists to be merged.

  A      (input) DOUBLE PRECISION array, dimension (N1+N2)
         The first N1 elements of A contain a list of numbers which
         are sorted in either ascending or descending order.  Likewise
         for the final N2 elements.

  DTRD1  (input) INTEGER
  DTRD2  (input) INTEGER
         These are the strides to be taken through the array A.
```

```
        Allowable strides are 1 and -1.  They indicate whether a
        subset of A is sorted in ascending (DTRDx = 1) or descending
        (DTRDx = -1) order.

  INDX  (output) INTEGER array, dimension (N1+N2)
        On exit this array will contain a permutation such that
        if B( I ) = A( INDX( I ) ) for I=1,N1+N2, then B will be
        sorted in ascending order.
```

— dlamrg.f —

```
      SUBROUTINE DLAMRG( N1, N2, A, DTRD1, DTRD2, INDX )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     September 30, 1994
*
*     .. Scalar Arguments ..
      INTEGER            DTRD1, DTRD2, N1, N2
*     ..
*     .. Array Arguments ..
      INTEGER            INDX( * )
      DOUBLE PRECISION   A( * )
*     ..
*
*  =====================================================================
*
*     .. Local Scalars ..
      INTEGER            I, IND1, IND2, N1SV, N2SV
*     ..
*     .. Executable Statements ..
*
      N1SV = N1
      N2SV = N2
      IF( DTRD1.GT.0 ) THEN
         IND1 = 1
      ELSE
         IND1 = N1
      END IF
      IF( DTRD2.GT.0 ) THEN
         IND2 = 1 + N1
      ELSE
         IND2 = N1 + N2
      END IF
      I = 1
```

```
*     while ( (N1SV > 0) & (N2SV > 0) )
   10 CONTINUE
      IF( N1SV.GT.0 .AND. N2SV.GT.0 ) THEN
         IF( A( IND1 ).LE.A( IND2 ) ) THEN
            INDX( I ) = IND1
            I = I + 1
            IND1 = IND1 + DTRD1
            N1SV = N1SV - 1
         ELSE
            INDX( I ) = IND2
            I = I + 1
            IND2 = IND2 + DTRD2
            N2SV = N2SV - 1
         END IF
         GO TO 10
      END IF
*     end while
      IF( N1SV.EQ.0 ) THEN
         DO 20 N1SV = 1, N2SV
            INDX( I ) = IND2
            I = I + 1
            IND2 = IND2 + DTRD2
   20    CONTINUE
      ELSE
*     N2SV .EQ. 0
         DO 30 N2SV = 1, N1SV
            INDX( I ) = IND1
            I = I + 1
            IND1 = IND1 + DTRD1
   30    CONTINUE
      END IF
*
      RETURN
*
*     End of DLAMRG
*
      END
```

———-

— LAPACK dlamrg —

```
(defun dlamrg (n1 n2 a dtrd1 dtrd2 indx)
  (declare (type (simple-array fixnum (*)) indx)
           (type (simple-array double-float (*)) a)
           (type fixnum dtrd2 dtrd1 n2 n1))
  (f2cl-lib:with-multi-array-data
      ((a double-float a-%data% a-%offset%)
```

```
      (indx fixnum indx-%data% indx-%offset%))
   (prog ((i 0) (ind1 0) (ind2 0) (n1sv 0) (n2sv 0))
     (declare (type fixnum n2sv n1sv ind2 ind1 i))
     (setf n1sv n1)
     (setf n2sv n2)
     (cond
       ((> dtrd1 0)
        (setf ind1 1))
       (t
        (setf ind1 n1)))
     (cond
       ((> dtrd2 0)
        (setf ind2 (f2cl-lib:int-add 1 n1)))
       (t
        (setf ind2 (f2cl-lib:int-add n1 n2))))
     (setf i 1)
label10
     (cond
       ((and (> n1sv 0) (> n2sv 0))
        (cond
          ((<= (f2cl-lib:fref a (ind1) ((1 *)))
               (f2cl-lib:fref a (ind2) ((1 *))))
           (setf (f2cl-lib:fref indx-%data% (i) ((1 *)) indx-%offset%) ind1)
           (setf i (f2cl-lib:int-add i 1))
           (setf ind1 (f2cl-lib:int-add ind1 dtrd1))
           (setf n1sv (f2cl-lib:int-sub n1sv 1)))
          (t
           (setf (f2cl-lib:fref indx-%data% (i) ((1 *)) indx-%offset%) ind2)
           (setf i (f2cl-lib:int-add i 1))
           (setf ind2 (f2cl-lib:int-add ind2 dtrd2))
           (setf n2sv (f2cl-lib:int-sub n2sv 1))))
        (go label10)))
     (cond
       ((= n1sv 0)
        (f2cl-lib:fdo (n1sv 1 (f2cl-lib:int-add n1sv 1))
                      ((> n1sv n2sv) nil)
          (tagbody
            (setf (f2cl-lib:fref indx-%data% (i) ((1 *)) indx-%offset%) ind2)
            (setf i (f2cl-lib:int-add i 1))
            (setf ind2 (f2cl-lib:int-add ind2 dtrd2)))))
       (t
        (f2cl-lib:fdo (n2sv 1 (f2cl-lib:int-add n2sv 1))
                      ((> n2sv n1sv) nil)
          (tagbody
            (setf (f2cl-lib:fref indx-%data% (i) ((1 *)) indx-%offset%) ind1)
            (setf i (f2cl-lib:int-add i 1))
            (setf ind1 (f2cl-lib:int-add ind1 dtrd1))))))
end_label
     (return (values nil nil nil nil nil nil)))))
```

———-

6.42 dlange LAPACK

— **dlange.input** —

```
)set break resume
)sys rm -f dlange.output
)spool dlange.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlange.help** —

```
=====================================================================
dlange examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DLANGE  -  the  value  of  the  one norm, or the Frobenius norm, or the
       infinity norm, or the element of  largest  absolute  value  of  a  real
       matrix A

SYNOPSIS
       DOUBLE PRECISION FUNCTION DLANGE( NORM, M, N, A, LDA, WORK )

           CHARACTER    NORM

           INTEGER      LDA, M, N

           DOUBLE       PRECISION A( LDA, * ), WORK( * )

PURPOSE
       DLANGE   returns  the value of the one norm,  or the Frobenius norm, or
       the  infinity norm,  or the  element of  largest absolute value   of  a
       real matrix A.
```

```
DESCRIPTION
       DLANGE returns the value

          DLANGE = ( max(abs(A(i,j))), NORM = 'M' or 'm'
                   (
                   ( norm1(A),         NORM = '1', 'O' or 'o'
                   (
                   ( normI(A),         NORM = 'I' or 'i'
                   (
                   ( normF(A),         NORM = 'F', 'f', 'E' or 'e'

       where  norm1  denotes the  one norm of a matrix (maximum column sum),
       normI  denotes the  infinity norm  of a matrix  (maximum row  sum)  and
       normF  denotes  the  Frobenius norm of a matrix (square root of sum of
       squares).  Note that  max(abs(A(i,j)))  is  not  a  consistent  matrix
       norm.


ARGUMENTS
       NORM    (input) CHARACTER*1
               Specifies  the  value  to  be  returned  in DLANGE as described
               above.

       M       (input) INTEGER
               The number of rows of the matrix A.  M  >=  0.  When  M  =  0,
               DLANGE is set to zero.

       N       (input) INTEGER
               The  number  of  columns of the matrix A.  N >= 0.  When N = 0,
               DLANGE is set to zero.

       A       (input) DOUBLE PRECISION array, dimension (LDA,N)
               The m by n matrix A.

       LDA     (input) INTEGER
               The leading dimension of the array A.  LDA >= max(M,1).

       WORK    (workspace) DOUBLE PRECISION array, dimension (MAX(1,LWORK)),
               where LWORK >= M when NORM = 'I'; otherwise, WORK is not refer-
               enced.
```

———-

— dlange.f —

```
      DOUBLE PRECISION FUNCTION DLANGE( NORM, M, N, A, LDA, WORK )
```

```
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1992
*
*     .. Scalar Arguments ..
      CHARACTER          NORM
      INTEGER            LDA, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), WORK( * )
*     ..
*
* =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE, ZERO
      PARAMETER          ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I, J
      DOUBLE PRECISION   SCALE, SUM, VALUE
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLASSQ
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX, MIN, SQRT
*     ..
*     .. Executable Statements ..
*
      IF( MIN( M, N ).EQ.0 ) THEN
         VALUE = ZERO
      ELSE IF( LSAME( NORM, 'M' ) ) THEN
*
*        Find max(abs(A(i,j))).
*
         VALUE = ZERO
         DO 20 J = 1, N
            DO 10 I = 1, M
               VALUE = MAX( VALUE, ABS( A( I, J ) ) )
   10       CONTINUE
   20    CONTINUE
      ELSE IF( ( LSAME( NORM, 'O' ) ) .OR. ( NORM.EQ.'1' ) ) THEN
*
```

```
*        Find norm1(A).
*
         VALUE = ZERO
         DO 40 J = 1, N
            SUM = ZERO
            DO 30 I = 1, M
               SUM = SUM + ABS( A( I, J ) )
   30       CONTINUE
            VALUE = MAX( VALUE, SUM )
   40    CONTINUE
      ELSE IF( LSAME( NORM, 'I' ) ) THEN
*
*        Find normI(A).
*
         DO 50 I = 1, M
            WORK( I ) = ZERO
   50    CONTINUE
         DO 70 J = 1, N
            DO 60 I = 1, M
               WORK( I ) = WORK( I ) + ABS( A( I, J ) )
   60       CONTINUE
   70    CONTINUE
         VALUE = ZERO
         DO 80 I = 1, M
            VALUE = MAX( VALUE, WORK( I ) )
   80    CONTINUE
      ELSE IF( ( LSAME( NORM, 'F' ) ) .OR. ( LSAME( NORM, 'E' ) ) ) THEN
*
*        Find normF(A).
*
         SCALE = ZERO
         SUM = ONE
         DO 90 J = 1, N
            CALL DLASSQ( M, A( 1, J ), 1, SCALE, SUM )
   90    CONTINUE
         VALUE = SCALE*SQRT( SUM )
      END IF
*
      DLANGE = VALUE
      RETURN
*
*     End of DLANGE
*
      END
```

— LAPACK dlange —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dlange (norm m n a lda work)
    (declare (type (simple-array double-float (*)) work a)
             (type fixnum lda n m)
             (type character norm))
    (f2cl-lib:with-multi-array-data
        ((norm character norm-%data% norm-%offset%)
         (a double-float a-%data% a-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((scale 0.0) (sum 0.0) (value 0.0) (i 0) (j 0) (dlange 0.0))
        (declare (type fixnum i j)
                 (type (double-float) scale sum value dlange))
        (cond
          ((= (min (the fixnum m) (the fixnum n)) 0)
           (setf value zero))
          ((char-equal norm #\M)
           (setf value zero)
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                             ((> i m) nil)
                 (tagbody
                   (setf value
                           (max value
                                (abs
                                 (f2cl-lib:fref a-%data%
                                                (i j)
                                                ((1 lda) (1 *))
                                                a-%offset%)))))))))
          ((or (char-equal norm #\O) (f2cl-lib:fstring-= norm "1"))
           (setf value zero)
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (setf sum zero)
               (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                             ((> i m) nil)
                 (tagbody
                   (setf sum
                           (+ sum
                              (abs
                               (f2cl-lib:fref a-%data%
                                              (i j)
                                              ((1 lda) (1 *))
                                              a-%offset%))))))
               (setf value (max value sum)))))
          ((char-equal norm #\I)
```

```
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
                      zero)))
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                        ((> j n) nil)
            (tagbody
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                            ((> i m) nil)
                (tagbody
                  (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
                          (+
                           (f2cl-lib:fref work-%data%
                                          (i)
                                          ((1 *))
                                          work-%offset%)
                           (abs
                            (f2cl-lib:fref a-%data%
                                           (i j)
                                           ((1 lda) (1 *))
                                           a-%offset%)))))))
          (setf value zero)
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i m) nil)
            (tagbody
              (setf value
                      (max value
                           (f2cl-lib:fref work-%data%
                                          (i)
                                          ((1 *))
                                          work-%offset%))))))
         ((or (char-equal norm #\F) (char-equal norm #\E))
          (setf scale zero)
          (setf sum one)
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                        ((> j n) nil)
            (tagbody
              (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
                  (dlassq m
                   (f2cl-lib:array-slice a double-float (1 j) ((1 lda) (1 *)))
                   1 scale sum)
                (declare (ignore var-0 var-1 var-2))
                (setf scale var-3)
                (setf sum var-4))))
          (setf value (* scale (f2cl-lib:fsqrt sum)))))
        (setf dlange value)
 end_label
        (return (values dlange nil nil nil nil nil nil))))))
```

———-

6.43 dlanhs LAPACK

— **dlanhs.input** —

```
)set break resume
)sys rm -f dlanhs.output
)spool dlanhs.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlanhs.help** —

```
====================================================================
dlanhs examples
====================================================================

====================================================================
Man Page Details
====================================================================

NAME
       DLANHS  -  the  value  of  the  one norm, or the Frobenius norm, or the
       infinity norm, or the element of largest absolute value of a Hessenberg
       matrix A

SYNOPSIS
       DOUBLE PRECISION FUNCTION DLANHS( NORM, N, A, LDA, WORK )

           CHARACTER    NORM

           INTEGER      LDA, N

           DOUBLE       PRECISION A( LDA, * ), WORK( * )

PURPOSE
       DLANHS   returns  the value of the one norm,  or the Frobenius norm, or
       the  infinity norm,  or the  element of  largest absolute value   of  a
       Hessenberg matrix A.
```

```
DESCRIPTION
       DLANHS returns the value

          DLANHS = ( max(abs(A(i,j))), NORM = 'M' or 'm'
                   (
                   ( norm1(A),         NORM = '1', 'O' or 'o'
                   (
                   ( normI(A),         NORM = 'I' or 'i'
                   (
                   ( normF(A),         NORM = 'F', 'f', 'E' or 'e'

       where  norm1  denotes the  one norm of a matrix (maximum column sum),
       normI  denotes the  infinity norm  of a matrix  (maximum row  sum)  and
       normF  denotes  the  Frobenius norm of a matrix (square root of sum of
       squares).  Note that  max(abs(A(i,j)))  is  not  a  consistent  matrix
       norm.


ARGUMENTS
       NORM    (input) CHARACTER*1
               Specifies  the  value  to  be  returned  in DLANHS as described
               above.

       N       (input) INTEGER
               The order of the matrix A.  N >= 0.  When N = 0, DLANHS is  set
               to zero.

       A       (input) DOUBLE PRECISION array, dimension (LDA,N)
               The  n  by n upper Hessenberg matrix A; the part of A below the
               first sub-diagonal is not referenced.

       LDA     (input) INTEGER
               The leading dimension of the array A.  LDA >= max(N,1).

       WORK    (workspace) DOUBLE PRECISION array, dimension (MAX(1,LWORK)),
               where LWORK >= N when NORM = 'I'; otherwise, WORK is not refer-
               enced.
```

— dlanhs.f —

```
      DOUBLE PRECISION FUNCTION DLANHS( NORM, N, A, LDA, WORK )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
```

```
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1992
*
*     .. Scalar Arguments ..
      CHARACTER          NORM
      INTEGER            LDA, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), WORK( * )
*     ..
*
* =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE, ZERO
      PARAMETER          ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I, J
      DOUBLE PRECISION   SCALE, SUM, VALUE
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLASSQ
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX, MIN, SQRT
*     ..
*     .. Executable Statements ..
*
      IF( N.EQ.0 ) THEN
         VALUE = ZERO
      ELSE IF( LSAME( NORM, 'M' ) ) THEN
*
*        Find max(abs(A(i,j))).
*
         VALUE = ZERO
         DO 20 J = 1, N
            DO 10 I = 1, MIN( N, J+1 )
               VALUE = MAX( VALUE, ABS( A( I, J ) ) )
   10       CONTINUE
   20    CONTINUE
      ELSE IF( ( LSAME( NORM, 'O' ) ) .OR. ( NORM.EQ.'1' ) ) THEN
*
*        Find norm1(A).
*
         VALUE = ZERO
```

```
         DO 40 J = 1, N
            SUM = ZERO
            DO 30 I = 1, MIN( N, J+1 )
               SUM = SUM + ABS( A( I, J ) )
   30       CONTINUE
            VALUE = MAX( VALUE, SUM )
   40    CONTINUE
      ELSE IF( LSAME( NORM, 'I' ) ) THEN
*
*        Find normI(A).
*
         DO 50 I = 1, N
            WORK( I ) = ZERO
   50    CONTINUE
         DO 70 J = 1, N
            DO 60 I = 1, MIN( N, J+1 )
               WORK( I ) = WORK( I ) + ABS( A( I, J ) )
   60       CONTINUE
   70    CONTINUE
         VALUE = ZERO
         DO 80 I = 1, N
            VALUE = MAX( VALUE, WORK( I ) )
   80    CONTINUE
      ELSE IF( ( LSAME( NORM, 'F' ) ) .OR. ( LSAME( NORM, 'E' ) ) ) THEN
*
*        Find normF(A).
*
         SCALE = ZERO
         SUM = ONE
         DO 90 J = 1, N
            CALL DLASSQ( MIN( N, J+1 ), A( 1, J ), 1, SCALE, SUM )
   90    CONTINUE
         VALUE = SCALE*SQRT( SUM )
      END IF
*
      DLANHS = VALUE
      RETURN
*
*     End of DLANHS
*
      END
```

— LAPACK dlanhs —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
```

```
         (type (double-float 0.0 0.0) zero))
(defun dlanhs (norm n a lda work)
  (declare (type (simple-array double-float (*)) work a)
           (type fixnum lda n)
           (type character norm))
  (f2cl-lib:with-multi-array-data
      ((norm character norm-%data% norm-%offset%)
       (a double-float a-%data% a-%offset%)
       (work double-float work-%data% work-%offset%))
    (prog ((scale 0.0) (sum 0.0) (value 0.0) (i 0) (j 0) (dlanhs 0.0))
      (declare (type fixnum i j)
               (type (double-float) scale sum value dlanhs))
      (cond
        ((= n 0)
         (setf value zero))
        ((char-equal norm #\M)
         (setf value zero)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i
                               (min (the fixnum n)
                                    (the fixnum
                                         (f2cl-lib:int-add j 1))))
                            nil)
               (tagbody
                 (setf value
                         (max value
                              (abs
                               (f2cl-lib:fref a-%data%
                                              (i j)
                                              ((1 lda) (1 *))
                                              a-%offset%)))))))))
        ((or (char-equal norm #\O) (f2cl-lib:fstring-= norm "1"))
         (setf value zero)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (setf sum zero)
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i
                               (min (the fixnum n)
                                    (the fixnum
                                         (f2cl-lib:int-add j 1))))
                            nil)
               (tagbody
                 (setf sum
                         (+ sum
                            (abs
```

```
                    (f2cl-lib:fref a-%data%
                                   (i j)
                                   ((1 lda) (1 *))
                                   a-%offset%))))))
     (setf value (max value sum)))))
((char-equal norm #\I)
 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
               ((> i n) nil)
   (tagbody
     (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
             zero)))
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                   ((> i
                       (min (the fixnum n)
                            (the fixnum
                                 (f2cl-lib:int-add j 1))))
                    nil)
       (tagbody
         (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
                 (+
                  (f2cl-lib:fref work-%data%
                                 (i)
                                 ((1 *))
                                 work-%offset%)
                  (abs
                   (f2cl-lib:fref a-%data%
                                  (i j)
                                  ((1 lda) (1 *))
                                  a-%offset%))))))))
 (setf value zero)
 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
               ((> i n) nil)
   (tagbody
     (setf value
             (max value
                  (f2cl-lib:fref work-%data%
                                 (i)
                                 ((1 *))
                                 work-%offset%))))))
((or (char-equal norm #\F) (char-equal norm #\E))
 (setf scale zero)
 (setf sum one)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
         (dlassq
```

```
                    (min (the fixnum n)
                         (the fixnum (f2cl-lib:int-add j 1)))
                    (f2cl-lib:array-slice a double-float (1 j) ((1 lda) (1 *)))
                    1 scale sum)
                  (declare (ignore var-0 var-1 var-2))
                  (setf scale var-3)
                  (setf sum var-4))))
            (setf value (* scale (f2cl-lib:fsqrt sum)))))
         (setf dlanhs value)
 end_label
         (return (values dlanhs nil nil nil nil nil))))))
```

———-

6.44 dlanst LAPACK

— dlanst.input —

```
)set break resume
)sys rm -f dlanst.output
)spool dlanst.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dlanst.help —

```
=====================================================================
dlanst examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DLANST  -  the  value  of  the  one norm, or the Frobenius norm, or the
       infinity norm, or the element of largest absolute value of a real  sym-
       metric tridiagonal matrix A
```

```
SYNOPSIS
       DOUBLE PRECISION FUNCTION DLANST( NORM, N, D, E )

           CHARACTER    NORM

           INTEGER      N

           DOUBLE       PRECISION D( * ), E( * )

PURPOSE
       DLANST  returns  the value of the one norm,  or the Frobenius norm, or
       the  infinity norm,  or the  element of  largest absolute value  of  a
       real symmetric tridiagonal matrix A.


DESCRIPTION
       DLANST returns the value

          DLANST = ( max(abs(A(i,j))), NORM = 'M' or 'm'
                   (
                   ( norm1(A),         NORM = '1', 'O' or 'o'
                   (
                   ( normI(A),         NORM = 'I' or 'i'
                   (
                   ( normF(A),         NORM = 'F', 'f', 'E' or 'e'

       where  norm1  denotes the  one norm of a matrix (maximum column sum),
       normI  denotes the  infinity norm  of a matrix  (maximum row  sum)  and
       normF  denotes  the  Frobenius norm of a matrix (square root of sum of
       squares).  Note that  max(abs(A(i,j)))  is  not  a  consistent  matrix
       norm.


ARGUMENTS
       NORM    (input) CHARACTER*1
               Specifies  the  value  to  be  returned  in DLANST as described
               above.

       N       (input) INTEGER
               The order of the matrix A.  N >= 0.  When N = 0, DLANST is  set
               to zero.

       D       (input) DOUBLE PRECISION array, dimension (N)
               The diagonal elements of A.

       E       (input) DOUBLE PRECISION array, dimension (N-1)
               The (n-1) sub-diagonal or super-diagonal elements of A.
```

— dlanst.f —

```
      DOUBLE PRECISION FUNCTION DLANST( NORM, N, D, E )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     February 29, 1992
*
*     .. Scalar Arguments ..
      CHARACTER          NORM
      INTEGER            N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   D( * ), E( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE, ZERO
      PARAMETER          ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I
      DOUBLE PRECISION   ANORM, SCALE, SUM
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLASSQ
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX, SQRT
*     ..
*     .. Executable Statements ..
*
      IF( N.LE.0 ) THEN
         ANORM = ZERO
      ELSE IF( LSAME( NORM, 'M' ) ) THEN
*
*        Find max(abs(A(i,j))).
*
         ANORM = ABS( D( N ) )
         DO 10 I = 1, N - 1
            ANORM = MAX( ANORM, ABS( D( I ) ) )
            ANORM = MAX( ANORM, ABS( E( I ) ) )
```

```
   10    CONTINUE
      ELSE IF( LSAME( NORM, 'O' ) .OR. NORM.EQ.'1' .OR.
     $         LSAME( NORM, 'I' ) ) THEN
*
*        Find norm1(A).
*
         IF( N.EQ.1 ) THEN
            ANORM = ABS( D( 1 ) )
         ELSE
            ANORM = MAX( ABS( D( 1 ) )+ABS( E( 1 ) ),
     $              ABS( E( N-1 ) )+ABS( D( N ) ) )
            DO 20 I = 2, N - 1
               ANORM = MAX( ANORM, ABS( D( I ) )+ABS( E( I ) )+
     $                 ABS( E( I-1 ) ) )
   20       CONTINUE
         END IF
      ELSE IF( ( LSAME( NORM, 'F' ) ) .OR. ( LSAME( NORM, 'E' ) ) ) THEN
*
*        Find normF(A).
*
         SCALE = ZERO
         SUM = ONE
         IF( N.GT.1 ) THEN
            CALL DLASSQ( N-1, E, 1, SCALE, SUM )
            SUM = 2*SUM
         END IF
         CALL DLASSQ( N, D, 1, SCALE, SUM )
         ANORM = SCALE*SQRT( SUM )
      END IF
*
      DLANST = ANORM
      RETURN
*
*     End of DLANST
*
      END
```

— LAPACK dlanst —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dlanst (norm n d e)
    (declare (type (simple-array double-float (*)) e d)
             (type fixnum n)
             (type character norm))
```

```
(f2cl-lib:with-multi-array-data
    ((norm character norm-%data% norm-%offset%)
     (d double-float d-%data% d-%offset%)
     (e double-float e-%data% e-%offset%))
  (prog ((anorm 0.0) (scale 0.0) (sum 0.0) (i 0) (dlanst 0.0))
    (declare (type fixnum i)
             (type (double-float) anorm scale sum dlanst))
    (cond
      ((<= n 0)
       (setf anorm zero))
      ((char-equal norm #\M)
       (setf anorm (abs (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)))
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
         (tagbody
           (setf anorm
                   (max anorm
                        (abs
                         (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))))
           (setf anorm
                   (max anorm
                    (abs
                     (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)))))))
      ((or (char-equal norm #\O) (f2cl-lib:fstring-= norm "1")
           (char-equal norm #\I))
       (cond
         ((= n 1)
          (setf anorm
                  (abs (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%))))
         (t
          (setf anorm
                  (max
                   (+ (abs (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%))
                      (abs
                       (f2cl-lib:fref e-%data% (1) ((1 *)) e-%offset%)))
                   (+
                    (abs
                     (f2cl-lib:fref e-%data%
                                    ((f2cl-lib:int-sub n 1))
                                    ((1 *))
                                    e-%offset%))
                    (abs (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)))))
          (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
                        ((> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1)))
                         nil)
            (tagbody
              (setf anorm
                      (max anorm
                           (+
                            (abs
```

```
                                (f2cl-lib:fref d-%data%
                                               (i)
                                               ((1 *))
                                               d-%offset%))
                               (abs
                                (f2cl-lib:fref e-%data%
                                               (i)
                                               ((1 *))
                                               e-%offset%))
                               (abs
                                (f2cl-lib:fref e-%data%
                                               ((f2cl-lib:int-sub i 1))
                                               ((1 *))
                                               e-%offset%)))))))))))
         ((or (char-equal norm #\F) (char-equal norm #\E))
          (setf scale zero)
          (setf sum one)
          (cond
            ((> n 1)
             (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
                 (dlassq (f2cl-lib:int-sub n 1) e 1 scale sum)
               (declare (ignore var-0 var-1 var-2))
               (setf scale var-3)
               (setf sum var-4))
             (setf sum (* 2 sum))))
          (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
              (dlassq n d 1 scale sum)
            (declare (ignore var-0 var-1 var-2))
            (setf scale var-3)
            (setf sum var-4))
          (setf anorm (* scale (f2cl-lib:fsqrt sum)))))
       (setf dlanst anorm)
 end_label
       (return (values dlanst nil nil nil nil))))))
```

———-

6.45 dlanv2 LAPACK

— dlanv2.input —

```
)set break resume
)sys rm -f dlanv2.output
)spool dlanv2.output
)set message test on
)set message auto off
```

```
)clear all

)spool
)lisp (bye)
```

———-

— dlanv2.help —

```
==========================================================================
dlanv2 examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

NAME
       DLANV2  -  the Schur factorization of a real 2-by-2 nonsymmetric matrix
       in standard form

SYNOPSIS
       SUBROUTINE DLANV2( A, B, C, D, RT1R, RT1I, RT2R, RT2I, CS, SN )

           DOUBLE         PRECISION A, B, C, CS, D, RT1I, RT1R, RT2I, RT2R, SN

 Purpose
 =======

  DLANV2 computes the Schur factorization of a real 2-by-2 nonsymmetric
  matrix in standard form:

       [ A  B ] = [ CS -SN ] [ AA  BB ] [ CS  SN ]
       [ C  D ]   [ SN  CS ] [ CC  DD ] [-SN  CS ]

  where either
  1) CC = 0 so that AA and DD are real eigenvalues of the matrix, or
  2) AA = DD and BB*CC < 0, so that AA + or - sqrt(BB*CC) are complex
  conjugate eigenvalues.

 Arguments
 =========

  A       (input/output) DOUBLE PRECISION
  B       (input/output) DOUBLE PRECISION
  C       (input/output) DOUBLE PRECISION
  D       (input/output) DOUBLE PRECISION
          On entry, the elements of the input matrix.
          On exit, they are overwritten by the elements of the
```

```
         standardised Schur form.

  RT1R    (output) DOUBLE PRECISION
  RT1I    (output) DOUBLE PRECISION
  RT2R    (output) DOUBLE PRECISION
  RT2I    (output) DOUBLE PRECISION
          The real and imaginary parts of the eigenvalues. If the
          eigenvalues are a complex conjugate pair, RT1I > 0.

  CS      (output) DOUBLE PRECISION
  SN      (output) DOUBLE PRECISION
          Parameters of the rotation matrix.

  Further Details
  ===============

  Modified by V. Sima, Research Institute for Informatics, Bucharest,
  Romania, to reduce the risk of cancellation errors,
  when computing real eigenvalues, and to ensure, if possible, that
  abs(RT1R) >= abs(RT2R).
```

———-

— dlanv2.f —

```
      SUBROUTINE DLANV2( A, B, C, D, RT1R, RT1I, RT2R, RT2I, CS, SN )
*
*  -- LAPACK driver routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      DOUBLE PRECISION   A, B, C, CS, D, RT1I, RT1R, RT2I, RT2R, SN
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, HALF, ONE
      PARAMETER          ( ZERO = 0.0D+0, HALF = 0.5D+0, ONE = 1.0D+0 )
      DOUBLE PRECISION   MULTPL
      PARAMETER          ( MULTPL = 4.0D+0 )
*     ..
*     .. Local Scalars ..
      DOUBLE PRECISION   AA, BB, BCMAX, BCMIS, CC, CS1, DD, EPS, P, SAB,
     $                   SAC, SCALE, SIGMA, SN1, TAU, TEMP, Z
*     ..
```

```
*     .. External Functions ..
      DOUBLE PRECISION   DLAMCH, DLAPY2
      EXTERNAL           DLAMCH, DLAPY2
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX, MIN, SIGN, SQRT
*     ..
*     .. Executable Statements ..
*
      EPS = DLAMCH( 'P' )
      IF( C.EQ.ZERO ) THEN
         CS = ONE
         SN = ZERO
         GO TO 10
*
      ELSE IF( B.EQ.ZERO ) THEN
*
*        Swap rows and columns
*
         CS = ZERO
         SN = ONE
         TEMP = D
         D = A
         A = TEMP
         B = -C
         C = ZERO
         GO TO 10
      ELSE IF( ( A-D ).EQ.ZERO .AND. SIGN( ONE, B ).NE.SIGN( ONE, C ) )
     $          THEN
         CS = ONE
         SN = ZERO
         GO TO 10
      ELSE
*
         TEMP = A - D
         P = HALF*TEMP
         BCMAX = MAX( ABS( B ), ABS( C ) )
         BCMIS = MIN( ABS( B ), ABS( C ) )*SIGN( ONE, B )*SIGN( ONE, C )
         SCALE = MAX( ABS( P ), BCMAX )
         Z = ( P / SCALE )*P + ( BCMAX / SCALE )*BCMIS
*
*        If Z is of the order of the machine accuracy, postpone the
*        decision on the nature of eigenvalues
*
         IF( Z.GE.MULTPL*EPS ) THEN
*
*           Real eigenvalues. Compute A and D.
*
            Z = P + SIGN( SQRT( SCALE )*SQRT( Z ), P )
            A = D + Z
```

```
            D = D - ( BCMAX / Z )*BCMIS
*
*           Compute B and the rotation matrix
*
            TAU = DLAPY2( C, Z )
            CS = Z / TAU
            SN = C / TAU
            B = B - C
            C = ZERO
         ELSE
*
*           Complex eigenvalues, or real (almost) equal eigenvalues.
*           Make diagonal elements equal.
*
            SIGMA = B + C
            TAU = DLAPY2( SIGMA, TEMP )
            CS = SQRT( HALF*( ONE+ABS( SIGMA ) / TAU ) )
            SN = -( P / ( TAU*CS ) )*SIGN( ONE, SIGMA )
*
*           Compute [ AA  BB ] = [ A  B ] [ CS -SN ]
*                   [ CC  DD ]   [ C  D ] [ SN  CS ]
*
            AA = A*CS + B*SN
            BB = -A*SN + B*CS
            CC = C*CS + D*SN
            DD = -C*SN + D*CS
*
*           Compute [ A  B ] = [ CS  SN ] [ AA  BB ]
*                   [ C  D ]   [-SN  CS ] [ CC  DD ]
*
            A = AA*CS + CC*SN
            B = BB*CS + DD*SN
            C = -AA*SN + CC*CS
            D = -BB*SN + DD*CS
*
            TEMP = HALF*( A+D )
            A = TEMP
            D = TEMP
*
            IF( C.NE.ZERO ) THEN
               IF( B.NE.ZERO ) THEN
                  IF( SIGN( ONE, B ).EQ.SIGN( ONE, C ) ) THEN
*
*                    Real eigenvalues: reduce to upper triangular form
*
                     SAB = SQRT( ABS( B ) )
                     SAC = SQRT( ABS( C ) )
                     P = SIGN( SAB*SAC, C )
                     TAU = ONE / SQRT( ABS( B+C ) )
                     A = TEMP + P
```

```
                  D = TEMP - P
                  B = B - C
                  C = ZERO
                  CS1 = SAB*TAU
                  SN1 = SAC*TAU
                  TEMP = CS*CS1 - SN*SN1
                  SN = CS*SN1 + SN*CS1
                  CS = TEMP
               END IF
            ELSE
               B = -C
               C = ZERO
               TEMP = CS
               CS = -SN
               SN = TEMP
            END IF
         END IF
      END IF
*
      END IF
*
   10 CONTINUE
*
*     Store eigenvalues in (RT1R,RT1I) and (RT2R,RT2I).
*
      RT1R = A
      RT2R = D
      IF( C.EQ.ZERO ) THEN
         RT1I = ZERO
         RT2I = ZERO
      ELSE
         RT1I = SQRT( ABS( B ) )*SQRT( ABS( C ) )
         RT2I = -RT1I
      END IF
      RETURN
*
*     End of DLANV2
*
      END
```

— LAPACK dlanv2 —

```
(let* ((zero 0.0) (half 0.5) (one 1.0) (multpl 4.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 0.5 0.5) half)
           (type (double-float 1.0 1.0) one)
```

```
         (type (double-float 4.0 4.0) multpl))
 (defun dlanv2 (a b c d rt1r rt1i rt2r rt2i cs sn)
   (declare (type (double-float) sn cs rt2i rt2r rt1i rt1r d c b a))
   (prog ((aa 0.0) (bb 0.0) (bcmax 0.0) (bcmis 0.0) (cc 0.0) (cs1 0.0)
          (dd 0.0) (eps 0.0) (p 0.0) (sab 0.0) (sac 0.0) (scale 0.0)
          (sigma 0.0) (sn1 0.0) (tau 0.0) (temp 0.0) (z 0.0))
     (declare (type (double-float) aa bb bcmax bcmis cc cs1 dd eps p sab sac
                                   scale sigma sn1 tau temp z))
     (setf eps (dlamch "P"))
     (cond
       ((= c zero)
        (setf cs one)
        (setf sn zero)
        (go label10))
       ((= b zero)
        (setf cs zero)
        (setf sn one)
        (setf temp d)
        (setf d a)
        (setf a temp)
        (setf b (- c))
        (setf c zero)
        (go label10))
       ((and (= (+ a (- d)) zero)
             (/= (f2cl-lib:sign one b) (f2cl-lib:sign one c)))
        (setf cs one)
        (setf sn zero)
        (go label10))
       (t
        (setf temp (- a d))
        (setf p (* half temp))
        (setf bcmax (max (abs b) (abs c)))
        (setf bcmis
                (* (min (abs b) (abs c))
                   (f2cl-lib:sign one b)
                   (f2cl-lib:sign one c)))
        (setf scale (max (abs p) bcmax))
        (setf z (+ (* (/ p scale) p) (* (/ bcmax scale) bcmis)))
        (cond
          ((>= z (* multpl eps))
           (setf z
                   (+ p
                      (f2cl-lib:sign
                       (* (f2cl-lib:fsqrt scale) (f2cl-lib:fsqrt z))
                       p)))
           (setf a (+ d z))
           (setf d (- d (* (/ bcmax z) bcmis)))
           (setf tau (dlapy2 c z))
           (setf cs (/ z tau))
           (setf sn (/ c tau))
```

```
            (setf b (- b c))
            (setf c zero))
           (t
            (setf sigma (+ b c))
            (setf tau (dlapy2 sigma temp))
            (setf cs (f2cl-lib:fsqrt (* half (+ one (/ (abs sigma) tau)))))
            (setf sn (* (- (/ p (* tau cs))) (f2cl-lib:sign one sigma)))
            (setf aa (+ (* a cs) (* b sn)))
            (setf bb (+ (* (- a) sn) (* b cs)))
            (setf cc (+ (* c cs) (* d sn)))
            (setf dd (+ (* (- c) sn) (* d cs)))
            (setf a (+ (* aa cs) (* cc sn)))
            (setf b (+ (* bb cs) (* dd sn)))
            (setf c (+ (* (- aa) sn) (* cc cs)))
            (setf d (+ (* (- bb) sn) (* dd cs)))
            (setf temp (* half (+ a d)))
            (setf a temp)
            (setf d temp)
            (cond
              ((/= c zero)
               (cond
                 ((/= b zero)
                  (cond
                    ((= (f2cl-lib:sign one b) (f2cl-lib:sign one c))
                     (setf sab (f2cl-lib:fsqrt (abs b)))
                     (setf sac (f2cl-lib:fsqrt (abs c)))
                     (setf p (f2cl-lib:sign (* sab sac) c))
                     (setf tau (/ one (f2cl-lib:fsqrt (abs (+ b c)))))
                     (setf a (+ temp p))
                     (setf d (- temp p))
                     (setf b (- b c))
                     (setf c zero)
                     (setf cs1 (* sab tau))
                     (setf sn1 (* sac tau))
                     (setf temp (- (* cs cs1) (* sn sn1)))
                     (setf sn (+ (* cs sn1) (* sn cs1)))
                     (setf cs temp))))
                 (t
                  (setf b (- c))
                  (setf c zero)
                  (setf temp cs)
                  (setf cs (- sn))
                  (setf sn temp)))))))))
label10
     (setf rt1r a)
     (setf rt2r d)
     (cond
       ((= c zero)
        (setf rt1i zero)
        (setf rt2i zero))
```

```
        (t
         (setf rt1i (* (f2cl-lib:fsqrt (abs b)) (f2cl-lib:fsqrt (abs c))))
         (setf rt2i (- rt1i))))
 end_label
      (return (values a b c d rt1r rt1i rt2r rt2i cs sn)))))
```

———-

6.46 dlapy2 LAPACK

— **dlapy2.input** —

```
)set break resume
)sys rm -f dlapy2.output
)spool dlapy2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlapy2.help** —

```
=======================================================================
dlapy2 examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

NAME
       DLAPY2 - sqrt(x**2+y**2), taking care not to cause unnecessary overflow

SYNOPSIS
       DOUBLE PRECISION FUNCTION DLAPY2( X, Y )

           DOUBLE       PRECISION X, Y

 Purpose
 =======
```

```
  DLAPY2 returns sqrt(x**2+y**2), taking care not to cause unnecessary
  overflow.

 Arguments
 =========

  X       (input) DOUBLE PRECISION
  Y       (input) DOUBLE PRECISION
          X and Y specify the values x and y.
```

———-

— dlapy2.f —

```
      DOUBLE PRECISION FUNCTION DLAPY2( X, Y )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1992
*
*     .. Scalar Arguments ..
      DOUBLE PRECISION   X, Y
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER          ( ZERO = 0.0D0 )
      DOUBLE PRECISION   ONE
      PARAMETER          ( ONE = 1.0D0 )
*     ..
*     .. Local Scalars ..
      DOUBLE PRECISION   W, XABS, YABS, Z
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX, MIN, SQRT
*     ..
*     .. Executable Statements ..
*
      XABS = ABS( X )
      YABS = ABS( Y )
      W = MAX( XABS, YABS )
      Z = MIN( XABS, YABS )
      IF( Z.EQ.ZERO ) THEN
         DLAPY2 = W
      ELSE
```

```
         DLAPY2 = W*SQRT( ONE+( Z / W )**2 )
      END IF
      RETURN
*
*     End of DLAPY2
*
      END
```

———-

— LAPACK dlapy2 —

```
(let* ((zero 0.0) (one 1.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one))
  (defun dlapy2 (x y)
    (declare (type (double-float) y x))
    (prog ((w 0.0) (xabs 0.0) (yabs 0.0) (z 0.0) (dlapy2 0.0))
      (declare (type (double-float) w xabs yabs z dlapy2))
      (setf xabs (abs x))
      (setf yabs (abs y))
      (setf w (max xabs yabs))
      (setf z (min xabs yabs))
      (cond
        ((= z zero)
         (setf dlapy2 w))
        (t
         (setf dlapy2 (* w (f2cl-lib:fsqrt (+ one (expt (/ z w) 2)))))))
      (return (values dlapy2 nil nil)))))
```

———-

6.47 dlapy3 LAPACK

— dlapy3.input —

```
)set break resume
)sys rm -f dlapy3.output
)spool dlapy3.output
)set message test on
)set message auto off
)clear all

)spool
```

```
)lisp (bye)
```

———-

— dlapy3.help —

```
========================================================================
dlapy3 examples
========================================================================

========================================================================
Man Page Details
========================================================================

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

      DOUBLE PRECISION FUNCTION DLAPY3( X, Y, Z )

      .. Scalar Arguments ..
      DOUBLE PRECISION   X, Y, Z
      ..


 Purpose:
 =============

 DLAPY3 returns sqrt(x**2+y**2+z**2), taking care not to cause
 unnecessary overflow.

 Arguments:
 ==========

 [in] X
          X is DOUBLE PRECISION

 [in] Y
          Y is DOUBLE PRECISION

 [in] Z
          Z is DOUBLE PRECISION
          X, Y and Z specify the values x, y and z.

 Authors:
 ========
   Univ. of Tennessee
```

```
   Univ. of California Berkeley
   Univ. of Colorado Denver
   NAG Ltd.

 November 2011
```

— dlapy3.f —

```
*  =====================================================================
      DOUBLE PRECISION FUNCTION DLAPY3( X, Y, Z )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      DOUBLE PRECISION   X, Y, Z
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER          ( ZERO = 0.0D0 )
*     ..
*     .. Local Scalars ..
      DOUBLE PRECISION   W, XABS, YABS, ZABS
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX, SQRT
*     ..
*     .. Executable Statements ..
*
      XABS = ABS( X )
      YABS = ABS( Y )
      ZABS = ABS( Z )
      W = MAX( XABS, YABS, ZABS )
      IF( W.EQ.ZERO ) THEN
*     W can be zero for max(0,nan,0)
*     adding all three entries together will make sure
*     NaN will not disappear.
         DLAPY3 =  XABS + YABS + ZABS
      ELSE
         DLAPY3 = W*SQRT( ( XABS / W )**2+( YABS / W )**2+
     $            ( ZABS / W )**2 )
```

```
      END IF
      RETURN
*
*     End of DLAPY3
*
      END
```

———-

— **LAPACK dlapy3** —

```
(let* ((zero 0.0d0))
 (declare (type (double-float 0.0d0 0.0d0) zero) (ignorable zero))
 (defun dlapy3 (x y z) (declare (type (double-float) z y x))
  (prog ((w 0.0d0) (xabs 0.0d0) (yabs 0.0d0) (zabs 0.0d0) (dlapy3 0.0d0))
   (declare (type (double-float) dlapy3 zabs yabs xabs w)) (setf xabs (abs x))
   (setf yabs (abs y)) (setf zabs (abs z)) (setf w (max xabs yabs zabs))
   (cond ((= w zero) (setf dlapy3 (+ xabs yabs zabs)))
    (t
     (setf dlapy3
      (* w
       (f2cl-lib:fsqrt
        (+ (expt (/ xabs w) 2) (expt (/ yabs w) 2) (expt (/ zabs w) 2)))))))
   (go end_label) end_label (return (values dlapy3 nil nil nil)))))
```

———-

6.48 dlaqtr LAPACK

— **dlaqtr.input** —

```
)set break resume
)sys rm -f dlaqtr.output
)spool dlaqtr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlaqtr.help** —

```
=====================================================================
dlaqtr examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DLAQTR - the real quasi-triangular system   op(T)*p = scale*c, if LREAL
       = .TRUE

SYNOPSIS
       SUBROUTINE DLAQTR( LTRAN, LREAL, N, T, LDT, B, W, SCALE, X, WORK,  INFO
                          )

           LOGICAL         LREAL, LTRAN

           INTEGER         INFO, LDT, N

           DOUBLE          PRECISION SCALE, W

           DOUBLE          PRECISION B( * ), T( LDT, * ), WORK( * ), X( * )

 Purpose
 =======

  DLAQTR solves the real quasi-triangular system

               op(T)*p = scale*c,               if LREAL = .TRUE.

  or the complex quasi-triangular systems

             op(T + iB)*(p+iq) = scale*(c+id),  if LREAL = .FALSE.

  in real arithmetic, where T is upper quasi-triangular.
  If LREAL = .FALSE., then the first diagonal block of T must be
  1 by 1, B is the specially structured matrix

                 B = [ b(1) b(2) ... b(n) ]
                     [       w            ]
                     [           w        ]
                     [              .     ]
                     [                 w  ]

  op(A) = A or A', A' denotes the conjugate transpose of
  matrix A.

  On input, X = [ c ].  On output, X = [ p ].
                [ d ]                  [ q ]
```

```
 This subroutine is designed for the condition number estimation
 in routine DTRSNA.

Arguments
=========

 LTRAN   (input) LOGICAL
         On entry, LTRAN specifies the option of conjugate transpose:
            = .FALSE.,    op(T+i*B) = T+i*B,
            = .TRUE.,     op(T+i*B) = (T+i*B)'.

 LREAL   (input) LOGICAL
         On entry, LREAL specifies the input matrix structure:
            = .FALSE.,    the input is complex
            = .TRUE.,     the input is real

 N       (input) INTEGER
         On entry, N specifies the order of T+i*B. N >= 0.

 T       (input) DOUBLE PRECISION array, dimension (LDT,N)
         On entry, T contains a matrix in Schur canonical form.
         If LREAL = .FALSE., then the first diagonal block of T mu
         be 1 by 1.

 LDT     (input) INTEGER
         The leading dimension of the matrix T. LDT >= max(1,N).

 B       (input) DOUBLE PRECISION array, dimension (N)
         On entry, B contains the elements to form the matrix
         B as described above.
         If LREAL = .TRUE., B is not referenced.

 W       (input) DOUBLE PRECISION
         On entry, W is the diagonal element of the matrix B.
         If LREAL = .TRUE., W is not referenced.

 SCALE   (output) DOUBLE PRECISION
         On exit, SCALE is the scale factor.

 X       (input/output) DOUBLE PRECISION array, dimension (2*N)
         On entry, X contains the right hand side of the system.
         On exit, X is overwritten by the solution.

 WORK    (workspace) DOUBLE PRECISION array, dimension (N)

 INFO    (output) INTEGER
         On exit, INFO is set to
            0: successful exit.
              1: the some diagonal 1 by 1 block has been perturbed by
```

```
                a small number SMIN to keep nonsingularity.
             2: the some diagonal 2 by 2 block has been perturbed by
                a small number in DLALN2 to keep nonsingularity.
        NOTE: In the interests of speed, this routine does not
              check the inputs for errors.
```

— dlaqtr.f —

```
      SUBROUTINE DLAQTR( LTRAN, LREAL, N, T, LDT, B, W, SCALE, X, WORK,
     $                   INFO )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      LOGICAL            LREAL, LTRAN
      INTEGER            INFO, LDT, N
      DOUBLE PRECISION   SCALE, W
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   B( * ), T( LDT, * ), WORK( * ), X( * )
*     ..
*
* =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            NOTRAN
      INTEGER            I, IERR, J, J1, J2, JNEXT, K, N1, N2
      DOUBLE PRECISION   BIGNUM, EPS, REC, SCALOC, SI, SMIN, SMINW,
     $                   SMLNUM, SR, TJJ, TMP, XJ, XMAX, XNORM, Z
*     ..
*     .. Local Arrays ..
      DOUBLE PRECISION   D( 2, 2 ), V( 2, 2 )
*     ..
*     .. External Functions ..
      INTEGER            IDAMAX
      DOUBLE PRECISION   DASUM, DDOT, DLAMCH, DLANGE
      EXTERNAL           IDAMAX, DASUM, DDOT, DLAMCH, DLANGE
*     ..
*     .. External Subroutines ..
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```
      EXTERNAL           DAXPY, DLADIV, DLALN2, DSCAL
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX
*     ..
*     .. Executable Statements ..
*
*     Do not test the input parameters for errors
*
      NOTRAN = .NOT.LTRAN
      INFO = 0
*
*     Quick return if possible
*
      IF( N.EQ.0 )
     $   RETURN
*
*     Set constants to control overflow
*
      EPS = DLAMCH( 'P' )
      SMLNUM = DLAMCH( 'S' ) / EPS
      BIGNUM = ONE / SMLNUM
*
      XNORM = DLANGE( 'M', N, N, T, LDT, D )
      IF( .NOT.LREAL )
     $   XNORM = MAX( XNORM, ABS( W ), DLANGE( 'M', N, 1, B, N, D ) )
      SMIN = MAX( SMLNUM, EPS*XNORM )
*
*     Compute 1-norm of each column of strictly upper triangular
*     part of T to control overflow in triangular solver.
*
      WORK( 1 ) = ZERO
      DO 10 J = 2, N
         WORK( J ) = DASUM( J-1, T( 1, J ), 1 )
   10 CONTINUE
*
      IF( .NOT.LREAL ) THEN
         DO 20 I = 2, N
            WORK( I ) = WORK( I ) + ABS( B( I ) )
   20    CONTINUE
      END IF
*
      N2 = 2*N
      N1 = N
      IF( .NOT.LREAL )
     $   N1 = N2
      K = IDAMAX( N1, X, 1 )
      XMAX = ABS( X( K ) )
      SCALE = ONE
*
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      IF( XMAX.GT.BIGNUM ) THEN
         SCALE = BIGNUM / XMAX
         CALL DSCAL( N1, SCALE, X, 1 )
         XMAX = BIGNUM
      END IF
*
      IF( LREAL ) THEN
*
         IF( NOTRAN ) THEN
*
*           Solve T*p = scale*c
*
            JNEXT = N
            DO 30 J = N, 1, -1
               IF( J.GT.JNEXT )
     $            GO TO 30
               J1 = J
               J2 = J
               JNEXT = J - 1
               IF( J.GT.1 ) THEN
                  IF( T( J, J-1 ).NE.ZERO ) THEN
                     J1 = J - 1
                     JNEXT = J - 2
                  END IF
               END IF
*
               IF( J1.EQ.J2 ) THEN
*
*                 Meet 1 by 1 diagonal block
*
*                 Scale to avoid overflow when computing
*                     x(j) = b(j)/T(j,j)
*
                  XJ = ABS( X( J1 ) )
                  TJJ = ABS( T( J1, J1 ) )
                  TMP = T( J1, J1 )
                  IF( TJJ.LT.SMIN ) THEN
                     TMP = SMIN
                     TJJ = SMIN
                     INFO = 1
                  END IF
*
                  IF( XJ.EQ.ZERO )
     $               GO TO 30
*
                  IF( TJJ.LT.ONE ) THEN
                     IF( XJ.GT.BIGNUM*TJJ ) THEN
                        REC = ONE / XJ
                        CALL DSCAL( N, REC, X, 1 )
                        SCALE = SCALE*REC
```

```
                     XMAX = XMAX*REC
                  END IF
               END IF
               X( J1 ) = X( J1 ) / TMP
               XJ = ABS( X( J1 ) )
*
*              Scale x if necessary to avoid overflow when adding a
*              multiple of column j1 of T.
*
               IF( XJ.GT.ONE ) THEN
                  REC = ONE / XJ
                  IF( WORK( J1 ).GT.( BIGNUM-XMAX )*REC ) THEN
                     CALL DSCAL( N, REC, X, 1 )
                     SCALE = SCALE*REC
                  END IF
               END IF
               IF( J1.GT.1 ) THEN
                  CALL DAXPY( J1-1, -X( J1 ), T( 1, J1 ), 1, X, 1 )
                  K = IDAMAX( J1-1, X, 1 )
                  XMAX = ABS( X( K ) )
               END IF
*
            ELSE
*
*              Meet 2 by 2 diagonal block
*
*              Call 2 by 2 linear system solve, to take
*              care of possible overflow by scaling factor.
*
               D( 1, 1 ) = X( J1 )
               D( 2, 1 ) = X( J2 )
               CALL DLALN2( .FALSE., 2, 1, SMIN, ONE, T( J1, J1 ),
     $                     LDT, ONE, ONE, D, 2, ZERO, ZERO, V, 2,
     $                     SCALOC, XNORM, IERR )
               IF( IERR.NE.0 )
     $            INFO = 2
*
               IF( SCALOC.NE.ONE ) THEN
                  CALL DSCAL( N, SCALOC, X, 1 )
                  SCALE = SCALE*SCALOC
               END IF
               X( J1 ) = V( 1, 1 )
               X( J2 ) = V( 2, 1 )
*
*              Scale V(1,1) (= X(J1)) and/or V(2,1) (=X(J2))
*              to avoid overflow in updating right-hand side.
*
               XJ = MAX( ABS( V( 1, 1 ) ), ABS( V( 2, 1 ) ) )
               IF( XJ.GT.ONE ) THEN
                  REC = ONE / XJ
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```
                  IF( MAX( WORK( J1 ), WORK( J2 ) ).GT.
     $                ( BIGNUM-XMAX )*REC ) THEN
                     CALL DSCAL( N, REC, X, 1 )
                     SCALE = SCALE*REC
                  END IF
               END IF
*
*              Update right-hand side
*
               IF( J1.GT.1 ) THEN
                  CALL DAXPY( J1-1, -X( J1 ), T( 1, J1 ), 1, X, 1 )
                  CALL DAXPY( J1-1, -X( J2 ), T( 1, J2 ), 1, X, 1 )
                  K = IDAMAX( J1-1, X, 1 )
                  XMAX = ABS( X( K ) )
               END IF
*
            END IF
*
   30       CONTINUE
*
         ELSE
*
*           Solve T'*p = scale*c
*
            JNEXT = 1
            DO 40 J = 1, N
               IF( J.LT.JNEXT )
     $            GO TO 40
               J1 = J
               J2 = J
               JNEXT = J + 1
               IF( J.LT.N ) THEN
                  IF( T( J+1, J ).NE.ZERO ) THEN
                     J2 = J + 1
                     JNEXT = J + 2
                  END IF
               END IF
*
               IF( J1.EQ.J2 ) THEN
*
*                 1 by 1 diagonal block
*
*                 Scale if necessary to avoid overflow in forming the
*                 right-hand side element by inner product.
*
                  XJ = ABS( X( J1 ) )
                  IF( XMAX.GT.ONE ) THEN
                     REC = ONE / XMAX
                     IF( WORK( J1 ).GT.( BIGNUM-XJ )*REC ) THEN
                        CALL DSCAL( N, REC, X, 1 )
```

```
                     SCALE = SCALE*REC
                     XMAX = XMAX*REC
                  END IF
               END IF
*
               X( J1 ) = X( J1 ) - DDOT( J1-1, T( 1, J1 ), 1, X, 1 )
*
               XJ = ABS( X( J1 ) )
               TJJ = ABS( T( J1, J1 ) )
               TMP = T( J1, J1 )
               IF( TJJ.LT.SMIN ) THEN
                  TMP = SMIN
                  TJJ = SMIN
                  INFO = 1
               END IF
*
               IF( TJJ.LT.ONE ) THEN
                  IF( XJ.GT.BIGNUM*TJJ ) THEN
                     REC = ONE / XJ
                     CALL DSCAL( N, REC, X, 1 )
                     SCALE = SCALE*REC
                     XMAX = XMAX*REC
                  END IF
               END IF
               X( J1 ) = X( J1 ) / TMP
               XMAX = MAX( XMAX, ABS( X( J1 ) ) )
*
            ELSE
*
*              2 by 2 diagonal block
*
*              Scale if necessary to avoid overflow in forming the
*              right-hand side elements by inner product.
*
               XJ = MAX( ABS( X( J1 ) ), ABS( X( J2 ) ) )
               IF( XMAX.GT.ONE ) THEN
                  REC = ONE / XMAX
                  IF( MAX( WORK( J2 ), WORK( J1 ) ).GT.( BIGNUM-XJ )*
     $                REC ) THEN
                     CALL DSCAL( N, REC, X, 1 )
                     SCALE = SCALE*REC
                     XMAX = XMAX*REC
                  END IF
               END IF
*
               D( 1, 1 ) = X( J1 ) - DDOT( J1-1, T( 1, J1 ), 1, X,
     $                     1 )
               D( 2, 1 ) = X( J2 ) - DDOT( J1-1, T( 1, J2 ), 1, X,
     $                     1 )
*
```

```
                  CALL DLALN2( .TRUE., 2, 1, SMIN, ONE, T( J1, J1 ),
     $                         LDT, ONE, ONE, D, 2, ZERO, ZERO, V, 2,
     $                         SCALOC, XNORM, IERR )
                  IF( IERR.NE.0 )
     $               INFO = 2
*
                  IF( SCALOC.NE.ONE ) THEN
                     CALL DSCAL( N, SCALOC, X, 1 )
                     SCALE = SCALE*SCALOC
                  END IF
                  X( J1 ) = V( 1, 1 )
                  X( J2 ) = V( 2, 1 )
                  XMAX = MAX( ABS( X( J1 ) ), ABS( X( J2 ) ), XMAX )
*
               END IF
   40       CONTINUE
         END IF
*
      ELSE
*
         SMINW = MAX( EPS*ABS( W ), SMIN )
         IF( NOTRAN ) THEN
*
*           Solve (T + iB)*(p+iq) = c+id
*
            JNEXT = N
            DO 70 J = N, 1, -1
               IF( J.GT.JNEXT )
     $            GO TO 70
               J1 = J
               J2 = J
               JNEXT = J - 1
               IF( J.GT.1 ) THEN
                  IF( T( J, J-1 ).NE.ZERO ) THEN
                     J1 = J - 1
                     JNEXT = J - 2
                  END IF
               END IF
*
               IF( J1.EQ.J2 ) THEN
*
*                 1 by 1 diagonal block
*
*                 Scale if necessary to avoid overflow in division
*
                  Z = W
                  IF( J1.EQ.1 )
     $               Z = B( 1 )
                  XJ = ABS( X( J1 ) ) + ABS( X( N+J1 ) )
                  TJJ = ABS( T( J1, J1 ) ) + ABS( Z )
```

```
                  TMP = T( J1, J1 )
                  IF( TJJ.LT.SMINW ) THEN
                     TMP = SMINW
                     TJJ = SMINW
                     INFO = 1
                  END IF
*
                  IF( XJ.EQ.ZERO )
     $               GO TO 70
*
                  IF( TJJ.LT.ONE ) THEN
                     IF( XJ.GT.BIGNUM*TJJ ) THEN
                        REC = ONE / XJ
                        CALL DSCAL( N2, REC, X, 1 )
                        SCALE = SCALE*REC
                        XMAX = XMAX*REC
                     END IF
                  END IF
                  CALL DLADIV( X( J1 ), X( N+J1 ), TMP, Z, SR, SI )
                  X( J1 ) = SR
                  X( N+J1 ) = SI
                  XJ = ABS( X( J1 ) ) + ABS( X( N+J1 ) )
*
*                 Scale x if necessary to avoid overflow when adding a
*                 multiple of column j1 of T.
*
                  IF( XJ.GT.ONE ) THEN
                     REC = ONE / XJ
                     IF( WORK( J1 ).GT.( BIGNUM-XMAX )*REC ) THEN
                        CALL DSCAL( N2, REC, X, 1 )
                        SCALE = SCALE*REC
                     END IF
                  END IF
*
                  IF( J1.GT.1 ) THEN
                     CALL DAXPY( J1-1, -X( J1 ), T( 1, J1 ), 1, X, 1 )
                     CALL DAXPY( J1-1, -X( N+J1 ), T( 1, J1 ), 1,
     $                           X( N+1 ), 1 )
*
                     X( 1 ) = X( 1 ) + B( J1 )*X( N+J1 )
                     X( N+1 ) = X( N+1 ) - B( J1 )*X( J1 )
*
                     XMAX = ZERO
                     DO 50 K = 1, J1 - 1
                        XMAX = MAX( XMAX, ABS( X( K ) )+
     $                         ABS( X( K+N ) ) )
   50                CONTINUE
                  END IF
*
               ELSE
```

```
*
*                Meet 2 by 2 diagonal block
*
                 D( 1, 1 ) = X( J1 )
                 D( 2, 1 ) = X( J2 )
                 D( 1, 2 ) = X( N+J1 )
                 D( 2, 2 ) = X( N+J2 )
                 CALL DLALN2( .FALSE., 2, 2, SMINW, ONE, T( J1, J1 ),
     $                        LDT, ONE, ONE, D, 2, ZERO, -W, V, 2,
     $                        SCALOC, XNORM, IERR )
                 IF( IERR.NE.0 )
     $              INFO = 2
*
                 IF( SCALOC.NE.ONE ) THEN
                    CALL DSCAL( 2*N, SCALOC, X, 1 )
                    SCALE = SCALOC*SCALE
                 END IF
                 X( J1 ) = V( 1, 1 )
                 X( J2 ) = V( 2, 1 )
                 X( N+J1 ) = V( 1, 2 )
                 X( N+J2 ) = V( 2, 2 )
*
*                Scale X(J1), .... to avoid overflow in
*                updating right hand side.
*
                 XJ = MAX( ABS( V( 1, 1 ) )+ABS( V( 1, 2 ) ),
     $                ABS( V( 2, 1 ) )+ABS( V( 2, 2 ) ) )
                 IF( XJ.GT.ONE ) THEN
                    REC = ONE / XJ
                    IF( MAX( WORK( J1 ), WORK( J2 ) ).GT.
     $                  ( BIGNUM-XMAX )*REC ) THEN
                       CALL DSCAL( N2, REC, X, 1 )
                       SCALE = SCALE*REC
                    END IF
                 END IF
*
*                Update the right-hand side.
*
                 IF( J1.GT.1 ) THEN
                    CALL DAXPY( J1-1, -X( J1 ), T( 1, J1 ), 1, X, 1 )
                    CALL DAXPY( J1-1, -X( J2 ), T( 1, J2 ), 1, X, 1 )
*
                    CALL DAXPY( J1-1, -X( N+J1 ), T( 1, J1 ), 1,
     $                          X( N+1 ), 1 )
                    CALL DAXPY( J1-1, -X( N+J2 ), T( 1, J2 ), 1,
     $                          X( N+1 ), 1 )
*
                    X( 1 ) = X( 1 ) + B( J1 )*X( N+J1 ) +
     $                       B( J2 )*X( N+J2 )
                    X( N+1 ) = X( N+1 ) - B( J1 )*X( J1 ) -
```

```
     $                        B( J2 )*X( J2 )
*
                     XMAX = ZERO
                     DO 60 K = 1, J1 - 1
                        XMAX = MAX( ABS( X( K ) )+ABS( X( K+N ) ),
     $                         XMAX )
   60                CONTINUE
                  END IF
*
               END IF
   70       CONTINUE
*
         ELSE
*
*           Solve (T + iB)'*(p+iq) = c+id
*
            JNEXT = 1
            DO 80 J = 1, N
               IF( J.LT.JNEXT )
     $            GO TO 80
               J1 = J
               J2 = J
               JNEXT = J + 1
               IF( J.LT.N ) THEN
                  IF( T( J+1, J ).NE.ZERO ) THEN
                     J2 = J + 1
                     JNEXT = J + 2
                  END IF
               END IF
*
               IF( J1.EQ.J2 ) THEN
*
*                 1 by 1 diagonal block
*
*                 Scale if necessary to avoid overflow in forming the
*                 right-hand side element by inner product.
*
                  XJ = ABS( X( J1 ) ) + ABS( X( J1+N ) )
                  IF( XMAX.GT.ONE ) THEN
                     REC = ONE / XMAX
                     IF( WORK( J1 ).GT.( BIGNUM-XJ )*REC ) THEN
                        CALL DSCAL( N2, REC, X, 1 )
                        SCALE = SCALE*REC
                        XMAX = XMAX*REC
                     END IF
                  END IF
*
                  X( J1 ) = X( J1 ) - DDOT( J1-1, T( 1, J1 ), 1, X, 1 )
                  X( N+J1 ) = X( N+J1 ) - DDOT( J1-1, T( 1, J1 ), 1,
     $                        X( N+1 ), 1 )
```

```
                  IF( J1.GT.1 ) THEN
                     X( J1 ) = X( J1 ) - B( J1 )*X( N+1 )
                     X( N+J1 ) = X( N+J1 ) + B( J1 )*X( 1 )
                  END IF
                  XJ = ABS( X( J1 ) ) + ABS( X( J1+N ) )
*
                  Z = W
                  IF( J1.EQ.1 )
     $               Z = B( 1 )
*
*                 Scale if necessary to avoid overflow in
*                 complex division
*
                  TJJ = ABS( T( J1, J1 ) ) + ABS( Z )
                  TMP = T( J1, J1 )
                  IF( TJJ.LT.SMINW ) THEN
                     TMP = SMINW
                     TJJ = SMINW
                     INFO = 1
                  END IF
*
                  IF( TJJ.LT.ONE ) THEN
                     IF( XJ.GT.BIGNUM*TJJ ) THEN
                        REC = ONE / XJ
                        CALL DSCAL( N2, REC, X, 1 )
                        SCALE = SCALE*REC
                        XMAX = XMAX*REC
                     END IF
                  END IF
                  CALL DLADIV( X( J1 ), X( N+J1 ), TMP, -Z, SR, SI )
                  X( J1 ) = SR
                  X( J1+N ) = SI
                  XMAX = MAX( ABS( X( J1 ) )+ABS( X( J1+N ) ), XMAX )
*
               ELSE
*
*                 2 by 2 diagonal block
*
*                 Scale if necessary to avoid overflow in forming the
*                 right-hand side element by inner product.
*
                  XJ = MAX( ABS( X( J1 ) )+ABS( X( N+J1 ) ),
     $                 ABS( X( J2 ) )+ABS( X( N+J2 ) ) )
                  IF( XMAX.GT.ONE ) THEN
                     REC = ONE / XMAX
                     IF( MAX( WORK( J1 ), WORK( J2 ) ).GT.
     $                   ( BIGNUM-XJ ) / XMAX ) THEN
                        CALL DSCAL( N2, REC, X, 1 )
                        SCALE = SCALE*REC
                        XMAX = XMAX*REC
```

```
                  END IF
               END IF
*
               D( 1, 1 ) = X( J1 ) - DDOT( J1-1, T( 1, J1 ), 1, X,
     $                     1 )
               D( 2, 1 ) = X( J2 ) - DDOT( J1-1, T( 1, J2 ), 1, X,
     $                     1 )
               D( 1, 2 ) = X( N+J1 ) - DDOT( J1-1, T( 1, J1 ), 1,
     $                     X( N+1 ), 1 )
               D( 2, 2 ) = X( N+J2 ) - DDOT( J1-1, T( 1, J2 ), 1,
     $                     X( N+1 ), 1 )
               D( 1, 1 ) = D( 1, 1 ) - B( J1 )*X( N+1 )
               D( 2, 1 ) = D( 2, 1 ) - B( J2 )*X( N+1 )
               D( 1, 2 ) = D( 1, 2 ) + B( J1 )*X( 1 )
               D( 2, 2 ) = D( 2, 2 ) + B( J2 )*X( 1 )
*
               CALL DLALN2( .TRUE., 2, 2, SMINW, ONE, T( J1, J1 ),
     $                     LDT, ONE, ONE, D, 2, ZERO, W, V, 2,
     $                     SCALOC, XNORM, IERR )
               IF( IERR.NE.0 )
     $            INFO = 2
*
               IF( SCALOC.NE.ONE ) THEN
                  CALL DSCAL( N2, SCALOC, X, 1 )
                  SCALE = SCALOC*SCALE
               END IF
               X( J1 ) = V( 1, 1 )
               X( J2 ) = V( 2, 1 )
               X( N+J1 ) = V( 1, 2 )
               X( N+J2 ) = V( 2, 2 )
               XMAX = MAX( ABS( X( J1 ) )+ABS( X( N+J1 ) ),
     $                ABS( X( J2 ) )+ABS( X( N+J2 ) ), XMAX )
*
            END IF
*
   80    CONTINUE
*
         END IF
*
      END IF
*
      RETURN
*
*     End of DLAQTR
*
      END
```

———-

— LAPACK dlaqtr —

```
(let* ((zero 0.0) (one 1.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one))
  (defun dlaqtr (ltran lreal n t$ ldt b w scale x work info)
    (declare (type (double-float) scale w)
             (type (simple-array double-float (*)) work x b t$)
             (type fixnum info ldt n)
             (type (member t nil) lreal ltran))
    (f2cl-lib:with-multi-array-data
        ((t$ double-float t$-%data% t$-%offset%)
         (b double-float b-%data% b-%offset%)
         (x double-float x-%data% x-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((d (make-array 4 :element-type 'double-float))
             (v (make-array 4 :element-type 'double-float)) (bignum 0.0)
             (eps 0.0) (rec 0.0) (scaloc 0.0) (si 0.0) (smin 0.0) (sminw 0.0)
             (smlnum 0.0) (sr 0.0) (tjj 0.0) (tmp 0.0) (xj 0.0) (xmax 0.0)
             (xnorm 0.0) (z 0.0) (i 0) (ierr 0) (j 0) (j1 0) (j2 0) (jnext 0)
             (k 0) (n1 0) (n2 0) (notran nil))
        (declare (type (simple-array double-float (4)) d v)
                 (type (double-float) bignum eps rec scaloc si smin sminw
                                      smlnum sr tjj tmp xj xmax xnorm z)
                 (type fixnum i ierr j j1 j2 jnext k n1 n2)
                 (type (member t nil) notran))
        (setf notran (not ltran))
        (setf info 0)
        (if (= n 0) (go end_label))
        (setf eps (dlamch "P"))
        (setf smlnum (/ (dlamch "S") eps))
        (setf bignum (/ one smlnum))
        (setf xnorm (dlange "M" n n t$ ldt d))
        (if (not lreal)
            (setf xnorm (max xnorm (abs w) (dlange "M" n 1 b n d))))
        (setf smin (max smlnum (* eps xnorm)))
        (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%) zero)
        (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
                      ((> j n) nil)
          (tagbody
            (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
                    (dasum (f2cl-lib:int-sub j 1)
                     (f2cl-lib:array-slice t$
                                           double-float
                                           (1 j)
                                           ((1 ldt) (1 *)))
                     1))))
        (cond
          ((not lreal)
```

```
   (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
                 ((> i n) nil)
     (tagbody
       (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
         (+ (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
          (abs
           (f2cl-lib:fref b-%data% (i) ((1 *)) b-%offset%))))))));tpd
(setf n2 (f2cl-lib:int-mul 2 n))
(setf n1 n)
(if (not lreal) (setf n1 n2))
(setf k (idamax n1 x 1))
(setf xmax (abs (f2cl-lib:fref x-%data% (k) ((1 *)) x-%offset%)))
(setf scale one)
(cond
  ((> xmax bignum)
   (setf scale (/ bignum xmax))
   (dscal n1 scale x 1)
   (setf xmax bignum)))
(cond
  (lreal
   (cond
     (notran
      (setf jnext n)
      (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                    ((> j 1) nil)
        (tagbody
          (if (> j jnext) (go label30))
          (setf j1 j)
          (setf j2 j)
          (setf jnext (f2cl-lib:int-sub j 1))
          (cond
            ((> j 1)
             (cond
               ((/=
                 (f2cl-lib:fref t$
                                (j
                                 (f2cl-lib:int-add j
                                                   (f2cl-lib:int-sub
                                                    1)))
                                ((1 ldt) (1 *)))
                 zero)
                (setf j1 (f2cl-lib:int-sub j 1))
                (setf jnext (f2cl-lib:int-sub j 2))))))
          (cond
            ((= j1 j2)
             (setf xj
                   (abs
                    (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)))
             (setf tjj
                    (abs
```

```
         (f2cl-lib:fref t$-%data%
                        (j1 j1)
                        ((1 ldt) (1 *))
                        t$-%offset%)))
(setf tmp
        (f2cl-lib:fref t$-%data%
                       (j1 j1)
                       ((1 ldt) (1 *))
                       t$-%offset%))
(cond
  ((< tjj smin)
   (setf tmp smin)
   (setf tjj smin)
   (setf info 1)))
(if (= xj zero) (go label30))
(cond
  ((< tjj one)
   (cond
     ((> xj (* bignum tjj))
      (setf rec (/ one xj))
      (dscal n rec x 1)
      (setf scale (* scale rec))
      (setf xmax (* xmax rec))))))
(setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
        (/
         (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
         tmp))
(setf xj
      (abs
       (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)))
(cond
  ((> xj one)
   (setf rec (/ one xj))
   (cond
     ((> (f2cl-lib:fref work (j1) ((1 *)))
         (* (+ bignum (- xmax)) rec))
      (dscal n rec x 1)
      (setf scale (* scale rec))))))
(cond
  ((> j1 1)
   (daxpy (f2cl-lib:int-sub j1 1)
    (- (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%))
    (f2cl-lib:array-slice t$
                          double-float
                          (1 j1)
                          ((1 ldt) (1 *)))
    1 x 1)
   (setf k (idamax (f2cl-lib:int-sub j1 1) x 1))
   (setf xmax
           (abs
```

```
            (f2cl-lib:fref x-%data%
                           (k)
                           ((1 *))
                           x-%offset%))))))
(t
 (setf (f2cl-lib:fref d (1 1) ((1 2) (1 2)))
         (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%))
 (setf (f2cl-lib:fref d (2 1) ((1 2) (1 2)))
         (f2cl-lib:fref x-%data% (j2) ((1 *)) x-%offset%))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
        var-8 var-9 var-10 var-11 var-12 var-13 var-14
        var-15 var-16 var-17)
     (dlaln2 nil 2 1 smin one
      (f2cl-lib:array-slice t$
                            double-float
                            (j1 j1)
                            ((1 ldt) (1 *)))
      ldt one one d 2 zero zero v 2 scaloc xnorm ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9 var-10 var-11
                    var-12 var-13 var-14))
   (setf scaloc var-15)
   (setf xnorm var-16)
   (setf ierr var-17))
 (if (/= ierr 0) (setf info 2))
 (cond
   ((/= scaloc one)
    (dscal n scaloc x 1)
    (setf scale (* scale scaloc))))
 (setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
         (f2cl-lib:fref v (1 1) ((1 2) (1 2))))
 (setf (f2cl-lib:fref x-%data% (j2) ((1 *)) x-%offset%)
         (f2cl-lib:fref v (2 1) ((1 2) (1 2))))
 (setf xj
         (max (abs (f2cl-lib:fref v (1 1) ((1 2) (1 2))))
              (abs (f2cl-lib:fref v (2 1) ((1 2) (1 2))))))
 (cond
   ((> xj one)
    (setf rec (/ one xj))
    (cond
      ((>
        (max (f2cl-lib:fref work (j1) ((1 *)))
             (f2cl-lib:fref work (j2) ((1 *))))
        (* (+ bignum (- xmax)) rec))
       (dscal n rec x 1)
       (setf scale (* scale rec))))))
 (cond
   ((> j1 1)
    (daxpy (f2cl-lib:int-sub j1 1)
```

```
                        (- (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%))
                        (f2cl-lib:array-slice t$
                                              double-float
                                              (1 j1)
                                              ((1 ldt) (1 *)))
                        1 x 1)
                       (daxpy (f2cl-lib:int-sub j1 1)
                        (- (f2cl-lib:fref x-%data% (j2) ((1 *)) x-%offset%))
                        (f2cl-lib:array-slice t$
                                              double-float
                                              (1 j2)
                                              ((1 ldt) (1 *)))
                        1 x 1)
                       (setf k (idamax (f2cl-lib:int-sub j1 1) x 1))
                       (setf xmax
                               (abs
                                (f2cl-lib:fref x-%data%
                                               (k)
                                               ((1 *))
                                               x-%offset%)))))))
label30)))
             (t
              (setf jnext 1)
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
                (tagbody
                  (if (< j jnext) (go label40))
                  (setf j1 j)
                  (setf j2 j)
                  (setf jnext (f2cl-lib:int-add j 1))
                  (cond
                    ((< j n)
                     (cond
                       ((/=
                         (f2cl-lib:fref t$
                                        ((f2cl-lib:int-add j 1) j)
                                        ((1 ldt) (1 *)))
                         zero)
                        (setf j2 (f2cl-lib:int-add j 1))
                        (setf jnext (f2cl-lib:int-add j 2))))))
                  (cond
                    ((= j1 j2)
                     (setf xj
                             (abs
                              (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)))
                     (cond
                       ((> xmax one)
                        (setf rec (/ one xmax))
                        (cond
                          ((> (f2cl-lib:fref work (j1) ((1 *)))
```

```
          (* (+ bignum (- xj)) rec))
        (dscal n rec x 1)
        (setf scale (* scale rec))
        (setf xmax (* xmax rec))))))
(setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
        (-
         (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
         (ddot (f2cl-lib:int-sub j1 1)
          (f2cl-lib:array-slice t$
                                double-float
                                (1 j1)
                                ((1 ldt) (1 *)))
          1 x 1)))
(setf xj
       (abs
        (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)))
(setf tjj
        (abs
         (f2cl-lib:fref t$-%data%
                        (j1 j1)
                        ((1 ldt) (1 *))
                        t$-%offset%)))
(setf tmp
        (f2cl-lib:fref t$-%data%
                       (j1 j1)
                       ((1 ldt) (1 *))
                       t$-%offset%))
(cond
  ((< tjj smin)
   (setf tmp smin)
   (setf tjj smin)
   (setf info 1)))
(cond
  ((< tjj one)
   (cond
     ((> xj (* bignum tjj))
      (setf rec (/ one xj))
      (dscal n rec x 1)
      (setf scale (* scale rec))
      (setf xmax (* xmax rec))))))
(setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
        (/
         (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
         tmp))
(setf xmax
        (max xmax
             (abs
              (f2cl-lib:fref x-%data%
                             (j1)
                             ((1 *))
```

```
                                x-%offset%)))))
                (t
                 (setf xj
                       (max
                        (abs
                         (f2cl-lib:fref x-%data%
                                        (j1)
                                        ((1 *))
                                        x-%offset%))
                        (abs
                         (f2cl-lib:fref x-%data%
                                        (j2)
                                        ((1 *))
                                        x-%offset%))))
                 (cond
                   ((> xmax one)
                    (setf rec (/ one xmax))
                    (cond
                      ((>
                        (max (f2cl-lib:fref work (j2) ((1 *)))
                             (f2cl-lib:fref work (j1) ((1 *))))
                        (* (+ bignum (- xj)) rec))
                       (dscal n rec x 1)
                       (setf scale (* scale rec))
                       (setf xmax (* xmax rec))))))
                 (setf (f2cl-lib:fref d (1 1) ((1 2) (1 2)))
                       (-
                        (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
                        (ddot (f2cl-lib:int-sub j1 1)
                         (f2cl-lib:array-slice t$
                                               double-float
                                               (1 j1)
                                               ((1 ldt) (1 *)))
                         1 x 1)))
                 (setf (f2cl-lib:fref d (2 1) ((1 2) (1 2)))
                       (-
                        (f2cl-lib:fref x-%data% (j2) ((1 *)) x-%offset%)
                        (ddot (f2cl-lib:int-sub j1 1)
                         (f2cl-lib:array-slice t$
                                               double-float
                                               (1 j2)
                                               ((1 ldt) (1 *)))
                         1 x 1)))
                 (multiple-value-bind
                     (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                      var-8 var-9 var-10 var-11 var-12 var-13 var-14
                      var-15 var-16 var-17)
                   (dlaln2 t 2 1 smin one
                    (f2cl-lib:array-slice t$
                                          double-float
```

```
                                          (j1 j1)
                                          ((1 ldt) (1 *)))
                        ldt one one d 2 zero zero v 2 scaloc xnorm ierr)
                    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                                     var-6 var-7 var-8 var-9 var-10 var-11
                                     var-12 var-13 var-14))
                    (setf scaloc var-15)
                    (setf xnorm var-16)
                    (setf ierr var-17))
                  (if (/= ierr 0) (setf info 2))
                  (cond
                    ((/= scaloc one)
                     (dscal n scaloc x 1)
                     (setf scale (* scale scaloc))))
                  (setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
                          (f2cl-lib:fref v (1 1) ((1 2) (1 2))))
                  (setf (f2cl-lib:fref x-%data% (j2) ((1 *)) x-%offset%)
                          (f2cl-lib:fref v (2 1) ((1 2) (1 2))))
                  (setf xmax
                          (max
                           (abs
                            (f2cl-lib:fref x-%data%
                                           (j1)
                                           ((1 *))
                                           x-%offset%))
                           (abs
                            (f2cl-lib:fref x-%data%
                                           (j2)
                                           ((1 *))
                                           x-%offset%))
                           xmax))))
label40)))))
           (t
            (setf sminw (max (* eps (abs w)) smin))
            (cond
              (notran
               (setf jnext n)
               (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                             ((> j 1) nil)
                 (tagbody
                   (if (> j jnext) (go label70))
                   (setf j1 j)
                   (setf j2 j)
                   (setf jnext (f2cl-lib:int-sub j 1))
                   (cond
                     ((> j 1)
                      (cond
                        ((/=
                          (f2cl-lib:fref t$
                                         (j
```

```
                          (f2cl-lib:int-add j
                                           (f2cl-lib:int-sub
                                            1)))
                         ((1 ldt) (1 *)))
       zero)
      (setf j1 (f2cl-lib:int-sub j 1))
      (setf jnext (f2cl-lib:int-sub j 2))))))
(cond
  ((= j1 j2)
   (setf z w)
   (if (= j1 1)
       (setf z
             (f2cl-lib:fref b-%data%
                            (1)
                            ((1 *))
                            b-%offset%)))
   (setf xj
         (+
          (abs
           (f2cl-lib:fref x-%data%
                          (j1)
                          ((1 *))
                          x-%offset%))
          (abs
           (f2cl-lib:fref x-%data%
                          ((f2cl-lib:int-add n j1))
                          ((1 *))
                          x-%offset%))))
   (setf tjj
         (+
          (abs
           (f2cl-lib:fref t$-%data%
                          (j1 j1)
                          ((1 ldt) (1 *))
                          t$-%offset%))
          (abs z)))
   (setf tmp
         (f2cl-lib:fref t$-%data%
                        (j1 j1)
                        ((1 ldt) (1 *))
                        t$-%offset%))
   (cond
     ((< tjj sminw)
      (setf tmp sminw)
      (setf tjj sminw)
      (setf info 1)))
   (if (= xj zero) (go label70))
   (cond
     ((< tjj one)
      (cond
```

```
     ((> xj (* bignum tjj))
      (setf rec (/ one xj))
      (dscal n2 rec x 1)
      (setf scale (* scale rec))
      (setf xmax (* xmax rec))))))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5)
    (dladiv
     (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
     (f2cl-lib:fref x-%data%
                    ((f2cl-lib:int-add n j1))
                    ((1 *))
                    x-%offset%)
     tmp z sr si)
  (declare (ignore var-0 var-1 var-2 var-3))
  (setf sr var-4)
  (setf si var-5))
(setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%) sr)
(setf (f2cl-lib:fref x-%data%
                     ((f2cl-lib:int-add n j1))
                     ((1 *))
                     x-%offset%)
       si)
(setf xj
        (+
         (abs
          (f2cl-lib:fref x-%data%
                         (j1)
                         ((1 *))
                         x-%offset%))
         (abs
          (f2cl-lib:fref x-%data%
                         ((f2cl-lib:int-add n j1))
                         ((1 *))
                         x-%offset%))))
(cond
  ((> xj one)
   (setf rec (/ one xj))
   (cond
     ((> (f2cl-lib:fref work (j1) ((1 *)))
         (* (+ bignum (- xmax)) rec))
      (dscal n2 rec x 1)
      (setf scale (* scale rec))))))
(cond
  ((> j1 1)
   (daxpy (f2cl-lib:int-sub j1 1)
    (- (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%))
    (f2cl-lib:array-slice t$
                          double-float
                          (1 j1)
                          ((1 ldt) (1 *)))
```

```
 1 x 1)
(daxpy (f2cl-lib:int-sub j1 1)
 (-
  (f2cl-lib:fref x-%data%
                 ((f2cl-lib:int-add n j1))
                 ((1 *))
                 x-%offset%))
 (f2cl-lib:array-slice t$
                       double-float
                       (1 j1)
                       ((1 ldt) (1 *)))
 1
 (f2cl-lib:array-slice x
                       double-float
                       ((+ n 1))
                       ((1 *)))
 1)
(setf (f2cl-lib:fref x-%data% (1) ((1 *)) x-%offset%)
        (+
         (f2cl-lib:fref x-%data%
                        (1)
                        ((1 *))
                        x-%offset%)
         (*
          (f2cl-lib:fref b-%data%
                         (j1)
                         ((1 *))
                         b-%offset%)
          (f2cl-lib:fref x-%data%
                         ((f2cl-lib:int-add n j1))
                         ((1 *))
                         x-%offset%))))
(setf (f2cl-lib:fref x-%data%
                     ((f2cl-lib:int-add n 1))
                     ((1 *))
                     x-%offset%)
        (-
         (f2cl-lib:fref x-%data%
                        ((f2cl-lib:int-add n 1))
                        ((1 *))
                        x-%offset%)
         (*
          (f2cl-lib:fref b-%data%
                         (j1)
                         ((1 *))
                         b-%offset%)
          (f2cl-lib:fref x-%data%
                         (j1)
                         ((1 *))
                         x-%offset%))))
```

```
    (setf xmax zero)
    (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                  ((> k
                      (f2cl-lib:int-add j1
                                        (f2cl-lib:int-sub
                                         1)))
                   nil)
      (tagbody
        (setf xmax
                (max xmax
                     (+
                      (abs
                       (f2cl-lib:fref x-%data%
                                      (k)
                                      ((1 *))
                                      x-%offset%))
                      (abs
                       (f2cl-lib:fref x-%data%
                                      ((f2cl-lib:int-add k
                                                         n))
                                      ((1 *))
                                      x-%offset%)))))))))
(t
 (setf (f2cl-lib:fref d (1 1) ((1 2) (1 2)))
       (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%))
 (setf (f2cl-lib:fref d (2 1) ((1 2) (1 2)))
       (f2cl-lib:fref x-%data% (j2) ((1 *)) x-%offset%))
 (setf (f2cl-lib:fref d (1 2) ((1 2) (1 2)))
       (f2cl-lib:fref x-%data%
                      ((f2cl-lib:int-add n j1))
                      ((1 *))
                      x-%offset%))
 (setf (f2cl-lib:fref d (2 2) ((1 2) (1 2)))
       (f2cl-lib:fref x-%data%
                      ((f2cl-lib:int-add n j2))
                      ((1 *))
                      x-%offset%))
 (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14
       var-15 var-16 var-17)
     (dlaln2 nil 2 2 sminw one
      (f2cl-lib:array-slice t$
                            double-float
                            (j1 j1)
                            ((1 ldt) (1 *)))
     ldt one one d 2 zero (- w) v 2 scaloc xnorm ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                    var-6 var-7 var-8 var-9 var-10 var-11
                    var-12 var-13 var-14))
```

```
  (setf scaloc var-15)
  (setf xnorm var-16)
  (setf ierr var-17))
(if (/= ierr 0) (setf info 2))
(cond
  ((/= scaloc one)
   (dscal (f2cl-lib:int-mul 2 n) scaloc x 1)
   (setf scale (* scaloc scale))))
(setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
        (f2cl-lib:fref v (1 1) ((1 2) (1 2))))
(setf (f2cl-lib:fref x-%data% (j2) ((1 *)) x-%offset%)
        (f2cl-lib:fref v (2 1) ((1 2) (1 2))))
(setf (f2cl-lib:fref x-%data%
                     ((f2cl-lib:int-add n j1))
                     ((1 *))
                     x-%offset%)
        (f2cl-lib:fref v (1 2) ((1 2) (1 2))))
(setf (f2cl-lib:fref x-%data%
                     ((f2cl-lib:int-add n j2))
                     ((1 *))
                     x-%offset%)
        (f2cl-lib:fref v (2 2) ((1 2) (1 2))))
(setf xj
        (max
         (+ (abs (f2cl-lib:fref v (1 1) ((1 2) (1 2))))
            (abs (f2cl-lib:fref v (1 2) ((1 2) (1 2)))))
         (+ (abs (f2cl-lib:fref v (2 1) ((1 2) (1 2))))
            (abs (f2cl-lib:fref v (2 2) ((1 2) (1 2)))))))
(cond
  ((> xj one)
   (setf rec (/ one xj))
   (cond
     ((>
       (max (f2cl-lib:fref work (j1) ((1 *)))
            (f2cl-lib:fref work (j2) ((1 *))))
       (* (+ bignum (- xmax)) rec))
      (dscal n2 rec x 1)
      (setf scale (* scale rec))))))
(cond
  ((> j1 1)
   (daxpy (f2cl-lib:int-sub j1 1)
    (- (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%))
    (f2cl-lib:array-slice t$
                          double-float
                          (1 j1)
                          ((1 ldt) (1 *)))
    1 x 1)
   (daxpy (f2cl-lib:int-sub j1 1)
    (- (f2cl-lib:fref x-%data% (j2) ((1 *)) x-%offset%))
    (f2cl-lib:array-slice t$
```

```
                      double-float
                      (1 j2)
                      ((1 ldt) (1 *)))
 1 x 1)
(daxpy (f2cl-lib:int-sub j1 1)
 (-
  (f2cl-lib:fref x-%data%
                 ((f2cl-lib:int-add n j1))
                 ((1 *))
                 x-%offset%))
 (f2cl-lib:array-slice t$
                       double-float
                       (1 j1)
                       ((1 ldt) (1 *)))
 1
 (f2cl-lib:array-slice x
                       double-float
                       ((+ n 1))
                       ((1 *)))
 1)
(daxpy (f2cl-lib:int-sub j1 1)
 (-
  (f2cl-lib:fref x-%data%
                 ((f2cl-lib:int-add n j2))
                 ((1 *))
                 x-%offset%))
 (f2cl-lib:array-slice t$
                       double-float
                       (1 j2)
                       ((1 ldt) (1 *)))
 1
 (f2cl-lib:array-slice x
                       double-float
                       ((+ n 1))
                       ((1 *)))
 1)
(setf (f2cl-lib:fref x-%data% (1) ((1 *)) x-%offset%)
       (+
        (f2cl-lib:fref x-%data%
                       (1)
                       ((1 *))
                       x-%offset%)
        (*
         (f2cl-lib:fref b-%data%
                        (j1)
                        ((1 *))
                        b-%offset%)
         (f2cl-lib:fref x-%data%
                        ((f2cl-lib:int-add n j1))
                        ((1 *))
```

```
                                x-%offset%))
                         (*
                          (f2cl-lib:fref b-%data%
                                         (j2)
                                         ((1 *))
                                         b-%offset%)
                          (f2cl-lib:fref x-%data%
                                         ((f2cl-lib:int-add n j2))
                                         ((1 *))
                                         x-%offset%))))
                (setf (f2cl-lib:fref x-%data%
                                     ((f2cl-lib:int-add n 1))
                                     ((1 *))
                                     x-%offset%)
                      (-
                       (f2cl-lib:fref x-%data%
                                      ((f2cl-lib:int-add n 1))
                                      ((1 *))
                                      x-%offset%)
                       (*
                        (f2cl-lib:fref b-%data%
                                       (j1)
                                       ((1 *))
                                       b-%offset%)
                        (f2cl-lib:fref x-%data%
                                       (j1)
                                       ((1 *))
                                       x-%offset%))
                       (*
                        (f2cl-lib:fref b-%data%
                                       (j2)
                                       ((1 *))
                                       b-%offset%)
                        (f2cl-lib:fref x-%data%
                                       (j2)
                                       ((1 *))
                                       x-%offset%))))
                (setf xmax zero)
                (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                              ((> k
                                  (f2cl-lib:int-add j1
                                                    (f2cl-lib:int-sub
                                                     1)))
                               nil)
                  (tagbody
                    (setf xmax
                          (max
                           (+
                            (abs
                             (f2cl-lib:fref x-%data%
```

```
                                                (k)
                                                ((1 *))
                                                x-%offset%))
                                       (abs
                                        (f2cl-lib:fref x-%data%
                                                ((f2cl-lib:int-add k n))
                                                ((1 *))
                                                x-%offset%)))
                                     xmax))))))))
 label70)))
             (t
              (setf jnext 1)
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
                (tagbody
                  (if (< j jnext) (go label80))
                  (setf j1 j)
                  (setf j2 j)
                  (setf jnext (f2cl-lib:int-add j 1))
                  (cond
                    ((< j n)
                     (cond
                       ((/=
                         (f2cl-lib:fref t$
                                        ((f2cl-lib:int-add j 1) j)
                                        ((1 ldt) (1 *)))
                        zero)
                       (setf j2 (f2cl-lib:int-add j 1))
                       (setf jnext (f2cl-lib:int-add j 2))))))
                  (cond
                    ((= j1 j2)
                     (setf xj
                             (+
                              (abs
                               (f2cl-lib:fref x-%data%
                                             (j1)
                                             ((1 *))
                                             x-%offset%))
                              (abs
                               (f2cl-lib:fref x-%data%
                                             ((f2cl-lib:int-add j1 n))
                                             ((1 *))
                                             x-%offset%))))
                     (cond
                       ((> xmax one)
                        (setf rec (/ one xmax))
                        (cond
                          ((> (f2cl-lib:fref work (j1) ((1 *)))
                              (* (+ bignum (- xj)) rec))
                           (dscal n2 rec x 1)
```

```
      (setf scale (* scale rec))
      (setf xmax (* xmax rec))))))
(setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
        (-
         (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
         (ddot (f2cl-lib:int-sub j1 1)
          (f2cl-lib:array-slice t$
                                double-float
                                (1 j1)
                                ((1 ldt) (1 *)))
          1 x 1)))
(setf (f2cl-lib:fref x-%data%
                     ((f2cl-lib:int-add n j1))
                     ((1 *))
                     x-%offset%)
        (-
         (f2cl-lib:fref x-%data%
                        ((f2cl-lib:int-add n j1))
                        ((1 *))
                        x-%offset%)
         (ddot (f2cl-lib:int-sub j1 1)
          (f2cl-lib:array-slice t$
                                double-float
                                (1 j1)
                                ((1 ldt) (1 *)))
          1
          (f2cl-lib:array-slice x
                                double-float
                                ((+ n 1))
                                ((1 *)))
          1)))
(cond
  ((> j1 1)
   (setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
           (-
            (f2cl-lib:fref x-%data%
                           (j1)
                           ((1 *))
                           x-%offset%)
            (*
             (f2cl-lib:fref b-%data%
                            (j1)
                            ((1 *))
                            b-%offset%)
             (f2cl-lib:fref x-%data%
                            ((f2cl-lib:int-add n 1))
                            ((1 *))
                            x-%offset%))))
   (setf (f2cl-lib:fref x-%data%
                        ((f2cl-lib:int-add n j1))
```

```
                              ((1 *))
                              x-%offset%)
                 (+
                  (f2cl-lib:fref x-%data%
                                 ((f2cl-lib:int-add n j1))
                                 ((1 *))
                                 x-%offset%)
                  (*
                   (f2cl-lib:fref b-%data%
                                  (j1)
                                  ((1 *))
                                  b-%offset%)
                   (f2cl-lib:fref x-%data%
                                  (1)
                                  ((1 *))
                                  x-%offset%))))))
(setf xj
        (+
         (abs
          (f2cl-lib:fref x-%data%
                         (j1)
                         ((1 *))
                         x-%offset%))
         (abs
          (f2cl-lib:fref x-%data%
                         ((f2cl-lib:int-add j1 n))
                         ((1 *))
                         x-%offset%))))
(setf z w)
(if (= j1 1)
    (setf z
            (f2cl-lib:fref b-%data%
                           (1)
                           ((1 *))
                           b-%offset%)))
(setf tjj
        (+
         (abs
          (f2cl-lib:fref t$-%data%
                         (j1 j1)
                         ((1 ldt) (1 *))
                         t$-%offset%))
         (abs z)))
(setf tmp
        (f2cl-lib:fref t$-%data%
                       (j1 j1)
                       ((1 ldt) (1 *))
                       t$-%offset%))
(cond
  ((< tjj sminw)
```

```
   (setf tmp sminw)
   (setf tjj sminw)
   (setf info 1)))
(cond
  ((< tjj one)
   (cond
     ((> xj (* bignum tjj))
      (setf rec (/ one xj))
      (dscal n2 rec x 1)
      (setf scale (* scale rec))
      (setf xmax (* xmax rec))))))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5)
    (dladiv
     (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
     (f2cl-lib:fref x-%data%
                    ((f2cl-lib:int-add n j1))
                    ((1 *))
                    x-%offset%)
     tmp (- z) sr si)
  (declare (ignore var-0 var-1 var-2 var-3))
  (setf sr var-4)
  (setf si var-5))
(setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%) sr)
(setf (f2cl-lib:fref x-%data%
                     ((f2cl-lib:int-add j1 n))
                     ((1 *))
                     x-%offset%)
        si)
(setf xmax
        (max
         (+
          (abs
           (f2cl-lib:fref x-%data%
                          (j1)
                          ((1 *))
                          x-%offset%))
          (abs
           (f2cl-lib:fref x-%data%
                          ((f2cl-lib:int-add j1 n))
                          ((1 *))
                          x-%offset%)))
         xmax)))
(t
 (setf xj
        (max
         (+
          (abs
           (f2cl-lib:fref x-%data%
                          (j1)
                          ((1 *))
```

```
                                x-%offset%))
                  (abs
                   (f2cl-lib:fref x-%data%
                                  ((f2cl-lib:int-add n j1))
                                  ((1 *))
                                  x-%offset%)))
                 (+
                  (abs
                   (f2cl-lib:fref x-%data%
                                  (j2)
                                  ((1 *))
                                  x-%offset%))
                  (abs
                   (f2cl-lib:fref x-%data%
                                  ((f2cl-lib:int-add n j2))
                                  ((1 *))
                                  x-%offset%)))))
          (cond
            ((> xmax one)
             (setf rec (/ one xmax))
             (cond
               ((>
                 (max (f2cl-lib:fref work (j1) ((1 *)))
                      (f2cl-lib:fref work (j2) ((1 *))))
                 (f2cl-lib:f2cl/ (+ bignum (- xj)) xmax))
                (dscal n2 rec x 1)
                (setf scale (* scale rec))
                (setf xmax (* xmax rec))))))
          (setf (f2cl-lib:fref d (1 1) ((1 2) (1 2)))
                  (-
                   (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
                   (ddot (f2cl-lib:int-sub j1 1)
                    (f2cl-lib:array-slice t$
                                          double-float
                                          (1 j1)
                                          ((1 ldt) (1 *)))
                    1 x 1)))
          (setf (f2cl-lib:fref d (2 1) ((1 2) (1 2)))
                  (-
                   (f2cl-lib:fref x-%data% (j2) ((1 *)) x-%offset%)
                   (ddot (f2cl-lib:int-sub j1 1)
                    (f2cl-lib:array-slice t$
                                          double-float
                                          (1 j2)
                                          ((1 ldt) (1 *)))
                    1 x 1)))
          (setf (f2cl-lib:fref d (1 2) ((1 2) (1 2)))
                  (-
                   (f2cl-lib:fref x-%data%
                                  ((f2cl-lib:int-add n j1))
```

```
                                ((1 *))
                                x-%offset%)
                          (ddot (f2cl-lib:int-sub j1 1)
                           (f2cl-lib:array-slice t$
                                                 double-float
                                                 (1 j1)
                                                 ((1 ldt) (1 *)))
                           1
                           (f2cl-lib:array-slice x
                                                 double-float
                                                 ((+ n 1))
                                                 ((1 *)))
                           1)))
                  (setf (f2cl-lib:fref d (2 2) ((1 2) (1 2)))
                        (-
                         (f2cl-lib:fref x-%data%
                                        ((f2cl-lib:int-add n j2))
                                        ((1 *))
                                        x-%offset%)
                         (ddot (f2cl-lib:int-sub j1 1)
                          (f2cl-lib:array-slice t$
                                                double-float
                                                (1 j2)
                                                ((1 ldt) (1 *)))
                          1
                          (f2cl-lib:array-slice x
                                                double-float
                                                ((+ n 1))
                                                ((1 *)))
                          1)))
                  (setf (f2cl-lib:fref d (1 1) ((1 2) (1 2)))
                        (- (f2cl-lib:fref d (1 1) ((1 2) (1 2)))
                           (*
                            (f2cl-lib:fref b-%data%
                                           (j1)
                                           ((1 *))
                                           b-%offset%)
                            (f2cl-lib:fref x-%data%
                                           ((f2cl-lib:int-add n 1))
                                           ((1 *))
                                           x-%offset%))))
                  (setf (f2cl-lib:fref d (2 1) ((1 2) (1 2)))
                        (- (f2cl-lib:fref d (2 1) ((1 2) (1 2)))
                           (*
                            (f2cl-lib:fref b-%data%
                                           (j2)
                                           ((1 *))
                                           b-%offset%)
                            (f2cl-lib:fref x-%data%
                                           ((f2cl-lib:int-add n 1))
```

```
                          ((1 *))
                          x-%offset%))))
(setf (f2cl-lib:fref d (1 2) ((1 2) (1 2)))
        (+ (f2cl-lib:fref d (1 2) ((1 2) (1 2)))
           (*
            (f2cl-lib:fref b-%data%
                          (j1)
                          ((1 *))
                          b-%offset%)
            (f2cl-lib:fref x-%data%
                          (1)
                          ((1 *))
                          x-%offset%))))
(setf (f2cl-lib:fref d (2 2) ((1 2) (1 2)))
        (+ (f2cl-lib:fref d (2 2) ((1 2) (1 2)))
           (*
            (f2cl-lib:fref b-%data%
                          (j2)
                          ((1 *))
                          b-%offset%)
            (f2cl-lib:fref x-%data%
                          (1)
                          ((1 *))
                          x-%offset%))))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14
       var-15 var-16 var-17)
    (dlaln2 t 2 2 sminw one
     (f2cl-lib:array-slice t$
                          double-float
                          (j1 j1)
                          ((1 ldt) (1 *)))
     ldt one one d 2 zero w v 2 scaloc xnorm ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9 var-10 var-11
                   var-12 var-13 var-14))
  (setf scaloc var-15)
  (setf xnorm var-16)
  (setf ierr var-17))
(if (/= ierr 0) (setf info 2))
(cond
  ((/= scaloc one)
   (dscal n2 scaloc x 1)
   (setf scale (* scaloc scale))))
(setf (f2cl-lib:fref x-%data% (j1) ((1 *)) x-%offset%)
        (f2cl-lib:fref v (1 1) ((1 2) (1 2))))
(setf (f2cl-lib:fref x-%data% (j2) ((1 *)) x-%offset%)
        (f2cl-lib:fref v (2 1) ((1 2) (1 2))))
(setf (f2cl-lib:fref x-%data%
```

```
                                        ((f2cl-lib:int-add n j1))
                                        ((1 *))
                                        x-%offset%)
                                (f2cl-lib:fref v (1 2) ((1 2) (1 2))))
                        (setf (f2cl-lib:fref x-%data%
                                        ((f2cl-lib:int-add n j2))
                                        ((1 *))
                                        x-%offset%)
                                (f2cl-lib:fref v (2 2) ((1 2) (1 2))))
                        (setf xmax
                                (max
                                 (+
                                  (abs
                                   (f2cl-lib:fref x-%data%
                                                  (j1)
                                                  ((1 *))
                                                  x-%offset%))
                                  (abs
                                   (f2cl-lib:fref x-%data%
                                                  ((f2cl-lib:int-add n j1))
                                                  ((1 *))
                                                  x-%offset%)))
                                 (+
                                  (abs
                                   (f2cl-lib:fref x-%data%
                                                  (j2)
                                                  ((1 *))
                                                  x-%offset%))
                                  (abs
                                   (f2cl-lib:fref x-%data%
                                                  ((f2cl-lib:int-add n j2))
                                                  ((1 *))
                                                  x-%offset%)))
                                 xmax))))
 label80))))))
 end_label
        (return (values nil nil nil nil nil nil nil scale nil nil info))))))
```

———-

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— dlarfb.input —

```
)set break resume
)sys rm -f dlarfb.output
```

```
)spool dlarfb.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dlarfb.help —

```
==========================================================================
dlarfb examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

NAME
       DLARFB  - a real block reflector H or its transpose H' to a real m by n
       matrix C, from either the left or the right

SYNOPSIS
       SUBROUTINE DLARFB( SIDE, TRANS, DIRECT, STOREV, M, N,  K,  V,  LDV,  T,
                          LDT, C, LDC, WORK, LDWORK )

           CHARACTER      DIRECT, SIDE, STOREV, TRANS

           INTEGER        K, LDC, LDT, LDV, LDWORK, M, N

           DOUBLE         PRECISION  C(  LDC,  *  ), T( LDT, * ), V( LDV, * ),
                          WORK( LDWORK, * )

 Purpose
 =======

  DLARFB applies a real block reflector H or its transpose H' to a
  real m by n matrix C, from either the left or the right.

 Arguments
 =========

  SIDE    (input) CHARACTER*1
          = 'L': apply H or H' from the Left
          = 'R': apply H or H' from the Right

  TRANS   (input) CHARACTER*1
```

```
          = 'N': apply H (No transpose)
          = 'T': apply H' (Transpose)

  DIRECT  (input) CHARACTER*1
          Indicates how H is formed from a product of elementary
          reflectors
          = 'F': H = H(1) H(2) . . . H(k) (Forward)
          = 'B': H = H(k) . . . H(2) H(1) (Backward)

  STOREV  (input) CHARACTER*1
          Indicates how the vectors which define the elementary
          reflectors are stored:
          = 'C': Columnwise
          = 'R': Rowwise

  M       (input) INTEGER
          The number of rows of the matrix C.

  N       (input) INTEGER
          The number of columns of the matrix C.

  K       (input) INTEGER
          The order of the matrix T (= the number of elementary
          reflectors whose product defines the block reflector).

  V       (input) DOUBLE PRECISION array, dimension
                                (LDV,K) if STOREV = 'C'
                                (LDV,M) if STOREV = 'R' and SIDE = 'L'
                                (LDV,N) if STOREV = 'R' and SIDE = 'R'
          The matrix V. See further details.

  LDV     (input) INTEGER
          The leading dimension of the array V.
          If STOREV = 'C' and SIDE = 'L', LDV >= max(1,M);
          if STOREV = 'C' and SIDE = 'R', LDV >= max(1,N);
          if STOREV = 'R', LDV >= K.

  T       (input) DOUBLE PRECISION array, dimension (LDT,K)
          The triangular k by k matrix T in the representation of the
          block reflector.

  LDT     (input) INTEGER
          The leading dimension of the array T. LDT >= K.

  C       (input/output) DOUBLE PRECISION array, dimension (LDC,N)
          On entry, the m by n matrix C.
          On exit, C is overwritten by H*C or H'*C or C*H or C*H'.

  LDC     (input) INTEGER
          The leading dimension of the array C. LDA >= max(1,M).
```

```
  WORK    (workspace) DOUBLE PRECISION array, dimension (LDWORK,K)

  LDWORK  (input) INTEGER
          The leading dimension of the array WORK.
          If SIDE = 'L', LDWORK >= max(1,N);
          if SIDE = 'R', LDWORK >= max(1,M).
```

———-

— dlarfb.f —

```
      SUBROUTINE DLARFB( SIDE, TRANS, DIRECT, STOREV, M, N, K, V, LDV,
     $                   T, LDT, C, LDC, WORK, LDWORK )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     February 29, 1992
*
*     .. Scalar Arguments ..
      CHARACTER          DIRECT, SIDE, STOREV, TRANS
      INTEGER            K, LDC, LDT, LDV, LDWORK, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   C( LDC, * ), T( LDT, * ), V( LDV, * ),
     $                   WORK( LDWORK, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE
      PARAMETER          ( ONE = 1.0D+0 )
*     ..
*     .. Local Scalars ..
      CHARACTER          TRANST
      INTEGER            I, J
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. External Subroutines ..
      EXTERNAL           DCOPY, DGEMM, DTRMM
*     ..
*     .. Executable Statements ..
*
```

```
*     Quick return if possible
*
      IF( M.LE.0 .OR. N.LE.0 )
     $   RETURN
*
      IF( LSAME( TRANS, 'N' ) ) THEN
         TRANST = 'T'
      ELSE
         TRANST = 'N'
      END IF
*
      IF( LSAME( STOREV, 'C' ) ) THEN
*
         IF( LSAME( DIRECT, 'F' ) ) THEN
*
*           Let  V =  ( V1 )    (first K rows)
*                     ( V2 )
*           where  V1  is unit lower triangular.
*
            IF( LSAME( SIDE, 'L' ) ) THEN
*
*              Form  H * C  or  H' * C  where  C = ( C1 )
*                                                  ( C2 )
*
*              W := C' * V  =  (C1'*V1 + C2'*V2)  (stored in WORK)
*
*              W := C1'
*
               DO 10 J = 1, K
                  CALL DCOPY( N, C( J, 1 ), LDC, WORK( 1, J ), 1 )
   10          CONTINUE
*
*              W := W * V1
*
               CALL DTRMM( 'Right', 'Lower', 'No transpose', 'Unit', N,
     $                     K, ONE, V, LDV, WORK, LDWORK )
               IF( M.GT.K ) THEN
*
*                 W := W + C2'*V2
*
                  CALL DGEMM( 'Transpose', 'No transpose', N, K, M-K,
     $                        ONE, C( K+1, 1 ), LDC, V( K+1, 1 ), LDV,
     $                        ONE, WORK, LDWORK )
               END IF
*
*              W := W * T'  or  W * T
*
               CALL DTRMM( 'Right', 'Upper', TRANST, 'Non-unit', N, K,
     $                     ONE, T, LDT, WORK, LDWORK )
*
```

```
*              C := C - V * W'
*
               IF( M.GT.K ) THEN
*
*                 C2 := C2 - V2 * W'
*
                  CALL DGEMM( 'No transpose', 'Transpose', M-K, N, K,
     $                        -ONE, V( K+1, 1 ), LDV, WORK, LDWORK, ONE,
     $                        C( K+1, 1 ), LDC )
               END IF
*
*              W := W * V1'
*
               CALL DTRMM( 'Right', 'Lower', 'Transpose', 'Unit', N, K,
     $                     ONE, V, LDV, WORK, LDWORK )
*
*              C1 := C1 - W'
*
               DO 30 J = 1, K
                  DO 20 I = 1, N
                     C( J, I ) = C( J, I ) - WORK( I, J )
   20             CONTINUE
   30          CONTINUE
*
            ELSE IF( LSAME( SIDE, 'R' ) ) THEN
*
*              Form  C * H  or  C * H'  where  C = ( C1  C2 )
*
*              W := C * V  =  (C1*V1 + C2*V2)  (stored in WORK)
*
*              W := C1
*
               DO 40 J = 1, K
                  CALL DCOPY( M, C( 1, J ), 1, WORK( 1, J ), 1 )
   40          CONTINUE
*
*              W := W * V1
*
               CALL DTRMM( 'Right', 'Lower', 'No transpose', 'Unit', M,
     $                     K, ONE, V, LDV, WORK, LDWORK )
               IF( N.GT.K ) THEN
*
*                 W := W + C2 * V2
*
                  CALL DGEMM( 'No transpose', 'No transpose', M, K, N-K,
     $                        ONE, C( 1, K+1 ), LDC, V( K+1, 1 ), LDV,
     $                        ONE, WORK, LDWORK )
               END IF
*
*              W := W * T  or  W * T'
```

```
*
               CALL DTRMM( 'Right', 'Upper', TRANS, 'Non-unit', M, K,
     $                     ONE, T, LDT, WORK, LDWORK )
*
*              C := C - W * V'
*
               IF( N.GT.K ) THEN
*
*                 C2 := C2 - W * V2'
*
                  CALL DGEMM( 'No transpose', 'Transpose', M, N-K, K,
     $                        -ONE, WORK, LDWORK, V( K+1, 1 ), LDV, ONE,
     $                        C( 1, K+1 ), LDC )
               END IF
*
*              W := W * V1'
*
               CALL DTRMM( 'Right', 'Lower', 'Transpose', 'Unit', M, K,
     $                     ONE, V, LDV, WORK, LDWORK )
*
*              C1 := C1 - W
*
               DO 60 J = 1, K
                  DO 50 I = 1, M
                     C( I, J ) = C( I, J ) - WORK( I, J )
   50             CONTINUE
   60          CONTINUE
            END IF
*
         ELSE
*
*           Let  V =  ( V1 )
*                     ( V2 )    (last K rows)
*           where  V2  is unit upper triangular.
*
            IF( LSAME( SIDE, 'L' ) ) THEN
*
*              Form  H * C  or  H' * C  where  C = ( C1 )
*                                                  ( C2 )
*
*              W := C' * V  =  (C1'*V1 + C2'*V2)  (stored in WORK)
*
*              W := C2'
*
               DO 70 J = 1, K
                  CALL DCOPY( N, C( M-K+J, 1 ), LDC, WORK( 1, J ), 1 )
   70          CONTINUE
*
*              W := W * V2
*
```

```
               CALL DTRMM( 'Right', 'Upper', 'No transpose', 'Unit', N,
     $                     K, ONE, V( M-K+1, 1 ), LDV, WORK, LDWORK )
               IF( M.GT.K ) THEN
*
*                 W := W + C1'*V1
*
                  CALL DGEMM( 'Transpose', 'No transpose', N, K, M-K,
     $                        ONE, C, LDC, V, LDV, ONE, WORK, LDWORK )
               END IF
*
*              W := W * T'  or  W * T
*
               CALL DTRMM( 'Right', 'Lower', TRANST, 'Non-unit', N, K,
     $                     ONE, T, LDT, WORK, LDWORK )
*
*              C := C - V * W'
*
               IF( M.GT.K ) THEN
*
*                 C1 := C1 - V1 * W'
*
                  CALL DGEMM( 'No transpose', 'Transpose', M-K, N, K,
     $                        -ONE, V, LDV, WORK, LDWORK, ONE, C, LDC )
               END IF
*
*              W := W * V2'
*
               CALL DTRMM( 'Right', 'Upper', 'Transpose', 'Unit', N, K,
     $                     ONE, V( M-K+1, 1 ), LDV, WORK, LDWORK )
*
*              C2 := C2 - W'
*
               DO 90 J = 1, K
                  DO 80 I = 1, N
                     C( M-K+J, I ) = C( M-K+J, I ) - WORK( I, J )
   80             CONTINUE
   90          CONTINUE
*
            ELSE IF( LSAME( SIDE, 'R' ) ) THEN
*
*              Form  C * H  or  C * H'  where  C = ( C1  C2 )
*
*              W := C * V  =  (C1*V1 + C2*V2)  (stored in WORK)
*
*              W := C2
*
               DO 100 J = 1, K
                  CALL DCOPY( M, C( 1, N-K+J ), 1, WORK( 1, J ), 1 )
  100          CONTINUE
*
```

```
*              W := W * V2
*
               CALL DTRMM( 'Right', 'Upper', 'No transpose', 'Unit', M,
     $                     K, ONE, V( N-K+1, 1 ), LDV, WORK, LDWORK )
               IF( N.GT.K ) THEN
*
*                 W := W + C1 * V1
*
                  CALL DGEMM( 'No transpose', 'No transpose', M, K, N-K,
     $                        ONE, C, LDC, V, LDV, ONE, WORK, LDWORK )
               END IF
*
*              W := W * T  or  W * T'
*
               CALL DTRMM( 'Right', 'Lower', TRANS, 'Non-unit', M, K,
     $                     ONE, T, LDT, WORK, LDWORK )
*
*              C := C - W * V'
*
               IF( N.GT.K ) THEN
*
*                 C1 := C1 - W * V1'
*
                  CALL DGEMM( 'No transpose', 'Transpose', M, N-K, K,
     $                        -ONE, WORK, LDWORK, V, LDV, ONE, C, LDC )
               END IF
*
*              W := W * V2'
*
               CALL DTRMM( 'Right', 'Upper', 'Transpose', 'Unit', M, K,
     $                     ONE, V( N-K+1, 1 ), LDV, WORK, LDWORK )
*
*              C2 := C2 - W
*
               DO 120 J = 1, K
                  DO 110 I = 1, M
                     C( I, N-K+J ) = C( I, N-K+J ) - WORK( I, J )
  110             CONTINUE
  120          CONTINUE
            END IF
         END IF
*
      ELSE IF( LSAME( STOREV, 'R' ) ) THEN
*
         IF( LSAME( DIRECT, 'F' ) ) THEN
*
*           Let  V =  ( V1  V2 )    (V1: first K columns)
*           where  V1  is unit upper triangular.
*
            IF( LSAME( SIDE, 'L' ) ) THEN
```

```
*
*              Form  H * C  or  H' * C  where  C = ( C1 )
*                                                  ( C2 )
*
*              W := C' * V'  =  (C1'*V1' + C2'*V2') (stored in WORK)
*
*              W := C1'
*
               DO 130 J = 1, K
                  CALL DCOPY( N, C( J, 1 ), LDC, WORK( 1, J ), 1 )
  130          CONTINUE
*
*              W := W * V1'
*
               CALL DTRMM( 'Right', 'Upper', 'Transpose', 'Unit', N, K,
     $                     ONE, V, LDV, WORK, LDWORK )
               IF( M.GT.K ) THEN
*
*                 W := W + C2'*V2'
*
                  CALL DGEMM( 'Transpose', 'Transpose', N, K, M-K, ONE,
     $                        C( K+1, 1 ), LDC, V( 1, K+1 ), LDV, ONE,
     $                        WORK, LDWORK )
               END IF
*
*              W := W * T'  or  W * T
*
               CALL DTRMM( 'Right', 'Upper', TRANST, 'Non-unit', N, K,
     $                     ONE, T, LDT, WORK, LDWORK )
*
*              C := C - V' * W'
*
               IF( M.GT.K ) THEN
*
*                 C2 := C2 - V2' * W'
*
                  CALL DGEMM( 'Transpose', 'Transpose', M-K, N, K, -ONE,
     $                        V( 1, K+1 ), LDV, WORK, LDWORK, ONE,
     $                        C( K+1, 1 ), LDC )
               END IF
*
*              W := W * V1
*
               CALL DTRMM( 'Right', 'Upper', 'No transpose', 'Unit', N,
     $                     K, ONE, V, LDV, WORK, LDWORK )
*
*              C1 := C1 - W'
*
               DO 150 J = 1, K
                  DO 140 I = 1, N
```

```
                     C( J, I ) = C( J, I ) - WORK( I, J )
  140             CONTINUE
  150          CONTINUE
*
            ELSE IF( LSAME( SIDE, 'R' ) ) THEN
*
*              Form  C * H  or  C * H'  where  C = ( C1  C2 )
*
*              W := C * V'  =  (C1*V1' + C2*V2')  (stored in WORK)
*
*              W := C1
*
               DO 160 J = 1, K
                  CALL DCOPY( M, C( 1, J ), 1, WORK( 1, J ), 1 )
  160          CONTINUE
*
*              W := W * V1'
*
               CALL DTRMM( 'Right', 'Upper', 'Transpose', 'Unit', M, K,
     $                     ONE, V, LDV, WORK, LDWORK )
               IF( N.GT.K ) THEN
*
*                 W := W + C2 * V2'
*
                  CALL DGEMM( 'No transpose', 'Transpose', M, K, N-K,
     $                        ONE, C( 1, K+1 ), LDC, V( 1, K+1 ), LDV,
     $                        ONE, WORK, LDWORK )
               END IF
*
*              W := W * T  or  W * T'
*
               CALL DTRMM( 'Right', 'Upper', TRANS, 'Non-unit', M, K,
     $                     ONE, T, LDT, WORK, LDWORK )
*
*              C := C - W * V
*
               IF( N.GT.K ) THEN
*
*                 C2 := C2 - W * V2
*
                  CALL DGEMM( 'No transpose', 'No transpose', M, N-K, K,
     $                        -ONE, WORK, LDWORK, V( 1, K+1 ), LDV, ONE,
     $                        C( 1, K+1 ), LDC )
               END IF
*
*              W := W * V1
*
               CALL DTRMM( 'Right', 'Upper', 'No transpose', 'Unit', M,
     $                     K, ONE, V, LDV, WORK, LDWORK )
*
```

```
*              C1 := C1 - W
*
               DO 180 J = 1, K
                  DO 170 I = 1, M
                     C( I, J ) = C( I, J ) - WORK( I, J )
  170             CONTINUE
  180          CONTINUE
*
            END IF
*
         ELSE
*
*           Let  V =  ( V1  V2 )    (V2: last K columns)
*           where  V2  is unit lower triangular.
*
            IF( LSAME( SIDE, 'L' ) ) THEN
*
*              Form  H * C  or  H' * C  where  C = ( C1 )
*                                                  ( C2 )
*
*              W := C' * V'  =  (C1'*V1' + C2'*V2') (stored in WORK)
*
*              W := C2'
*
               DO 190 J = 1, K
                  CALL DCOPY( N, C( M-K+J, 1 ), LDC, WORK( 1, J ), 1 )
  190          CONTINUE
*
*              W := W * V2'
*
               CALL DTRMM( 'Right', 'Lower', 'Transpose', 'Unit', N, K,
     $                     ONE, V( 1, M-K+1 ), LDV, WORK, LDWORK )
               IF( M.GT.K ) THEN
*
*                 W := W + C1'*V1'
*
                  CALL DGEMM( 'Transpose', 'Transpose', N, K, M-K, ONE,
     $                        C, LDC, V, LDV, ONE, WORK, LDWORK )
               END IF
*
*              W := W * T'  or  W * T
*
               CALL DTRMM( 'Right', 'Lower', TRANST, 'Non-unit', N, K,
     $                     ONE, T, LDT, WORK, LDWORK )
*
*              C := C - V' * W'
*
               IF( M.GT.K ) THEN
*
*                 C1 := C1 - V1' * W'
```

```
*
                  CALL DGEMM( 'Transpose', 'Transpose', M-K, N, K, -ONE,
     $                        V, LDV, WORK, LDWORK, ONE, C, LDC )
               END IF
*
*              W := W * V2
*
               CALL DTRMM( 'Right', 'Lower', 'No transpose', 'Unit', N,
     $                     K, ONE, V( 1, M-K+1 ), LDV, WORK, LDWORK )
*
*              C2 := C2 - W'
*
               DO 210 J = 1, K
                  DO 200 I = 1, N
                     C( M-K+J, I ) = C( M-K+J, I ) - WORK( I, J )
  200             CONTINUE
  210          CONTINUE
*
            ELSE IF( LSAME( SIDE, 'R' ) ) THEN
*
*              Form  C * H  or  C * H'  where  C = ( C1  C2 )
*
*              W := C * V'  =  (C1*V1' + C2*V2')  (stored in WORK)
*
*              W := C2
*
               DO 220 J = 1, K
                  CALL DCOPY( M, C( 1, N-K+J ), 1, WORK( 1, J ), 1 )
  220          CONTINUE
*
*              W := W * V2'
*
               CALL DTRMM( 'Right', 'Lower', 'Transpose', 'Unit', M, K,
     $                     ONE, V( 1, N-K+1 ), LDV, WORK, LDWORK )
               IF( N.GT.K ) THEN
*
*                 W := W + C1 * V1'
*
                  CALL DGEMM( 'No transpose', 'Transpose', M, K, N-K,
     $                        ONE, C, LDC, V, LDV, ONE, WORK, LDWORK )
               END IF
*
*              W := W * T  or  W * T'
*
               CALL DTRMM( 'Right', 'Lower', TRANS, 'Non-unit', M, K,
     $                     ONE, T, LDT, WORK, LDWORK )
*
*              C := C - W * V
*
               IF( N.GT.K ) THEN
```

```
*
*                C1 := C1 - W * V1
*
                 CALL DGEMM( 'No transpose', 'No transpose', M, N-K, K,
     $                       -ONE, WORK, LDWORK, V, LDV, ONE, C, LDC )
              END IF
*
*              W := W * V2
*
              CALL DTRMM( 'Right', 'Lower', 'No transpose', 'Unit', M,
     $                    K, ONE, V( 1, N-K+1 ), LDV, WORK, LDWORK )
*
*              C1 := C1 - W
*
              DO 240 J = 1, K
                 DO 230 I = 1, M
                    C( I, N-K+J ) = C( I, N-K+J ) - WORK( I, J )
  230            CONTINUE
  240         CONTINUE
*
           END IF
*
        END IF
      END IF
*
      RETURN
*
*     End of DLARFB
*
      END
```

———-

— LAPACK dlarfb —

```
(let* ((one 1.0))
  (declare (type (double-float 1.0 1.0) one))
  (defun dlarfb (side trans direct storev m n k v ldv t$ ldt c ldc work ldwork)
    (declare (type (simple-array double-float (*)) work c t$ v)
             (type fixnum ldwork ldc ldt ldv k n m)
             (type character storev direct trans side))
    (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (trans character trans-%data% trans-%offset%)
         (direct character direct-%data% direct-%offset%)
         (storev character storev-%data% storev-%offset%)
         (v double-float v-%data% v-%offset%)
         (t$ double-float t$-%data% t$-%offset%)
```

```
   (c double-float c-%data% c-%offset%)
   (work double-float work-%data% work-%offset%))
  (prog ((i 0) (j 0)
         (transt
          (make-array '(1) :element-type 'character :initial-element #\ )))
    (declare (type fixnum i j)
             (type (simple-array character (1)) transt))
    (if (or (<= m 0) (<= n 0)) (go end_label))
    (cond
      ((char-equal trans #\N)
       (f2cl-lib:f2cl-set-string transt "T" (string 1)))
      (t
       (f2cl-lib:f2cl-set-string transt "N" (string 1))))
    (cond
      ((char-equal storev #\C)
       (cond
         ((char-equal direct #\F)
          (cond
            ((char-equal side #\L)
             (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                           ((> j k) nil)
               (tagbody
                 (dcopy n
                  (f2cl-lib:array-slice c
                                        double-float
                                        (j 1)
                                        ((1 ldc) (1 *)))
                  ldc
                  (f2cl-lib:array-slice work
                                        double-float
                                        (1 j)
                                        ((1 ldwork) (1 *)))
                  1)))
             (dtrmm "Right" "Lower" "No transpose" "Unit" n k one v ldv
              work ldwork)
             (cond
               ((> m k)
                (dgemm "Transpose" "No transpose" n k
                 (f2cl-lib:int-sub m k) one
                 (f2cl-lib:array-slice c
                                       double-float
                                       ((+ k 1) 1)
                                       ((1 ldc) (1 *)))
                 ldc
                 (f2cl-lib:array-slice v
                                       double-float
                                       ((+ k 1) 1)
                                       ((1 ldv) (1 *)))
                 ldv one work ldwork)))
             (dtrmm "Right" "Upper" transt "Non-unit" n k one t$ ldt work
```

```
 ldwork)
(cond
  ((> m k)
   (dgemm "No transpose" "Transpose" (f2cl-lib:int-sub m k) n
    k (- one)
    (f2cl-lib:array-slice v
                          double-float
                          ((+ k 1) 1)
                          ((1 ldv) (1 *)))
    ldv work ldwork one
    (f2cl-lib:array-slice c
                          double-float
                          ((+ k 1) 1)
                          ((1 ldc) (1 *)))
    ldc)))
 (dtrmm "Right" "Lower" "Transpose" "Unit" n k one v ldv work
  ldwork)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j k) nil)
   (tagbody
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                   ((> i n) nil)
       (tagbody
         (setf (f2cl-lib:fref c-%data%
                              (j i)
                              ((1 ldc) (1 *))
                              c-%offset%)
                 (-
                  (f2cl-lib:fref c-%data%
                                 (j i)
                                 ((1 ldc) (1 *))
                                 c-%offset%)
                  (f2cl-lib:fref work-%data%
                                 (i j)
                                 ((1 ldwork) (1 *))
                                 work-%offset%))))))))
((char-equal side #\R)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j k) nil)
   (tagbody
     (dcopy m
      (f2cl-lib:array-slice c
                            double-float
                            (1 j)
                            ((1 ldc) (1 *)))
      1
      (f2cl-lib:array-slice work
                            double-float
                            (1 j)
                            ((1 ldwork) (1 *)))
```

```
     1)))
(dtrmm "Right" "Lower" "No transpose" "Unit" m k one v ldv
 work ldwork)
(cond
  ((> n k)
   (dgemm "No transpose" "No transpose" m k
    (f2cl-lib:int-sub n k) one
    (f2cl-lib:array-slice c
                          double-float
                          (1 (f2cl-lib:int-add k 1))
                          ((1 ldc) (1 *)))
    ldc
    (f2cl-lib:array-slice v
                          double-float
                          ((+ k 1) 1)
                          ((1 ldv) (1 *)))
    ldv one work ldwork)))
(dtrmm "Right" "Upper" trans "Non-unit" m k one t$ ldt work
 ldwork)
(cond
  ((> n k)
   (dgemm "No transpose" "Transpose" m (f2cl-lib:int-sub n k)
    k (- one) work ldwork
    (f2cl-lib:array-slice v
                          double-float
                          ((+ k 1) 1)
                          ((1 ldv) (1 *)))
    ldv one
    (f2cl-lib:array-slice c
                          double-float
                          (1 (f2cl-lib:int-add k 1))
                          ((1 ldc) (1 *)))
    ldc)))
(dtrmm "Right" "Lower" "Transpose" "Unit" m k one v ldv work
 ldwork)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j k) nil)
  (tagbody
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  ((> i m) nil)
      (tagbody
        (setf (f2cl-lib:fref c-%data%
                             (i j)
                             ((1 ldc) (1 *))
                             c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (i j)
                                ((1 ldc) (1 *))
                                c-%offset%)
```

```
                    (f2cl-lib:fref work-%data%
                                   (i j)
                                   ((1 ldwork) (1 *))
                                   work-%offset%))))))))))
          (t
           (cond
             ((char-equal side #\L)
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j k) nil)
                (tagbody
                  (dcopy n
                   (f2cl-lib:array-slice c
                                         double-float
                                         ((+ m (f2cl-lib:int-sub k) j) 1)
                                         ((1 ldc) (1 *)))
                   ldc
                   (f2cl-lib:array-slice work
                                         double-float
                                         (1 j)
                                         ((1 ldwork) (1 *)))
                   1)))
              (dtrmm "Right" "Upper" "No transpose" "Unit" n k one
               (f2cl-lib:array-slice v
                                     double-float
                                     ((+ m (f2cl-lib:int-sub k) 1) 1)
                                     ((1 ldv) (1 *)))
               ldv work ldwork)
              (cond
                ((> m k)
                 (dgemm "Transpose" "No transpose" n k
                  (f2cl-lib:int-sub m k) one c ldc v ldv one work ldwork)))
              (dtrmm "Right" "Lower" transt "Non-unit" n k one t$ ldt work
               ldwork)
              (cond
                ((> m k)
                 (dgemm "No transpose" "Transpose" (f2cl-lib:int-sub m k) n
                  k (- one) v ldv work ldwork one c ldc)))
              (dtrmm "Right" "Upper" "Transpose" "Unit" n k one
               (f2cl-lib:array-slice v
                                     double-float
                                     ((+ m (f2cl-lib:int-sub k) 1) 1)
                                     ((1 ldv) (1 *)))
               ldv work ldwork)
              (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                            ((> j k) nil)
                (tagbody
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                ((> i n) nil)
                    (tagbody
                      (setf (f2cl-lib:fref c-%data%
```

```
                                    ((f2cl-lib:int-add
                                      (f2cl-lib:int-sub m k)
                                      j)
                                     i)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                                (-
                                 (f2cl-lib:fref c-%data%
                                                ((f2cl-lib:int-add
                                                  (f2cl-lib:int-sub m k)
                                                  j)
                                                 i)
                                                ((1 ldc) (1 *))
                                                c-%offset%)
                                 (f2cl-lib:fref work-%data%
                                                (i j)
                                                ((1 ldwork) (1 *))
                                                work-%offset%))))))))
                        ((char-equal side #\R)
                         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                                       ((> j k) nil)
                           (tagbody
                             (dcopy m
                              (f2cl-lib:array-slice c
                                                    double-float
                                                    (1
                                                     (f2cl-lib:int-add
                                                      (f2cl-lib:int-sub n k)
                                                      j))
                                                    ((1 ldc) (1 *)))
                              1
                              (f2cl-lib:array-slice work
                                                    double-float
                                                    (1 j)
                                                    ((1 ldwork) (1 *)))
                              1)))
                         (dtrmm "Right" "Upper" "No transpose" "Unit" m k one
                          (f2cl-lib:array-slice v
                                                double-float
                                                ((+ n (f2cl-lib:int-sub k) 1) 1)
                                                ((1 ldv) (1 *)))
                          ldv work ldwork)
                         (cond
                           ((> n k)
                            (dgemm "No transpose" "No transpose" m k
                             (f2cl-lib:int-sub n k) one c ldc v ldv one work ldwork)))
                         (dtrmm "Right" "Lower" trans "Non-unit" m k one t$ ldt work
                          ldwork)
                         (cond
                           ((> n k)
```

```
            (dgemm "No transpose" "Transpose" m (f2cl-lib:int-sub n k)
             k (- one) work ldwork v ldv one c ldc)))
           (dtrmm "Right" "Upper" "Transpose" "Unit" m k one
            (f2cl-lib:array-slice v
                                  double-float
                                  ((+ n (f2cl-lib:int-sub k) 1) 1)
                                  ((1 ldv) (1 *)))
            ldv work ldwork)
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j k) nil)
             (tagbody
               (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                             ((> i m) nil)
                 (tagbody
                   (setf (f2cl-lib:fref c-%data%
                                        (i
                                         (f2cl-lib:int-add
                                          (f2cl-lib:int-sub n k)
                                          j))
                                        ((1 ldc) (1 *))
                                        c-%offset%)
                         (-
                          (f2cl-lib:fref c-%data%
                                         (i
                                          (f2cl-lib:int-add
                                           (f2cl-lib:int-sub n k)
                                           j))
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                          (f2cl-lib:fref work-%data%
                                         (i j)
                                         ((1 ldwork) (1 *))
                                         work-%offset%)))))))))))
      ((char-equal storev #\R)
       (cond
         ((char-equal direct #\F)
          (cond
            ((char-equal side #\L)
             (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                           ((> j k) nil)
               (tagbody
                 (dcopy n
                  (f2cl-lib:array-slice c
                                        double-float
                                        (j 1)
                                        ((1 ldc) (1 *)))
                  ldc
                  (f2cl-lib:array-slice work
                                        double-float
                                        (1 j)
```

```
                          ((1 ldwork) (1 *)))
     1)))
(dtrmm "Right" "Upper" "Transpose" "Unit" n k one v ldv work
 ldwork)
(cond
  ((> m k)
   (dgemm "Transpose" "Transpose" n k (f2cl-lib:int-sub m k)
    one
    (f2cl-lib:array-slice c
                          double-float
                          ((+ k 1) 1)
                          ((1 ldc) (1 *)))
    ldc
    (f2cl-lib:array-slice v
                          double-float
                          (1 (f2cl-lib:int-add k 1))
                          ((1 ldv) (1 *)))
    ldv one work ldwork)))
(dtrmm "Right" "Upper" transt "Non-unit" n k one t$ ldt work
 ldwork)
(cond
  ((> m k)
   (dgemm "Transpose" "Transpose" (f2cl-lib:int-sub m k) n k
    (- one)
    (f2cl-lib:array-slice v
                          double-float
                          (1 (f2cl-lib:int-add k 1))
                          ((1 ldv) (1 *)))
    ldv work ldwork one
    (f2cl-lib:array-slice c
                          double-float
                          ((+ k 1) 1)
                          ((1 ldc) (1 *)))
    ldc)))
(dtrmm "Right" "Upper" "No transpose" "Unit" n k one v ldv
 work ldwork)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j k) nil)
  (tagbody
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  ((> i n) nil)
      (tagbody
        (setf (f2cl-lib:fref c-%data%
                             (j i)
                             ((1 ldc) (1 *))
                             c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (j i)
                                ((1 ldc) (1 *))
```

```
                                    c-%offset%)
                    (f2cl-lib:fref work-%data%
                                    (i j)
                                    ((1 ldwork) (1 *))
                                    work-%offset%))))))))
((char-equal side #\R)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j k) nil)
   (tagbody
     (dcopy m
      (f2cl-lib:array-slice c
                            double-float
                            (1 j)
                            ((1 ldc) (1 *)))
      1
      (f2cl-lib:array-slice work
                            double-float
                            (1 j)
                            ((1 ldwork) (1 *)))
      1)))
 (dtrmm "Right" "Upper" "Transpose" "Unit" m k one v ldv work
  ldwork)
 (cond
   ((> n k)
    (dgemm "No transpose" "Transpose" m k
     (f2cl-lib:int-sub n k) one
     (f2cl-lib:array-slice c
                           double-float
                           (1 (f2cl-lib:int-add k 1))
                           ((1 ldc) (1 *)))
     ldc
     (f2cl-lib:array-slice v
                           double-float
                           (1 (f2cl-lib:int-add k 1))
                           ((1 ldv) (1 *)))
     ldv one work ldwork)))
 (dtrmm "Right" "Upper" trans "Non-unit" m k one t$ ldt work
  ldwork)
 (cond
   ((> n k)
    (dgemm "No transpose" "No transpose" m
     (f2cl-lib:int-sub n k) k (- one) work ldwork
     (f2cl-lib:array-slice v
                           double-float
                           (1 (f2cl-lib:int-add k 1))
                           ((1 ldv) (1 *)))
     ldv one
     (f2cl-lib:array-slice c
                           double-float
                           (1 (f2cl-lib:int-add k 1))
```

```
                                ((1 ldc) (1 *)))
          ldc)))
      (dtrmm "Right" "Upper" "No transpose" "Unit" m k one v ldv
       work ldwork)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j k) nil)
        (tagbody
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i m) nil)
            (tagbody
              (setf (f2cl-lib:fref c-%data%
                                   (i j)
                                   ((1 ldc) (1 *))
                                   c-%offset%)
                    (-
                     (f2cl-lib:fref c-%data%
                                    (i j)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                     (f2cl-lib:fref work-%data%
                                    (i j)
                                    ((1 ldwork) (1 *))
                                    work-%offset%)))))))))
  (t
   (cond
     ((char-equal side #\L)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j k) nil)
        (tagbody
          (dcopy n
           (f2cl-lib:array-slice c
                                 double-float
                                 ((+ m (f2cl-lib:int-sub k) j) 1)
                                 ((1 ldc) (1 *)))
           ldc
           (f2cl-lib:array-slice work
                                 double-float
                                 (1 j)
                                 ((1 ldwork) (1 *)))
           1)))
      (dtrmm "Right" "Lower" "Transpose" "Unit" n k one
       (f2cl-lib:array-slice v
                             double-float
                             (1
                              (f2cl-lib:int-add
                               (f2cl-lib:int-sub m k)
                               1))
                             ((1 ldv) (1 *)))
       ldv work ldwork)
      (cond
```

```
  ((> m k)
   (dgemm "Transpose" "Transpose" n k (f2cl-lib:int-sub m k)
    one c ldc v ldv one work ldwork)))
 (dtrmm "Right" "Lower" transt "Non-unit" n k one t$ ldt work
  ldwork)
 (cond
   ((> m k)
    (dgemm "Transpose" "Transpose" (f2cl-lib:int-sub m k) n k
     (- one) v ldv work ldwork one c ldc)))
 (dtrmm "Right" "Lower" "No transpose" "Unit" n k one
  (f2cl-lib:array-slice v
                        double-float
                        (1
                         (f2cl-lib:int-add
                          (f2cl-lib:int-sub m k)
                          1))
                        ((1 ldv) (1 *)))
  ldv work ldwork)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j k) nil)
   (tagbody
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                   ((> i n) nil)
       (tagbody
         (setf (f2cl-lib:fref c-%data%
                              ((f2cl-lib:int-add
                                (f2cl-lib:int-sub m k)
                                j)
                               i)
                              ((1 ldc) (1 *))
                              c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                ((f2cl-lib:int-add
                                  (f2cl-lib:int-sub m k)
                                  j)
                                 i)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (f2cl-lib:fref work-%data%
                                (i j)
                                ((1 ldwork) (1 *))
                                work-%offset%))))))))
((char-equal side #\R)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j k) nil)
   (tagbody
     (dcopy m
      (f2cl-lib:array-slice c
                            double-float
```

```
                              (1
                               (f2cl-lib:int-add
                                (f2cl-lib:int-sub n k)
                                j))
                              ((1 ldc) (1 *)))
      1
      (f2cl-lib:array-slice work
                              double-float
                              (1 j)
                              ((1 ldwork) (1 *)))
      1)))
(dtrmm "Right" "Lower" "Transpose" "Unit" m k one
 (f2cl-lib:array-slice v
                        double-float
                        (1
                         (f2cl-lib:int-add
                          (f2cl-lib:int-sub n k)
                          1))
                        ((1 ldv) (1 *)))
 ldv work ldwork)
(cond
  ((> n k)
   (dgemm "No transpose" "Transpose" m k
    (f2cl-lib:int-sub n k) one c ldc v ldv one work ldwork)))
(dtrmm "Right" "Lower" trans "Non-unit" m k one t$ ldt work
 ldwork)
(cond
  ((> n k)
   (dgemm "No transpose" "No transpose" m
    (f2cl-lib:int-sub n k) k (- one) work ldwork v ldv one c
    ldc)))
(dtrmm "Right" "Lower" "No transpose" "Unit" m k one
 (f2cl-lib:array-slice v
                        double-float
                        (1
                         (f2cl-lib:int-add
                          (f2cl-lib:int-sub n k)
                          1))
                        ((1 ldv) (1 *)))
 ldv work ldwork)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j k) nil)
  (tagbody
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  ((> i m) nil)
      (tagbody
        (setf (f2cl-lib:fref c-%data%
                             (i
                              (f2cl-lib:int-add
                               (f2cl-lib:int-sub n k)
```

```
                                          j))
                                        ((1 ldc) (1 *))
                                        c-%offset%)
                                (-
                                 (f2cl-lib:fref c-%data%
                                                (i
                                                 (f2cl-lib:int-add
                                                  (f2cl-lib:int-sub n k)
                                                  j))
                                                ((1 ldc) (1 *))
                                                c-%offset%)
                                 (f2cl-lib:fref work-%data%
                                                (i j)
                                                ((1 ldwork) (1 *))
                                                work-%offset%)))))))))))))
 end_label
        (return
         (values nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil))))))
```

———-

6.50 dlarfg LAPACK

— dlarfg.input —

```
)set break resume
)sys rm -f dlarfg.output
)spool dlarfg.output
)set message test on
)set message auto off
)clear all
```

```
)spool
)lisp (bye)
```

———-

— dlarfg.help —

```
==========================================================================
dlarfg examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

NAME
       DLARFG  -  a  real elementary reflector H of order n, such that   H * (
       alpha ) = ( beta ), H' * H = I

SYNOPSIS
       SUBROUTINE DLARFG( N, ALPHA, X, INCX, TAU )

           INTEGER        INCX, N

           DOUBLE         PRECISION ALPHA, TAU

           DOUBLE         PRECISION X( * )

 Purpose
 =======

  DLARFG generates a real elementary reflector H of order n, such
  that

        H * ( alpha ) = ( beta ),   H' * H = I.
            (   x   )   (   0  )

  where alpha and beta are scalars, and x is an (n-1)-element real
  vector. H is represented in the form

        H = I - tau * ( 1 ) * ( 1 v' ) ,
                      ( v )

  where tau is a real scalar and v is a real (n-1)-element
  vector.

  If the elements of x are all zero, then tau = 0 and H is taken to be
  the unit matrix.
```

```
  Otherwise  1 <= tau <= 2.

 Arguments
 =========

  N       (input) INTEGER
          The order of the elementary reflector.

  ALPHA   (input/output) DOUBLE PRECISION
          On entry, the value alpha.
          On exit, it is overwritten with the value beta.

  X       (input/output) DOUBLE PRECISION array, dimension
                         (1+(N-2)*abs(INCX))
          On entry, the vector x.
          On exit, it is overwritten with the vector v.

  INCX    (input) INTEGER
          The increment between elements of X. INCX > 0.

  TAU     (output) DOUBLE PRECISION
          The value tau.
```

———-

— dlarfg.f —

```
      SUBROUTINE DLARFG( N, ALPHA, X, INCX, TAU )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     September 30, 1994
*
*     .. Scalar Arguments ..
      INTEGER            INCX, N
      DOUBLE PRECISION   ALPHA, TAU
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   X( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE, ZERO
      PARAMETER          ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
```

```
*     .. Local Scalars ..
      INTEGER            J, KNT
      DOUBLE PRECISION   BETA, RSAFMN, SAFMIN, XNORM
*     ..
*     .. External Functions ..
      DOUBLE PRECISION   DLAMCH, DLAPY2, DNRM2
      EXTERNAL           DLAMCH, DLAPY2, DNRM2
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, SIGN
*     ..
*     .. External Subroutines ..
      EXTERNAL           DSCAL
*     ..
*     .. Executable Statements ..
*
      IF( N.LE.1 ) THEN
         TAU = ZERO
         RETURN
      END IF
*
      XNORM = DNRM2( N-1, X, INCX )
*
      IF( XNORM.EQ.ZERO ) THEN
*
*        H  =  I
*
         TAU = ZERO
      ELSE
*
*        general case
*
         BETA = -SIGN( DLAPY2( ALPHA, XNORM ), ALPHA )
         SAFMIN = DLAMCH( 'S' ) / DLAMCH( 'E' )
         IF( ABS( BETA ).LT.SAFMIN ) THEN
*
*           XNORM, BETA may be inaccurate; scale X and recompute them
*
            RSAFMN = ONE / SAFMIN
            KNT = 0
   10       CONTINUE
            KNT = KNT + 1
            CALL DSCAL( N-1, RSAFMN, X, INCX )
            BETA = BETA*RSAFMN
            ALPHA = ALPHA*RSAFMN
            IF( ABS( BETA ).LT.SAFMIN )
     $         GO TO 10
*
*           New BETA is at most 1, at least SAFMIN
*
```

```
            XNORM = DNRM2( N-1, X, INCX )
            BETA = -SIGN( DLAPY2( ALPHA, XNORM ), ALPHA )
            TAU = ( BETA-ALPHA ) / BETA
            CALL DSCAL( N-1, ONE / ( ALPHA-BETA ), X, INCX )
*
*           If ALPHA is subnormal, it may lose relative accuracy
*
            ALPHA = BETA
            DO 20 J = 1, KNT
               ALPHA = ALPHA*SAFMIN
   20       CONTINUE
         ELSE
            TAU = ( BETA-ALPHA ) / BETA
            CALL DSCAL( N-1, ONE / ( ALPHA-BETA ), X, INCX )
            ALPHA = BETA
         END IF
      END IF
*
      RETURN
*
*     End of DLARFG
*
      END
```

———-

— LAPACK dlarfg —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dlarfg (n alpha x incx tau)
    (declare (type (simple-array double-float (*)) x)
             (type (double-float) tau alpha)
             (type fixnum incx n))
    (f2cl-lib:with-multi-array-data
        ((x double-float x-%data% x-%offset%))
      (prog ((beta 0.0) (rsafmn 0.0) (safmin 0.0) (xnorm 0.0) (j 0) (knt 0))
        (declare (type (double-float) beta rsafmn safmin xnorm)
                 (type fixnum j knt))
        (cond
          ((<= n 1)
           (setf tau zero)
           (go end_label)))
        (setf xnorm (dnrm2 (f2cl-lib:int-sub n 1) x incx))
        (cond
          ((= xnorm zero)
           (setf tau zero))
```

```
         (t
          (setf beta (- (f2cl-lib:sign (dlapy2 alpha xnorm) alpha)))
          (setf safmin (/ (dlamch "S") (dlamch "E")))
          (cond
            ((< (abs beta) safmin)
             (tagbody
               (setf rsafmn (/ one safmin))
               (setf knt 0)
label10
               (setf knt (f2cl-lib:int-add knt 1))
               (dscal (f2cl-lib:int-sub n 1) rsafmn x incx)
               (setf beta (* beta rsafmn))
               (setf alpha (* alpha rsafmn))
               (if (< (abs beta) safmin) (go label10))
               (setf xnorm (dnrm2 (f2cl-lib:int-sub n 1) x incx))
               (setf beta (- (f2cl-lib:sign (dlapy2 alpha xnorm) alpha)))
               (setf tau (/ (- beta alpha) beta))
               (dscal (f2cl-lib:int-sub n 1) (/ one (- alpha beta)) x incx)
               (setf alpha beta)
               (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                             ((> j knt) nil)
                 (tagbody (setf alpha (* alpha safmin)) label20))))
            (t
             (setf tau (/ (- beta alpha) beta))
             (dscal (f2cl-lib:int-sub n 1) (/ one (- alpha beta)) x incx)
             (setf alpha beta)))))
end_label
        (return (values nil alpha nil nil tau))))))
```

———-

6.51 dlarf LAPACK

— **dlarf.input** —

```
)set break resume
)sys rm -f dlarf.output
)spool dlarf.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dlarf.help —

```
=====================================================================
dlarf examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DLARF  -  a real elementary reflector H to a real m by n matrix C, from
       either the left or the right

SYNOPSIS
       SUBROUTINE DLARF( SIDE, M, N, V, INCV, TAU, C, LDC, WORK )

           CHARACTER     SIDE

           INTEGER       INCV, LDC, M, N

           DOUBLE        PRECISION TAU

           DOUBLE        PRECISION C( LDC, * ), V( * ), WORK( * )

 Purpose
 =======

  DLARF applies a real elementary reflector H to a real m by n matrix
  C, from either the left or the right. H is represented in the form

        H = I - tau * v * v'

  where tau is a real scalar and v is a real vector.

  If tau = 0, then H is taken to be the unit matrix.

 Arguments
 =========

  SIDE    (input) CHARACTER*1
          = 'L': form  H * C
          = 'R': form  C * H

  M       (input) INTEGER
          The number of rows of the matrix C.

  N       (input) INTEGER
          The number of columns of the matrix C.
```

```
  V       (input) DOUBLE PRECISION array, dimension
                     (1 + (M-1)*abs(INCV)) if SIDE = 'L'
                  or (1 + (N-1)*abs(INCV)) if SIDE = 'R'
          The vector v in the representation of H. V is not used if
          TAU = 0.

  INCV    (input) INTEGER
          The increment between elements of v. INCV <> 0.

  TAU     (input) DOUBLE PRECISION
          The value tau in the representation of H.

  C       (input/output) DOUBLE PRECISION array, dimension (LDC,N)
          On entry, the m by n matrix C.
          On exit, C is overwritten by the matrix H * C if SIDE = 'L',
          or C * H if SIDE = 'R'.

  LDC     (input) INTEGER
          The leading dimension of the array C. LDC >= max(1,M).

  WORK    (workspace) DOUBLE PRECISION array, dimension
                         (N) if SIDE = 'L'
                      or (M) if SIDE = 'R'
```

———-

— dlarf.f —

```
      SUBROUTINE DLARF( SIDE, M, N, V, INCV, TAU, C, LDC, WORK )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     February 29, 1992
*
*     .. Scalar Arguments ..
      CHARACTER          SIDE
      INTEGER            INCV, LDC, M, N
      DOUBLE PRECISION   TAU
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   C( LDC, * ), V( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
```

```
      DOUBLE PRECISION   ONE, ZERO
      PARAMETER          ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. External Subroutines ..
      EXTERNAL           DGEMV, DGER
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. Executable Statements ..
*
      IF( LSAME( SIDE, 'L' ) ) THEN
*
*        Form  H * C
*
         IF( TAU.NE.ZERO ) THEN
*
*           w := C' * v
*
            CALL DGEMV( 'Transpose', M, N, ONE, C, LDC, V, INCV, ZERO,
     $                  WORK, 1 )
*
*           C := C - v * w'
*
            CALL DGER( M, N, -TAU, V, INCV, WORK, 1, C, LDC )
         END IF
      ELSE
*
*        Form  C * H
*
         IF( TAU.NE.ZERO ) THEN
*
*           w := C * v
*
            CALL DGEMV( 'No transpose', M, N, ONE, C, LDC, V, INCV,
     $                  ZERO, WORK, 1 )
*
*           C := C - w * v'
*
            CALL DGER( M, N, -TAU, WORK, 1, V, INCV, C, LDC )
         END IF
      END IF
      RETURN
*
*     End of DLARF
*
      END
```

———-

— **LAPACK dlarf** —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dlarf (side m n v incv tau c ldc work)
    (declare (type (double-float) tau)
             (type (simple-array double-float (*)) work c v)
             (type fixnum ldc incv n m)
             (type character side))
    (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (v double-float v-%data% v-%offset%)
         (c double-float c-%data% c-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ()
        (declare)
        (cond
          ((char-equal side #\L)
           (cond
             ((/= tau zero)
              (dgemv "Transpose" m n one c ldc v incv zero work 1)
              (dger m n (- tau) v incv work 1 c ldc))))
          (t
           (cond
             ((/= tau zero)
              (dgemv "No transpose" m n one c ldc v incv zero work 1)
              (dger m n (- tau) work 1 v incv c ldc)))))
        (return (values nil nil nil nil nil nil nil nil nil))))))
```

———-

6.52 dlarft LAPACK

— **dlarft.input** —

```
)set break resume
)sys rm -f dlarft.output
)spool dlarft.output
)set message test on
)set message auto off
)clear all
```

```
)spool
)lisp (bye)
```

———-

— dlarft.help —

```
==========================================================================
dlarft examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

NAME
       DLARFT  -  the triangular factor T of a real block reflector H of order
       n, which is defined as a product of k elementary reflectors

SYNOPSIS
       SUBROUTINE DLARFT( DIRECT, STOREV, N, K, V, LDV, TAU, T, LDT )

           CHARACTER      DIRECT, STOREV

           INTEGER        K, LDT, LDV, N

           DOUBLE         PRECISION T( LDT, * ), TAU( * ), V( LDV, * )

 Purpose
 =======

  DLARFT forms the triangular factor T of a real block reflector H
  of order n, which is defined as a product of k elementary reflectors.

  If DIRECT = 'F', H = H(1) H(2) . . . H(k) and T is upper triangular;

  If DIRECT = 'B', H = H(k) . . . H(2) H(1) and T is lower triangular.

  If STOREV = 'C', the vector which defines the elementary reflector
  H(i) is stored in the i-th column of the array V, and

     H  =  I - V * T * V'

  If STOREV = 'R', the vector which defines the elementary reflector
  H(i) is stored in the i-th row of the array V, and

     H  =  I - V' * T * V

 Arguments
```

```
=========

 DIRECT  (input) CHARACTER*1
         Specifies the order in which the elementary reflectors are
         multiplied to form the block reflector:
         = 'F': H = H(1) H(2) . . . H(k) (Forward)
         = 'B': H = H(k) . . . H(2) H(1) (Backward)

 STOREV  (input) CHARACTER*1
         Specifies how the vectors which define the elementary
         reflectors are stored (see also Further Details):
         = 'C': columnwise
         = 'R': rowwise

 N       (input) INTEGER
         The order of the block reflector H. N >= 0.

 K       (input) INTEGER
         The order of the triangular factor T (= the number of
         elementary reflectors). K >= 1.

 V       (input/output) DOUBLE PRECISION array, dimension
                              (LDV,K) if STOREV = 'C'
                              (LDV,N) if STOREV = 'R'
         The matrix V. See further details.

 LDV     (input) INTEGER
         The leading dimension of the array V.
         If STOREV = 'C', LDV >= max(1,N); if STOREV = 'R', LDV >= K.

 TAU     (input) DOUBLE PRECISION array, dimension (K)
         TAU(i) must contain the scalar factor of the elementary
         reflector H(i).

 T       (output) DOUBLE PRECISION array, dimension (LDT,K)
         The k by k triangular factor T of the block reflector.
         If DIRECT = 'F', T is upper triangular; if DIRECT = 'B', T is
         lower triangular. The rest of the array is not used.

 LDT     (input) INTEGER
         The leading dimension of the array T. LDT >= K.

 Further Details
 ===============

 The shape of the matrix V and the storage of the vectors which define
 the H(i) is best illustrated by the following example with n = 5 and
 k = 3. The elements equal to 1 are not stored; the corresponding
 array elements are modified but restored on exit. The rest of the
 array is not used.
```

```
  DIRECT = 'F' and STOREV = 'C':         DIRECT = 'F' and STOREV = 'R':

               V = (  1       )                 V = (  1 v1 v1 v1 v1 )
                   ( v1  1    )                     (     1 v2 v2 v2 )
                   ( v1 v2  1 )                     (        1 v3 v3 )
                   ( v1 v2 v3 )
                   ( v1 v2 v3 )

  DIRECT = 'B' and STOREV = 'C':         DIRECT = 'B' and STOREV = 'R':

               V = ( v1 v2 v3 )                 V = ( v1 v1  1       )
                   ( v1 v2 v3 )                     ( v2 v2 v2  1    )
                   (  1 v2 v3 )                     ( v3 v3 v3 v3  1 )
                   (     1 v3 )
                   (        1 )
```

———-

— dlarft.f —

```
      SUBROUTINE DLARFT( DIRECT, STOREV, N, K, V, LDV, TAU, T, LDT )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     February 29, 1992
*
*     .. Scalar Arguments ..
      CHARACTER          DIRECT, STOREV
      INTEGER            K, LDT, LDV, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   T( LDT, * ), TAU( * ), V( LDV, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE, ZERO
      PARAMETER          ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I, J
      DOUBLE PRECISION   VII
*     ..
*     .. External Subroutines ..
      EXTERNAL           DGEMV, DTRMV
```

```
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. Executable Statements ..
*
*     Quick return if possible
*
      IF( N.EQ.0 )
     $   RETURN
*
      IF( LSAME( DIRECT, 'F' ) ) THEN
         DO 20 I = 1, K
            IF( TAU( I ).EQ.ZERO ) THEN
*
*              H(i)  =  I
*
               DO 10 J = 1, I
                  T( J, I ) = ZERO
   10          CONTINUE
            ELSE
*
*              general case
*
               VII = V( I, I )
               V( I, I ) = ONE
               IF( LSAME( STOREV, 'C' ) ) THEN
*
*                 T(1:i-1,i) := - tau(i) * V(i:n,1:i-1)' * V(i:n,i)
*
                  CALL DGEMV( 'Transpose', N-I+1, I-1, -TAU( I ),
     $                        V( I, 1 ), LDV, V( I, I ), 1, ZERO,
     $                        T( 1, I ), 1 )
               ELSE
*
*                 T(1:i-1,i) := - tau(i) * V(1:i-1,i:n) * V(i,i:n)'
*
                  CALL DGEMV( 'No transpose', I-1, N-I+1, -TAU( I ),
     $                        V( 1, I ), LDV, V( I, I ), LDV, ZERO,
     $                        T( 1, I ), 1 )
               END IF
               V( I, I ) = VII
*
*              T(1:i-1,i) := T(1:i-1,1:i-1) * T(1:i-1,i)
*
               CALL DTRMV( 'Upper', 'No transpose', 'Non-unit', I-1, T,
     $                     LDT, T( 1, I ), 1 )
               T( I, I ) = TAU( I )
            END IF
```

```
   20    CONTINUE
      ELSE
         DO 40 I = K, 1, -1
            IF( TAU( I ).EQ.ZERO ) THEN
*
*              H(i)  =  I
*
               DO 30 J = I, K
                  T( J, I ) = ZERO
   30          CONTINUE
            ELSE
*
*              general case
*
               IF( I.LT.K ) THEN
                  IF( LSAME( STOREV, 'C' ) ) THEN
                     VII = V( N-K+I, I )
                     V( N-K+I, I ) = ONE
*
*                    T(i+1:k,i) :=
*                            - tau(i) * V(1:n-k+i,i+1:k)' * V(1:n-k+i,i)
*
                     CALL DGEMV( 'Transpose', N-K+I, K-I, -TAU( I ),
     $                           V( 1, I+1 ), LDV, V( 1, I ), 1, ZERO,
     $                           T( I+1, I ), 1 )
                     V( N-K+I, I ) = VII
                  ELSE
                     VII = V( I, N-K+I )
                     V( I, N-K+I ) = ONE
*
*                    T(i+1:k,i) :=
*                            - tau(i) * V(i+1:k,1:n-k+i) * V(i,1:n-k+i)'
*
                     CALL DGEMV( 'No transpose', K-I, N-K+I, -TAU( I ),
     $                           V( I+1, 1 ), LDV, V( I, 1 ), LDV, ZERO,
     $                           T( I+1, I ), 1 )
                     V( I, N-K+I ) = VII
                  END IF
*
*                 T(i+1:k,i) := T(i+1:k,i+1:k) * T(i+1:k,i)
*
                  CALL DTRMV( 'Lower', 'No transpose', 'Non-unit', K-I,
     $                        T( I+1, I+1 ), LDT, T( I+1, I ), 1 )
               END IF
               T( I, I ) = TAU( I )
            END IF
   40    CONTINUE
      END IF
      RETURN
*
```

```
*     End of DLARFT
*
      END
```

— LAPACK dlarft —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dlarft (direct storev n k v ldv tau t$ ldt)
    (declare (type (simple-array double-float (*)) t$ tau v)
             (type fixnum ldt ldv k n)
             (type character storev direct))
    (f2cl-lib:with-multi-array-data
        ((direct character direct-%data% direct-%offset%)
         (storev character storev-%data% storev-%offset%)
         (v double-float v-%data% v-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (t$ double-float t$-%data% t$-%offset%))
      (prog ((vii 0.0) (i 0) (j 0))
        (declare (type (double-float) vii) (type fixnum i j))
        (if (= n 0) (go end_label))
        (cond
          ((char-equal direct #\F)
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i k) nil)
             (tagbody
               (cond
                 ((= (f2cl-lib:fref tau (i) ((1 *))) zero)
                  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                                ((> j i) nil)
                    (tagbody
                      (setf (f2cl-lib:fref t$-%data%
                                           (j i)
                                           ((1 ldt) (1 *))
                                           t$-%offset%)
                                    zero))))
                 (t
                  (setf vii
                          (f2cl-lib:fref v-%data%
                                         (i i)
                                         ((1 ldv) (1 *))
                                         v-%offset%))
                  (setf (f2cl-lib:fref v-%data%
                                       (i i)
                                       ((1 ldv) (1 *))
```

```
                      v-%offset%)
        one)
(cond
  ((char-equal storev #\C)
   (dgemv "Transpose"
    (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
    (f2cl-lib:int-sub i 1)
    (- (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%))
    (f2cl-lib:array-slice v
                          double-float
                          (i 1)
                          ((1 ldv) (1 *)))
    ldv
    (f2cl-lib:array-slice v
                          double-float
                          (i i)
                          ((1 ldv) (1 *)))
    1 zero
    (f2cl-lib:array-slice t$
                          double-float
                          (1 i)
                          ((1 ldt) (1 *)))
    1))
  (t
   (dgemv "No transpose" (f2cl-lib:int-sub i 1)
    (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
    (- (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%))
    (f2cl-lib:array-slice v
                          double-float
                          (1 i)
                          ((1 ldv) (1 *)))
    ldv
    (f2cl-lib:array-slice v
                          double-float
                          (i i)
                          ((1 ldv) (1 *)))
    ldv zero
    (f2cl-lib:array-slice t$
                          double-float
                          (1 i)
                          ((1 ldt) (1 *)))
    1)))
(setf (f2cl-lib:fref v-%data%
                     (i i)
                     ((1 ldv) (1 *))
                     v-%offset%)
        vii)
(dtrmv "Upper" "No transpose" "Non-unit"
 (f2cl-lib:int-sub i 1) t$ ldt
 (f2cl-lib:array-slice t$ double-float (1 i) ((1 ldt) (1 *)))
```

```
          1)
         (setf (f2cl-lib:fref t$-%data%
                              (i i)
                              ((1 ldt) (1 *))
                              t$-%offset%)
                (f2cl-lib:fref tau-%data%
                               (i)
                               ((1 *))
                               tau-%offset%)))))))
(t
 (f2cl-lib:fdo (i k (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
               ((> i 1) nil)
   (tagbody
     (cond
       ((= (f2cl-lib:fref tau (i) ((1 *))) zero)
        (f2cl-lib:fdo (j i (f2cl-lib:int-add j 1))
                      ((> j k) nil)
          (tagbody
            (setf (f2cl-lib:fref t$-%data%
                                 (j i)
                                 ((1 ldt) (1 *))
                                 t$-%offset%)
                  zero))))
       (t
        (cond
          ((< i k)
           (cond
             ((char-equal storev #\C)
              (setf vii
                      (f2cl-lib:fref v-%data%
                                     ((f2cl-lib:int-add
                                       (f2cl-lib:int-sub n k)
                                       i)
                                      i)
                                     ((1 ldv) (1 *))
                                     v-%offset%))
              (setf (f2cl-lib:fref v-%data%
                                   ((f2cl-lib:int-add
                                     (f2cl-lib:int-sub n k)
                                     i)
                                    i)
                                   ((1 ldv) (1 *))
                                   v-%offset%)
                      one)
              (dgemv "Transpose"
               (f2cl-lib:int-add (f2cl-lib:int-sub n k) i)
               (f2cl-lib:int-sub k i)
               (-
                (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%))
               (f2cl-lib:array-slice v
```

```
                          double-float
                          (1 (f2cl-lib:int-add i 1))
                          ((1 ldv) (1 *)))
  ldv
  (f2cl-lib:array-slice v
                          double-float
                          (1 i)
                          ((1 ldv) (1 *)))
  1 zero
  (f2cl-lib:array-slice t$
                          double-float
                          ((+ i 1) i)
                          ((1 ldt) (1 *)))
  1)
 (setf (f2cl-lib:fref v-%data%
                       ((f2cl-lib:int-add
                         (f2cl-lib:int-sub n k)
                         i)
                        i)
                       ((1 ldv) (1 *))
                       v-%offset%)
         vii))
(t
 (setf vii
         (f2cl-lib:fref v-%data%
                         (i
                          (f2cl-lib:int-add
                           (f2cl-lib:int-sub n k)
                           i))
                         ((1 ldv) (1 *))
                         v-%offset%))
 (setf (f2cl-lib:fref v-%data%
                       (i
                        (f2cl-lib:int-add
                         (f2cl-lib:int-sub n k)
                         i))
                       ((1 ldv) (1 *))
                       v-%offset%)
         one)
 (dgemv "No transpose" (f2cl-lib:int-sub k i)
  (f2cl-lib:int-add (f2cl-lib:int-sub n k) i)
  (-
   (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%))
  (f2cl-lib:array-slice v
                          double-float
                          ((+ i 1) 1)
                          ((1 ldv) (1 *)))
  ldv
  (f2cl-lib:array-slice v
                          double-float
```

```
                                        (i 1)
                                        ((1 ldv) (1 *)))
                        ldv zero
                        (f2cl-lib:array-slice t$
                                        double-float
                                        ((+ i 1) i)
                                        ((1 ldt) (1 *)))
                        1)
                       (setf (f2cl-lib:fref v-%data%
                                        (i
                                         (f2cl-lib:int-add
                                          (f2cl-lib:int-sub n k)
                                          i))
                                        ((1 ldv) (1 *))
                                        v-%offset%)
                                vii)))
                     (dtrmv "Lower" "No transpose" "Non-unit"
                      (f2cl-lib:int-sub k i)
                      (f2cl-lib:array-slice t$
                                        double-float
                                        ((+ i 1) (f2cl-lib:int-add i 1))
                                        ((1 ldt) (1 *)))
                      ldt
                      (f2cl-lib:array-slice t$
                                        double-float
                                        ((+ i 1) i)
                                        ((1 ldt) (1 *)))
                      1)))
                   (setf (f2cl-lib:fref t$-%data%
                                        (i i)
                                        ((1 ldt) (1 *))
                                        t$-%offset%)
                         (f2cl-lib:fref tau-%data%
                                        (i)
                                        ((1 *))
                                        tau-%offset%))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil))))))
```

———-

6.53 dlarfx LAPACK

— **dlarfx.input** —

```
)set break resume
```

```
)sys rm -f dlarfx.output
)spool dlarfx.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dlarfx.help —

```
==========================================================================
dlarfx examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

NAME
       DLARFX  - a real elementary reflector H to a real m by n matrix C, from
       either the left or the right

SYNOPSIS
       SUBROUTINE DLARFX( SIDE, M, N, V, TAU, C, LDC, WORK )

           CHARACTER      SIDE

           INTEGER        LDC, M, N

           DOUBLE         PRECISION TAU

           DOUBLE         PRECISION C( LDC, * ), V( * ), WORK( * )

 Purpose
 =======

  DLARFX applies a real elementary reflector H to a real m by n
  matrix C, from either the left or the right. H is represented in the
  form

        H = I - tau * v * v'

  where tau is a real scalar and v is a real vector.

  If tau = 0, then H is taken to be the unit matrix
```

```
 This version uses inline code if H has order < 11.

Arguments
=========

 SIDE    (input) CHARACTER*1
         = 'L': form  H * C
         = 'R': form  C * H

 M       (input) INTEGER
         The number of rows of the matrix C.

 N       (input) INTEGER
         The number of columns of the matrix C.

 V       (input) DOUBLE PRECISION array, dimension (M) if SIDE = 'L'
                                      or (N) if SIDE = 'R'
         The vector v in the representation of H.

 TAU     (input) DOUBLE PRECISION
         The value tau in the representation of H.

 C       (input/output) DOUBLE PRECISION array, dimension (LDC,N)
         On entry, the m by n matrix C.
         On exit, C is overwritten by the matrix H * C if SIDE = 'L',
         or C * H if SIDE = 'R'.

 LDC     (input) INTEGER
         The leading dimension of the array C. LDA >= (1,M).

 WORK    (workspace) DOUBLE PRECISION array, dimension
                     (N) if SIDE = 'L'
                     or (M) if SIDE = 'R'
         WORK is not referenced if H has order < 11.
```

— dlarfx.f —

```
      SUBROUTINE DLARFX( SIDE, M, N, V, TAU, C, LDC, WORK )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     February 29, 1992
*
*     .. Scalar Arguments ..
      CHARACTER          SIDE
```

```
      INTEGER            LDC, M, N
      DOUBLE PRECISION   TAU
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   C( LDC, * ), V( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            J
      DOUBLE PRECISION   SUM, T1, T10, T2, T3, T4, T5, T6, T7, T8, T9,
     $                   V1, V10, V2, V3, V4, V5, V6, V7, V8, V9
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. External Subroutines ..
      EXTERNAL           DGEMV, DGER
*     ..
*     .. Executable Statements ..
*
      IF( TAU.EQ.ZERO )
     $   RETURN
      IF( LSAME( SIDE, 'L' ) ) THEN
*
*        Form  H * C, where H has order m.
*
         GO TO ( 10, 30, 50, 70, 90, 110, 130, 150,
     $           170, 190 )M
*
*        Code for general M
*
*        w := C'*v
*
         CALL DGEMV( 'Transpose', M, N, ONE, C, LDC, V, 1, ZERO, WORK,
     $               1 )
*
*        C := C - tau * v * w'
*
         CALL DGER( M, N, -TAU, V, 1, WORK, 1, C, LDC )
         GO TO 410
   10    CONTINUE
*
*        Special code for 1 x 1 Householder
```

```
*
        T1 = ONE - TAU*V( 1 )*V( 1 )
        DO 20 J = 1, N
           C( 1, J ) = T1*C( 1, J )
   20   CONTINUE
        GO TO 410
   30   CONTINUE
*
*       Special code for 2 x 2 Householder
*
        V1 = V( 1 )
        T1 = TAU*V1
        V2 = V( 2 )
        T2 = TAU*V2
        DO 40 J = 1, N
           SUM = V1*C( 1, J ) + V2*C( 2, J )
           C( 1, J ) = C( 1, J ) - SUM*T1
           C( 2, J ) = C( 2, J ) - SUM*T2
   40   CONTINUE
        GO TO 410
   50   CONTINUE
*
*       Special code for 3 x 3 Householder
*
        V1 = V( 1 )
        T1 = TAU*V1
        V2 = V( 2 )
        T2 = TAU*V2
        V3 = V( 3 )
        T3 = TAU*V3
        DO 60 J = 1, N
           SUM = V1*C( 1, J ) + V2*C( 2, J ) + V3*C( 3, J )
           C( 1, J ) = C( 1, J ) - SUM*T1
           C( 2, J ) = C( 2, J ) - SUM*T2
           C( 3, J ) = C( 3, J ) - SUM*T3
   60   CONTINUE
        GO TO 410
   70   CONTINUE
*
*       Special code for 4 x 4 Householder
*
        V1 = V( 1 )
        T1 = TAU*V1
        V2 = V( 2 )
        T2 = TAU*V2
        V3 = V( 3 )
        T3 = TAU*V3
        V4 = V( 4 )
        T4 = TAU*V4
        DO 80 J = 1, N
```

```
            SUM = V1*C( 1, J ) + V2*C( 2, J ) + V3*C( 3, J ) +
     $            V4*C( 4, J )
            C( 1, J ) = C( 1, J ) - SUM*T1
            C( 2, J ) = C( 2, J ) - SUM*T2
            C( 3, J ) = C( 3, J ) - SUM*T3
            C( 4, J ) = C( 4, J ) - SUM*T4
   80    CONTINUE
         GO TO 410
   90    CONTINUE
*
*        Special code for 5 x 5 Householder
*
         V1 = V( 1 )
         T1 = TAU*V1
         V2 = V( 2 )
         T2 = TAU*V2
         V3 = V( 3 )
         T3 = TAU*V3
         V4 = V( 4 )
         T4 = TAU*V4
         V5 = V( 5 )
         T5 = TAU*V5
         DO 100 J = 1, N
            SUM = V1*C( 1, J ) + V2*C( 2, J ) + V3*C( 3, J ) +
     $            V4*C( 4, J ) + V5*C( 5, J )
            C( 1, J ) = C( 1, J ) - SUM*T1
            C( 2, J ) = C( 2, J ) - SUM*T2
            C( 3, J ) = C( 3, J ) - SUM*T3
            C( 4, J ) = C( 4, J ) - SUM*T4
            C( 5, J ) = C( 5, J ) - SUM*T5
  100    CONTINUE
         GO TO 410
  110    CONTINUE
*
*        Special code for 6 x 6 Householder
*
         V1 = V( 1 )
         T1 = TAU*V1
         V2 = V( 2 )
         T2 = TAU*V2
         V3 = V( 3 )
         T3 = TAU*V3
         V4 = V( 4 )
         T4 = TAU*V4
         V5 = V( 5 )
         T5 = TAU*V5
         V6 = V( 6 )
         T6 = TAU*V6
         DO 120 J = 1, N
            SUM = V1*C( 1, J ) + V2*C( 2, J ) + V3*C( 3, J ) +
```

```
     $            V4*C( 4, J ) + V5*C( 5, J ) + V6*C( 6, J )
                  C( 1, J ) = C( 1, J ) - SUM*T1
                  C( 2, J ) = C( 2, J ) - SUM*T2
                  C( 3, J ) = C( 3, J ) - SUM*T3
                  C( 4, J ) = C( 4, J ) - SUM*T4
                  C( 5, J ) = C( 5, J ) - SUM*T5
                  C( 6, J ) = C( 6, J ) - SUM*T6
  120          CONTINUE
               GO TO 410
  130          CONTINUE
*
*              Special code for 7 x 7 Householder
*
               V1 = V( 1 )
               T1 = TAU*V1
               V2 = V( 2 )
               T2 = TAU*V2
               V3 = V( 3 )
               T3 = TAU*V3
               V4 = V( 4 )
               T4 = TAU*V4
               V5 = V( 5 )
               T5 = TAU*V5
               V6 = V( 6 )
               T6 = TAU*V6
               V7 = V( 7 )
               T7 = TAU*V7
               DO 140 J = 1, N
                  SUM = V1*C( 1, J ) + V2*C( 2, J ) + V3*C( 3, J ) +
     $                  V4*C( 4, J ) + V5*C( 5, J ) + V6*C( 6, J ) +
     $                  V7*C( 7, J )
                  C( 1, J ) = C( 1, J ) - SUM*T1
                  C( 2, J ) = C( 2, J ) - SUM*T2
                  C( 3, J ) = C( 3, J ) - SUM*T3
                  C( 4, J ) = C( 4, J ) - SUM*T4
                  C( 5, J ) = C( 5, J ) - SUM*T5
                  C( 6, J ) = C( 6, J ) - SUM*T6
                  C( 7, J ) = C( 7, J ) - SUM*T7
  140          CONTINUE
               GO TO 410
  150          CONTINUE
*
*              Special code for 8 x 8 Householder
*
               V1 = V( 1 )
               T1 = TAU*V1
               V2 = V( 2 )
               T2 = TAU*V2
               V3 = V( 3 )
               T3 = TAU*V3
```

```
         V4 = V( 4 )
         T4 = TAU*V4
         V5 = V( 5 )
         T5 = TAU*V5
         V6 = V( 6 )
         T6 = TAU*V6
         V7 = V( 7 )
         T7 = TAU*V7
         V8 = V( 8 )
         T8 = TAU*V8
         DO 160 J = 1, N
            SUM = V1*C( 1, J ) + V2*C( 2, J ) + V3*C( 3, J ) +
     $            V4*C( 4, J ) + V5*C( 5, J ) + V6*C( 6, J ) +
     $            V7*C( 7, J ) + V8*C( 8, J )
            C( 1, J ) = C( 1, J ) - SUM*T1
            C( 2, J ) = C( 2, J ) - SUM*T2
            C( 3, J ) = C( 3, J ) - SUM*T3
            C( 4, J ) = C( 4, J ) - SUM*T4
            C( 5, J ) = C( 5, J ) - SUM*T5
            C( 6, J ) = C( 6, J ) - SUM*T6
            C( 7, J ) = C( 7, J ) - SUM*T7
            C( 8, J ) = C( 8, J ) - SUM*T8
  160    CONTINUE
         GO TO 410
  170    CONTINUE
*
*        Special code for 9 x 9 Householder
*
         V1 = V( 1 )
         T1 = TAU*V1
         V2 = V( 2 )
         T2 = TAU*V2
         V3 = V( 3 )
         T3 = TAU*V3
         V4 = V( 4 )
         T4 = TAU*V4
         V5 = V( 5 )
         T5 = TAU*V5
         V6 = V( 6 )
         T6 = TAU*V6
         V7 = V( 7 )
         T7 = TAU*V7
         V8 = V( 8 )
         T8 = TAU*V8
         V9 = V( 9 )
         T9 = TAU*V9
         DO 180 J = 1, N
            SUM = V1*C( 1, J ) + V2*C( 2, J ) + V3*C( 3, J ) +
     $            V4*C( 4, J ) + V5*C( 5, J ) + V6*C( 6, J ) +
     $            V7*C( 7, J ) + V8*C( 8, J ) + V9*C( 9, J )
```

```
            C( 1, J ) = C( 1, J ) - SUM*T1
            C( 2, J ) = C( 2, J ) - SUM*T2
            C( 3, J ) = C( 3, J ) - SUM*T3
            C( 4, J ) = C( 4, J ) - SUM*T4
            C( 5, J ) = C( 5, J ) - SUM*T5
            C( 6, J ) = C( 6, J ) - SUM*T6
            C( 7, J ) = C( 7, J ) - SUM*T7
            C( 8, J ) = C( 8, J ) - SUM*T8
            C( 9, J ) = C( 9, J ) - SUM*T9
  180    CONTINUE
         GO TO 410
  190    CONTINUE
*
*        Special code for 10 x 10 Householder
*
         V1 = V( 1 )
         T1 = TAU*V1
         V2 = V( 2 )
         T2 = TAU*V2
         V3 = V( 3 )
         T3 = TAU*V3
         V4 = V( 4 )
         T4 = TAU*V4
         V5 = V( 5 )
         T5 = TAU*V5
         V6 = V( 6 )
         T6 = TAU*V6
         V7 = V( 7 )
         T7 = TAU*V7
         V8 = V( 8 )
         T8 = TAU*V8
         V9 = V( 9 )
         T9 = TAU*V9
         V10 = V( 10 )
         T10 = TAU*V10
         DO 200 J = 1, N
            SUM = V1*C( 1, J ) + V2*C( 2, J ) + V3*C( 3, J ) +
     $            V4*C( 4, J ) + V5*C( 5, J ) + V6*C( 6, J ) +
     $            V7*C( 7, J ) + V8*C( 8, J ) + V9*C( 9, J ) +
     $            V10*C( 10, J )
            C( 1, J ) = C( 1, J ) - SUM*T1
            C( 2, J ) = C( 2, J ) - SUM*T2
            C( 3, J ) = C( 3, J ) - SUM*T3
            C( 4, J ) = C( 4, J ) - SUM*T4
            C( 5, J ) = C( 5, J ) - SUM*T5
            C( 6, J ) = C( 6, J ) - SUM*T6
            C( 7, J ) = C( 7, J ) - SUM*T7
            C( 8, J ) = C( 8, J ) - SUM*T8
            C( 9, J ) = C( 9, J ) - SUM*T9
            C( 10, J ) = C( 10, J ) - SUM*T10
```

```
  200    CONTINUE
         GO TO 410
      ELSE
*
*        Form  C * H, where H has order n.
*
         GO TO ( 210, 230, 250, 270, 290, 310, 330, 350,
     $           370, 390 )N
*
*        Code for general N
*
*        w := C * v
*
         CALL DGEMV( 'No transpose', M, N, ONE, C, LDC, V, 1, ZERO,
     $               WORK, 1 )
*
*        C := C - tau * w * v'
*
         CALL DGER( M, N, -TAU, WORK, 1, V, 1, C, LDC )
         GO TO 410
  210    CONTINUE
*
*        Special code for 1 x 1 Householder
*
         T1 = ONE - TAU*V( 1 )*V( 1 )
         DO 220 J = 1, M
            C( J, 1 ) = T1*C( J, 1 )
  220    CONTINUE
         GO TO 410
  230    CONTINUE
*
*        Special code for 2 x 2 Householder
*
         V1 = V( 1 )
         T1 = TAU*V1
         V2 = V( 2 )
         T2 = TAU*V2
         DO 240 J = 1, M
            SUM = V1*C( J, 1 ) + V2*C( J, 2 )
            C( J, 1 ) = C( J, 1 ) - SUM*T1
            C( J, 2 ) = C( J, 2 ) - SUM*T2
  240    CONTINUE
         GO TO 410
  250    CONTINUE
*
*        Special code for 3 x 3 Householder
*
         V1 = V( 1 )
         T1 = TAU*V1
         V2 = V( 2 )
```

```
         T2 = TAU*V2
         V3 = V( 3 )
         T3 = TAU*V3
         DO 260 J = 1, M
            SUM = V1*C( J, 1 ) + V2*C( J, 2 ) + V3*C( J, 3 )
            C( J, 1 ) = C( J, 1 ) - SUM*T1
            C( J, 2 ) = C( J, 2 ) - SUM*T2
            C( J, 3 ) = C( J, 3 ) - SUM*T3
  260    CONTINUE
         GO TO 410
  270    CONTINUE
*
*        Special code for 4 x 4 Householder
*
         V1 = V( 1 )
         T1 = TAU*V1
         V2 = V( 2 )
         T2 = TAU*V2
         V3 = V( 3 )
         T3 = TAU*V3
         V4 = V( 4 )
         T4 = TAU*V4
         DO 280 J = 1, M
            SUM = V1*C( J, 1 ) + V2*C( J, 2 ) + V3*C( J, 3 ) +
     $            V4*C( J, 4 )
            C( J, 1 ) = C( J, 1 ) - SUM*T1
            C( J, 2 ) = C( J, 2 ) - SUM*T2
            C( J, 3 ) = C( J, 3 ) - SUM*T3
            C( J, 4 ) = C( J, 4 ) - SUM*T4
  280    CONTINUE
         GO TO 410
  290    CONTINUE
*
*        Special code for 5 x 5 Householder
*
         V1 = V( 1 )
         T1 = TAU*V1
         V2 = V( 2 )
         T2 = TAU*V2
         V3 = V( 3 )
         T3 = TAU*V3
         V4 = V( 4 )
         T4 = TAU*V4
         V5 = V( 5 )
         T5 = TAU*V5
         DO 300 J = 1, M
            SUM = V1*C( J, 1 ) + V2*C( J, 2 ) + V3*C( J, 3 ) +
     $            V4*C( J, 4 ) + V5*C( J, 5 )
            C( J, 1 ) = C( J, 1 ) - SUM*T1
            C( J, 2 ) = C( J, 2 ) - SUM*T2
```

```
            C( J, 3 ) = C( J, 3 ) - SUM*T3
            C( J, 4 ) = C( J, 4 ) - SUM*T4
            C( J, 5 ) = C( J, 5 ) - SUM*T5
  300    CONTINUE
         GO TO 410
  310    CONTINUE
*
*        Special code for 6 x 6 Householder
*
         V1 = V( 1 )
         T1 = TAU*V1
         V2 = V( 2 )
         T2 = TAU*V2
         V3 = V( 3 )
         T3 = TAU*V3
         V4 = V( 4 )
         T4 = TAU*V4
         V5 = V( 5 )
         T5 = TAU*V5
         V6 = V( 6 )
         T6 = TAU*V6
         DO 320 J = 1, M
            SUM = V1*C( J, 1 ) + V2*C( J, 2 ) + V3*C( J, 3 ) +
     $            V4*C( J, 4 ) + V5*C( J, 5 ) + V6*C( J, 6 )
            C( J, 1 ) = C( J, 1 ) - SUM*T1
            C( J, 2 ) = C( J, 2 ) - SUM*T2
            C( J, 3 ) = C( J, 3 ) - SUM*T3
            C( J, 4 ) = C( J, 4 ) - SUM*T4
            C( J, 5 ) = C( J, 5 ) - SUM*T5
            C( J, 6 ) = C( J, 6 ) - SUM*T6
  320    CONTINUE
         GO TO 410
  330    CONTINUE
*
*        Special code for 7 x 7 Householder
*
         V1 = V( 1 )
         T1 = TAU*V1
         V2 = V( 2 )
         T2 = TAU*V2
         V3 = V( 3 )
         T3 = TAU*V3
         V4 = V( 4 )
         T4 = TAU*V4
         V5 = V( 5 )
         T5 = TAU*V5
         V6 = V( 6 )
         T6 = TAU*V6
         V7 = V( 7 )
         T7 = TAU*V7
```

```
         DO 340 J = 1, M
            SUM = V1*C( J, 1 ) + V2*C( J, 2 ) + V3*C( J, 3 ) +
     $            V4*C( J, 4 ) + V5*C( J, 5 ) + V6*C( J, 6 ) +
     $            V7*C( J, 7 )
            C( J, 1 ) = C( J, 1 ) - SUM*T1
            C( J, 2 ) = C( J, 2 ) - SUM*T2
            C( J, 3 ) = C( J, 3 ) - SUM*T3
            C( J, 4 ) = C( J, 4 ) - SUM*T4
            C( J, 5 ) = C( J, 5 ) - SUM*T5
            C( J, 6 ) = C( J, 6 ) - SUM*T6
            C( J, 7 ) = C( J, 7 ) - SUM*T7
  340    CONTINUE
         GO TO 410
  350    CONTINUE
*
*        Special code for 8 x 8 Householder
*
         V1 = V( 1 )
         T1 = TAU*V1
         V2 = V( 2 )
         T2 = TAU*V2
         V3 = V( 3 )
         T3 = TAU*V3
         V4 = V( 4 )
         T4 = TAU*V4
         V5 = V( 5 )
         T5 = TAU*V5
         V6 = V( 6 )
         T6 = TAU*V6
         V7 = V( 7 )
         T7 = TAU*V7
         V8 = V( 8 )
         T8 = TAU*V8
         DO 360 J = 1, M
            SUM = V1*C( J, 1 ) + V2*C( J, 2 ) + V3*C( J, 3 ) +
     $            V4*C( J, 4 ) + V5*C( J, 5 ) + V6*C( J, 6 ) +
     $            V7*C( J, 7 ) + V8*C( J, 8 )
            C( J, 1 ) = C( J, 1 ) - SUM*T1
            C( J, 2 ) = C( J, 2 ) - SUM*T2
            C( J, 3 ) = C( J, 3 ) - SUM*T3
            C( J, 4 ) = C( J, 4 ) - SUM*T4
            C( J, 5 ) = C( J, 5 ) - SUM*T5
            C( J, 6 ) = C( J, 6 ) - SUM*T6
            C( J, 7 ) = C( J, 7 ) - SUM*T7
            C( J, 8 ) = C( J, 8 ) - SUM*T8
  360    CONTINUE
         GO TO 410
  370    CONTINUE
*
*        Special code for 9 x 9 Householder
```

```
*
         V1 = V( 1 )
         T1 = TAU*V1
         V2 = V( 2 )
         T2 = TAU*V2
         V3 = V( 3 )
         T3 = TAU*V3
         V4 = V( 4 )
         T4 = TAU*V4
         V5 = V( 5 )
         T5 = TAU*V5
         V6 = V( 6 )
         T6 = TAU*V6
         V7 = V( 7 )
         T7 = TAU*V7
         V8 = V( 8 )
         T8 = TAU*V8
         V9 = V( 9 )
         T9 = TAU*V9
         DO 380 J = 1, M
            SUM = V1*C( J, 1 ) + V2*C( J, 2 ) + V3*C( J, 3 ) +
     $            V4*C( J, 4 ) + V5*C( J, 5 ) + V6*C( J, 6 ) +
     $            V7*C( J, 7 ) + V8*C( J, 8 ) + V9*C( J, 9 )
            C( J, 1 ) = C( J, 1 ) - SUM*T1
            C( J, 2 ) = C( J, 2 ) - SUM*T2
            C( J, 3 ) = C( J, 3 ) - SUM*T3
            C( J, 4 ) = C( J, 4 ) - SUM*T4
            C( J, 5 ) = C( J, 5 ) - SUM*T5
            C( J, 6 ) = C( J, 6 ) - SUM*T6
            C( J, 7 ) = C( J, 7 ) - SUM*T7
            C( J, 8 ) = C( J, 8 ) - SUM*T8
            C( J, 9 ) = C( J, 9 ) - SUM*T9
  380    CONTINUE
         GO TO 410
  390    CONTINUE
*
*        Special code for 10 x 10 Householder
*
         V1 = V( 1 )
         T1 = TAU*V1
         V2 = V( 2 )
         T2 = TAU*V2
         V3 = V( 3 )
         T3 = TAU*V3
         V4 = V( 4 )
         T4 = TAU*V4
         V5 = V( 5 )
         T5 = TAU*V5
         V6 = V( 6 )
         T6 = TAU*V6
```

```
         V7 = V( 7 )
         T7 = TAU*V7
         V8 = V( 8 )
         T8 = TAU*V8
         V9 = V( 9 )
         T9 = TAU*V9
         V10 = V( 10 )
         T10 = TAU*V10
         DO 400 J = 1, M
            SUM = V1*C( J, 1 ) + V2*C( J, 2 ) + V3*C( J, 3 ) +
     $            V4*C( J, 4 ) + V5*C( J, 5 ) + V6*C( J, 6 ) +
     $            V7*C( J, 7 ) + V8*C( J, 8 ) + V9*C( J, 9 ) +
     $            V10*C( J, 10 )
            C( J, 1 ) = C( J, 1 ) - SUM*T1
            C( J, 2 ) = C( J, 2 ) - SUM*T2
            C( J, 3 ) = C( J, 3 ) - SUM*T3
            C( J, 4 ) = C( J, 4 ) - SUM*T4
            C( J, 5 ) = C( J, 5 ) - SUM*T5
            C( J, 6 ) = C( J, 6 ) - SUM*T6
            C( J, 7 ) = C( J, 7 ) - SUM*T7
            C( J, 8 ) = C( J, 8 ) - SUM*T8
            C( J, 9 ) = C( J, 9 ) - SUM*T9
            C( J, 10 ) = C( J, 10 ) - SUM*T10
  400    CONTINUE
         GO TO 410
      END IF
  410 CONTINUE
      RETURN
*
*     End of DLARFX
*
      END
```

———-

— LAPACK dlarfx —

```
(let* ((zero 0.0) (one 1.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one))
  (defun dlarfx (side m n v tau c ldc work)
    (declare (type (double-float) tau)
             (type (simple-array double-float (*)) work c v)
             (type fixnum ldc n m)
             (type character side))
    (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (v double-float v-%data% v-%offset%)
```

```
         (c double-float c-%data% c-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((sum 0.0) (t1 0.0) (t10 0.0) (t2 0.0) (t3 0.0) (t4 0.0) (t5 0.0)
             (t6 0.0) (t7 0.0) (t8 0.0) (t9 0.0) (v1 0.0) (v10 0.0) (v2 0.0)
             (v3 0.0) (v4 0.0) (v5 0.0) (v6 0.0) (v7 0.0) (v8 0.0) (v9 0.0)
             (j 0))
        (declare (type (double-float) sum t1 t10 t2 t3 t4 t5 t6 t7 t8 t9 v1 v10
                                      v2 v3 v4 v5 v6 v7 v8 v9)
                 (type fixnum j))
        (if (= tau zero) (go end_label))
        (cond
          ((char-equal side #\L)
           (tagbody
             (f2cl-lib:computed-goto
              (label10 label30 label50 label70 label90 label110 label130
               label150 label170 label190)
              m)
             (dgemv "Transpose" m n one c ldc v 1 zero work 1)
             (dger m n (- tau) v 1 work 1 c ldc)
             (go end_label)
label10
             (setf t1
                     (+ one
                        (* (- tau)
                           (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%)
                           (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))))
             (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                           ((> j n) nil)
               (tagbody
                 (setf (f2cl-lib:fref c-%data%
                                      (1 j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                           (* t1
                              (f2cl-lib:fref c-%data%
                                             (1 j)
                                             ((1 ldc) (1 *))
                                             c-%offset%)))))
             (go end_label)
label30
             (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
             (setf t1 (* tau v1))
             (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
             (setf t2 (* tau v2))
             (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                           ((> j n) nil)
               (tagbody
                 (setf sum
                         (+
                          (* v1
```

```
                        (f2cl-lib:fref c-%data%
                                      (1 j)
                                      ((1 ldc) (1 *))
                                      c-%offset%))
                     (* v2
                        (f2cl-lib:fref c-%data%
                                      (2 j)
                                      ((1 ldc) (1 *))
                                      c-%offset%))))
                (setf (f2cl-lib:fref c-%data%
                                     (1 j)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (-
                       (f2cl-lib:fref c-%data%
                                      (1 j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (* sum t1)))
                (setf (f2cl-lib:fref c-%data%
                                     (2 j)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (-
                       (f2cl-lib:fref c-%data%
                                      (2 j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (* sum t2)))))
          (go end_label)
label50
          (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
          (setf t1 (* tau v1))
          (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
          (setf t2 (* tau v2))
          (setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
          (setf t3 (* tau v3))
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                        ((> j n) nil)
            (tagbody
              (setf sum
                      (+
                       (* v1
                          (f2cl-lib:fref c-%data%
                                        (1 j)
                                        ((1 ldc) (1 *))
                                        c-%offset%))
                       (* v2
                          (f2cl-lib:fref c-%data%
                                        (2 j)
```

```
                                        ((1 ldc) (1 *))
                                        c-%offset%))
                         (* v3
                            (f2cl-lib:fref c-%data%
                                        (3 j)
                                        ((1 ldc) (1 *))
                                        c-%offset%))))
                    (setf (f2cl-lib:fref c-%data%
                                         (1 j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                            (-
                             (f2cl-lib:fref c-%data%
                                           (1 j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                             (* sum t1)))
                    (setf (f2cl-lib:fref c-%data%
                                         (2 j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                            (-
                             (f2cl-lib:fref c-%data%
                                           (2 j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                             (* sum t2)))
                    (setf (f2cl-lib:fref c-%data%
                                         (3 j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                            (-
                             (f2cl-lib:fref c-%data%
                                           (3 j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                             (* sum t3)))))
            (go end_label)
label70
            (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
            (setf t1 (* tau v1))
            (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
            (setf t2 (* tau v2))
            (setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
            (setf t3 (* tau v3))
            (setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
            (setf t4 (* tau v4))
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
              (tagbody
```

```
(setf sum
        (+
         (* v1
            (f2cl-lib:fref c-%data%
                           (1 j)
                           ((1 ldc) (1 *))
                           c-%offset%))
         (* v2
            (f2cl-lib:fref c-%data%
                           (2 j)
                           ((1 ldc) (1 *))
                           c-%offset%))
         (* v3
            (f2cl-lib:fref c-%data%
                           (3 j)
                           ((1 ldc) (1 *))
                           c-%offset%))
         (* v4
            (f2cl-lib:fref c-%data%
                           (4 j)
                           ((1 ldc) (1 *))
                           c-%offset%))))
(setf (f2cl-lib:fref c-%data%
                     (1 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (1 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t1)))
(setf (f2cl-lib:fref c-%data%
                     (2 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (2 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t2)))
(setf (f2cl-lib:fref c-%data%
                     (3 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (3 j)
                        ((1 ldc) (1 *))
```

```
                                    c-%offset%)
                          (* sum t3)))
                    (setf (f2cl-lib:fref c-%data%
                                         (4 j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                          (-
                           (f2cl-lib:fref c-%data%
                                         (4 j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                           (* sum t4)))))
            (go end_label)
label90
            (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
            (setf t1 (* tau v1))
            (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
            (setf t2 (* tau v2))
            (setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
            (setf t3 (* tau v3))
            (setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
            (setf t4 (* tau v4))
            (setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
            (setf t5 (* tau v5))
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
              (tagbody
                (setf sum
                      (+
                       (* v1
                          (f2cl-lib:fref c-%data%
                                        (1 j)
                                        ((1 ldc) (1 *))
                                        c-%offset%))
                       (* v2
                          (f2cl-lib:fref c-%data%
                                        (2 j)
                                        ((1 ldc) (1 *))
                                        c-%offset%))
                       (* v3
                          (f2cl-lib:fref c-%data%
                                        (3 j)
                                        ((1 ldc) (1 *))
                                        c-%offset%))
                       (* v4
                          (f2cl-lib:fref c-%data%
                                        (4 j)
                                        ((1 ldc) (1 *))
                                        c-%offset%))
                       (* v5
```

```
            (f2cl-lib:fref c-%data%
                           (5 j)
                           ((1 ldc) (1 *))
                           c-%offset%))))
(setf (f2cl-lib:fref c-%data%
                     (1 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (1 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t1)))
(setf (f2cl-lib:fref c-%data%
                     (2 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (2 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t2)))
(setf (f2cl-lib:fref c-%data%
                     (3 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (3 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t3)))
(setf (f2cl-lib:fref c-%data%
                     (4 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (4 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t4)))
(setf (f2cl-lib:fref c-%data%
                     (5 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
```

```
                                    (5 j)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                     (* sum t5)))))
            (go end_label)
label110
            (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
            (setf t1 (* tau v1))
            (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
            (setf t2 (* tau v2))
            (setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
            (setf t3 (* tau v3))
            (setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
            (setf t4 (* tau v4))
            (setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
            (setf t5 (* tau v5))
            (setf v6 (f2cl-lib:fref v-%data% (6) ((1 *)) v-%offset%))
            (setf t6 (* tau v6))
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
              (tagbody
                (setf sum
                        (+
                         (* v1
                            (f2cl-lib:fref c-%data%
                                           (1 j)
                                           ((1 ldc) (1 *))
                                           c-%offset%))
                         (* v2
                            (f2cl-lib:fref c-%data%
                                           (2 j)
                                           ((1 ldc) (1 *))
                                           c-%offset%))
                         (* v3
                            (f2cl-lib:fref c-%data%
                                           (3 j)
                                           ((1 ldc) (1 *))
                                           c-%offset%))
                         (* v4
                            (f2cl-lib:fref c-%data%
                                           (4 j)
                                           ((1 ldc) (1 *))
                                           c-%offset%))
                         (* v5
                            (f2cl-lib:fref c-%data%
                                           (5 j)
                                           ((1 ldc) (1 *))
                                           c-%offset%))
                         (* v6
                            (f2cl-lib:fref c-%data%
```

```
                              (6 j)
                              ((1 ldc) (1 *))
                              c-%offset%))))
(setf (f2cl-lib:fref c-%data%
                     (1 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (1 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t1)))
(setf (f2cl-lib:fref c-%data%
                     (2 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (2 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t2)))
(setf (f2cl-lib:fref c-%data%
                     (3 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (3 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t3)))
(setf (f2cl-lib:fref c-%data%
                     (4 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (4 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t4)))
(setf (f2cl-lib:fref c-%data%
                     (5 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (5 j)
```

```
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                     (* sum t5)))
                (setf (f2cl-lib:fref c-%data%
                                     (6 j)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (-
                       (f2cl-lib:fref c-%data%
                                      (6 j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (* sum t6)))))
            (go end_label)
label130
            (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
            (setf t1 (* tau v1))
            (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
            (setf t2 (* tau v2))
            (setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
            (setf t3 (* tau v3))
            (setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
            (setf t4 (* tau v4))
            (setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
            (setf t5 (* tau v5))
            (setf v6 (f2cl-lib:fref v-%data% (6) ((1 *)) v-%offset%))
            (setf t6 (* tau v6))
            (setf v7 (f2cl-lib:fref v-%data% (7) ((1 *)) v-%offset%))
            (setf t7 (* tau v7))
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j n) nil)
              (tagbody
                (setf sum
                      (+
                       (* v1
                          (f2cl-lib:fref c-%data%
                                        (1 j)
                                        ((1 ldc) (1 *))
                                        c-%offset%))
                       (* v2
                          (f2cl-lib:fref c-%data%
                                        (2 j)
                                        ((1 ldc) (1 *))
                                        c-%offset%))
                       (* v3
                          (f2cl-lib:fref c-%data%
                                        (3 j)
                                        ((1 ldc) (1 *))
                                        c-%offset%))
                       (* v4
```

```
                  (f2cl-lib:fref c-%data%
                                 (4 j)
                                 ((1 ldc) (1 *))
                                 c-%offset%))
               (* v5
                  (f2cl-lib:fref c-%data%
                                 (5 j)
                                 ((1 ldc) (1 *))
                                 c-%offset%))
               (* v6
                  (f2cl-lib:fref c-%data%
                                 (6 j)
                                 ((1 ldc) (1 *))
                                 c-%offset%))
               (* v7
                  (f2cl-lib:fref c-%data%
                                 (7 j)
                                 ((1 ldc) (1 *))
                                 c-%offset%))))
(setf (f2cl-lib:fref c-%data%
                     (1 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (1 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t1)))
(setf (f2cl-lib:fref c-%data%
                     (2 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (2 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t2)))
(setf (f2cl-lib:fref c-%data%
                     (3 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (3 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t3)))
(setf (f2cl-lib:fref c-%data%
```

```
                                    (4 j)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                            (-
                             (f2cl-lib:fref c-%data%
                                           (4 j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                             (* sum t4)))
                    (setf (f2cl-lib:fref c-%data%
                                    (5 j)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                            (-
                             (f2cl-lib:fref c-%data%
                                           (5 j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                             (* sum t5)))
                    (setf (f2cl-lib:fref c-%data%
                                    (6 j)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                            (-
                             (f2cl-lib:fref c-%data%
                                           (6 j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                             (* sum t6)))
                    (setf (f2cl-lib:fref c-%data%
                                    (7 j)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                            (-
                             (f2cl-lib:fref c-%data%
                                           (7 j)
                                           ((1 ldc) (1 *))
                                           c-%offset%)
                             (* sum t7)))))
            (go end_label)
label150
            (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
            (setf t1 (* tau v1))
            (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
            (setf t2 (* tau v2))
            (setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
            (setf t3 (* tau v3))
            (setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
            (setf t4 (* tau v4))
            (setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
```

```
(setf t5 (* tau v5))
(setf v6 (f2cl-lib:fref v-%data% (6) ((1 *)) v-%offset%))
(setf t6 (* tau v6))
(setf v7 (f2cl-lib:fref v-%data% (7) ((1 *)) v-%offset%))
(setf t7 (* tau v7))
(setf v8 (f2cl-lib:fref v-%data% (8) ((1 *)) v-%offset%))
(setf t8 (* tau v8))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j n) nil)
  (tagbody
    (setf sum
            (+
             (* v1
                (f2cl-lib:fref c-%data%
                               (1 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v2
                (f2cl-lib:fref c-%data%
                               (2 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v3
                (f2cl-lib:fref c-%data%
                               (3 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v4
                (f2cl-lib:fref c-%data%
                               (4 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v5
                (f2cl-lib:fref c-%data%
                               (5 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v6
                (f2cl-lib:fref c-%data%
                               (6 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v7
                (f2cl-lib:fref c-%data%
                               (7 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v8
                (f2cl-lib:fref c-%data%
                               (8 j)
```

```
                              ((1 ldc) (1 *))
                              c-%offset%))))
(setf (f2cl-lib:fref c-%data%
                     (1 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (1 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t1)))
(setf (f2cl-lib:fref c-%data%
                     (2 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (2 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t2)))
(setf (f2cl-lib:fref c-%data%
                     (3 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (3 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t3)))
(setf (f2cl-lib:fref c-%data%
                     (4 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (4 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t4)))
(setf (f2cl-lib:fref c-%data%
                     (5 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (5 j)
                        ((1 ldc) (1 *))
```

```
                                    c-%offset%)
                           (* sum t5)))
                    (setf (f2cl-lib:fref c-%data%
                                         (6 j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                          (-
                           (f2cl-lib:fref c-%data%
                                          (6 j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)
                           (* sum t6)))
                    (setf (f2cl-lib:fref c-%data%
                                         (7 j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                          (-
                           (f2cl-lib:fref c-%data%
                                          (7 j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)
                           (* sum t7)))
                    (setf (f2cl-lib:fref c-%data%
                                         (8 j)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                          (-
                           (f2cl-lib:fref c-%data%
                                          (8 j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)
                           (* sum t8)))))
              (go end_label)
label170
              (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
              (setf t1 (* tau v1))
              (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
              (setf t2 (* tau v2))
              (setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
              (setf t3 (* tau v3))
              (setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
              (setf t4 (* tau v4))
              (setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
              (setf t5 (* tau v5))
              (setf v6 (f2cl-lib:fref v-%data% (6) ((1 *)) v-%offset%))
              (setf t6 (* tau v6))
              (setf v7 (f2cl-lib:fref v-%data% (7) ((1 *)) v-%offset%))
              (setf t7 (* tau v7))
              (setf v8 (f2cl-lib:fref v-%data% (8) ((1 *)) v-%offset%))
              (setf t8 (* tau v8))
```

```
(setf v9 (f2cl-lib:fref v-%data% (9) ((1 *)) v-%offset%))
(setf t9 (* tau v9))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j n) nil)
  (tagbody
    (setf sum
            (+
             (* v1
                (f2cl-lib:fref c-%data%
                               (1 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v2
                (f2cl-lib:fref c-%data%
                               (2 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v3
                (f2cl-lib:fref c-%data%
                               (3 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v4
                (f2cl-lib:fref c-%data%
                               (4 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v5
                (f2cl-lib:fref c-%data%
                               (5 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v6
                (f2cl-lib:fref c-%data%
                               (6 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v7
                (f2cl-lib:fref c-%data%
                               (7 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v8
                (f2cl-lib:fref c-%data%
                               (8 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v9
                (f2cl-lib:fref c-%data%
                               (9 j)
```

```
                              ((1 ldc) (1 *))
                              c-%offset%))))
(setf (f2cl-lib:fref c-%data%
                     (1 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (1 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t1)))
(setf (f2cl-lib:fref c-%data%
                     (2 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (2 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t2)))
(setf (f2cl-lib:fref c-%data%
                     (3 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (3 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t3)))
(setf (f2cl-lib:fref c-%data%
                     (4 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (4 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t4)))
(setf (f2cl-lib:fref c-%data%
                     (5 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (5 j)
                        ((1 ldc) (1 *))
```

```
                                    c-%offset%)
                          (* sum t5)))
                (setf (f2cl-lib:fref c-%data%
                                     (6 j)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (-
                       (f2cl-lib:fref c-%data%
                                      (6 j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (* sum t6)))
                (setf (f2cl-lib:fref c-%data%
                                     (7 j)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (-
                       (f2cl-lib:fref c-%data%
                                      (7 j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (* sum t7)))
                (setf (f2cl-lib:fref c-%data%
                                     (8 j)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (-
                       (f2cl-lib:fref c-%data%
                                      (8 j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (* sum t8)))
                (setf (f2cl-lib:fref c-%data%
                                     (9 j)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (-
                       (f2cl-lib:fref c-%data%
                                      (9 j)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (* sum t9)))))
          (go end_label)
label190
          (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
          (setf t1 (* tau v1))
          (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
          (setf t2 (* tau v2))
          (setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
          (setf t3 (* tau v3))
```

```
(setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
(setf t4 (* tau v4))
(setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
(setf t5 (* tau v5))
(setf v6 (f2cl-lib:fref v-%data% (6) ((1 *)) v-%offset%))
(setf t6 (* tau v6))
(setf v7 (f2cl-lib:fref v-%data% (7) ((1 *)) v-%offset%))
(setf t7 (* tau v7))
(setf v8 (f2cl-lib:fref v-%data% (8) ((1 *)) v-%offset%))
(setf t8 (* tau v8))
(setf v9 (f2cl-lib:fref v-%data% (9) ((1 *)) v-%offset%))
(setf t9 (* tau v9))
(setf v10 (f2cl-lib:fref v-%data% (10) ((1 *)) v-%offset%))
(setf t10 (* tau v10))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j n) nil)
  (tagbody
    (setf sum
            (+
             (* v1
                (f2cl-lib:fref c-%data%
                               (1 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v2
                (f2cl-lib:fref c-%data%
                               (2 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v3
                (f2cl-lib:fref c-%data%
                               (3 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v4
                (f2cl-lib:fref c-%data%
                               (4 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v5
                (f2cl-lib:fref c-%data%
                               (5 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v6
                (f2cl-lib:fref c-%data%
                               (6 j)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v7
```

```
                (f2cl-lib:fref c-%data%
                              (7 j)
                              ((1 ldc) (1 *))
                              c-%offset%))
             (* v8
                (f2cl-lib:fref c-%data%
                              (8 j)
                              ((1 ldc) (1 *))
                              c-%offset%))
             (* v9
                (f2cl-lib:fref c-%data%
                              (9 j)
                              ((1 ldc) (1 *))
                              c-%offset%))
             (* v10
                (f2cl-lib:fref c-%data%
                              (10 j)
                              ((1 ldc) (1 *))
                              c-%offset%))))
(setf (f2cl-lib:fref c-%data%
                     (1 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (1 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t1)))
(setf (f2cl-lib:fref c-%data%
                     (2 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (2 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t2)))
(setf (f2cl-lib:fref c-%data%
                     (3 j)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (3 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t3)))
(setf (f2cl-lib:fref c-%data%
```

```
                        (4 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (4 j)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t4)))
(setf (f2cl-lib:fref c-%data%
                        (5 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (5 j)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t5)))
(setf (f2cl-lib:fref c-%data%
                        (6 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (6 j)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t6)))
(setf (f2cl-lib:fref c-%data%
                        (7 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (7 j)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t7)))
(setf (f2cl-lib:fref c-%data%
                        (8 j)
                        ((1 ldc) (1 *))
                        c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (8 j)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t8)))
(setf (f2cl-lib:fref c-%data%
```

```
                                    (9 j)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                          (-
                           (f2cl-lib:fref c-%data%
                                          (9 j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)
                           (* sum t9)))
                     (setf (f2cl-lib:fref c-%data%
                                    (10 j)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                           (-
                            (f2cl-lib:fref c-%data%
                                          (10 j)
                                          ((1 ldc) (1 *))
                                          c-%offset%)
                            (* sum t10)))))
                (go end_label)))
              (t
               (tagbody
                 (f2cl-lib:computed-goto
                  (label210 label230 label250 label270 label290 label310 label330
                   label350 label370 label390)
                  n)
                 (dgemv "No transpose" m n one c ldc v 1 zero work 1)
                 (dger m n (- tau) work 1 v 1 c ldc)
                 (go end_label)
label210
                 (setf t1
                         (+ one
                            (* (- tau)
                               (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%)
                               (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))))
                 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                               ((> j m) nil)
                   (tagbody
                     (setf (f2cl-lib:fref c-%data%
                                    (j 1)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                           (* t1
                              (f2cl-lib:fref c-%data%
                                            (j 1)
                                            ((1 ldc) (1 *))
                                            c-%offset%)))))
                 (go end_label)
label230
                 (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
```

```
            (setf t1 (* tau v1))
            (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
            (setf t2 (* tau v2))
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j m) nil)
              (tagbody
                (setf sum
                        (+
                         (* v1
                            (f2cl-lib:fref c-%data%
                                           (j 1)
                                           ((1 ldc) (1 *))
                                           c-%offset%))
                         (* v2
                            (f2cl-lib:fref c-%data%
                                           (j 2)
                                           ((1 ldc) (1 *))
                                           c-%offset%))))
                (setf (f2cl-lib:fref c-%data%
                                     (j 1)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                        (-
                         (f2cl-lib:fref c-%data%
                                        (j 1)
                                        ((1 ldc) (1 *))
                                        c-%offset%)
                         (* sum t1)))
                (setf (f2cl-lib:fref c-%data%
                                     (j 2)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                        (-
                         (f2cl-lib:fref c-%data%
                                        (j 2)
                                        ((1 ldc) (1 *))
                                        c-%offset%)
                         (* sum t2)))))
            (go end_label)
label250
            (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
            (setf t1 (* tau v1))
            (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
            (setf t2 (* tau v2))
            (setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
            (setf t3 (* tau v3))
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j m) nil)
              (tagbody
                (setf sum
```

```
                        (+
                         (* v1
                            (f2cl-lib:fref c-%data%
                                           (j 1)
                                           ((1 ldc) (1 *))
                                           c-%offset%))
                         (* v2
                            (f2cl-lib:fref c-%data%
                                           (j 2)
                                           ((1 ldc) (1 *))
                                           c-%offset%))
                         (* v3
                            (f2cl-lib:fref c-%data%
                                           (j 3)
                                           ((1 ldc) (1 *))
                                           c-%offset%))))
                  (setf (f2cl-lib:fref c-%data%
                                       (j 1)
                                       ((1 ldc) (1 *))
                                       c-%offset%)
                        (-
                         (f2cl-lib:fref c-%data%
                                        (j 1)
                                        ((1 ldc) (1 *))
                                        c-%offset%)
                         (* sum t1)))
                  (setf (f2cl-lib:fref c-%data%
                                       (j 2)
                                       ((1 ldc) (1 *))
                                       c-%offset%)
                        (-
                         (f2cl-lib:fref c-%data%
                                        (j 2)
                                        ((1 ldc) (1 *))
                                        c-%offset%)
                         (* sum t2)))
                  (setf (f2cl-lib:fref c-%data%
                                       (j 3)
                                       ((1 ldc) (1 *))
                                       c-%offset%)
                        (-
                         (f2cl-lib:fref c-%data%
                                        (j 3)
                                        ((1 ldc) (1 *))
                                        c-%offset%)
                         (* sum t3)))))
            (go end_label)
label270
            (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
            (setf t1 (* tau v1))
```

```
(setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
(setf t2 (* tau v2))
(setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
(setf t3 (* tau v3))
(setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
(setf t4 (* tau v4))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j m) nil)
  (tagbody
    (setf sum
            (+
             (* v1
                (f2cl-lib:fref c-%data%
                               (j 1)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v2
                (f2cl-lib:fref c-%data%
                               (j 2)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v3
                (f2cl-lib:fref c-%data%
                               (j 3)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v4
                (f2cl-lib:fref c-%data%
                               (j 4)
                               ((1 ldc) (1 *))
                               c-%offset%))))
    (setf (f2cl-lib:fref c-%data%
                         (j 1)
                         ((1 ldc) (1 *))
                         c-%offset%)
            (-
             (f2cl-lib:fref c-%data%
                            (j 1)
                            ((1 ldc) (1 *))
                            c-%offset%)
             (* sum t1)))
    (setf (f2cl-lib:fref c-%data%
                         (j 2)
                         ((1 ldc) (1 *))
                         c-%offset%)
            (-
             (f2cl-lib:fref c-%data%
                            (j 2)
                            ((1 ldc) (1 *))
                            c-%offset%)
```

```
                    (* sum t2)))
               (setf (f2cl-lib:fref c-%data%
                                    (j 3)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                     (-
                      (f2cl-lib:fref c-%data%
                                     (j 3)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (* sum t3)))
               (setf (f2cl-lib:fref c-%data%
                                    (j 4)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                     (-
                      (f2cl-lib:fref c-%data%
                                     (j 4)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (* sum t4)))))
          (go end_label)
label290
          (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
          (setf t1 (* tau v1))
          (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
          (setf t2 (* tau v2))
          (setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
          (setf t3 (* tau v3))
          (setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
          (setf t4 (* tau v4))
          (setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
          (setf t5 (* tau v5))
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                        ((> j m) nil)
            (tagbody
              (setf sum
                    (+
                     (* v1
                        (f2cl-lib:fref c-%data%
                                       (j 1)
                                       ((1 ldc) (1 *))
                                       c-%offset%))
                     (* v2
                        (f2cl-lib:fref c-%data%
                                       (j 2)
                                       ((1 ldc) (1 *))
                                       c-%offset%))
                     (* v3
                        (f2cl-lib:fref c-%data%
```

```
                                (j 3)
                                ((1 ldc) (1 *))
                                c-%offset%))
                  (* v4
                     (f2cl-lib:fref c-%data%
                                (j 4)
                                ((1 ldc) (1 *))
                                c-%offset%))
                  (* v5
                     (f2cl-lib:fref c-%data%
                                (j 5)
                                ((1 ldc) (1 *))
                                c-%offset%))))
          (setf (f2cl-lib:fref c-%data%
                               (j 1)
                               ((1 ldc) (1 *))
                               c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (j 1)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t1)))
          (setf (f2cl-lib:fref c-%data%
                               (j 2)
                               ((1 ldc) (1 *))
                               c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (j 2)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t2)))
          (setf (f2cl-lib:fref c-%data%
                               (j 3)
                               ((1 ldc) (1 *))
                               c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (j 3)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t3)))
          (setf (f2cl-lib:fref c-%data%
                               (j 4)
                               ((1 ldc) (1 *))
                               c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (j 4)
```

```
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                     (* sum t4)))
                (setf (f2cl-lib:fref c-%data%
                                     (j 5)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (-
                       (f2cl-lib:fref c-%data%
                                      (j 5)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (* sum t5)))))
            (go end_label)
label310
            (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
            (setf t1 (* tau v1))
            (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
            (setf t2 (* tau v2))
            (setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
            (setf t3 (* tau v3))
            (setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
            (setf t4 (* tau v4))
            (setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
            (setf t5 (* tau v5))
            (setf v6 (f2cl-lib:fref v-%data% (6) ((1 *)) v-%offset%))
            (setf t6 (* tau v6))
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j m) nil)
              (tagbody
                (setf sum
                      (+
                       (* v1
                          (f2cl-lib:fref c-%data%
                                         (j 1)
                                         ((1 ldc) (1 *))
                                         c-%offset%))
                       (* v2
                          (f2cl-lib:fref c-%data%
                                         (j 2)
                                         ((1 ldc) (1 *))
                                         c-%offset%))
                       (* v3
                          (f2cl-lib:fref c-%data%
                                         (j 3)
                                         ((1 ldc) (1 *))
                                         c-%offset%))
                       (* v4
                          (f2cl-lib:fref c-%data%
                                         (j 4)
```

```
                                ((1 ldc) (1 *))
                                c-%offset%))
                 (* v5
                    (f2cl-lib:fref c-%data%
                                (j 5)
                                ((1 ldc) (1 *))
                                c-%offset%))
                 (* v6
                    (f2cl-lib:fref c-%data%
                                (j 6)
                                ((1 ldc) (1 *))
                                c-%offset%))))
          (setf (f2cl-lib:fref c-%data%
                               (j 1)
                               ((1 ldc) (1 *))
                               c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (j 1)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t1)))
          (setf (f2cl-lib:fref c-%data%
                               (j 2)
                               ((1 ldc) (1 *))
                               c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (j 2)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t2)))
          (setf (f2cl-lib:fref c-%data%
                               (j 3)
                               ((1 ldc) (1 *))
                               c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (j 3)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t3)))
          (setf (f2cl-lib:fref c-%data%
                               (j 4)
                               ((1 ldc) (1 *))
                               c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (j 4)
                                ((1 ldc) (1 *))
```

```
                                    c-%offset%)
                           (* sum t4)))
                    (setf (f2cl-lib:fref c-%data%
                                         (j 5)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                          (-
                           (f2cl-lib:fref c-%data%
                                         (j 5)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                           (* sum t5)))
                    (setf (f2cl-lib:fref c-%data%
                                         (j 6)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                          (-
                           (f2cl-lib:fref c-%data%
                                         (j 6)
                                         ((1 ldc) (1 *))
                                         c-%offset%)
                           (* sum t6)))))
            (go end_label)
label330
            (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
            (setf t1 (* tau v1))
            (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
            (setf t2 (* tau v2))
            (setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
            (setf t3 (* tau v3))
            (setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
            (setf t4 (* tau v4))
            (setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
            (setf t5 (* tau v5))
            (setf v6 (f2cl-lib:fref v-%data% (6) ((1 *)) v-%offset%))
            (setf t6 (* tau v6))
            (setf v7 (f2cl-lib:fref v-%data% (7) ((1 *)) v-%offset%))
            (setf t7 (* tau v7))
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j m) nil)
              (tagbody
                (setf sum
                      (+
                       (* v1
                          (f2cl-lib:fref c-%data%
                                        (j 1)
                                        ((1 ldc) (1 *))
                                        c-%offset%))
                       (* v2
                          (f2cl-lib:fref c-%data%
```

```
                                (j 2)
                                ((1 ldc) (1 *))
                                c-%offset%))
                        (* v3
                           (f2cl-lib:fref c-%data%
                                (j 3)
                                ((1 ldc) (1 *))
                                c-%offset%))
                        (* v4
                           (f2cl-lib:fref c-%data%
                                (j 4)
                                ((1 ldc) (1 *))
                                c-%offset%))
                        (* v5
                           (f2cl-lib:fref c-%data%
                                (j 5)
                                ((1 ldc) (1 *))
                                c-%offset%))
                        (* v6
                           (f2cl-lib:fref c-%data%
                                (j 6)
                                ((1 ldc) (1 *))
                                c-%offset%))
                        (* v7
                           (f2cl-lib:fref c-%data%
                                (j 7)
                                ((1 ldc) (1 *))
                                c-%offset%))))
                (setf (f2cl-lib:fref c-%data%
                                     (j 1)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (-
                       (f2cl-lib:fref c-%data%
                                      (j 1)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (* sum t1)))
                (setf (f2cl-lib:fref c-%data%
                                     (j 2)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (-
                       (f2cl-lib:fref c-%data%
                                      (j 2)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (* sum t2)))
                (setf (f2cl-lib:fref c-%data%
                                     (j 3)
```

```
                                ((1 ldc) (1 *))
                                c-%offset%)
                        (-
                         (f2cl-lib:fref c-%data%
                                        (j 3)
                                        ((1 ldc) (1 *))
                                        c-%offset%)
                         (* sum t3)))
                (setf (f2cl-lib:fref c-%data%
                                     (j 4)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                        (-
                         (f2cl-lib:fref c-%data%
                                        (j 4)
                                        ((1 ldc) (1 *))
                                        c-%offset%)
                         (* sum t4)))
                (setf (f2cl-lib:fref c-%data%
                                     (j 5)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                        (-
                         (f2cl-lib:fref c-%data%
                                        (j 5)
                                        ((1 ldc) (1 *))
                                        c-%offset%)
                         (* sum t5)))
                (setf (f2cl-lib:fref c-%data%
                                     (j 6)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                        (-
                         (f2cl-lib:fref c-%data%
                                        (j 6)
                                        ((1 ldc) (1 *))
                                        c-%offset%)
                         (* sum t6)))
                (setf (f2cl-lib:fref c-%data%
                                     (j 7)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                        (-
                         (f2cl-lib:fref c-%data%
                                        (j 7)
                                        ((1 ldc) (1 *))
                                        c-%offset%)
                         (* sum t7)))))
            (go end_label)
label350
```

```
(setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
(setf t1 (* tau v1))
(setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
(setf t2 (* tau v2))
(setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
(setf t3 (* tau v3))
(setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
(setf t4 (* tau v4))
(setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
(setf t5 (* tau v5))
(setf v6 (f2cl-lib:fref v-%data% (6) ((1 *)) v-%offset%))
(setf t6 (* tau v6))
(setf v7 (f2cl-lib:fref v-%data% (7) ((1 *)) v-%offset%))
(setf t7 (* tau v7))
(setf v8 (f2cl-lib:fref v-%data% (8) ((1 *)) v-%offset%))
(setf t8 (* tau v8))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j m) nil)
  (tagbody
    (setf sum
            (+
             (* v1
                (f2cl-lib:fref c-%data%
                               (j 1)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v2
                (f2cl-lib:fref c-%data%
                               (j 2)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v3
                (f2cl-lib:fref c-%data%
                               (j 3)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v4
                (f2cl-lib:fref c-%data%
                               (j 4)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v5
                (f2cl-lib:fref c-%data%
                               (j 5)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v6
                (f2cl-lib:fref c-%data%
                               (j 6)
                               ((1 ldc) (1 *))
```

```
                              c-%offset%))
            (* v7
               (f2cl-lib:fref c-%data%
                              (j 7)
                              ((1 ldc) (1 *))
                              c-%offset%))
            (* v8
               (f2cl-lib:fref c-%data%
                              (j 8)
                              ((1 ldc) (1 *))
                              c-%offset%))))
(setf (f2cl-lib:fref c-%data%
                     (j 1)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (j 1)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t1)))
(setf (f2cl-lib:fref c-%data%
                     (j 2)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (j 2)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t2)))
(setf (f2cl-lib:fref c-%data%
                     (j 3)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (j 3)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t3)))
(setf (f2cl-lib:fref c-%data%
                     (j 4)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (j 4)
                        ((1 ldc) (1 *))
                        c-%offset%)
```

```
                        (* sum t4)))
                (setf (f2cl-lib:fref c-%data%
                                     (j 5)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (-
                       (f2cl-lib:fref c-%data%
                                      (j 5)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (* sum t5)))
                (setf (f2cl-lib:fref c-%data%
                                     (j 6)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (-
                       (f2cl-lib:fref c-%data%
                                      (j 6)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (* sum t6)))
                (setf (f2cl-lib:fref c-%data%
                                     (j 7)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (-
                       (f2cl-lib:fref c-%data%
                                      (j 7)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (* sum t7)))
                (setf (f2cl-lib:fref c-%data%
                                     (j 8)
                                     ((1 ldc) (1 *))
                                     c-%offset%)
                      (-
                       (f2cl-lib:fref c-%data%
                                      (j 8)
                                      ((1 ldc) (1 *))
                                      c-%offset%)
                       (* sum t8)))))
          (go end_label)
label370
          (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
          (setf t1 (* tau v1))
          (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
          (setf t2 (* tau v2))
          (setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
          (setf t3 (* tau v3))
          (setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
```

```
(setf t4 (* tau v4))
(setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
(setf t5 (* tau v5))
(setf v6 (f2cl-lib:fref v-%data% (6) ((1 *)) v-%offset%))
(setf t6 (* tau v6))
(setf v7 (f2cl-lib:fref v-%data% (7) ((1 *)) v-%offset%))
(setf t7 (* tau v7))
(setf v8 (f2cl-lib:fref v-%data% (8) ((1 *)) v-%offset%))
(setf t8 (* tau v8))
(setf v9 (f2cl-lib:fref v-%data% (9) ((1 *)) v-%offset%))
(setf t9 (* tau v9))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j m) nil)
  (tagbody
    (setf sum
            (+
             (* v1
                (f2cl-lib:fref c-%data%
                               (j 1)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v2
                (f2cl-lib:fref c-%data%
                               (j 2)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v3
                (f2cl-lib:fref c-%data%
                               (j 3)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v4
                (f2cl-lib:fref c-%data%
                               (j 4)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v5
                (f2cl-lib:fref c-%data%
                               (j 5)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v6
                (f2cl-lib:fref c-%data%
                               (j 6)
                               ((1 ldc) (1 *))
                               c-%offset%))
             (* v7
                (f2cl-lib:fref c-%data%
                               (j 7)
                               ((1 ldc) (1 *))
```

```
                                c-%offset%))
                  (* v8
                     (f2cl-lib:fref c-%data%
                                    (j 8)
                                    ((1 ldc) (1 *))
                                    c-%offset%))
                  (* v9
                     (f2cl-lib:fref c-%data%
                                    (j 9)
                                    ((1 ldc) (1 *))
                                    c-%offset%))))
          (setf (f2cl-lib:fref c-%data%
                               (j 1)
                               ((1 ldc) (1 *))
                               c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (j 1)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t1)))
          (setf (f2cl-lib:fref c-%data%
                               (j 2)
                               ((1 ldc) (1 *))
                               c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (j 2)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t2)))
          (setf (f2cl-lib:fref c-%data%
                               (j 3)
                               ((1 ldc) (1 *))
                               c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (j 3)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t3)))
          (setf (f2cl-lib:fref c-%data%
                               (j 4)
                               ((1 ldc) (1 *))
                               c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (j 4)
                                ((1 ldc) (1 *))
                                c-%offset%)
```

```
         (* sum t4)))
(setf (f2cl-lib:fref c-%data%
                     (j 5)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (j 5)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t5)))
(setf (f2cl-lib:fref c-%data%
                     (j 6)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (j 6)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t6)))
(setf (f2cl-lib:fref c-%data%
                     (j 7)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (j 7)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t7)))
(setf (f2cl-lib:fref c-%data%
                     (j 8)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (j 8)
                        ((1 ldc) (1 *))
                        c-%offset%)
         (* sum t8)))
(setf (f2cl-lib:fref c-%data%
                     (j 9)
                     ((1 ldc) (1 *))
                     c-%offset%)
        (-
         (f2cl-lib:fref c-%data%
                        (j 9)
                        ((1 ldc) (1 *))
                        c-%offset%)
```

```
                (* sum t9)))))
            (go end_label)
label390
            (setf v1 (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%))
            (setf t1 (* tau v1))
            (setf v2 (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%))
            (setf t2 (* tau v2))
            (setf v3 (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%))
            (setf t3 (* tau v3))
            (setf v4 (f2cl-lib:fref v-%data% (4) ((1 *)) v-%offset%))
            (setf t4 (* tau v4))
            (setf v5 (f2cl-lib:fref v-%data% (5) ((1 *)) v-%offset%))
            (setf t5 (* tau v5))
            (setf v6 (f2cl-lib:fref v-%data% (6) ((1 *)) v-%offset%))
            (setf t6 (* tau v6))
            (setf v7 (f2cl-lib:fref v-%data% (7) ((1 *)) v-%offset%))
            (setf t7 (* tau v7))
            (setf v8 (f2cl-lib:fref v-%data% (8) ((1 *)) v-%offset%))
            (setf t8 (* tau v8))
            (setf v9 (f2cl-lib:fref v-%data% (9) ((1 *)) v-%offset%))
            (setf t9 (* tau v9))
            (setf v10 (f2cl-lib:fref v-%data% (10) ((1 *)) v-%offset%))
            (setf t10 (* tau v10))
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j m) nil)
              (tagbody
                (setf sum
                        (+
                         (* v1
                            (f2cl-lib:fref c-%data%
                                           (j 1)
                                           ((1 ldc) (1 *))
                                           c-%offset%))
                         (* v2
                            (f2cl-lib:fref c-%data%
                                           (j 2)
                                           ((1 ldc) (1 *))
                                           c-%offset%))
                         (* v3
                            (f2cl-lib:fref c-%data%
                                           (j 3)
                                           ((1 ldc) (1 *))
                                           c-%offset%))
                         (* v4
                            (f2cl-lib:fref c-%data%
                                           (j 4)
                                           ((1 ldc) (1 *))
                                           c-%offset%))
                         (* v5
                            (f2cl-lib:fref c-%data%
```

```
                                (j 5)
                                ((1 ldc) (1 *))
                                c-%offset%))
                  (* v6
                     (f2cl-lib:fref c-%data%
                                (j 6)
                                ((1 ldc) (1 *))
                                c-%offset%))
                  (* v7
                     (f2cl-lib:fref c-%data%
                                (j 7)
                                ((1 ldc) (1 *))
                                c-%offset%))
                  (* v8
                     (f2cl-lib:fref c-%data%
                                (j 8)
                                ((1 ldc) (1 *))
                                c-%offset%))
                  (* v9
                     (f2cl-lib:fref c-%data%
                                (j 9)
                                ((1 ldc) (1 *))
                                c-%offset%))
                  (* v10
                     (f2cl-lib:fref c-%data%
                                (j 10)
                                ((1 ldc) (1 *))
                                c-%offset%))))
          (setf (f2cl-lib:fref c-%data%
                               (j 1)
                               ((1 ldc) (1 *))
                               c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (j 1)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t1)))
          (setf (f2cl-lib:fref c-%data%
                               (j 2)
                               ((1 ldc) (1 *))
                               c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (j 2)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t2)))
          (setf (f2cl-lib:fref c-%data%
                               (j 3)
```

```
                        ((1 ldc) (1 *))
                        c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (j 3)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t3)))
(setf (f2cl-lib:fref c-%data%
                        (j 4)
                        ((1 ldc) (1 *))
                        c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (j 4)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t4)))
(setf (f2cl-lib:fref c-%data%
                        (j 5)
                        ((1 ldc) (1 *))
                        c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (j 5)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t5)))
(setf (f2cl-lib:fref c-%data%
                        (j 6)
                        ((1 ldc) (1 *))
                        c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (j 6)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t6)))
(setf (f2cl-lib:fref c-%data%
                        (j 7)
                        ((1 ldc) (1 *))
                        c-%offset%)
                (-
                 (f2cl-lib:fref c-%data%
                                (j 7)
                                ((1 ldc) (1 *))
                                c-%offset%)
                 (* sum t7)))
(setf (f2cl-lib:fref c-%data%
                        (j 8)
```

```
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                            (-
                             (f2cl-lib:fref c-%data%
                                            (j 8)
                                            ((1 ldc) (1 *))
                                            c-%offset%)
                             (* sum t8)))
                    (setf (f2cl-lib:fref c-%data%
                                    (j 9)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                            (-
                             (f2cl-lib:fref c-%data%
                                            (j 9)
                                            ((1 ldc) (1 *))
                                            c-%offset%)
                             (* sum t9)))
                    (setf (f2cl-lib:fref c-%data%
                                    (j 10)
                                    ((1 ldc) (1 *))
                                    c-%offset%)
                            (-
                             (f2cl-lib:fref c-%data%
                                            (j 10)
                                            ((1 ldc) (1 *))
                                            c-%offset%)
                             (* sum t10)))))
                (go end_label))))
 end_label
        (return (values nil nil nil nil nil nil nil nil))))))
```

———-

6.54 dlartg LAPACK

— dlartg.input —

```
)set break resume
)sys rm -f dlartg.output
)spool dlartg.output
)set message test on
)set message auto off
)clear all

)spool
```

```
)lisp (bye)
```

———-

— dlartg.help —

```
=========================================================================
dlartg examples
=========================================================================

=========================================================================
Man Page Details
=========================================================================

NAME
       DLARTG - a plane rotation so that   [ CS SN ]

SYNOPSIS
       SUBROUTINE DLARTG( F, G, CS, SN, R )

           DOUBLE         PRECISION CS, F, G, R, SN

 Purpose
 =======

  DLARTG generate a plane rotation so that

     [  CS  SN  ]  .  [ F ]  =  [ R ]   where CS**2 + SN**2 = 1.
     [ -SN  CS  ]     [ G ]     [ 0 ]

  This is a slower, more accurate version of the BLAS1 routine DROTG,
  with the following other differences:
     F and G are unchanged on return.
     If G=0, then CS=1 and SN=0.
     If F=0 and (G .ne. 0), then CS=0 and SN=1 without doing any
        floating point operations (saves work in DBDSQR when
        there are zeros on the diagonal).

  If F exceeds G in magnitude, CS will be positive.

 Arguments
 =========

  F       (input) DOUBLE PRECISION
          The first component of vector to be rotated.

  G       (input) DOUBLE PRECISION
          The second component of vector to be rotated.
```

```
  CS      (output) DOUBLE PRECISION
          The cosine of the rotation.

  SN      (output) DOUBLE PRECISION
          The sine of the rotation.

  R       (output) DOUBLE PRECISION
          The nonzero component of the rotated vector.
```

———-

— dlartg.f —

```
      SUBROUTINE DLARTG( F, G, CS, SN, R )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     September 30, 1994
*
*     .. Scalar Arguments ..
      DOUBLE PRECISION   CS, F, G, R, SN
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER          ( ZERO = 0.0D0 )
      DOUBLE PRECISION   ONE
      PARAMETER          ( ONE = 1.0D0 )
      DOUBLE PRECISION   TWO
      PARAMETER          ( TWO = 2.0D0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            FIRST
      INTEGER            COUNT, I
      DOUBLE PRECISION   EPS, F1, G1, SAFMIN, SAFMN2, SAFMX2, SCALE
*     ..
*     .. External Functions ..
      DOUBLE PRECISION   DLAMCH
      EXTERNAL           DLAMCH
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, INT, LOG, MAX, SQRT
*     ..
*     .. Save statement ..
      SAVE               FIRST, SAFMX2, SAFMIN, SAFMN2
```

```
*     ..
*     .. Data statements ..
      DATA               FIRST / .TRUE. /
*     ..
*     .. Executable Statements ..
*
      IF( FIRST ) THEN
         FIRST = .FALSE.
         SAFMIN = DLAMCH( 'S' )
         EPS = DLAMCH( 'E' )
         SAFMN2 = DLAMCH( 'B' )**INT( LOG( SAFMIN / EPS ) /
     $            LOG( DLAMCH( 'B' ) ) / TWO )
         SAFMX2 = ONE / SAFMN2
      END IF
      IF( G.EQ.ZERO ) THEN
         CS = ONE
         SN = ZERO
         R = F
      ELSE IF( F.EQ.ZERO ) THEN
         CS = ZERO
         SN = ONE
         R = G
      ELSE
         F1 = F
         G1 = G
         SCALE = MAX( ABS( F1 ), ABS( G1 ) )
         IF( SCALE.GE.SAFMX2 ) THEN
            COUNT = 0
   10       CONTINUE
            COUNT = COUNT + 1
            F1 = F1*SAFMN2
            G1 = G1*SAFMN2
            SCALE = MAX( ABS( F1 ), ABS( G1 ) )
            IF( SCALE.GE.SAFMX2 )
     $         GO TO 10
            R = SQRT( F1**2+G1**2 )
            CS = F1 / R
            SN = G1 / R
            DO 20 I = 1, COUNT
               R = R*SAFMX2
   20       CONTINUE
         ELSE IF( SCALE.LE.SAFMN2 ) THEN
            COUNT = 0
   30       CONTINUE
            COUNT = COUNT + 1
            F1 = F1*SAFMX2
            G1 = G1*SAFMX2
            SCALE = MAX( ABS( F1 ), ABS( G1 ) )
            IF( SCALE.LE.SAFMN2 )
     $         GO TO 30
```

```
            R = SQRT( F1**2+G1**2 )
            CS = F1 / R
            SN = G1 / R
            DO 40 I = 1, COUNT
               R = R*SAFMN2
   40       CONTINUE
         ELSE
            R = SQRT( F1**2+G1**2 )
            CS = F1 / R
            SN = G1 / R
         END IF
         IF( ABS( F ).GT.ABS( G ) .AND. CS.LT.ZERO ) THEN
            CS = -CS
            SN = -SN
            R = -R
         END IF
      END IF
      RETURN
*
*     End of DLARTG
*
      END
```

———-

— LAPACK dlartg —

```
(let* ((zero 0.0) (one 1.0) (two 2.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one)
           (type (double-float 2.0 2.0) two))
  (let ((safmx2 0.0) (safmin 0.0) (safmn2 0.0) (first$ nil))
    (declare (type (member t nil) first$)
             (type (double-float) safmn2 safmin safmx2))
    (setq first$ t)
    (defun dlartg (f g cs sn r)
      (declare (type (double-float) r sn cs g f))
      (prog ((eps 0.0) (f1 0.0) (g1 0.0) (scale 0.0) (i 0) (count$ 0))
        (declare (type (double-float) eps f1 g1 scale)
                 (type fixnum count$ i))
        (cond
          (first$
           (setf first$ nil)
           (setf safmin (dlamch "S"))
           (setf eps (dlamch "E"))
           (setf safmn2
                   (expt (dlamch "B")
                         (f2cl-lib:int
```

```
                        (/
                         (/ (f2cl-lib:flog (/ safmin eps))
                            (f2cl-lib:flog (dlamch "B")))
                         two))))
          (setf safmx2 (/ one safmn2))))
       (cond
         ((= g zero)
          (setf cs one)
          (setf sn zero)
          (setf r f))
         ((= f zero)
          (setf cs zero)
          (setf sn one)
          (setf r g))
         (t
          (setf f1 f)
          (setf g1 g)
          (setf scale (max (abs f1) (abs g1)))
          (cond
            ((>= scale safmx2)
             (tagbody
               (setf count$ 0)
label10
               (setf count$ (f2cl-lib:int-add count$ 1))
               (setf f1 (* f1 safmn2))
               (setf g1 (* g1 safmn2))
               (setf scale (max (abs f1) (abs g1)))
               (if (>= scale safmx2) (go label10))
               (setf r (f2cl-lib:fsqrt (+ (expt f1 2) (expt g1 2))))
               (setf cs (/ f1 r))
               (setf sn (/ g1 r))
               (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                             ((> i count$) nil)
                 (tagbody (setf r (* r safmx2)) label20))))
            ((<= scale safmn2)
             (tagbody
               (setf count$ 0)
label30
               (setf count$ (f2cl-lib:int-add count$ 1))
               (setf f1 (* f1 safmx2))
               (setf g1 (* g1 safmx2))
               (setf scale (max (abs f1) (abs g1)))
               (if (<= scale safmn2) (go label30))
               (setf r (f2cl-lib:fsqrt (+ (expt f1 2) (expt g1 2))))
               (setf cs (/ f1 r))
               (setf sn (/ g1 r))
               (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                             ((> i count$) nil)
                 (tagbody (setf r (* r safmn2)) label40))))
            (t
```

```
              (setf r (f2cl-lib:fsqrt (+ (expt f1 2) (expt g1 2))))
              (setf cs (/ f1 r))
              (setf sn (/ g1 r))))
           (cond
             ((and (> (abs f) (abs g)) (< cs zero))
              (setf cs (- cs))
              (setf sn (- sn))
              (setf r (- r))))))
 end_label
        (return (values nil nil cs sn r))))))
```

———-

6.55 dlas2 LAPACK

— **dlas2.input** —

```
)set break resume
)sys rm -f dlas2.output
)spool dlas2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlas2.help** —

```
=====================================================================
dlas2 examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DLAS2 - the singular values of the 2-by-2 matrix  [ F G ]  [ 0 H ]

SYNOPSIS
       SUBROUTINE DLAS2( F, G, H, SSMIN, SSMAX )
```

```
          DOUBLE        PRECISION F, G, H, SSMAX, SSMIN

PURPOSE
       DLAS2  computes the singular values of the 2-by-2 matrix
          [  F   G  ]
          [  0   H  ].  On return, SSMIN is the smaller singular value and
       SSMAX is the larger singular value.


ARGUMENTS
       F       (input) DOUBLE PRECISION
               The (1,1) element of the 2-by-2 matrix.

       G       (input) DOUBLE PRECISION
               The (1,2) element of the 2-by-2 matrix.

       H       (input) DOUBLE PRECISION
               The (2,2) element of the 2-by-2 matrix.

       SSMIN   (output) DOUBLE PRECISION
               The smaller singular value.

       SSMAX   (output) DOUBLE PRECISION
               The larger singular value.

FURTHER DETAILS
       Barring over/underflow, all output quantities are correct to  within  a
       few  units  in  the  last  place (ulps), even in the absence of a guard
       digit in addition/subtraction.

       In IEEE arithmetic, the code works correctly if one matrix  element  is
       infinite.

       Overflow  will not occur unless the largest singular value itself over-
       flows, or is within a few ulps of overflow. (On machines  with  partial
       overflow,  like  the  Cray,  overflow may occur if the largest singular
       value is within a factor of 2 of overflow.)

       Underflow is harmless if underflow is gradual. Otherwise,  results  may
       correspond  to  a  matrix  modified  by  perturbations of size near the
       underflow threshold.
```

———-

— dlas2.f —

```
      SUBROUTINE DLAS2( F, G, H, SSMIN, SSMAX )
*
```

```
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     September 30, 1994
*
*     .. Scalar Arguments ..
      DOUBLE PRECISION   F, G, H, SSMAX, SSMIN
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER          ( ZERO = 0.0D0 )
      DOUBLE PRECISION   ONE
      PARAMETER          ( ONE = 1.0D0 )
      DOUBLE PRECISION   TWO
      PARAMETER          ( TWO = 2.0D0 )
*     ..
*     .. Local Scalars ..
      DOUBLE PRECISION   AS, AT, AU, C, FA, FHMN, FHMX, GA, HA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX, MIN, SQRT
*     ..
*     .. Executable Statements ..
*
      FA = ABS( F )
      GA = ABS( G )
      HA = ABS( H )
      FHMN = MIN( FA, HA )
      FHMX = MAX( FA, HA )
      IF( FHMN.EQ.ZERO ) THEN
         SSMIN = ZERO
         IF( FHMX.EQ.ZERO ) THEN
            SSMAX = GA
         ELSE
            SSMAX = MAX( FHMX, GA )*SQRT( ONE+
     $              ( MIN( FHMX, GA ) / MAX( FHMX, GA ) )**2 )
         END IF
      ELSE
         IF( GA.LT.FHMX ) THEN
            AS = ONE + FHMN / FHMX
            AT = ( FHMX-FHMN ) / FHMX
            AU = ( GA / FHMX )**2
            C = TWO / ( SQRT( AS*AS+AU )+SQRT( AT*AT+AU ) )
            SSMIN = FHMN*C
            SSMAX = FHMX / C
         ELSE
            AU = FHMX / GA
```

```
            IF( AU.EQ.ZERO ) THEN
*
*              Avoid possible harmful underflow if exponent range
*              asymmetric (true SSMIN may not underflow even if
*              AU underflows)
*
               SSMIN = ( FHMN*FHMX ) / GA
               SSMAX = GA
            ELSE
               AS = ONE + FHMN / FHMX
               AT = ( FHMX-FHMN ) / FHMX
               C = ONE / ( SQRT( ONE+( AS*AU )**2 )+
     $             SQRT( ONE+( AT*AU )**2 ) )
               SSMIN = ( FHMN*C )*AU
               SSMIN = SSMIN + SSMIN
               SSMAX = GA / ( C+C )
            END IF
         END IF
      END IF
      RETURN
*
*     End of DLAS2
*
      END
```

———-

— LAPACK dlas2 —

```
(let* ((zero 0.0) (one 1.0) (two 2.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one)
           (type (double-float 2.0 2.0) two))
  (defun dlas2 (f g h ssmin ssmax)
    (declare (type (double-float) ssmax ssmin h g f))
    (prog ((as 0.0) (at 0.0) (au 0.0) (c 0.0) (fa 0.0) (fhmn 0.0) (fhmx 0.0)
           (ga 0.0) (ha 0.0))
      (declare (type (double-float) as at au c fa fhmn fhmx ga ha))
      (setf fa (abs f))
      (setf ga (abs g))
      (setf ha (abs h))
      (setf fhmn (min fa ha))
      (setf fhmx (max fa ha))
      (cond
        ((= fhmn zero)
         (setf ssmin zero)
         (cond
           ((= fhmx zero)
```

```
            (setf ssmax ga))
           (t
            (setf ssmax
                    (* (max fhmx ga)
                       (f2cl-lib:fsqrt
                        (+ one (expt (/ (min fhmx ga) (max fhmx ga)) 2))))))))
         (t
          (cond
            ((< ga fhmx)
             (setf as (+ one (/ fhmn fhmx)))
             (setf at (/ (- fhmx fhmn) fhmx))
             (setf au (expt (/ ga fhmx) 2))
             (setf c
                    (/ two
                       (+ (f2cl-lib:fsqrt (+ (* as as) au))
                          (f2cl-lib:fsqrt (+ (* at at) au)))))
             (setf ssmin (* fhmn c))
             (setf ssmax (/ fhmx c)))
            (t
             (setf au (/ fhmx ga))
             (cond
               ((= au zero)
                (setf ssmin (/ (* fhmn fhmx) ga))
                (setf ssmax ga))
               (t
                (setf as (+ one (/ fhmn fhmx)))
                (setf at (/ (- fhmx fhmn) fhmx))
                (setf c
                        (/ one
                           (+ (f2cl-lib:fsqrt (+ one (expt (* as au) 2)))
                              (f2cl-lib:fsqrt (+ one (expt (* at au) 2))))))
                (setf ssmin (* fhmn c au))
                (setf ssmin (+ ssmin ssmin))
                (setf ssmax (/ ga (+ c c)))))))))
      (return (values nil nil nil ssmin ssmax)))))
```

———-

6.56 dlascl LAPACK

— dlascl.input —

```
)set break resume
)sys rm -f dlascl.output
)spool dlascl.output
)set message test on
```

```
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dlascl.help —

```
=====================================================================
dlascl examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DLASCL - the M by N real matrix A by the real scalar CTO/CFROM

SYNOPSIS
       SUBROUTINE DLASCL( TYPE, KL, KU, CFROM, CTO, M, N, A, LDA, INFO )

           CHARACTER      TYPE

           INTEGER        INFO, KL, KU, LDA, M, N

           DOUBLE         PRECISION CFROM, CTO

           DOUBLE         PRECISION A( LDA, * )

 Purpose
 =======

  DLASCL multiplies the M by N real matrix A by the real scalar
  CTO/CFROM.  This is done without over/underflow as long as the final
  result CTO*A(I,J)/CFROM does not over/underflow. TYPE specifies that
  A may be full, upper triangular, lower triangular, upper Hessenberg,
  or banded.

 Arguments
 =========

  TYPE    (input) CHARACTER*1
          TYPE indices the storage type of the input matrix.
          = 'G':  A is a full matrix.
          = 'L':  A is a lower triangular matrix.
          = 'U':  A is an upper triangular matrix.
```

```
          = 'H':  A is an upper Hessenberg matrix.
          = 'B':  A is a symmetric band matrix with lower bandwidth KL
                  and upper bandwidth KU and with the only the lower
                  half stored.
          = 'Q':  A is a symmetric band matrix with lower bandwidth KL
                  and upper bandwidth KU and with the only the upper
                  half stored.
          = 'Z':  A is a band matrix with lower bandwidth KL and upper
                  bandwidth KU.

  KL      (input) INTEGER
          The lower bandwidth of A.  Referenced only if TYPE = 'B',
          'Q' or 'Z'.

  KU      (input) INTEGER
          The upper bandwidth of A.  Referenced only if TYPE = 'B',
          'Q' or 'Z'.

  CFROM   (input) DOUBLE PRECISION
  CTO     (input) DOUBLE PRECISION
          The matrix A is multiplied by CTO/CFROM. A(I,J) is computed
          without over/underflow if the final result CTO*A(I,J)/CFROM
          can be represented without over/underflow.  CFROM must be
          nonzero.

  M       (input) INTEGER
          The number of rows of the matrix A.  M >= 0.

  N       (input) INTEGER
          The number of columns of the matrix A.  N >= 0.

  A       (input/output) DOUBLE PRECISION array, dimension (LDA,M)
          The matrix to be multiplied by CTO/CFROM.  See TYPE for the
          storage type.

  LDA     (input) INTEGER
          The leading dimension of the array A.  LDA >= max(1,M).

  INFO    (output) INTEGER
          0  - successful exit
          <0 - if INFO = -i, the i-th argument had an illegal value.
```

———-

— dlascl.f —

```
      SUBROUTINE DLASCL( TYPE, KL, KU, CFROM, CTO, M, N, A, LDA, INFO )
*
```

```
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     February 29, 1992
*
*     .. Scalar Arguments ..
      CHARACTER          TYPE
      INTEGER            INFO, KL, KU, LDA, M, N
      DOUBLE PRECISION   CFROM, CTO
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D0, ONE = 1.0D0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            DONE
      INTEGER            I, ITYPE, J, K1, K2, K3, K4
      DOUBLE PRECISION   BIGNUM, CFROM1, CFROMC, CTO1, CTOC, MUL, SMLNUM
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      DOUBLE PRECISION   DLAMCH
      EXTERNAL           LSAME, DLAMCH
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX, MIN
*     ..
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
*
      IF( LSAME( TYPE, 'G' ) ) THEN
         ITYPE = 0
      ELSE IF( LSAME( TYPE, 'L' ) ) THEN
         ITYPE = 1
      ELSE IF( LSAME( TYPE, 'U' ) ) THEN
         ITYPE = 2
      ELSE IF( LSAME( TYPE, 'H' ) ) THEN
         ITYPE = 3
```

```
      ELSE IF( LSAME( TYPE, 'B' ) ) THEN
         ITYPE = 4
      ELSE IF( LSAME( TYPE, 'Q' ) ) THEN
         ITYPE = 5
      ELSE IF( LSAME( TYPE, 'Z' ) ) THEN
         ITYPE = 6
      ELSE
         ITYPE = -1
      END IF
*
      IF( ITYPE.EQ.-1 ) THEN
         INFO = -1
      ELSE IF( CFROM.EQ.ZERO ) THEN
         INFO = -4
      ELSE IF( M.LT.0 ) THEN
         INFO = -6
      ELSE IF( N.LT.0 .OR. ( ITYPE.EQ.4 .AND. N.NE.M ) .OR.
     $         ( ITYPE.EQ.5 .AND. N.NE.M ) ) THEN
         INFO = -7
      ELSE IF( ITYPE.LE.3 .AND. LDA.LT.MAX( 1, M ) ) THEN
         INFO = -9
      ELSE IF( ITYPE.GE.4 ) THEN
         IF( KL.LT.0 .OR. KL.GT.MAX( M-1, 0 ) ) THEN
            INFO = -2
         ELSE IF( KU.LT.0 .OR. KU.GT.MAX( N-1, 0 ) .OR.
     $            ( ( ITYPE.EQ.4 .OR. ITYPE.EQ.5 ) .AND. KL.NE.KU ) )
     $             THEN
            INFO = -3
         ELSE IF( ( ITYPE.EQ.4 .AND. LDA.LT.KL+1 ) .OR.
     $            ( ITYPE.EQ.5 .AND. LDA.LT.KU+1 ) .OR.
     $            ( ITYPE.EQ.6 .AND. LDA.LT.2*KL+KU+1 ) ) THEN
            INFO = -9
         END IF
      END IF
*
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DLASCL', -INFO )
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( N.EQ.0 .OR. M.EQ.0 )
     $   RETURN
*
*     Get machine parameters
*
      SMLNUM = DLAMCH( 'S' )
      BIGNUM = ONE / SMLNUM
*
```

```
      CFROMC = CFROM
      CTOC = CTO
*
   10 CONTINUE
      CFROM1 = CFROMC*SMLNUM
      CTO1 = CTOC / BIGNUM
      IF( ABS( CFROM1 ).GT.ABS( CTOC ) .AND. CTOC.NE.ZERO ) THEN
         MUL = SMLNUM
         DONE = .FALSE.
         CFROMC = CFROM1
      ELSE IF( ABS( CTO1 ).GT.ABS( CFROMC ) ) THEN
         MUL = BIGNUM
         DONE = .FALSE.
         CTOC = CTO1
      ELSE
         MUL = CTOC / CFROMC
         DONE = .TRUE.
      END IF
*
      IF( ITYPE.EQ.0 ) THEN
*
*        Full matrix
*
         DO 30 J = 1, N
            DO 20 I = 1, M
               A( I, J ) = A( I, J )*MUL
   20       CONTINUE
   30    CONTINUE
*
      ELSE IF( ITYPE.EQ.1 ) THEN
*
*        Lower triangular matrix
*
         DO 50 J = 1, N
            DO 40 I = J, M
               A( I, J ) = A( I, J )*MUL
   40       CONTINUE
   50    CONTINUE
*
      ELSE IF( ITYPE.EQ.2 ) THEN
*
*        Upper triangular matrix
*
         DO 70 J = 1, N
            DO 60 I = 1, MIN( J, M )
               A( I, J ) = A( I, J )*MUL
   60       CONTINUE
   70    CONTINUE
*
      ELSE IF( ITYPE.EQ.3 ) THEN
```

```
*
*        Upper Hessenberg matrix
*
         DO 90 J = 1, N
            DO 80 I = 1, MIN( J+1, M )
               A( I, J ) = A( I, J )*MUL
   80       CONTINUE
   90    CONTINUE
*
      ELSE IF( ITYPE.EQ.4 ) THEN
*
*        Lower half of a symmetric band matrix
*
         K3 = KL + 1
         K4 = N + 1
         DO 110 J = 1, N
            DO 100 I = 1, MIN( K3, K4-J )
               A( I, J ) = A( I, J )*MUL
  100       CONTINUE
  110    CONTINUE
*
      ELSE IF( ITYPE.EQ.5 ) THEN
*
*        Upper half of a symmetric band matrix
*
         K1 = KU + 2
         K3 = KU + 1
         DO 130 J = 1, N
            DO 120 I = MAX( K1-J, 1 ), K3
               A( I, J ) = A( I, J )*MUL
  120       CONTINUE
  130    CONTINUE
*
      ELSE IF( ITYPE.EQ.6 ) THEN
*
*        Band matrix
*
         K1 = KL + KU + 2
         K2 = KL + 1
         K3 = 2*KL + KU + 1
         K4 = KL + KU + 1 + M
         DO 150 J = 1, N
            DO 140 I = MAX( K1-J, K2 ), MIN( K3, K4-J )
               A( I, J ) = A( I, J )*MUL
  140       CONTINUE
  150    CONTINUE
*
      END IF
*
      IF( .NOT.DONE )
```

```
     $   GO TO 10
*
      RETURN
*
*     End of DLASCL
*
      END
```

———-

— LAPACK dlascl —

```
(let* ((zero 0.0) (one 1.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one))
  (defun dlascl (type kl ku cfrom cto m n a lda info)
    (declare (type (simple-array double-float (*)) a)
             (type (double-float) cto cfrom)
             (type fixnum info lda n m ku kl)
             (type character type))
    (f2cl-lib:with-multi-array-data
        ((type double-float type-%data% type-%offset%)
         (a double-float a-%data% a-%offset%))
      (prog ((bignum 0.0) (cfrom1 0.0) (cfromc 0.0) (cto1 0.0) (ctoc 0.0)
             (mul 0.0) (smlnum 0.0) (i 0) (itype 0) (j 0) (k1 0) (k2 0) (k3 0)
             (k4 0) (done nil))
        (declare (type (double-float) bignum cfrom1 cfromc cto1 ctoc mul
                                      smlnum)
                 (type fixnum i itype j k1 k2 k3 k4)
                 (type (member t nil) done))
        (setf info 0)
        (cond
          ((char-equal type #\G)
           (setf itype 0))
          ((char-equal type #\L)
           (setf itype 1))
          ((char-equal type #\U)
           (setf itype 2))
          ((char-equal type #\H)
           (setf itype 3))
          ((char-equal type #\B)
           (setf itype 4))
          ((char-equal type #\Q)
           (setf itype 5))
          ((char-equal type #\Z)
           (setf itype 6))
          (t
           (setf itype -1)))
```

```
        (cond
          ((= itype (f2cl-lib:int-sub 1))
           (setf info -1))
          ((= cfrom zero)
           (setf info -4))
          ((< m 0)
           (setf info -6))
          ((or (< n 0) (and (= itype 4) (/= n m)) (and (= itype 5) (/= n m)))
           (setf info -7))
          ((and (<= itype 3)
                (< lda
                   (max (the fixnum 1) (the fixnum m))))
           (setf info -9))
          ((>= itype 4)
           (cond
             ((or (< kl 0)
                  (> kl
                     (max
                      (the fixnum
                           (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
                      (the fixnum 0))))
              (setf info -2))
             ((or (< ku 0)
                  (> ku
                     (max
                      (the fixnum
                           (f2cl-lib:int-add n (f2cl-lib:int-sub 1)))
                      (the fixnum 0)))
                  (and (or (= itype 4) (= itype 5)) (/= kl ku)))
              (setf info -3))
             ((or (and (= itype 4) (< lda (f2cl-lib:int-add kl 1)))
                  (and (= itype 5) (< lda (f2cl-lib:int-add ku 1)))
                  (and (= itype 6)
                       (< lda (f2cl-lib:int-add (f2cl-lib:int-mul 2 kl) ku 1))))
              (setf info -9)))))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DLASCL" (f2cl-lib:int-sub info))
           (go end_label)))
        (if (or (= n 0) (= m 0)) (go end_label))
        (setf smlnum (dlamch "S"))
        (setf bignum (/ one smlnum))
        (setf cfromc cfrom)
        (setf ctoc cto)
label10
        (setf cfrom1 (* cfromc smlnum))
        (setf cto1 (/ ctoc bignum))
        (cond
```

```
  ((and (> (abs cfrom1) (abs ctoc)) (/= ctoc zero))
   (setf mul smlnum)
   (setf done nil)
   (setf cfromc cfrom1))
  ((> (abs cto1) (abs cfromc))
   (setf mul bignum)
   (setf done nil)
   (setf ctoc cto1))
  (t
   (setf mul (/ ctoc cfromc))
   (setf done t)))
(cond
  ((= itype 0)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
     (tagbody
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i m) nil)
         (tagbody
           (setf (f2cl-lib:fref a-%data%
                                (i j)
                                ((1 lda) (1 *))
                                a-%offset%)
                 (*
                  (f2cl-lib:fref a-%data%
                                 (i j)
                                 ((1 lda) (1 *))
                                 a-%offset%)
                  mul)))))))
  ((= itype 1)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
     (tagbody
       (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                     ((> i m) nil)
         (tagbody
           (setf (f2cl-lib:fref a-%data%
                                (i j)
                                ((1 lda) (1 *))
                                a-%offset%)
                 (*
                  (f2cl-lib:fref a-%data%
                                 (i j)
                                 ((1 lda) (1 *))
                                 a-%offset%)
                  mul)))))))
  ((= itype 2)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
     (tagbody
```

```
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i
                            (min (the fixnum j)
                                 (the fixnum m)))
                         nil)
            (tagbody
              (setf (f2cl-lib:fref a-%data%
                                   (i j)
                                   ((1 lda) (1 *))
                                   a-%offset%)
                    (*
                     (f2cl-lib:fref a-%data%
                                    (i j)
                                    ((1 lda) (1 *))
                                    a-%offset%)
                     mul)))))))
        ((= itype 3)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i
                               (min
                                (the fixnum
                                     (f2cl-lib:int-add j 1))
                                (the fixnum m)))
                            nil)
               (tagbody
                 (setf (f2cl-lib:fref a-%data%
                                      (i j)
                                      ((1 lda) (1 *))
                                      a-%offset%)
                       (*
                        (f2cl-lib:fref a-%data%
                                       (i j)
                                       ((1 lda) (1 *))
                                       a-%offset%)
                        mul)))))))
        ((= itype 4)
         (setf k3 (f2cl-lib:int-add kl 1))
         (setf k4 (f2cl-lib:int-add n 1))
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i
                               (min (the fixnum k3)
                                    (the fixnum
                                         (f2cl-lib:int-add k4
                                                           (f2cl-lib:int-sub
```

```
                                                                j)))))
                        nil)
          (tagbody
            (setf (f2cl-lib:fref a-%data%
                                 (i j)
                                 ((1 lda) (1 *))
                                 a-%offset%)
                  (*
                   (f2cl-lib:fref a-%data%
                                  (i j)
                                  ((1 lda) (1 *))
                                  a-%offset%)
                   mul)))))))
 ((= itype 5)
  (setf k1 (f2cl-lib:int-add ku 2))
  (setf k3 (f2cl-lib:int-add ku 1))
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                ((> j n) nil)
    (tagbody
      (f2cl-lib:fdo (i
                     (max
                      (the fixnum
                           (f2cl-lib:int-add k1 (f2cl-lib:int-sub j)))
                      (the fixnum 1))
                     (f2cl-lib:int-add i 1))
                    ((> i k3) nil)
        (tagbody
          (setf (f2cl-lib:fref a-%data%
                               (i j)
                               ((1 lda) (1 *))
                               a-%offset%)
                (*
                 (f2cl-lib:fref a-%data%
                                (i j)
                                ((1 lda) (1 *))
                                a-%offset%)
                 mul)))))))
 ((= itype 6)
  (setf k1 (f2cl-lib:int-add kl ku 2))
  (setf k2 (f2cl-lib:int-add kl 1))
  (setf k3 (f2cl-lib:int-add (f2cl-lib:int-mul 2 kl) ku 1))
  (setf k4 (f2cl-lib:int-add kl ku 1 m))
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                ((> j n) nil)
    (tagbody
      (f2cl-lib:fdo (i
                     (max
                      (the fixnum
                           (f2cl-lib:int-add k1 (f2cl-lib:int-sub j)))
                      (the fixnum k2))
```

```
                              (f2cl-lib:int-add i 1))
                             ((> i
                                 (min (the fixnum k3)
                                      (the fixnum
                                           (f2cl-lib:int-add k4
                                                             (f2cl-lib:int-sub
                                                              j)))))
                              nil)
                    (tagbody
                      (setf (f2cl-lib:fref a-%data%
                                           (i j)
                                           ((1 lda) (1 *))
                                           a-%offset%)
                            (*
                             (f2cl-lib:fref a-%data%
                                            (i j)
                                            ((1 lda) (1 *))
                                            a-%offset%)
                             mul))))))))
           (if (not done) (go label10))
     end_label
           (return (values nil nil nil nil nil nil nil nil nil info))))))
```

———-

6.57 dlasd0 LAPACK

— **dlasd0.input** —

```
)set break resume
)sys rm -f dlasd0.output
)spool dlasd0.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlasd0.help** —

```
====================================================================
dlasd0 examples
```

```
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DLASD0  -  divide  and  conquer  approach, DLASD0 computes the singular
       value decomposition (SVD) of a real upper bidiagonal  N-by-M  matrix  B
       with diagonal D and offdiagonal E, where M = N + SQRE

SYNOPSIS
       SUBROUTINE DLASD0( N,  SQRE,  D,  E,  U,  LDU, VT, LDVT, SMLSIZ, IWORK,
                          WORK, INFO )

           INTEGER        INFO, LDU, LDVT, N, SMLSIZ, SQRE

           INTEGER        IWORK( * )

           DOUBLE         PRECISION D( * ), E( * ), U( LDU, * ), VT(  LDVT,  *
                          ), WORK( * )

 Purpose
 =======

  Using a divide and conquer approach, DLASD0 computes the singular
  value decomposition (SVD) of a real upper bidiagonal N-by-M
  matrix B with diagonal D and offdiagonal E, where M = N + SQRE.
  The algorithm computes orthogonal matrices U and VT such that
  B = U * S * VT. The singular values S are overwritten on D.

  A related subroutine, DLASDA, computes only the singular values,
  and optionally, the singular vectors in compact form.

  Arguments
  =========

  N      (input) INTEGER
         On entry, the row dimension of the upper bidiagonal matrix.
         This is also the dimension of the main diagonal array D.

  SQRE   (input) INTEGER
         Specifies the column dimension of the bidiagonal matrix.
         = 0: The bidiagonal matrix has column dimension M = N;
         = 1: The bidiagonal matrix has column dimension M = N+1;

  D      (input/output) DOUBLE PRECISION array, dimension (N)
         On entry D contains the main diagonal of the bidiagonal
         matrix.
         On exit D, if INFO = 0, contains its singular values.
```

```
  E      (input) DOUBLE PRECISION array, dimension (M-1)
         Contains the subdiagonal entries of the bidiagonal matrix.
         On exit, E has been destroyed.

  U      (output) DOUBLE PRECISION array, dimension at least (LDQ, N)
         On exit, U contains the left singular vectors.

  LDU    (input) INTEGER
         On entry, leading dimension of U.

  VT     (output) DOUBLE PRECISION array, dimension at least (LDVT, M)
         On exit, VT' contains the right singular vectors.

  LDVT   (input) INTEGER
         On entry, leading dimension of VT.

  SMLSIZ (input) INTEGER
         On entry, maximum size of the subproblems at the
         bottom of the computation tree.

  IWORK  INTEGER work array.
         Dimension must be at least (8 * N)

  WORK   DOUBLE PRECISION work array.
         Dimension must be at least (3 * M**2 + 2 * M)

  INFO   (output) INTEGER
          = 0:  successful exit.
          < 0:  if INFO = -i, the i-th argument had an illegal value.
          > 0:  if INFO = 1, an singular value did not converge

  Further Details
  ===============

  Based on contributions by
     Ming Gu and Huan Ren, Computer Science Division, University of
     California at Berkeley, USA
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— dlasd0.f —

```
      SUBROUTINE DLASD0( N, SQRE, D, E, U, LDU, VT, LDVT, SMLSIZ, IWORK,
     $                   WORK, INFO )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
```

```
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      INTEGER            INFO, LDU, LDVT, N, SMLSIZ, SQRE
*     ..
*     .. Array Arguments ..
      INTEGER            IWORK( * )
      DOUBLE PRECISION   D( * ), E( * ), U( LDU, * ), VT( LDVT, * ),
     $                   WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Local Scalars ..
      INTEGER            I, I1, IC, IDXQ, IDXQC, IM1, INODE, ITEMP, IWK,
     $                   J, LF, LL, LVL, M, NCC, ND, NDB1, NDIML, NDIMR,
     $                   NL, NLF, NLP1, NLVL, NR, NRF, NRP1, SQREI
      DOUBLE PRECISION   ALPHA, BETA
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLASD1, DLASDQ, DLASDT, XERBLA
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
*
      IF( N.LT.0 ) THEN
         INFO = -1
      ELSE IF( ( SQRE.LT.0 ) .OR. ( SQRE.GT.1 ) ) THEN
         INFO = -2
      END IF
*
      M = N + SQRE
*
      IF( LDU.LT.N ) THEN
         INFO = -6
      ELSE IF( LDVT.LT.M ) THEN
         INFO = -8
      ELSE IF( SMLSIZ.LT.3 ) THEN
         INFO = -9
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DLASD0', -INFO )
         RETURN
      END IF
*
*     If the input matrix is too small, call DLASDQ to find the SVD.
```

```
*
      IF( N.LE.SMLSIZ ) THEN
         CALL DLASDQ( 'U', SQRE, N, M, N, 0, D, E, VT, LDVT, U, LDU, U,
     $                LDU, WORK, INFO )
         RETURN
      END IF
*
*     Set up the computation tree.
*
      INODE = 1
      NDIML = INODE + N
      NDIMR = NDIML + N
      IDXQ = NDIMR + N
      IWK = IDXQ + N
      CALL DLASDT( N, NLVL, ND, IWORK( INODE ), IWORK( NDIML ),
     $             IWORK( NDIMR ), SMLSIZ )
*
*     For the nodes on bottom level of the tree, solve
*     their subproblems by DLASDQ.
*
      NDB1 = ( ND+1 ) / 2
      NCC = 0
      DO 30 I = NDB1, ND
*
*     IC : center row of each node
*     NL : number of rows of left  subproblem
*     NR : number of rows of right subproblem
*     NLF: starting row of the left   subproblem
*     NRF: starting row of the right  subproblem
*
         I1 = I - 1
         IC = IWORK( INODE+I1 )
         NL = IWORK( NDIML+I1 )
         NLP1 = NL + 1
         NR = IWORK( NDIMR+I1 )
         NRP1 = NR + 1
         NLF = IC - NL
         NRF = IC + 1
         SQREI = 1
         CALL DLASDQ( 'U', SQREI, NL, NLP1, NL, NCC, D( NLF ), E( NLF ),
     $                VT( NLF, NLF ), LDVT, U( NLF, NLF ), LDU,
     $                U( NLF, NLF ), LDU, WORK, INFO )
         IF( INFO.NE.0 ) THEN
            RETURN
         END IF
         ITEMP = IDXQ + NLF - 2
         DO 10 J = 1, NL
            IWORK( ITEMP+J ) = J
   10    CONTINUE
         IF( I.EQ.ND ) THEN
```

```
            SQREI = SQRE
         ELSE
            SQREI = 1
         END IF
         NRP1 = NR + SQREI
         CALL DLASDQ( 'U', SQREI, NR, NRP1, NR, NCC, D( NRF ), E( NRF ),
     $                VT( NRF, NRF ), LDVT, U( NRF, NRF ), LDU,
     $                U( NRF, NRF ), LDU, WORK, INFO )
         IF( INFO.NE.0 ) THEN
            RETURN
         END IF
         ITEMP = IDXQ + IC
         DO 20 J = 1, NR
            IWORK( ITEMP+J-1 ) = J
   20    CONTINUE
   30 CONTINUE
*
*     Now conquer each subproblem bottom-up.
*
      DO 50 LVL = NLVL, 1, -1
*
*        Find the first node LF and last node LL on the
*        current level LVL.
*
         IF( LVL.EQ.1 ) THEN
            LF = 1
            LL = 1
         ELSE
            LF = 2**( LVL-1 )
            LL = 2*LF - 1
         END IF
         DO 40 I = LF, LL
            IM1 = I - 1
            IC = IWORK( INODE+IM1 )
            NL = IWORK( NDIML+IM1 )
            NR = IWORK( NDIMR+IM1 )
            NLF = IC - NL
            IF( ( SQRE.EQ.0 ) .AND. ( I.EQ.LL ) ) THEN
               SQREI = SQRE
            ELSE
               SQREI = 1
            END IF
            IDXQC = IDXQ + NLF - 1
            ALPHA = D( IC )
            BETA = E( IC )
            CALL DLASD1( NL, NR, SQREI, D( NLF ), ALPHA, BETA,
     $                   U( NLF, NLF ), LDU, VT( NLF, NLF ), LDVT,
     $                   IWORK( IDXQC ), IWORK( IWK ), WORK, INFO )
            IF( INFO.NE.0 ) THEN
               RETURN
```

```
            END IF
   40    CONTINUE
   50 CONTINUE
*
      RETURN
*
*     End of DLASD0
*
      END
```

— LAPACK dlasd0 —

```
(defun dlasd0 (n sqre d e u ldu vt ldvt smlsiz iwork work info)
  (declare (type (simple-array fixnum (*)) iwork)
           (type (simple-array double-float (*)) work vt u e d)
           (type fixnum info smlsiz ldvt ldu sqre n))
  (f2cl-lib:with-multi-array-data
      ((d double-float d-%data% d-%offset%)
       (e double-float e-%data% e-%offset%)
       (u double-float u-%data% u-%offset%)
       (vt double-float vt-%data% vt-%offset%)
       (work double-float work-%data% work-%offset%)
       (iwork fixnum iwork-%data% iwork-%offset%))
    (prog ((alpha 0.0) (beta 0.0) (i 0) (i1 0) (ic 0) (idxq 0) (idxqc 0)
           (im1 0) (inode 0) (itemp 0) (iwk 0) (j 0) (lf 0) (ll 0) (lvl 0)
           (m 0) (ncc 0) (nd 0) (ndb1 0) (ndiml 0) (ndimr 0) (nl 0) (nlf 0)
           (nlp1 0) (nlvl 0) (nr 0) (nrf 0) (nrp1 0) (sqrei 0))
      (declare (type fixnum sqrei nrp1 nrf nr nlvl nlp1 nlf nl
                                        ndimr ndiml ndb1 nd ncc m lvl ll lf j
                                        iwk itemp inode im1 idxqc idxq ic i1
                                        i)
               (type (double-float) beta alpha))
      (setf info 0)
      (cond
        ((< n 0)
         (setf info -1))
        ((or (< sqre 0) (> sqre 1))
         (setf info -2)))
      (setf m (f2cl-lib:int-add n sqre))
      (cond
        ((< ldu n)
         (setf info -6))
        ((< ldvt m)
         (setf info -8))
        ((< smlsiz 3)
         (setf info -9)))
```

```
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DLASD0" (f2cl-lib:int-sub info))
   (go end_label)))
(cond
  ((<= n smlsiz)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
          var-10 var-11 var-12 var-13 var-14 var-15)
       (dlasdq "U" sqre n m n 0 d e vt ldvt u ldu u ldu work info)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                      var-8 var-9 var-10 var-11 var-12 var-13 var-14))
     (setf info var-15))
   (go end_label)))
(setf inode 1)
(setf ndiml (f2cl-lib:int-add inode n))
(setf ndimr (f2cl-lib:int-add ndiml n))
(setf idxq (f2cl-lib:int-add ndimr n))
(setf iwk (f2cl-lib:int-add idxq n))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
    (dlasdt n nlvl nd
     (f2cl-lib:array-slice iwork fixnum (inode) ((1 *)))
     (f2cl-lib:array-slice iwork fixnum (ndiml) ((1 *)))
     (f2cl-lib:array-slice iwork fixnum (ndimr) ((1 *)))
     smlsiz)
  (declare (ignore var-0 var-3 var-4 var-5 var-6))
  (setf nlvl var-1)
  (setf nd var-2))
(setf ndb1 (the fixnum (truncate (+ nd 1) 2)))
(setf ncc 0)
(f2cl-lib:fdo (i ndb1 (f2cl-lib:int-add i 1))
              ((> i nd) nil)
  (tagbody
    (setf i1 (f2cl-lib:int-sub i 1))
    (setf ic
            (f2cl-lib:fref iwork-%data%
                           ((f2cl-lib:int-add inode i1))
                           ((1 *))
                           iwork-%offset%))
    (setf nl
            (f2cl-lib:fref iwork-%data%
                           ((f2cl-lib:int-add ndiml i1))
                           ((1 *))
                           iwork-%offset%))
    (setf nlp1 (f2cl-lib:int-add nl 1))
    (setf nr
            (f2cl-lib:fref iwork-%data%
                           ((f2cl-lib:int-add ndimr i1))
```

```
                      ((1 *))
                      iwork-%offset%))
(setf nrp1 (f2cl-lib:int-add nr 1))
(setf nlf (f2cl-lib:int-sub ic nl))
(setf nrf (f2cl-lib:int-add ic 1))
(setf sqrei 1)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
       var-10 var-11 var-12 var-13 var-14 var-15)
    (dlasdq "U" sqrei nl nlp1 nl ncc
     (f2cl-lib:array-slice d double-float (nlf) ((1 *)))
     (f2cl-lib:array-slice e double-float (nlf) ((1 *)))
     (f2cl-lib:array-slice vt
                           double-float
                           (nlf nlf)
                           ((1 ldvt) (1 *)))
     ldvt
     (f2cl-lib:array-slice u double-float (nlf nlf) ((1 ldu) (1 *)))
     ldu
     (f2cl-lib:array-slice u double-float (nlf nlf) ((1 ldu) (1 *)))
     ldu work info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                   var-8 var-9 var-10 var-11 var-12 var-13 var-14))
  (setf info var-15))
(cond
  ((/= info 0)
   (go end_label)))
(setf itemp (f2cl-lib:int-sub (f2cl-lib:int-add idxq nlf) 2))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j nl) nil)
  (tagbody
    (setf (f2cl-lib:fref iwork-%data%
                         ((f2cl-lib:int-add itemp j))
                         ((1 *))
                         iwork-%offset%)
            j)))
(cond
  ((= i nd)
   (setf sqrei sqre))
  (t
   (setf sqrei 1)))
(setf nrp1 (f2cl-lib:int-add nr sqrei))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
       var-10 var-11 var-12 var-13 var-14 var-15)
    (dlasdq "U" sqrei nr nrp1 nr ncc
     (f2cl-lib:array-slice d double-float (nrf) ((1 *)))
     (f2cl-lib:array-slice e double-float (nrf) ((1 *)))
     (f2cl-lib:array-slice vt
                           double-float
```

```
                                (nrf nrf)
                                ((1 ldvt) (1 *)))
            ldvt
            (f2cl-lib:array-slice u double-float (nrf nrf) ((1 ldu) (1 *)))
            ldu
            (f2cl-lib:array-slice u double-float (nrf nrf) ((1 ldu) (1 *)))
            ldu work info)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                           var-8 var-9 var-10 var-11 var-12 var-13 var-14))
          (setf info var-15))
        (cond
          ((/= info 0)
           (go end_label)))
        (setf itemp (f2cl-lib:int-add idxq ic))
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                      ((> j nr) nil)
          (tagbody
            (setf (f2cl-lib:fref iwork-%data%
                                 ((f2cl-lib:int-sub
                                   (f2cl-lib:int-add itemp j)
                                   1))
                                 ((1 *))
                                 iwork-%offset%)
                  j)))))
    (f2cl-lib:fdo (lvl nlvl (f2cl-lib:int-add lvl (f2cl-lib:int-sub 1)))
                  ((> lvl 1) nil)
      (tagbody
        (cond
          ((= lvl 1)
           (setf lf 1)
           (setf ll 1))
          (t
           (setf lf (expt 2 (f2cl-lib:int-sub lvl 1)))
           (setf ll (f2cl-lib:int-sub (f2cl-lib:int-mul 2 lf) 1))))
        (f2cl-lib:fdo (i lf (f2cl-lib:int-add i 1))
                      ((> i ll) nil)
          (tagbody
            (setf im1 (f2cl-lib:int-sub i 1))
            (setf ic
                    (f2cl-lib:fref iwork-%data%
                                   ((f2cl-lib:int-add inode im1))
                                   ((1 *))
                                   iwork-%offset%))
            (setf nl
                    (f2cl-lib:fref iwork-%data%
                                   ((f2cl-lib:int-add ndiml im1))
                                   ((1 *))
                                   iwork-%offset%))
            (setf nr
                    (f2cl-lib:fref iwork-%data%
```

```
                              ((f2cl-lib:int-add ndimr im1))
                              ((1 *))
                              iwork-%offset%))
             (setf nlf (f2cl-lib:int-sub ic nl))
             (cond
               ((and (= sqre 0) (= i ll))
                (setf sqrei sqre))
               (t
                (setf sqrei 1)))
             (setf idxqc (f2cl-lib:int-sub (f2cl-lib:int-add idxq nlf) 1))
             (setf alpha (f2cl-lib:fref d-%data% (ic) ((1 *)) d-%offset%))
             (setf beta (f2cl-lib:fref e-%data% (ic) ((1 *)) e-%offset%))
             (multiple-value-bind
                   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                    var-9 var-10 var-11 var-12 var-13)
                 (dlasd1 nl nr sqrei
                  (f2cl-lib:array-slice d double-float (nlf) ((1 *))) alpha
                  beta
                  (f2cl-lib:array-slice u
                                        double-float
                                        (nlf nlf)
                                        ((1 ldu) (1 *)))
                  ldu
                  (f2cl-lib:array-slice vt
                                        double-float
                                        (nlf nlf)
                                        ((1 ldvt) (1 *)))
                  ldvt
                  (f2cl-lib:array-slice iwork
                                        fixnum
                                        (idxqc)
                                        ((1 *)))
                  (f2cl-lib:array-slice iwork fixnum (iwk) ((1 *)))
                  work info)
               (declare (ignore var-0 var-1 var-2 var-3 var-6 var-7 var-8
                                var-9 var-10 var-11 var-12))
               (setf alpha var-4)
               (setf beta var-5)
               (setf info var-13))
             (cond
               ((/= info 0)
                (go end_label)))))))
end_label
     (return (values nil nil nil nil nil nil nil nil nil nil nil info)))))
```

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— dlasd1.input —

```
)set break resume
)sys rm -f dlasd1.output
)spool dlasd1.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

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— dlasd1.help —

```
==========================================================================
dlasd1 examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

NAME
       DLASD1 - the SVD of an upper bidiagonal N-by-M matrix B,

SYNOPSIS
       SUBROUTINE DLASD1( NL,  NR,  SQRE,  D,  ALPHA,  BETA, U, LDU, VT, LDVT,
                          IDXQ, IWORK, WORK, INFO )

           INTEGER        INFO, LDU, LDVT, NL, NR, SQRE

           DOUBLE         PRECISION ALPHA, BETA

           INTEGER        IDXQ( * ), IWORK( * )

           DOUBLE         PRECISION D( * ), U( LDU, * ), VT( LDVT, * ),  WORK(
                          * )

  Purpose
  =======

  DLASD1 computes the SVD of an upper bidiagonal N-by-M matrix B,
  where N = NL + NR + 1 and M = N + SQRE. DLASD1 is called from DLASD0.
```

```
A related subroutine DLASD7 handles the case in which the singular
values (and the singular vectors in factored form) are desired.

DLASD1 computes the SVD as follows:

              ( D1(in)  0    0     0 )
  B = U(in) * (   Z1'   a   Z2'    b ) * VT(in)
              (   0     0   D2(in) 0 )

    = U(out) * ( D(out) 0) * VT(out)

where Z' = (Z1' a Z2' b) = u' VT', and u is a vector of dimension M
with ALPHA and BETA in the NL+1 and NL+2 th entries and zeros
elsewhere; and the entry b is empty if SQRE = 0.

The left singular vectors of the original matrix are stored in U, and
the transpose of the right singular vectors are stored in VT, and the
singular values are in D.  The algorithm consists of three stages:

   The first stage consists of deflating the size of the problem
   when there are multiple singular values or when there are zeros in
   the Z vector.  For each such occurence the dimension of the
   secular equation problem is reduced by one.  This stage is
   performed by the routine DLASD2.

   The second stage consists of calculating the updated
   singular values. This is done by finding the square roots of the
   roots of the secular equation via the routine DLASD4 (as called
   by DLASD3). This routine also calculates the singular vectors of
   the current problem.

   The final stage consists of computing the updated singular vectors
   directly using the updated singular values.  The singular vectors
   for the current problem are multiplied with the singular vectors
   from the overall problem.

Arguments
=========

NL     (input) INTEGER
       The row dimension of the upper block.  NL >= 1.

NR     (input) INTEGER
       The row dimension of the lower block.  NR >= 1.

SQRE   (input) INTEGER
       = 0: the lower block is an NR-by-NR square matrix.
       = 1: the lower block is an NR-by-(NR+1) rectangular matrix.

       The bidiagonal matrix has row dimension N = NL + NR + 1,
```

```
       and column dimension M = N + SQRE.

 D     (input/output) DOUBLE PRECISION array,
                      dimension (N = NL+NR+1).
       On entry D(1:NL,1:NL) contains the singular values of the
       upper block; and D(NL+2:N) contains the singular values of
       the lower block. On exit D(1:N) contains the singular values
       of the modified matrix.

 ALPHA (input) DOUBLE PRECISION
       Contains the diagonal element associated with the added row.

 BETA  (input) DOUBLE PRECISION
       Contains the off-diagonal element associated with the added
       row.

 U     (input/output) DOUBLE PRECISION array, dimension(LDU,N)
       On entry U(1:NL, 1:NL) contains the left singular vectors of
       the upper block; U(NL+2:N, NL+2:N) contains the left singular
       vectors of the lower block. On exit U contains the left
       singular vectors of the bidiagonal matrix.

 LDU   (input) INTEGER
       The leading dimension of the array U.  LDU >= max( 1, N ).

 VT    (input/output) DOUBLE PRECISION array, dimension(LDVT,M)
       where M = N + SQRE.
       On entry VT(1:NL+1, 1:NL+1)' contains the right singular
       vectors of the upper block; VT(NL+2:M, NL+2:M)' contains
       the right singular vectors of the lower block. On exit
       VT' contains the right singular vectors of the
       bidiagonal matrix.

 LDVT  (input) INTEGER
       The leading dimension of the array VT.  LDVT >= max( 1, M ).

 IDXQ  (output) INTEGER array, dimension(N)
       This contains the permutation which will reintegrate the
       subproblem just solved back into sorted order, i.e.
       D( IDXQ( I = 1, N ) ) will be in ascending order.

 IWORK (workspace) INTEGER array, dimension( 4 * N )

 WORK  (workspace) DOUBLE PRECISION array, dimension( 3*M**2 + 2*M )

 INFO  (output) INTEGER
        = 0:  successful exit.
        < 0:  if INFO = -i, the i-th argument had an illegal value.
        > 0:  if INFO = 1, an singular value did not converge
```

```
  Further Details
  ===============

  Based on contributions by
     Ming Gu and Huan Ren, Computer Science Division, University of
     California at Berkeley, USA
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— dlasd1.f —

```
      SUBROUTINE DLASD1( NL, NR, SQRE, D, ALPHA, BETA, U, LDU, VT, LDVT,
     $                   IDXQ, IWORK, WORK, INFO )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      INTEGER            INFO, LDU, LDVT, NL, NR, SQRE
      DOUBLE PRECISION   ALPHA, BETA
*     ..
*     .. Array Arguments ..
      INTEGER            IDXQ( * ), IWORK( * )
      DOUBLE PRECISION   D( * ), U( LDU, * ), VT( LDVT, * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
*
      DOUBLE PRECISION   ONE, ZERO
      PARAMETER          ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            COLTYP, I, IDX, IDXC, IDXP, IQ, ISIGMA, IU2,
     $                   IVT2, IZ, K, LDQ, LDU2, LDVT2, M, N, N1, N2
      DOUBLE PRECISION   ORGNRM
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLAMRG, DLASCL, DLASD2, DLASD3, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX
*     ..
*     .. Executable Statements ..
*
```

```
*     Test the input parameters.
*
      INFO = 0
*
      IF( NL.LT.1 ) THEN
         INFO = -1
      ELSE IF( NR.LT.1 ) THEN
         INFO = -2
      ELSE IF( ( SQRE.LT.0 ) .OR. ( SQRE.GT.1 ) ) THEN
         INFO = -3
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DLASD1', -INFO )
         RETURN
      END IF
*
      N = NL + NR + 1
      M = N + SQRE
*
*     The following values are for bookkeeping purposes only.  They are
*     integer pointers which indicate the portion of the workspace
*     used by a particular array in DLASD2 and DLASD3.
*
      LDU2 = N
      LDVT2 = M
*
      IZ = 1
      ISIGMA = IZ + M
      IU2 = ISIGMA + N
      IVT2 = IU2 + LDU2*N
      IQ = IVT2 + LDVT2*M
*
      IDX = 1
      IDXC = IDX + N
      COLTYP = IDXC + N
      IDXP = COLTYP + N
*
*     Scale.
*
      ORGNRM = MAX( ABS( ALPHA ), ABS( BETA ) )
      D( NL+1 ) = ZERO
      DO 10 I = 1, N
         IF( ABS( D( I ) ).GT.ORGNRM ) THEN
            ORGNRM = ABS( D( I ) )
         END IF
   10 CONTINUE
      CALL DLASCL( 'G', 0, 0, ORGNRM, ONE, N, 1, D, N, INFO )
      ALPHA = ALPHA / ORGNRM
      BETA = BETA / ORGNRM
*
```

```
*     Deflate singular values.
*
      CALL DLASD2( NL, NR, SQRE, K, D, WORK( IZ ), ALPHA, BETA, U, LDU,
     $             VT, LDVT, WORK( ISIGMA ), WORK( IU2 ), LDU2,
     $             WORK( IVT2 ), LDVT2, IWORK( IDXP ), IWORK( IDX ),
     $             IWORK( IDXC ), IDXQ, IWORK( COLTYP ), INFO )
*
*     Solve Secular Equation and update singular vectors.
*
      LDQ = K
      CALL DLASD3( NL, NR, SQRE, K, D, WORK( IQ ), LDQ, WORK( ISIGMA ),
     $             U, LDU, WORK( IU2 ), LDU2, VT, LDVT, WORK( IVT2 ),
     $             LDVT2, IWORK( IDXC ), IWORK( COLTYP ), WORK( IZ ),
     $             INFO )
      IF( INFO.NE.0 ) THEN
         RETURN
      END IF
*
*     Unscale.
*
      CALL DLASCL( 'G', 0, 0, ONE, ORGNRM, N, 1, D, N, INFO )
*
*     Prepare the IDXQ sorting permutation.
*
      N1 = K
      N2 = N - K
      CALL DLAMRG( N1, N2, D, 1, -1, IDXQ )
*
      RETURN
*
*     End of DLASD1
*
      END
```

— LAPACK dlasd1 —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dlasd1 (nl nr sqre d alpha beta u ldu vt ldvt idxq iwork work info)
    (declare (type (simple-array fixnum (*)) iwork idxq)
             (type (double-float) beta alpha)
             (type (simple-array double-float (*)) work vt u d)
             (type fixnum info ldvt ldu sqre nr nl))
    (f2cl-lib:with-multi-array-data
        ((d double-float d-%data% d-%offset%)
```

```
   (u double-float u-%data% u-%offset%)
   (vt double-float vt-%data% vt-%offset%)
   (work double-float work-%data% work-%offset%)
   (idxq fixnum idxq-%data% idxq-%offset%)
   (iwork fixnum iwork-%data% iwork-%offset%))
  (prog ((orgnrm 0.0) (coltyp 0) (i 0) (idx 0) (idxc 0) (idxp 0) (iq 0)
         (isigma 0) (iu2 0) (ivt2 0) (iz 0) (k 0) (ldq 0) (ldu2 0)
         (ldvt2 0) (m 0) (n 0) (n1 0) (n2 0))
    (declare (type (double-float) orgnrm)
             (type fixnum coltyp i idx idxc idxp iq isigma iu2
                                    ivt2 iz k ldq ldu2 ldvt2 m n n1 n2))
    (setf info 0)
    (cond
      ((< nl 1)
       (setf info -1))
      ((< nr 1)
       (setf info -2))
      ((or (< sqre 0) (> sqre 1))
       (setf info -3)))
    (cond
      ((/= info 0)
       (error
        " ** On entry to ~a parameter number ~a had an illegal value~%"
        "DLASD1" (f2cl-lib:int-sub info))
       (go end_label)))
    (setf n (f2cl-lib:int-add nl nr 1))
    (setf m (f2cl-lib:int-add n sqre))
    (setf ldu2 n)
    (setf ldvt2 m)
    (setf iz 1)
    (setf isigma (f2cl-lib:int-add iz m))
    (setf iu2 (f2cl-lib:int-add isigma n))
    (setf ivt2 (f2cl-lib:int-add iu2 (f2cl-lib:int-mul ldu2 n)))
    (setf iq (f2cl-lib:int-add ivt2 (f2cl-lib:int-mul ldvt2 m)))
    (setf idx 1)
    (setf idxc (f2cl-lib:int-add idx n))
    (setf coltyp (f2cl-lib:int-add idxc n))
    (setf idxp (f2cl-lib:int-add coltyp n))
    (setf orgnrm (max (abs alpha) (abs beta)))
    (setf (f2cl-lib:fref d-%data%
                         ((f2cl-lib:int-add nl 1))
                         ((1 *))
                         d-%offset%)
          zero)
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  ((> i n) nil)
      (tagbody
        (cond
          ((> (abs (f2cl-lib:fref d (i) ((1 *)))) orgnrm)
           (setf orgnrm
```

```
            (abs (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)))))))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
    (dlascl "G" 0 0 orgnrm one n 1 d n info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                   var-8))
  (setf info var-9))
(setf alpha (/ alpha orgnrm))
(setf beta (/ beta orgnrm))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
       var-10 var-11 var-12 var-13 var-14 var-15 var-16 var-17 var-18
       var-19 var-20 var-21 var-22)
    (dlasd2 nl nr sqre k d
     (f2cl-lib:array-slice work double-float (iz) ((1 *))) alpha beta u
     ldu vt ldvt
     (f2cl-lib:array-slice work double-float (isigma) ((1 *)))
     (f2cl-lib:array-slice work double-float (iu2) ((1 *))) ldu2
     (f2cl-lib:array-slice work double-float (ivt2) ((1 *))) ldvt2
     (f2cl-lib:array-slice iwork fixnum (idxp) ((1 *)))
     (f2cl-lib:array-slice iwork fixnum (idx) ((1 *)))
     (f2cl-lib:array-slice iwork fixnum (idxc) ((1 *))) idxq
     (f2cl-lib:array-slice iwork fixnum (coltyp) ((1 *)))
     info)
  (declare (ignore var-0 var-1 var-2 var-4 var-5 var-6 var-7 var-8
                   var-9 var-10 var-11 var-12 var-13 var-14 var-15
                   var-16 var-17 var-18 var-19 var-20 var-21))
  (setf k var-3)
  (setf info var-22))
(setf ldq k)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
       var-10 var-11 var-12 var-13 var-14 var-15 var-16 var-17 var-18
       var-19)
    (dlasd3 nl nr sqre k d
     (f2cl-lib:array-slice work double-float (iq) ((1 *))) ldq
     (f2cl-lib:array-slice work double-float (isigma) ((1 *))) u ldu
     (f2cl-lib:array-slice work double-float (iu2) ((1 *))) ldu2 vt
     ldvt (f2cl-lib:array-slice work double-float (ivt2) ((1 *))) ldvt2
     (f2cl-lib:array-slice iwork fixnum (idxc) ((1 *)))
     (f2cl-lib:array-slice iwork fixnum (coltyp) ((1 *)))
     (f2cl-lib:array-slice work double-float (iz) ((1 *))) info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                   var-8 var-9 var-10 var-11 var-12 var-13 var-14
                   var-15 var-16 var-17 var-18))
  (setf info var-19))
(cond
  ((/= info 0)
   (go end_label)))
(multiple-value-bind
```

```
            (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
          (dlascl "G" 0 0 one orgnrm n 1 d n info)
         (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                          var-8))
         (setf info var-9))
       (setf n1 k)
       (setf n2 (f2cl-lib:int-sub n k))
       (dlamrg n1 n2 d 1 -1 idxq)
end_label
       (return
        (values nil
                nil
                nil
                nil
                alpha
                beta
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                info))))))
```

———-

6.59 dlasd2 LAPACK

— **dlasd2.input** —

```
)set break resume
)sys rm -f dlasd2.output
)spool dlasd2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlasd2.help** —

```
=====================================================================
```

```
dlasd2 examples
==============================================================

==============================================================
Man Page Details
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NAME
       DLASD2  - the two sets of singular values together into a single sorted
       set

SYNOPSIS
       SUBROUTINE DLASD2( NL, NR, SQRE, K, D, Z,  ALPHA,  BETA,  U,  LDU,  VT,
                          LDVT, DSIGMA, U2, LDU2, VT2, LDVT2, IDXP, IDX, IDXC,
                          IDXQ, COLTYP, INFO )

           INTEGER        INFO, K, LDU, LDU2, LDVT, LDVT2, NL, NR, SQRE

           DOUBLE         PRECISION ALPHA, BETA

           INTEGER        COLTYP( * ), IDX( * ), IDXC( * ), IDXP( * ), IDXQ( *
                          )

           DOUBLE         PRECISION  D(  *  ),  DSIGMA(  * ), U( LDU, * ), U2(
                          LDU2, * ), VT( LDVT, * ), VT2( LDVT2, * ), Z( * )

  Purpose
  =======

  DLASD2 merges the two sets of singular values together into a single
  sorted set.  Then it tries to deflate the size of the problem.
  There are two ways in which deflation can occur:  when two or more
  singular values are close together or if there is a tiny entry in the
  Z vector.  For each such occurrence the order of the related secular
  equation problem is reduced by one.

  DLASD2 is called from DLASD1.

  Arguments
  =========

  NL     (input) INTEGER
         The row dimension of the upper block.  NL >= 1.

  NR     (input) INTEGER
         The row dimension of the lower block.  NR >= 1.

  SQRE   (input) INTEGER
         = 0: the lower block is an NR-by-NR square matrix.
         = 1: the lower block is an NR-by-(NR+1) rectangular matrix.
```

```
       The bidiagonal matrix has N = NL + NR + 1 rows and
       M = N + SQRE >= N columns.

K      (output) INTEGER
       Contains the dimension of the non-deflated matrix,
       This is the order of the related secular equation. 1 <= K <=N.

D      (input/output) DOUBLE PRECISION array, dimension(N)
       On entry D contains the singular values of the two submatrices
       to be combined.  On exit D contains the trailing (N-K) updated
       singular values (those which were deflated) sorted into
       increasing order.

ALPHA  (input) DOUBLE PRECISION
       Contains the diagonal element associated with the added row.

BETA   (input) DOUBLE PRECISION
       Contains the off-diagonal element associated with the added
       row.

U      (input/output) DOUBLE PRECISION array, dimension(LDU,N)
       On entry U contains the left singular vectors of two
       submatrices in the two square blocks with corners at (1,1),
       (NL, NL), and (NL+2, NL+2), (N,N).
       On exit U contains the trailing (N-K) updated left singular
       vectors (those which were deflated) in its last N-K columns.

LDU    (input) INTEGER
       The leading dimension of the array U.  LDU >= N.

Z      (output) DOUBLE PRECISION array, dimension(N)
       On exit Z contains the updating row vector in the secular
       equation.

DSIGMA (output) DOUBLE PRECISION array, dimension (N)
       Contains a copy of the diagonal elements (K-1 singular values
       and one zero) in the secular equation.

U2     (output) DOUBLE PRECISION array, dimension(LDU2,N)
       Contains a copy of the first K-1 left singular vectors which
       will be used by DLASD3 in a matrix multiply (DGEMM) to solve
       for the new left singular vectors. U2 is arranged into four
       blocks. The first block contains a column with 1 at NL+1 and
       zero everywhere else; the second block contains non-zero
       entries only at and above NL; the third contains non-zero
       entries only below NL+1; and the fourth is dense.

LDU2   (input) INTEGER
       The leading dimension of the array U2.  LDU2 >= N.
```

```
VT     (input/output) DOUBLE PRECISION array, dimension(LDVT,M)
       On entry VT' contains the right singular vectors of two
       submatrices in the two square blocks with corners at (1,1),
       (NL+1, NL+1), and (NL+2, NL+2), (M,M).
       On exit VT' contains the trailing (N-K) updated right singular
       vectors (those which were deflated) in its last N-K columns.
       In case SQRE =1, the last row of VT spans the right null
       space.

LDVT   (input) INTEGER
       The leading dimension of the array VT.  LDVT >= M.

VT2    (output) DOUBLE PRECISION array, dimension(LDVT2,N)
       VT2' contains a copy of the first K right singular vectors
       which will be used by DLASD3 in a matrix multiply (DGEMM) to
       solve for the new right singular vectors. VT2 is arranged into
       three blocks. The first block contains a row that corresponds
       to the special 0 diagonal element in SIGMA; the second block
       contains non-zeros only at and before NL +1; the third block
       contains non-zeros only at and after  NL +2.

LDVT2  (input) INTEGER
       The leading dimension of the array VT2.  LDVT2 >= M.

IDXP   (workspace) INTEGER array, dimension(N)
       This will contain the permutation used to place deflated
       values of D at the end of the array. On output IDXP(2:K)
       points to the nondeflated D-values and IDXP(K+1:N)
       points to the deflated singular values.

IDX    (workspace) INTEGER array, dimension(N)
       This will contain the permutation used to sort the contents of
       D into ascending order.

IDXC   (output) INTEGER array, dimension(N)
       This will contain the permutation used to arrange the columns
       of the deflated U matrix into three groups:  the first group
       contains non-zero entries only at and above NL, the second
       contains non-zero entries only below NL+2, and the third is
       dense.

COLTYP (workspace/output) INTEGER array, dimension(N)
       As workspace, this will contain a label which will indicate
       which of the following types a column in the U2 matrix or a
       row in the VT2 matrix is:
       1 : non-zero in the upper half only
       2 : non-zero in the lower half only
       3 : dense
       4 : deflated
```

```
        On exit, it is an array of dimension 4, with COLTYP(I) being
        the dimension of the I-th type columns.

  IDXQ   (input) INTEGER array, dimension(N)
        This contains the permutation which separately sorts the two
        sub-problems in D into ascending order.  Note that entries in
        the first hlaf of this permutation must first be moved one
        position backward; and entries in the second half
        must first have NL+1 added to their values.

  INFO   (output) INTEGER
         = 0:  successful exit.
         < 0:  if INFO = -i, the i-th argument had an illegal value.

  Further Details
  ===============

  Based on contributions by
     Ming Gu and Huan Ren, Computer Science Division, University of
     California at Berkeley, USA
```

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— dlasd2.f —

```
      SUBROUTINE DLASD2( NL, NR, SQRE, K, D, Z, ALPHA, BETA, U, LDU, VT,
     $                   LDVT, DSIGMA, U2, LDU2, VT2, LDVT2, IDXP, IDX,
     $                   IDXC, IDXQ, COLTYP, INFO )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Oak Ridge National Lab, Argonne National Lab,
*     Courant Institute, NAG Ltd., and Rice University
*     October 31, 1999
*
*     .. Scalar Arguments ..
      INTEGER            INFO, K, LDU, LDU2, LDVT, LDVT2, NL, NR, SQRE
      DOUBLE PRECISION   ALPHA, BETA
*     ..
*     .. Array Arguments ..
      INTEGER            COLTYP( * ), IDX( * ), IDXC( * ), IDXP( * ),
     $                   IDXQ( * )
      DOUBLE PRECISION   D( * ), DSIGMA( * ), U( LDU, * ),
     $                   U2( LDU2, * ), VT( LDVT, * ), VT2( LDVT2, * ),
     $                   Z( * )
*     ..
*
*  =====================================================================
```

```
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE, TWO, EIGHT
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0, TWO = 2.0D+0,
     $                   EIGHT = 8.0D+0 )
*     ..
*     .. Local Arrays ..
      INTEGER            CTOT( 4 ), PSM( 4 )
*     ..
*     .. Local Scalars ..
      INTEGER            CT, I, IDXI, IDXJ, IDXJP, J, JP, JPREV, K2, M,
     $                   N, NLP1, NLP2
      DOUBLE PRECISION   C, EPS, HLFTOL, S, TAU, TOL, Z1
*     ..
*     .. External Functions ..
      DOUBLE PRECISION   DLAMCH, DLAPY2
      EXTERNAL           DLAMCH, DLAPY2
*     ..
*     .. External Subroutines ..
      EXTERNAL           DCOPY, DLACPY, DLAMRG, DLASET, DROT, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
*
      IF( NL.LT.1 ) THEN
         INFO = -1
      ELSE IF( NR.LT.1 ) THEN
         INFO = -2
      ELSE IF( ( SQRE.NE.1 ) .AND. ( SQRE.NE.0 ) ) THEN
         INFO = -3
      END IF
*
      N = NL + NR + 1
      M = N + SQRE
*
      IF( LDU.LT.N ) THEN
         INFO = -10
      ELSE IF( LDVT.LT.M ) THEN
         INFO = -12
      ELSE IF( LDU2.LT.N ) THEN
         INFO = -15
      ELSE IF( LDVT2.LT.M ) THEN
         INFO = -17
      END IF
```

```
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DLASD2', -INFO )
         RETURN
      END IF
*
      NLP1 = NL + 1
      NLP2 = NL + 2
*
*     Generate the first part of the vector Z; and move the singular
*     values in the first part of D one position backward.
*
      Z1 = ALPHA*VT( NLP1, NLP1 )
      Z( 1 ) = Z1
      DO 10 I = NL, 1, -1
         Z( I+1 ) = ALPHA*VT( I, NLP1 )
         D( I+1 ) = D( I )
         IDXQ( I+1 ) = IDXQ( I ) + 1
   10 CONTINUE
*
*     Generate the second part of the vector Z.
*
      DO 20 I = NLP2, M
         Z( I ) = BETA*VT( I, NLP2 )
   20 CONTINUE
*
*     Initialize some reference arrays.
*
      DO 30 I = 2, NLP1
         COLTYP( I ) = 1
   30 CONTINUE
      DO 40 I = NLP2, N
         COLTYP( I ) = 2
   40 CONTINUE
*
*     Sort the singular values into increasing order
*
      DO 50 I = NLP2, N
         IDXQ( I ) = IDXQ( I ) + NLP1
   50 CONTINUE
*
*     DSIGMA, IDXC, IDXC, and the first column of U2
*     are used as storage space.
*
      DO 60 I = 2, N
         DSIGMA( I ) = D( IDXQ( I ) )
         U2( I, 1 ) = Z( IDXQ( I ) )
         IDXC( I ) = COLTYP( IDXQ( I ) )
   60 CONTINUE
*
      CALL DLAMRG( NL, NR, DSIGMA( 2 ), 1, 1, IDX( 2 ) )
```

```
*
      DO 70 I = 2, N
         IDXI = 1 + IDX( I )
         D( I ) = DSIGMA( IDXI )
         Z( I ) = U2( IDXI, 1 )
         COLTYP( I ) = IDXC( IDXI )
   70 CONTINUE
*
*     Calculate the allowable deflation tolerance
*
      EPS = DLAMCH( 'Epsilon' )
      TOL = MAX( ABS( ALPHA ), ABS( BETA ) )
      TOL = EIGHT*EPS*MAX( ABS( D( N ) ), TOL )
*
*     There are 2 kinds of deflation -- first a value in the z-vector
*     is small, second two (or more) singular values are very close
*     together (their difference is small).
*
*     If the value in the z-vector is small, we simply permute the
*     array so that the corresponding singular value is moved to the
*     end.
*
*     If two values in the D-vector are close, we perform a two-sided
*     rotation designed to make one of the corresponding z-vector
*     entries zero, and then permute the array so that the deflated
*     singular value is moved to the end.
*
*     If there are multiple singular values then the problem deflates.
*     Here the number of equal singular values are found.  As each equal
*     singular value is found, an elementary reflector is computed to
*     rotate the corresponding singular subspace so that the
*     corresponding components of Z are zero in this new basis.
*
      K = 1
      K2 = N + 1
      DO 80 J = 2, N
         IF( ABS( Z( J ) ).LE.TOL ) THEN
*
*           Deflate due to small z component.
*
            K2 = K2 - 1
            IDXP( K2 ) = J
            COLTYP( J ) = 4
            IF( J.EQ.N )
     $         GO TO 120
         ELSE
            JPREV = J
            GO TO 90
         END IF
   80 CONTINUE
```

```
   90 CONTINUE
      J = JPREV
  100 CONTINUE
      J = J + 1
      IF( J.GT.N )
     $   GO TO 110
      IF( ABS( Z( J ) ).LE.TOL ) THEN
*
*        Deflate due to small z component.
*
         K2 = K2 - 1
         IDXP( K2 ) = J
         COLTYP( J ) = 4
      ELSE
*
*        Check if singular values are close enough to allow deflation.
*
         IF( ABS( D( J )-D( JPREV ) ).LE.TOL ) THEN
*
*           Deflation is possible.
*
            S = Z( JPREV )
            C = Z( J )
*
*           Find sqrt(a**2+b**2) without overflow or
*           destructive underflow.
*
            TAU = DLAPY2( C, S )
            C = C / TAU
            S = -S / TAU
            Z( J ) = TAU
            Z( JPREV ) = ZERO
*
*           Apply back the Givens rotation to the left and right
*           singular vector matrices.
*
            IDXJP = IDXQ( IDX( JPREV )+1 )
            IDXJ = IDXQ( IDX( J )+1 )
            IF( IDXJP.LE.NLP1 ) THEN
               IDXJP = IDXJP - 1
            END IF
            IF( IDXJ.LE.NLP1 ) THEN
               IDXJ = IDXJ - 1
            END IF
            CALL DROT( N, U( 1, IDXJP ), 1, U( 1, IDXJ ), 1, C, S )
            CALL DROT( M, VT( IDXJP, 1 ), LDVT, VT( IDXJ, 1 ), LDVT, C,
     $                 S )
            IF( COLTYP( J ).NE.COLTYP( JPREV ) ) THEN
               COLTYP( J ) = 3
            END IF
```

```
            COLTYP( JPREV ) = 4
            K2 = K2 - 1
            IDXP( K2 ) = JPREV
            JPREV = J
         ELSE
            K = K + 1
            U2( K, 1 ) = Z( JPREV )
            DSIGMA( K ) = D( JPREV )
            IDXP( K ) = JPREV
            JPREV = J
         END IF
      END IF
      GO TO 100
  110 CONTINUE
*
*     Record the last singular value.
*
      K = K + 1
      U2( K, 1 ) = Z( JPREV )
      DSIGMA( K ) = D( JPREV )
      IDXP( K ) = JPREV
*
  120 CONTINUE
*
*     Count up the total number of the various types of columns, then
*     form a permutation which positions the four column types into
*     four groups of uniform structure (although one or more of these
*     groups may be empty).
*
      DO 130 J = 1, 4
         CTOT( J ) = 0
  130 CONTINUE
      DO 140 J = 2, N
         CT = COLTYP( J )
         CTOT( CT ) = CTOT( CT ) + 1
  140 CONTINUE
*
*     PSM(*) = Position in SubMatrix (of types 1 through 4)
*
      PSM( 1 ) = 2
      PSM( 2 ) = 2 + CTOT( 1 )
      PSM( 3 ) = PSM( 2 ) + CTOT( 2 )
      PSM( 4 ) = PSM( 3 ) + CTOT( 3 )
*
*     Fill out the IDXC array so that the permutation which it induces
*     will place all type-1 columns first, all type-2 columns next,
*     then all type-3's, and finally all type-4's, starting from the
*     second column. This applies similarly to the rows of VT.
*
      DO 150 J = 2, N
```

```
         JP = IDXP( J )
         CT = COLTYP( JP )
         IDXC( PSM( CT ) ) = J
         PSM( CT ) = PSM( CT ) + 1
  150 CONTINUE
*
*     Sort the singular values and corresponding singular vectors into
*     DSIGMA, U2, and VT2 respectively.  The singular values/vectors
*     which were not deflated go into the first K slots of DSIGMA, U2,
*     and VT2 respectively, while those which were deflated go into the
*     last N - K slots, except that the first column/row will be treated
*     separately.
*
      DO 160 J = 2, N
         JP = IDXP( J )
         DSIGMA( J ) = D( JP )
         IDXJ = IDXQ( IDX( IDXP( IDXC( J ) ) )+1 )
         IF( IDXJ.LE.NLP1 ) THEN
            IDXJ = IDXJ - 1
         END IF
         CALL DCOPY( N, U( 1, IDXJ ), 1, U2( 1, J ), 1 )
         CALL DCOPY( M, VT( IDXJ, 1 ), LDVT, VT2( J, 1 ), LDVT2 )
  160 CONTINUE
*
*     Determine DSIGMA(1), DSIGMA(2) and Z(1)
*
      DSIGMA( 1 ) = ZERO
      HLFTOL = TOL / TWO
      IF( ABS( DSIGMA( 2 ) ).LE.HLFTOL )
     $   DSIGMA( 2 ) = HLFTOL
      IF( M.GT.N ) THEN
         Z( 1 ) = DLAPY2( Z1, Z( M ) )
         IF( Z( 1 ).LE.TOL ) THEN
            C = ONE
            S = ZERO
            Z( 1 ) = TOL
         ELSE
            C = Z1 / Z( 1 )
            S = Z( M ) / Z( 1 )
         END IF
      ELSE
         IF( ABS( Z1 ).LE.TOL ) THEN
            Z( 1 ) = TOL
         ELSE
            Z( 1 ) = Z1
         END IF
      END IF
*
*     Move the rest of the updating row to Z.
*
```

```
      CALL DCOPY( K-1, U2( 2, 1 ), 1, Z( 2 ), 1 )
*
*     Determine the first column of U2, the first row of VT2 and the
*     last row of VT.
*
      CALL DLASET( 'A', N, 1, ZERO, ZERO, U2, LDU2 )
      U2( NLP1, 1 ) = ONE
      IF( M.GT.N ) THEN
         DO 170 I = 1, NLP1
            VT( M, I ) = -S*VT( NLP1, I )
            VT2( 1, I ) = C*VT( NLP1, I )
  170    CONTINUE
         DO 180 I = NLP2, M
            VT2( 1, I ) = S*VT( M, I )
            VT( M, I ) = C*VT( M, I )
  180    CONTINUE
      ELSE
         CALL DCOPY( M, VT( NLP1, 1 ), LDVT, VT2( 1, 1 ), LDVT2 )
      END IF
      IF( M.GT.N ) THEN
         CALL DCOPY( M, VT( M, 1 ), LDVT, VT2( M, 1 ), LDVT2 )
      END IF
*
*     The deflated singular values and their corresponding vectors go
*     into the back of D, U, and V respectively.
*
      IF( N.GT.K ) THEN
         CALL DCOPY( N-K, DSIGMA( K+1 ), 1, D( K+1 ), 1 )
         CALL DLACPY( 'A', N, N-K, U2( 1, K+1 ), LDU2, U( 1, K+1 ),
     $                LDU )
         CALL DLACPY( 'A', N-K, M, VT2( K+1, 1 ), LDVT2, VT( K+1, 1 ),
     $                LDVT )
      END IF
*
*     Copy CTOT into COLTYP for referencing in DLASD3.
*
      DO 190 J = 1, 4
         COLTYP( J ) = CTOT( J )
  190 CONTINUE
*
      RETURN
*
*     End of DLASD2
*
      END
```

— LAPACK dlasd2 —

```
(let* ((zero 0.0) (one 1.0) (two 2.0) (eight 8.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one)
           (type (double-float 2.0 2.0) two)
           (type (double-float 8.0 8.0) eight))
  (defun dlasd2
         (nl nr sqre k d z alpha beta u ldu vt ldvt dsigma u2 ldu2 vt2 ldvt2
          idxp idx idxc idxq coltyp info)
    (declare (type (simple-array fixnum (*)) coltyp idxq idxc idx idxp)
             (type (double-float) beta alpha)
             (type (simple-array double-float (*)) vt2 u2 dsigma vt u z d)
             (type fixnum info ldvt2 ldu2 ldvt ldu k sqre nr nl))
    (f2cl-lib:with-multi-array-data
        ((d double-float d-%data% d-%offset%)
         (z double-float z-%data% z-%offset%)
         (u double-float u-%data% u-%offset%)
         (vt double-float vt-%data% vt-%offset%)
         (dsigma double-float dsigma-%data% dsigma-%offset%)
         (u2 double-float u2-%data% u2-%offset%)
         (vt2 double-float vt2-%data% vt2-%offset%)
         (idxp fixnum idxp-%data% idxp-%offset%)
         (idx fixnum idx-%data% idx-%offset%)
         (idxc fixnum idxc-%data% idxc-%offset%)
         (idxq fixnum idxq-%data% idxq-%offset%)
         (coltyp fixnum coltyp-%data% coltyp-%offset%))
      (prog ((c 0.0) (eps 0.0) (hlftol 0.0) (s 0.0) (tau 0.0) (tol 0.0)
             (z1 0.0) (ct 0) (i 0) (idxi 0) (idxj 0) (idxjp 0) (j 0) (jp 0)
             (jprev 0) (k2 0) (m 0) (n 0) (nlp1 0) (nlp2 0)
             (ctot (make-array 4 :element-type 'fixnum))
             (psm (make-array 4 :element-type 'fixnum)))
        (declare (type (double-float) c eps hlftol s tau tol z1)
                 (type fixnum ct i idxi idxj idxjp j jp jprev k2 m
                                      n nlp1 nlp2)
                 (type (simple-array fixnum (4)) ctot psm))
        (setf info 0)
        (cond
          ((< nl 1)
           (setf info -1))
          ((< nr 1)
           (setf info -2))
          ((and (/= sqre 1) (/= sqre 0))
           (setf info -3)))
        (setf n (f2cl-lib:int-add nl nr 1))
        (setf m (f2cl-lib:int-add n sqre))
        (cond
          ((< ldu n)
           (setf info -10))
          ((< ldvt m)
```

```
   (setf info -12))
  ((< ldu2 n)
   (setf info -15))
  ((< ldvt2 m)
   (setf info -17)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DLASD2" (f2cl-lib:int-sub info))
   (go end_label)))
(setf nlp1 (f2cl-lib:int-add nl 1))
(setf nlp2 (f2cl-lib:int-add nl 2))
(setf z1
        (* alpha
           (f2cl-lib:fref vt-%data%
                          (nlp1 nlp1)
                          ((1 ldvt) (1 *))
                          vt-%offset%)))
(setf (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%) z1)
(f2cl-lib:fdo (i nl (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
              ((> i 1) nil)
  (tagbody
    (setf (f2cl-lib:fref z-%data%
                         ((f2cl-lib:int-add i 1))
                         ((1 *))
                         z-%offset%)
            (* alpha
               (f2cl-lib:fref vt-%data%
                              (i nlp1)
                              ((1 ldvt) (1 *))
                              vt-%offset%)))
    (setf (f2cl-lib:fref d-%data%
                         ((f2cl-lib:int-add i 1))
                         ((1 *))
                         d-%offset%)
            (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
    (setf (f2cl-lib:fref idxq-%data%
                         ((f2cl-lib:int-add i 1))
                         ((1 *))
                         idxq-%offset%)
            (f2cl-lib:int-add
             (f2cl-lib:fref idxq-%data% (i) ((1 *)) idxq-%offset%)
             1))))
(f2cl-lib:fdo (i nlp2 (f2cl-lib:int-add i 1))
              ((> i m) nil)
  (tagbody
    (setf (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
            (* beta
               (f2cl-lib:fref vt-%data%
```

```
                              (i nlp2)
                              ((1 ldvt) (1 *))
                              vt-%offset%)))))
(f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
              ((> i nlp1) nil)
  (tagbody
   (setf (f2cl-lib:fref coltyp-%data% (i) ((1 *)) coltyp-%offset%) 1)))
(f2cl-lib:fdo (i nlp2 (f2cl-lib:int-add i 1))
              ((> i n) nil)
  (tagbody
   (setf (f2cl-lib:fref coltyp-%data% (i) ((1 *)) coltyp-%offset%) 2)))
(f2cl-lib:fdo (i nlp2 (f2cl-lib:int-add i 1))
              ((> i n) nil)
  (tagbody
    (setf (f2cl-lib:fref idxq-%data% (i) ((1 *)) idxq-%offset%)
            (f2cl-lib:int-add
             (f2cl-lib:fref idxq-%data% (i) ((1 *)) idxq-%offset%)
             nlp1))))
(f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
              ((> i n) nil)
  (tagbody
    (setf (f2cl-lib:fref dsigma-%data% (i) ((1 *)) dsigma-%offset%)
            (f2cl-lib:fref d-%data%
                           ((f2cl-lib:fref idxq (i) ((1 *))))
                           ((1 *))
                           d-%offset%))
    (setf (f2cl-lib:fref u2-%data% (i 1) ((1 ldu2) (1 *)) u2-%offset%)
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:fref idxq (i) ((1 *))))
                           ((1 *))
                           z-%offset%))
    (setf (f2cl-lib:fref idxc-%data% (i) ((1 *)) idxc-%offset%)
            (f2cl-lib:fref coltyp-%data%
                           ((f2cl-lib:fref idxq (i) ((1 *))))
                           ((1 *))
                           coltyp-%offset%))))
(dlamrg nl nr (f2cl-lib:array-slice dsigma double-float (2) ((1 *))) 1
 1 (f2cl-lib:array-slice idx fixnum (2) ((1 *))))
(f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
              ((> i n) nil)
  (tagbody
    (setf idxi
            (f2cl-lib:int-add 1
                              (f2cl-lib:fref idx-%data%
                                             (i)
                                             ((1 *))
                                             idx-%offset%)))
    (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
            (f2cl-lib:fref dsigma-%data%
                           (idxi)
```

```
                                ((1 *))
                                dsigma-%offset%))
            (setf (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
                    (f2cl-lib:fref u2-%data%
                                (idxi 1)
                                ((1 ldu2) (1 *))
                                u2-%offset%))
            (setf (f2cl-lib:fref coltyp-%data% (i) ((1 *)) coltyp-%offset%)
                    (f2cl-lib:fref idxc-%data% (idxi) ((1 *)) idxc-%offset%))))
        (setf eps (dlamch "Epsilon"))
        (setf tol (max (abs alpha) (abs beta)))
        (setf tol
                (* eight
                   eps
                   (max (abs (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%))
                        tol)))
        (setf k 1)
        (setf k2 (f2cl-lib:int-add n 1))
        (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
                      ((> j n) nil)
          (tagbody
            (cond
              ((<= (abs (f2cl-lib:fref z (j) ((1 *)))) tol)
               (setf k2 (f2cl-lib:int-sub k2 1))
               (setf (f2cl-lib:fref idxp-%data% (k2) ((1 *)) idxp-%offset%) j)
               (setf (f2cl-lib:fref coltyp-%data% (j) ((1 *)) coltyp-%offset%)
                     4)
               (if (= j n) (go label120)))
              (t
               (setf jprev j)
               (go label90)))))
label90
        (setf j jprev)
label100
        (setf j (f2cl-lib:int-add j 1))
        (if (> j n) (go label110))
        (cond
          ((<= (abs (f2cl-lib:fref z (j) ((1 *)))) tol)
           (setf k2 (f2cl-lib:int-sub k2 1))
           (setf (f2cl-lib:fref idxp-%data% (k2) ((1 *)) idxp-%offset%) j)
           (setf (f2cl-lib:fref coltyp-%data% (j) ((1 *)) coltyp-%offset%) 4))
          (t
           (cond
             ((<=
               (abs
                (+ (f2cl-lib:fref d (j) ((1 *)))
                   (- (f2cl-lib:fref d (jprev) ((1 *))))))
               tol)
              (setf s (f2cl-lib:fref z-%data% (jprev) ((1 *)) z-%offset%))
              (setf c (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%))
```

```
(setf tau (dlapy2 c s))
(setf c (/ c tau))
(setf s (/ (- s) tau))
(setf (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%) tau)
(setf (f2cl-lib:fref z-%data% (jprev) ((1 *)) z-%offset%) zero)
(setf idxjp
        (f2cl-lib:fref idxq-%data%
                       ((f2cl-lib:int-add
                         (f2cl-lib:fref idx (jprev) ((1 *)))
                         1))
                       ((1 *))
                       idxq-%offset%))
(setf idxj
        (f2cl-lib:fref idxq-%data%
                       ((f2cl-lib:int-add
                         (f2cl-lib:fref idx (j) ((1 *)))
                         1))
                       ((1 *))
                       idxq-%offset%))
(cond
  ((<= idxjp nlp1)
   (setf idxjp (f2cl-lib:int-sub idxjp 1))))
(cond
  ((<= idxj nlp1)
   (setf idxj (f2cl-lib:int-sub idxj 1))))
(drot n
 (f2cl-lib:array-slice u double-float (1 idxjp) ((1 ldu) (1 *)))
 1 (f2cl-lib:array-slice u double-float (1 idxj) ((1 ldu) (1 *)))
 1 c s)
(drot m
 (f2cl-lib:array-slice vt
                       double-float
                       (idxjp 1)
                       ((1 ldvt) (1 *)))
 ldvt
 (f2cl-lib:array-slice vt double-float (idxj 1) ((1 ldvt) (1 *)))
 ldvt c s)
(cond
  ((/= (f2cl-lib:fref coltyp (j) ((1 *)))
       (f2cl-lib:fref coltyp (jprev) ((1 *))))
   (setf (f2cl-lib:fref coltyp-%data%
                        (j)
                        ((1 *))
                        coltyp-%offset%)
          3)))
(setf (f2cl-lib:fref coltyp-%data%
                     (jprev)
                     ((1 *))
                     coltyp-%offset%)
       4)
```

```
             (setf k2 (f2cl-lib:int-sub k2 1))
             (setf (f2cl-lib:fref idxp-%data% (k2) ((1 *)) idxp-%offset%)
                     jprev)
             (setf jprev j))
            (t
             (setf k (f2cl-lib:int-add k 1))
             (setf (f2cl-lib:fref u2-%data%
                                  (k 1)
                                  ((1 ldu2) (1 *))
                                  u2-%offset%)
                     (f2cl-lib:fref z-%data% (jprev) ((1 *)) z-%offset%))
             (setf (f2cl-lib:fref dsigma-%data% (k) ((1 *)) dsigma-%offset%)
                     (f2cl-lib:fref d-%data% (jprev) ((1 *)) d-%offset%))
             (setf (f2cl-lib:fref idxp-%data% (k) ((1 *)) idxp-%offset%) jprev)
             (setf jprev j)))))
       (go label100)
label110
       (setf k (f2cl-lib:int-add k 1))
       (setf (f2cl-lib:fref u2-%data% (k 1) ((1 ldu2) (1 *)) u2-%offset%)
               (f2cl-lib:fref z-%data% (jprev) ((1 *)) z-%offset%))
       (setf (f2cl-lib:fref dsigma-%data% (k) ((1 *)) dsigma-%offset%)
               (f2cl-lib:fref d-%data% (jprev) ((1 *)) d-%offset%))
       (setf (f2cl-lib:fref idxp-%data% (k) ((1 *)) idxp-%offset%) jprev)
label120
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j 4) nil)
         (tagbody (setf (f2cl-lib:fref ctot (j) ((1 4))) 0)))
       (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (setf ct (f2cl-lib:fref coltyp-%data% (j) ((1 *)) coltyp-%offset%))
           (setf (f2cl-lib:fref ctot (ct) ((1 4)))
                   (f2cl-lib:int-add (f2cl-lib:fref ctot (ct) ((1 4))) 1))))
       (setf (f2cl-lib:fref psm (1) ((1 4))) 2)
       (setf (f2cl-lib:fref psm (2) ((1 4)))
               (f2cl-lib:int-add 2 (f2cl-lib:fref ctot (1) ((1 4)))))
       (setf (f2cl-lib:fref psm (3) ((1 4)))
               (f2cl-lib:int-add (f2cl-lib:fref psm (2) ((1 4)))
                                 (f2cl-lib:fref ctot (2) ((1 4)))))
       (setf (f2cl-lib:fref psm (4) ((1 4)))
               (f2cl-lib:int-add (f2cl-lib:fref psm (3) ((1 4)))
                                 (f2cl-lib:fref ctot (3) ((1 4)))))
       (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (setf jp (f2cl-lib:fref idxp-%data% (j) ((1 *)) idxp-%offset%))
           (setf ct
                   (f2cl-lib:fref coltyp-%data% (jp) ((1 *)) coltyp-%offset%))
           (setf (f2cl-lib:fref idxc-%data%
                                ((f2cl-lib:fref psm (ct) ((1 4))))
```

```
                          ((1 *))
                          idxc-%offset%)
                 j)
    (setf (f2cl-lib:fref psm (ct) ((1 4)))
            (f2cl-lib:int-add (f2cl-lib:fref psm (ct) ((1 4))) 1))))
(f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
              ((> j n) nil)
  (tagbody
    (setf jp (f2cl-lib:fref idxp-%data% (j) ((1 *)) idxp-%offset%))
    (setf (f2cl-lib:fref dsigma-%data% (j) ((1 *)) dsigma-%offset%)
            (f2cl-lib:fref d-%data% (jp) ((1 *)) d-%offset%))
    (setf idxj
            (f2cl-lib:fref idxq-%data%
             ((f2cl-lib:int-add
               (f2cl-lib:fref idx
                ((f2cl-lib:fref idxp
                  ((f2cl-lib:fref
                    idxc
                    (j)
                    ((1 *))))
                  ((1 *))))
                ((1 *)))
               1))
             ((1 *))
             idxq-%offset%))
    (cond
      ((<= idxj nlp1)
       (setf idxj (f2cl-lib:int-sub idxj 1))))
    (dcopy n
     (f2cl-lib:array-slice u double-float (1 idxj) ((1 ldu) (1 *))) 1
     (f2cl-lib:array-slice u2 double-float (1 j) ((1 ldu2) (1 *))) 1)
    (dcopy m
     (f2cl-lib:array-slice vt double-float (idxj 1) ((1 ldvt) (1 *)))
     ldvt
     (f2cl-lib:array-slice vt2 double-float (j 1) ((1 ldvt2) (1 *)))
     ldvt2)))
(setf (f2cl-lib:fref dsigma-%data% (1) ((1 *)) dsigma-%offset%) zero)
(setf hlftol (/ tol two))
(if
 (<= (abs (f2cl-lib:fref dsigma-%data% (2) ((1 *)) dsigma-%offset%))
     hlftol)
 (setf (f2cl-lib:fref dsigma-%data% (2) ((1 *)) dsigma-%offset%)
         hlftol))
(cond
  ((> m n)
   (setf (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)
           (dlapy2 z1 (f2cl-lib:fref z-%data% (m) ((1 *)) z-%offset%)))
   (cond
     ((<= (f2cl-lib:fref z (1) ((1 *))) tol)
      (setf c one)
```

```
       (setf s zero)
       (setf (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%) tol))
      (t
       (setf c (/ z1 (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)))
       (setf s
               (/ (f2cl-lib:fref z-%data% (m) ((1 *)) z-%offset%)
                  (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%))))))
  (t
   (cond
     ((<= (abs z1) tol)
      (setf (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%) tol))
     (t
      (setf (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%) z1)))))
(dcopy (f2cl-lib:int-sub k 1)
 (f2cl-lib:array-slice u2 double-float (2 1) ((1 ldu2) (1 *))) 1
 (f2cl-lib:array-slice z double-float (2) ((1 *))) 1)
(dlaset "A" n 1 zero zero u2 ldu2)
(setf (f2cl-lib:fref u2-%data% (nlp1 1) ((1 ldu2) (1 *)) u2-%offset%)
       one)
(cond
  ((> m n)
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i nlp1) nil)
     (tagbody
       (setf (f2cl-lib:fref vt-%data%
                            (m i)
                            ((1 ldvt) (1 *))
                            vt-%offset%)
                (* (- s)
                   (f2cl-lib:fref vt-%data%
                                  (nlp1 i)
                                  ((1 ldvt) (1 *))
                                  vt-%offset%)))
       (setf (f2cl-lib:fref vt2-%data%
                            (1 i)
                            ((1 ldvt2) (1 *))
                            vt2-%offset%)
                (* c
                   (f2cl-lib:fref vt-%data%
                                  (nlp1 i)
                                  ((1 ldvt) (1 *))
                                  vt-%offset%)))))
   (f2cl-lib:fdo (i nlp2 (f2cl-lib:int-add i 1))
                 ((> i m) nil)
     (tagbody
       (setf (f2cl-lib:fref vt2-%data%
                            (1 i)
                            ((1 ldvt2) (1 *))
                            vt2-%offset%)
                (* s
```

```
                    (f2cl-lib:fref vt-%data%
                                   (m i)
                                   ((1 ldvt) (1 *))
                                   vt-%offset%)))
          (setf (f2cl-lib:fref vt-%data%
                               (m i)
                               ((1 ldvt) (1 *))
                               vt-%offset%)
                (* c
                   (f2cl-lib:fref vt-%data%
                                  (m i)
                                  ((1 ldvt) (1 *))
                                  vt-%offset%))))))
  (t
   (dcopy m
    (f2cl-lib:array-slice vt double-float (nlp1 1) ((1 ldvt) (1 *)))
    ldvt
    (f2cl-lib:array-slice vt2 double-float (1 1) ((1 ldvt2) (1 *)))
    ldvt2)))
(cond
  ((> m n)
   (dcopy m
    (f2cl-lib:array-slice vt double-float (m 1) ((1 ldvt) (1 *))) ldvt
    (f2cl-lib:array-slice vt2 double-float (m 1) ((1 ldvt2) (1 *)))
    ldvt2)))
(cond
  ((> n k)
   (dcopy (f2cl-lib:int-sub n k)
    (f2cl-lib:array-slice dsigma double-float ((+ k 1)) ((1 *))) 1
    (f2cl-lib:array-slice d double-float ((+ k 1)) ((1 *))) 1)
   (dlacpy "A" n (f2cl-lib:int-sub n k)
    (f2cl-lib:array-slice u2
                          double-float
                          (1 (f2cl-lib:int-add k 1))
                          ((1 ldu2) (1 *)))
    ldu2
    (f2cl-lib:array-slice u
                          double-float
                          (1 (f2cl-lib:int-add k 1))
                          ((1 ldu) (1 *)))
    ldu)
   (dlacpy "A" (f2cl-lib:int-sub n k) m
    (f2cl-lib:array-slice vt2
                          double-float
                          ((+ k 1) 1)
                          ((1 ldvt2) (1 *)))
    ldvt2
    (f2cl-lib:array-slice vt double-float ((+ k 1) 1) ((1 ldvt) (1 *)))
    ldvt)))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
```

```
                    ((> j 4) nil)
          (tagbody
            (setf (f2cl-lib:fref coltyp-%data% (j) ((1 *)) coltyp-%offset%)
                    (f2cl-lib:fref ctot (j) ((1 4))))))
 end_label
        (return
         (values nil
                 nil
                 nil
                 k
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 info))))))
```

———-

6.60 dlasd3 LAPACK

— dlasd3.input —

```
)set break resume
)sys rm -f dlasd3.output
)spool dlasd3.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dlasd3.help —

```
=====================================================================
dlasd3 examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DLASD3  - all the square roots of the roots of the secular equation, as
       defined by the values in D and Z

SYNOPSIS
       SUBROUTINE DLASD3( NL, NR, SQRE, K, D, Q,  LDQ,  DSIGMA,  U,  LDU,  U2,
                          LDU2, VT, LDVT, VT2, LDVT2, IDXC, CTOT, Z, INFO )

           INTEGER        INFO, K, LDQ, LDU, LDU2, LDVT, LDVT2, NL, NR, SQRE

           INTEGER        CTOT( * ), IDXC( * )

           DOUBLE         PRECISION  D( * ), DSIGMA( * ), Q( LDQ, * ), U( LDU,
                          * ), U2( LDU2, * ), VT( LDVT, * ), VT2( LDVT2, *  ),
                          Z( * )

  Purpose
  =======

  DLASD3 finds all the square roots of the roots of the secular
  equation, as defined by the values in D and Z.  It makes the
  appropriate calls to DLASD4 and then updates the singular
  vectors by matrix multiplication.

  This code makes very mild assumptions about floating point
  arithmetic. It will work on machines with a guard digit in
  add/subtract, or on those binary machines without guard digits
  which subtract like the Cray XMP, Cray YMP, Cray C 90, or Cray 2.
  It could conceivably fail on hexadecimal or decimal machines
  without guard digits, but we know of none.

  DLASD3 is called from DLASD1.

  Arguments
  =========

  NL     (input) INTEGER
```

```
        The row dimension of the upper block.  NL >= 1.

NR      (input) INTEGER
        The row dimension of the lower block.  NR >= 1.

SQRE    (input) INTEGER
        = 0: the lower block is an NR-by-NR square matrix.
        = 1: the lower block is an NR-by-(NR+1) rectangular matrix.

        The bidiagonal matrix has N = NL + NR + 1 rows and
        M = N + SQRE >= N columns.

K       (input) INTEGER
        The size of the secular equation, 1 =< K = < N.

D       (output) DOUBLE PRECISION array, dimension(K)
        On exit the square roots of the roots of the secular equation,
        in ascending order.

Q       (workspace) DOUBLE PRECISION array,
                    dimension at least (LDQ,K).

LDQ     (input) INTEGER
        The leading dimension of the array Q.  LDQ >= K.

DSIGMA (input) DOUBLE PRECISION array, dimension(K)
        The first K elements of this array contain the old roots
        of the deflated updating problem.  These are the poles
        of the secular equation.

U       (input) DOUBLE PRECISION array, dimension (LDU, N)
        The last N - K columns of this matrix contain the deflated
        left singular vectors.

LDU     (input) INTEGER
        The leading dimension of the array U.  LDU >= N.

U2      (input) DOUBLE PRECISION array, dimension (LDU2, N)
        The first K columns of this matrix contain the non-deflated
        left singular vectors for the split problem.

LDU2    (input) INTEGER
        The leading dimension of the array U2.  LDU2 >= N.

VT      (input) DOUBLE PRECISION array, dimension (LDVT, M)
        The last M - K columns of VT' contain the deflated
        right singular vectors.

LDVT    (input) INTEGER
        The leading dimension of the array VT.  LDVT >= N.
```

```
VT2    (input) DOUBLE PRECISION array, dimension (LDVT2, N)
       The first K columns of VT2' contain the non-deflated
       right singular vectors for the split problem.

LDVT2  (input) INTEGER
       The leading dimension of the array VT2.  LDVT2 >= N.

IDXC   (input) INTEGER array, dimension ( N )
       The permutation used to arrange the columns of U (and rows of
       VT) into three groups:  the first group contains non-zero
       entries only at and above (or before) NL +1; the second
       contains non-zero entries only at and below (or after) NL+2;
       and the third is dense. The first column of U and the row of
       VT are treated separately, however.

       The rows of the singular vectors found by DLASD4
       must be likewise permuted before the matrix multiplies can
       take place.

CTOT   (input) INTEGER array, dimension ( 4 )
       A count of the total number of the various types of columns
       in U (or rows in VT), as described in IDXC. The fourth column
       type is any column which has been deflated.

Z      (input) DOUBLE PRECISION array, dimension (K)
       The first K elements of this array contain the components
       of the deflation-adjusted updating row vector.

INFO   (output) INTEGER
       = 0:  successful exit.
       < 0:  if INFO = -i, the i-th argument had an illegal value.
       > 0:  if INFO = 1, an singular value did not converge

Further Details
===============

Based on contributions by
   Ming Gu and Huan Ren, Computer Science Division, University of
   California at Berkeley, USA
```

———-

— dlasd3.f —

```
    SUBROUTINE DLASD3( NL, NR, SQRE, K, D, Q, LDQ, DSIGMA, U, LDU, U2,
   $                   LDU2, VT, LDVT, VT2, LDVT2, IDXC, CTOT, Z,
   $                   INFO )
```

```
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Oak Ridge National Lab, Argonne National Lab,
*     Courant Institute, NAG Ltd., and Rice University
*     October 31, 1999
*
*     .. Scalar Arguments ..
      INTEGER            INFO, K, LDQ, LDU, LDU2, LDVT, LDVT2, NL, NR,
     $                   SQRE
*     ..
*     .. Array Arguments ..
      INTEGER            CTOT( * ), IDXC( * )
      DOUBLE PRECISION   D( * ), DSIGMA( * ), Q( LDQ, * ), U( LDU, * ),
     $                   U2( LDU2, * ), VT( LDVT, * ), VT2( LDVT2, * ),
     $                   Z( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE, ZERO, NEGONE
      PARAMETER          ( ONE = 1.0D+0, ZERO = 0.0D+0,
     $                   NEGONE = -1.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            CTEMP, I, J, JC, KTEMP, M, N, NLP1, NLP2, NRP1
      DOUBLE PRECISION   RHO, TEMP
*     ..
*     .. External Functions ..
      DOUBLE PRECISION   DLAMC3, DNRM2
      EXTERNAL           DLAMC3, DNRM2
*     ..
*     .. External Subroutines ..
      EXTERNAL           DCOPY, DGEMM, DLACPY, DLASCL, DLASD4, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, SIGN, SQRT
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
*
      IF( NL.LT.1 ) THEN
         INFO = -1
      ELSE IF( NR.LT.1 ) THEN
         INFO = -2
      ELSE IF( ( SQRE.NE.1 ) .AND. ( SQRE.NE.0 ) ) THEN
         INFO = -3
```

```
      END IF
*
      N = NL + NR + 1
      M = N + SQRE
      NLP1 = NL + 1
      NLP2 = NL + 2
*
      IF( ( K.LT.1 ) .OR. ( K.GT.N ) ) THEN
         INFO = -4
      ELSE IF( LDQ.LT.K ) THEN
         INFO = -7
      ELSE IF( LDU.LT.N ) THEN
         INFO = -10
      ELSE IF( LDU2.LT.N ) THEN
         INFO = -12
      ELSE IF( LDVT.LT.M ) THEN
         INFO = -14
      ELSE IF( LDVT2.LT.M ) THEN
         INFO = -16
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DLASD3', -INFO )
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( K.EQ.1 ) THEN
         D( 1 ) = ABS( Z( 1 ) )
         CALL DCOPY( M, VT2( 1, 1 ), LDVT2, VT( 1, 1 ), LDVT )
         IF( Z( 1 ).GT.ZERO ) THEN
            CALL DCOPY( N, U2( 1, 1 ), 1, U( 1, 1 ), 1 )
         ELSE
            DO 10 I = 1, N
               U( I, 1 ) = -U2( I, 1 )
   10       CONTINUE
         END IF
         RETURN
      END IF
*
*     Modify values DSIGMA(i) to make sure all DSIGMA(i)-DSIGMA(j) can
*     be computed with high relative accuracy (barring over/underflow).
*     This is a problem on machines without a guard digit in
*     add/subtract (Cray XMP, Cray YMP, Cray C 90 and Cray 2).
*     The following code replaces DSIGMA(I) by 2*DSIGMA(I)-DSIGMA(I),
*     which on any of these machines zeros out the bottommost
*     bit of DSIGMA(I) if it is 1; this makes the subsequent
*     subtractions DSIGMA(I)-DSIGMA(J) unproblematic when cancellation
*     occurs. On binary machines with a guard digit (almost all
*     machines) it does not change DSIGMA(I) at all. On hexadecimal
```

```
*     and decimal machines with a guard digit, it slightly
*     changes the bottommost bits of DSIGMA(I). It does not account
*     for hexadecimal or decimal machines without guard digits
*     (we know of none). We use a subroutine call to compute
*     2*DLAMBDA(I) to prevent optimizing compilers from eliminating
*     this code.
*
      DO 20 I = 1, K
         DSIGMA( I ) = DLAMC3( DSIGMA( I ), DSIGMA( I ) ) - DSIGMA( I )
   20 CONTINUE
*
*     Keep a copy of Z.
*
      CALL DCOPY( K, Z, 1, Q, 1 )
*
*     Normalize Z.
*
      RHO = DNRM2( K, Z, 1 )
      CALL DLASCL( 'G', 0, 0, RHO, ONE, K, 1, Z, K, INFO )
      RHO = RHO*RHO
*
*     Find the new singular values.
*
      DO 30 J = 1, K
         CALL DLASD4( K, J, DSIGMA, Z, U( 1, J ), RHO, D( J ),
     $                VT( 1, J ), INFO )
*
*        If the zero finder fails, the computation is terminated.
*
         IF( INFO.NE.0 ) THEN
            RETURN
         END IF
   30 CONTINUE
*
*     Compute updated Z.
*
      DO 60 I = 1, K
         Z( I ) = U( I, K )*VT( I, K )
         DO 40 J = 1, I - 1
            Z( I ) = Z( I )*( U( I, J )*VT( I, J ) /
     $               ( DSIGMA( I )-DSIGMA( J ) ) /
     $               ( DSIGMA( I )+DSIGMA( J ) ) )
   40    CONTINUE
         DO 50 J = I, K - 1
            Z( I ) = Z( I )*( U( I, J )*VT( I, J ) /
     $               ( DSIGMA( I )-DSIGMA( J+1 ) ) /
     $               ( DSIGMA( I )+DSIGMA( J+1 ) ) )
   50    CONTINUE
         Z( I ) = SIGN( SQRT( ABS( Z( I ) ) ), Q( I, 1 ) )
   60 CONTINUE
```

```
*
*     Compute left singular vectors of the modified diagonal matrix,
*     and store related information for the right singular vectors.
*
      DO 90 I = 1, K
         VT( 1, I ) = Z( 1 ) / U( 1, I ) / VT( 1, I )
         U( 1, I ) = NEGONE
         DO 70 J = 2, K
            VT( J, I ) = Z( J ) / U( J, I ) / VT( J, I )
            U( J, I ) = DSIGMA( J )*VT( J, I )
   70    CONTINUE
         TEMP = DNRM2( K, U( 1, I ), 1 )
         Q( 1, I ) = U( 1, I ) / TEMP
         DO 80 J = 2, K
            JC = IDXC( J )
            Q( J, I ) = U( JC, I ) / TEMP
   80    CONTINUE
   90 CONTINUE
*
*     Update the left singular vector matrix.
*
      IF( K.EQ.2 ) THEN
         CALL DGEMM( 'N', 'N', N, K, K, ONE, U2, LDU2, Q, LDQ, ZERO, U,
     $               LDU )
         GO TO 100
      END IF
      IF( CTOT( 1 ).GT.0 ) THEN
         CALL DGEMM( 'N', 'N', NL, K, CTOT( 1 ), ONE, U2( 1, 2 ), LDU2,
     $               Q( 2, 1 ), LDQ, ZERO, U( 1, 1 ), LDU )
         IF( CTOT( 3 ).GT.0 ) THEN
            KTEMP = 2 + CTOT( 1 ) + CTOT( 2 )
            CALL DGEMM( 'N', 'N', NL, K, CTOT( 3 ), ONE, U2( 1, KTEMP ),
     $                  LDU2, Q( KTEMP, 1 ), LDQ, ONE, U( 1, 1 ), LDU )
         END IF
      ELSE IF( CTOT( 3 ).GT.0 ) THEN
         KTEMP = 2 + CTOT( 1 ) + CTOT( 2 )
         CALL DGEMM( 'N', 'N', NL, K, CTOT( 3 ), ONE, U2( 1, KTEMP ),
     $               LDU2, Q( KTEMP, 1 ), LDQ, ZERO, U( 1, 1 ), LDU )
      ELSE
         CALL DLACPY( 'F', NL, K, U2, LDU2, U, LDU )
      END IF
      CALL DCOPY( K, Q( 1, 1 ), LDQ, U( NLP1, 1 ), LDU )
      KTEMP = 2 + CTOT( 1 )
      CTEMP = CTOT( 2 ) + CTOT( 3 )
      CALL DGEMM( 'N', 'N', NR, K, CTEMP, ONE, U2( NLP2, KTEMP ), LDU2,
     $            Q( KTEMP, 1 ), LDQ, ZERO, U( NLP2, 1 ), LDU )
*
*     Generate the right singular vectors.
*
  100 CONTINUE
```

```
      DO 120 I = 1, K
         TEMP = DNRM2( K, VT( 1, I ), 1 )
         Q( I, 1 ) = VT( 1, I ) / TEMP
         DO 110 J = 2, K
            JC = IDXC( J )
            Q( I, J ) = VT( JC, I ) / TEMP
  110    CONTINUE
  120 CONTINUE
*
*     Update the right singular vector matrix.
*
      IF( K.EQ.2 ) THEN
         CALL DGEMM( 'N', 'N', K, M, K, ONE, Q, LDQ, VT2, LDVT2, ZERO,
     $               VT, LDVT )
         RETURN
      END IF
      KTEMP = 1 + CTOT( 1 )
      CALL DGEMM( 'N', 'N', K, NLP1, KTEMP, ONE, Q( 1, 1 ), LDQ,
     $            VT2( 1, 1 ), LDVT2, ZERO, VT( 1, 1 ), LDVT )
      KTEMP = 2 + CTOT( 1 ) + CTOT( 2 )
      IF( KTEMP.LE.LDVT2 )
     $   CALL DGEMM( 'N', 'N', K, NLP1, CTOT( 3 ), ONE, Q( 1, KTEMP ),
     $               LDQ, VT2( KTEMP, 1 ), LDVT2, ONE, VT( 1, 1 ),
     $               LDVT )
*
      KTEMP = CTOT( 1 ) + 1
      NRP1 = NR + SQRE
      IF( KTEMP.GT.1 ) THEN
         DO 130 I = 1, K
            Q( I, KTEMP ) = Q( I, 1 )
  130    CONTINUE
         DO 140 I = NLP2, M
            VT2( KTEMP, I ) = VT2( 1, I )
  140    CONTINUE
      END IF
      CTEMP = 1 + CTOT( 2 ) + CTOT( 3 )
      CALL DGEMM( 'N', 'N', K, NRP1, CTEMP, ONE, Q( 1, KTEMP ), LDQ,
     $            VT2( KTEMP, NLP2 ), LDVT2, ZERO, VT( 1, NLP2 ), LDVT )
*
      RETURN
*
*     End of DLASD3
*
      END
```

———-

— LAPACK dlasd3 —

```
(let* ((one 1.0) (zero 0.0) (negone (- 1.0)))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero)
           (type (double-float) negone))
  (defun dlasd3
         (nl nr sqre k d q ldq dsigma u ldu u2 ldu2 vt ldvt vt2 ldvt2 idxc ctot
          z info)
    (declare (type (simple-array fixnum (*)) ctot idxc)
             (type (simple-array double-float (*)) z vt2 vt u2 u dsigma q d)
             (type fixnum info ldvt2 ldvt ldu2 ldu ldq k sqre nr
                                  nl))
    (f2cl-lib:with-multi-array-data
        ((d double-float d-%data% d-%offset%)
         (q double-float q-%data% q-%offset%)
         (dsigma double-float dsigma-%data% dsigma-%offset%)
         (u double-float u-%data% u-%offset%)
         (u2 double-float u2-%data% u2-%offset%)
         (vt double-float vt-%data% vt-%offset%)
         (vt2 double-float vt2-%data% vt2-%offset%)
         (z double-float z-%data% z-%offset%)
         (idxc fixnum idxc-%data% idxc-%offset%)
         (ctot fixnum ctot-%data% ctot-%offset%))
      (prog ((rho 0.0) (temp 0.0) (ctemp 0) (i 0) (j 0) (jc 0) (ktemp 0) (m 0)
             (n 0) (nlp1 0) (nlp2 0) (nrp1 0))
        (declare (type (double-float) rho temp)
                 (type fixnum ctemp i j jc ktemp m n nlp1 nlp2
                                      nrp1))
        (setf info 0)
        (cond
          ((< nl 1)
           (setf info -1))
          ((< nr 1)
           (setf info -2))
          ((and (/= sqre 1) (/= sqre 0))
           (setf info -3)))
        (setf n (f2cl-lib:int-add nl nr 1))
        (setf m (f2cl-lib:int-add n sqre))
        (setf nlp1 (f2cl-lib:int-add nl 1))
        (setf nlp2 (f2cl-lib:int-add nl 2))
        (cond
          ((or (< k 1) (> k n))
           (setf info -4))
          ((< ldq k)
           (setf info -7))
          ((< ldu n)
           (setf info -10))
          ((< ldu2 n)
           (setf info -12))
          ((< ldvt m)
           (setf info -14))
```

```
  ((< ldvt2 m)
   (setf info -16)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DLASD3" (f2cl-lib:int-sub info))
   (go end_label)))
(cond
  ((= k 1)
   (setf (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)
           (abs (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)))
   (dcopy m
    (f2cl-lib:array-slice vt2 double-float (1 1) ((1 ldvt2) (1 *)))
    ldvt2 (f2cl-lib:array-slice vt double-float (1 1) ((1 ldvt) (1 *)))
    ldvt)
   (cond
     ((> (f2cl-lib:fref z (1) ((1 *))) zero)
      (dcopy n
       (f2cl-lib:array-slice u2 double-float (1 1) ((1 ldu2) (1 *))) 1
       (f2cl-lib:array-slice u double-float (1 1) ((1 ldu) (1 *))) 1))
     (t
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i n) nil)
        (tagbody
          (setf (f2cl-lib:fref u-%data%
                               (i 1)
                               ((1 ldu) (1 *))
                               u-%offset%)
                  (-
                   (f2cl-lib:fref u2-%data%
                                  (i 1)
                                  ((1 ldu2) (1 *))
                                  u2-%offset%)))))))
   (go end_label)))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i k) nil)
  (tagbody
    (setf (f2cl-lib:fref dsigma-%data% (i) ((1 *)) dsigma-%offset%)
            (-
             (multiple-value-bind (ret-val var-0 var-1)
                 (dlamc3
                  (f2cl-lib:fref dsigma-%data%
                                 (i)
                                 ((1 *))
                                 dsigma-%offset%)
                  (f2cl-lib:fref dsigma-%data%
                                 (i)
                                 ((1 *))
                                 dsigma-%offset%))
```

```
                (declare (ignore))
                (setf (f2cl-lib:fref dsigma-%data%
                                     (i)
                                     ((1 *))
                                     dsigma-%offset%)
                      var-0)
                (setf (f2cl-lib:fref dsigma-%data%
                                     (i)
                                     ((1 *))
                                     dsigma-%offset%)
                      var-1)
                ret-val)
              (f2cl-lib:fref dsigma-%data%
                             (i)
                             ((1 *))
                             dsigma-%offset%)))))
(dcopy k z 1 q 1)
(setf rho (dnrm2 k z 1))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
    (dlascl "G" 0 0 rho one k 1 z k info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                   var-8))
  (setf info var-9))
(setf rho (* rho rho))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j k) nil)
  (tagbody
    (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
        (dlasd4 k j dsigma z
         (f2cl-lib:array-slice u double-float (1 j) ((1 ldu) (1 *)))
         rho (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
         (f2cl-lib:array-slice vt double-float (1 j) ((1 ldvt) (1 *)))
         info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-7))
      (setf (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%) var-6)
      (setf info var-8))
    (cond
      ((/= info 0)
       (go end_label)))))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i k) nil)
  (tagbody
    (setf (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
          (*
           (f2cl-lib:fref u-%data% (i k) ((1 ldu) (1 *)) u-%offset%)
           (f2cl-lib:fref vt-%data%
                          (i k)
                          ((1 ldvt) (1 *))
```

```
                        vt-%offset%)))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j (f2cl-lib:int-add i (f2cl-lib:int-sub 1))) nil)
  (tagbody
    (setf (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
            (* (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
               (/
                (/
                 (*
                  (f2cl-lib:fref u-%data%
                                 (i j)
                                 ((1 ldu) (1 *))
                                 u-%offset%)
                  (f2cl-lib:fref vt-%data%
                                 (i j)
                                 ((1 ldvt) (1 *))
                                 vt-%offset%))
                 (-
                  (f2cl-lib:fref dsigma-%data%
                                 (i)
                                 ((1 *))
                                 dsigma-%offset%)
                  (f2cl-lib:fref dsigma-%data%
                                 (j)
                                 ((1 *))
                                 dsigma-%offset%)))
                (+
                 (f2cl-lib:fref dsigma-%data%
                                (i)
                                ((1 *))
                                dsigma-%offset%)
                 (f2cl-lib:fref dsigma-%data%
                                (j)
                                ((1 *))
                                dsigma-%offset%)))))))
(f2cl-lib:fdo (j i (f2cl-lib:int-add j 1))
              ((> j (f2cl-lib:int-add k (f2cl-lib:int-sub 1))) nil)
  (tagbody
    (setf (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
            (* (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
               (/
                (/
                 (*
                  (f2cl-lib:fref u-%data%
                                 (i j)
                                 ((1 ldu) (1 *))
                                 u-%offset%)
                  (f2cl-lib:fref vt-%data%
                                 (i j)
                                 ((1 ldvt) (1 *))
```

```
                                        vt-%offset%))
                          (-
                           (f2cl-lib:fref dsigma-%data%
                                          (i)
                                          ((1 *))
                                          dsigma-%offset%)
                           (f2cl-lib:fref dsigma-%data%
                                          ((f2cl-lib:int-add j 1))
                                          ((1 *))
                                          dsigma-%offset%)))
                         (+
                          (f2cl-lib:fref dsigma-%data%
                                         (i)
                                         ((1 *))
                                         dsigma-%offset%)
                          (f2cl-lib:fref dsigma-%data%
                                         ((f2cl-lib:int-add j 1))
                                         ((1 *))
                                         dsigma-%offset%)))))))
    (setf (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
            (f2cl-lib:sign
             (f2cl-lib:fsqrt
              (abs (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)))
             (f2cl-lib:fref q-%data%
                            (i 1)
                            ((1 ldq) (1 *))
                            q-%offset%)))))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i k) nil)
  (tagbody
    (setf (f2cl-lib:fref vt-%data% (1 i) ((1 ldvt) (1 *)) vt-%offset%)
            (/
             (/ (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)
                (f2cl-lib:fref u-%data%
                               (1 i)
                               ((1 ldu) (1 *))
                               u-%offset%))
             (f2cl-lib:fref vt-%data%
                            (1 i)
                            ((1 ldvt) (1 *))
                            vt-%offset%)))
    (setf (f2cl-lib:fref u-%data% (1 i) ((1 ldu) (1 *)) u-%offset%)
            negone)
    (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
                  ((> j k) nil)
      (tagbody
        (setf (f2cl-lib:fref vt-%data%
                             (j i)
                             ((1 ldvt) (1 *))
                             vt-%offset%)
```

```
                    (/
                     (/ (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
                        (f2cl-lib:fref u-%data%
                                       (j i)
                                       ((1 ldu) (1 *))
                                       u-%offset%))
                     (f2cl-lib:fref vt-%data%
                                    (j i)
                                    ((1 ldvt) (1 *))
                                    vt-%offset%)))
              (setf (f2cl-lib:fref u-%data% (j i) ((1 ldu) (1 *)) u-%offset%)
                    (*
                     (f2cl-lib:fref dsigma-%data%
                                    (j)
                                    ((1 *))
                                    dsigma-%offset%)
                     (f2cl-lib:fref vt-%data%
                                    (j i)
                                    ((1 ldvt) (1 *))
                                    vt-%offset%)))))
          (setf temp
                (dnrm2 k
                 (f2cl-lib:array-slice u
                                       double-float
                                       (1 i)
                                       ((1 ldu) (1 *)))
                 1))
          (setf (f2cl-lib:fref q-%data% (1 i) ((1 ldq) (1 *)) q-%offset%)
                (/
                 (f2cl-lib:fref u-%data% (1 i) ((1 ldu) (1 *)) u-%offset%)
                 temp))
          (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
                        ((> j k) nil)
            (tagbody
              (setf jc (f2cl-lib:fref idxc-%data% (j) ((1 *)) idxc-%offset%))
              (setf (f2cl-lib:fref q-%data% (j i) ((1 ldq) (1 *)) q-%offset%)
                    (/
                     (f2cl-lib:fref u-%data%
                                    (jc i)
                                    ((1 ldu) (1 *))
                                    u-%offset%)
                     temp))))))
      (cond
        ((= k 2)
         (dgemm "N" "N" n k k one u2 ldu2 q ldq zero u ldu)
         (go label100)))
      (cond
        ((> (f2cl-lib:fref ctot (1) ((1 *))) 0)
         (dgemm "N" "N" nl k
          (f2cl-lib:fref ctot-%data% (1) ((1 *)) ctot-%offset%) one
```

```
     (f2cl-lib:array-slice u2 double-float (1 2) ((1 ldu2) (1 *))) ldu2
     (f2cl-lib:array-slice q double-float (2 1) ((1 ldq) (1 *))) ldq
     zero (f2cl-lib:array-slice u double-float (1 1) ((1 ldu) (1 *)))
     ldu)
    (cond
      ((> (f2cl-lib:fref ctot (3) ((1 *))) 0)
       (setf ktemp
             (f2cl-lib:int-add 2
                               (f2cl-lib:fref ctot-%data%
                                              (1)
                                              ((1 *))
                                              ctot-%offset%)
                               (f2cl-lib:fref ctot-%data%
                                              (2)
                                              ((1 *))
                                              ctot-%offset%)))
       (dgemm "N" "N" nl k
        (f2cl-lib:fref ctot-%data% (3) ((1 *)) ctot-%offset%) one
        (f2cl-lib:array-slice u2
                              double-float
                              (1 ktemp)
                              ((1 ldu2) (1 *)))
        ldu2
        (f2cl-lib:array-slice q double-float (ktemp 1) ((1 ldq) (1 *)))
        ldq one
        (f2cl-lib:array-slice u double-float (1 1) ((1 ldu) (1 *)))
        ldu))))
   ((> (f2cl-lib:fref ctot (3) ((1 *))) 0)
    (setf ktemp
          (f2cl-lib:int-add 2
                            (f2cl-lib:fref ctot-%data%
                                           (1)
                                           ((1 *))
                                           ctot-%offset%)
                            (f2cl-lib:fref ctot-%data%
                                           (2)
                                           ((1 *))
                                           ctot-%offset%)))
    (dgemm "N" "N" nl k
     (f2cl-lib:fref ctot-%data% (3) ((1 *)) ctot-%offset%) one
     (f2cl-lib:array-slice u2 double-float (1 ktemp) ((1 ldu2) (1 *)))
     ldu2
     (f2cl-lib:array-slice q double-float (ktemp 1) ((1 ldq) (1 *))) ldq
     zero (f2cl-lib:array-slice u double-float (1 1) ((1 ldu) (1 *)))
     ldu))
   (t
    (dlacpy "F" nl k u2 ldu2 u ldu)))
  (dcopy k (f2cl-lib:array-slice q double-float (1 1) ((1 ldq) (1 *)))
   ldq (f2cl-lib:array-slice u double-float (nlp1 1) ((1 ldu) (1 *)))
   ldu)
```

```
        (setf ktemp
                (f2cl-lib:int-add 2
                                  (f2cl-lib:fref ctot-%data%
                                                 (1)
                                                 ((1 *))
                                                 ctot-%offset%)))
        (setf ctemp
                (f2cl-lib:int-add
                 (f2cl-lib:fref ctot-%data% (2) ((1 *)) ctot-%offset%)
                 (f2cl-lib:fref ctot-%data% (3) ((1 *)) ctot-%offset%)))
        (dgemm "N" "N" nr k ctemp one
         (f2cl-lib:array-slice u2 double-float (nlp2 ktemp) ((1 ldu2) (1 *)))
         ldu2 (f2cl-lib:array-slice q double-float (ktemp 1) ((1 ldq) (1 *)))
         ldq zero
         (f2cl-lib:array-slice u double-float (nlp2 1) ((1 ldu) (1 *))) ldu)
label100
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i k) nil)
          (tagbody
            (setf temp
                    (dnrm2 k
                     (f2cl-lib:array-slice vt
                                           double-float
                                           (1 i)
                                           ((1 ldvt) (1 *)))
                     1))
            (setf (f2cl-lib:fref q-%data% (i 1) ((1 ldq) (1 *)) q-%offset%)
                    (/
                     (f2cl-lib:fref vt-%data%
                                    (1 i)
                                    ((1 ldvt) (1 *))
                                    vt-%offset%)
                     temp))
            (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
                          ((> j k) nil)
              (tagbody
                (setf jc (f2cl-lib:fref idxc-%data% (j) ((1 *)) idxc-%offset%))
                (setf (f2cl-lib:fref q-%data% (i j) ((1 ldq) (1 *)) q-%offset%)
                        (/
                         (f2cl-lib:fref vt-%data%
                                        (jc i)
                                        ((1 ldvt) (1 *))
                                        vt-%offset%)
                         temp))))))
        (cond
          ((= k 2)
           (dgemm "N" "N" k m k one q ldq vt2 ldvt2 zero vt ldvt)
           (go end_label)))
        (setf ktemp
                (f2cl-lib:int-add 1
```

```
                          (f2cl-lib:fref ctot-%data%
                                         (1)
                                         ((1 *))
                                         ctot-%offset%)))
(dgemm "N" "N" k nlp1 ktemp one
 (f2cl-lib:array-slice q double-float (1 1) ((1 ldq) (1 *))) ldq
 (f2cl-lib:array-slice vt2 double-float (1 1) ((1 ldvt2) (1 *))) ldvt2
 zero (f2cl-lib:array-slice vt double-float (1 1) ((1 ldvt) (1 *)))
 ldvt)
(setf ktemp
        (f2cl-lib:int-add 2
                          (f2cl-lib:fref ctot-%data%
                                         (1)
                                         ((1 *))
                                         ctot-%offset%)
                          (f2cl-lib:fref ctot-%data%
                                         (2)
                                         ((1 *))
                                         ctot-%offset%)))
(if (<= ktemp ldvt2)
    (dgemm "N" "N" k nlp1
     (f2cl-lib:fref ctot-%data% (3) ((1 *)) ctot-%offset%) one
     (f2cl-lib:array-slice q double-float (1 ktemp) ((1 ldq) (1 *)))
     ldq
     (f2cl-lib:array-slice vt2
                           double-float
                           (ktemp 1)
                           ((1 ldvt2) (1 *)))
     ldvt2 one
     (f2cl-lib:array-slice vt double-float (1 1) ((1 ldvt) (1 *)))
     ldvt))
(setf ktemp
        (f2cl-lib:int-add
         (f2cl-lib:fref ctot-%data% (1) ((1 *)) ctot-%offset%)
         1))
(setf nrp1 (f2cl-lib:int-add nr sqre))
(cond
  ((> ktemp 1)
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i k) nil)
     (tagbody
       (setf (f2cl-lib:fref q-%data%
                            (i ktemp)
                            ((1 ldq) (1 *))
                            q-%offset%)
             (f2cl-lib:fref q-%data%
                            (i 1)
                            ((1 ldq) (1 *))
                            q-%offset%))))
   (f2cl-lib:fdo (i nlp2 (f2cl-lib:int-add i 1))
```

```
                        ((> i m) nil)
             (tagbody
               (setf (f2cl-lib:fref vt2-%data%
                                    (ktemp i)
                                    ((1 ldvt2) (1 *))
                                    vt2-%offset%)
                     (f2cl-lib:fref vt2-%data%
                                    (1 i)
                                    ((1 ldvt2) (1 *))
                                    vt2-%offset%))))))
       (setf ctemp
             (f2cl-lib:int-add 1
                               (f2cl-lib:fref ctot-%data%
                                              (2)
                                              ((1 *))
                                              ctot-%offset%)
                               (f2cl-lib:fref ctot-%data%
                                              (3)
                                              ((1 *))
                                              ctot-%offset%)))
       (dgemm "N" "N" k nrp1 ctemp one
        (f2cl-lib:array-slice q double-float (1 ktemp) ((1 ldq) (1 *))) ldq
        (f2cl-lib:array-slice vt2 double-float (ktemp nlp2) ((1 ldvt2) (1 *)))
        ldvt2 zero
        (f2cl-lib:array-slice vt double-float (1 nlp2) ((1 ldvt) (1 *))) ldvt)
 end_label
       (return
        (values nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                info))))))
```

———-

6.61 dlasd4 LAPACK

— dlasd4.input —

```
)set break resume
)sys rm -f dlasd4.output
)spool dlasd4.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dlasd4.help —

```
==========================================================================
dlasd4 examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

NAME
       DLASD4  -  compute  the square root of the I-th updated eigenvalue of a
       positive symmetric rank-one modification to a positive diagonal  matrix
       whose  entries are given as the squares of the corresponding entries in
       the array d, and that   0 <= D(i) < D(j) for i < j  and that RHO > 0

SYNOPSIS
       SUBROUTINE DLASD4( N, I, D, Z, DELTA, RHO, SIGMA, WORK, INFO )

           INTEGER        I, INFO, N

           DOUBLE         PRECISION RHO, SIGMA

           DOUBLE         PRECISION D( * ), DELTA( * ), WORK( * ), Z( * )

  Purpose
  =======

  This subroutine computes the square root of the I-th updated
  eigenvalue of a positive symmetric rank-one modification to
  a positive diagonal matrix whose entries are given as the squares
  of the corresponding entries in the array d, and that
```

```
       0 <= D(i) < D(j)  for  i < j

and that RHO > 0. This is arranged by the calling routine, and is
no loss in generality.  The rank-one modified system is thus

       diag( D ) * diag( D ) +  RHO *  Z * Z_transpose.

where we assume the Euclidean norm of Z is 1.

The method consists of approximating the rational functions in the
secular equation by simpler interpolating rational functions.

Arguments
=========

N      (input) INTEGER
       The length of all arrays.

I      (input) INTEGER
       The index of the eigenvalue to be computed.  1 <= I <= N.

D      (input) DOUBLE PRECISION array, dimension ( N )
       The original eigenvalues.  It is assumed that they are in
       order, 0 <= D(I) < D(J)  for I < J.

Z      (input) DOUBLE PRECISION array, dimension ( N )
       The components of the updating vector.

DELTA  (output) DOUBLE PRECISION array, dimension ( N )
       If N .ne. 1, DELTA contains (D(j) - sigma_I) in its  j-th
       component.  If N = 1, then DELTA(1) = 1.  The vector DELTA
       contains the information necessary to construct the
       (singular) eigenvectors.

RHO    (input) DOUBLE PRECISION
       The scalar in the symmetric updating formula.

SIGMA  (output) DOUBLE PRECISION
       The computed lambda_I, the I-th updated eigenvalue.

WORK   (workspace) DOUBLE PRECISION array, dimension ( N )
       If N .ne. 1, WORK contains (D(j) + sigma_I) in its  j-th
       component.  If N = 1, then WORK( 1 ) = 1.

INFO   (output) INTEGER
       = 0:  successful exit
       > 0:  if INFO = 1, the updating process failed.

Internal Parameters
```

```
  ==================

  Logical variable ORGATI (origin-at-i?) is used for distinguishing
  whether D(i) or D(i+1) is treated as the origin.

            ORGATI = .true.    origin at i
            ORGATI = .false.   origin at i+1

  Logical variable SWTCH3 (switch-for-3-poles?) is for noting
  if we are working with THREE poles!

  MAXIT is the maximum number of iterations allowed for each
  eigenvalue.

  Further Details
  ===============

  Based on contributions by
     Ren-Cang Li, Computer Science Division, University of California
     at Berkeley, USA
```

———-

— dlasd4.f —

```
      SUBROUTINE DLASD4( N, I, D, Z, DELTA, RHO, SIGMA, WORK, INFO )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Oak Ridge National Lab, Argonne National Lab,
*     Courant Institute, NAG Ltd., and Rice University
*     October 31, 1999
*
*     .. Scalar Arguments ..
      INTEGER            I, INFO, N
      DOUBLE PRECISION   RHO, SIGMA
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   D( * ), DELTA( * ), WORK( * ), Z( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      INTEGER            MAXIT
      PARAMETER          ( MAXIT = 20 )
      DOUBLE PRECISION   ZERO, ONE, TWO, THREE, FOUR, EIGHT, TEN
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0, TWO = 2.0D+0,
     $                   THREE = 3.0D+0, FOUR = 4.0D+0, EIGHT = 8.0D+0,
```

```
     $                   TEN = 10.0D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL             ORGATI, SWTCH, SWTCH3
      INTEGER             II, IIM1, IIP1, IP1, ITER, J, NITER
      DOUBLE PRECISION    A, B, C, DELSQ, DELSQ2, DPHI, DPSI, DTIIM,
     $                    DTIIP, DTIPSQ, DTISQ, DTNSQ, DTNSQ1, DW, EPS,
     $                    ERRETM, ETA, PHI, PREW, PSI, RHOINV, SG2LB,
     $                    SG2UB, TAU, TEMP, TEMP1, TEMP2, W
*     ..
*     .. Local Arrays ..
      DOUBLE PRECISION    DD( 3 ), ZZ( 3 )
*     ..
*     .. External Subroutines ..
      EXTERNAL            DLAED6, DLASD5
*     ..
*     .. External Functions ..
      DOUBLE PRECISION    DLAMCH
      EXTERNAL            DLAMCH
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC           ABS, MAX, MIN, SQRT
*     ..
*     .. Executable Statements ..
*
*     Since this routine is called in an inner loop, we do no argument
*     checking.
*
*     Quick return for N=1 and 2.
*
      INFO = 0
      IF( N.EQ.1 ) THEN
*
*        Presumably, I=1 upon entry
*
         SIGMA = SQRT( D( 1 )*D( 1 )+RHO*Z( 1 )*Z( 1 ) )
         DELTA( 1 ) = ONE
         WORK( 1 ) = ONE
         RETURN
      END IF
      IF( N.EQ.2 ) THEN
         CALL DLASD5( I, D, Z, DELTA, RHO, SIGMA, WORK )
         RETURN
      END IF
*
*     Compute machine epsilon
*
      EPS = DLAMCH( 'Epsilon' )
      RHOINV = ONE / RHO
*
```

```
*     The case I = N
*
      IF( I.EQ.N ) THEN
*
*        Initialize some basic variables
*
         II = N - 1
         NITER = 1
*
*        Calculate initial guess
*
         TEMP = RHO / TWO
*
*        If ||Z||_2 is not one, then TEMP should be set to
*        RHO * ||Z||_2^2 / TWO
*
         TEMP1 = TEMP / ( D( N )+SQRT( D( N )*D( N )+TEMP ) )
         DO 10 J = 1, N
            WORK( J ) = D( J ) + D( N ) + TEMP1
            DELTA( J ) = ( D( J )-D( N ) ) - TEMP1
   10    CONTINUE
*
         PSI = ZERO
         DO 20 J = 1, N - 2
            PSI = PSI + Z( J )*Z( J ) / ( DELTA( J )*WORK( J ) )
   20    CONTINUE
*
         C = RHOINV + PSI
         W = C + Z( II )*Z( II ) / ( DELTA( II )*WORK( II ) ) +
     $       Z( N )*Z( N ) / ( DELTA( N )*WORK( N ) )
*
         IF( W.LE.ZERO ) THEN
            TEMP1 = SQRT( D( N )*D( N )+RHO )
            TEMP = Z( N-1 )*Z( N-1 ) / ( ( D( N-1 )+TEMP1 )*
     $              ( D( N )-D( N-1 )+RHO / ( D( N )+TEMP1 ) ) ) +
     $              Z( N )*Z( N ) / RHO
*
*           The following TAU is to approximate
*           SIGMA_n^2 - D( N )*D( N )
*
            IF( C.LE.TEMP ) THEN
               TAU = RHO
            ELSE
               DELSQ = ( D( N )-D( N-1 ) )*( D( N )+D( N-1 ) )
               A = -C*DELSQ + Z( N-1 )*Z( N-1 ) + Z( N )*Z( N )
               B = Z( N )*Z( N )*DELSQ
               IF( A.LT.ZERO ) THEN
                  TAU = TWO*B / ( SQRT( A*A+FOUR*B*C )-A )
               ELSE
                  TAU = ( A+SQRT( A*A+FOUR*B*C ) ) / ( TWO*C )
```

```
               END IF
            END IF
*
*           It can be proved that
*               D(N)^2+RHO/2 <= SIGMA_n^2 < D(N)^2+TAU <= D(N)^2+RHO
*
         ELSE
            DELSQ = ( D( N )-D( N-1 ) )*( D( N )+D( N-1 ) )
            A = -C*DELSQ + Z( N-1 )*Z( N-1 ) + Z( N )*Z( N )
            B = Z( N )*Z( N )*DELSQ
*
*           The following TAU is to approximate
*           SIGMA_n^2 - D( N )*D( N )
*
            IF( A.LT.ZERO ) THEN
               TAU = TWO*B / ( SQRT( A*A+FOUR*B*C )-A )
            ELSE
               TAU = ( A+SQRT( A*A+FOUR*B*C ) ) / ( TWO*C )
            END IF
*
*           It can be proved that
*           D(N)^2 < D(N)^2+TAU < SIGMA(N)^2 < D(N)^2+RHO/2
*
         END IF
*
*        The following ETA is to approximate SIGMA_n - D( N )
*
         ETA = TAU / ( D( N )+SQRT( D( N )*D( N )+TAU ) )
*
         SIGMA = D( N ) + ETA
         DO 30 J = 1, N
            DELTA( J ) = ( D( J )-D( I ) ) - ETA
            WORK( J ) = D( J ) + D( I ) + ETA
   30    CONTINUE
*
*        Evaluate PSI and the derivative DPSI
*
         DPSI = ZERO
         PSI = ZERO
         ERRETM = ZERO
         DO 40 J = 1, II
            TEMP = Z( J ) / ( DELTA( J )*WORK( J ) )
            PSI = PSI + Z( J )*TEMP
            DPSI = DPSI + TEMP*TEMP
            ERRETM = ERRETM + PSI
   40    CONTINUE
         ERRETM = ABS( ERRETM )
*
*        Evaluate PHI and the derivative DPHI
*
```

```
         TEMP = Z( N ) / ( DELTA( N )*WORK( N ) )
         PHI = Z( N )*TEMP
         DPHI = TEMP*TEMP
         ERRETM = EIGHT*( -PHI-PSI ) + ERRETM - PHI + RHOINV +
     $            ABS( TAU )*( DPSI+DPHI )
*
         W = RHOINV + PHI + PSI
*
*        Test for convergence
*
         IF( ABS( W ).LE.EPS*ERRETM ) THEN
            GO TO 240
         END IF
*
*        Calculate the new step
*
         NITER = NITER + 1
         DTNSQ1 = WORK( N-1 )*DELTA( N-1 )
         DTNSQ = WORK( N )*DELTA( N )
         C = W - DTNSQ1*DPSI - DTNSQ*DPHI
         A = ( DTNSQ+DTNSQ1 )*W - DTNSQ*DTNSQ1*( DPSI+DPHI )
         B = DTNSQ*DTNSQ1*W
         IF( C.LT.ZERO )
     $      C = ABS( C )
         IF( C.EQ.ZERO ) THEN
            ETA = RHO - SIGMA*SIGMA
         ELSE IF( A.GE.ZERO ) THEN
            ETA = ( A+SQRT( ABS( A*A-FOUR*B*C ) ) ) / ( TWO*C )
         ELSE
            ETA = TWO*B / ( A-SQRT( ABS( A*A-FOUR*B*C ) ) )
         END IF
*
*        Note, eta should be positive if w is negative, and
*        eta should be negative otherwise. However,
*        if for some reason caused by roundoff, eta*w > 0,
*        we simply use one Newton step instead. This way
*        will guarantee eta*w < 0.
*
         IF( W*ETA.GT.ZERO )
     $      ETA = -W / ( DPSI+DPHI )
         TEMP = ETA - DTNSQ
         IF( TEMP.GT.RHO )
     $      ETA = RHO + DTNSQ
*
         TAU = TAU + ETA
         ETA = ETA / ( SIGMA+SQRT( ETA+SIGMA*SIGMA ) )
         DO 50 J = 1, N
            DELTA( J ) = DELTA( J ) - ETA
            WORK( J ) = WORK( J ) + ETA
   50    CONTINUE
```

```
*
         SIGMA = SIGMA + ETA
*
*        Evaluate PSI and the derivative DPSI
*
         DPSI = ZERO
         PSI = ZERO
         ERRETM = ZERO
         DO 60 J = 1, II
            TEMP = Z( J ) / ( WORK( J )*DELTA( J ) )
            PSI = PSI + Z( J )*TEMP
            DPSI = DPSI + TEMP*TEMP
            ERRETM = ERRETM + PSI
   60    CONTINUE
         ERRETM = ABS( ERRETM )
*
*        Evaluate PHI and the derivative DPHI
*
         TEMP = Z( N ) / ( WORK( N )*DELTA( N ) )
         PHI = Z( N )*TEMP
         DPHI = TEMP*TEMP
         ERRETM = EIGHT*( -PHI-PSI ) + ERRETM - PHI + RHOINV +
     $            ABS( TAU )*( DPSI+DPHI )
*
         W = RHOINV + PHI + PSI
*
*        Main loop to update the values of the array   DELTA
*
         ITER = NITER + 1
*
         DO 90 NITER = ITER, MAXIT
*
*           Test for convergence
*
            IF( ABS( W ).LE.EPS*ERRETM ) THEN
               GO TO 240
            END IF
*
*           Calculate the new step
*
            DTNSQ1 = WORK( N-1 )*DELTA( N-1 )
            DTNSQ = WORK( N )*DELTA( N )
            C = W - DTNSQ1*DPSI - DTNSQ*DPHI
            A = ( DTNSQ+DTNSQ1 )*W - DTNSQ1*DTNSQ*( DPSI+DPHI )
            B = DTNSQ1*DTNSQ*W
            IF( A.GE.ZERO ) THEN
               ETA = ( A+SQRT( ABS( A*A-FOUR*B*C ) ) ) / ( TWO*C )
            ELSE
               ETA = TWO*B / ( A-SQRT( ABS( A*A-FOUR*B*C ) ) )
            END IF
```

```
*
*           Note, eta should be positive if w is negative, and
*           eta should be negative otherwise. However,
*           if for some reason caused by roundoff, eta*w > 0,
*           we simply use one Newton step instead. This way
*           will guarantee eta*w < 0.
*
            IF( W*ETA.GT.ZERO )
     $         ETA = -W / ( DPSI+DPHI )
            TEMP = ETA - DTNSQ
            IF( TEMP.LE.ZERO )
     $         ETA = ETA / TWO
*
            TAU = TAU + ETA
            ETA = ETA / ( SIGMA+SQRT( ETA+SIGMA*SIGMA ) )
            DO 70 J = 1, N
               DELTA( J ) = DELTA( J ) - ETA
               WORK( J ) = WORK( J ) + ETA
   70       CONTINUE
*
            SIGMA = SIGMA + ETA
*
*           Evaluate PSI and the derivative DPSI
*
            DPSI = ZERO
            PSI = ZERO
            ERRETM = ZERO
            DO 80 J = 1, II
               TEMP = Z( J ) / ( WORK( J )*DELTA( J ) )
               PSI = PSI + Z( J )*TEMP
               DPSI = DPSI + TEMP*TEMP
               ERRETM = ERRETM + PSI
   80       CONTINUE
            ERRETM = ABS( ERRETM )
*
*           Evaluate PHI and the derivative DPHI
*
            TEMP = Z( N ) / ( WORK( N )*DELTA( N ) )
            PHI = Z( N )*TEMP
            DPHI = TEMP*TEMP
            ERRETM = EIGHT*( -PHI-PSI ) + ERRETM - PHI + RHOINV +
     $               ABS( TAU )*( DPSI+DPHI )
*
            W = RHOINV + PHI + PSI
   90    CONTINUE
*
*        Return with INFO = 1, NITER = MAXIT and not converged
*
         INFO = 1
         GO TO 240
```

```
*
*        End for the case I = N
*
      ELSE
*
*        The case for I < N
*
         NITER = 1
         IP1 = I + 1
*
*        Calculate initial guess
*
         DELSQ = ( D( IP1 )-D( I ) )*( D( IP1 )+D( I ) )
         DELSQ2 = DELSQ / TWO
         TEMP = DELSQ2 / ( D( I )+SQRT( D( I )*D( I )+DELSQ2 ) )
         DO 100 J = 1, N
            WORK( J ) = D( J ) + D( I ) + TEMP
            DELTA( J ) = ( D( J )-D( I ) ) - TEMP
  100    CONTINUE
*
         PSI = ZERO
         DO 110 J = 1, I - 1
            PSI = PSI + Z( J )*Z( J ) / ( WORK( J )*DELTA( J ) )
  110    CONTINUE
*
         PHI = ZERO
         DO 120 J = N, I + 2, -1
            PHI = PHI + Z( J )*Z( J ) / ( WORK( J )*DELTA( J ) )
  120    CONTINUE
         C = RHOINV + PSI + PHI
         W = C + Z( I )*Z( I ) / ( WORK( I )*DELTA( I ) ) +
     $       Z( IP1 )*Z( IP1 ) / ( WORK( IP1 )*DELTA( IP1 ) )
*
         IF( W.GT.ZERO ) THEN
*
*           d(i)^2 < the ith sigma^2 < (d(i)^2+d(i+1)^2)/2
*
*           We choose d(i) as origin.
*
            ORGATI = .TRUE.
            SG2LB = ZERO
            SG2UB = DELSQ2
            A = C*DELSQ + Z( I )*Z( I ) + Z( IP1 )*Z( IP1 )
            B = Z( I )*Z( I )*DELSQ
            IF( A.GT.ZERO ) THEN
               TAU = TWO*B / ( A+SQRT( ABS( A*A-FOUR*B*C ) ) )
            ELSE
               TAU = ( A-SQRT( ABS( A*A-FOUR*B*C ) ) ) / ( TWO*C )
            END IF
*
```

```
*           TAU now is an estimation of SIGMA^2 - D( I )^2. The
*           following, however, is the corresponding estimation of
*           SIGMA - D( I ).
*
            ETA = TAU / ( D( I )+SQRT( D( I )*D( I )+TAU ) )
         ELSE
*
*           (d(i)^2+d(i+1)^2)/2 <= the ith sigma^2 < d(i+1)^2/2
*
*           We choose d(i+1) as origin.
*
            ORGATI = .FALSE.
            SG2LB = -DELSQ2
            SG2UB = ZERO
            A = C*DELSQ - Z( I )*Z( I ) - Z( IP1 )*Z( IP1 )
            B = Z( IP1 )*Z( IP1 )*DELSQ
            IF( A.LT.ZERO ) THEN
               TAU = TWO*B / ( A-SQRT( ABS( A*A+FOUR*B*C ) ) )
            ELSE
               TAU = -( A+SQRT( ABS( A*A+FOUR*B*C ) ) ) / ( TWO*C )
            END IF
*
*           TAU now is an estimation of SIGMA^2 - D( IP1 )^2. The
*           following, however, is the corresponding estimation of
*           SIGMA - D( IP1 ).
*
            ETA = TAU / ( D( IP1 )+SQRT( ABS( D( IP1 )*D( IP1 )+
     $            TAU ) ) )
         END IF
*
         IF( ORGATI ) THEN
            II = I
            SIGMA = D( I ) + ETA
            DO 130 J = 1, N
               WORK( J ) = D( J ) + D( I ) + ETA
               DELTA( J ) = ( D( J )-D( I ) ) - ETA
  130       CONTINUE
         ELSE
            II = I + 1
            SIGMA = D( IP1 ) + ETA
            DO 140 J = 1, N
               WORK( J ) = D( J ) + D( IP1 ) + ETA
               DELTA( J ) = ( D( J )-D( IP1 ) ) - ETA
  140       CONTINUE
         END IF
         IIM1 = II - 1
         IIP1 = II + 1
*
*        Evaluate PSI and the derivative DPSI
*
```

```
         DPSI = ZERO
         PSI = ZERO
         ERRETM = ZERO
         DO 150 J = 1, IIM1
            TEMP = Z( J ) / ( WORK( J )*DELTA( J ) )
            PSI = PSI + Z( J )*TEMP
            DPSI = DPSI + TEMP*TEMP
            ERRETM = ERRETM + PSI
  150    CONTINUE
         ERRETM = ABS( ERRETM )
*
*        Evaluate PHI and the derivative DPHI
*
         DPHI = ZERO
         PHI = ZERO
         DO 160 J = N, IIP1, -1
            TEMP = Z( J ) / ( WORK( J )*DELTA( J ) )
            PHI = PHI + Z( J )*TEMP
            DPHI = DPHI + TEMP*TEMP
            ERRETM = ERRETM + PHI
  160    CONTINUE
*
         W = RHOINV + PHI + PSI
*
*        W is the value of the secular function with
*        its ii-th element removed.
*
         SWTCH3 = .FALSE.
         IF( ORGATI ) THEN
            IF( W.LT.ZERO )
     $         SWTCH3 = .TRUE.
         ELSE
            IF( W.GT.ZERO )
     $         SWTCH3 = .TRUE.
         END IF
         IF( II.EQ.1 .OR. II.EQ.N )
     $      SWTCH3 = .FALSE.
*
         TEMP = Z( II ) / ( WORK( II )*DELTA( II ) )
         DW = DPSI + DPHI + TEMP*TEMP
         TEMP = Z( II )*TEMP
         W = W + TEMP
         ERRETM = EIGHT*( PHI-PSI ) + ERRETM + TWO*RHOINV +
     $            THREE*ABS( TEMP ) + ABS( TAU )*DW
*
*        Test for convergence
*
         IF( ABS( W ).LE.EPS*ERRETM ) THEN
            GO TO 240
         END IF
```

```
*
        IF( W.LE.ZERO ) THEN
           SG2LB = MAX( SG2LB, TAU )
        ELSE
           SG2UB = MIN( SG2UB, TAU )
        END IF
*
*       Calculate the new step
*
        NITER = NITER + 1
        IF( .NOT.SWTCH3 ) THEN
           DTIPSQ = WORK( IP1 )*DELTA( IP1 )
           DTISQ = WORK( I )*DELTA( I )
           IF( ORGATI ) THEN
              C = W - DTIPSQ*DW + DELSQ*( Z( I ) / DTISQ )**2
           ELSE
              C = W - DTISQ*DW - DELSQ*( Z( IP1 ) / DTIPSQ )**2
           END IF
           A = ( DTIPSQ+DTISQ )*W - DTIPSQ*DTISQ*DW
           B = DTIPSQ*DTISQ*W
           IF( C.EQ.ZERO ) THEN
              IF( A.EQ.ZERO ) THEN
                 IF( ORGATI ) THEN
                    A = Z( I )*Z( I ) + DTIPSQ*DTIPSQ*( DPSI+DPHI )
                 ELSE
                    A = Z( IP1 )*Z( IP1 ) + DTISQ*DTISQ*( DPSI+DPHI )
                 END IF
              END IF
              ETA = B / A
           ELSE IF( A.LE.ZERO ) THEN
              ETA = ( A-SQRT( ABS( A*A-FOUR*B*C ) ) ) / ( TWO*C )
           ELSE
              ETA = TWO*B / ( A+SQRT( ABS( A*A-FOUR*B*C ) ) )
           END IF
        ELSE
*
*          Interpolation using THREE most relevant poles
*
           DTIIM = WORK( IIM1 )*DELTA( IIM1 )
           DTIIP = WORK( IIP1 )*DELTA( IIP1 )
           TEMP = RHOINV + PSI + PHI
           IF( ORGATI ) THEN
              TEMP1 = Z( IIM1 ) / DTIIM
              TEMP1 = TEMP1*TEMP1
              C = ( TEMP - DTIIP*( DPSI+DPHI ) ) -
     $            ( D( IIM1 )-D( IIP1 ) )*( D( IIM1 )+D( IIP1 ) )*TEMP1
              ZZ( 1 ) = Z( IIM1 )*Z( IIM1 )
              IF( DPSI.LT.TEMP1 ) THEN
                 ZZ( 3 ) = DTIIP*DTIIP*DPHI
              ELSE
```

```
                  ZZ( 3 ) = DTIIP*DTIIP*( ( DPSI-TEMP1 )+DPHI )
               END IF
            ELSE
               TEMP1 = Z( IIP1 ) / DTIIP
               TEMP1 = TEMP1*TEMP1
               C = ( TEMP - DTIIM*( DPSI+DPHI ) ) -
     $             ( D( IIP1 )-D( IIM1 ) )*( D( IIM1 )+D( IIP1 ) )*TEMP1
               IF( DPHI.LT.TEMP1 ) THEN
                  ZZ( 1 ) = DTIIM*DTIIM*DPSI
               ELSE
                  ZZ( 1 ) = DTIIM*DTIIM*( DPSI+( DPHI-TEMP1 ) )
               END IF
               ZZ( 3 ) = Z( IIP1 )*Z( IIP1 )
            END IF
            ZZ( 2 ) = Z( II )*Z( II )
            DD( 1 ) = DTIIM
            DD( 2 ) = DELTA( II )*WORK( II )
            DD( 3 ) = DTIIP
            CALL DLAED6( NITER, ORGATI, C, DD, ZZ, W, ETA, INFO )
            IF( INFO.NE.0 )
     $         GO TO 240
         END IF
*
*        Note, eta should be positive if w is negative, and
*        eta should be negative otherwise. However,
*        if for some reason caused by roundoff, eta*w > 0,
*        we simply use one Newton step instead. This way
*        will guarantee eta*w < 0.
*
         IF( W*ETA.GE.ZERO )
     $      ETA = -W / DW
         IF( ORGATI ) THEN
            TEMP1 = WORK( I )*DELTA( I )
            TEMP = ETA - TEMP1
         ELSE
            TEMP1 = WORK( IP1 )*DELTA( IP1 )
            TEMP = ETA - TEMP1
         END IF
         IF( TEMP.GT.SG2UB .OR. TEMP.LT.SG2LB ) THEN
            IF( W.LT.ZERO ) THEN
               ETA = ( SG2UB-TAU ) / TWO
            ELSE
               ETA = ( SG2LB-TAU ) / TWO
            END IF
         END IF
*
         TAU = TAU + ETA
         ETA = ETA / ( SIGMA+SQRT( SIGMA*SIGMA+ETA ) )
*
         PREW = W
```

```
*
        SIGMA = SIGMA + ETA
        DO 170 J = 1, N
           WORK( J ) = WORK( J ) + ETA
           DELTA( J ) = DELTA( J ) - ETA
  170   CONTINUE
*
*       Evaluate PSI and the derivative DPSI
*
        DPSI = ZERO
        PSI = ZERO
        ERRETM = ZERO
        DO 180 J = 1, IIM1
           TEMP = Z( J ) / ( WORK( J )*DELTA( J ) )
           PSI = PSI + Z( J )*TEMP
           DPSI = DPSI + TEMP*TEMP
           ERRETM = ERRETM + PSI
  180   CONTINUE
        ERRETM = ABS( ERRETM )
*
*       Evaluate PHI and the derivative DPHI
*
        DPHI = ZERO
        PHI = ZERO
        DO 190 J = N, IIP1, -1
           TEMP = Z( J ) / ( WORK( J )*DELTA( J ) )
           PHI = PHI + Z( J )*TEMP
           DPHI = DPHI + TEMP*TEMP
           ERRETM = ERRETM + PHI
  190   CONTINUE
*
        TEMP = Z( II ) / ( WORK( II )*DELTA( II ) )
        DW = DPSI + DPHI + TEMP*TEMP
        TEMP = Z( II )*TEMP
        W = RHOINV + PHI + PSI + TEMP
        ERRETM = EIGHT*( PHI-PSI ) + ERRETM + TWO*RHOINV +
     $           THREE*ABS( TEMP ) + ABS( TAU )*DW
*
        IF( W.LE.ZERO ) THEN
           SG2LB = MAX( SG2LB, TAU )
        ELSE
           SG2UB = MIN( SG2UB, TAU )
        END IF
*
        SWTCH = .FALSE.
        IF( ORGATI ) THEN
           IF( -W.GT.ABS( PREW ) / TEN )
     $        SWTCH = .TRUE.
        ELSE
           IF( W.GT.ABS( PREW ) / TEN )
```

```
     $         SWTCH = .TRUE.
           END IF
*
*        Main loop to update the values of the array   DELTA and WORK
*
           ITER = NITER + 1
*
           DO 230 NITER = ITER, MAXIT
*
*             Test for convergence
*
              IF( ABS( W ).LE.EPS*ERRETM ) THEN
                 GO TO 240
              END IF
*
*             Calculate the new step
*
              IF( .NOT.SWTCH3 ) THEN
                 DTIPSQ = WORK( IP1 )*DELTA( IP1 )
                 DTISQ = WORK( I )*DELTA( I )
                 IF( .NOT.SWTCH ) THEN
                    IF( ORGATI ) THEN
                       C = W - DTIPSQ*DW + DELSQ*( Z( I ) / DTISQ )**2
                    ELSE
                       C = W - DTISQ*DW - DELSQ*( Z( IP1 ) / DTIPSQ )**2
                    END IF
                 ELSE
                    TEMP = Z( II ) / ( WORK( II )*DELTA( II ) )
                    IF( ORGATI ) THEN
                       DPSI = DPSI + TEMP*TEMP
                    ELSE
                       DPHI = DPHI + TEMP*TEMP
                    END IF
                    C = W - DTISQ*DPSI - DTIPSQ*DPHI
                 END IF
                 A = ( DTIPSQ+DTISQ )*W - DTIPSQ*DTISQ*DW
                 B = DTIPSQ*DTISQ*W
                 IF( C.EQ.ZERO ) THEN
                    IF( A.EQ.ZERO ) THEN
                       IF( .NOT.SWTCH ) THEN
                          IF( ORGATI ) THEN
                             A = Z( I )*Z( I ) + DTIPSQ*DTIPSQ*
     $                            ( DPSI+DPHI )
                          ELSE
                             A = Z( IP1 )*Z( IP1 ) +
     $                            DTISQ*DTISQ*( DPSI+DPHI )
                          END IF
                       ELSE
                          A = DTISQ*DTISQ*DPSI + DTIPSQ*DTIPSQ*DPHI
                       END IF
```

```
               END IF
               ETA = B / A
            ELSE IF( A.LE.ZERO ) THEN
               ETA = ( A-SQRT( ABS( A*A-FOUR*B*C ) ) ) / ( TWO*C )
            ELSE
               ETA = TWO*B / ( A+SQRT( ABS( A*A-FOUR*B*C ) ) )
            END IF
         ELSE
*
*           Interpolation using THREE most relevant poles
*
            DTIIM = WORK( IIM1 )*DELTA( IIM1 )
            DTIIP = WORK( IIP1 )*DELTA( IIP1 )
            TEMP = RHOINV + PSI + PHI
            IF( SWTCH ) THEN
               C = TEMP - DTIIM*DPSI - DTIIP*DPHI
               ZZ( 1 ) = DTIIM*DTIIM*DPSI
               ZZ( 3 ) = DTIIP*DTIIP*DPHI
            ELSE
               IF( ORGATI ) THEN
                  TEMP1 = Z( IIM1 ) / DTIIM
                  TEMP1 = TEMP1*TEMP1
                  TEMP2 = ( D( IIM1 )-D( IIP1 ) )*
     $                    ( D( IIM1 )+D( IIP1 ) )*TEMP1
                  C = TEMP - DTIIP*( DPSI+DPHI ) - TEMP2
                  ZZ( 1 ) = Z( IIM1 )*Z( IIM1 )
                  IF( DPSI.LT.TEMP1 ) THEN
                     ZZ( 3 ) = DTIIP*DTIIP*DPHI
                  ELSE
                     ZZ( 3 ) = DTIIP*DTIIP*( ( DPSI-TEMP1 )+DPHI )
                  END IF
               ELSE
                  TEMP1 = Z( IIP1 ) / DTIIP
                  TEMP1 = TEMP1*TEMP1
                  TEMP2 = ( D( IIP1 )-D( IIM1 ) )*
     $                    ( D( IIM1 )+D( IIP1 ) )*TEMP1
                  C = TEMP - DTIIM*( DPSI+DPHI ) - TEMP2
                  IF( DPHI.LT.TEMP1 ) THEN
                     ZZ( 1 ) = DTIIM*DTIIM*DPSI
                  ELSE
                     ZZ( 1 ) = DTIIM*DTIIM*( DPSI+( DPHI-TEMP1 ) )
                  END IF
                  ZZ( 3 ) = Z( IIP1 )*Z( IIP1 )
               END IF
            END IF
            DD( 1 ) = DTIIM
            DD( 2 ) = DELTA( II )*WORK( II )
            DD( 3 ) = DTIIP
            CALL DLAED6( NITER, ORGATI, C, DD, ZZ, W, ETA, INFO )
            IF( INFO.NE.0 )
```

```
     $            GO TO 240
               END IF
*
*              Note, eta should be positive if w is negative, and
*              eta should be negative otherwise. However,
*              if for some reason caused by roundoff, eta*w > 0,
*              we simply use one Newton step instead. This way
*              will guarantee eta*w < 0.
*
               IF( W*ETA.GE.ZERO )
     $            ETA = -W / DW
               IF( ORGATI ) THEN
                  TEMP1 = WORK( I )*DELTA( I )
                  TEMP = ETA - TEMP1
               ELSE
                  TEMP1 = WORK( IP1 )*DELTA( IP1 )
                  TEMP = ETA - TEMP1
               END IF
               IF( TEMP.GT.SG2UB .OR. TEMP.LT.SG2LB ) THEN
                  IF( W.LT.ZERO ) THEN
                     ETA = ( SG2UB-TAU ) / TWO
                  ELSE
                     ETA = ( SG2LB-TAU ) / TWO
                  END IF
               END IF
*
               TAU = TAU + ETA
               ETA = ETA / ( SIGMA+SQRT( SIGMA*SIGMA+ETA ) )
*
               SIGMA = SIGMA + ETA
               DO 200 J = 1, N
                  WORK( J ) = WORK( J ) + ETA
                  DELTA( J ) = DELTA( J ) - ETA
  200          CONTINUE
*
               PREW = W
*
*              Evaluate PSI and the derivative DPSI
*
               DPSI = ZERO
               PSI = ZERO
               ERRETM = ZERO
               DO 210 J = 1, IIM1
                  TEMP = Z( J ) / ( WORK( J )*DELTA( J ) )
                  PSI = PSI + Z( J )*TEMP
                  DPSI = DPSI + TEMP*TEMP
                  ERRETM = ERRETM + PSI
  210          CONTINUE
               ERRETM = ABS( ERRETM )
*
```

```
*           Evaluate PHI and the derivative DPHI
*
            DPHI = ZERO
            PHI = ZERO
            DO 220 J = N, IIP1, -1
               TEMP = Z( J ) / ( WORK( J )*DELTA( J ) )
               PHI = PHI + Z( J )*TEMP
               DPHI = DPHI + TEMP*TEMP
               ERRETM = ERRETM + PHI
  220       CONTINUE
*
            TEMP = Z( II ) / ( WORK( II )*DELTA( II ) )
            DW = DPSI + DPHI + TEMP*TEMP
            TEMP = Z( II )*TEMP
            W = RHOINV + PHI + PSI + TEMP
            ERRETM = EIGHT*( PHI-PSI ) + ERRETM + TWO*RHOINV +
     $               THREE*ABS( TEMP ) + ABS( TAU )*DW
            IF( W*PREW.GT.ZERO .AND. ABS( W ).GT.ABS( PREW ) / TEN )
     $         SWTCH = .NOT.SWTCH
*
            IF( W.LE.ZERO ) THEN
               SG2LB = MAX( SG2LB, TAU )
            ELSE
               SG2UB = MIN( SG2UB, TAU )
            END IF
*
  230    CONTINUE
*
*        Return with INFO = 1, NITER = MAXIT and not converged
*
         INFO = 1
*
      END IF
*
  240 CONTINUE
      RETURN
*
*     End of DLASD4
*
      END
```

— LAPACK dlasd4 —

```
(let* ((maxit 20)
       (zero 0.0)
       (one 1.0)
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```
      (two 2.0)
      (three 3.0)
      (four 4.0)
      (eight 8.0)
      (ten 10.0))
  (declare (type (fixnum 20 20) maxit)
           (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one)
           (type (double-float 2.0 2.0) two)
           (type (double-float 3.0 3.0) three)
           (type (double-float 4.0 4.0) four)
           (type (double-float 8.0 8.0) eight)
           (type (double-float 10.0 10.0) ten))
  (defun dlasd4 (n i d z delta rho sigma work info)
    (declare (type (double-float) sigma rho)
             (type (simple-array double-float (*)) work delta z d)
             (type fixnum info i n))
    (f2cl-lib:with-multi-array-data
        ((d double-float d-%data% d-%offset%)
         (z double-float z-%data% z-%offset%)
         (delta double-float delta-%data% delta-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((dd (make-array 3 :element-type 'double-float))
             (zz (make-array 3 :element-type 'double-float)) (a 0.0) (b 0.0)
             (c 0.0) (delsq 0.0) (delsq2 0.0) (dphi 0.0) (dpsi 0.0) (dtiim 0.0)
             (dtiip 0.0) (dtipsq 0.0) (dtisq 0.0) (dtnsq 0.0) (dtnsq1 0.0)
             (dw 0.0) (eps 0.0) (erretm 0.0) (eta 0.0) (phi 0.0) (prew 0.0)
             (psi 0.0) (rhoinv 0.0) (sg2lb 0.0) (sg2ub 0.0) (tau 0.0)
             (temp 0.0) (temp1 0.0) (temp2 0.0) (w 0.0) (ii 0) (iim1 0)
             (iip1 0) (ip1 0) (iter 0) (j 0) (niter 0) (orgati nil) (swtch nil)
             (swtch3 nil))
        (declare (type (simple-array double-float (3)) dd zz)
                 (type (double-float) a b c delsq delsq2 dphi dpsi dtiim dtiip
                                      dtipsq dtisq dtnsq dtnsq1 dw eps erretm
                                      eta phi prew psi rhoinv sg2lb sg2ub tau
                                      temp temp1 temp2 w)
                 (type fixnum ii iim1 iip1 ip1 iter j niter)
                 (type (member t nil) orgati swtch swtch3))
        (setf info 0)
        (cond
          ((= n 1)
           (setf sigma
                   (f2cl-lib:fsqrt
                    (+
                     (* (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)
                        (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%))
                     (* rho
                        (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)
                        (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)))))
           (setf (f2cl-lib:fref delta-%data% (1) ((1 *)) delta-%offset%) one)
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   (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%) one)
   (go end_label)))
(cond
  ((= n 2)
   (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
       (dlasd5 i d z delta rho sigma work)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-6))
     (setf sigma var-5))
   (go end_label)))
(setf eps (dlamch "Epsilon"))
(setf rhoinv (/ one rho))
(cond
  ((= i n)
   (setf ii (f2cl-lib:int-sub n 1))
   (setf niter 1)
   (setf temp (/ rho two))
   (setf temp1
           (/ temp
              (+ (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
                 (f2cl-lib:fsqrt
                  (+
                   (* (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
                      (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%))
                   temp)))))
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
     (tagbody
       (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
               (+ (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
                  (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
                  temp1))
       (setf (f2cl-lib:fref delta-%data% (j) ((1 *)) delta-%offset%)
               (- (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
                  (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
                  temp1))))
   (setf psi zero)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j (f2cl-lib:int-add n (f2cl-lib:int-sub 2))) nil)
     (tagbody
       (setf psi
               (+ psi
                  (/
                   (* (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
                      (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%))
                   (*
                    (f2cl-lib:fref delta-%data%
                                   (j)
                                   ((1 *))
                                   delta-%offset%)
                    (f2cl-lib:fref work-%data%
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                                (j)
                                ((1 *))
                                work-%offset%)))))))
        (setf c (+ rhoinv psi))
        (setf w
              (+ c
                 (/
                  (* (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%)
                     (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%))
                  (*
                   (f2cl-lib:fref delta-%data%
                                  (ii)
                                  ((1 *))
                                  delta-%offset%)
                   (f2cl-lib:fref work-%data%
                                  (ii)
                                  ((1 *))
                                  work-%offset%)))
                 (/
                  (* (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
                     (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%))
                  (*
                   (f2cl-lib:fref delta-%data% (n) ((1 *)) delta-%offset%)
                   (f2cl-lib:fref work-%data%
                                  (n)
                                  ((1 *))
                                  work-%offset%)))))
        (cond
          ((<= w zero)
           (setf temp1
                 (f2cl-lib:fsqrt
                  (+
                   (* (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
                      (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%))
                   rho)))
           (setf temp
                 (+
                  (/
                   (*
                    (f2cl-lib:fref z-%data%
                                   ((f2cl-lib:int-sub n 1))
                                   ((1 *))
                                   z-%offset%)
                    (f2cl-lib:fref z-%data%
                                   ((f2cl-lib:int-sub n 1))
                                   ((1 *))
                                   z-%offset%))
                   (*
                    (+
                     (f2cl-lib:fref d-%data%
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                                ((f2cl-lib:int-sub n 1))
                                ((1 *))
                                d-%offset%)
                     temp1)
                    (+
                     (- (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
                        (f2cl-lib:fref d-%data%
                                       ((f2cl-lib:int-sub n 1))
                                       ((1 *))
                                       d-%offset%))
                     (/ rho
                        (+ (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
                           temp1)))))
                  (/
                   (* (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
                      (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%))
                   rho)))
            (cond
              ((<= c temp)
               (setf tau rho))
              (t
               (setf delsq
                       (*
                        (- (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
                           (f2cl-lib:fref d-%data%
                                          ((f2cl-lib:int-sub n 1))
                                          ((1 *))
                                          d-%offset%))
                        (+ (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
                           (f2cl-lib:fref d-%data%
                                          ((f2cl-lib:int-sub n 1))
                                          ((1 *))
                                          d-%offset%))))
               (setf a
                       (+ (* (- c) delsq)
                          (*
                           (f2cl-lib:fref z-%data%
                                          ((f2cl-lib:int-sub n 1))
                                          ((1 *))
                                          z-%offset%)
                           (f2cl-lib:fref z-%data%
                                          ((f2cl-lib:int-sub n 1))
                                          ((1 *))
                                          z-%offset%))
                          (* (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
                             (f2cl-lib:fref z-%data%
                                            (n)
                                            ((1 *))
                                            z-%offset%))))
               (setf b
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            (* (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
               (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
               delsq))
    (cond
      ((< a zero)
       (setf tau
               (/ (* two b)
                  (- (f2cl-lib:fsqrt (+ (* a a) (* four b c)))
                     a))))
      (t
       (setf tau
               (/ (+ a (f2cl-lib:fsqrt (+ (* a a) (* four b c))))
                  (* two c))))))))
(t
 (setf delsq
         (*
          (- (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
             (f2cl-lib:fref d-%data%
                            ((f2cl-lib:int-sub n 1))
                            ((1 *))
                            d-%offset%))
          (+ (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
             (f2cl-lib:fref d-%data%
                            ((f2cl-lib:int-sub n 1))
                            ((1 *))
                            d-%offset%))))
 (setf a
         (+ (* (- c) delsq)
            (*
             (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-sub n 1))
                            ((1 *))
                            z-%offset%)
             (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-sub n 1))
                            ((1 *))
                            z-%offset%))
            (* (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
               (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%))))
 (setf b
         (* (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
            (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
            delsq))
 (cond
   ((< a zero)
    (setf tau
            (/ (* two b)
               (- (f2cl-lib:fsqrt (+ (* a a) (* four b c))) a))))
   (t
    (setf tau
```

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              (/ (+ a (f2cl-lib:fsqrt (+ (* a a) (* four b c))))
                 (* two c)))))))
(setf eta
        (/ tau
           (+ (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
              (f2cl-lib:fsqrt
               (+
                (* (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
                   (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%))
                tau)))))
(setf sigma (+ (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%) eta))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j n) nil)
  (tagbody
    (setf (f2cl-lib:fref delta-%data% (j) ((1 *)) delta-%offset%)
            (- (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
               (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
               eta))
    (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
            (+ (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
               (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
               eta))))
(setf dpsi zero)
(setf psi zero)
(setf erretm zero)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j ii) nil)
  (tagbody
    (setf temp
            (/ (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
               (*
                (f2cl-lib:fref delta-%data%
                               (j)
                               ((1 *))
                               delta-%offset%)
                (f2cl-lib:fref work-%data%
                               (j)
                               ((1 *))
                               work-%offset%))))
    (setf psi
            (+ psi
               (* (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
                  temp)))
    (setf dpsi (+ dpsi (* temp temp)))
    (setf erretm (+ erretm psi))))
(setf erretm (abs erretm))
(setf temp
        (/ (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
           (*
            (f2cl-lib:fref delta-%data% (n) ((1 *)) delta-%offset%)
```

```
            (f2cl-lib:fref work-%data% (n) ((1 *)) work-%offset%))))
(setf phi (* (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%) temp))
(setf dphi (* temp temp))
(setf erretm
        (+ (- (+ (* eight (- (- psi) phi)) erretm) phi)
           rhoinv
           (* (abs tau) (+ dpsi dphi))))
(setf w (+ rhoinv phi psi))
(cond
  ((<= (abs w) (* eps erretm))
   (go end_label)))
(setf niter (f2cl-lib:int-add niter 1))
(setf dtnsq1
        (*
         (f2cl-lib:fref work-%data%
                        ((f2cl-lib:int-sub n 1))
                        ((1 *))
                        work-%offset%)
         (f2cl-lib:fref delta-%data%
                        ((f2cl-lib:int-sub n 1))
                        ((1 *))
                        delta-%offset%)))
(setf dtnsq
        (* (f2cl-lib:fref work-%data% (n) ((1 *)) work-%offset%)
           (f2cl-lib:fref delta-%data% (n) ((1 *)) delta-%offset%)))
(setf c (- w (* dtnsq1 dpsi) (* dtnsq dphi)))
(setf a
        (+ (* (+ dtnsq dtnsq1) w)
           (* (- dtnsq) dtnsq1 (+ dpsi dphi))))
(setf b (* dtnsq dtnsq1 w))
(if (< c zero) (setf c (abs c)))
(cond
  ((= c zero)
   (setf eta (- rho (* sigma sigma))))
  ((>= a zero)
   (setf eta
           (/
            (+ a
               (f2cl-lib:fsqrt (abs (+ (* a a) (* (- four) b c)))))
            (* two c))))
  (t
   (setf eta
           (/ (* two b)
              (- a
                 (f2cl-lib:fsqrt
                  (abs (+ (* a a) (* (- four) b c)))))))))
(if (> (* w eta) zero) (setf eta (/ (- w) (+ dpsi dphi))))
(setf temp (- eta dtnsq))
(if (> temp rho) (setf eta (+ rho dtnsq)))
(setf tau (+ tau eta))
```

```
(setf eta (/ eta (+ sigma (f2cl-lib:fsqrt (+ eta (* sigma sigma))))))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j n) nil)
  (tagbody
    (setf (f2cl-lib:fref delta-%data% (j) ((1 *)) delta-%offset%)
            (-
             (f2cl-lib:fref delta-%data% (j) ((1 *)) delta-%offset%)
             eta))
    (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
            (+ (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
               eta))))
(setf sigma (+ sigma eta))
(setf dpsi zero)
(setf psi zero)
(setf erretm zero)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j ii) nil)
  (tagbody
    (setf temp
            (/ (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
               (*
                (f2cl-lib:fref work-%data%
                               (j)
                               ((1 *))
                               work-%offset%)
                (f2cl-lib:fref delta-%data%
                               (j)
                               ((1 *))
                               delta-%offset%))))
    (setf psi
            (+ psi
               (* (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
                  temp)))
    (setf dpsi (+ dpsi (* temp temp)))
    (setf erretm (+ erretm psi))))
(setf erretm (abs erretm))
(setf temp
       (/ (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
          (* (f2cl-lib:fref work-%data% (n) ((1 *)) work-%offset%)
             (f2cl-lib:fref delta-%data%
                            (n)
                            ((1 *))
                            delta-%offset%))))
(setf phi (* (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%) temp))
(setf dphi (* temp temp))
(setf erretm
       (+ (- (+ (* eight (- (- psi) phi)) erretm) phi)
          rhoinv
          (* (abs tau) (+ dpsi dphi))))
(setf w (+ rhoinv phi psi))
```

```
(setf iter (f2cl-lib:int-add niter 1))
(f2cl-lib:fdo (niter iter (f2cl-lib:int-add niter 1))
              ((> niter maxit) nil)
  (tagbody
    (cond
      ((<= (abs w) (* eps erretm))
       (go end_label)))
    (setf dtnsq1
            (*
             (f2cl-lib:fref work-%data%
                            ((f2cl-lib:int-sub n 1))
                            ((1 *))
                            work-%offset%)
             (f2cl-lib:fref delta-%data%
                            ((f2cl-lib:int-sub n 1))
                            ((1 *))
                            delta-%offset%)))
    (setf dtnsq
            (* (f2cl-lib:fref work-%data% (n) ((1 *)) work-%offset%)
               (f2cl-lib:fref delta-%data%
                              (n)
                              ((1 *))
                              delta-%offset%)))
    (setf c (- w (* dtnsq1 dpsi) (* dtnsq dphi)))
    (setf a
            (+ (* (+ dtnsq dtnsq1) w)
               (* (- dtnsq1) dtnsq (+ dpsi dphi))))
    (setf b (* dtnsq1 dtnsq w))
    (cond
      ((>= a zero)
       (setf eta
               (/
                (+ a
                   (f2cl-lib:fsqrt
                    (abs (+ (* a a) (* (- four) b c)))))
                (* two c))))
      (t
       (setf eta
               (/ (* two b)
                  (- a
                     (f2cl-lib:fsqrt
                      (abs (+ (* a a) (* (- four) b c)))))))))
    (if (> (* w eta) zero) (setf eta (/ (- w) (+ dpsi dphi))))
    (setf temp (- eta dtnsq))
    (if (<= temp zero) (setf eta (/ eta two)))
    (setf tau (+ tau eta))
    (setf eta
            (/ eta
               (+ sigma (f2cl-lib:fsqrt (+ eta (* sigma sigma))))))
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
```

```
              ((> j n) nil)
  (tagbody
    (setf (f2cl-lib:fref delta-%data%
                         (j)
                         ((1 *))
                         delta-%offset%)
            (-
             (f2cl-lib:fref delta-%data%
                            (j)
                            ((1 *))
                            delta-%offset%)
             eta))
    (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
            (+
             (f2cl-lib:fref work-%data%
                            (j)
                            ((1 *))
                            work-%offset%)
             eta))))
(setf sigma (+ sigma eta))
(setf dpsi zero)
(setf psi zero)
(setf erretm zero)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j ii) nil)
  (tagbody
    (setf temp
            (/ (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
               (*
                (f2cl-lib:fref work-%data%
                               (j)
                               ((1 *))
                               work-%offset%)
                (f2cl-lib:fref delta-%data%
                               (j)
                               ((1 *))
                               delta-%offset%))))
    (setf psi
            (+ psi
               (*
                (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
                temp)))
    (setf dpsi (+ dpsi (* temp temp)))
    (setf erretm (+ erretm psi))))
(setf erretm (abs erretm))
(setf temp
       (/ (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
          (*
           (f2cl-lib:fref work-%data%
                          (n)
```

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                                ((1 *))
                                work-%offset%)
                    (f2cl-lib:fref delta-%data%
                                (n)
                                ((1 *))
                                delta-%offset%))))
        (setf phi
                (* (f2cl-lib:fref z-%data% (n) ((1 *)) z-%offset%)
                   temp))
        (setf dphi (* temp temp))
        (setf erretm
                (+ (- (+ (* eight (- (- psi) phi)) erretm) phi)
                   rhoinv
                   (* (abs tau) (+ dpsi dphi))))
        (setf w (+ rhoinv phi psi))))
     (setf info 1)
     (go end_label))
    (t
     (setf niter 1)
     (setf ip1 (f2cl-lib:int-add i 1))
     (setf delsq
             (*
              (- (f2cl-lib:fref d-%data% (ip1) ((1 *)) d-%offset%)
                 (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
              (+ (f2cl-lib:fref d-%data% (ip1) ((1 *)) d-%offset%)
                 (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))))
     (setf delsq2 (/ delsq two))
     (setf temp
             (/ delsq2
                (+ (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
                   (f2cl-lib:fsqrt
                    (+
                     (* (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
                        (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
                     delsq2)))))
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   ((> j n) nil)
       (tagbody
         (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
                 (+ (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
                    (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
                    temp))
         (setf (f2cl-lib:fref delta-%data% (j) ((1 *)) delta-%offset%)
                 (- (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
                    (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
                    temp))))
     (setf psi zero)
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   ((> j (f2cl-lib:int-add i (f2cl-lib:int-sub 1))) nil)
       (tagbody
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```
    (setf psi
            (+ psi
               (/
                (* (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
                   (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%))
                (*
                 (f2cl-lib:fref work-%data%
                                (j)
                                ((1 *))
                                work-%offset%)
                 (f2cl-lib:fref delta-%data%
                                (j)
                                ((1 *))
                                delta-%offset%)))))))
(setf phi zero)
(f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
              ((> j (f2cl-lib:int-add i 2)) nil)
  (tagbody
    (setf phi
            (+ phi
               (/
                (* (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
                   (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%))
                (*
                 (f2cl-lib:fref work-%data%
                                (j)
                                ((1 *))
                                work-%offset%)
                 (f2cl-lib:fref delta-%data%
                                (j)
                                ((1 *))
                                delta-%offset%)))))))
(setf c (+ rhoinv psi phi))
(setf w
        (+ c
           (/
            (* (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
               (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%))
            (* (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
               (f2cl-lib:fref delta-%data%
                              (i)
                              ((1 *))
                              delta-%offset%)))
           (/
            (* (f2cl-lib:fref z-%data% (ip1) ((1 *)) z-%offset%)
               (f2cl-lib:fref z-%data% (ip1) ((1 *)) z-%offset%))
            (*
             (f2cl-lib:fref work-%data% (ip1) ((1 *)) work-%offset%)
             (f2cl-lib:fref delta-%data%
                            (ip1)
```

```
                              ((1 *))
                              delta-%offset%)))))
      (cond
        ((> w zero)
         (setf orgati t)
         (setf sg2lb zero)
         (setf sg2ub delsq2)
         (setf a
                 (+ (* c delsq)
                    (* (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
                       (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%))
                    (* (f2cl-lib:fref z-%data% (ip1) ((1 *)) z-%offset%)
                       (f2cl-lib:fref z-%data% (ip1) ((1 *)) z-%offset%))))
         (setf b
                 (* (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
                    (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
                    delsq))
         (cond
           ((> a zero)
            (setf tau
                    (/ (* two b)
                       (+ a
                          (f2cl-lib:fsqrt
                           (abs (+ (* a a) (* (- four) b c))))))))
           (t
            (setf tau
                    (/
                     (- a
                        (f2cl-lib:fsqrt
                         (abs (+ (* a a) (* (- four) b c)))))
                     (* two c)))))
         (setf eta
                 (/ tau
                    (+ (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
                       (f2cl-lib:fsqrt
                        (+
                         (*
                          (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
                          (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
                         tau))))))
        (t
         (setf orgati nil)
         (setf sg2lb (- delsq2))
         (setf sg2ub zero)
         (setf a
                 (- (* c delsq)
                    (* (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
                       (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%))
                    (* (f2cl-lib:fref z-%data% (ip1) ((1 *)) z-%offset%)
                       (f2cl-lib:fref z-%data% (ip1) ((1 *)) z-%offset%))))
```

```
      (setf b
            (* (f2cl-lib:fref z-%data% (ip1) ((1 *)) z-%offset%)
               (f2cl-lib:fref z-%data% (ip1) ((1 *)) z-%offset%)
               delsq))
      (cond
        ((< a zero)
         (setf tau
                 (/ (* two b)
                    (- a
                       (f2cl-lib:fsqrt
                        (abs (+ (* a a) (* four b c))))))))
        (t
         (setf tau
                 (/
                  (-
                   (+ a
                      (f2cl-lib:fsqrt (abs (+ (* a a) (* four b c))))))
                  (* two c)))))
      (setf eta
            (/ tau
               (+ (f2cl-lib:fref d-%data% (ip1) ((1 *)) d-%offset%)
                  (f2cl-lib:fsqrt
                   (abs
                    (+
                     (*
                      (f2cl-lib:fref d-%data%
                                     (ip1)
                                     ((1 *))
                                     d-%offset%)
                      (f2cl-lib:fref d-%data%
                                     (ip1)
                                     ((1 *))
                                     d-%offset%))
                     tau))))))))
  (cond
    (orgati
     (setf ii i)
     (setf sigma
           (+ (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) eta))
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                   ((> j n) nil)
       (tagbody
         (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
                 (+ (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
                    (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
                    eta))
         (setf (f2cl-lib:fref delta-%data% (j) ((1 *)) delta-%offset%)
                 (- (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
                    (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
                    eta)))))
```

```
      (t
       (setf ii (f2cl-lib:int-add i 1))
       (setf sigma
             (+ (f2cl-lib:fref d-%data% (ip1) ((1 *)) d-%offset%) eta))
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                     ((> j n) nil)
         (tagbody
           (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
                 (+ (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
                    (f2cl-lib:fref d-%data% (ip1) ((1 *)) d-%offset%)
                    eta))
           (setf (f2cl-lib:fref delta-%data% (j) ((1 *)) delta-%offset%)
                 (- (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
                    (f2cl-lib:fref d-%data% (ip1) ((1 *)) d-%offset%)
                    eta))))))
    (setf iim1 (f2cl-lib:int-sub ii 1))
    (setf iip1 (f2cl-lib:int-add ii 1))
    (setf dpsi zero)
    (setf psi zero)
    (setf erretm zero)
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j iim1) nil)
      (tagbody
        (setf temp
              (/ (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
                 (*
                  (f2cl-lib:fref work-%data%
                                 (j)
                                 ((1 *))
                                 work-%offset%)
                  (f2cl-lib:fref delta-%data%
                                 (j)
                                 ((1 *))
                                 delta-%offset%))))
        (setf psi
              (+ psi
                 (* (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
                    temp)))
        (setf dpsi (+ dpsi (* temp temp)))
        (setf erretm (+ erretm psi))))
    (setf erretm (abs erretm))
    (setf dphi zero)
    (setf phi zero)
    (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                  ((> j iip1) nil)
      (tagbody
        (setf temp
              (/ (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
                 (*
                  (f2cl-lib:fref work-%data%
```

```
                                (j)
                                ((1 *))
                                work-%offset%)
                     (f2cl-lib:fref delta-%data%
                                (j)
                                ((1 *))
                                delta-%offset%))))
    (setf phi
            (+ phi
               (* (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
                  temp)))
    (setf dphi (+ dphi (* temp temp)))
    (setf erretm (+ erretm phi))))
(setf w (+ rhoinv phi psi))
(setf swtch3 nil)
(cond
  (orgati
   (if (< w zero) (setf swtch3 t)))
  (t
   (if (> w zero) (setf swtch3 t))))
(if (or (= ii 1) (= ii n)) (setf swtch3 nil))
(setf temp
        (/ (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%)
           (* (f2cl-lib:fref work-%data% (ii) ((1 *)) work-%offset%)
              (f2cl-lib:fref delta-%data%
                             (ii)
                             ((1 *))
                             delta-%offset%))))
(setf dw (+ dpsi dphi (* temp temp)))
(setf temp (* (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%) temp))
(setf w (+ w temp))
(setf erretm
        (+ (* eight (- phi psi))
           erretm
           (* two rhoinv)
           (* three (abs temp))
           (* (abs tau) dw)))
(cond
  ((<= (abs w) (* eps erretm))
   (go end_label)))
(cond
  ((<= w zero)
   (setf sg2lb (max sg2lb tau)))
  (t
   (setf sg2ub (min sg2ub tau))))
(setf niter (f2cl-lib:int-add niter 1))
(cond
  ((not swtch3)
   (setf dtipsq
           (*
```

```
         (f2cl-lib:fref work-%data% (ip1) ((1 *)) work-%offset%)
         (f2cl-lib:fref delta-%data%
                        (ip1)
                        ((1 *))
                        delta-%offset%)))
(setf dtisq
       (* (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
          (f2cl-lib:fref delta-%data%
                         (i)
                         ((1 *))
                         delta-%offset%)))
(cond
  (orgati
   (setf c
           (+ (- w (* dtipsq dw))
              (* delsq
                 (expt
                  (/
                   (f2cl-lib:fref z-%data%
                                  (i)
                                  ((1 *))
                                  z-%offset%)
                   dtisq)
                  2)))))
  (t
   (setf c
           (- w
              (* dtisq dw)
              (* delsq
                 (expt
                  (/
                   (f2cl-lib:fref z-%data%
                                  (ip1)
                                  ((1 *))
                                  z-%offset%)
                   dtipsq)
                  2))))))
(setf a (+ (* (+ dtipsq dtisq) w) (* (- dtipsq) dtisq dw)))
(setf b (* dtipsq dtisq w))
(cond
  ((= c zero)
   (cond
     ((= a zero)
      (cond
        (orgati
         (setf a
                 (+
                  (*
                   (f2cl-lib:fref z-%data%
                                  (i)
```

```
                                        ((1 *))
                                        z-%offset%)
                             (f2cl-lib:fref z-%data%
                                        (i)
                                        ((1 *))
                                        z-%offset%))
                             (* dtipsq dtipsq (+ dpsi dphi)))))
                    (t
                     (setf a
                            (+
                             (*
                              (f2cl-lib:fref z-%data%
                                        (ip1)
                                        ((1 *))
                                        z-%offset%)
                              (f2cl-lib:fref z-%data%
                                        (ip1)
                                        ((1 *))
                                        z-%offset%))
                             (* dtisq dtisq (+ dpsi dphi))))))))
               (setf eta (/ b a)))
              ((<= a zero)
               (setf eta
                       (/
                        (- a
                           (f2cl-lib:fsqrt
                            (abs (+ (* a a) (* (- four) b c)))))
                        (* two c))))
              (t
               (setf eta
                       (/ (* two b)
                          (+ a
                             (f2cl-lib:fsqrt
                              (abs (+ (* a a) (* (- four) b c)))))))))
            (t
             (setf dtiim
                    (*
                     (f2cl-lib:fref work-%data% (iim1) ((1 *)) work-%offset%)
                     (f2cl-lib:fref delta-%data%
                                    (iim1)
                                    ((1 *))
                                    delta-%offset%)))
             (setf dtiip
                    (*
                     (f2cl-lib:fref work-%data% (iip1) ((1 *)) work-%offset%)
                     (f2cl-lib:fref delta-%data%
                                    (iip1)
                                    ((1 *))
                                    delta-%offset%)))
             (setf temp (+ rhoinv psi phi))
```

```
(cond
  (orgati
   (setf temp1
           (/ (f2cl-lib:fref z-%data% (iim1) ((1 *)) z-%offset%)
              dtiim))
   (setf temp1 (* temp1 temp1))
   (setf c
           (+ (- temp (* dtiip (+ dpsi dphi)))
              (*
               (-
                (-
                 (f2cl-lib:fref d-%data%
                                (iim1)
                                ((1 *))
                                d-%offset%)
                 (f2cl-lib:fref d-%data%
                                (iip1)
                                ((1 *))
                                d-%offset%)))
               (+
                (f2cl-lib:fref d-%data%
                               (iim1)
                               ((1 *))
                               d-%offset%)
                (f2cl-lib:fref d-%data%
                               (iip1)
                               ((1 *))
                               d-%offset%))
               temp1)))
   (setf (f2cl-lib:fref zz (1) ((1 3)))
           (* (f2cl-lib:fref z-%data% (iim1) ((1 *)) z-%offset%)
              (f2cl-lib:fref z-%data% (iim1) ((1 *)) z-%offset%)))
   (cond
     ((< dpsi temp1)
      (setf (f2cl-lib:fref zz (3) ((1 3))) (* dtiip dtiip dphi)))
     (t
      (setf (f2cl-lib:fref zz (3) ((1 3)))
              (* dtiip dtiip (+ (- dpsi temp1) dphi))))))
  (t
   (setf temp1
           (/ (f2cl-lib:fref z-%data% (iip1) ((1 *)) z-%offset%)
              dtiip))
   (setf temp1 (* temp1 temp1))
   (setf c
           (+ (- temp (* dtiim (+ dpsi dphi)))
              (*
               (-
                (-
                 (f2cl-lib:fref d-%data%
                                (iip1)
```

```
                                    ((1 *))
                                    d-%offset%)
                          (f2cl-lib:fref d-%data%
                                    (iim1)
                                    ((1 *))
                                    d-%offset%)))
                         (+
                          (f2cl-lib:fref d-%data%
                                    (iim1)
                                    ((1 *))
                                    d-%offset%)
                          (f2cl-lib:fref d-%data%
                                    (iip1)
                                    ((1 *))
                                    d-%offset%))
                         temp1)))
            (cond
              ((< dphi temp1)
               (setf (f2cl-lib:fref zz (1) ((1 3))) (* dtiim dtiim dpsi)))
              (t
               (setf (f2cl-lib:fref zz (1) ((1 3)))
                     (* dtiim dtiim (+ dpsi (- dphi temp1))))))
            (setf (f2cl-lib:fref zz (3) ((1 3)))
                  (* (f2cl-lib:fref z-%data% (iip1) ((1 *)) z-%offset%)
                     (f2cl-lib:fref z-%data%
                                    (iip1)
                                    ((1 *))
                                    z-%offset%)))))
         (setf (f2cl-lib:fref zz (2) ((1 3)))
               (* (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%)
                  (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%)))
         (setf (f2cl-lib:fref dd (1) ((1 3))) dtiim)
         (setf (f2cl-lib:fref dd (2) ((1 3)))
               (*
                (f2cl-lib:fref delta-%data% (ii) ((1 *)) delta-%offset%)
                (f2cl-lib:fref work-%data% (ii) ((1 *)) work-%offset%)))
         (setf (f2cl-lib:fref dd (3) ((1 3))) dtiip)
         (multiple-value-bind
               (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
             (dlaed6 niter orgati c dd zz w eta info)
           (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5))
           (setf eta var-6)
           (setf info var-7))
         (if (/= info 0) (go end_label))))
      (if (>= (* w eta) zero) (setf eta (/ (- w) dw)))
      (cond
        (orgati
         (setf temp1
               (* (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
                  (f2cl-lib:fref delta-%data%
```

```
                              (i)
                              ((1 *))
                              delta-%offset%)))
   (setf temp (- eta temp1)))
  (t
   (setf temp1
         (*
          (f2cl-lib:fref work-%data% (ip1) ((1 *)) work-%offset%)
          (f2cl-lib:fref delta-%data%
                         (ip1)
                         ((1 *))
                         delta-%offset%)))
   (setf temp (- eta temp1))))
(cond
  ((or (> temp sg2ub) (< temp sg2lb))
   (cond
     ((< w zero)
      (setf eta (/ (- sg2ub tau) two)))
     (t
      (setf eta (/ (- sg2lb tau) two))))))
(setf tau (+ tau eta))
(setf eta (/ eta (+ sigma (f2cl-lib:fsqrt (+ (* sigma sigma) eta)))))
(setf prew w)
(setf sigma (+ sigma eta))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j n) nil)
  (tagbody
    (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
            (+ (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
               eta))
    (setf (f2cl-lib:fref delta-%data% (j) ((1 *)) delta-%offset%)
            (-
             (f2cl-lib:fref delta-%data% (j) ((1 *)) delta-%offset%)
             eta))))
(setf dpsi zero)
(setf psi zero)
(setf erretm zero)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j iim1) nil)
  (tagbody
    (setf temp
            (/ (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
               (*
                (f2cl-lib:fref work-%data%
                               (j)
                               ((1 *))
                               work-%offset%)
                (f2cl-lib:fref delta-%data%
                               (j)
                               ((1 *))
```

```
                                delta-%offset%))))
    (setf psi
            (+ psi
               (* (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
                  temp)))
    (setf dpsi (+ dpsi (* temp temp)))
    (setf erretm (+ erretm psi))))
(setf erretm (abs erretm))
(setf dphi zero)
(setf phi zero)
(f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
              ((> j iip1) nil)
  (tagbody
    (setf temp
            (/ (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
               (*
                (f2cl-lib:fref work-%data%
                               (j)
                               ((1 *))
                               work-%offset%)
                (f2cl-lib:fref delta-%data%
                               (j)
                               ((1 *))
                               delta-%offset%))))
    (setf phi
            (+ phi
               (* (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
                  temp)))
    (setf dphi (+ dphi (* temp temp)))
    (setf erretm (+ erretm phi))))
(setf temp
        (/ (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%)
           (* (f2cl-lib:fref work-%data% (ii) ((1 *)) work-%offset%)
              (f2cl-lib:fref delta-%data%
                             (ii)
                             ((1 *))
                             delta-%offset%))))
(setf dw (+ dpsi dphi (* temp temp)))
(setf temp (* (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%) temp))
(setf w (+ rhoinv phi psi temp))
(setf erretm
        (+ (* eight (- phi psi))
           erretm
           (* two rhoinv)
           (* three (abs temp))
           (* (abs tau) dw)))
(cond
  ((<= w zero)
   (setf sg2lb (max sg2lb tau)))
  (t
```

```
   (setf sg2ub (min sg2ub tau))))
(setf swtch nil)
(cond
  (orgati
   (if (> (- w) (/ (abs prew) ten)) (setf swtch t)))
  (t
   (if (> w (/ (abs prew) ten)) (setf swtch t))))
(setf iter (f2cl-lib:int-add niter 1))
(f2cl-lib:fdo (niter iter (f2cl-lib:int-add niter 1))
              ((> niter maxit) nil)
  (tagbody
    (cond
      ((<= (abs w) (* eps erretm))
       (go end_label)))
    (cond
      ((not swtch3)
       (setf dtipsq
               (*
                (f2cl-lib:fref work-%data%
                               (ip1)
                               ((1 *))
                               work-%offset%)
                (f2cl-lib:fref delta-%data%
                               (ip1)
                               ((1 *))
                               delta-%offset%)))
       (setf dtisq
               (*
                (f2cl-lib:fref work-%data%
                               (i)
                               ((1 *))
                               work-%offset%)
                (f2cl-lib:fref delta-%data%
                               (i)
                               ((1 *))
                               delta-%offset%)))
       (cond
         ((not swtch)
          (cond
            (orgati
             (setf c
                     (+ (- w (* dtipsq dw))
                        (* delsq
                           (expt
                            (/
                             (f2cl-lib:fref z-%data%
                                            (i)
                                            ((1 *))
                                            z-%offset%)
                             dtisq)
```

```
                        2)))))
          (t
           (setf c
                 (- w
                    (* dtisq dw)
                    (* delsq
                       (expt
                        (/
                         (f2cl-lib:fref z-%data%
                                        (ip1)
                                        ((1 *))
                                        z-%offset%)
                         dtipsq)
                        2)))))))
      (t
       (setf temp
             (/
              (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%)
              (*
               (f2cl-lib:fref work-%data%
                              (ii)
                              ((1 *))
                              work-%offset%)
               (f2cl-lib:fref delta-%data%
                              (ii)
                              ((1 *))
                              delta-%offset%))))
       (cond
         (orgati
          (setf dpsi (+ dpsi (* temp temp))))
         (t
          (setf dphi (+ dphi (* temp temp)))))
       (setf c (- w (* dtisq dpsi) (* dtipsq dphi)))))
    (setf a (+ (* (+ dtipsq dtisq) w) (* (- dtipsq) dtisq dw)))
    (setf b (* dtipsq dtisq w))
    (cond
      ((= c zero)
       (cond
         ((= a zero)
          (cond
            ((not swtch)
             (cond
               (orgati
                (setf a
                      (+
                       (*
                        (f2cl-lib:fref z-%data%
                                       (i)
                                       ((1 *))
                                       z-%offset%)
```

```
                              (f2cl-lib:fref z-%data%
                                             (i)
                                             ((1 *))
                                             z-%offset%))
                             (* dtipsq dtipsq (+ dpsi dphi)))))
                (t
                 (setf a
                         (+
                          (*
                           (f2cl-lib:fref z-%data%
                                          (ip1)
                                          ((1 *))
                                          z-%offset%)
                           (f2cl-lib:fref z-%data%
                                          (ip1)
                                          ((1 *))
                                          z-%offset%))
                          (* dtisq dtisq (+ dpsi dphi)))))))
              (t
               (setf a
                       (+ (* dtisq dtisq dpsi)
                          (* dtipsq dtipsq dphi)))))))
     (setf eta (/ b a)))
    ((<= a zero)
     (setf eta
             (/
              (- a
                 (f2cl-lib:fsqrt
                  (abs (+ (* a a) (* (- four) b c)))))
              (* two c))))
    (t
     (setf eta
             (/ (* two b)
                (+ a
                   (f2cl-lib:fsqrt
                    (abs (+ (* a a) (* (- four) b c))))))))))
(t
 (setf dtiim
         (*
          (f2cl-lib:fref work-%data%
                         (iim1)
                         ((1 *))
                         work-%offset%)
          (f2cl-lib:fref delta-%data%
                         (iim1)
                         ((1 *))
                         delta-%offset%)))
 (setf dtiip
         (*
          (f2cl-lib:fref work-%data%
```

```
                        (iip1)
                        ((1 *))
                        work-%offset%)
          (f2cl-lib:fref delta-%data%
                        (iip1)
                        ((1 *))
                        delta-%offset%)))
(setf temp (+ rhoinv psi phi))
(cond
  (swtch
   (setf c (- temp (* dtiim dpsi) (* dtiip dphi)))
   (setf (f2cl-lib:fref zz (1) ((1 3))) (* dtiim dtiim dpsi))
   (setf (f2cl-lib:fref zz (3) ((1 3))) (* dtiip dtiip dphi)))
  (t
   (cond
     (orgati
      (setf temp1
            (/
             (f2cl-lib:fref z-%data%
                            (iim1)
                            ((1 *))
                            z-%offset%)
             dtiim))
      (setf temp1 (* temp1 temp1))
      (setf temp2
            (*
             (-
              (f2cl-lib:fref d-%data%
                             (iim1)
                             ((1 *))
                             d-%offset%)
              (f2cl-lib:fref d-%data%
                             (iip1)
                             ((1 *))
                             d-%offset%))
             (+
              (f2cl-lib:fref d-%data%
                             (iim1)
                             ((1 *))
                             d-%offset%)
              (f2cl-lib:fref d-%data%
                             (iip1)
                             ((1 *))
                             d-%offset%))
             temp1))
      (setf c (- temp (* dtiip (+ dpsi dphi)) temp2))
      (setf (f2cl-lib:fref zz (1) ((1 3)))
            (*
             (f2cl-lib:fref z-%data%
                            (iim1)
```

```
                          ((1 *))
                          z-%offset%)
                 (f2cl-lib:fref z-%data%
                          (iim1)
                          ((1 *))
                          z-%offset%)))
         (cond
           ((< dpsi temp1)
            (setf (f2cl-lib:fref zz (3) ((1 3)))
                    (* dtiip dtiip dphi)))
           (t
            (setf (f2cl-lib:fref zz (3) ((1 3)))
                    (* dtiip dtiip (+ (- dpsi temp1) dphi))))))
        (t
         (setf temp1
                (/
                 (f2cl-lib:fref z-%data%
                          (iip1)
                          ((1 *))
                          z-%offset%)
                 dtiip))
         (setf temp1 (* temp1 temp1))
         (setf temp2
                (*
                 (-
                  (f2cl-lib:fref d-%data%
                           (iip1)
                           ((1 *))
                           d-%offset%)
                  (f2cl-lib:fref d-%data%
                           (iim1)
                           ((1 *))
                           d-%offset%))
                 (+
                  (f2cl-lib:fref d-%data%
                           (iim1)
                           ((1 *))
                           d-%offset%)
                  (f2cl-lib:fref d-%data%
                           (iip1)
                           ((1 *))
                           d-%offset%))
                 temp1))
         (setf c (- temp (* dtiim (+ dpsi dphi)) temp2))
         (cond
           ((< dphi temp1)
            (setf (f2cl-lib:fref zz (1) ((1 3)))
                    (* dtiim dtiim dpsi)))
           (t
            (setf (f2cl-lib:fref zz (1) ((1 3)))
```

```
                        (* dtiim dtiim (+ dpsi (- dphi temp1))))))
              (setf (f2cl-lib:fref zz (3) ((1 3)))
                    (*
                     (f2cl-lib:fref z-%data%
                                    (iip1)
                                    ((1 *))
                                    z-%offset%)
                     (f2cl-lib:fref z-%data%
                                    (iip1)
                                    ((1 *))
                                    z-%offset%)))))))
    (setf (f2cl-lib:fref dd (1) ((1 3))) dtiim)
    (setf (f2cl-lib:fref dd (2) ((1 3)))
          (*
           (f2cl-lib:fref delta-%data%
                          (ii)
                          ((1 *))
                          delta-%offset%)
           (f2cl-lib:fref work-%data%
                          (ii)
                          ((1 *))
                          work-%offset%)))
    (setf (f2cl-lib:fref dd (3) ((1 3))) dtiip)
    (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
        (dlaed6 niter orgati c dd zz w eta info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5))
      (setf eta var-6)
      (setf info var-7))
    (if (/= info 0) (go end_label))))
(if (>= (* w eta) zero) (setf eta (/ (- w) dw)))
(cond
  (orgati
   (setf temp1
         (*
          (f2cl-lib:fref work-%data%
                         (i)
                         ((1 *))
                         work-%offset%)
          (f2cl-lib:fref delta-%data%
                         (i)
                         ((1 *))
                         delta-%offset%)))
   (setf temp (- eta temp1)))
  (t
   (setf temp1
         (*
          (f2cl-lib:fref work-%data%
                         (ip1)
                         ((1 *))
```

```
                              work-%offset%)
                 (f2cl-lib:fref delta-%data%
                              (ip1)
                              ((1 *))
                              delta-%offset%)))
     (setf temp (- eta temp1))))
  (cond
    ((or (> temp sg2ub) (< temp sg2lb))
     (cond
       ((< w zero)
        (setf eta (/ (- sg2ub tau) two)))
       (t
        (setf eta (/ (- sg2lb tau) two))))))
  (setf tau (+ tau eta))
  (setf eta
          (/ eta
             (+ sigma (f2cl-lib:fsqrt (+ (* sigma sigma) eta)))))
  (setf sigma (+ sigma eta))
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                ((> j n) nil)
    (tagbody
      (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
              (+
               (f2cl-lib:fref work-%data%
                              (j)
                              ((1 *))
                              work-%offset%)
               eta))
      (setf (f2cl-lib:fref delta-%data%
                           (j)
                           ((1 *))
                           delta-%offset%)
              (-
               (f2cl-lib:fref delta-%data%
                              (j)
                              ((1 *))
                              delta-%offset%)
               eta))))
  (setf prew w)
  (setf dpsi zero)
  (setf psi zero)
  (setf erretm zero)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                ((> j iim1) nil)
    (tagbody
      (setf temp
              (/ (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
                 (*
                  (f2cl-lib:fref work-%data%
                                 (j)
```

```
                                ((1 *))
                                work-%offset%)
                    (f2cl-lib:fref delta-%data%
                                (j)
                                ((1 *))
                                delta-%offset%))))
        (setf psi
                (+ psi
                   (*
                    (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
                    temp)))
        (setf dpsi (+ dpsi (* temp temp)))
        (setf erretm (+ erretm psi))))
    (setf erretm (abs erretm))
    (setf dphi zero)
    (setf phi zero)
    (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                  ((> j iip1) nil)
      (tagbody
        (setf temp
                (/ (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
                   (*
                    (f2cl-lib:fref work-%data%
                                (j)
                                ((1 *))
                                work-%offset%)
                    (f2cl-lib:fref delta-%data%
                                (j)
                                ((1 *))
                                delta-%offset%))))
        (setf phi
                (+ phi
                   (*
                    (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%)
                    temp)))
        (setf dphi (+ dphi (* temp temp)))
        (setf erretm (+ erretm phi))))
    (setf temp
            (/ (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%)
               (*
                (f2cl-lib:fref work-%data%
                               (ii)
                               ((1 *))
                               work-%offset%)
                (f2cl-lib:fref delta-%data%
                               (ii)
                               ((1 *))
                               delta-%offset%))))
    (setf dw (+ dpsi dphi (* temp temp)))
    (setf temp
```

```
                        (* (f2cl-lib:fref z-%data% (ii) ((1 *)) z-%offset%)
                           temp))
                (setf w (+ rhoinv phi psi temp))
                (setf erretm
                        (+ (* eight (- phi psi))
                           erretm
                           (* two rhoinv)
                           (* three (abs temp))
                           (* (abs tau) dw)))
                (if (and (> (* w prew) zero) (> (abs w) (/ (abs prew) ten)))
                    (setf swtch (not swtch)))
                (cond
                  ((<= w zero)
                   (setf sg2lb (max sg2lb tau)))
                  (t
                   (setf sg2ub (min sg2ub tau))))))
           (setf info 1)))
 end_label
        (return (values nil nil nil nil nil nil sigma nil info))))))
```

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6.62 dlasd5 LAPACK

— **dlasd5.input** —

```
)set break resume
)sys rm -f dlasd5.output
)spool dlasd5.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlasd5.help** —

```
==========================================================================
dlasd5 examples
==========================================================================

==========================================================================
```

```
Man Page Details
=================================================================

NAME
       DLASD5  -  compute the square root of the I-th eigenvalue of a positive
       symmetric rank-one modification of a 2-by-2 diagonal matrix   diag( D )
       *  diag(  D ) + RHO  The diagonal entries in the array D are assumed to
       satisfy   0 <= D(i) < D(j) for i < j

SYNOPSIS
       SUBROUTINE DLASD5( I, D, Z, DELTA, RHO, DSIGMA, WORK )

           INTEGER        I

           DOUBLE         PRECISION DSIGMA, RHO

           DOUBLE         PRECISION D( 2 ), DELTA( 2 ), WORK( 2 ), Z( 2 )

  Purpose
  =======

  This subroutine computes the square root of the I-th eigenvalue
  of a positive symmetric rank-one modification of a 2-by-2 diagonal
  matrix

             diag( D ) * diag( D ) +  RHO *  Z * transpose(Z) .

  The diagonal entries in the array D are assumed to satisfy

             0 <= D(i) < D(j)  for  i < j .

  We also assume RHO > 0 and that the Euclidean norm of the vector
  Z is one.

  Arguments
  =========

  I      (input) INTEGER
         The index of the eigenvalue to be computed.  I = 1 or I = 2.

  D      (input) DOUBLE PRECISION array, dimension ( 2 )
         The original eigenvalues.  We assume 0 <= D(1) < D(2).

  Z      (input) DOUBLE PRECISION array, dimension ( 2 )
         The components of the updating vector.

  DELTA  (output) DOUBLE PRECISION array, dimension ( 2 )
         Contains (D(j) - lambda_I) in its  j-th component.
         The vector DELTA contains the information necessary
         to construct the eigenvectors.
```

```
  RHO    (input) DOUBLE PRECISION
         The scalar in the symmetric updating formula.

  DSIGMA (output) DOUBLE PRECISION
         The computed lambda_I, the I-th updated eigenvalue.

  WORK   (workspace) DOUBLE PRECISION array, dimension ( 2 )
         WORK contains (D(j) + sigma_I) in its  j-th component.

  Further Details
  ===============

  Based on contributions by
     Ren-Cang Li, Computer Science Division, University of California
     at Berkeley, USA
```

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— dlasd5.f —

```
      SUBROUTINE DLASD5( I, D, Z, DELTA, RHO, DSIGMA, WORK )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Oak Ridge National Lab, Argonne National Lab,
*     Courant Institute, NAG Ltd., and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      INTEGER            I
      DOUBLE PRECISION   DSIGMA, RHO
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   D( 2 ), DELTA( 2 ), WORK( 2 ), Z( 2 )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE, TWO, THREE, FOUR
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0, TWO = 2.0D+0,
     $                   THREE = 3.0D+0, FOUR = 4.0D+0 )
*     ..
*     .. Local Scalars ..
      DOUBLE PRECISION   B, C, DEL, DELSQ, TAU, W
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, SQRT
```

```
*     ..
*     .. Executable Statements ..
*
      DEL = D( 2 ) - D( 1 )
      DELSQ = DEL*( D( 2 )+D( 1 ) )
      IF( I.EQ.1 ) THEN
         W = ONE + FOUR*RHO*( Z( 2 )*Z( 2 ) / ( D( 1 )+THREE*D( 2 ) )-
     $       Z( 1 )*Z( 1 ) / ( THREE*D( 1 )+D( 2 ) ) ) / DEL
         IF( W.GT.ZERO ) THEN
            B = DELSQ + RHO*( Z( 1 )*Z( 1 )+Z( 2 )*Z( 2 ) )
            C = RHO*Z( 1 )*Z( 1 )*DELSQ
*
*           B > ZERO, always
*
*           The following TAU is DSIGMA * DSIGMA - D( 1 ) * D( 1 )
*
            TAU = TWO*C / ( B+SQRT( ABS( B*B-FOUR*C ) ) )
*
*           The following TAU is DSIGMA - D( 1 )
*
            TAU = TAU / ( D( 1 )+SQRT( D( 1 )*D( 1 )+TAU ) )
            DSIGMA = D( 1 ) + TAU
            DELTA( 1 ) = -TAU
            DELTA( 2 ) = DEL - TAU
            WORK( 1 ) = TWO*D( 1 ) + TAU
            WORK( 2 ) = ( D( 1 )+TAU ) + D( 2 )
*           DELTA( 1 ) = -Z( 1 ) / TAU
*           DELTA( 2 ) = Z( 2 ) / ( DEL-TAU )
         ELSE
            B = -DELSQ + RHO*( Z( 1 )*Z( 1 )+Z( 2 )*Z( 2 ) )
            C = RHO*Z( 2 )*Z( 2 )*DELSQ
*
*           The following TAU is DSIGMA * DSIGMA - D( 2 ) * D( 2 )
*
            IF( B.GT.ZERO ) THEN
               TAU = -TWO*C / ( B+SQRT( B*B+FOUR*C ) )
            ELSE
               TAU = ( B-SQRT( B*B+FOUR*C ) ) / TWO
            END IF
*
*           The following TAU is DSIGMA - D( 2 )
*
            TAU = TAU / ( D( 2 )+SQRT( ABS( D( 2 )*D( 2 )+TAU ) ) )
            DSIGMA = D( 2 ) + TAU
            DELTA( 1 ) = -( DEL+TAU )
            DELTA( 2 ) = -TAU
            WORK( 1 ) = D( 1 ) + TAU + D( 2 )
            WORK( 2 ) = TWO*D( 2 ) + TAU
*           DELTA( 1 ) = -Z( 1 ) / ( DEL+TAU )
*           DELTA( 2 ) = -Z( 2 ) / TAU
```

```
         END IF
*        TEMP = SQRT( DELTA( 1 )*DELTA( 1 )+DELTA( 2 )*DELTA( 2 ) )
*        DELTA( 1 ) = DELTA( 1 ) / TEMP
*        DELTA( 2 ) = DELTA( 2 ) / TEMP
      ELSE
*
*        Now I=2
*
         B = -DELSQ + RHO*( Z( 1 )*Z( 1 )+Z( 2 )*Z( 2 ) )
         C = RHO*Z( 2 )*Z( 2 )*DELSQ
*
*        The following TAU is DSIGMA * DSIGMA - D( 2 ) * D( 2 )
*
         IF( B.GT.ZERO ) THEN
            TAU = ( B+SQRT( B*B+FOUR*C ) ) / TWO
         ELSE
            TAU = TWO*C / ( -B+SQRT( B*B+FOUR*C ) )
         END IF
*
*        The following TAU is DSIGMA - D( 2 )
*
         TAU = TAU / ( D( 2 )+SQRT( D( 2 )*D( 2 )+TAU ) )
         DSIGMA = D( 2 ) + TAU
         DELTA( 1 ) = -( DEL+TAU )
         DELTA( 2 ) = -TAU
         WORK( 1 ) = D( 1 ) + TAU + D( 2 )
         WORK( 2 ) = TWO*D( 2 ) + TAU
*        DELTA( 1 ) = -Z( 1 ) / ( DEL+TAU )
*        DELTA( 2 ) = -Z( 2 ) / TAU
*        TEMP = SQRT( DELTA( 1 )*DELTA( 1 )+DELTA( 2 )*DELTA( 2 ) )
*        DELTA( 1 ) = DELTA( 1 ) / TEMP
*        DELTA( 2 ) = DELTA( 2 ) / TEMP
      END IF
      RETURN
*
*     End of DLASD5
*
      END
```

———-

— LAPACK dlasd5 —

```
(let* ((zero 0.0) (one 1.0) (two 2.0) (three 3.0) (four 4.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one)
           (type (double-float 2.0 2.0) two)
           (type (double-float 3.0 3.0) three)
```

```
         (type (double-float 4.0 4.0) four))
 (defun dlasd5 (i d z delta rho dsigma work)
   (declare (type (double-float) dsigma rho)
            (type (simple-array double-float (*)) work delta z d)
            (type fixnum i))
   (f2cl-lib:with-multi-array-data
       ((d double-float d-%data% d-%offset%)
        (z double-float z-%data% z-%offset%)
        (delta double-float delta-%data% delta-%offset%)
        (work double-float work-%data% work-%offset%))
     (prog ((b 0.0) (c 0.0) (del 0.0) (delsq 0.0) (tau 0.0) (w 0.0))
       (declare (type (double-float) b c del delsq tau w))
       (setf del
             (- (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%)
                (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%)))
       (setf delsq
             (* del
                (+ (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%)
                   (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%))))
       (cond
         ((= i 1)
          (setf w
                (+ one
                   (/
                    (* four
                       rho
                       (+
                        (/
                         (* (f2cl-lib:fref z-%data% (2) ((1 2)) z-%offset%)
                            (f2cl-lib:fref z-%data% (2) ((1 2)) z-%offset%))
                         (+ (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%)
                            (* three
                               (f2cl-lib:fref d-%data%
                                              (2)
                                              ((1 2))
                                              d-%offset%))))
                        (/
                         (*
                          (-
                           (f2cl-lib:fref z-%data% (1) ((1 2)) z-%offset%))
                          (f2cl-lib:fref z-%data% (1) ((1 2)) z-%offset%))
                         (+
                          (* three
                             (f2cl-lib:fref d-%data%
                                            (1)
                                            ((1 2))
                                            d-%offset%))
                          (f2cl-lib:fref d-%data%
                                         (2)
                                         ((1 2))
```

```
                                    d-%offset%)))))
             del)))
(cond
  ((> w zero)
   (setf b
           (+ delsq
              (* rho
                 (+
                  (* (f2cl-lib:fref z-%data% (1) ((1 2)) z-%offset%)
                     (f2cl-lib:fref z-%data%
                                    (1)
                                    ((1 2))
                                    z-%offset%))
                  (* (f2cl-lib:fref z-%data% (2) ((1 2)) z-%offset%)
                     (f2cl-lib:fref z-%data%
                                    (2)
                                    ((1 2))
                                    z-%offset%))))))
   (setf c
           (* rho
              (f2cl-lib:fref z-%data% (1) ((1 2)) z-%offset%)
              (f2cl-lib:fref z-%data% (1) ((1 2)) z-%offset%)
              delsq))
   (setf tau
           (/ (* two c)
              (+ b (f2cl-lib:fsqrt (abs (- (* b b) (* four c)))))))
   (setf tau
           (/ tau
              (+ (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%)
                 (f2cl-lib:fsqrt
                  (+
                   (*
                    (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%)
                    (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%))
                   tau)))))
   (setf dsigma
           (+ (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%) tau))
   (setf (f2cl-lib:fref delta-%data% (1) ((1 2)) delta-%offset%)
           (- tau))
   (setf (f2cl-lib:fref delta-%data% (2) ((1 2)) delta-%offset%)
           (- del tau))
   (setf (f2cl-lib:fref work-%data% (1) ((1 2)) work-%offset%)
           (+
            (* two (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%))
            tau))
   (setf (f2cl-lib:fref work-%data% (2) ((1 2)) work-%offset%)
           (+ (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%)
              tau
              (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%))))
  (t
```

```
(setf b
        (-
         (* rho
            (+
             (* (f2cl-lib:fref z-%data% (1) ((1 2)) z-%offset%)
                (f2cl-lib:fref z-%data% (1) ((1 2)) z-%offset%))
             (* (f2cl-lib:fref z-%data% (2) ((1 2)) z-%offset%)
                (f2cl-lib:fref z-%data%
                               (2)
                               ((1 2))
                               z-%offset%))))
         delsq))
(setf c
        (* rho
           (f2cl-lib:fref z-%data% (2) ((1 2)) z-%offset%)
           (f2cl-lib:fref z-%data% (2) ((1 2)) z-%offset%)
           delsq))
(cond
  ((> b zero)
   (setf tau
           (/ (* (- two) c)
              (+ b (f2cl-lib:fsqrt (+ (* b b) (* four c)))))))
  (t
   (setf tau
           (/ (- b (f2cl-lib:fsqrt (+ (* b b) (* four c))))
              two))))
(setf tau
        (/ tau
           (+ (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%)
              (f2cl-lib:fsqrt
               (abs
                (+
                 (*
                  (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%)
                  (f2cl-lib:fref d-%data%
                                 (2)
                                 ((1 2))
                                 d-%offset%))
                  tau))))))
(setf dsigma
        (+ (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%) tau))
(setf (f2cl-lib:fref delta-%data% (1) ((1 2)) delta-%offset%)
        (- (+ del tau)))
(setf (f2cl-lib:fref delta-%data% (2) ((1 2)) delta-%offset%)
        (- tau))
(setf (f2cl-lib:fref work-%data% (1) ((1 2)) work-%offset%)
        (+ (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%)
           tau
           (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%)))
(setf (f2cl-lib:fref work-%data% (2) ((1 2)) work-%offset%)
```

```
                (+
                 (* two (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%))
                 tau)))))
          (t
           (setf b
                 (-
                  (* rho
                     (+
                      (* (f2cl-lib:fref z-%data% (1) ((1 2)) z-%offset%)
                         (f2cl-lib:fref z-%data% (1) ((1 2)) z-%offset%))
                      (* (f2cl-lib:fref z-%data% (2) ((1 2)) z-%offset%)
                         (f2cl-lib:fref z-%data% (2) ((1 2)) z-%offset%))))
                  delsq))
           (setf c
                 (* rho
                    (f2cl-lib:fref z-%data% (2) ((1 2)) z-%offset%)
                    (f2cl-lib:fref z-%data% (2) ((1 2)) z-%offset%)
                    delsq))
           (cond
             ((> b zero)
              (setf tau (/ (+ b (f2cl-lib:fsqrt (+ (* b b) (* four c)))) two)))
             (t
              (setf tau
                      (/ (* two c)
                         (- (f2cl-lib:fsqrt (+ (* b b) (* four c))) b)))))
           (setf tau
                 (/ tau
                    (+ (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%)
                       (f2cl-lib:fsqrt
                        (+
                         (* (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%)
                            (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%))
                         tau)))))
           (setf dsigma (+ (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%) tau))
           (setf (f2cl-lib:fref delta-%data% (1) ((1 2)) delta-%offset%)
                 (- (+ del tau)))
           (setf (f2cl-lib:fref delta-%data% (2) ((1 2)) delta-%offset%)
                 (- tau))
           (setf (f2cl-lib:fref work-%data% (1) ((1 2)) work-%offset%)
                 (+ (f2cl-lib:fref d-%data% (1) ((1 2)) d-%offset%)
                    tau
                    (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%)))
           (setf (f2cl-lib:fref work-%data% (2) ((1 2)) work-%offset%)
                 (+ (* two (f2cl-lib:fref d-%data% (2) ((1 2)) d-%offset%))
                    tau))))
        (return (values nil nil nil nil nil dsigma nil))))))
```

6.63 dlasd6 LAPACK

— **dlasd6.input** —

```
)set break resume
)sys rm -f dlasd6.output
)spool dlasd6.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlasd6.help** —

```
==========================================================================
dlasd6 examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

NAME
       DLASD6  -  the  SVD of an updated upper bidiagonal matrix B obtained by
       merging two smaller ones by appending a row

SYNOPSIS
       SUBROUTINE DLASD6( ICOMPQ, NL, NR, SQRE, D, VF, VL, ALPHA, BETA,  IDXQ,
                          PERM, GIVPTR, GIVCOL, LDGCOL, GIVNUM, LDGNUM, POLES,
                          DIFL, DIFR, Z, K, C, S, WORK, IWORK, INFO )

           INTEGER        GIVPTR, ICOMPQ, INFO, K,  LDGCOL,  LDGNUM,  NL,  NR,
                          SQRE

           DOUBLE         PRECISION ALPHA, BETA, C, S

           INTEGER        GIVCOL(  LDGCOL, * ), IDXQ( * ), IWORK( * ), PERM( *
                          )

           DOUBLE         PRECISION D( * ), DIFL( *  ),  DIFR(  *  ),  GIVNUM(
                          LDGNUM,  *  ), POLES( LDGNUM, * ), VF( * ), VL( * ),
                          WORK( * ), Z( * )

  Purpose
```

```
=======

DLASD6 computes the SVD of an updated upper bidiagonal matrix B
obtained by merging two smaller ones by appending a row. This
routine is used only for the problem which requires all singular
values and optionally singular vector matrices in factored form.
B is an N-by-M matrix with N = NL + NR + 1 and M = N + SQRE.
A related subroutine, DLASD1, handles the case in which all singular
values and singular vectors of the bidiagonal matrix are desired.

DLASD6 computes the SVD as follows:

              ( D1(in)  0    0     0 )
  B = U(in) * (   Z1'   a   Z2'    b ) * VT(in)
              (   0     0   D2(in) 0 )

    = U(out) * ( D(out) 0) * VT(out)

where Z' = (Z1' a Z2' b) = u' VT', and u is a vector of dimension M
with ALPHA and BETA in the NL+1 and NL+2 th entries and zeros
elsewhere; and the entry b is empty if SQRE = 0.

The singular values of B can be computed using D1, D2, the first
components of all the right singular vectors of the lower block, and
the last components of all the right singular vectors of the upper
block. These components are stored and updated in VF and VL,
respectively, in DLASD6. Hence U and VT are not explicitly
referenced.

The singular values are stored in D. The algorithm consists of two
stages:

      The first stage consists of deflating the size of the problem
      when there are multiple singular values or if there is a zero
      in the Z vector. For each such occurence the dimension of the
      secular equation problem is reduced by one. This stage is
      performed by the routine DLASD7.

      The second stage consists of calculating the updated
      singular values. This is done by finding the roots of the
      secular equation via the routine DLASD4 (as called by DLASD8).
      This routine also updates VF and VL and computes the distances
      between the updated singular values and the old singular
      values.

DLASD6 is called from DLASDA.

Arguments
=========
```

```
ICOMPQ (input) INTEGER
       Specifies whether singular vectors are to be computed in
       factored form:
       = 0: Compute singular values only.
       = 1: Compute singular vectors in factored form as well.

NL     (input) INTEGER
       The row dimension of the upper block.  NL >= 1.

NR     (input) INTEGER
       The row dimension of the lower block.  NR >= 1.

SQRE   (input) INTEGER
       = 0: the lower block is an NR-by-NR square matrix.
       = 1: the lower block is an NR-by-(NR+1) rectangular matrix.

       The bidiagonal matrix has row dimension N = NL + NR + 1,
       and column dimension M = N + SQRE.

D      (input/output) DOUBLE PRECISION array, dimension ( NL+NR+1 ).
       On entry D(1:NL,1:NL) contains the singular values of the
       upper block, and D(NL+2:N) contains the singular values
       of the lower block. On exit D(1:N) contains the singular
       values of the modified matrix.

VF     (input/output) DOUBLE PRECISION array, dimension ( M )
       On entry, VF(1:NL+1) contains the first components of all
       right singular vectors of the upper block; and VF(NL+2:M)
       contains the first components of all right singular vectors
       of the lower block. On exit, VF contains the first components
       of all right singular vectors of the bidiagonal matrix.

VL     (input/output) DOUBLE PRECISION array, dimension ( M )
       On entry, VL(1:NL+1) contains the  last components of all
       right singular vectors of the upper block; and VL(NL+2:M)
       contains the last components of all right singular vectors of
       the lower block. On exit, VL contains the last components of
       all right singular vectors of the bidiagonal matrix.

ALPHA  (input) DOUBLE PRECISION
       Contains the diagonal element associated with the added row.

BETA   (input) DOUBLE PRECISION
       Contains the off-diagonal element associated with the added
       row.

IDXQ   (output) INTEGER array, dimension ( N )
       This contains the permutation which will reintegrate the
       subproblem just solved back into sorted order, i.e.
       D( IDXQ( I = 1, N ) ) will be in ascending order.
```

```
PERM   (output) INTEGER array, dimension ( N )
       The permutations (from deflation and sorting) to be applied
       to each block. Not referenced if ICOMPQ = 0.

GIVPTR (output) INTEGER
       The number of Givens rotations which took place in this
       subproblem. Not referenced if ICOMPQ = 0.

GIVCOL (output) INTEGER array, dimension ( LDGCOL, 2 )
       Each pair of numbers indicates a pair of columns to take place
       in a Givens rotation. Not referenced if ICOMPQ = 0.

LDGCOL (input) INTEGER
       leading dimension of GIVCOL, must be at least N.

GIVNUM (output) DOUBLE PRECISION array, dimension ( LDGNUM, 2 )
       Each number indicates the C or S value to be used in the
       corresponding Givens rotation. Not referenced if ICOMPQ = 0.

LDGNUM (input) INTEGER
       The leading dimension of GIVNUM and POLES, must be at least N.

POLES  (output) DOUBLE PRECISION array, dimension ( LDGNUM, 2 )
       On exit, POLES(1,*) is an array containing the new singular
       values obtained from solving the secular equation, and
       POLES(2,*) is an array containing the poles in the secular
       equation. Not referenced if ICOMPQ = 0.

DIFL   (output) DOUBLE PRECISION array, dimension ( N )
       On exit, DIFL(I) is the distance between I-th updated
       (undeflated) singular value and the I-th (undeflated) old
       singular value.

DIFR   (output) DOUBLE PRECISION array,
                dimension ( LDGNUM, 2 ) if ICOMPQ = 1 and
                dimension ( N ) if ICOMPQ = 0.
       On exit, DIFR(I, 1) is the distance between I-th updated
       (undeflated) singular value and the I+1-th (undeflated) old
       singular value.

       If ICOMPQ = 1, DIFR(1:K,2) is an array containing the
       normalizing factors for the right singular vector matrix.

       See DLASD8 for details on DIFL and DIFR.

Z      (output) DOUBLE PRECISION array, dimension ( M )
       The first elements of this array contain the components
       of the deflation-adjusted updating row vector.
```

```
  K      (output) INTEGER
         Contains the dimension of the non-deflated matrix,
         This is the order of the related secular equation. 1 <= K <=N.

  C      (output) DOUBLE PRECISION
         C contains garbage if SQRE =0 and the C-value of a Givens
         rotation related to the right null space if SQRE = 1.

  S      (output) DOUBLE PRECISION
         S contains garbage if SQRE =0 and the S-value of a Givens
         rotation related to the right null space if SQRE = 1.

  WORK   (workspace) DOUBLE PRECISION array, dimension ( 4 * M )

  IWORK  (workspace) INTEGER array, dimension ( 3 * N )

  INFO   (output) INTEGER
          = 0:  successful exit.
          < 0:  if INFO = -i, the i-th argument had an illegal value.
          > 0:  if INFO = 1, an singular value did not converge

  Further Details
  ===============

  Based on contributions by
     Ming Gu and Huan Ren, Computer Science Division, University of
     California at Berkeley, USA
```

———-

— dlasd6.f —

```
      SUBROUTINE DLASD6( ICOMPQ, NL, NR, SQRE, D, VF, VL, ALPHA, BETA,
     $                   IDXQ, PERM, GIVPTR, GIVCOL, LDGCOL, GIVNUM,
     $                   LDGNUM, POLES, DIFL, DIFR, Z, K, C, S, WORK,
     $                   IWORK, INFO )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      INTEGER            GIVPTR, ICOMPQ, INFO, K, LDGCOL, LDGNUM, NL,
     $                   NR, SQRE
      DOUBLE PRECISION   ALPHA, BETA, C, S
*     ..
*     .. Array Arguments ..
```

```
      INTEGER            GIVCOL( LDGCOL, * ), IDXQ( * ), IWORK( * ),
     $                   PERM( * )
      DOUBLE PRECISION   D( * ), DIFL( * ), DIFR( * ),
     $                   GIVNUM( LDGNUM, * ), POLES( LDGNUM, * ),
     $                   VF( * ), VL( * ), WORK( * ), Z( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE, ZERO
      PARAMETER          ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I, IDX, IDXC, IDXP, ISIGMA, IVFW, IVLW, IW, M,
     $                   N, N1, N2
      DOUBLE PRECISION   ORGNRM
*     ..
*     .. External Subroutines ..
      EXTERNAL           DCOPY, DLAMRG, DLASCL, DLASD7, DLASD8, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      N = NL + NR + 1
      M = N + SQRE
*
      IF( ( ICOMPQ.LT.0 ) .OR. ( ICOMPQ.GT.1 ) ) THEN
         INFO = -1
      ELSE IF( NL.LT.1 ) THEN
         INFO = -2
      ELSE IF( NR.LT.1 ) THEN
         INFO = -3
      ELSE IF( ( SQRE.LT.0 ) .OR. ( SQRE.GT.1 ) ) THEN
         INFO = -4
      ELSE IF( LDGCOL.LT.N ) THEN
         INFO = -14
      ELSE IF( LDGNUM.LT.N ) THEN
         INFO = -16
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DLASD6', -INFO )
         RETURN
      END IF
*
```

```
*     The following values are for bookkeeping purposes only.  They are
*     integer pointers which indicate the portion of the workspace
*     used by a particular array in DLASD7 and DLASD8.
*
      ISIGMA = 1
      IW = ISIGMA + N
      IVFW = IW + M
      IVLW = IVFW + M
*
      IDX = 1
      IDXC = IDX + N
      IDXP = IDXC + N
*
*     Scale.
*
      ORGNRM = MAX( ABS( ALPHA ), ABS( BETA ) )
      D( NL+1 ) = ZERO
      DO 10 I = 1, N
         IF( ABS( D( I ) ).GT.ORGNRM ) THEN
            ORGNRM = ABS( D( I ) )
         END IF
   10 CONTINUE
      CALL DLASCL( 'G', 0, 0, ORGNRM, ONE, N, 1, D, N, INFO )
      ALPHA = ALPHA / ORGNRM
      BETA = BETA / ORGNRM
*
*     Sort and Deflate singular values.
*
      CALL DLASD7( ICOMPQ, NL, NR, SQRE, K, D, Z, WORK( IW ), VF,
     $             WORK( IVFW ), VL, WORK( IVLW ), ALPHA, BETA,
     $             WORK( ISIGMA ), IWORK( IDX ), IWORK( IDXP ), IDXQ,
     $             PERM, GIVPTR, GIVCOL, LDGCOL, GIVNUM, LDGNUM, C, S,
     $             INFO )
*
*     Solve Secular Equation, compute DIFL, DIFR, and update VF, VL.
*
      CALL DLASD8( ICOMPQ, K, D, Z, VF, VL, DIFL, DIFR, LDGNUM,
     $             WORK( ISIGMA ), WORK( IW ), INFO )
*
*     Save the poles if ICOMPQ = 1.
*
      IF( ICOMPQ.EQ.1 ) THEN
         CALL DCOPY( K, D, 1, POLES( 1, 1 ), 1 )
         CALL DCOPY( K, WORK( ISIGMA ), 1, POLES( 1, 2 ), 1 )
      END IF
*
*     Unscale.
*
      CALL DLASCL( 'G', 0, 0, ONE, ORGNRM, N, 1, D, N, INFO )
*
```

```
*     Prepare the IDXQ sorting permutation.
*
      N1 = K
      N2 = N - K
      CALL DLAMRG( N1, N2, D, 1, -1, IDXQ )
*
      RETURN
*
*     End of DLASD6
*
      END
```

———-

— LAPACK dlasd6 —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dlasd6
         (icompq nl nr sqre d vf vl alpha beta idxq perm givptr givcol ldgcol
          givnum ldgnum poles difl difr z k c s work iwork info)
    (declare (type (simple-array fixnum (*)) iwork givcol perm idxq)
             (type (double-float) s c beta alpha)
             (type (simple-array double-float (*)) work z difr
                 difl poles givnum vl vf d)
             (type fixnum info k ldgnum ldgcol givptr sqre nr nl
                                    icompq))
    (f2cl-lib:with-multi-array-data
        ((d double-float d-%data% d-%offset%)
         (vf double-float vf-%data% vf-%offset%)
         (vl double-float vl-%data% vl-%offset%)
         (givnum double-float givnum-%data% givnum-%offset%)
         (poles double-float poles-%data% poles-%offset%)
         (difl double-float difl-%data% difl-%offset%)
         (difr double-float difr-%data% difr-%offset%)
         (z double-float z-%data% z-%offset%)
         (work double-float work-%data% work-%offset%)
         (idxq fixnum idxq-%data% idxq-%offset%)
         (perm fixnum perm-%data% perm-%offset%)
         (givcol fixnum givcol-%data% givcol-%offset%)
         (iwork fixnum iwork-%data% iwork-%offset%))
      (prog ((orgnrm 0.0) (i 0) (idx 0) (idxc 0) (idxp 0) (isigma 0) (ivfw 0)
             (ivlw 0) (iw 0) (m 0) (n 0) (n1 0) (n2 0))
        (declare (type (double-float) orgnrm)
                 (type fixnum i idx idxc idxp isigma ivfw ivlw iw
                                       m n n1 n2))
        (setf info 0)
```

```
(setf n (f2cl-lib:int-add nl nr 1))
(setf m (f2cl-lib:int-add n sqre))
(cond
  ((or (< icompq 0) (> icompq 1))
   (setf info -1))
  ((< nl 1)
   (setf info -2))
  ((< nr 1)
   (setf info -3))
  ((or (< sqre 0) (> sqre 1))
   (setf info -4))
  ((< ldgcol n)
   (setf info -14))
  ((< ldgnum n)
   (setf info -16)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DLASD6" (f2cl-lib:int-sub info))
   (go end_label)))
(setf isigma 1)
(setf iw (f2cl-lib:int-add isigma n))
(setf ivfw (f2cl-lib:int-add iw m))
(setf ivlw (f2cl-lib:int-add ivfw m))
(setf idx 1)
(setf idxc (f2cl-lib:int-add idx n))
(setf idxp (f2cl-lib:int-add idxc n))
(setf orgnrm (max (abs alpha) (abs beta)))
(setf (f2cl-lib:fref d-%data%
                     ((f2cl-lib:int-add nl 1))
                     ((1 *))
                     d-%offset%)
        zero)
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i n) nil)
  (tagbody
    (cond
      ((> (abs (f2cl-lib:fref d (i) ((1 *)))) orgnrm)
       (setf orgnrm
           (abs (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)))))))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
    (dlascl "G" 0 0 orgnrm one n 1 d n info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                   var-8))
  (setf info var-9))
(setf alpha (/ alpha orgnrm))
(setf beta (/ beta orgnrm))
(multiple-value-bind
```

```
             (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
              var-10 var-11 var-12 var-13 var-14 var-15 var-16 var-17 var-18
              var-19 var-20 var-21 var-22 var-23 var-24 var-25 var-26)
            (dlasd7 icompq nl nr sqre k d z
             (f2cl-lib:array-slice work double-float (iw) ((1 *))) vf
             (f2cl-lib:array-slice work double-float (ivfw) ((1 *))) vl
             (f2cl-lib:array-slice work double-float (ivlw) ((1 *))) alpha beta
             (f2cl-lib:array-slice work double-float (isigma) ((1 *)))
             (f2cl-lib:array-slice iwork fixnum (idx) ((1 *)))
             (f2cl-lib:array-slice iwork fixnum (idxp) ((1 *))) idxq
            perm givptr givcol ldgcol givnum ldgnum c s info)
          (declare (ignore var-0 var-1 var-2 var-3 var-5 var-6 var-7 var-8
                           var-9 var-10 var-11 var-12 var-13 var-14 var-15
                           var-16 var-17 var-18 var-20 var-21 var-22 var-23))
          (setf k var-4)
          (setf givptr var-19)
          (setf c var-24)
          (setf s var-25)
          (setf info var-26))
        (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
               var-10 var-11)
            (dlasd8 icompq k d z vf vl difl difr ldgnum
             (f2cl-lib:array-slice work double-float (isigma) ((1 *)))
             (f2cl-lib:array-slice work double-float (iw) ((1 *))) info)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                           var-8 var-9 var-10))
          (setf info var-11))
        (cond
          ((= icompq 1)
           (dcopy k d 1
            (f2cl-lib:array-slice poles double-float (1 1) ((1 ldgnum) (1 *)))
            1)
           (dcopy k (f2cl-lib:array-slice work double-float (isigma) ((1 *))) 1
            (f2cl-lib:array-slice poles double-float (1 2) ((1 ldgnum) (1 *)))
            1)))
        (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
            (dlascl "G" 0 0 one orgnrm n 1 d n info)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                           var-8))
          (setf info var-9))
        (setf n1 k)
        (setf n2 (f2cl-lib:int-sub n k))
        (dlamrg n1 n2 d 1 -1 idxq)
end_label
        (return
         (values nil
                 nil
                 nil
```

```
                nil
                nil
                nil
                nil
                alpha
                beta
                nil
                nil
                givptr
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                k
                c
                s
                nil
                nil
                info))))))
```

———-

6.64 dlasd7 LAPACK

— **dlasd7.input** —

```
)set break resume
)sys rm -f dlasd7.output
)spool dlasd7.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlasd7.help** —

```
=======================================================================
```

```
dlasd7 examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DLASD7  - the two sets of singular values together into a single sorted
       set

SYNOPSIS
       SUBROUTINE DLASD7( ICOMPQ, NL, NR, SQRE, K, D, Z, ZW, VF, VFW, VL, VLW,
                          ALPHA,  BETA, DSIGMA, IDX, IDXP, IDXQ, PERM, GIVPTR,
                          GIVCOL, LDGCOL, GIVNUM, LDGNUM, C, S, INFO )

           INTEGER        GIVPTR, ICOMPQ, INFO, K,  LDGCOL,  LDGNUM,  NL,  NR,
                          SQRE

           DOUBLE         PRECISION ALPHA, BETA, C, S

           INTEGER        GIVCOL( LDGCOL, * ), IDX( * ), IDXP( * ), IDXQ( * ),
                          PERM( * )

           DOUBLE         PRECISION D( * ), DSIGMA( * ), GIVNUM( LDGNUM, *  ),
                          VF(  * ), VFW( * ), VL( * ), VLW( * ), Z( * ), ZW( *
                          )

  Purpose
  =======

  DLASD7 merges the two sets of singular values together into a single
  sorted set. Then it tries to deflate the size of the problem. There
  are two ways in which deflation can occur:  when two or more singular
  values are close together or if there is a tiny entry in the Z
  vector. For each such occurrence the order of the related
  secular equation problem is reduced by one.

  DLASD7 is called from DLASD6.

  Arguments
  =========

  ICOMPQ  (input) INTEGER
          Specifies whether singular vectors are to be computed
          in compact form, as follows:
          = 0: Compute singular values only.
          = 1: Compute singular vectors of upper
               bidiagonal matrix in compact form.
```

```
NL     (input) INTEGER
       The row dimension of the upper block. NL >= 1.

NR     (input) INTEGER
       The row dimension of the lower block. NR >= 1.

SQRE   (input) INTEGER
       = 0: the lower block is an NR-by-NR square matrix.
       = 1: the lower block is an NR-by-(NR+1) rectangular matrix.

       The bidiagonal matrix has
       N = NL + NR + 1 rows and
       M = N + SQRE >= N columns.

K      (output) INTEGER
       Contains the dimension of the non-deflated matrix, this is
       the order of the related secular equation. 1 <= K <=N.

D      (input/output) DOUBLE PRECISION array, dimension ( N )
       On entry D contains the singular values of the two submatrices
       to be combined. On exit D contains the trailing (N-K) updated
       singular values (those which were deflated) sorted into
       increasing order.

Z      (output) DOUBLE PRECISION array, dimension ( M )
       On exit Z contains the updating row vector in the secular
       equation.

ZW     (workspace) DOUBLE PRECISION array, dimension ( M )
       Workspace for Z.

VF     (input/output) DOUBLE PRECISION array, dimension ( M )
       On entry, VF(1:NL+1) contains the first components of all
       right singular vectors of the upper block; and VF(NL+2:M)
       contains the first components of all right singular vectors
       of the lower block. On exit, VF contains the first components
       of all right singular vectors of the bidiagonal matrix.

VFW    (workspace) DOUBLE PRECISION array, dimension ( M )
       Workspace for VF.

VL     (input/output) DOUBLE PRECISION array, dimension ( M )
       On entry, VL(1:NL+1) contains the  last components of all
       right singular vectors of the upper block; and VL(NL+2:M)
       contains the last components of all right singular vectors
       of the lower block. On exit, VL contains the last components
       of all right singular vectors of the bidiagonal matrix.

VLW    (workspace) DOUBLE PRECISION array, dimension ( M )
       Workspace for VL.
```

```
ALPHA  (input) DOUBLE PRECISION
       Contains the diagonal element associated with the added row.

BETA   (input) DOUBLE PRECISION
       Contains the off-diagonal element associated with the added
       row.

DSIGMA (output) DOUBLE PRECISION array, dimension ( N )
       Contains a copy of the diagonal elements (K-1 singular values
       and one zero) in the secular equation.

IDX    (workspace) INTEGER array, dimension ( N )
       This will contain the permutation used to sort the contents of
       D into ascending order.

IDXP   (workspace) INTEGER array, dimension ( N )
       This will contain the permutation used to place deflated
       values of D at the end of the array. On output IDXP(2:K)
       points to the nondeflated D-values and IDXP(K+1:N)
       points to the deflated singular values.

IDXQ   (input) INTEGER array, dimension ( N )
       This contains the permutation which separately sorts the two
       sub-problems in D into ascending order.  Note that entries in
       the first half of this permutation must first be moved one
       position backward; and entries in the second half
       must first have NL+1 added to their values.

PERM   (output) INTEGER array, dimension ( N )
       The permutations (from deflation and sorting) to be applied
       to each singular block. Not referenced if ICOMPQ = 0.

GIVPTR (output) INTEGER
       The number of Givens rotations which took place in this
       subproblem. Not referenced if ICOMPQ = 0.

GIVCOL (output) INTEGER array, dimension ( LDGCOL, 2 )
       Each pair of numbers indicates a pair of columns to take place
       in a Givens rotation. Not referenced if ICOMPQ = 0.

LDGCOL (input) INTEGER
       The leading dimension of GIVCOL, must be at least N.

GIVNUM (output) DOUBLE PRECISION array, dimension ( LDGNUM, 2 )
       Each number indicates the C or S value to be used in the
       corresponding Givens rotation. Not referenced if ICOMPQ = 0.

LDGNUM (input) INTEGER
       The leading dimension of GIVNUM, must be at least N.
```

```
  C      (output) DOUBLE PRECISION
         C contains garbage if SQRE =0 and the C-value of a Givens
         rotation related to the right null space if SQRE = 1.

  S      (output) DOUBLE PRECISION
         S contains garbage if SQRE =0 and the S-value of a Givens
         rotation related to the right null space if SQRE = 1.

  INFO   (output) INTEGER
         = 0:  successful exit.
         < 0:  if INFO = -i, the i-th argument had an illegal value.

  Further Details
  ===============

  Based on contributions by
     Ming Gu and Huan Ren, Computer Science Division, University of
     California at Berkeley, USA
```

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— dlasd7.f —

```
      SUBROUTINE DLASD7( ICOMPQ, NL, NR, SQRE, K, D, Z, ZW, VF, VFW, VL,
     $                   VLW, ALPHA, BETA, DSIGMA, IDX, IDXP, IDXQ,
     $                   PERM, GIVPTR, GIVCOL, LDGCOL, GIVNUM, LDGNUM,
     $                   C, S, INFO )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Oak Ridge National Lab, Argonne National Lab,
*     Courant Institute, NAG Ltd., and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      INTEGER            GIVPTR, ICOMPQ, INFO, K, LDGCOL, LDGNUM, NL,
     $                   NR, SQRE
      DOUBLE PRECISION   ALPHA, BETA, C, S
*     ..
*     .. Array Arguments ..
      INTEGER            GIVCOL( LDGCOL, * ), IDX( * ), IDXP( * ),
     $                   IDXQ( * ), PERM( * )
      DOUBLE PRECISION   D( * ), DSIGMA( * ), GIVNUM( LDGNUM, * ),
     $                   VF( * ), VFW( * ), VL( * ), VLW( * ), Z( * ),
     $                   ZW( * )
*     ..
*
*  =====================================================================
```

```
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE, TWO, EIGHT
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0, TWO = 2.0D+0,
     $                   EIGHT = 8.0D+0 )
*     ..
*     .. Local Scalars ..
*
      INTEGER            I, IDXI, IDXJ, IDXJP, J, JP, JPREV, K2, M, N,
     $                   NLP1, NLP2
      DOUBLE PRECISION   EPS, HLFTOL, TAU, TOL, Z1
*     ..
*     .. External Subroutines ..
      EXTERNAL           DCOPY, DLAMRG, DROT, XERBLA
*     ..
*     .. External Functions ..
      DOUBLE PRECISION   DLAMCH, DLAPY2
      EXTERNAL           DLAMCH, DLAPY2
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      N = NL + NR + 1
      M = N + SQRE
*
      IF( ( ICOMPQ.LT.0 ) .OR. ( ICOMPQ.GT.1 ) ) THEN
         INFO = -1
      ELSE IF( NL.LT.1 ) THEN
         INFO = -2
      ELSE IF( NR.LT.1 ) THEN
         INFO = -3
      ELSE IF( ( SQRE.LT.0 ) .OR. ( SQRE.GT.1 ) ) THEN
         INFO = -4
      ELSE IF( LDGCOL.LT.N ) THEN
         INFO = -22
      ELSE IF( LDGNUM.LT.N ) THEN
         INFO = -24
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DLASD7', -INFO )
         RETURN
      END IF
*
      NLP1 = NL + 1
      NLP2 = NL + 2
```

```
      IF( ICOMPQ.EQ.1 ) THEN
         GIVPTR = 0
      END IF
*
*     Generate the first part of the vector Z and move the singular
*     values in the first part of D one position backward.
*
      Z1 = ALPHA*VL( NLP1 )
      VL( NLP1 ) = ZERO
      TAU = VF( NLP1 )
      DO 10 I = NL, 1, -1
         Z( I+1 ) = ALPHA*VL( I )
         VL( I ) = ZERO
         VF( I+1 ) = VF( I )
         D( I+1 ) = D( I )
         IDXQ( I+1 ) = IDXQ( I ) + 1
   10 CONTINUE
      VF( 1 ) = TAU
*
*     Generate the second part of the vector Z.
*
      DO 20 I = NLP2, M
         Z( I ) = BETA*VF( I )
         VF( I ) = ZERO
   20 CONTINUE
*
*     Sort the singular values into increasing order
*
      DO 30 I = NLP2, N
         IDXQ( I ) = IDXQ( I ) + NLP1
   30 CONTINUE
*
*     DSIGMA, IDXC, IDXC, and ZW are used as storage space.
*
      DO 40 I = 2, N
         DSIGMA( I ) = D( IDXQ( I ) )
         ZW( I ) = Z( IDXQ( I ) )
         VFW( I ) = VF( IDXQ( I ) )
         VLW( I ) = VL( IDXQ( I ) )
   40 CONTINUE
*
      CALL DLAMRG( NL, NR, DSIGMA( 2 ), 1, 1, IDX( 2 ) )
*
      DO 50 I = 2, N
         IDXI = 1 + IDX( I )
         D( I ) = DSIGMA( IDXI )
         Z( I ) = ZW( IDXI )
         VF( I ) = VFW( IDXI )
         VL( I ) = VLW( IDXI )
   50 CONTINUE
```

```
*
*     Calculate the allowable deflation tolerence
*
      EPS = DLAMCH( 'Epsilon' )
      TOL = MAX( ABS( ALPHA ), ABS( BETA ) )
      TOL = EIGHT*EIGHT*EPS*MAX( ABS( D( N ) ), TOL )
*
*     There are 2 kinds of deflation -- first a value in the z-vector
*     is small, second two (or more) singular values are very close
*     together (their difference is small).
*
*     If the value in the z-vector is small, we simply permute the
*     array so that the corresponding singular value is moved to the
*     end.
*
*     If two values in the D-vector are close, we perform a two-sided
*     rotation designed to make one of the corresponding z-vector
*     entries zero, and then permute the array so that the deflated
*     singular value is moved to the end.
*
*     If there are multiple singular values then the problem deflates.
*     Here the number of equal singular values are found.  As each equal
*     singular value is found, an elementary reflector is computed to
*     rotate the corresponding singular subspace so that the
*     corresponding components of Z are zero in this new basis.
*
      K = 1
      K2 = N + 1
      DO 60 J = 2, N
         IF( ABS( Z( J ) ).LE.TOL ) THEN
*
*           Deflate due to small z component.
*
            K2 = K2 - 1
            IDXP( K2 ) = J
            IF( J.EQ.N )
     $         GO TO 100
         ELSE
            JPREV = J
            GO TO 70
         END IF
   60 CONTINUE
   70 CONTINUE
      J = JPREV
   80 CONTINUE
      J = J + 1
      IF( J.GT.N )
     $   GO TO 90
      IF( ABS( Z( J ) ).LE.TOL ) THEN
*
```

```
*        Deflate due to small z component.
*
         K2 = K2 - 1
         IDXP( K2 ) = J
      ELSE
*
*        Check if singular values are close enough to allow deflation.
*
         IF( ABS( D( J )-D( JPREV ) ).LE.TOL ) THEN
*
*           Deflation is possible.
*
            S = Z( JPREV )
            C = Z( J )
*
*           Find sqrt(a**2+b**2) without overflow or
*           destructive underflow.
*
            TAU = DLAPY2( C, S )
            Z( J ) = TAU
            Z( JPREV ) = ZERO
            C = C / TAU
            S = -S / TAU
*
*           Record the appropriate Givens rotation
*
            IF( ICOMPQ.EQ.1 ) THEN
               GIVPTR = GIVPTR + 1
               IDXJP = IDXQ( IDX( JPREV )+1 )
               IDXJ = IDXQ( IDX( J )+1 )
               IF( IDXJP.LE.NLP1 ) THEN
                  IDXJP = IDXJP - 1
               END IF
               IF( IDXJ.LE.NLP1 ) THEN
                  IDXJ = IDXJ - 1
               END IF
               GIVCOL( GIVPTR, 2 ) = IDXJP
               GIVCOL( GIVPTR, 1 ) = IDXJ
               GIVNUM( GIVPTR, 2 ) = C
               GIVNUM( GIVPTR, 1 ) = S
            END IF
            CALL DROT( 1, VF( JPREV ), 1, VF( J ), 1, C, S )
            CALL DROT( 1, VL( JPREV ), 1, VL( J ), 1, C, S )
            K2 = K2 - 1
            IDXP( K2 ) = JPREV
            JPREV = J
         ELSE
            K = K + 1
            ZW( K ) = Z( JPREV )
            DSIGMA( K ) = D( JPREV )
```

```
            IDXP( K ) = JPREV
            JPREV = J
         END IF
      END IF
      GO TO 80
   90 CONTINUE
*
*     Record the last singular value.
*
      K = K + 1
      ZW( K ) = Z( JPREV )
      DSIGMA( K ) = D( JPREV )
      IDXP( K ) = JPREV
*
  100 CONTINUE
*
*     Sort the singular values into DSIGMA. The singular values which
*     were not deflated go into the first K slots of DSIGMA, except
*     that DSIGMA(1) is treated separately.
*
      DO 110 J = 2, N
         JP = IDXP( J )
         DSIGMA( J ) = D( JP )
         VFW( J ) = VF( JP )
         VLW( J ) = VL( JP )
  110 CONTINUE
      IF( ICOMPQ.EQ.1 ) THEN
         DO 120 J = 2, N
            JP = IDXP( J )
            PERM( J ) = IDXQ( IDX( JP )+1 )
            IF( PERM( J ).LE.NLP1 ) THEN
               PERM( J ) = PERM( J ) - 1
            END IF
  120    CONTINUE
      END IF
*
*     The deflated singular values go back into the last N - K slots of
*     D.
*
      CALL DCOPY( N-K, DSIGMA( K+1 ), 1, D( K+1 ), 1 )
*
*     Determine DSIGMA(1), DSIGMA(2), Z(1), VF(1), VL(1), VF(M), and
*     VL(M).
*
      DSIGMA( 1 ) = ZERO
      HLFTOL = TOL / TWO
      IF( ABS( DSIGMA( 2 ) ).LE.HLFTOL )
     $   DSIGMA( 2 ) = HLFTOL
      IF( M.GT.N ) THEN
         Z( 1 ) = DLAPY2( Z1, Z( M ) )
```

```
         IF( Z( 1 ).LE.TOL ) THEN
            C = ONE
            S = ZERO
            Z( 1 ) = TOL
         ELSE
            C = Z1 / Z( 1 )
            S = -Z( M ) / Z( 1 )
         END IF
         CALL DROT( 1, VF( M ), 1, VF( 1 ), 1, C, S )
         CALL DROT( 1, VL( M ), 1, VL( 1 ), 1, C, S )
      ELSE
         IF( ABS( Z1 ).LE.TOL ) THEN
            Z( 1 ) = TOL
         ELSE
            Z( 1 ) = Z1
         END IF
      END IF
*
*     Restore Z, VF, and VL.
*
      CALL DCOPY( K-1, ZW( 2 ), 1, Z( 2 ), 1 )
      CALL DCOPY( N-1, VFW( 2 ), 1, VF( 2 ), 1 )
      CALL DCOPY( N-1, VLW( 2 ), 1, VL( 2 ), 1 )
*
      RETURN
*
*     End of DLASD7
*
      END
```

———-

— LAPACK dlasd7 —

```
(let* ((zero 0.0) (one 1.0) (two 2.0) (eight 8.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one)
           (type (double-float 2.0 2.0) two)
           (type (double-float 8.0 8.0) eight))
  (defun dlasd7
         (icompq nl nr sqre k d z zw vf vfw vl vlw alpha beta dsigma idx idxp
          idxq perm givptr givcol ldgcol givnum ldgnum c s info)
    (declare (type (simple-array fixnum (*)) givcol perm idxq idxp idx)
             (type (double-float) s c beta alpha)
             (type (simple-array double-float (*)) givnum dsigma vlw vl
                                                   vfw vf zw z d)
             (type fixnum info ldgnum ldgcol givptr k sqre nr nl
                               icompq))
```

```
(f2cl-lib:with-multi-array-data
    ((d double-float d-%data% d-%offset%)
     (z double-float z-%data% z-%offset%)
     (zw double-float zw-%data% zw-%offset%)
     (vf double-float vf-%data% vf-%offset%)
     (vfw double-float vfw-%data% vfw-%offset%)
     (vl double-float vl-%data% vl-%offset%)
     (vlw double-float vlw-%data% vlw-%offset%)
     (dsigma double-float dsigma-%data% dsigma-%offset%)
     (givnum double-float givnum-%data% givnum-%offset%)
     (idx fixnum idx-%data% idx-%offset%)
     (idxp fixnum idxp-%data% idxp-%offset%)
     (idxq fixnum idxq-%data% idxq-%offset%)
     (perm fixnum perm-%data% perm-%offset%)
     (givcol fixnum givcol-%data% givcol-%offset%))
  (prog ((eps 0.0) (hlftol 0.0) (tau 0.0) (tol 0.0) (z1 0.0) (i 0) (idxi 0)
         (idxj 0) (idxjp 0) (j 0) (jp 0) (jprev 0) (k2 0) (m 0) (n 0)
         (nlp1 0) (nlp2 0))
    (declare (type (double-float) eps hlftol tau tol z1)
             (type fixnum i idxi idxj idxjp j jp jprev k2 m n
                                    nlp1 nlp2))
    (setf info 0)
    (setf n (f2cl-lib:int-add nl nr 1))
    (setf m (f2cl-lib:int-add n sqre))
    (cond
      ((or (< icompq 0) (> icompq 1))
       (setf info -1))
      ((< nl 1)
       (setf info -2))
      ((< nr 1)
       (setf info -3))
      ((or (< sqre 0) (> sqre 1))
       (setf info -4))
      ((< ldgcol n)
       (setf info -22))
      ((< ldgnum n)
       (setf info -24)))
    (cond
      ((/= info 0)
       (error
        " ** On entry to ~a parameter number ~a had an illegal value~%"
        "DLASD7" (f2cl-lib:int-sub info))
       (go end_label)))
    (setf nlp1 (f2cl-lib:int-add nl 1))
    (setf nlp2 (f2cl-lib:int-add nl 2))
    (cond
      ((= icompq 1)
       (setf givptr 0)))
    (setf z1
            (* alpha (f2cl-lib:fref vl-%data% (nlp1) ((1 *)) vl-%offset%)))
```

```
(setf (f2cl-lib:fref vl-%data% (nlp1) ((1 *)) vl-%offset%) zero)
(setf tau (f2cl-lib:fref vf-%data% (nlp1) ((1 *)) vf-%offset%))
(f2cl-lib:fdo (i nl (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
              ((> i 1) nil)
  (tagbody
    (setf (f2cl-lib:fref z-%data%
                         ((f2cl-lib:int-add i 1))
                         ((1 *))
                         z-%offset%)
            (* alpha
               (f2cl-lib:fref vl-%data% (i) ((1 *)) vl-%offset%)))
    (setf (f2cl-lib:fref vl-%data% (i) ((1 *)) vl-%offset%) zero)
    (setf (f2cl-lib:fref vf-%data%
                         ((f2cl-lib:int-add i 1))
                         ((1 *))
                         vf-%offset%)
            (f2cl-lib:fref vf-%data% (i) ((1 *)) vf-%offset%))
    (setf (f2cl-lib:fref d-%data%
                         ((f2cl-lib:int-add i 1))
                         ((1 *))
                         d-%offset%)
            (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
    (setf (f2cl-lib:fref idxq-%data%
                         ((f2cl-lib:int-add i 1))
                         ((1 *))
                         idxq-%offset%)
            (f2cl-lib:int-add
             (f2cl-lib:fref idxq-%data% (i) ((1 *)) idxq-%offset%)
             1))))
(setf (f2cl-lib:fref vf-%data% (1) ((1 *)) vf-%offset%) tau)
(f2cl-lib:fdo (i nlp2 (f2cl-lib:int-add i 1))
              ((> i m) nil)
  (tagbody
    (setf (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
            (* beta (f2cl-lib:fref vf-%data% (i) ((1 *)) vf-%offset%)))
    (setf (f2cl-lib:fref vf-%data% (i) ((1 *)) vf-%offset%) zero)))
(f2cl-lib:fdo (i nlp2 (f2cl-lib:int-add i 1))
              ((> i n) nil)
  (tagbody
    (setf (f2cl-lib:fref idxq-%data% (i) ((1 *)) idxq-%offset%)
            (f2cl-lib:int-add
             (f2cl-lib:fref idxq-%data% (i) ((1 *)) idxq-%offset%)
             nlp1))))
(f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
              ((> i n) nil)
  (tagbody
    (setf (f2cl-lib:fref dsigma-%data% (i) ((1 *)) dsigma-%offset%)
            (f2cl-lib:fref d-%data%
                           ((f2cl-lib:fref idxq (i) ((1 *))))
                           ((1 *))
```

```
                          d-%offset%))
    (setf (f2cl-lib:fref zw-%data% (i) ((1 *)) zw-%offset%)
            (f2cl-lib:fref z-%data%
                          ((f2cl-lib:fref idxq (i) ((1 *))))
                          ((1 *))
                          z-%offset%))
    (setf (f2cl-lib:fref vfw-%data% (i) ((1 *)) vfw-%offset%)
            (f2cl-lib:fref vf-%data%
                          ((f2cl-lib:fref idxq (i) ((1 *))))
                          ((1 *))
                          vf-%offset%))
    (setf (f2cl-lib:fref vlw-%data% (i) ((1 *)) vlw-%offset%)
            (f2cl-lib:fref vl-%data%
                          ((f2cl-lib:fref idxq (i) ((1 *))))
                          ((1 *))
                          vl-%offset%))))
(dlamrg nl nr (f2cl-lib:array-slice dsigma double-float (2) ((1 *))) 1
 1 (f2cl-lib:array-slice idx fixnum (2) ((1 *))))
(f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
              ((> i n) nil)
  (tagbody
    (setf idxi
            (f2cl-lib:int-add 1
                              (f2cl-lib:fref idx-%data%
                                             (i)
                                             ((1 *))
                                             idx-%offset%)))
    (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
            (f2cl-lib:fref dsigma-%data%
                          (idxi)
                          ((1 *))
                          dsigma-%offset%))
    (setf (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
            (f2cl-lib:fref zw-%data% (idxi) ((1 *)) zw-%offset%))
    (setf (f2cl-lib:fref vf-%data% (i) ((1 *)) vf-%offset%)
            (f2cl-lib:fref vfw-%data% (idxi) ((1 *)) vfw-%offset%))
    (setf (f2cl-lib:fref vl-%data% (i) ((1 *)) vl-%offset%)
            (f2cl-lib:fref vlw-%data% (idxi) ((1 *)) vlw-%offset%))))
(setf eps (dlamch "Epsilon"))
(setf tol (max (abs alpha) (abs beta)))
(setf tol
        (* eight
           eight
           eps
           (max (abs (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%))
                tol)))
(setf k 1)
(setf k2 (f2cl-lib:int-add n 1))
(f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
              ((> j n) nil)
```

```
          (tagbody
            (cond
              ((<= (abs (f2cl-lib:fref z (j) ((1 *)))) tol)
               (setf k2 (f2cl-lib:int-sub k2 1))
               (setf (f2cl-lib:fref idxp-%data% (k2) ((1 *)) idxp-%offset%) j)
               (if (= j n) (go label100)))
              (t
               (setf jprev j)
               (go label70)))))
label70
        (setf j jprev)
label80
        (setf j (f2cl-lib:int-add j 1))
        (if (> j n) (go label90))
        (cond
          ((<= (abs (f2cl-lib:fref z (j) ((1 *)))) tol)
           (setf k2 (f2cl-lib:int-sub k2 1))
           (setf (f2cl-lib:fref idxp-%data% (k2) ((1 *)) idxp-%offset%) j))
          (t
           (cond
             ((<=
               (abs
                (+ (f2cl-lib:fref d (j) ((1 *)))
                   (- (f2cl-lib:fref d (jprev) ((1 *))))))
               tol)
              (setf s (f2cl-lib:fref z-%data% (jprev) ((1 *)) z-%offset%))
              (setf c (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%))
              (setf tau (dlapy2 c s))
              (setf (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%) tau)
              (setf (f2cl-lib:fref z-%data% (jprev) ((1 *)) z-%offset%) zero)
              (setf c (/ c tau))
              (setf s (/ (- s) tau))
              (cond
                ((= icompq 1)
                 (setf givptr (f2cl-lib:int-add givptr 1))
                 (setf idxjp
                         (f2cl-lib:fref idxq-%data%
                                        ((f2cl-lib:int-add
                                          (f2cl-lib:fref idx (jprev) ((1 *)))
                                          1))
                                        ((1 *))
                                        idxq-%offset%))
                 (setf idxj
                         (f2cl-lib:fref idxq-%data%
                                        ((f2cl-lib:int-add
                                          (f2cl-lib:fref idx (j) ((1 *)))
                                          1))
                                        ((1 *))
                                        idxq-%offset%))
                 (cond
```

```
                  ((<= idxjp nlp1)
                   (setf idxjp (f2cl-lib:int-sub idxjp 1))))
                 (cond
                  ((<= idxj nlp1)
                   (setf idxj (f2cl-lib:int-sub idxj 1))))
                 (setf (f2cl-lib:fref givcol-%data%
                                      (givptr 2)
                                      ((1 ldgcol) (1 *))
                                      givcol-%offset%)
                         idxjp)
                 (setf (f2cl-lib:fref givcol-%data%
                                      (givptr 1)
                                      ((1 ldgcol) (1 *))
                                      givcol-%offset%)
                         idxj)
                 (setf (f2cl-lib:fref givnum-%data%
                                      (givptr 2)
                                      ((1 ldgnum) (1 *))
                                      givnum-%offset%)
                         c)
                 (setf (f2cl-lib:fref givnum-%data%
                                      (givptr 1)
                                      ((1 ldgnum) (1 *))
                                      givnum-%offset%)
                         s)))
           (drot 1 (f2cl-lib:array-slice vf double-float (jprev) ((1 *))) 1
            (f2cl-lib:array-slice vf double-float (j) ((1 *))) 1 c s)
           (drot 1 (f2cl-lib:array-slice vl double-float (jprev) ((1 *))) 1
            (f2cl-lib:array-slice vl double-float (j) ((1 *))) 1 c s)
           (setf k2 (f2cl-lib:int-sub k2 1))
           (setf (f2cl-lib:fref idxp-%data% (k2) ((1 *)) idxp-%offset%)
                   jprev)
           (setf jprev j))
          (t
           (setf k (f2cl-lib:int-add k 1))
           (setf (f2cl-lib:fref zw-%data% (k) ((1 *)) zw-%offset%)
                   (f2cl-lib:fref z-%data% (jprev) ((1 *)) z-%offset%))
           (setf (f2cl-lib:fref dsigma-%data% (k) ((1 *)) dsigma-%offset%)
                   (f2cl-lib:fref d-%data% (jprev) ((1 *)) d-%offset%))
           (setf (f2cl-lib:fref idxp-%data% (k) ((1 *)) idxp-%offset%) jprev)
           (setf jprev j)))))
      (go label80)
label90
      (setf k (f2cl-lib:int-add k 1))
      (setf (f2cl-lib:fref zw-%data% (k) ((1 *)) zw-%offset%)
              (f2cl-lib:fref z-%data% (jprev) ((1 *)) z-%offset%))
      (setf (f2cl-lib:fref dsigma-%data% (k) ((1 *)) dsigma-%offset%)
              (f2cl-lib:fref d-%data% (jprev) ((1 *)) d-%offset%))
      (setf (f2cl-lib:fref idxp-%data% (k) ((1 *)) idxp-%offset%) jprev)
label100
```

```
(f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
              ((> j n) nil)
  (tagbody
    (setf jp (f2cl-lib:fref idxp-%data% (j) ((1 *)) idxp-%offset%))
    (setf (f2cl-lib:fref dsigma-%data% (j) ((1 *)) dsigma-%offset%)
            (f2cl-lib:fref d-%data% (jp) ((1 *)) d-%offset%))
    (setf (f2cl-lib:fref vfw-%data% (j) ((1 *)) vfw-%offset%)
            (f2cl-lib:fref vf-%data% (jp) ((1 *)) vf-%offset%))
    (setf (f2cl-lib:fref vlw-%data% (j) ((1 *)) vlw-%offset%)
            (f2cl-lib:fref vl-%data% (jp) ((1 *)) vl-%offset%))))
(cond
  ((= icompq 1)
   (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
     (tagbody
       (setf jp (f2cl-lib:fref idxp-%data% (j) ((1 *)) idxp-%offset%))
       (setf (f2cl-lib:fref perm-%data% (j) ((1 *)) perm-%offset%)
               (f2cl-lib:fref idxq-%data%
                              ((f2cl-lib:int-add
                                (f2cl-lib:fref idx (jp) ((1 *)))
                                1))
                              ((1 *))
                              idxq-%offset%))
       (cond
         ((<= (f2cl-lib:fref perm (j) ((1 *))) nlp1)
          (setf (f2cl-lib:fref perm-%data% (j) ((1 *)) perm-%offset%)
                  (f2cl-lib:int-sub
                   (f2cl-lib:fref perm-%data%
                                  (j)
                                  ((1 *))
                                  perm-%offset%)
                   1)))))))
(dcopy (f2cl-lib:int-sub n k)
 (f2cl-lib:array-slice dsigma double-float ((+ k 1)) ((1 *))) 1
 (f2cl-lib:array-slice d double-float ((+ k 1)) ((1 *))) 1)
(setf (f2cl-lib:fref dsigma-%data% (1) ((1 *)) dsigma-%offset%) zero)
(setf hlftol (/ tol two))
(if
 (<= (abs (f2cl-lib:fref dsigma-%data% (2) ((1 *)) dsigma-%offset%))
     hlftol)
 (setf (f2cl-lib:fref dsigma-%data% (2) ((1 *)) dsigma-%offset%)
         hlftol))
(cond
  ((> m n)
   (setf (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)
           (dlapy2 z1 (f2cl-lib:fref z-%data% (m) ((1 *)) z-%offset%)))
   (cond
     ((<= (f2cl-lib:fref z (1) ((1 *))) tol)
      (setf c one)
      (setf s zero)
```

```
             (setf (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%) tol))
            (t
             (setf c (/ z1 (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)))
             (setf s
                     (/ (- (f2cl-lib:fref z-%data% (m) ((1 *)) z-%offset%))
                        (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)))))
           (drot 1 (f2cl-lib:array-slice vf double-float (m) ((1 *))) 1
            (f2cl-lib:array-slice vf double-float (1) ((1 *))) 1 c s)
           (drot 1 (f2cl-lib:array-slice vl double-float (m) ((1 *))) 1
            (f2cl-lib:array-slice vl double-float (1) ((1 *))) 1 c s))
          (t
           (cond
             ((<= (abs z1) tol)
              (setf (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%) tol))
             (t
              (setf (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%) z1)))))
        (dcopy (f2cl-lib:int-sub k 1)
         (f2cl-lib:array-slice zw double-float (2) ((1 *))) 1
         (f2cl-lib:array-slice z double-float (2) ((1 *))) 1)
        (dcopy (f2cl-lib:int-sub n 1)
         (f2cl-lib:array-slice vfw double-float (2) ((1 *))) 1
         (f2cl-lib:array-slice vf double-float (2) ((1 *))) 1)
        (dcopy (f2cl-lib:int-sub n 1)
         (f2cl-lib:array-slice vlw double-float (2) ((1 *))) 1
         (f2cl-lib:array-slice vl double-float (2) ((1 *))) 1)
 end_label
        (return
         (values nil
                 nil
                 nil
                 nil
                 k
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 givptr
                 nil
                 nil
                 nil
```

```
                nil
                c
                s
                info))))))
```

———-

6.65 dlasd8 LAPACK

— **dlasd8.input** —

```
)set break resume
)sys rm -f dlasd8.output
)spool dlasd8.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlasd8.help** —

```
=======================================================================
dlasd8 examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

NAME
       DLASD8 - the square roots of the roots of the secular equation,

SYNOPSIS
       SUBROUTINE DLASD8( ICOMPQ, K, D, Z, VF, VL, DIFL, DIFR, LDDIFR, DSIGMA,
                          WORK, INFO )

           INTEGER        ICOMPQ, INFO, K, LDDIFR

           DOUBLE         PRECISION D( * ), DIFL( *  ),  DIFR(  LDDIFR,  *  ),
                          DSIGMA( * ), VF( * ), VL( * ), WORK( * ), Z( * )
```

```
Purpose
=======

DLASD8 finds the square roots of the roots of the secular equation,
as defined by the values in DSIGMA and Z. It makes the appropriate
calls to DLASD4, and stores, for each  element in D, the distance
to its two nearest poles (elements in DSIGMA). It also updates
the arrays VF and VL, the first and last components of all the
right singular vectors of the original bidiagonal matrix.

DLASD8 is called from DLASD6.

Arguments
=========

ICOMPQ  (input) INTEGER
        Specifies whether singular vectors are to be computed in
        factored form in the calling routine:
        = 0: Compute singular values only.
        = 1: Compute singular vectors in factored form as well.

K       (input) INTEGER
        The number of terms in the rational function to be solved
        by DLASD4.  K >= 1.

D       (output) DOUBLE PRECISION array, dimension ( K )
        On output, D contains the updated singular values.

Z       (input) DOUBLE PRECISION array, dimension ( K )
        The first K elements of this array contain the components
        of the deflation-adjusted updating row vector.

VF      (input/output) DOUBLE PRECISION array, dimension ( K )
        On entry, VF contains  information passed through DBEDE8.
        On exit, VF contains the first K components of the first
        components of all right singular vectors of the bidiagonal
        matrix.

VL      (input/output) DOUBLE PRECISION array, dimension ( K )
        On entry, VL contains  information passed through DBEDE8.
        On exit, VL contains the first K components of the last
        components of all right singular vectors of the bidiagonal
        matrix.

DIFL    (output) DOUBLE PRECISION array, dimension ( K )
        On exit, DIFL(I) = D(I) - DSIGMA(I).

DIFR    (output) DOUBLE PRECISION array,
                 dimension ( LDDIFR, 2 ) if ICOMPQ = 1 and
                 dimension ( K ) if ICOMPQ = 0.
```

```
          On exit, DIFR(I,1) = D(I) - DSIGMA(I+1), DIFR(K,1) is not
          defined and will not be referenced.

          If ICOMPQ = 1, DIFR(1:K,2) is an array containing the
          normalizing factors for the right singular vector matrix.

  LDDIFR  (input) INTEGER
          The leading dimension of DIFR, must be at least K.

  DSIGMA  (input) DOUBLE PRECISION array, dimension ( K )
          The first K elements of this array contain the old roots
          of the deflated updating problem.  These are the poles
          of the secular equation.

  WORK    (workspace) DOUBLE PRECISION array, dimension at least 3 * K

  INFO    (output) INTEGER
          = 0:  successful exit.
          < 0:  if INFO = -i, the i-th argument had an illegal value.
          > 0:  if INFO = 1, an singular value did not converge

  Further Details
  ===============

  Based on contributions by
     Ming Gu and Huan Ren, Computer Science Division, University of
     California at Berkeley, USA
```

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— dlasd8.f —

```
      SUBROUTINE DLASD8( ICOMPQ, K, D, Z, VF, VL, DIFL, DIFR, LDDIFR,
     $                   DSIGMA, WORK, INFO )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Oak Ridge National Lab, Argonne National Lab,
*     Courant Institute, NAG Ltd., and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      INTEGER            ICOMPQ, INFO, K, LDDIFR
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   D( * ), DIFL( * ), DIFR( LDDIFR, * ),
     $                   DSIGMA( * ), VF( * ), VL( * ), WORK( * ),
     $                   Z( * )
*     ..
```

```
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE
      PARAMETER          ( ONE = 1.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I, IWK1, IWK2, IWK2I, IWK3, IWK3I, J
      DOUBLE PRECISION   DIFLJ, DIFRJ, DJ, DSIGJ, DSIGJP, RHO, TEMP
*     ..
*     .. External Subroutines ..
      EXTERNAL           DCOPY, DLASCL, DLASD4, DLASET, XERBLA
*     ..
*     .. External Functions ..
      DOUBLE PRECISION   DDOT, DLAMC3, DNRM2
      EXTERNAL           DDOT, DLAMC3, DNRM2
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, SIGN, SQRT
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
*
      IF( ( ICOMPQ.LT.0 ) .OR. ( ICOMPQ.GT.1 ) ) THEN
         INFO = -1
      ELSE IF( K.LT.1 ) THEN
         INFO = -2
      ELSE IF( LDDIFR.LT.K ) THEN
         INFO = -9
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DLASD8', -INFO )
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( K.EQ.1 ) THEN
         D( 1 ) = ABS( Z( 1 ) )
         DIFL( 1 ) = D( 1 )
         IF( ICOMPQ.EQ.1 ) THEN
            DIFL( 2 ) = ONE
            DIFR( 1, 2 ) = ONE
         END IF
         RETURN
      END IF
```

```
*
*     Modify values DSIGMA(i) to make sure all DSIGMA(i)-DSIGMA(j) can
*     be computed with high relative accuracy (barring over/underflow).
*     This is a problem on machines without a guard digit in
*     add/subtract (Cray XMP, Cray YMP, Cray C 90 and Cray 2).
*     The following code replaces DSIGMA(I) by 2*DSIGMA(I)-DSIGMA(I),
*     which on any of these machines zeros out the bottommost
*     bit of DSIGMA(I) if it is 1; this makes the subsequent
*     subtractions DSIGMA(I)-DSIGMA(J) unproblematic when cancellation
*     occurs. On binary machines with a guard digit (almost all
*     machines) it does not change DSIGMA(I) at all. On hexadecimal
*     and decimal machines with a guard digit, it slightly
*     changes the bottommost bits of DSIGMA(I). It does not account
*     for hexadecimal or decimal machines without guard digits
*     (we know of none). We use a subroutine call to compute
*     2*DLAMBDA(I) to prevent optimizing compilers from eliminating
*     this code.
*
      DO 10 I = 1, K
         DSIGMA( I ) = DLAMC3( DSIGMA( I ), DSIGMA( I ) ) - DSIGMA( I )
   10 CONTINUE
*
*     Book keeping.
*
      IWK1 = 1
      IWK2 = IWK1 + K
      IWK3 = IWK2 + K
      IWK2I = IWK2 - 1
      IWK3I = IWK3 - 1
*
*     Normalize Z.
*
      RHO = DNRM2( K, Z, 1 )
      CALL DLASCL( 'G', 0, 0, RHO, ONE, K, 1, Z, K, INFO )
      RHO = RHO*RHO
*
*     Initialize WORK(IWK3).
*
      CALL DLASET( 'A', K, 1, ONE, ONE, WORK( IWK3 ), K )
*
*     Compute the updated singular values, the arrays DIFL, DIFR,
*     and the updated Z.
*
      DO 40 J = 1, K
         CALL DLASD4( K, J, DSIGMA, Z, WORK( IWK1 ), RHO, D( J ),
     $                WORK( IWK2 ), INFO )
*
*        If the root finder fails, the computation is terminated.
*
         IF( INFO.NE.0 ) THEN
```

```
            RETURN
         END IF
         WORK( IWK3I+J ) = WORK( IWK3I+J )*WORK( J )*WORK( IWK2I+J )
         DIFL( J ) = -WORK( J )
         DIFR( J, 1 ) = -WORK( J+1 )
         DO 20 I = 1, J - 1
            WORK( IWK3I+I ) = WORK( IWK3I+I )*WORK( I )*
     $                        WORK( IWK2I+I ) / ( DSIGMA( I )-
     $                        DSIGMA( J ) ) / ( DSIGMA( I )+
     $                        DSIGMA( J ) )
   20    CONTINUE
         DO 30 I = J + 1, K
            WORK( IWK3I+I ) = WORK( IWK3I+I )*WORK( I )*
     $                        WORK( IWK2I+I ) / ( DSIGMA( I )-
     $                        DSIGMA( J ) ) / ( DSIGMA( I )+
     $                        DSIGMA( J ) )
   30    CONTINUE
   40 CONTINUE
*
*     Compute updated Z.
*
      DO 50 I = 1, K
         Z( I ) = SIGN( SQRT( ABS( WORK( IWK3I+I ) ) ), Z( I ) )
   50 CONTINUE
*
*     Update VF and VL.
*
      DO 80 J = 1, K
         DIFLJ = DIFL( J )
         DJ = D( J )
         DSIGJ = -DSIGMA( J )
         IF( J.LT.K ) THEN
            DIFRJ = -DIFR( J, 1 )
            DSIGJP = -DSIGMA( J+1 )
         END IF
         WORK( J ) = -Z( J ) / DIFLJ / ( DSIGMA( J )+DJ )
         DO 60 I = 1, J - 1
            WORK( I ) = Z( I ) / ( DLAMC3( DSIGMA( I ), DSIGJ )-DIFLJ )
     $                  / ( DSIGMA( I )+DJ )
   60    CONTINUE
         DO 70 I = J + 1, K
            WORK( I ) = Z( I ) / ( DLAMC3( DSIGMA( I ), DSIGJP )+DIFRJ )
     $                  / ( DSIGMA( I )+DJ )
   70    CONTINUE
         TEMP = DNRM2( K, WORK, 1 )
         WORK( IWK2I+J ) = DDOT( K, WORK, 1, VF, 1 ) / TEMP
         WORK( IWK3I+J ) = DDOT( K, WORK, 1, VL, 1 ) / TEMP
         IF( ICOMPQ.EQ.1 ) THEN
            DIFR( J, 2 ) = TEMP
         END IF
```

```
   80 CONTINUE
*
      CALL DCOPY( K, WORK( IWK2 ), 1, VF, 1 )
      CALL DCOPY( K, WORK( IWK3 ), 1, VL, 1 )
*
      RETURN
*
*     End of DLASD8
*
      END
```

———-

— LAPACK dlasd8 —

```
(let* ((one 1.0))
  (declare (type (double-float 1.0 1.0) one))
  (defun dlasd8 (icompq k d z vf vl difl difr lddifr dsigma work info)
    (declare (type (simple-array double-float (*)) work dsigma difr difl vl vf z d)
             (type fixnum info lddifr k icompq))
    (f2cl-lib:with-multi-array-data
        ((d double-float d-%data% d-%offset%)
         (z double-float z-%data% z-%offset%)
         (vf double-float vf-%data% vf-%offset%)
         (vl double-float vl-%data% vl-%offset%)
         (difl double-float difl-%data% difl-%offset%)
         (difr double-float difr-%data% difr-%offset%)
         (dsigma double-float dsigma-%data% dsigma-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((diflj 0.0) (difrj 0.0) (dj 0.0) (dsigj 0.0) (dsigjp 0.0)
             (rho 0.0) (temp 0.0) (i 0) (iwk1 0) (iwk2 0) (iwk2i 0) (iwk3 0)
             (iwk3i 0) (j 0))
        (declare (type (double-float) diflj difrj dj dsigj dsigjp rho temp)
                 (type fixnum i iwk1 iwk2 iwk2i iwk3 iwk3i j))
        (setf info 0)
        (cond
          ((or (< icompq 0) (> icompq 1))
           (setf info -1))
          ((< k 1)
           (setf info -2))
          ((< lddifr k)
           (setf info -9)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DLASD8" (f2cl-lib:int-sub info))
           (go end_label)))
```

```
(cond
  ((= k 1)
   (setf (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)
         (abs (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)))
   (setf (f2cl-lib:fref difl-%data% (1) ((1 *)) difl-%offset%)
         (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%))
   (cond
     ((= icompq 1)
      (setf (f2cl-lib:fref difl-%data% (2) ((1 *)) difl-%offset%) one)
      (setf (f2cl-lib:fref difr-%data%
                           (1 2)
                           ((1 lddifr) (1 *))
                           difr-%offset%)
            one)))
   (go end_label)))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i k) nil)
  (tagbody
    (setf (f2cl-lib:fref dsigma-%data% (i) ((1 *)) dsigma-%offset%)
          (-
           (multiple-value-bind (ret-val var-0 var-1)
               (dlamc3
                (f2cl-lib:fref dsigma-%data%
                               (i)
                               ((1 *))
                               dsigma-%offset%)
                (f2cl-lib:fref dsigma-%data%
                               (i)
                               ((1 *))
                               dsigma-%offset%))
             (declare (ignore))
             (setf (f2cl-lib:fref dsigma-%data%
                                  (i)
                                  ((1 *))
                                  dsigma-%offset%)
                   var-0)
             (setf (f2cl-lib:fref dsigma-%data%
                                  (i)
                                  ((1 *))
                                  dsigma-%offset%)
                   var-1)
             ret-val)
           (f2cl-lib:fref dsigma-%data%
                          (i)
                          ((1 *))
                          dsigma-%offset%)))))
(setf iwk1 1)
(setf iwk2 (f2cl-lib:int-add iwk1 k))
(setf iwk3 (f2cl-lib:int-add iwk2 k))
(setf iwk2i (f2cl-lib:int-sub iwk2 1))
```

```
(setf iwk3i (f2cl-lib:int-sub iwk3 1))
(setf rho (dnrm2 k z 1))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
    (dlascl "G" 0 0 rho one k 1 z k info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                   var-8))
  (setf info var-9))
(setf rho (* rho rho))
(dlaset "A" k 1 one one
 (f2cl-lib:array-slice work double-float (iwk3) ((1 *))) k)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j k) nil)
  (tagbody
    (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
        (dlasd4 k j dsigma z
         (f2cl-lib:array-slice work double-float (iwk1) ((1 *))) rho
         (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
         (f2cl-lib:array-slice work double-float (iwk2) ((1 *))) info)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-7))
      (setf (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%) var-6)
      (setf info var-8))
    (cond
      ((/= info 0)
       (go end_label)))
    (setf (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-add iwk3i j))
                         ((1 *))
                         work-%offset%)
            (*
             (f2cl-lib:fref work-%data%
                            ((f2cl-lib:int-add iwk3i j))
                            ((1 *))
                            work-%offset%)
             (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
             (f2cl-lib:fref work-%data%
                            ((f2cl-lib:int-add iwk2i j))
                            ((1 *))
                            work-%offset%)))
    (setf (f2cl-lib:fref difl-%data% (j) ((1 *)) difl-%offset%)
            (- (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)))
    (setf (f2cl-lib:fref difr-%data%
                         (j 1)
                         ((1 lddifr) (1 *))
                         difr-%offset%)
            (-
             (f2cl-lib:fref work-%data%
                            ((f2cl-lib:int-add j 1))
                            ((1 *))
```

```
                        work-%offset%)))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i (f2cl-lib:int-add j (f2cl-lib:int-sub 1))) nil)
  (tagbody
    (setf (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-add iwk3i i))
                         ((1 *))
                         work-%offset%)
            (/
             (/
              (*
               (f2cl-lib:fref work-%data%
                              ((f2cl-lib:int-add iwk3i i))
                              ((1 *))
                              work-%offset%)
               (f2cl-lib:fref work-%data%
                              (i)
                              ((1 *))
                              work-%offset%)
               (f2cl-lib:fref work-%data%
                              ((f2cl-lib:int-add iwk2i i))
                              ((1 *))
                              work-%offset%))
              (-
               (f2cl-lib:fref dsigma-%data%
                              (i)
                              ((1 *))
                              dsigma-%offset%)
               (f2cl-lib:fref dsigma-%data%
                              (j)
                              ((1 *))
                              dsigma-%offset%)))
             (+
              (f2cl-lib:fref dsigma-%data%
                             (i)
                             ((1 *))
                             dsigma-%offset%)
              (f2cl-lib:fref dsigma-%data%
                             (j)
                             ((1 *))
                             dsigma-%offset%))))))
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1) (f2cl-lib:int-add i 1))
              ((> i k) nil)
  (tagbody
    (setf (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-add iwk3i i))
                         ((1 *))
                         work-%offset%)
            (/
             (/
```

```
                     (*
                      (f2cl-lib:fref work-%data%
                                     ((f2cl-lib:int-add iwk3i i))
                                     ((1 *))
                                     work-%offset%)
                      (f2cl-lib:fref work-%data%
                                     (i)
                                     ((1 *))
                                     work-%offset%)
                      (f2cl-lib:fref work-%data%
                                     ((f2cl-lib:int-add iwk2i i))
                                     ((1 *))
                                     work-%offset%))
                     (-
                      (f2cl-lib:fref dsigma-%data%
                                     (i)
                                     ((1 *))
                                     dsigma-%offset%)
                      (f2cl-lib:fref dsigma-%data%
                                     (j)
                                     ((1 *))
                                     dsigma-%offset%)))
                    (+
                     (f2cl-lib:fref dsigma-%data%
                                    (i)
                                    ((1 *))
                                    dsigma-%offset%)
                     (f2cl-lib:fref dsigma-%data%
                                    (j)
                                    ((1 *))
                                    dsigma-%offset%))))))))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i k) nil)
  (tagbody
    (setf (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
            (f2cl-lib:sign
             (f2cl-lib:fsqrt
              (abs
               (f2cl-lib:fref work-%data%
                              ((f2cl-lib:int-add iwk3i i))
                              ((1 *))
                              work-%offset%)))
             (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)))))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j k) nil)
  (tagbody
    (setf diflj (f2cl-lib:fref difl-%data% (j) ((1 *)) difl-%offset%))
    (setf dj (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%))
    (setf dsigj
            (-
```

```
          (f2cl-lib:fref dsigma-%data%
                         (j)
                         ((1 *))
                         dsigma-%offset%)))
(cond
  ((< j k)
   (setf difrj
           (-
            (f2cl-lib:fref difr-%data%
                           (j 1)
                           ((1 lddifr) (1 *))
                           difr-%offset%)))
   (setf dsigjp
           (-
            (f2cl-lib:fref dsigma-%data%
                           ((f2cl-lib:int-add j 1))
                           ((1 *))
                           dsigma-%offset%)))))
(setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
        (/
         (/ (- (f2cl-lib:fref z-%data% (j) ((1 *)) z-%offset%))
            diflj)
         (+
          (f2cl-lib:fref dsigma-%data% (j) ((1 *)) dsigma-%offset%)
          dj)))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i (f2cl-lib:int-add j (f2cl-lib:int-sub 1))) nil)
  (tagbody
    (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
            (/
             (/ (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
                (-
                 (multiple-value-bind (ret-val var-0 var-1)
                     (dlamc3
                      (f2cl-lib:fref dsigma-%data%
                                     (i)
                                     ((1 *))
                                     dsigma-%offset%)
                      dsigj)
                   (declare (ignore))
                   (setf (f2cl-lib:fref dsigma-%data%
                                        (i)
                                        ((1 *))
                                        dsigma-%offset%)
                         var-0)
                   (setf dsigj var-1)
                   ret-val)
                 diflj))
              (+
               (f2cl-lib:fref dsigma-%data%
```

```
                                (i)
                                ((1 *))
                                dsigma-%offset%)
                     dj)))))
(f2cl-lib:fdo (i (f2cl-lib:int-add j 1) (f2cl-lib:int-add i 1))
              ((> i k) nil)
  (tagbody
    (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
            (/
             (/ (f2cl-lib:fref z-%data% (i) ((1 *)) z-%offset%)
                (+
                 (multiple-value-bind (ret-val var-0 var-1)
                     (dlamc3
                      (f2cl-lib:fref dsigma-%data%
                                     (i)
                                     ((1 *))
                                     dsigma-%offset%)
                      dsigjp)
                   (declare (ignore))
                   (setf (f2cl-lib:fref dsigma-%data%
                                        (i)
                                        ((1 *))
                                        dsigma-%offset%)
                         var-0)
                   (setf dsigjp var-1)
                   ret-val)
                 difrj))
             (+
              (f2cl-lib:fref dsigma-%data%
                             (i)
                             ((1 *))
                             dsigma-%offset%)
              dj)))))
(setf temp (dnrm2 k work 1))
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add iwk2i j))
                     ((1 *))
                     work-%offset%)
        (/ (ddot k work 1 vf 1) temp))
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add iwk3i j))
                     ((1 *))
                     work-%offset%)
        (/ (ddot k work 1 vl 1) temp))
(cond
  ((= icompq 1)
   (setf (f2cl-lib:fref difr-%data%
                        (j 2)
                        ((1 lddifr) (1 *))
                        difr-%offset%)
```

```
                    temp)))))
       (dcopy k (f2cl-lib:array-slice work double-float (iwk2) ((1 *))) 1 vf 1)
       (dcopy k (f2cl-lib:array-slice work double-float (iwk3) ((1 *))) 1 vl 1)
 end_label
       (return (values nil nil nil nil nil nil nil nil nil nil nil info))))))
```

———-

6.66 dlasda LAPACK

— dlasda.input —

```
)set break resume
)sys rm -f dlasda.output
)spool dlasda.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dlasda.help —

```
==========================================================================
dlasda examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

NAME
       DLASDA  -  divide  and  conquer  approach, DLASDA computes the singular
       value decomposition (SVD) of a real upper bidiagonal  N-by-M  matrix  B
       with diagonal D and offdiagonal E, where M = N + SQRE

SYNOPSIS
       SUBROUTINE DLASDA( ICOMPQ,  SMLSIZ, N, SQRE, D, E, U, LDU, VT, K, DIFL,
                          DIFR,  Z,  POLES,  GIVPTR,  GIVCOL,  LDGCOL,   PERM,
                          GIVNUM, C, S, WORK, IWORK, INFO )

           INTEGER        ICOMPQ, INFO, LDGCOL, LDU, N, SMLSIZ, SQRE
```

```
          INTEGER        GIVCOL(  LDGCOL,  * ), GIVPTR( * ), IWORK( * ), K( *
                         ), PERM( LDGCOL, * )

          DOUBLE         PRECISION C( * ), D( * ), DIFL( LDU, * ), DIFR( LDU,
                         * ), E( * ), GIVNUM( LDU, * ), POLES( LDU, * ), S( *
                         ), U( LDU, * ), VT( LDU, * ), WORK( * ), Z( LDU, * )

  Purpose
  =======

  Using a divide and conquer approach, DLASDA computes the singular
  value decomposition (SVD) of a real upper bidiagonal N-by-M matrix
  B with diagonal D and offdiagonal E, where M = N + SQRE. The
  algorithm computes the singular values in the SVD B = U * S * VT.
  The orthogonal matrices U and VT are optionally computed in
  compact form.

  A related subroutine, DLASD0, computes the singular values and
  the singular vectors in explicit form.

  Arguments
  =========

  ICOMPQ (input) INTEGER
         Specifies whether singular vectors are to be computed
         in compact form, as follows
         = 0: Compute singular values only.
         = 1: Compute singular vectors of upper bidiagonal
              matrix in compact form.

  SMLSIZ (input) INTEGER
         The maximum size of the subproblems at the bottom of the
         computation tree.

  N      (input) INTEGER
         The row dimension of the upper bidiagonal matrix. This is
         also the dimension of the main diagonal array D.

  SQRE   (input) INTEGER
         Specifies the column dimension of the bidiagonal matrix.
         = 0: The bidiagonal matrix has column dimension M = N;
         = 1: The bidiagonal matrix has column dimension M = N + 1.

  D      (input/output) DOUBLE PRECISION array, dimension ( N )
         On entry D contains the main diagonal of the bidiagonal
         matrix. On exit D, if INFO = 0, contains its singular values.

  E      (input) DOUBLE PRECISION array, dimension ( M-1 )
         Contains the subdiagonal entries of the bidiagonal matrix.
```

```
        On exit, E has been destroyed.

  U     (output) DOUBLE PRECISION array,
        dimension ( LDU, SMLSIZ ) if ICOMPQ = 1, and not referenced
        if ICOMPQ = 0. If ICOMPQ = 1, on exit, U contains the left
        singular vector matrices of all subproblems at the bottom
        level.

  LDU   (input) INTEGER, LDU = > N.
        The leading dimension of arrays U, VT, DIFL, DIFR, POLES,
        GIVNUM, and Z.

  VT    (output) DOUBLE PRECISION array,
        dimension ( LDU, SMLSIZ+1 ) if ICOMPQ = 1, and not referenced
        if ICOMPQ = 0. If ICOMPQ = 1, on exit, VT' contains the right
        singular vector matrices of all subproblems at the bottom
        level.

  K     (output) INTEGER array,
        dimension ( N ) if ICOMPQ = 1 and dimension 1 if ICOMPQ = 0.
        If ICOMPQ = 1, on exit, K(I) is the dimension of the I-th
        secular equation on the computation tree.

  DIFL  (output) DOUBLE PRECISION array, dimension ( LDU, NLVL ),
        where NLVL = floor(log_2 (N/SMLSIZ))).

  DIFR  (output) DOUBLE PRECISION array,
                 dimension ( LDU, 2 * NLVL ) if ICOMPQ = 1 and
                 dimension ( N ) if ICOMPQ = 0.
        If ICOMPQ = 1, on exit, DIFL(1:N, I) and DIFR(1:N, 2 * I - 1)
        record distances between singular values on the I-th
        level and singular values on the (I -1)-th level, and
        DIFR(1:N, 2 * I ) contains the normalizing factors for
        the right singular vector matrix. See DLASD8 for details.

  Z     (output) DOUBLE PRECISION array,
                 dimension ( LDU, NLVL ) if ICOMPQ = 1 and
                 dimension ( N ) if ICOMPQ = 0.
        The first K elements of Z(1, I) contain the components of
        the deflation-adjusted updating row vector for subproblems
        on the I-th level.

  POLES (output) DOUBLE PRECISION array,
        dimension ( LDU, 2 * NLVL ) if ICOMPQ = 1, and not referenced
        if ICOMPQ = 0. If ICOMPQ = 1, on exit, POLES(1, 2*I - 1) and
        POLES(1, 2*I) contain  the new and old singular values
        involved in the secular equations on the I-th level.

  GIVPTR (output) INTEGER array,
        dimension ( N ) if ICOMPQ = 1, and not referenced if
```

```
       ICOMPQ = 0. If ICOMPQ = 1, on exit, GIVPTR( I ) records
       the number of Givens rotations performed on the I-th
       problem on the computation tree.

GIVCOL (output) INTEGER array,
       dimension ( LDGCOL, 2 * NLVL ) if ICOMPQ = 1, and not
       referenced if ICOMPQ = 0. If ICOMPQ = 1, on exit, for each I,
       GIVCOL(1, 2 *I - 1) and GIVCOL(1, 2 *I) record the locations
       of Givens rotations performed on the I-th level on the
       computation tree.

LDGCOL (input) INTEGER, LDGCOL = > N.
       The leading dimension of arrays GIVCOL and PERM.

PERM   (output) INTEGER array,
       dimension ( LDGCOL, NLVL ) if ICOMPQ = 1, and not referenced
       if ICOMPQ = 0. If ICOMPQ = 1, on exit, PERM(1, I) records
       permutations done on the I-th level of the computation tree.

GIVNUM (output) DOUBLE PRECISION array,
       dimension ( LDU,  2 * NLVL ) if ICOMPQ = 1, and not
       referenced if ICOMPQ = 0. If ICOMPQ = 1, on exit, for each I,
       GIVNUM(1, 2 *I - 1) and GIVNUM(1, 2 *I) record the C- and S-
       values of Givens rotations performed on the I-th level on
       the computation tree.

C      (output) DOUBLE PRECISION array,
       dimension ( N ) if ICOMPQ = 1, and dimension 1 if ICOMPQ = 0.
       If ICOMPQ = 1 and the I-th subproblem is not square, on exit,
       C( I ) contains the C-value of a Givens rotation related to
       the right null space of the I-th subproblem.

S      (output) DOUBLE PRECISION array, dimension ( N ) if
       ICOMPQ = 1, and dimension 1 if ICOMPQ = 0. If ICOMPQ = 1
       and the I-th subproblem is not square, on exit, S( I )
       contains the S-value of a Givens rotation related to
       the right null space of the I-th subproblem.

WORK   (workspace) DOUBLE PRECISION array, dimension
       (6 * N + (SMLSIZ + 1)*(SMLSIZ + 1)).

IWORK  (workspace) INTEGER array.
       Dimension must be at least (7 * N).

INFO   (output) INTEGER
        = 0:  successful exit.
        < 0:  if INFO = -i, the i-th argument had an illegal value.
        > 0:  if INFO = 1, an singular value did not converge

Further Details
```

```
  ===============

  Based on contributions by
     Ming Gu and Huan Ren, Computer Science Division, University of
     California at Berkeley, USA
```

———-

— dlasda.f —

```
      SUBROUTINE DLASDA( ICOMPQ, SMLSIZ, N, SQRE, D, E, U, LDU, VT, K,
     $                   DIFL, DIFR, Z, POLES, GIVPTR, GIVCOL, LDGCOL,
     $                   PERM, GIVNUM, C, S, WORK, IWORK, INFO )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1999
*
*     .. Scalar Arguments ..
      INTEGER            ICOMPQ, INFO, LDGCOL, LDU, N, SMLSIZ, SQRE
*     ..
*     .. Array Arguments ..
      INTEGER            GIVCOL( LDGCOL, * ), GIVPTR( * ), IWORK( * ),
     $                   K( * ), PERM( LDGCOL, * )
      DOUBLE PRECISION   C( * ), D( * ), DIFL( LDU, * ), DIFR( LDU, * ),
     $                   E( * ), GIVNUM( LDU, * ), POLES( LDU, * ),
     $                   S( * ), U( LDU, * ), VT( LDU, * ), WORK( * ),
     $                   Z( LDU, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I, I1, IC, IDXQ, IDXQI, IM1, INODE, ITEMP, IWK,
     $                   J, LF, LL, LVL, LVL2, M, NCC, ND, NDB1, NDIML,
     $                   NDIMR, NL, NLF, NLP1, NLVL, NR, NRF, NRP1, NRU,
     $                   NWORK1, NWORK2, SMLSZP, SQREI, VF, VFI, VL, VLI
      DOUBLE PRECISION   ALPHA, BETA
*     ..
*     .. External Subroutines ..
      EXTERNAL           DCOPY, DLASD6, DLASDQ, DLASDT, DLASET, XERBLA
*     ..
*     .. Executable Statements ..
```

```
*
*     Test the input parameters.
*
      INFO = 0
*
      IF( ( ICOMPQ.LT.0 ) .OR. ( ICOMPQ.GT.1 ) ) THEN
         INFO = -1
      ELSE IF( SMLSIZ.LT.3 ) THEN
         INFO = -2
      ELSE IF( N.LT.0 ) THEN
         INFO = -3
      ELSE IF( ( SQRE.LT.0 ) .OR. ( SQRE.GT.1 ) ) THEN
         INFO = -4
      ELSE IF( LDU.LT.( N+SQRE ) ) THEN
         INFO = -8
      ELSE IF( LDGCOL.LT.N ) THEN
         INFO = -17
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DLASDA', -INFO )
         RETURN
      END IF
*
      M = N + SQRE
*
*     If the input matrix is too small, call DLASDQ to find the SVD.
*
      IF( N.LE.SMLSIZ ) THEN
         IF( ICOMPQ.EQ.0 ) THEN
            CALL DLASDQ( 'U', SQRE, N, 0, 0, 0, D, E, VT, LDU, U, LDU,
     $                   U, LDU, WORK, INFO )
         ELSE
            CALL DLASDQ( 'U', SQRE, N, M, N, 0, D, E, VT, LDU, U, LDU,
     $                   U, LDU, WORK, INFO )
         END IF
         RETURN
      END IF
*
*     Book-keeping and  set up the computation tree.
*
      INODE = 1
      NDIML = INODE + N
      NDIMR = NDIML + N
      IDXQ = NDIMR + N
      IWK = IDXQ + N
*
      NCC = 0
      NRU = 0
*
      SMLSZP = SMLSIZ + 1
```

```
      VF = 1
      VL = VF + M
      NWORK1 = VL + M
      NWORK2 = NWORK1 + SMLSZP*SMLSZP
*
      CALL DLASDT( N, NLVL, ND, IWORK( INODE ), IWORK( NDIML ),
     $             IWORK( NDIMR ), SMLSIZ )
*
*     for the nodes on bottom level of the tree, solve
*     their subproblems by DLASDQ.
*
      NDB1 = ( ND+1 ) / 2
      DO 30 I = NDB1, ND
*
*        IC : center row of each node
*        NL : number of rows of left  subproblem
*        NR : number of rows of right subproblem
*        NLF: starting row of the left   subproblem
*        NRF: starting row of the right  subproblem
*
         I1 = I - 1
         IC = IWORK( INODE+I1 )
         NL = IWORK( NDIML+I1 )
         NLP1 = NL + 1
         NR = IWORK( NDIMR+I1 )
         NLF = IC - NL
         NRF = IC + 1
         IDXQI = IDXQ + NLF - 2
         VFI = VF + NLF - 1
         VLI = VL + NLF - 1
         SQREI = 1
         IF( ICOMPQ.EQ.0 ) THEN
            CALL DLASET( 'A', NLP1, NLP1, ZERO, ONE, WORK( NWORK1 ),
     $                   SMLSZP )
            CALL DLASDQ( 'U', SQREI, NL, NLP1, NRU, NCC, D( NLF ),
     $                   E( NLF ), WORK( NWORK1 ), SMLSZP,
     $                   WORK( NWORK2 ), NL, WORK( NWORK2 ), NL,
     $                   WORK( NWORK2 ), INFO )
            ITEMP = NWORK1 + NL*SMLSZP
            CALL DCOPY( NLP1, WORK( NWORK1 ), 1, WORK( VFI ), 1 )
            CALL DCOPY( NLP1, WORK( ITEMP ), 1, WORK( VLI ), 1 )
         ELSE
            CALL DLASET( 'A', NL, NL, ZERO, ONE, U( NLF, 1 ), LDU )
            CALL DLASET( 'A', NLP1, NLP1, ZERO, ONE, VT( NLF, 1 ), LDU )
            CALL DLASDQ( 'U', SQREI, NL, NLP1, NL, NCC, D( NLF ),
     $                   E( NLF ), VT( NLF, 1 ), LDU, U( NLF, 1 ), LDU,
     $                   U( NLF, 1 ), LDU, WORK( NWORK1 ), INFO )
            CALL DCOPY( NLP1, VT( NLF, 1 ), 1, WORK( VFI ), 1 )
            CALL DCOPY( NLP1, VT( NLF, NLP1 ), 1, WORK( VLI ), 1 )
         END IF
```

```
         IF( INFO.NE.0 ) THEN
            RETURN
         END IF
         DO 10 J = 1, NL
            IWORK( IDXQI+J ) = J
   10    CONTINUE
         IF( ( I.EQ.ND ) .AND. ( SQRE.EQ.0 ) ) THEN
            SQREI = 0
         ELSE
            SQREI = 1
         END IF
         IDXQI = IDXQI + NLP1
         VFI = VFI + NLP1
         VLI = VLI + NLP1
         NRP1 = NR + SQREI
         IF( ICOMPQ.EQ.0 ) THEN
            CALL DLASET( 'A', NRP1, NRP1, ZERO, ONE, WORK( NWORK1 ),
     $                   SMLSZP )
            CALL DLASDQ( 'U', SQREI, NR, NRP1, NRU, NCC, D( NRF ),
     $                   E( NRF ), WORK( NWORK1 ), SMLSZP,
     $                   WORK( NWORK2 ), NR, WORK( NWORK2 ), NR,
     $                   WORK( NWORK2 ), INFO )
            ITEMP = NWORK1 + ( NRP1-1 )*SMLSZP
            CALL DCOPY( NRP1, WORK( NWORK1 ), 1, WORK( VFI ), 1 )
            CALL DCOPY( NRP1, WORK( ITEMP ), 1, WORK( VLI ), 1 )
         ELSE
            CALL DLASET( 'A', NR, NR, ZERO, ONE, U( NRF, 1 ), LDU )
            CALL DLASET( 'A', NRP1, NRP1, ZERO, ONE, VT( NRF, 1 ), LDU )
            CALL DLASDQ( 'U', SQREI, NR, NRP1, NR, NCC, D( NRF ),
     $                   E( NRF ), VT( NRF, 1 ), LDU, U( NRF, 1 ), LDU,
     $                   U( NRF, 1 ), LDU, WORK( NWORK1 ), INFO )
            CALL DCOPY( NRP1, VT( NRF, 1 ), 1, WORK( VFI ), 1 )
            CALL DCOPY( NRP1, VT( NRF, NRP1 ), 1, WORK( VLI ), 1 )
         END IF
         IF( INFO.NE.0 ) THEN
            RETURN
         END IF
         DO 20 J = 1, NR
            IWORK( IDXQI+J ) = J
   20    CONTINUE
   30 CONTINUE
*
*     Now conquer each subproblem bottom-up.
*
      J = 2**NLVL
      DO 50 LVL = NLVL, 1, -1
         LVL2 = LVL*2 - 1
*
*        Find the first node LF and last node LL on
*        the current level LVL.
```

```
*
         IF( LVL.EQ.1 ) THEN
            LF = 1
            LL = 1
         ELSE
            LF = 2**( LVL-1 )
            LL = 2*LF - 1
         END IF
         DO 40 I = LF, LL
            IM1 = I - 1
            IC = IWORK( INODE+IM1 )
            NL = IWORK( NDIML+IM1 )
            NR = IWORK( NDIMR+IM1 )
            NLF = IC - NL
            NRF = IC + 1
            IF( I.EQ.LL ) THEN
               SQREI = SQRE
            ELSE
               SQREI = 1
            END IF
            VFI = VF + NLF - 1
            VLI = VL + NLF - 1
            IDXQI = IDXQ + NLF - 1
            ALPHA = D( IC )
            BETA = E( IC )
            IF( ICOMPQ.EQ.0 ) THEN
               CALL DLASD6( ICOMPQ, NL, NR, SQREI, D( NLF ),
     $                      WORK( VFI ), WORK( VLI ), ALPHA, BETA,
     $                      IWORK( IDXQI ), PERM, GIVPTR( 1 ), GIVCOL,
     $                      LDGCOL, GIVNUM, LDU, POLES, DIFL, DIFR, Z,
     $                      K( 1 ), C( 1 ), S( 1 ), WORK( NWORK1 ),
     $                      IWORK( IWK ), INFO )
            ELSE
               J = J - 1
               CALL DLASD6( ICOMPQ, NL, NR, SQREI, D( NLF ),
     $                      WORK( VFI ), WORK( VLI ), ALPHA, BETA,
     $                      IWORK( IDXQI ), PERM( NLF, LVL ),
     $                      GIVPTR( J ), GIVCOL( NLF, LVL2 ), LDGCOL,
     $                      GIVNUM( NLF, LVL2 ), LDU,
     $                      POLES( NLF, LVL2 ), DIFL( NLF, LVL ),
     $                      DIFR( NLF, LVL2 ), Z( NLF, LVL ), K( J ),
     $                      C( J ), S( J ), WORK( NWORK1 ),
     $                      IWORK( IWK ), INFO )
            END IF
            IF( INFO.NE.0 ) THEN
               RETURN
            END IF
   40    CONTINUE
   50 CONTINUE
*
```

```
      RETURN
*
*     End of DLASDA
*
      END
```

— LAPACK dlasda —

```
(let* ((zero 0.0) (one 1.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one))
  (defun dlasda
         (icompq smlsiz n sqre d e u ldu vt k difl difr z poles givptr givcol
          ldgcol perm givnum c s work iwork info)
    (declare (type (simple-array fixnum (*)) iwork perm givcol givptr k)
             (type (simple-array double-float (*)) work s c givnum poles z difr difl
                                                   vt u e d)
             (type fixnum info ldgcol ldu sqre n smlsiz icompq))
    (f2cl-lib:with-multi-array-data
        ((d double-float d-%data% d-%offset%)
         (e double-float e-%data% e-%offset%)
         (u double-float u-%data% u-%offset%)
         (vt double-float vt-%data% vt-%offset%)
         (difl double-float difl-%data% difl-%offset%)
         (difr double-float difr-%data% difr-%offset%)
         (z double-float z-%data% z-%offset%)
         (poles double-float poles-%data% poles-%offset%)
         (givnum double-float givnum-%data% givnum-%offset%)
         (c double-float c-%data% c-%offset%)
         (s double-float s-%data% s-%offset%)
         (work double-float work-%data% work-%offset%)
         (k fixnum k-%data% k-%offset%)
         (givptr fixnum givptr-%data% givptr-%offset%)
         (givcol fixnum givcol-%data% givcol-%offset%)
         (perm fixnum perm-%data% perm-%offset%)
         (iwork fixnum iwork-%data% iwork-%offset%))
      (prog ((alpha 0.0) (beta 0.0) (i 0) (i1 0) (ic 0) (idxq 0) (idxqi 0)
             (im1 0) (inode 0) (itemp 0) (iwk 0) (j 0) (lf 0) (ll 0) (lvl 0)
             (lvl2 0) (m 0) (ncc 0) (nd 0) (ndb1 0) (ndiml 0) (ndimr 0) (nl 0)
             (nlf 0) (nlp1 0) (nlvl 0) (nr 0) (nrf 0) (nrp1 0) (nru 0)
             (nwork1 0) (nwork2 0) (smlszp 0) (sqrei 0) (vf 0) (vfi 0) (vl 0)
             (vli 0))
        (declare (type (double-float) alpha beta)
                 (type fixnum i i1 ic idxq idxqi im1 inode itemp
                                       iwk j lf ll lvl lvl2 m ncc nd ndb1
                                       ndiml ndimr nl nlf nlp1 nlvl nr nrf
```

```
                                    nrp1 nru nwork1 nwork2 smlszp sqrei
                                    vf vfi vl vli))
  (setf info 0)
  (cond
    ((or (< icompq 0) (> icompq 1))
     (setf info -1))
    ((< smlsiz 3)
     (setf info -2))
    ((< n 0)
     (setf info -3))
    ((or (< sqre 0) (> sqre 1))
     (setf info -4))
    ((< ldu (f2cl-lib:int-add n sqre))
     (setf info -8))
    ((< ldgcol n)
     (setf info -17)))
  (cond
    ((/= info 0)
     (error
      " ** On entry to ~a parameter number ~a had an illegal value~%"
      "DLASDA" (f2cl-lib:int-sub info))
     (go end_label)))
  (setf m (f2cl-lib:int-add n sqre))
  (cond
    ((<= n smlsiz)
     (cond
       ((= icompq 0)
        (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
               var-9 var-10 var-11 var-12 var-13 var-14 var-15)
            (dlasdq "U" sqre n 0 0 0 d e vt ldu u ldu u ldu work info)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                           var-7 var-8 var-9 var-10 var-11 var-12 var-13
                           var-14))
          (setf info var-15)))
       (t
        (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
               var-9 var-10 var-11 var-12 var-13 var-14 var-15)
            (dlasdq "U" sqre n m n 0 d e vt ldu u ldu u ldu work info)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                           var-7 var-8 var-9 var-10 var-11 var-12 var-13
                           var-14))
          (setf info var-15))))
     (go end_label)))
  (setf inode 1)
  (setf ndiml (f2cl-lib:int-add inode n))
  (setf ndimr (f2cl-lib:int-add ndiml n))
  (setf idxq (f2cl-lib:int-add ndimr n))
  (setf iwk (f2cl-lib:int-add idxq n))
```

```
(setf ncc 0)
(setf nru 0)
(setf smlszp (f2cl-lib:int-add smlsiz 1))
(setf vf 1)
(setf vl (f2cl-lib:int-add vf m))
(setf nwork1 (f2cl-lib:int-add vl m))
(setf nwork2
        (f2cl-lib:int-add nwork1 (f2cl-lib:int-mul smlszp smlszp)))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
    (dlasdt n nlvl nd
     (f2cl-lib:array-slice iwork fixnum (inode) ((1 *)))
     (f2cl-lib:array-slice iwork fixnum (ndiml) ((1 *)))
     (f2cl-lib:array-slice iwork fixnum (ndimr) ((1 *)))
     smlsiz)
  (declare (ignore var-0 var-3 var-4 var-5 var-6))
  (setf nlvl var-1)
  (setf nd var-2))
(setf ndb1 (the fixnum (truncate (+ nd 1) 2)))
(f2cl-lib:fdo (i ndb1 (f2cl-lib:int-add i 1))
              ((> i nd) nil)
  (tagbody
    (setf i1 (f2cl-lib:int-sub i 1))
    (setf ic
            (f2cl-lib:fref iwork-%data%
                           ((f2cl-lib:int-add inode i1))
                           ((1 *))
                           iwork-%offset%))
    (setf nl
            (f2cl-lib:fref iwork-%data%
                           ((f2cl-lib:int-add ndiml i1))
                           ((1 *))
                           iwork-%offset%))
    (setf nlp1 (f2cl-lib:int-add nl 1))
    (setf nr
            (f2cl-lib:fref iwork-%data%
                           ((f2cl-lib:int-add ndimr i1))
                           ((1 *))
                           iwork-%offset%))
    (setf nlf (f2cl-lib:int-sub ic nl))
    (setf nrf (f2cl-lib:int-add ic 1))
    (setf idxqi (f2cl-lib:int-sub (f2cl-lib:int-add idxq nlf) 2))
    (setf vfi (f2cl-lib:int-sub (f2cl-lib:int-add vf nlf) 1))
    (setf vli (f2cl-lib:int-sub (f2cl-lib:int-add vl nlf) 1))
    (setf sqrei 1)
    (cond
      ((= icompq 0)
       (dlaset "A" nlp1 nlp1 zero one
        (f2cl-lib:array-slice work double-float (nwork1) ((1 *)))
        smlszp)
       (multiple-value-bind
```

```
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9 var-10 var-11 var-12 var-13 var-14 var-15)
      (dlasdq "U" sqrei nl nlp1 nru ncc
       (f2cl-lib:array-slice d double-float (nlf) ((1 *)))
       (f2cl-lib:array-slice e double-float (nlf) ((1 *)))
       (f2cl-lib:array-slice work double-float (nwork1) ((1 *)))
       smlszp
       (f2cl-lib:array-slice work double-float (nwork2) ((1 *)))
       nl
       (f2cl-lib:array-slice work double-float (nwork2) ((1 *)))
       nl
       (f2cl-lib:array-slice work double-float (nwork2) ((1 *)))
       info)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                      var-7 var-8 var-9 var-10 var-11 var-12 var-13
                      var-14))
     (setf info var-15))
   (setf itemp
         (f2cl-lib:int-add nwork1 (f2cl-lib:int-mul nl smlszp)))
   (dcopy nlp1
    (f2cl-lib:array-slice work double-float (nwork1) ((1 *))) 1
    (f2cl-lib:array-slice work double-float (vfi) ((1 *))) 1)
   (dcopy nlp1
    (f2cl-lib:array-slice work double-float (itemp) ((1 *))) 1
    (f2cl-lib:array-slice work double-float (vli) ((1 *))) 1))
  (t
   (dlaset "A" nl nl zero one
    (f2cl-lib:array-slice u double-float (nlf 1) ((1 ldu) (1 *)))
    ldu)
   (dlaset "A" nlp1 nlp1 zero one
    (f2cl-lib:array-slice vt double-float (nlf 1) ((1 ldu) (1 *)))
    ldu)
   (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
         var-9 var-10 var-11 var-12 var-13 var-14 var-15)
       (dlasdq "U" sqrei nl nlp1 nl ncc
        (f2cl-lib:array-slice d double-float (nlf) ((1 *)))
        (f2cl-lib:array-slice e double-float (nlf) ((1 *)))
        (f2cl-lib:array-slice vt
                              double-float
                              (nlf 1)
                              ((1 ldu) (1 *)))
        ldu
        (f2cl-lib:array-slice u
                              double-float
                              (nlf 1)
                              ((1 ldu) (1 *)))
        ldu
        (f2cl-lib:array-slice u
                              double-float
```

```
                                (nlf 1)
                                ((1 ldu) (1 *)))
          ldu
          (f2cl-lib:array-slice work double-float (nwork1) ((1 *)))
          info)
       (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                        var-7 var-8 var-9 var-10 var-11 var-12 var-13
                        var-14))
       (setf info var-15))
     (dcopy nlp1
      (f2cl-lib:array-slice vt double-float (nlf 1) ((1 ldu) (1 *)))
      1 (f2cl-lib:array-slice work double-float (vfi) ((1 *))) 1)
     (dcopy nlp1
      (f2cl-lib:array-slice vt
                            double-float
                            (nlf nlp1)
                            ((1 ldu) (1 *)))
      1 (f2cl-lib:array-slice work double-float (vli) ((1 *))) 1)))
(cond
  ((/= info 0)
   (go end_label)))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j nl) nil)
  (tagbody
    (setf (f2cl-lib:fref iwork-%data%
                         ((f2cl-lib:int-add idxqi j))
                         ((1 *))
                         iwork-%offset%)
            j)))
(cond
  ((and (= i nd) (= sqre 0))
   (setf sqrei 0))
  (t
   (setf sqrei 1)))
(setf idxqi (f2cl-lib:int-add idxqi nlp1))
(setf vfi (f2cl-lib:int-add vfi nlp1))
(setf vli (f2cl-lib:int-add vli nlp1))
(setf nrp1 (f2cl-lib:int-add nr sqrei))
(cond
  ((= icompq 0)
   (dlaset "A" nrp1 nrp1 zero one
    (f2cl-lib:array-slice work double-float (nwork1) ((1 *)))
    smlszp)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
          var-9 var-10 var-11 var-12 var-13 var-14 var-15)
       (dlasdq "U" sqrei nr nrp1 nru ncc
        (f2cl-lib:array-slice d double-float (nrf) ((1 *)))
        (f2cl-lib:array-slice e double-float (nrf) ((1 *)))
        (f2cl-lib:array-slice work double-float (nwork1) ((1 *)))
```

```
      smlszp
      (f2cl-lib:array-slice work double-float (nwork2) ((1 *)))
      nr
      (f2cl-lib:array-slice work double-float (nwork2) ((1 *)))
      nr
      (f2cl-lib:array-slice work double-float (nwork2) ((1 *)))
      info)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9 var-10 var-11 var-12 var-13
                    var-14))
   (setf info var-15))
 (setf itemp
         (f2cl-lib:int-add nwork1
                           (f2cl-lib:int-mul
                            (f2cl-lib:int-sub nrp1 1)
                            smlszp)))
 (dcopy nrp1
  (f2cl-lib:array-slice work double-float (nwork1) ((1 *))) 1
  (f2cl-lib:array-slice work double-float (vfi) ((1 *))) 1)
 (dcopy nrp1
  (f2cl-lib:array-slice work double-float (itemp) ((1 *))) 1
  (f2cl-lib:array-slice work double-float (vli) ((1 *))) 1))
(t
 (dlaset "A" nr nr zero one
  (f2cl-lib:array-slice u double-float (nrf 1) ((1 ldu) (1 *)))
  ldu)
 (dlaset "A" nrp1 nrp1 zero one
  (f2cl-lib:array-slice vt double-float (nrf 1) ((1 ldu) (1 *)))
  ldu)
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9 var-10 var-11 var-12 var-13 var-14 var-15)
     (dlasdq "U" sqrei nr nrp1 nr ncc
      (f2cl-lib:array-slice d double-float (nrf) ((1 *)))
      (f2cl-lib:array-slice e double-float (nrf) ((1 *)))
      (f2cl-lib:array-slice vt
                            double-float
                            (nrf 1)
                            ((1 ldu) (1 *)))
      ldu
      (f2cl-lib:array-slice u
                            double-float
                            (nrf 1)
                            ((1 ldu) (1 *)))
      ldu
      (f2cl-lib:array-slice u
                            double-float
                            (nrf 1)
                            ((1 ldu) (1 *)))
      ldu
```

```
              (f2cl-lib:array-slice work double-float (nwork1) ((1 *)))
              info)
             (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                              var-7 var-8 var-9 var-10 var-11 var-12 var-13
                              var-14))
             (setf info var-15))
            (dcopy nrp1
             (f2cl-lib:array-slice vt double-float (nrf 1) ((1 ldu) (1 *)))
             1 (f2cl-lib:array-slice work double-float (vfi) ((1 *))) 1)
            (dcopy nrp1
             (f2cl-lib:array-slice vt
                                   double-float
                                   (nrf nrp1)
                                   ((1 ldu) (1 *)))
             1 (f2cl-lib:array-slice work double-float (vli) ((1 *))) 1)))
        (cond
          ((/= info 0)
           (go end_label)))
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                      ((> j nr) nil)
          (tagbody
            (setf (f2cl-lib:fref iwork-%data%
                                 ((f2cl-lib:int-add idxqi j))
                                 ((1 *))
                                 iwork-%offset%)
                  j)))))
    (setf j (expt 2 nlvl))
    (f2cl-lib:fdo (lvl nlvl (f2cl-lib:int-add lvl (f2cl-lib:int-sub 1)))
                  ((> lvl 1) nil)
      (tagbody
        (setf lvl2 (f2cl-lib:int-sub (f2cl-lib:int-mul lvl 2) 1))
        (cond
          ((= lvl 1)
           (setf lf 1)
           (setf ll 1))
          (t
           (setf lf (expt 2 (f2cl-lib:int-sub lvl 1)))
           (setf ll (f2cl-lib:int-sub (f2cl-lib:int-mul 2 lf) 1))))
        (f2cl-lib:fdo (i lf (f2cl-lib:int-add i 1))
                      ((> i ll) nil)
          (tagbody
            (setf im1 (f2cl-lib:int-sub i 1))
            (setf ic
                    (f2cl-lib:fref iwork-%data%
                                   ((f2cl-lib:int-add inode im1))
                                   ((1 *))
                                   iwork-%offset%))
            (setf nl
                    (f2cl-lib:fref iwork-%data%
                                   ((f2cl-lib:int-add ndiml im1))
```

```
                      ((1 *))
                      iwork-%offset%))
(setf nr
       (f2cl-lib:fref iwork-%data%
                      ((f2cl-lib:int-add ndimr im1))
                      ((1 *))
                      iwork-%offset%))
(setf nlf (f2cl-lib:int-sub ic nl))
(setf nrf (f2cl-lib:int-add ic 1))
(cond
  ((= i ll)
   (setf sqrei sqre))
  (t
   (setf sqrei 1)))
(setf vfi (f2cl-lib:int-sub (f2cl-lib:int-add vf nlf) 1))
(setf vli (f2cl-lib:int-sub (f2cl-lib:int-add vl nlf) 1))
(setf idxqi (f2cl-lib:int-sub (f2cl-lib:int-add idxq nlf) 1))
(setf alpha (f2cl-lib:fref d-%data% (ic) ((1 *)) d-%offset%))
(setf beta (f2cl-lib:fref e-%data% (ic) ((1 *)) e-%offset%))
(cond
  ((= icompq 0)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
          var-9 var-10 var-11 var-12 var-13 var-14 var-15
          var-16 var-17 var-18 var-19 var-20 var-21 var-22
          var-23 var-24 var-25)
       (dlasd6 icompq nl nr sqrei
        (f2cl-lib:array-slice d double-float (nlf) ((1 *)))
        (f2cl-lib:array-slice work double-float (vfi) ((1 *)))
        (f2cl-lib:array-slice work double-float (vli) ((1 *)))
        alpha beta
        (f2cl-lib:array-slice iwork
                              fixnum
                              (idxqi)
                              ((1 *)))
        perm
        (f2cl-lib:fref givptr-%data%
                       (1)
                       ((1 *))
                       givptr-%offset%)
        givcol ldgcol givnum ldu poles difl difr z
        (f2cl-lib:fref k-%data% (1) ((1 *)) k-%offset%)
        (f2cl-lib:fref c-%data% (1) ((1 *)) c-%offset%)
        (f2cl-lib:fref s-%data% (1) ((1 *)) s-%offset%)
        (f2cl-lib:array-slice work
                              double-float
                              (nwork1)
                              ((1 *)))
        (f2cl-lib:array-slice iwork
                              fixnum
```

```
                              (iwk)
                              ((1 *)))
      info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                     var-9 var-10 var-12 var-13 var-14 var-15
                     var-16 var-17 var-18 var-19 var-23
                     var-24))
    (setf alpha var-7)
    (setf beta var-8)
    (setf (f2cl-lib:fref givptr-%data%
                         (1)
                         ((1 *))
                         givptr-%offset%)
          var-11)
    (setf (f2cl-lib:fref k-%data% (1) ((1 *)) k-%offset%)
          var-20)
    (setf (f2cl-lib:fref c-%data% (1) ((1 *)) c-%offset%)
          var-21)
    (setf (f2cl-lib:fref s-%data% (1) ((1 *)) s-%offset%)
          var-22)
    (setf info var-25)))
(t
 (setf j (f2cl-lib:int-sub j 1))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9 var-10 var-11 var-12 var-13 var-14 var-15
        var-16 var-17 var-18 var-19 var-20 var-21 var-22
        var-23 var-24 var-25)
     (dlasd6 icompq nl nr sqrei
      (f2cl-lib:array-slice d double-float (nlf) ((1 *)))
      (f2cl-lib:array-slice work double-float (vfi) ((1 *)))
      (f2cl-lib:array-slice work double-float (vli) ((1 *)))
      alpha beta
      (f2cl-lib:array-slice iwork
                            fixnum
                            (idxqi)
                            ((1 *)))
      (f2cl-lib:array-slice perm
                            fixnum
                            (nlf lvl)
                            ((1 ldgcol) (1 *)))
      (f2cl-lib:fref givptr-%data%
                     (j)
                     ((1 *))
                     givptr-%offset%)
      (f2cl-lib:array-slice givcol
                            fixnum
                            (nlf lvl2)
                            ((1 ldgcol) (1 *)))
      ldgcol
```

```
   (f2cl-lib:array-slice givnum
                         double-float
                         (nlf lvl2)
                         ((1 ldu) (1 *)))
   ldu
   (f2cl-lib:array-slice poles
                         double-float
                         (nlf lvl2)
                         ((1 ldu) (1 *)))
   (f2cl-lib:array-slice difl
                         double-float
                         (nlf lvl)
                         ((1 ldu) (1 *)))
   (f2cl-lib:array-slice difr
                         double-float
                         (nlf lvl2)
                         ((1 ldu) (1 *)))
   (f2cl-lib:array-slice z
                         double-float
                         (nlf lvl)
                         ((1 ldu) (1 *)))
   (f2cl-lib:fref k-%data% (j) ((1 *)) k-%offset%)
   (f2cl-lib:fref c-%data% (j) ((1 *)) c-%offset%)
   (f2cl-lib:fref s-%data% (j) ((1 *)) s-%offset%)
   (f2cl-lib:array-slice work
                         double-float
                         (nwork1)
                         ((1 *)))
   (f2cl-lib:array-slice iwork
                         fixnum
                         (iwk)
                         ((1 *)))
   info)
(declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                 var-9 var-10 var-12 var-13 var-14 var-15
                 var-16 var-17 var-18 var-19 var-23
                 var-24))
(setf alpha var-7)
(setf beta var-8)
(setf (f2cl-lib:fref givptr-%data%
                     (j)
                     ((1 *))
                     givptr-%offset%)
        var-11)
(setf (f2cl-lib:fref k-%data% (j) ((1 *)) k-%offset%)
        var-20)
(setf (f2cl-lib:fref c-%data% (j) ((1 *)) c-%offset%)
        var-21)
(setf (f2cl-lib:fref s-%data% (j) ((1 *)) s-%offset%)
        var-22)
```

```
                    (setf info var-25))))
                (cond
                  ((/= info 0)
                   (go end_label)))))))
 end_label
        (return
         (values nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 info))))))
```

————-

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— dlasdq.input —

```
)set break resume
)sys rm -f dlasdq.output
)spool dlasdq.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dlasdq.help —

```
=====================================================================
dlasdq examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DLASDQ  -  the  singular  value decomposition (SVD) of a real (upper or
       lower) bidiagonal matrix with diagonal D and offdiagonal E,  accumulat-
       ing the transformations if desired

SYNOPSIS
       SUBROUTINE DLASDQ( UPLO,  SQRE,  N,  NCVT, NRU, NCC, D, E, VT, LDVT, U,
                          LDU, C, LDC, WORK, INFO )

           CHARACTER      UPLO

           INTEGER        INFO, LDC, LDU, LDVT, N, NCC, NCVT, NRU, SQRE

           DOUBLE         PRECISION C( LDC, * ), D( * ), E( * ), U( LDU, *  ),
                          VT( LDVT, * ), WORK( * )

  Purpose
  =======

  DLASDQ computes the singular value decomposition (SVD) of a real
  (upper or lower) bidiagonal matrix with diagonal D and offdiagonal
  E, accumulating the transformations if desired. Letting B denote
  the input bidiagonal matrix, the algorithm computes orthogonal
  matrices Q and P such that B = Q * S * P' (P' denotes the transpose
  of P). The singular values S are overwritten on D.

  The input matrix U  is changed to U  * Q  if desired.
  The input matrix VT is changed to P' * VT if desired.
  The input matrix C  is changed to Q' * C  if desired.

  See "Computing  Small Singular Values of Bidiagonal Matrices With
  Guaranteed High Relative Accuracy," by J. Demmel and W. Kahan,
  LAPACK Working Note #3, for a detailed description of the algorithm.

  Arguments
  =========
```

```
UPLO  (input) CHARACTER*1
      On entry, UPLO specifies whether the input bidiagonal matrix
      is upper or lower bidiagonal, and wether it is square are
      not.
         UPLO = 'U' or 'u'   B is upper bidiagonal.
         UPLO = 'L' or 'l'   B is lower bidiagonal.

SQRE  (input) INTEGER
      = 0: then the input matrix is N-by-N.
      = 1: then the input matrix is N-by-(N+1) if UPLU = 'U' and
           (N+1)-by-N if UPLU = 'L'.

      The bidiagonal matrix has
      N = NL + NR + 1 rows and
      M = N + SQRE >= N columns.

N     (input) INTEGER
      On entry, N specifies the number of rows and columns
      in the matrix. N must be at least 0.

NCVT  (input) INTEGER
      On entry, NCVT specifies the number of columns of
      the matrix VT. NCVT must be at least 0.

NRU   (input) INTEGER
      On entry, NRU specifies the number of rows of
      the matrix U. NRU must be at least 0.

NCC   (input) INTEGER
      On entry, NCC specifies the number of columns of
      the matrix C. NCC must be at least 0.

D     (input/output) DOUBLE PRECISION array, dimension (N)
      On entry, D contains the diagonal entries of the
      bidiagonal matrix whose SVD is desired. On normal exit,
      D contains the singular values in ascending order.

E     (input/output) DOUBLE PRECISION array.
      dimension is (N-1) if SQRE = 0 and N if SQRE = 1.
      On entry, the entries of E contain the offdiagonal entries
      of the bidiagonal matrix whose SVD is desired. On normal
      exit, E will contain 0. If the algorithm does not converge,
      D and E will contain the diagonal and superdiagonal entries
      of a bidiagonal matrix orthogonally equivalent to the one
      given as input.

VT    (input/output) DOUBLE PRECISION array, dimension (LDVT, NCVT)
      On entry, contains a matrix which on exit has been
      premultiplied by P', dimension N-by-NCVT if SQRE = 0
      and (N+1)-by-NCVT if SQRE = 1 (not referenced if NCVT=0).
```

```
LDVT  (input) INTEGER
      On entry, LDVT specifies the leading dimension of VT as
      declared in the calling (sub) program. LDVT must be at
      least 1. If NCVT is nonzero LDVT must also be at least N.

U     (input/output) DOUBLE PRECISION array, dimension (LDU, N)
      On entry, contains a  matrix which on exit has been
      postmultiplied by Q, dimension NRU-by-N if SQRE = 0
      and NRU-by-(N+1) if SQRE = 1 (not referenced if NRU=0).

LDU   (input) INTEGER
      On entry, LDU  specifies the leading dimension of U as
      declared in the calling (sub) program. LDU must be at
      least max( 1, NRU ) .

C     (input/output) DOUBLE PRECISION array, dimension (LDC, NCC)
      On entry, contains an N-by-NCC matrix which on exit
      has been premultiplied by Q'  dimension N-by-NCC if SQRE = 0
      and (N+1)-by-NCC if SQRE = 1 (not referenced if NCC=0).

LDC   (input) INTEGER
      On entry, LDC  specifies the leading dimension of C as
      declared in the calling (sub) program. LDC must be at
      least 1. If NCC is nonzero, LDC must also be at least N.

WORK  (workspace) DOUBLE PRECISION array, dimension (4*N)
      Workspace. Only referenced if one of NCVT, NRU, or NCC is
      nonzero, and if N is at least 2.

INFO  (output) INTEGER
      On exit, a value of 0 indicates a successful exit.
      If INFO < 0, argument number -INFO is illegal.
      If INFO > 0, the algorithm did not converge, and INFO
      specifies how many superdiagonals did not converge.

Further Details
===============

Based on contributions by
   Ming Gu and Huan Ren, Computer Science Division, University of
   California at Berkeley, USA
```

———-

— dlasdq.f —

```
    SUBROUTINE DLASDQ( UPLO, SQRE, N, NCVT, NRU, NCC, D, E, VT, LDVT,
```

```
     $                   U, LDU, C, LDC, WORK, INFO )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1999
*
*     .. Scalar Arguments ..
      CHARACTER          UPLO
      INTEGER            INFO, LDC, LDU, LDVT, N, NCC, NCVT, NRU, SQRE
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   C( LDC, * ), D( * ), E( * ), U( LDU, * ),
     $                   VT( LDVT, * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER          ( ZERO = 0.0D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            ROTATE
      INTEGER            I, ISUB, IUPLO, J, NP1, SQRE1
      DOUBLE PRECISION   CS, R, SMIN, SN
*     ..
*     .. External Subroutines ..
      EXTERNAL           DBDSQR, DLARTG, DLASR, DSWAP, XERBLA
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters.
*
      INFO = 0
      IUPLO = 0
      IF( LSAME( UPLO, 'U' ) )
     $   IUPLO = 1
      IF( LSAME( UPLO, 'L' ) )
     $   IUPLO = 2
      IF( IUPLO.EQ.0 ) THEN
         INFO = -1
      ELSE IF( ( SQRE.LT.0 ) .OR. ( SQRE.GT.1 ) ) THEN
```

```
         INFO = -2
      ELSE IF( N.LT.0 ) THEN
         INFO = -3
      ELSE IF( NCVT.LT.0 ) THEN
         INFO = -4
      ELSE IF( NRU.LT.0 ) THEN
         INFO = -5
      ELSE IF( NCC.LT.0 ) THEN
         INFO = -6
      ELSE IF( ( NCVT.EQ.0 .AND. LDVT.LT.1 ) .OR.
     $         ( NCVT.GT.0 .AND. LDVT.LT.MAX( 1, N ) ) ) THEN
         INFO = -10
      ELSE IF( LDU.LT.MAX( 1, NRU ) ) THEN
         INFO = -12
      ELSE IF( ( NCC.EQ.0 .AND. LDC.LT.1 ) .OR.
     $         ( NCC.GT.0 .AND. LDC.LT.MAX( 1, N ) ) ) THEN
         INFO = -14
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DLASDQ', -INFO )
         RETURN
      END IF
      IF( N.EQ.0 )
     $   RETURN
*
*     ROTATE is true if any singular vectors desired, false otherwise
*
      ROTATE = ( NCVT.GT.0 ) .OR. ( NRU.GT.0 ) .OR. ( NCC.GT.0 )
      NP1 = N + 1
      SQRE1 = SQRE
*
*     If matrix non-square upper bidiagonal, rotate to be lower
*     bidiagonal.  The rotations are on the right.
*
      IF( ( IUPLO.EQ.1 ) .AND. ( SQRE1.EQ.1 ) ) THEN
         DO 10 I = 1, N - 1
            CALL DLARTG( D( I ), E( I ), CS, SN, R )
            D( I ) = R
            E( I ) = SN*D( I+1 )
            D( I+1 ) = CS*D( I+1 )
            IF( ROTATE ) THEN
               WORK( I ) = CS
               WORK( N+I ) = SN
            END IF
   10    CONTINUE
         CALL DLARTG( D( N ), E( N ), CS, SN, R )
         D( N ) = R
         E( N ) = ZERO
         IF( ROTATE ) THEN
            WORK( N ) = CS
```

```
            WORK( N+N ) = SN
         END IF
         IUPLO = 2
         SQRE1 = 0
*
*        Update singular vectors if desired.
*
         IF( NCVT.GT.0 )
     $      CALL DLASR( 'L', 'V', 'F', NP1, NCVT, WORK( 1 ),
     $                  WORK( NP1 ), VT, LDVT )
      END IF
*
*     If matrix lower bidiagonal, rotate to be upper bidiagonal
*     by applying Givens rotations on the left.
*
      IF( IUPLO.EQ.2 ) THEN
         DO 20 I = 1, N - 1
            CALL DLARTG( D( I ), E( I ), CS, SN, R )
            D( I ) = R
            E( I ) = SN*D( I+1 )
            D( I+1 ) = CS*D( I+1 )
            IF( ROTATE ) THEN
               WORK( I ) = CS
               WORK( N+I ) = SN
            END IF
   20    CONTINUE
*
*        If matrix (N+1)-by-N lower bidiagonal, one additional
*        rotation is needed.
*
         IF( SQRE1.EQ.1 ) THEN
            CALL DLARTG( D( N ), E( N ), CS, SN, R )
            D( N ) = R
            IF( ROTATE ) THEN
               WORK( N ) = CS
               WORK( N+N ) = SN
            END IF
         END IF
*
*        Update singular vectors if desired.
*
         IF( NRU.GT.0 ) THEN
            IF( SQRE1.EQ.0 ) THEN
               CALL DLASR( 'R', 'V', 'F', NRU, N, WORK( 1 ),
     $                     WORK( NP1 ), U, LDU )
            ELSE
               CALL DLASR( 'R', 'V', 'F', NRU, NP1, WORK( 1 ),
     $                     WORK( NP1 ), U, LDU )
            END IF
         END IF
```

```
         IF( NCC.GT.0 ) THEN
            IF( SQRE1.EQ.0 ) THEN
               CALL DLASR( 'L', 'V', 'F', N, NCC, WORK( 1 ),
     $                     WORK( NP1 ), C, LDC )
            ELSE
               CALL DLASR( 'L', 'V', 'F', NP1, NCC, WORK( 1 ),
     $                     WORK( NP1 ), C, LDC )
            END IF
         END IF
      END IF
*
*     Call DBDSQR to compute the SVD of the reduced real
*     N-by-N upper bidiagonal matrix.
*
      CALL DBDSQR( 'U', N, NCVT, NRU, NCC, D, E, VT, LDVT, U, LDU, C,
     $             LDC, WORK, INFO )
*
*     Sort the singular values into ascending order (insertion sort on
*     singular values, but only one transposition per singular vector)
*
      DO 40 I = 1, N
*
*        Scan for smallest D(I).
*
         ISUB = I
         SMIN = D( I )
         DO 30 J = I + 1, N
            IF( D( J ).LT.SMIN ) THEN
               ISUB = J
               SMIN = D( J )
            END IF
   30    CONTINUE
         IF( ISUB.NE.I ) THEN
*
*           Swap singular values and vectors.
*
            D( ISUB ) = D( I )
            D( I ) = SMIN
            IF( NCVT.GT.0 )
     $         CALL DSWAP( NCVT, VT( ISUB, 1 ), LDVT, VT( I, 1 ), LDVT )
            IF( NRU.GT.0 )
     $         CALL DSWAP( NRU, U( 1, ISUB ), 1, U( 1, I ), 1 )
            IF( NCC.GT.0 )
     $         CALL DSWAP( NCC, C( ISUB, 1 ), LDC, C( I, 1 ), LDC )
         END IF
   40 CONTINUE
*
      RETURN
*
*     End of DLASDQ
```

```
*
      END
```

— LAPACK dlasdq —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dlasdq (uplo sqre n ncvt nru ncc d e vt ldvt u ldu c ldc work info)
    (declare (type (simple-array double-float (*)) work c u vt e d)
             (type fixnum info ldc ldu ldvt ncc nru ncvt n sqre)
             (type character uplo))
    (f2cl-lib:with-multi-array-data
        ((uplo character uplo-%data% uplo-%offset%)
         (d double-float d-%data% d-%offset%)
         (e double-float e-%data% e-%offset%)
         (vt double-float vt-%data% vt-%offset%)
         (u double-float u-%data% u-%offset%)
         (c double-float c-%data% c-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((cs 0.0) (r 0.0) (smin 0.0) (sn 0.0) (i 0) (isub 0) (iuplo 0)
             (j 0) (np1 0) (sqre1 0) (rotate nil))
        (declare (type (double-float) cs r smin sn)
                 (type fixnum i isub iuplo j np1 sqre1)
                 (type (member t nil) rotate))
        (setf info 0)
        (setf iuplo 0)
        (if (char-equal uplo #\U) (setf iuplo 1))
        (if (char-equal uplo #\L) (setf iuplo 2))
        (cond
          ((= iuplo 0)
           (setf info -1))
          ((or (< sqre 0) (> sqre 1))
           (setf info -2))
          ((< n 0)
           (setf info -3))
          ((< ncvt 0)
           (setf info -4))
          ((< nru 0)
           (setf info -5))
          ((< ncc 0)
           (setf info -6))
          ((or (and (= ncvt 0) (< ldvt 1))
               (and (> ncvt 0)
                    (< ldvt
                       (max (the fixnum 1)
                            (the fixnum n)))))
```

```
   (setf info -10))
  ((< ldu (max (the fixnum 1) (the fixnum nru)))
   (setf info -12))
  ((or (and (= ncc 0) (< ldc 1))
       (and (> ncc 0)
            (< ldc
               (max (the fixnum 1)
                    (the fixnum n)))))
   (setf info -14)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DLASDQ" (f2cl-lib:int-sub info))
   (go end_label)))
(if (= n 0) (go end_label))
(setf rotate (or (> ncvt 0) (> nru 0) (> ncc 0)))
(setf np1 (f2cl-lib:int-add n 1))
(setf sqre1 sqre)
(cond
  ((and (= iuplo 1) (= sqre1 1))
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
     (tagbody
       (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
           (dlartg (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
            (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%) cs sn r)
         (declare (ignore var-0 var-1))
         (setf cs var-2)
         (setf sn var-3)
         (setf r var-4))
       (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) r)
       (setf (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)
               (* sn
                  (f2cl-lib:fref d-%data%
                                 ((f2cl-lib:int-add i 1))
                                 ((1 *))
                                 d-%offset%)))
       (setf (f2cl-lib:fref d-%data%
                            ((f2cl-lib:int-add i 1))
                            ((1 *))
                            d-%offset%)
               (* cs
                  (f2cl-lib:fref d-%data%
                                 ((f2cl-lib:int-add i 1))
                                 ((1 *))
                                 d-%offset%)))
       (cond
         (rotate
          (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
```

```
                    cs)
             (setf (f2cl-lib:fref work-%data%
                                  ((f2cl-lib:int-add n i))
                                  ((1 *))
                                  work-%offset%)
                    sn)))))
      (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
          (dlartg (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
           (f2cl-lib:fref e-%data% (n) ((1 *)) e-%offset%) cs sn r)
        (declare (ignore var-0 var-1))
        (setf cs var-2)
        (setf sn var-3)
        (setf r var-4))
      (setf (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%) r)
      (setf (f2cl-lib:fref e-%data% (n) ((1 *)) e-%offset%) zero)
      (cond
        (rotate
         (setf (f2cl-lib:fref work-%data% (n) ((1 *)) work-%offset%) cs)
         (setf (f2cl-lib:fref work-%data%
                              ((f2cl-lib:int-add n n))
                              ((1 *))
                              work-%offset%)
               sn)))
      (setf iuplo 2)
      (setf sqre1 0)
      (if (> ncvt 0)
          (dlasr "L" "V" "F" np1 ncvt
           (f2cl-lib:array-slice work double-float (1) ((1 *)))
           (f2cl-lib:array-slice work double-float (np1) ((1 *))) vt
           ldvt))))
(cond
  ((= iuplo 2)
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
     (tagbody
       (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
           (dlartg (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
            (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%) cs sn r)
         (declare (ignore var-0 var-1))
         (setf cs var-2)
         (setf sn var-3)
         (setf r var-4))
       (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) r)
       (setf (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%)
               (* sn
                  (f2cl-lib:fref d-%data%
                                 ((f2cl-lib:int-add i 1))
                                 ((1 *))
                                 d-%offset%)))
       (setf (f2cl-lib:fref d-%data%
```

```
                          ((f2cl-lib:int-add i 1))
                          ((1 *))
                          d-%offset%)
                (* cs
                   (f2cl-lib:fref d-%data%
                                  ((f2cl-lib:int-add i 1))
                                  ((1 *))
                                  d-%offset%)))
            (cond
              (rotate
               (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
                       cs)
               (setf (f2cl-lib:fref work-%data%
                                    ((f2cl-lib:int-add n i))
                                    ((1 *))
                                    work-%offset%)
                       sn)))))
        (cond
          ((= sqre1 1)
           (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
               (dlartg (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
                (f2cl-lib:fref e-%data% (n) ((1 *)) e-%offset%) cs sn r)
             (declare (ignore var-0 var-1))
             (setf cs var-2)
             (setf sn var-3)
             (setf r var-4))
           (setf (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%) r)
           (cond
             (rotate
              (setf (f2cl-lib:fref work-%data% (n) ((1 *)) work-%offset%) cs)
              (setf (f2cl-lib:fref work-%data%
                                   ((f2cl-lib:int-add n n))
                                   ((1 *))
                                   work-%offset%)
                      sn)))))
        (cond
          ((> nru 0)
           (cond
             ((= sqre1 0)
              (dlasr "R" "V" "F" nru n
               (f2cl-lib:array-slice work double-float (1) ((1 *)))
               (f2cl-lib:array-slice work double-float (np1) ((1 *))) u ldu))
             (t
              (dlasr "R" "V" "F" nru np1
               (f2cl-lib:array-slice work double-float (1) ((1 *)))
               (f2cl-lib:array-slice work double-float (np1) ((1 *))) u
               ldu)))))
        (cond
          ((> ncc 0)
           (cond
```

```
        ((= sqre1 0)
         (dlasr "L" "V" "F" n ncc
          (f2cl-lib:array-slice work double-float (1) ((1 *)))
          (f2cl-lib:array-slice work double-float (np1) ((1 *))) c ldc))
        (t
         (dlasr "L" "V" "F" np1 ncc
          (f2cl-lib:array-slice work double-float (1) ((1 *)))
          (f2cl-lib:array-slice work double-float (np1) ((1 *))) c
          ldc)))))))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
       var-10 var-11 var-12 var-13 var-14)
    (dbdsqr "U" n ncvt nru ncc d e vt ldvt u ldu c ldc work info)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                   var-8 var-9 var-10 var-11 var-12 var-13))
  (setf info var-14))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i n) nil)
  (tagbody
    (setf isub i)
    (setf smin (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
    (f2cl-lib:fdo (j (f2cl-lib:int-add i 1) (f2cl-lib:int-add j 1))
                  ((> j n) nil)
      (tagbody
        (cond
          ((< (f2cl-lib:fref d (j) ((1 *))) smin)
           (setf isub j)
           (setf smin
                   (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%))))))
    (cond
      ((/= isub i)
       (setf (f2cl-lib:fref d-%data% (isub) ((1 *)) d-%offset%)
             (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
       (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) smin)
       (if (> ncvt 0)
           (dswap ncvt
            (f2cl-lib:array-slice vt
                                  double-float
                                  (isub 1)
                                  ((1 ldvt) (1 *)))
            ldvt
            (f2cl-lib:array-slice vt
                                  double-float
                                  (i 1)
                                  ((1 ldvt) (1 *)))
            ldvt))
       (if (> nru 0)
           (dswap nru
            (f2cl-lib:array-slice u
                                  double-float
```

```
                                        (1 isub)
                                        ((1 ldu) (1 *)))
                    1
                    (f2cl-lib:array-slice u double-float (1 i) ((1 ldu) (1 *)))
                    1))
                (if (> ncc 0)
                    (dswap ncc
                     (f2cl-lib:array-slice c
                                           double-float
                                           (isub 1)
                                           ((1 ldc) (1 *)))
                     ldc
                     (f2cl-lib:array-slice c double-float (i 1) ((1 ldc) (1 *)))
                     ldc))))))
 end_label
        (return
         (values nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 nil
                 info))))))
```

———-

6.68 dlasdt LAPACK

— dlasdt.input —

```
)set break resume
)sys rm -f dlasdt.output
)spool dlasdt.output
)set message test on
)set message auto off
)clear all
```

```
)spool
)lisp (bye)
```

———-

— dlasdt.help —

```
=======================================================================
dlasdt examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

NAME
       DLASDT - a tree of subproblems for bidiagonal divide and conquer

SYNOPSIS
       SUBROUTINE DLASDT( N, LVL, ND, INODE, NDIML, NDIMR, MSUB )

           INTEGER        LVL, MSUB, N, ND

           INTEGER        INODE( * ), NDIML( * ), NDIMR( * )

  Purpose
  =======

  DLASDT creates a tree of subproblems for bidiagonal divide and
  conquer.

  Arguments
  =========

   N      (input) INTEGER
          On entry, the number of diagonal elements of the
          bidiagonal matrix.

   LVL    (output) INTEGER
          On exit, the number of levels on the computation tree.

   ND     (output) INTEGER
          On exit, the number of nodes on the tree.

   INODE  (output) INTEGER array, dimension ( N )
          On exit, centers of subproblems.

   NDIML  (output) INTEGER array, dimension ( N )
          On exit, row dimensions of left children.
```

```
   NDIMR  (output) INTEGER array, dimension ( N )
          On exit, row dimensions of right children.

   MSUB   (input) INTEGER.
          On entry, the maximum row dimension each subproblem at the
          bottom of the tree can be of.

  Further Details
  ===============

  Based on contributions by
     Ming Gu and Huan Ren, Computer Science Division, University of
     California at Berkeley, USA
```

———-

— dlasdt.f —

```
      SUBROUTINE DLASDT( N, LVL, ND, INODE, NDIML, NDIMR, MSUB )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      INTEGER            LVL, MSUB, N, ND
*     ..
*     .. Array Arguments ..
      INTEGER            INODE( * ), NDIML( * ), NDIMR( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   TWO
      PARAMETER          ( TWO = 2.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I, IL, IR, LLST, MAXN, NCRNT, NLVL
      DOUBLE PRECISION   TEMP
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          DBLE, INT, LOG, MAX
*     ..
*     .. Executable Statements ..
*
```

```
*     Find the number of levels on the tree.
*
      MAXN = MAX( 1, N )
      TEMP = LOG( DBLE( MAXN ) / DBLE( MSUB+1 ) ) / LOG( TWO )
      LVL = INT( TEMP ) + 1
*
      I = N / 2
      INODE( 1 ) = I + 1
      NDIML( 1 ) = I
      NDIMR( 1 ) = N - I - 1
      IL = 0
      IR = 1
      LLST = 1
      DO 20 NLVL = 1, LVL - 1
*
*        Constructing the tree at (NLVL+1)-st level. The number of
*        nodes created on this level is LLST * 2.
*
         DO 10 I = 0, LLST - 1
            IL = IL + 2
            IR = IR + 2
            NCRNT = LLST + I
            NDIML( IL ) = NDIML( NCRNT ) / 2
            NDIMR( IL ) = NDIML( NCRNT ) - NDIML( IL ) - 1
            INODE( IL ) = INODE( NCRNT ) - NDIMR( IL ) - 1
            NDIML( IR ) = NDIMR( NCRNT ) / 2
            NDIMR( IR ) = NDIMR( NCRNT ) - NDIML( IR ) - 1
            INODE( IR ) = INODE( NCRNT ) + NDIML( IR ) + 1
   10    CONTINUE
         LLST = LLST*2
   20 CONTINUE
      ND = LLST*2 - 1
*
      RETURN
*
*     End of DLASDT
*
      END
```

— LAPACK dlasdt —

```
(let* ((two 2.0))
  (declare (type (double-float 2.0 2.0) two))
  (defun dlasdt (n lvl nd inode ndiml ndimr msub)
    (declare (type (simple-array fixnum (*)) ndimr ndiml inode)
             (type fixnum msub nd lvl n))
```

```
(f2cl-lib:with-multi-array-data
    ((inode fixnum inode-%data% inode-%offset%)
     (ndiml fixnum ndiml-%data% ndiml-%offset%)
     (ndimr fixnum ndimr-%data% ndimr-%offset%))
  (prog ((temp 0.0) (i 0) (il 0) (ir 0) (llst 0) (maxn 0) (ncrnt 0)
         (nlvl 0))
    (declare (type (double-float) temp)
             (type fixnum i il ir llst maxn ncrnt nlvl))
    (setf maxn (max (the fixnum 1) (the fixnum n)))
    (setf temp
     (/
      (f2cl-lib:flog
       (/ (coerce (realpart maxn) 'double-float)
          (coerce (realpart (f2cl-lib:int-add msub 1)) 'double-float)))
      (f2cl-lib:flog two)))
    (setf lvl (f2cl-lib:int-add (f2cl-lib:int temp) 1))
    (setf i (the fixnum (truncate n 2)))
    (setf (f2cl-lib:fref inode-%data% (1) ((1 *)) inode-%offset%)
            (f2cl-lib:int-add i 1))
    (setf (f2cl-lib:fref ndiml-%data% (1) ((1 *)) ndiml-%offset%) i)
    (setf (f2cl-lib:fref ndimr-%data% (1) ((1 *)) ndimr-%offset%)
            (f2cl-lib:int-sub n i 1))
    (setf il 0)
    (setf ir 1)
    (setf llst 1)
    (f2cl-lib:fdo (nlvl 1 (f2cl-lib:int-add nlvl 1))
                  ((> nlvl (f2cl-lib:int-add lvl (f2cl-lib:int-sub 1))) nil)
      (tagbody
        (f2cl-lib:fdo (i 0 (f2cl-lib:int-add i 1))
                      ((> i (f2cl-lib:int-add llst (f2cl-lib:int-sub 1)))
                       nil)
          (tagbody
            (setf il (f2cl-lib:int-add il 2))
            (setf ir (f2cl-lib:int-add ir 2))
            (setf ncrnt (f2cl-lib:int-add llst i))
            (setf (f2cl-lib:fref ndiml-%data% (il) ((1 *)) ndiml-%offset%)
                    (the fixnum
                         (truncate
                          (f2cl-lib:fref ndiml-%data%
                                         (ncrnt)
                                         ((1 *))
                                         ndiml-%offset%)
                          2)))
            (setf (f2cl-lib:fref ndimr-%data% (il) ((1 *)) ndimr-%offset%)
                    (f2cl-lib:int-sub
                     (f2cl-lib:fref ndiml-%data%
                                    (ncrnt)
                                    ((1 *))
                                    ndiml-%offset%)
                     (f2cl-lib:fref ndiml-%data%
```

```
                                    (il)
                                    ((1 *))
                                    ndiml-%offset%)
                             1))
                    (setf (f2cl-lib:fref inode-%data% (il) ((1 *)) inode-%offset%)
                            (f2cl-lib:int-sub
                             (f2cl-lib:fref inode-%data%
                                            (ncrnt)
                                            ((1 *))
                                            inode-%offset%)
                             (f2cl-lib:fref ndimr-%data%
                                            (il)
                                            ((1 *))
                                            ndimr-%offset%)
                             1))
                    (setf (f2cl-lib:fref ndiml-%data% (ir) ((1 *)) ndiml-%offset%)
                            (the fixnum
                                 (truncate
                                  (f2cl-lib:fref ndimr-%data%
                                                 (ncrnt)
                                                 ((1 *))
                                                 ndimr-%offset%)
                                  2)))
                    (setf (f2cl-lib:fref ndimr-%data% (ir) ((1 *)) ndimr-%offset%)
                            (f2cl-lib:int-sub
                             (f2cl-lib:fref ndimr-%data%
                                            (ncrnt)
                                            ((1 *))
                                            ndimr-%offset%)
                             (f2cl-lib:fref ndiml-%data%
                                            (ir)
                                            ((1 *))
                                            ndiml-%offset%)
                             1))
                    (setf (f2cl-lib:fref inode-%data% (ir) ((1 *)) inode-%offset%)
                            (f2cl-lib:int-add
                             (f2cl-lib:fref inode-%data%
                                            (ncrnt)
                                            ((1 *))
                                            inode-%offset%)
                             (f2cl-lib:fref ndiml-%data%
                                            (ir)
                                            ((1 *))
                                            ndiml-%offset%)
                             1))))
                (setf llst (f2cl-lib:int-mul llst 2))))
          (setf nd (f2cl-lib:int-sub (f2cl-lib:int-mul llst 2) 1))
end_label
          (return (values nil lvl nd nil nil nil nil))))))
```

———-

6.69 dlaset LAPACK

— **dlaset.input** —

```
)set break resume
)sys rm -f dlaset.output
)spool dlaset.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlaset.help** —

```
=====================================================================
dlaset examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DLASET  -  an  m-by-n matrix A to BETA on the diagonal and ALPHA on the
       offdiagonals

SYNOPSIS
       SUBROUTINE DLASET( UPLO, M, N, ALPHA, BETA, A, LDA )

           CHARACTER      UPLO

           INTEGER        LDA, M, N

           DOUBLE         PRECISION ALPHA, BETA

           DOUBLE         PRECISION A( LDA, * )

  Purpose
  =======
```

```
  DLASET initializes an m-by-n matrix A to BETA on the diagonal and
  ALPHA on the offdiagonals.

  Arguments
  =========

  UPLO    (input) CHARACTER*1
          Specifies the part of the matrix A to be set.
          = 'U':      Upper triangular part is set; the strictly lower
                      triangular part of A is not changed.
          = 'L':      Lower triangular part is set; the strictly upper
                      triangular part of A is not changed.
          Otherwise:  All of the matrix A is set.

  M       (input) INTEGER
          The number of rows of the matrix A.  M >= 0.

  N       (input) INTEGER
          The number of columns of the matrix A.  N >= 0.

  ALPHA   (input) DOUBLE PRECISION
          The constant to which the offdiagonal elements are to be set.

  BETA    (input) DOUBLE PRECISION
          The constant to which the diagonal elements are to be set.

  A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
          On exit, the leading m-by-n submatrix of A is set as follows:

          if UPLO = 'U', A(i,j) = ALPHA, 1<=i<=j-1, 1<=j<=n,
          if UPLO = 'L', A(i,j) = ALPHA, j+1<=i<=m, 1<=j<=n,
          otherwise,     A(i,j) = ALPHA, 1<=i<=m, 1<=j<=n, i.ne.j,

          and, for all UPLO, A(i,i) = BETA, 1<=i<=min(m,n).

  LDA     (input) INTEGER
          The leading dimension of the array A.  LDA >= max(1,M).
```

— dlaset.f —

```
      SUBROUTINE DLASET( UPLO, M, N, ALPHA, BETA, A, LDA )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1992
```

```
*
*     .. Scalar Arguments ..
      CHARACTER          UPLO
      INTEGER            LDA, M, N
      DOUBLE PRECISION   ALPHA, BETA
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * )
*     ..
*
* =====================================================================
*
*     .. Local Scalars ..
      INTEGER            I, J
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MIN
*     ..
*     .. Executable Statements ..
*
      IF( LSAME( UPLO, 'U' ) ) THEN
*
*        Set the strictly upper triangular or trapezoidal part of the
*        array to ALPHA.
*
         DO 20 J = 2, N
            DO 10 I = 1, MIN( J-1, M )
               A( I, J ) = ALPHA
   10       CONTINUE
   20    CONTINUE
*
      ELSE IF( LSAME( UPLO, 'L' ) ) THEN
*
*        Set the strictly lower triangular or trapezoidal part of the
*        array to ALPHA.
*
         DO 40 J = 1, MIN( M, N )
            DO 30 I = J + 1, M
               A( I, J ) = ALPHA
   30       CONTINUE
   40    CONTINUE
*
      ELSE
*
*        Set the leading m-by-n submatrix to ALPHA.
*
```

```
         DO 60 J = 1, N
            DO 50 I = 1, M
               A( I, J ) = ALPHA
   50       CONTINUE
   60    CONTINUE
      END IF
*
*     Set the first min(M,N) diagonal elements to BETA.
*
      DO 70 I = 1, MIN( M, N )
         A( I, I ) = BETA
   70 CONTINUE
*
      RETURN
*
*     End of DLASET
*
      END
```

— LAPACK dlaset —

```
(defun dlaset (uplo m n alpha beta a lda)
  (declare (type (simple-array double-float (*)) a)
           (type (double-float) beta alpha)
           (type fixnum lda n m)
           (type character uplo))
  (f2cl-lib:with-multi-array-data
      ((uplo character uplo-%data% uplo-%offset%)
       (a double-float a-%data% a-%offset%))
    (prog ((i 0) (j 0))
      (declare (type fixnum j i))
      (cond
        ((char-equal uplo #\U)
         (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i
                               (min
                                (the fixnum
                                     (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                                (the fixnum m)))
                            nil)
               (tagbody
                 (setf (f2cl-lib:fref a-%data%
                                      (i j)
```

```
                                    ((1 lda) (1 *))
                                    a-%offset%)
                       alpha))))))
        ((char-equal uplo #\L)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j
                           (min (the fixnum m)
                                (the fixnum n)))
                        nil)
           (tagbody
             (f2cl-lib:fdo (i (f2cl-lib:int-add j 1) (f2cl-lib:int-add i 1))
                           ((> i m) nil)
               (tagbody
                 (setf (f2cl-lib:fref a-%data%
                                      (i j)
                                      ((1 lda) (1 *))
                                      a-%offset%)
                       alpha))))))
        (t
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                       ((> j n) nil)
           (tagbody
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                           ((> i m) nil)
               (tagbody
                 (setf (f2cl-lib:fref a-%data%
                                      (i j)
                                      ((1 lda) (1 *))
                                      a-%offset%)
                       alpha)))))))
      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                    ((> i
                        (min (the fixnum m)
                             (the fixnum n)))
                     nil)
        (tagbody
          (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%) beta)))
      (return (values nil nil nil nil nil nil nil)))))
```

———-

6.70 dlasq1 LAPACK

— dlasq1.input —

```
)set break resume
```

```
)sys rm -f dlasq1.output
)spool dlasq1.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dlasq1.help —

```
=========================================================================
dlasq1 examples
=========================================================================

=========================================================================
Man Page Details
=========================================================================

NAME
       DLASQ1  -  the  singular values of a real N-by-N bidiagonal matrix with
       diagonal D and off-diagonal E

SYNOPSIS
       SUBROUTINE DLASQ1( N, D, E, WORK, INFO )

           INTEGER        INFO, N

           DOUBLE         PRECISION D( * ), E( * ), WORK( * )

  Purpose
  =======

  DLASQ1 computes the singular values of a real N-by-N bidiagonal
  matrix with diagonal D and off-diagonal E. The singular values
  are computed to high relative accuracy, in the absence of
  denormalization, underflow and overflow. The algorithm was first
  presented in

  "Accurate singular values and differential qd algorithms" by K. V.
  Fernando and B. N. Parlett, Numer. Math., Vol-67, No. 2, pp. 191-230,
  1994,

  and the present implementation is described in "An implementation of
  the dqds Algorithm (Positive Case)", LAPACK Working Note.

  Arguments
```

```
  =========

  N     (input) INTEGER
        The number of rows and columns in the matrix. N >= 0.

  D     (input/output) DOUBLE PRECISION array, dimension (N)
        On entry, D contains the diagonal elements of the
        bidiagonal matrix whose SVD is desired. On normal exit,
        D contains the singular values in decreasing order.

  E     (input/output) DOUBLE PRECISION array, dimension (N)
        On entry, elements E(1:N-1) contain the off-diagonal elements
        of the bidiagonal matrix whose SVD is desired.
        On exit, E is overwritten.

  WORK  (workspace) DOUBLE PRECISION array, dimension (4*N)

  INFO  (output) INTEGER
        = 0: successful exit
        < 0: if INFO = -i, the i-th argument had an illegal value
        > 0: the algorithm failed
             = 1, a split was marked by a positive value in E
             = 2, current block of Z not diagonalized after 30*N
                  iterations (in inner while loop)
             = 3, termination criterion of outer while loop not met
                  (program created more than N unreduced blocks)
```

———-

— dlasq1.f —

```
      SUBROUTINE DLASQ1( N, D, E, WORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1999
*
*     .. Scalar Arguments ..
      INTEGER            INFO, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   D( * ), E( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
```

```
      DOUBLE PRECISION   ZERO
      PARAMETER          ( ZERO = 0.0D0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I, IINFO
      DOUBLE PRECISION   EPS, SCALE, SAFMIN, SIGMN, SIGMX
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLAS2, DLASQ2, DLASRT, XERBLA
*     ..
*     .. External Functions ..
      DOUBLE PRECISION   DLAMCH
      EXTERNAL           DLAMCH
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX, SQRT
*     ..
*     .. Executable Statements ..
*
      INFO = 0
      IF( N.LT.0 ) THEN
         INFO = -2
         CALL XERBLA( 'DLASQ1', -INFO )
         RETURN
      ELSE IF( N.EQ.0 ) THEN
         RETURN
      ELSE IF( N.EQ.1 ) THEN
         D( 1 ) = ABS( D( 1 ) )
         RETURN
      ELSE IF( N.EQ.2 ) THEN
         CALL DLAS2( D( 1 ), E( 1 ), D( 2 ), SIGMN, SIGMX )
         D( 1 ) = SIGMX
         D( 2 ) = SIGMN
         RETURN
      END IF
*
*     Estimate the largest singular value.
*
      SIGMX = ZERO
      DO 10 I = 1, N - 1
         D( I ) = ABS( D( I ) )
         SIGMX = MAX( SIGMX, ABS( E( I ) ) )
   10 CONTINUE
      D( N ) = ABS( D( N ) )
*
*     Early return if SIGMX is zero (matrix is already diagonal).
*
      IF( SIGMX.EQ.ZERO ) THEN
         CALL DLASRT( 'D', N, D, IINFO )
         RETURN
```

```
      END IF
*
      DO 20 I = 1, N
         SIGMX = MAX( SIGMX, D( I ) )
   20 CONTINUE
*
*     Copy D and E into WORK (in the Z format) and scale (squaring the
*     input data makes scaling by a power of the radix pointless).
*
      EPS = DLAMCH( 'Precision' )
      SAFMIN = DLAMCH( 'Safe minimum' )
      SCALE = SQRT( EPS / SAFMIN )
      CALL DCOPY( N, D, 1, WORK( 1 ), 2 )
      CALL DCOPY( N-1, E, 1, WORK( 2 ), 2 )
      CALL DLASCL( 'G', 0, 0, SIGMX, SCALE, 2*N-1, 1, WORK, 2*N-1,
     $             IINFO )
*
*     Compute the q's and e's.
*
      DO 30 I = 1, 2*N - 1
         WORK( I ) = WORK( I )**2
   30 CONTINUE
      WORK( 2*N ) = ZERO
*
      CALL DLASQ2( N, WORK, INFO )
*
      IF( INFO.EQ.0 ) THEN
         DO 40 I = 1, N
            D( I ) = SQRT( WORK( I ) )
   40    CONTINUE
         CALL DLASCL( 'G', 0, 0, SCALE, SIGMX, N, 1, D, N, IINFO )
      END IF
*
      RETURN
*
*     End of DLASQ1
*
      END
```

———-

— LAPACK dlasq1 —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dlasq1 (n d e work info)
    (declare (type (simple-array double-float (*)) work e d)
             (type fixnum info n))
```

```
(f2cl-lib:with-multi-array-data
    ((d double-float d-%data% d-%offset%)
     (e double-float e-%data% e-%offset%)
     (work double-float work-%data% work-%offset%))
  (prog ((eps 0.0) (scale 0.0) (safmin 0.0) (sigmn 0.0) (sigmx 0.0) (i 0)
         (iinfo 0))
    (declare (type (double-float) eps scale safmin sigmn sigmx)
             (type fixnum i iinfo))
    (setf info 0)
    (cond
      ((< n 0)
       (setf info -2)
       (error
        " ** On entry to ~a parameter number ~a had an illegal value~%"
        "DLASQ1" (f2cl-lib:int-sub info))
       (go end_label))
      ((= n 0)
       (go end_label))
      ((= n 1)
       (setf (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)
             (abs (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)))
       (go end_label))
      ((= n 2)
       (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
           (dlas2 (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%)
            (f2cl-lib:fref e-%data% (1) ((1 *)) e-%offset%)
            (f2cl-lib:fref d-%data% (2) ((1 *)) d-%offset%) sigmn sigmx)
         (declare (ignore var-0 var-1 var-2))
         (setf sigmn var-3)
         (setf sigmx var-4))
       (setf (f2cl-lib:fref d-%data% (1) ((1 *)) d-%offset%) sigmx)
       (setf (f2cl-lib:fref d-%data% (2) ((1 *)) d-%offset%) sigmn)
       (go end_label)))
    (setf sigmx zero)
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  ((> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
      (tagbody
        (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
              (abs (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)))
        (setf sigmx
              (max sigmx
                   (abs
                    (f2cl-lib:fref e-%data% (i) ((1 *)) e-%offset%))))))
    (setf (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)
          (abs (f2cl-lib:fref d-%data% (n) ((1 *)) d-%offset%)))
    (cond
      ((= sigmx zero)
       (multiple-value-bind (var-0 var-1 var-2 var-3)
           (dlasrt "D" n d iinfo)
         (declare (ignore var-0 var-1 var-2))
```

```
     (setf iinfo var-3))
   (go end_label)))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i n) nil)
  (tagbody
    (setf sigmx
            (max sigmx
                 (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)))))
(setf eps (dlamch "Precision"))
(setf safmin (dlamch "Safe minimum"))
(setf scale (f2cl-lib:fsqrt (/ eps safmin)))
(dcopy n d 1 (f2cl-lib:array-slice work double-float (1) ((1 *))) 2)
(dcopy (f2cl-lib:int-sub n 1) e 1
 (f2cl-lib:array-slice work double-float (2) ((1 *))) 2)
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
    (dlascl "G" 0 0 sigmx scale
     (f2cl-lib:int-sub (f2cl-lib:int-mul 2 n) 1) 1 work
     (f2cl-lib:int-sub (f2cl-lib:int-mul 2 n) 1) iinfo)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                   var-8))
  (setf iinfo var-9))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i
                  (f2cl-lib:int-add (f2cl-lib:int-mul 2 n)
                                    (f2cl-lib:int-sub 1)))
               nil)
  (tagbody
    (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
            (expt (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
                  2))))
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-mul 2 n))
                     ((1 *))
                     work-%offset%)
        zero)
(multiple-value-bind (var-0 var-1 var-2)
    (dlasq2 n work info)
  (declare (ignore var-0 var-1))
  (setf info var-2))
(cond
  ((= info 0)
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i n) nil)
     (tagbody
      (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
            (f2cl-lib:fsqrt
             (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)))))
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
```

```
              (dlascl "G" 0 0 scale sigmx n 1 d n iinfo)
             (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                              var-8))
             (setf iinfo var-9))))
 end_label
        (return (values nil nil nil nil info))))))
```

———-

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— dlasq2.input —

```
)set break resume
)sys rm -f dlasq2.output
)spool dlasq2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dlasq2.help —

```
==========================================================================
dlasq2 examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

NAME
       DLASQ2  - all the eigenvalues of the symmetric positive definite tridi-
       agonal matrix associated with the qd array Z to high relative  accuracy
       are  computed to high relative accuracy, in the absence of denormaliza-
       tion, underflow and overflow

SYNOPSIS
       SUBROUTINE DLASQ2( N, Z, INFO )

           INTEGER        INFO, N
```

```
         DOUBLE         PRECISION Z( * )

Purpose
=======

DLASQ2 computes all the eigenvalues of the symmetric positive
definite tridiagonal matrix associated with the qd array Z to high
relative accuracy are computed to high relative accuracy, in the
absence of denormalization, underflow and overflow.

To see the relation of Z to the tridiagonal matrix, let L be a
unit lower bidiagonal matrix with subdiagonals Z(2,4,6,,..) and
let U be an upper bidiagonal matrix with 1's above and diagonal
Z(1,3,5,,..). The tridiagonal is L*U or, if you prefer, the
symmetric tridiagonal to which it is similar.

Note : DLASQ2 defines a logical variable, IEEE, which is true
on machines which follow ieee-754 floating-point standard in their
handling of infinities and NaNs, and false otherwise. This variable
is passed to DLASQ3.

Arguments
=========

N     (input) INTEGER
      The number of rows and columns in the matrix. N >= 0.

Z     (workspace) DOUBLE PRECISION array, dimension ( 4*N )
      On entry Z holds the qd array. On exit, entries 1 to N hold
      the eigenvalues in decreasing order, Z( 2*N+1 ) holds the
      trace, and Z( 2*N+2 ) holds the sum of the eigenvalues. If
      N > 2, then Z( 2*N+3 ) holds the iteration count, Z( 2*N+4 )
      holds NDIVS/NIN^2, and Z( 2*N+5 ) holds the percentage of
      shifts that failed.

INFO  (output) INTEGER
      = 0: successful exit
      < 0: if the i-th argument is a scalar and had an illegal
           value, then INFO = -i, if the i-th argument is an
           array and the j-entry had an illegal value, then
           INFO = -(i*100+j)
      > 0: the algorithm failed
            = 1, a split was marked by a positive value in E
            = 2, current block of Z not diagonalized after 30*N
                 iterations (in inner while loop)
            = 3, termination criterion of outer while loop not met
                 (program created more than N unreduced blocks)

Further Details
```

```
*  ===============
*  Local Variables: I0:N0 defines a current unreduced segment of Z.
*  The shifts are accumulated in SIGMA. Iteration count is in ITER.
*  Ping-pong is controlled by PP (alternates between 0 and 1).
```

— dlasq2.f —

```
      SUBROUTINE DLASQ2( N, Z, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1999
*
*     .. Scalar Arguments ..
      INTEGER            INFO, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   Z( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   CBIAS
      PARAMETER          ( CBIAS = 1.50D0 )
      DOUBLE PRECISION   ZERO, HALF, ONE, TWO, FOUR, HUNDRD
      PARAMETER          ( ZERO = 0.0D0, HALF = 0.5D0, ONE = 1.0D0,
     $                     TWO = 2.0D0, FOUR = 4.0D0, HUNDRD = 100.0D0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            IEEE
      INTEGER            I0, I4, IINFO, IPN4, ITER, IWHILA, IWHILB, K,
     $                   N0, NBIG, NDIV, NFAIL, PP, SPLT
      DOUBLE PRECISION   D, DESIG, DMIN, E, EMAX, EMIN, EPS, OLDEMN,
     $                   QMAX, QMIN, S, SAFMIN, SIGMA, T, TEMP, TOL,
     $                   TOL2, TRACE, ZMAX
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLASQ3, DLASRT, XERBLA
*     ..
*     .. External Functions ..
      INTEGER            ILAENV
      DOUBLE PRECISION   DLAMCH
      EXTERNAL           DLAMCH, ILAENV
*     ..
```

```
*     .. Intrinsic Functions ..
      INTRINSIC          DBLE, MAX, MIN, SQRT
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments.
*     (in case DLASQ2 is not called by DLASQ1)
*
      INFO = 0
      EPS = DLAMCH( 'Precision' )
      SAFMIN = DLAMCH( 'Safe minimum' )
      TOL = EPS*HUNDRD
      TOL2 = TOL**2
*
      IF( N.LT.0 ) THEN
         INFO = -1
         CALL XERBLA( 'DLASQ2', 1 )
         RETURN
      ELSE IF( N.EQ.0 ) THEN
         RETURN
      ELSE IF( N.EQ.1 ) THEN
*
*        1-by-1 case.
*
         IF( Z( 1 ).LT.ZERO ) THEN
            INFO = -201
            CALL XERBLA( 'DLASQ2', 2 )
         END IF
         RETURN
      ELSE IF( N.EQ.2 ) THEN
*
*        2-by-2 case.
*
         IF( Z( 2 ).LT.ZERO .OR. Z( 3 ).LT.ZERO ) THEN
            INFO = -2
            CALL XERBLA( 'DLASQ2', 2 )
            RETURN
         ELSE IF( Z( 3 ).GT.Z( 1 ) ) THEN
            D = Z( 3 )
            Z( 3 ) = Z( 1 )
            Z( 1 ) = D
         END IF
         Z( 5 ) = Z( 1 ) + Z( 2 ) + Z( 3 )
         IF( Z( 2 ).GT.Z( 3 )*TOL2 ) THEN
            T = HALF*( ( Z( 1 )-Z( 3 ) )+Z( 2 ) )
            S = Z( 3 )*( Z( 2 ) / T )
            IF( S.LE.T ) THEN
               S = Z( 3 )*( Z( 2 ) / ( T*( ONE+SQRT( ONE+S / T ) ) ) )
            ELSE
               S = Z( 3 )*( Z( 2 ) / ( T+SQRT( T )*SQRT( T+S ) ) )
```

```
            END IF
            T = Z( 1 ) + ( S+Z( 2 ) )
            Z( 3 ) = Z( 3 )*( Z( 1 ) / T )
            Z( 1 ) = T
         END IF
         Z( 2 ) = Z( 3 )
         Z( 6 ) = Z( 2 ) + Z( 1 )
         RETURN
      END IF
*
*     Check for negative data and compute sums of q's and e's.
*
      Z( 2*N ) = ZERO
      EMIN = Z( 2 )
      QMAX = ZERO
      ZMAX = ZERO
      D = ZERO
      E = ZERO
*
      DO 10 K = 1, 2*( N-1 ), 2
         IF( Z( K ).LT.ZERO ) THEN
            INFO = -( 200+K )
            CALL XERBLA( 'DLASQ2', 2 )
            RETURN
         ELSE IF( Z( K+1 ).LT.ZERO ) THEN
            INFO = -( 200+K+1 )
            CALL XERBLA( 'DLASQ2', 2 )
            RETURN
         END IF
         D = D + Z( K )
         E = E + Z( K+1 )
         QMAX = MAX( QMAX, Z( K ) )
         EMIN = MIN( EMIN, Z( K+1 ) )
         ZMAX = MAX( QMAX, ZMAX, Z( K+1 ) )
   10 CONTINUE
      IF( Z( 2*N-1 ).LT.ZERO ) THEN
         INFO = -( 200+2*N-1 )
         CALL XERBLA( 'DLASQ2', 2 )
         RETURN
      END IF
      D = D + Z( 2*N-1 )
      QMAX = MAX( QMAX, Z( 2*N-1 ) )
      ZMAX = MAX( QMAX, ZMAX )
*
*     Check for diagonality.
*
      IF( E.EQ.ZERO ) THEN
         DO 20 K = 2, N
            Z( K ) = Z( 2*K-1 )
   20    CONTINUE
```

```
         CALL DLASRT( 'D', N, Z, IINFO )
         Z( 2*N-1 ) = D
         RETURN
      END IF
*
      TRACE = D + E
*
*     Check for zero data.
*
      IF( TRACE.EQ.ZERO ) THEN
         Z( 2*N-1 ) = ZERO
         RETURN
      END IF
*
*     Check whether the machine is IEEE conformable.
*
      IEEE = ILAENV( 10, 'DLASQ2', 'N', 1, 2, 3, 4 ).EQ.1 .AND.
     $       ILAENV( 11, 'DLASQ2', 'N', 1, 2, 3, 4 ).EQ.1
*
*     Rearrange data for locality: Z=(q1,qq1,e1,ee1,q2,qq2,e2,ee2,...).
*
      DO 30 K = 2*N, 2, -2
         Z( 2*K ) = ZERO
         Z( 2*K-1 ) = Z( K )
         Z( 2*K-2 ) = ZERO
         Z( 2*K-3 ) = Z( K-1 )
   30 CONTINUE
*
      I0 = 1
      N0 = N
*
*     Reverse the qd-array, if warranted.
*
      IF( CBIAS*Z( 4*I0-3 ).LT.Z( 4*N0-3 ) ) THEN
         IPN4 = 4*( I0+N0 )
         DO 40 I4 = 4*I0, 2*( I0+N0-1 ), 4
            TEMP = Z( I4-3 )
            Z( I4-3 ) = Z( IPN4-I4-3 )
            Z( IPN4-I4-3 ) = TEMP
            TEMP = Z( I4-1 )
            Z( I4-1 ) = Z( IPN4-I4-5 )
            Z( IPN4-I4-5 ) = TEMP
   40    CONTINUE
      END IF
*
*     Initial split checking via dqd and Li's test.
*
      PP = 0
*
      DO 80 K = 1, 2
```

```
*
        D = Z( 4*N0+PP-3 )
        DO 50 I4 = 4*( N0-1 ) + PP, 4*I0 + PP, -4
           IF( Z( I4-1 ).LE.TOL2*D ) THEN
              Z( I4-1 ) = -ZERO
              D = Z( I4-3 )
           ELSE
              D = Z( I4-3 )*( D / ( D+Z( I4-1 ) ) )
           END IF
   50    CONTINUE
*
*       dqd maps Z to ZZ plus Li's test.
*
        EMIN = Z( 4*I0+PP+1 )
        D = Z( 4*I0+PP-3 )
        DO 60 I4 = 4*I0 + PP, 4*( N0-1 ) + PP, 4
           Z( I4-2*PP-2 ) = D + Z( I4-1 )
           IF( Z( I4-1 ).LE.TOL2*D ) THEN
              Z( I4-1 ) = -ZERO
              Z( I4-2*PP-2 ) = D
              Z( I4-2*PP ) = ZERO
              D = Z( I4+1 )
           ELSE IF( SAFMIN*Z( I4+1 ).LT.Z( I4-2*PP-2 ) .AND.
     $             SAFMIN*Z( I4-2*PP-2 ).LT.Z( I4+1 ) ) THEN
              TEMP = Z( I4+1 ) / Z( I4-2*PP-2 )
              Z( I4-2*PP ) = Z( I4-1 )*TEMP
              D = D*TEMP
           ELSE
              Z( I4-2*PP ) = Z( I4+1 )*( Z( I4-1 ) / Z( I4-2*PP-2 ) )
              D = Z( I4+1 )*( D / Z( I4-2*PP-2 ) )
           END IF
           EMIN = MIN( EMIN, Z( I4-2*PP ) )
   60    CONTINUE
         Z( 4*N0-PP-2 ) = D
*
*       Now find qmax.
*
        QMAX = Z( 4*I0-PP-2 )
        DO 70 I4 = 4*I0 - PP + 2, 4*N0 - PP - 2, 4
           QMAX = MAX( QMAX, Z( I4 ) )
   70    CONTINUE
*
*       Prepare for the next iteration on K.
*
        PP = 1 - PP
   80 CONTINUE
*
      ITER = 2
      NFAIL = 0
      NDIV = 2*( N0-I0 )
```

```
*
      DO 140 IWHILA = 1, N + 1
         IF( N0.LT.1 )
     $      GO TO 150
*
*        While array unfinished do
*
*        E(N0) holds the value of SIGMA when submatrix in I0:N0
*        splits from the rest of the array, but is negated.
*
         DESIG = ZERO
         IF( N0.EQ.N ) THEN
            SIGMA = ZERO
         ELSE
            SIGMA = -Z( 4*N0-1 )
         END IF
         IF( SIGMA.LT.ZERO ) THEN
            INFO = 1
            RETURN
         END IF
*
*        Find last unreduced submatrix's top index I0, find QMAX and
*        EMIN. Find Gershgorin-type bound if Q's much greater than E's.
*
         EMAX = ZERO
         IF( N0.GT.I0 ) THEN
            EMIN = ABS( Z( 4*N0-5 ) )
         ELSE
            EMIN = ZERO
         END IF
         QMIN = Z( 4*N0-3 )
         QMAX = QMIN
         DO 90 I4 = 4*N0, 8, -4
            IF( Z( I4-5 ).LE.ZERO )
     $         GO TO 100
            IF( QMIN.GE.FOUR*EMAX ) THEN
               QMIN = MIN( QMIN, Z( I4-3 ) )
               EMAX = MAX( EMAX, Z( I4-5 ) )
            END IF
            QMAX = MAX( QMAX, Z( I4-7 )+Z( I4-5 ) )
            EMIN = MIN( EMIN, Z( I4-5 ) )
   90    CONTINUE
         I4 = 4
*
  100    CONTINUE
         I0 = I4 / 4
*
*        Store EMIN for passing to DLASQ3.
*
         Z( 4*N0-1 ) = EMIN
```

```
*
*        Put -(initial shift) into DMIN.
*
         DMIN = -MAX( ZERO, QMIN-TWO*SQRT( QMIN )*SQRT( EMAX ) )
*
*        Now I0:N0 is unreduced. PP = 0 for ping, PP = 1 for pong.
*
         PP = 0
*
         NBIG = 30*( N0-I0+1 )
         DO 120 IWHILB = 1, NBIG
            IF( I0.GT.N0 )
     $         GO TO 130
*
*           While submatrix unfinished take a good dqds step.
*
            CALL DLASQ3( I0, N0, Z, PP, DMIN, SIGMA, DESIG, QMAX, NFAIL,
     $                   ITER, NDIV, IEEE )
*
            PP = 1 - PP
*
*           When EMIN is very small check for splits.
*
            IF( PP.EQ.0 .AND. N0-I0.GE.3 ) THEN
               IF( Z( 4*N0 ).LE.TOL2*QMAX .OR.
     $             Z( 4*N0-1 ).LE.TOL2*SIGMA ) THEN
                  SPLT = I0 - 1
                  QMAX = Z( 4*I0-3 )
                  EMIN = Z( 4*I0-1 )
                  OLDEMN = Z( 4*I0 )
                  DO 110 I4 = 4*I0, 4*( N0-3 ), 4
                     IF( Z( I4 ).LE.TOL2*Z( I4-3 ) .OR.
     $                   Z( I4-1 ).LE.TOL2*SIGMA ) THEN
                        Z( I4-1 ) = -SIGMA
                        SPLT = I4 / 4
                        QMAX = ZERO
                        EMIN = Z( I4+3 )
                        OLDEMN = Z( I4+4 )
                     ELSE
                        QMAX = MAX( QMAX, Z( I4+1 ) )
                        EMIN = MIN( EMIN, Z( I4-1 ) )
                        OLDEMN = MIN( OLDEMN, Z( I4 ) )
                     END IF
  110             CONTINUE
                  Z( 4*N0-1 ) = EMIN
                  Z( 4*N0 ) = OLDEMN
                  I0 = SPLT + 1
               END IF
            END IF
*
```

```
  120    CONTINUE
*
         INFO = 2
         RETURN
*
*        end IWHILB
*
  130    CONTINUE
*
  140 CONTINUE
*
      INFO = 3
      RETURN
*
*     end IWHILA
*
  150 CONTINUE
*
*     Move q's to the front.
*
      DO 160 K = 2, N
         Z( K ) = Z( 4*K-3 )
  160 CONTINUE
*
*     Sort and compute sum of eigenvalues.
*
      CALL DLASRT( 'D', N, Z, IINFO )
*
      E = ZERO
      DO 170 K = N, 1, -1
         E = E + Z( K )
  170 CONTINUE
*
*     Store trace, sum(eigenvalues) and information on performance.
*
      Z( 2*N+1 ) = TRACE
      Z( 2*N+2 ) = E
      Z( 2*N+3 ) = DBLE( ITER )
      Z( 2*N+4 ) = DBLE( NDIV ) / DBLE( N**2 )
      Z( 2*N+5 ) = HUNDRD*NFAIL / DBLE( ITER )
      RETURN
*
*     End of DLASQ2
*
      END
```

———-

— LAPACK dlasq2 —

```
(let* ((cbias 1.5)
       (zero 0.0)
       (half 0.5)
       (one 1.0)
       (two 2.0)
       (four 4.0)
       (hundrd 100.0))
  (declare (type (double-float 1.5 1.5) cbias)
           (type (double-float 0.0 0.0) zero)
           (type (double-float 0.5 0.5) half)
           (type (double-float 1.0 1.0) one)
           (type (double-float 2.0 2.0) two)
           (type (double-float 4.0 4.0) four)
           (type (double-float 100.0 100.0) hundrd))
  (defun dlasq2 (n z info)
    (declare (type (simple-array double-float (*)) z)
             (type fixnum info n))
    (f2cl-lib:with-multi-array-data
        ((z double-float z-%data% z-%offset%))
      (prog ((d 0.0) (desig 0.0) (dmin 0.0) (e 0.0) (emax 0.0) (emin 0.0)
             (eps 0.0) (oldemn 0.0) (qmax 0.0) (qmin 0.0) (s 0.0) (safmin 0.0)
             (sigma 0.0) (temp 0.0) (tol 0.0) (tol2 0.0) (zmax 0.0) (i0 0)
             (i4 0) (iinfo 0) (ipn4 0) (iter 0) (iwhila 0) (iwhilb 0) (k 0)
             (n0 0) (nbig 0) (ndiv 0) (nfail 0) (pp 0) (splt 0) (ieee nil)
             (trace$ 0.0) (t$ 0.0))
        (declare (type (double-float) t$ trace$ d desig dmin e emax emin eps
                                      oldemn qmax qmin s safmin sigma temp tol
                                      tol2 zmax)
                 (type fixnum i0 i4 iinfo ipn4 iter iwhila iwhilb
                                       k n0 nbig ndiv nfail pp splt)
                 (type (member t nil) ieee))
        (setf info 0)
        (setf eps (dlamch "Precision"))
        (setf safmin (dlamch "Safe minimum"))
        (setf tol (* eps hundrd))
        (setf tol2 (expt tol 2))
        (cond
          ((< n 0)
           (setf info -1)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DLASQ2" 1)
           (go end_label))
          ((= n 0)
           (go end_label))
          ((= n 1)
           (cond
             ((< (f2cl-lib:fref z (1) ((1 *))) zero)
```

```
    (setf info -201)
    (error
     " ** On entry to ~a parameter number ~a had an illegal value~%"
     "DLASQ2" 2)))
 (go end_label))
((= n 2)
 (cond
   ((or (< (f2cl-lib:fref z (2) ((1 *))) zero)
        (< (f2cl-lib:fref z (3) ((1 *))) zero))
    (setf info -2)
    (error
     " ** On entry to ~a parameter number ~a had an illegal value~%"
     "DLASQ2" 2)
    (go end_label))
   ((> (f2cl-lib:fref z (3) ((1 *))) (f2cl-lib:fref z (1) ((1 *))))
    (setf d (f2cl-lib:fref z-%data% (3) ((1 *)) z-%offset%))
    (setf (f2cl-lib:fref z-%data% (3) ((1 *)) z-%offset%)
            (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%))
    (setf (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%) d)))
 (setf (f2cl-lib:fref z-%data% (5) ((1 *)) z-%offset%)
        (+ (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)
           (f2cl-lib:fref z-%data% (2) ((1 *)) z-%offset%)
           (f2cl-lib:fref z-%data% (3) ((1 *)) z-%offset%)))
 (cond
   ((> (f2cl-lib:fref z (2) ((1 *)))
       (* (f2cl-lib:fref z (3) ((1 *))) tol2))
    (setf t$
            (* half
               (+
                (- (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)
                   (f2cl-lib:fref z-%data% (3) ((1 *)) z-%offset%))
                (f2cl-lib:fref z-%data% (2) ((1 *)) z-%offset%))))
    (setf s
            (* (f2cl-lib:fref z-%data% (3) ((1 *)) z-%offset%)
               (/ (f2cl-lib:fref z-%data% (2) ((1 *)) z-%offset%)
                  t$)))
    (cond
      ((<= s t$)
       (setf s
               (* (f2cl-lib:fref z-%data% (3) ((1 *)) z-%offset%)
                  (/ (f2cl-lib:fref z-%data% (2) ((1 *)) z-%offset%)
                     (* t$
                        (+ one (f2cl-lib:fsqrt (+ one (/ s t$)))))))))
      (t
       (setf s
               (* (f2cl-lib:fref z-%data% (3) ((1 *)) z-%offset%)
                  (/ (f2cl-lib:fref z-%data% (2) ((1 *)) z-%offset%)
                     (+ t$
                        (* (f2cl-lib:fsqrt t$)
                           (f2cl-lib:fsqrt (+ t$ s)))))))))
```

```
      (setf t$
              (+ (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)
                 (+ s (f2cl-lib:fref z-%data% (2) ((1 *)) z-%offset%))))
      (setf (f2cl-lib:fref z-%data% (3) ((1 *)) z-%offset%)
              (* (f2cl-lib:fref z-%data% (3) ((1 *)) z-%offset%)
                 (/ (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)
                    t$)))
      (setf (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%) t$)))
   (setf (f2cl-lib:fref z-%data% (2) ((1 *)) z-%offset%)
           (f2cl-lib:fref z-%data% (3) ((1 *)) z-%offset%))
   (setf (f2cl-lib:fref z-%data% (6) ((1 *)) z-%offset%)
           (+ (f2cl-lib:fref z-%data% (2) ((1 *)) z-%offset%)
              (f2cl-lib:fref z-%data% (1) ((1 *)) z-%offset%)))
   (go end_label)))
(setf (f2cl-lib:fref z-%data%
                     ((f2cl-lib:int-mul 2 n))
                     ((1 *))
                     z-%offset%)
       zero)
(setf emin (f2cl-lib:fref z-%data% (2) ((1 *)) z-%offset%))
(setf qmax zero)
(setf zmax zero)
(setf d zero)
(setf e zero)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 2))
              ((> k
                  (f2cl-lib:int-mul 2
                                    (f2cl-lib:int-add n
                                                      (f2cl-lib:int-sub
                                                       1))))
               nil)
  (tagbody
    (cond
      ((< (f2cl-lib:fref z (k) ((1 *))) zero)
       (setf info (f2cl-lib:int-sub (f2cl-lib:int-add 200 k)))
       (error
        " ** On entry to ~a parameter number ~a had an illegal value~%"
        "DLASQ2" 2)
       (go end_label))
      ((< (f2cl-lib:fref z ((f2cl-lib:int-add k 1)) ((1 *))) zero)
       (setf info (f2cl-lib:int-sub (f2cl-lib:int-add 200 k 1)))
       (error
        " ** On entry to ~a parameter number ~a had an illegal value~%"
        "DLASQ2" 2)
       (go end_label)))
    (setf d (+ d (f2cl-lib:fref z-%data% (k) ((1 *)) z-%offset%)))
    (setf e
            (+ e
               (f2cl-lib:fref z-%data%
                              ((f2cl-lib:int-add k 1))
```

```
                                ((1 *))
                                z-%offset%)))
      (setf qmax
              (max qmax (f2cl-lib:fref z-%data% (k) ((1 *)) z-%offset%)))
      (setf emin
              (min emin
                   (f2cl-lib:fref z-%data%
                                  ((f2cl-lib:int-add k 1))
                                  ((1 *))
                                  z-%offset%)))
      (setf zmax
              (max qmax
                   zmax
                   (f2cl-lib:fref z-%data%
                                  ((f2cl-lib:int-add k 1))
                                  ((1 *))
                                  z-%offset%)))))
  (cond
    ((<
      (f2cl-lib:fref z
                     ((f2cl-lib:int-add (f2cl-lib:int-mul 2 n)
                                        (f2cl-lib:int-sub 1)))
                     ((1 *)))
      zero)
     (setf info
             (f2cl-lib:int-sub
              (f2cl-lib:int-sub
               (f2cl-lib:int-add 200 (f2cl-lib:int-mul 2 n))
               1)))
     (error
      " ** On entry to ~a parameter number ~a had an illegal value~%"
      "DLASQ2" 2)
     (go end_label)))
  (setf d
          (+ d
             (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-sub (f2cl-lib:int-mul 2 n) 1))
                            ((1 *))
                            z-%offset%)))
  (setf qmax
          (max qmax
               (f2cl-lib:fref z-%data%
                              ((f2cl-lib:int-sub (f2cl-lib:int-mul 2 n)
                                                 1))
                              ((1 *))
                              z-%offset%)))
  (setf zmax (max qmax zmax))
  (cond
    ((= e zero)
     (f2cl-lib:fdo (k 2 (f2cl-lib:int-add k 1))
```

```
                ((> k n) nil)
      (tagbody
        (setf (f2cl-lib:fref z-%data% (k) ((1 *)) z-%offset%)
                (f2cl-lib:fref z-%data%
                               ((f2cl-lib:int-sub (f2cl-lib:int-mul 2 k)
                                                  1))
                               ((1 *))
                               z-%offset%))))
   (multiple-value-bind (var-0 var-1 var-2 var-3)
       (dlasrt "D" n z iinfo)
     (declare (ignore var-0 var-1 var-2))
     (setf iinfo var-3))
   (setf (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub (f2cl-lib:int-mul 2 n) 1))
                        ((1 *))
                        z-%offset%)
          d)
   (go end_label)))
(setf trace$ (+ d e))
(cond
  ((= trace$ zero)
   (setf (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub (f2cl-lib:int-mul 2 n) 1))
                        ((1 *))
                        z-%offset%)
          zero)
   (go end_label)))
(setf ieee
        (and (= (ilaenv 10 "DLASQ2" "N" 1 2 3 4) 1)
             (= (ilaenv 11 "DLASQ2" "N" 1 2 3 4) 1)))
(f2cl-lib:fdo (k (f2cl-lib:int-mul 2 n)
                 (f2cl-lib:int-add k (f2cl-lib:int-sub 2)))
              ((> k 2) nil)
  (tagbody
    (setf (f2cl-lib:fref z-%data%
                         ((f2cl-lib:int-mul 2 k))
                         ((1 *))
                         z-%offset%)
           zero)
    (setf (f2cl-lib:fref z-%data%
                         ((f2cl-lib:int-sub (f2cl-lib:int-mul 2 k) 1))
                         ((1 *))
                         z-%offset%)
           (f2cl-lib:fref z-%data% (k) ((1 *)) z-%offset%))
    (setf (f2cl-lib:fref z-%data%
                         ((f2cl-lib:int-sub (f2cl-lib:int-mul 2 k) 2))
                         ((1 *))
                         z-%offset%)
           zero)
    (setf (f2cl-lib:fref z-%data%
```

```
                          ((f2cl-lib:int-sub (f2cl-lib:int-mul 2 k) 3))
                          ((1 *))
                          z-%offset%)
                (f2cl-lib:fref z-%data%
                               ((f2cl-lib:int-sub k 1))
                               ((1 *))
                               z-%offset%))))
      (setf i0 1)
      (setf n0 n)
      (cond
        ((<
          (* cbias
             (f2cl-lib:fref z
                            ((f2cl-lib:int-add (f2cl-lib:int-mul 4 i0)
                                               (f2cl-lib:int-sub 3)))
                            ((1 *))))
          (f2cl-lib:fref z
                         ((f2cl-lib:int-add (f2cl-lib:int-mul 4 n0)
                                            (f2cl-lib:int-sub 3)))
                         ((1 *))))
         (setf ipn4 (f2cl-lib:int-mul 4 (f2cl-lib:int-add i0 n0)))
         (f2cl-lib:fdo (i4 (f2cl-lib:int-mul 4 i0) (f2cl-lib:int-add i4 4))
                       ((> i4
                           (f2cl-lib:int-mul 2
                                             (f2cl-lib:int-add i0
                                                               n0
                                                               (f2cl-lib:int-sub
                                                                1))))
                        nil)
           (tagbody
             (setf temp
                     (f2cl-lib:fref z-%data%
                                    ((f2cl-lib:int-sub i4 3))
                                    ((1 *))
                                    z-%offset%))
             (setf (f2cl-lib:fref z-%data%
                                  ((f2cl-lib:int-sub i4 3))
                                  ((1 *))
                                  z-%offset%)
                     (f2cl-lib:fref z-%data%
                                    ((f2cl-lib:int-sub ipn4 i4 3))
                                    ((1 *))
                                    z-%offset%))
             (setf (f2cl-lib:fref z-%data%
                                  ((f2cl-lib:int-sub ipn4 i4 3))
                                  ((1 *))
                                  z-%offset%)
                     temp)
             (setf temp
                     (f2cl-lib:fref z-%data%
```

```
                                ((f2cl-lib:int-sub i4 1))
                                ((1 *))
                                z-%offset%))
          (setf (f2cl-lib:fref z-%data%
                               ((f2cl-lib:int-sub i4 1))
                               ((1 *))
                               z-%offset%)
                (f2cl-lib:fref z-%data%
                               ((f2cl-lib:int-sub ipn4 i4 5))
                               ((1 *))
                               z-%offset%))
          (setf (f2cl-lib:fref z-%data%
                               ((f2cl-lib:int-sub ipn4 i4 5))
                               ((1 *))
                               z-%offset%)
                temp)))))
(setf pp 0)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
              ((> k 2) nil)
  (tagbody
    (setf d
          (f2cl-lib:fref z-%data%
                         ((f2cl-lib:int-sub
                           (f2cl-lib:int-add (f2cl-lib:int-mul 4 n0)
                                             pp)
                           3))
                         ((1 *))
                         z-%offset%))
    (f2cl-lib:fdo (i4
                   (f2cl-lib:int-add
                    (f2cl-lib:int-mul 4
                                      (f2cl-lib:int-add n0
                                                        (f2cl-lib:int-sub
                                                         1)))
                    pp)
                   (f2cl-lib:int-add i4 (f2cl-lib:int-sub 4)))
                  ((> i4 (f2cl-lib:int-add (f2cl-lib:int-mul 4 i0) pp))
                   nil)
      (tagbody
        (cond
          ((<=
            (f2cl-lib:fref z
                           ((f2cl-lib:int-add i4 (f2cl-lib:int-sub 1)))
                           ((1 *)))
            (* tol2 d))
           (setf (f2cl-lib:fref z-%data%
                                ((f2cl-lib:int-sub i4 1))
                                ((1 *))
                                z-%offset%)
                 (- zero))
```

```
                (setf d
                        (f2cl-lib:fref z-%data%
                                       ((f2cl-lib:int-sub i4 3))
                                       ((1 *))
                                       z-%offset%)))
               (t
                (setf d
                        (*
                         (f2cl-lib:fref z-%data%
                                        ((f2cl-lib:int-sub i4 3))
                                        ((1 *))
                                        z-%offset%)
                         (/ d
                            (+ d
                               (f2cl-lib:fref z-%data%
                                              ((f2cl-lib:int-sub i4 1))
                                              ((1 *))
                                              z-%offset%)))))))))
          (setf emin
                (f2cl-lib:fref z-%data%
                               ((f2cl-lib:int-add (f2cl-lib:int-mul 4 i0)
                                                  pp
                                                  1))
                               ((1 *))
                               z-%offset%))
          (setf d
                (f2cl-lib:fref z-%data%
                               ((f2cl-lib:int-sub
                                 (f2cl-lib:int-add (f2cl-lib:int-mul 4 i0)
                                                   pp)
                                 3))
                               ((1 *))
                               z-%offset%))
          (f2cl-lib:fdo (i4 (f2cl-lib:int-add (f2cl-lib:int-mul 4 i0) pp)
                         (f2cl-lib:int-add i4 4))
                        ((> i4
                            (f2cl-lib:int-add
                             (f2cl-lib:int-mul 4
                                               (f2cl-lib:int-add n0
                                                                 (f2cl-lib:int-sub
                                                                  1)))
                             pp))
                         nil)
            (tagbody
              (setf (f2cl-lib:fref z-%data%
                                   ((f2cl-lib:int-sub
                                     (f2cl-lib:int-add i4
                                                       (f2cl-lib:int-mul -1
                                                                         2
                                                                         pp))
```

```
                          2))
                        ((1 *))
                        z-%offset%)
              (+ d
                 (f2cl-lib:fref z-%data%
                                ((f2cl-lib:int-sub i4 1))
                                ((1 *))
                                z-%offset%)))
      (cond
        ((<=
          (f2cl-lib:fref z
                         ((f2cl-lib:int-add i4 (f2cl-lib:int-sub 1)))
                         ((1 *)))
          (* tol2 d))
         (setf (f2cl-lib:fref z-%data%
                              ((f2cl-lib:int-sub i4 1))
                              ((1 *))
                              z-%offset%)
                 (- zero))
         (setf (f2cl-lib:fref z-%data%
                              ((f2cl-lib:int-sub
                                (f2cl-lib:int-add i4
                                                  (f2cl-lib:int-mul
                                                   -1
                                                   2
                                                   pp))
                                2))
                              ((1 *))
                              z-%offset%)
                 d)
         (setf (f2cl-lib:fref z-%data%
                              ((f2cl-lib:int-add i4
                                                 (f2cl-lib:int-mul -1
                                                                   2
                                                                   pp)))
                              ((1 *))
                              z-%offset%)
                 zero)
         (setf d
                 (f2cl-lib:fref z-%data%
                                ((f2cl-lib:int-add i4 1))
                                ((1 *))
                                z-%offset%)))
        ((and
          (<
           (* safmin
              (f2cl-lib:fref z ((f2cl-lib:int-add i4 1)) ((1 *))))
           (f2cl-lib:fref z
                          ((f2cl-lib:int-add i4
                                             (f2cl-lib:int-mul -1
```

```
                                                              2
                                                              pp)
                                          (f2cl-lib:int-sub 2)))
                    ((1 *))))
     (<
      (* safmin
         (f2cl-lib:fref z
                        ((f2cl-lib:int-add i4
                                           (f2cl-lib:int-mul -1
                                                             2
                                                             pp)
                                           (f2cl-lib:int-sub
                                            2)))
                        ((1 *))))
       (f2cl-lib:fref z ((f2cl-lib:int-add i4 1)) ((1 *)))))
     (setf temp
           (/
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-add i4 1))
                           ((1 *))
                           z-%offset%)
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub
                             (f2cl-lib:int-add i4
                                               (f2cl-lib:int-mul
                                                -1
                                                2
                                                pp))
                             2))
                           ((1 *))
                           z-%offset%)))
     (setf (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-add i4
                                             (f2cl-lib:int-mul -1
                                                               2
                                                               pp)))
                          ((1 *))
                          z-%offset%)
           (*
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub i4 1))
                           ((1 *))
                           z-%offset%)
            temp))
     (setf d (* d temp)))
    (t
     (setf (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-add i4
                                             (f2cl-lib:int-mul -1
                                                               2
```

```
                                                                  pp)))
                                    ((1 *))
                                    z-%offset%)
                             (*
                              (f2cl-lib:fref z-%data%
                                             ((f2cl-lib:int-add i4 1))
                                             ((1 *))
                                             z-%offset%)
                              (/
                               (f2cl-lib:fref z-%data%
                                              ((f2cl-lib:int-sub i4 1))
                                              ((1 *))
                                              z-%offset%)
                               (f2cl-lib:fref z-%data%
                                              ((f2cl-lib:int-sub
                                                (f2cl-lib:int-add i4
                                                                  (f2cl-lib:int-mul
                                                                   -1
                                                                   2
                                                                   pp))
                                                2))
                                              ((1 *))
                                              z-%offset%))))
                      (setf d
                            (*
                             (f2cl-lib:fref z-%data%
                                            ((f2cl-lib:int-add i4 1))
                                            ((1 *))
                                            z-%offset%)
                             (/ d
                                (f2cl-lib:fref z-%data%
                                               ((f2cl-lib:int-sub
                                                 (f2cl-lib:int-add i4
                                                                   (f2cl-lib:int-mul
                                                                    -1
                                                                    2
                                                                    pp))
                                                 2))
                                               ((1 *))
                                               z-%offset%))))))
                (setf emin
                      (min emin
                           (f2cl-lib:fref z-%data%
                                          ((f2cl-lib:int-add i4
                                                             (f2cl-lib:int-mul
                                                              -1
                                                              2
                                                              pp)))
                                          ((1 *))
                                          z-%offset%)))))
```

```
      (setf (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub (f2cl-lib:int-mul 4 n0)
                                              pp
                                              2))
                           ((1 *))
                           z-%offset%)
            d)
      (setf qmax
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub (f2cl-lib:int-mul 4 i0)
                                              pp
                                              2))
                           ((1 *))
                           z-%offset%))
      (f2cl-lib:fdo (i4
                     (f2cl-lib:int-add (f2cl-lib:int-mul 4 i0)
                                       (f2cl-lib:int-sub pp)
                                       2)
                     (f2cl-lib:int-add i4 4))
                    ((> i4
                        (f2cl-lib:int-add (f2cl-lib:int-mul 4 n0)
                                          (f2cl-lib:int-sub pp)
                                          (f2cl-lib:int-sub 2)))
                     nil)
        (tagbody
          (setf qmax
                (max qmax
                     (f2cl-lib:fref z-%data% (i4) ((1 *)) z-%offset%)))))
      (setf pp (f2cl-lib:int-sub 1 pp))))
  (setf iter 2)
  (setf nfail 0)
  (setf ndiv (f2cl-lib:int-mul 2 (f2cl-lib:int-sub n0 i0)))
  (f2cl-lib:fdo (iwhila 1 (f2cl-lib:int-add iwhila 1))
                ((> iwhila (f2cl-lib:int-add n 1)) nil)
    (tagbody
      (if (< n0 1) (go label150))
      (setf desig zero)
      (cond
        ((= n0 n)
         (setf sigma zero))
        (t
         (setf sigma
                 (-
                  (f2cl-lib:fref z-%data%
                                 ((f2cl-lib:int-sub
                                   (f2cl-lib:int-mul 4 n0)
                                   1))
                                 ((1 *))
                                 z-%offset%)))))
      (cond
```

```
  ((< sigma zero)
   (setf info 1)
   (go end_label)))
(setf emax zero)
(cond
  ((> n0 i0)
   (setf emin
           (abs
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub
                             (f2cl-lib:int-mul 4 n0)
                             5))
                           ((1 *))
                           z-%offset%))))
  (t
   (setf emin zero)))
(setf qmin
       (f2cl-lib:fref z-%data%
                      ((f2cl-lib:int-sub (f2cl-lib:int-mul 4 n0)
                                         3))
                      ((1 *))
                      z-%offset%))
(setf qmax qmin)
(f2cl-lib:fdo (i4 (f2cl-lib:int-mul 4 n0)
               (f2cl-lib:int-add i4 (f2cl-lib:int-sub 4)))
              ((> i4 8) nil)
  (tagbody
    (if
     (<=
      (f2cl-lib:fref z-%data%
                     ((f2cl-lib:int-sub i4 5))
                     ((1 *))
                     z-%offset%)
      zero)
     (go label100))
    (cond
      ((>= qmin (* four emax))
       (setf qmin
               (min qmin
                    (f2cl-lib:fref z-%data%
                                   ((f2cl-lib:int-sub i4 3))
                                   ((1 *))
                                   z-%offset%)))
       (setf emax
               (max emax
                    (f2cl-lib:fref z-%data%
                                   ((f2cl-lib:int-sub i4 5))
                                   ((1 *))
                                   z-%offset%)))))
    (setf qmax
```

```
                    (max qmax
                         (+
                          (f2cl-lib:fref z-%data%
                                         ((f2cl-lib:int-sub i4 7))
                                         ((1 *))
                                         z-%offset%)
                          (f2cl-lib:fref z-%data%
                                         ((f2cl-lib:int-sub i4 5))
                                         ((1 *))
                                         z-%offset%))))
                (setf emin
                        (min emin
                             (f2cl-lib:fref z-%data%
                                           ((f2cl-lib:int-sub i4 5))
                                           ((1 *))
                                           z-%offset%)))))
           (setf i4 4)
label100
           (setf i0 (the fixnum (truncate i4 4)))
           (setf (f2cl-lib:fref z-%data%
                                ((f2cl-lib:int-sub (f2cl-lib:int-mul 4 n0) 1))
                                ((1 *))
                                z-%offset%)
                 emin)
           (setf dmin
                 (-
                  (max zero
                       (+ qmin
                          (* (- two)
                             (f2cl-lib:fsqrt qmin)
                             (f2cl-lib:fsqrt emax))))))
           (setf pp 0)
           (setf nbig
                 (f2cl-lib:int-mul 30
                                   (f2cl-lib:int-add
                                    (f2cl-lib:int-sub n0 i0)
                                    1)))
           (f2cl-lib:fdo (iwhilb 1 (f2cl-lib:int-add iwhilb 1))
                         ((> iwhilb nbig) nil)
             (tagbody
               (if (> i0 n0) (go label130))
               (multiple-value-bind
                     (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                      var-9 var-10 var-11)
                   (dlasq3 i0 n0 z pp dmin sigma desig qmax nfail iter ndiv
                    ieee)
                 (declare (ignore var-0 var-2 var-3 var-11))
                 (setf n0 var-1)
                 (setf dmin var-4)
                 (setf sigma var-5)
```

```
  (setf desig var-6)
  (setf qmax var-7)
  (setf nfail var-8)
  (setf iter var-9)
  (setf ndiv var-10))
(setf pp (f2cl-lib:int-sub 1 pp))
(cond
  ((and (= pp 0)
        (>= (f2cl-lib:int-add n0 (f2cl-lib:int-sub i0)) 3))
   (cond
     ((or
       (<= (f2cl-lib:fref z ((f2cl-lib:int-mul 4 n0)) ((1 *)))
           (* tol2 qmax))
       (<=
        (f2cl-lib:fref z
                       ((f2cl-lib:int-add
                         (f2cl-lib:int-mul 4 n0)
                         (f2cl-lib:int-sub 1)))
                       ((1 *)))
        (* tol2 sigma)))
      (setf splt (f2cl-lib:int-sub i0 1))
      (setf qmax
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub
                             (f2cl-lib:int-mul 4 i0)
                             3))
                           ((1 *))
                           z-%offset%))
      (setf emin
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub
                             (f2cl-lib:int-mul 4 i0)
                             1))
                           ((1 *))
                           z-%offset%))
      (setf oldemn
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-mul 4 i0))
                           ((1 *))
                           z-%offset%))
      (f2cl-lib:fdo (i4 (f2cl-lib:int-mul 4 i0)
                     (f2cl-lib:int-add i4 4))
                    ((> i4
                        (f2cl-lib:int-mul 4
                          (f2cl-lib:int-add n0
                           (f2cl-lib:int-sub
                             3))))
                     nil)
        (tagbody
          (cond
```

```
((or
  (<= (f2cl-lib:fref z (i4) ((1 *)))
      (* tol2
         (f2cl-lib:fref z
           ((f2cl-lib:int-add i4
              (f2cl-lib:int-sub
                                          3)))
                       ((1 *)))))
  (<=
   (f2cl-lib:fref z
                  ((f2cl-lib:int-add i4
                     (f2cl-lib:int-sub
                                    1)))
                  ((1 *)))
   (* tol2 sigma)))
 (setf (f2cl-lib:fref z-%data%
                      ((f2cl-lib:int-sub i4 1))
                      ((1 *))
                      z-%offset%)
         (- sigma))
 (setf splt (the fixnum (truncate i4 4)))
 (setf qmax zero)
 (setf emin
         (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-add i4 3))
                        ((1 *))
                        z-%offset%))
 (setf oldemn
         (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-add i4 4))
                        ((1 *))
                        z-%offset%)))
(t
 (setf qmax
         (max qmax
              (f2cl-lib:fref z-%data%
                             ((f2cl-lib:int-add i4
                                                1))
                             ((1 *))
                             z-%offset%)))
 (setf emin
         (min emin
              (f2cl-lib:fref z-%data%
                             ((f2cl-lib:int-sub i4
                                                1))
                             ((1 *))
                             z-%offset%)))
 (setf oldemn
         (min oldemn
              (f2cl-lib:fref z-%data%
```

```
                                                  (i4)
                                                  ((1 *))
                                                  z-%offset%)))))))
                    (setf (f2cl-lib:fref z-%data%
                                         ((f2cl-lib:int-sub
                                           (f2cl-lib:int-mul 4 n0)
                                           1))
                                         ((1 *))
                                         z-%offset%)
                            emin)
                    (setf (f2cl-lib:fref z-%data%
                                         ((f2cl-lib:int-mul 4 n0))
                                         ((1 *))
                                         z-%offset%)
                            oldemn)
                    (setf i0 (f2cl-lib:int-add splt 1))))))))
           (setf info 2)
           (go end_label)
label130))
       (setf info 3)
       (go end_label)
label150
       (f2cl-lib:fdo (k 2 (f2cl-lib:int-add k 1))
                     ((> k n) nil)
         (tagbody
           (setf (f2cl-lib:fref z-%data% (k) ((1 *)) z-%offset%)
                   (f2cl-lib:fref z-%data%
                                  ((f2cl-lib:int-sub (f2cl-lib:int-mul 4 k)
                                                     3))
                                  ((1 *))
                                  z-%offset%))))
       (multiple-value-bind (var-0 var-1 var-2 var-3)
           (dlasrt "D" n z iinfo)
         (declare (ignore var-0 var-1 var-2))
         (setf iinfo var-3))
       (setf e zero)
       (f2cl-lib:fdo (k n (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
                     ((> k 1) nil)
         (tagbody
           (setf e (+ e (f2cl-lib:fref z-%data% (k) ((1 *)) z-%offset%)))))
       (setf (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-add (f2cl-lib:int-mul 2 n) 1))
                            ((1 *))
                            z-%offset%)
             trace$)
       (setf (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-add (f2cl-lib:int-mul 2 n) 2))
                            ((1 *))
                            z-%offset%)
             e)
```

```
        (setf (f2cl-lib:fref z-%data%
                             ((f2cl-lib:int-add (f2cl-lib:int-mul 2 n) 3))
                             ((1 *))
                             z-%offset%)
                (coerce (realpart iter) 'double-float))
        (setf (f2cl-lib:fref z-%data%
                             ((f2cl-lib:int-add (f2cl-lib:int-mul 2 n) 4))
                             ((1 *))
                             z-%offset%)
                (/ (coerce (realpart ndiv) 'double-float)
                   (coerce (realpart (expt n 2)) 'double-float)))
        (setf (f2cl-lib:fref z-%data%
                             ((f2cl-lib:int-add (f2cl-lib:int-mul 2 n) 5))
                             ((1 *))
                             z-%offset%)
                (/ (* hundrd nfail)
                   (coerce (realpart iter) 'double-float)))
        (go end_label)
 end_label
        (return (values nil nil info))))))
```

———-

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— **dlasq3.input** —

```
)set break resume
)sys rm -f dlasq3.output
)spool dlasq3.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlasq3.help** —

```
====================================================================
dlasq3 examples
====================================================================
```

```
=====================================================================
Man Page Details
=====================================================================

NAME
       DLASQ3 - for deflation, computes a shift (TAU) and calls dqds

SYNOPSIS
       SUBROUTINE DLASQ3( I0,  N0,  Z,  PP,  DMIN,  SIGMA, DESIG, QMAX, NFAIL,
                          ITER, NDIV, IEEE )

           LOGICAL        IEEE

           INTEGER        I0, ITER, N0, NDIV, NFAIL, PP

           DOUBLE         PRECISION DESIG, DMIN, QMAX, SIGMA

           DOUBLE         PRECISION Z( * )

  Purpose
  =======

  DLASQ3 checks for deflation, computes a shift (TAU) and calls dqds.
  In case of failure it changes shifts, and tries again until output
  is positive.

  Arguments
  =========

  I0     (input) INTEGER
         First index.

  N0     (input) INTEGER
         Last index.

  Z      (input) DOUBLE PRECISION array, dimension ( 4*N )
         Z holds the qd array.

  PP     (input) INTEGER
         PP=0 for ping, PP=1 for pong.

  DMIN   (output) DOUBLE PRECISION
         Minimum value of d.

  SIGMA  (output) DOUBLE PRECISION
         Sum of shifts used in current segment.

  DESIG  (input/output) DOUBLE PRECISION
         Lower order part of SIGMA
```

```
  QMAX   (input) DOUBLE PRECISION
         Maximum value of q.

  NFAIL  (output) INTEGER
         Number of times shift was too big.

  ITER   (output) INTEGER
         Number of iterations.

  NDIV   (output) INTEGER
         Number of divisions.

  TTYPE  (output) INTEGER
         Shift type.

  IEEE   (input) LOGICAL
         Flag for IEEE or non IEEE arithmetic (passed to DLASQ5).
```

———-

— dlasq3.f —

```
      SUBROUTINE DLASQ3( I0, N0, Z, PP, DMIN, SIGMA, DESIG, QMAX, NFAIL,
     $                   ITER, NDIV, IEEE )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     May 17, 2000
*
*     .. Scalar Arguments ..
      LOGICAL            IEEE
      INTEGER            I0, ITER, N0, NDIV, NFAIL, PP
      DOUBLE PRECISION   DESIG, DMIN, QMAX, SIGMA
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   Z( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   CBIAS
      PARAMETER          ( CBIAS = 1.50D0 )
      DOUBLE PRECISION   ZERO, QURTR, HALF, ONE, TWO, HUNDRD
      PARAMETER          ( ZERO = 0.0D0, QURTR = 0.250D0, HALF = 0.5D0,
     $                     ONE = 1.0D0, TWO = 2.0D0, HUNDRD = 100.0D0 )
*     ..
```

```
*     .. Local Scalars ..
      INTEGER            IPN4, J4, NOIN, NN, TTYPE
      DOUBLE PRECISION   DMIN1, DMIN2, DN, DN1, DN2, EPS, S, SAFMIN, T,
     $                   TAU, TEMP, TOL, TOL2
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLASQ4, DLASQ5, DLASQ6
*     ..
*     .. External Function ..
      DOUBLE PRECISION   DLAMCH
      EXTERNAL           DLAMCH
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MIN, SQRT
*     ..
*     .. Save statement ..
      SAVE               TTYPE
      SAVE               DMIN1, DMIN2, DN, DN1, DN2, TAU
*     ..
*     .. Data statement ..
      DATA               TTYPE / 0 /
      DATA               DMIN1 / ZERO /, DMIN2 / ZERO /, DN / ZERO /,
     $                   DN1 / ZERO /, DN2 / ZERO /, TAU / ZERO /
*     ..
*     .. Executable Statements ..
*
      NOIN = N0
      EPS = DLAMCH( 'Precision' )
      SAFMIN = DLAMCH( 'Safe minimum' )
      TOL = EPS*HUNDRD
      TOL2 = TOL**2
*
*     Check for deflation.
*
   10 CONTINUE
*
      IF( N0.LT.I0 )
     $   RETURN
      IF( N0.EQ.I0 )
     $   GO TO 20
      NN = 4*N0 + PP
      IF( N0.EQ.( I0+1 ) )
     $   GO TO 40
*
*     Check whether E(N0-1) is negligible, 1 eigenvalue.
*
      IF( Z( NN-5 ).GT.TOL2*( SIGMA+Z( NN-3 ) ) .AND.
     $    Z( NN-2*PP-4 ).GT.TOL2*Z( NN-7 ) )
     $   GO TO 30
*
```

```
   20 CONTINUE
*
      Z( 4*N0-3 ) = Z( 4*N0+PP-3 ) + SIGMA
      N0 = N0 - 1
      GO TO 10
*
*     Check  whether E(N0-2) is negligible, 2 eigenvalues.
*
   30 CONTINUE
*
      IF( Z( NN-9 ).GT.TOL2*SIGMA .AND.
     $    Z( NN-2*PP-8 ).GT.TOL2*Z( NN-11 ) )
     $   GO TO 50
*
   40 CONTINUE
*
      IF( Z( NN-3 ).GT.Z( NN-7 ) ) THEN
         S = Z( NN-3 )
         Z( NN-3 ) = Z( NN-7 )
         Z( NN-7 ) = S
      END IF
      IF( Z( NN-5 ).GT.Z( NN-3 )*TOL2 ) THEN
         T = HALF*( ( Z( NN-7 )-Z( NN-3 ) )+Z( NN-5 ) )
         S = Z( NN-3 )*( Z( NN-5 ) / T )
         IF( S.LE.T ) THEN
            S = Z( NN-3 )*( Z( NN-5 ) /
     $          ( T*( ONE+SQRT( ONE+S / T ) ) ) )
         ELSE
            S = Z( NN-3 )*( Z( NN-5 ) / ( T+SQRT( T )*SQRT( T+S ) ) )
         END IF
         T = Z( NN-7 ) + ( S+Z( NN-5 ) )
         Z( NN-3 ) = Z( NN-3 )*( Z( NN-7 ) / T )
         Z( NN-7 ) = T
      END IF
      Z( 4*N0-7 ) = Z( NN-7 ) + SIGMA
      Z( 4*N0-3 ) = Z( NN-3 ) + SIGMA
      N0 = N0 - 2
      GO TO 10
*
   50 CONTINUE
*
*     Reverse the qd-array, if warranted.
*
      IF( DMIN.LE.ZERO .OR. N0.LT.NOIN ) THEN
         IF( CBIAS*Z( 4*I0+PP-3 ).LT.Z( 4*N0+PP-3 ) ) THEN
            IPN4 = 4*( I0+N0 )
            DO 60 J4 = 4*I0, 2*( I0+N0-1 ), 4
               TEMP = Z( J4-3 )
               Z( J4-3 ) = Z( IPN4-J4-3 )
               Z( IPN4-J4-3 ) = TEMP
```

```
               TEMP = Z( J4-2 )
               Z( J4-2 ) = Z( IPN4-J4-2 )
               Z( IPN4-J4-2 ) = TEMP
               TEMP = Z( J4-1 )
               Z( J4-1 ) = Z( IPN4-J4-5 )
               Z( IPN4-J4-5 ) = TEMP
               TEMP = Z( J4 )
               Z( J4 ) = Z( IPN4-J4-4 )
               Z( IPN4-J4-4 ) = TEMP
   60       CONTINUE
            IF( N0-I0.LE.4 ) THEN
               Z( 4*N0+PP-1 ) = Z( 4*I0+PP-1 )
               Z( 4*N0-PP ) = Z( 4*I0-PP )
            END IF
            DMIN2 = MIN( DMIN2, Z( 4*N0+PP-1 ) )
            Z( 4*N0+PP-1 ) = MIN( Z( 4*N0+PP-1 ), Z( 4*I0+PP-1 ),
     $                            Z( 4*I0+PP+3 ) )
            Z( 4*N0-PP ) = MIN( Z( 4*N0-PP ), Z( 4*I0-PP ),
     $                          Z( 4*I0-PP+4 ) )
            QMAX = MAX( QMAX, Z( 4*I0+PP-3 ), Z( 4*I0+PP+1 ) )
            DMIN = -ZERO
         END IF
      END IF
*
   70 CONTINUE
*
      IF( DMIN.LT.ZERO .OR. SAFMIN*QMAX.LT.MIN( Z( 4*N0+PP-1 ),
     $    Z( 4*N0+PP-9 ), DMIN2+Z( 4*N0-PP ) ) ) THEN
*
*        Choose a shift.
*
         CALL DLASQ4( I0, N0, Z, PP, N0IN, DMIN, DMIN1, DMIN2, DN, DN1,
     $                DN2, TAU, TTYPE )
*
*        Call dqds until DMIN > 0.
*
   80    CONTINUE
*
         CALL DLASQ5( I0, N0, Z, PP, TAU, DMIN, DMIN1, DMIN2, DN,
     $                DN1, DN2, IEEE )
*
         NDIV = NDIV + ( N0-I0+2 )
         ITER = ITER + 1
*
*        Check status.
*
         IF( DMIN.GE.ZERO .AND. DMIN1.GT.ZERO ) THEN
*
*           Success.
*
```

```
            GO TO 100
*
         ELSE IF( DMIN.LT.ZERO .AND. DMIN1.GT.ZERO .AND.
     $            Z( 4*( N0-1 )-PP ).LT.TOL*( SIGMA+DN1 ) .AND.
     $            ABS( DN ).LT.TOL*SIGMA ) THEN
*
*           Convergence hidden by negative DN.
*
            Z( 4*( N0-1 )-PP+2 ) = ZERO
            DMIN = ZERO
            GO TO 100
         ELSE IF( DMIN.LT.ZERO ) THEN
*
*           TAU too big. Select new TAU and try again.
*
            NFAIL = NFAIL + 1
            IF( TTYPE.LT.-22 ) THEN
*
*              Failed twice. Play it safe.
*
               TAU = ZERO
            ELSE IF( DMIN1.GT.ZERO ) THEN
*
*              Late failure. Gives excellent shift.
*
               TAU = ( TAU+DMIN )*( ONE-TWO*EPS )
               TTYPE = TTYPE - 11
            ELSE
*
*              Early failure. Divide by 4.
*
               TAU = QURTR*TAU
               TTYPE = TTYPE - 12
            END IF
            GO TO 80
         ELSE IF( DMIN.NE.DMIN ) THEN
*
*           NaN.
*
            TAU = ZERO
            GO TO 80
         ELSE
*
*           Possible underflow. Play it safe.
*
            GO TO 90
         END IF
      END IF
*
*     Risk of underflow.
```

```
*
   90 CONTINUE
      CALL DLASQ6( I0, N0, Z, PP, DMIN, DMIN1, DMIN2, DN, DN1, DN2 )
      NDIV = NDIV + ( N0-I0+2 )
      ITER = ITER + 1
      TAU = ZERO
*
  100 CONTINUE
      IF( TAU.LT.SIGMA ) THEN
         DESIG = DESIG + TAU
         T = SIGMA + DESIG
         DESIG = DESIG - ( T-SIGMA )
      ELSE
         T = SIGMA + TAU
         DESIG = SIGMA - ( T-TAU ) + DESIG
      END IF
      SIGMA = T
*
      RETURN
*
*     End of DLASQ3
*
      END
```

———-

— LAPACK dlasq3 —

```
(let* ((cbias 1.5)
       (zero 0.0)
       (qurtr 0.25)
       (half 0.5)
       (one 1.0)
       (two 2.0)
       (hundrd 100.0))
  (declare (type (double-float 1.5 1.5) cbias)
           (type (double-float 0.0 0.0) zero)
           (type (double-float 0.25 0.25) qurtr)
           (type (double-float 0.5 0.5) half)
           (type (double-float 1.0 1.0) one)
           (type (double-float 2.0 2.0) two)
           (type (double-float 100.0 100.0) hundrd))
  (let ((ttype 0)
        (f2cl-lib:dmin1 zero)
        (dmin2 zero)
        (dn zero)
        (dn1 zero)
        (dn2 zero)
```

```
       (tau zero))
   (declare (type (double-float) tau dn2 dn1 dn dmin2 f2cl-lib:dmin1)
            (type fixnum ttype))
   (defun dlasq3 (i0 n0 z pp dmin sigma desig qmax nfail iter ndiv ieee)
     (declare (type (member t nil) ieee)
              (type (double-float) qmax desig sigma dmin)
              (type (simple-array double-float (*)) z)
              (type fixnum ndiv iter nfail pp n0 i0))
     (f2cl-lib:with-multi-array-data
         ((z double-float z-%data% z-%offset%))
       (prog ((eps 0.0) (s 0.0) (safmin 0.0) (temp 0.0) (tol 0.0) (tol2 0.0)
              (ipn4 0) (j4 0) (n0in 0) (nn 0) (t$ 0.0))
         (declare (type (double-float) t$ eps s safmin temp tol tol2)
                  (type fixnum ipn4 j4 n0in nn))
         (setf n0in n0)
         (setf eps (dlamch "Precision"))
         (setf safmin (dlamch "Safe minimum"))
         (setf tol (* eps hundrd))
         (setf tol2 (expt tol 2))
label10
         (if (< n0 i0) (go end_label))
         (if (= n0 i0) (go label20))
         (setf nn (f2cl-lib:int-add (f2cl-lib:int-mul 4 n0) pp))
         (if (= n0 (f2cl-lib:int-add i0 1)) (go label40))
         (if
          (and
           (>
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub nn 5))
                           ((1 *))
                           z-%offset%)
            (* tol2
               (+ sigma
                  (f2cl-lib:fref z-%data%
                                 ((f2cl-lib:int-sub nn 3))
                                 ((1 *))
                                 z-%offset%))))
           (>
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub
                             (f2cl-lib:int-add nn (f2cl-lib:int-mul -1 2 pp))
                             4))
                           ((1 *))
                           z-%offset%)
            (* tol2
               (f2cl-lib:fref z-%data%
                              ((f2cl-lib:int-sub nn 7))
                              ((1 *))
                              z-%offset%))))
          (go label30))
```

```
label20
         (setf (f2cl-lib:fref z-%data%
                              ((f2cl-lib:int-sub (f2cl-lib:int-mul 4 n0) 3))
                              ((1 *))
                              z-%offset%)
               (+
                (f2cl-lib:fref z-%data%
                               ((f2cl-lib:int-sub
                                 (f2cl-lib:int-add (f2cl-lib:int-mul 4 n0)
                                                   pp)
                                 3))
                               ((1 *))
                               z-%offset%)
                sigma))
         (setf n0 (f2cl-lib:int-sub n0 1))
         (go label10)
label30
         (if
          (and
           (>
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub nn 9))
                           ((1 *))
                           z-%offset%)
            (* tol2 sigma))
           (>
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub
                             (f2cl-lib:int-add nn (f2cl-lib:int-mul -1 2 pp))
                             8))
                           ((1 *))
                           z-%offset%)
            (* tol2
               (f2cl-lib:fref z-%data%
                              ((f2cl-lib:int-sub nn 11))
                              ((1 *))
                              z-%offset%))))
          (go label50))
label40
         (cond
           ((>
             (f2cl-lib:fref z
                            ((f2cl-lib:int-add nn (f2cl-lib:int-sub 3)))
                            ((1 *)))
             (f2cl-lib:fref z
                            ((f2cl-lib:int-add nn (f2cl-lib:int-sub 7)))
                            ((1 *))))
            (setf s
                  (f2cl-lib:fref z-%data%
                                 ((f2cl-lib:int-sub nn 3))
```

```
                          ((1 *))
                          z-%offset%))
   (setf (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub nn 3))
                        ((1 *))
                        z-%offset%)
         (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub nn 7))
                        ((1 *))
                        z-%offset%))
   (setf (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub nn 7))
                        ((1 *))
                        z-%offset%)
         s)))
(cond
  ((>
    (f2cl-lib:fref z
                   ((f2cl-lib:int-add nn (f2cl-lib:int-sub 5)))
                   ((1 *)))
    (*
     (f2cl-lib:fref z
                    ((f2cl-lib:int-add nn (f2cl-lib:int-sub 3)))
                    ((1 *)))
     tol2))
   (setf t$
         (* half
            (+
             (-
              (f2cl-lib:fref z-%data%
                             ((f2cl-lib:int-sub nn 7))
                             ((1 *))
                             z-%offset%)
              (f2cl-lib:fref z-%data%
                             ((f2cl-lib:int-sub nn 3))
                             ((1 *))
                             z-%offset%))
             (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-sub nn 5))
                            ((1 *))
                            z-%offset%))))
   (setf s
         (*
          (f2cl-lib:fref z-%data%
                         ((f2cl-lib:int-sub nn 3))
                         ((1 *))
                         z-%offset%)
          (/
           (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-sub nn 5))
```

```
                          ((1 *))
                          z-%offset%)
          t$)))
(cond
  ((<= s t$)
   (setf s
          (*
           (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-sub nn 3))
                          ((1 *))
                          z-%offset%)
           (/
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub nn 5))
                           ((1 *))
                           z-%offset%)
            (* t$ (+ one (f2cl-lib:fsqrt (+ one (/ s t$))))))))))
  (t
   (setf s
          (*
           (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-sub nn 3))
                          ((1 *))
                          z-%offset%)
           (/
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub nn 5))
                           ((1 *))
                           z-%offset%)
            (+ t$
               (* (f2cl-lib:fsqrt t$)
                  (f2cl-lib:fsqrt (+ t$ s)))))))))
(setf t$
        (+
         (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub nn 7))
                        ((1 *))
                        z-%offset%)
         (+ s
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub nn 5))
                           ((1 *))
                           z-%offset%))))
(setf (f2cl-lib:fref z-%data%
                     ((f2cl-lib:int-sub nn 3))
                     ((1 *))
                     z-%offset%)
        (*
         (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub nn 3))
```

```
                                   ((1 *))
                                   z-%offset%)
                     (/
                      (f2cl-lib:fref z-%data%
                                     ((f2cl-lib:int-sub nn 7))
                                     ((1 *))
                                     z-%offset%)
                      t$)))
            (setf (f2cl-lib:fref z-%data%
                                 ((f2cl-lib:int-sub nn 7))
                                 ((1 *))
                                 z-%offset%)
                  t$)))
          (setf (f2cl-lib:fref z-%data%
                               ((f2cl-lib:int-sub (f2cl-lib:int-mul 4 n0) 7))
                               ((1 *))
                               z-%offset%)
                (+
                 (f2cl-lib:fref z-%data%
                                ((f2cl-lib:int-sub nn 7))
                                ((1 *))
                                z-%offset%)
                 sigma))
          (setf (f2cl-lib:fref z-%data%
                               ((f2cl-lib:int-sub (f2cl-lib:int-mul 4 n0) 3))
                               ((1 *))
                               z-%offset%)
                (+
                 (f2cl-lib:fref z-%data%
                                ((f2cl-lib:int-sub nn 3))
                                ((1 *))
                                z-%offset%)
                 sigma))
          (setf n0 (f2cl-lib:int-sub n0 2))
          (go label10)
label50
          (cond
            ((or (<= dmin zero) (< n0 n0in))
             (cond
               ((<
                 (* cbias
                    (f2cl-lib:fref z
                                   ((f2cl-lib:int-add (f2cl-lib:int-mul 4 i0)
                                                      pp
                                                      (f2cl-lib:int-sub 3)))
                                   ((1 *))))
                 (f2cl-lib:fref z
                                ((f2cl-lib:int-add (f2cl-lib:int-mul 4 n0)
                                                   pp
                                                   (f2cl-lib:int-sub 3)))
```

```
                ((1 *))))
(setf ipn4 (f2cl-lib:int-mul 4 (f2cl-lib:int-add i0 n0)))
(f2cl-lib:fdo (j4 (f2cl-lib:int-mul 4 i0)
                (f2cl-lib:int-add j4 4))
               ((> j4
                   (f2cl-lib:int-mul 2
                                     (f2cl-lib:int-add i0
                                       n0
                                       (f2cl-lib:int-sub
                                                      1))))
                nil)
  (tagbody
    (setf temp
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub j4 3))
                           ((1 *))
                           z-%offset%))
    (setf (f2cl-lib:fref z-%data%
                         ((f2cl-lib:int-sub j4 3))
                         ((1 *))
                         z-%offset%)
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub ipn4 j4 3))
                           ((1 *))
                           z-%offset%))
    (setf (f2cl-lib:fref z-%data%
                         ((f2cl-lib:int-sub ipn4 j4 3))
                         ((1 *))
                         z-%offset%)
            temp)
    (setf temp
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub j4 2))
                           ((1 *))
                           z-%offset%))
    (setf (f2cl-lib:fref z-%data%
                         ((f2cl-lib:int-sub j4 2))
                         ((1 *))
                         z-%offset%)
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub ipn4 j4 2))
                           ((1 *))
                           z-%offset%))
    (setf (f2cl-lib:fref z-%data%
                         ((f2cl-lib:int-sub ipn4 j4 2))
                         ((1 *))
                         z-%offset%)
            temp)
    (setf temp
            (f2cl-lib:fref z-%data%
```

```
                              ((f2cl-lib:int-sub j4 1))
                              ((1 *))
                              z-%offset%))
        (setf (f2cl-lib:fref z-%data%
                             ((f2cl-lib:int-sub j4 1))
                             ((1 *))
                             z-%offset%)
              (f2cl-lib:fref z-%data%
                              ((f2cl-lib:int-sub ipn4 j4 5))
                              ((1 *))
                              z-%offset%))
        (setf (f2cl-lib:fref z-%data%
                             ((f2cl-lib:int-sub ipn4 j4 5))
                             ((1 *))
                             z-%offset%)
              temp)
        (setf temp
              (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%))
        (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
              (f2cl-lib:fref z-%data%
                              ((f2cl-lib:int-sub ipn4 j4 4))
                              ((1 *))
                              z-%offset%))
        (setf (f2cl-lib:fref z-%data%
                             ((f2cl-lib:int-sub ipn4 j4 4))
                             ((1 *))
                             z-%offset%)
              temp)))
    (cond
      ((<= (f2cl-lib:int-add n0 (f2cl-lib:int-sub i0)) 4)
       (setf (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-sub
                              (f2cl-lib:int-add
                               (f2cl-lib:int-mul 4 n0)
                               pp)
                              1))
                            ((1 *))
                            z-%offset%)
             (f2cl-lib:fref z-%data%
                             ((f2cl-lib:int-sub
                               (f2cl-lib:int-add
                                (f2cl-lib:int-mul 4 i0)
                                pp)
                               1))
                             ((1 *))
                             z-%offset%))
       (setf (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-sub
                              (f2cl-lib:int-mul 4 n0)
                              pp))
```

```
                                ((1 *))
                                z-%offset%)
                          (f2cl-lib:fref z-%data%
                                         ((f2cl-lib:int-sub
                                           (f2cl-lib:int-mul 4 i0)
                                           pp))
                                         ((1 *))
                                         z-%offset%))))
                (setf dmin2
                      (min dmin2
                           (f2cl-lib:fref z-%data%
                                          ((f2cl-lib:int-sub
                                            (f2cl-lib:int-add
                                             (f2cl-lib:int-mul 4 n0)
                                             pp)
                                            1))
                                          ((1 *))
                                          z-%offset%)))
                (setf (f2cl-lib:fref z-%data%
                                     ((f2cl-lib:int-sub
                                       (f2cl-lib:int-add
                                        (f2cl-lib:int-mul 4 n0)
                                        pp)
                                       1))
                                     ((1 *))
                                     z-%offset%)
                      (min
                       (f2cl-lib:fref z-%data%
                                      ((f2cl-lib:int-sub
                                        (f2cl-lib:int-add
                                         (f2cl-lib:int-mul 4 n0)
                                         pp)
                                        1))
                                      ((1 *))
                                      z-%offset%)
                       (f2cl-lib:fref z-%data%
                                      ((f2cl-lib:int-sub
                                        (f2cl-lib:int-add
                                         (f2cl-lib:int-mul 4 i0)
                                         pp)
                                        1))
                                      ((1 *))
                                      z-%offset%)
                       (f2cl-lib:fref z-%data%
                                      ((f2cl-lib:int-add
                                        (f2cl-lib:int-mul 4 i0)
                                        pp
                                        3))
                                      ((1 *))
                                      z-%offset%)))
```

```
          (setf (f2cl-lib:fref z-%data%
                               ((f2cl-lib:int-sub (f2cl-lib:int-mul 4 n0)
                                                  pp))
                               ((1 *))
                               z-%offset%)
                (min
                 (f2cl-lib:fref z-%data%
                                ((f2cl-lib:int-sub
                                  (f2cl-lib:int-mul 4 n0)
                                  pp))
                                ((1 *))
                                z-%offset%)
                 (f2cl-lib:fref z-%data%
                                ((f2cl-lib:int-sub
                                  (f2cl-lib:int-mul 4 i0)
                                  pp))
                                ((1 *))
                                z-%offset%)
                 (f2cl-lib:fref z-%data%
                                ((f2cl-lib:int-add
                                  (f2cl-lib:int-sub
                                   (f2cl-lib:int-mul 4 i0)
                                   pp)
                                  4))
                                ((1 *))
                                z-%offset%)))
          (setf qmax
                (max qmax
                     (f2cl-lib:fref z-%data%
                                    ((f2cl-lib:int-sub
                                      (f2cl-lib:int-add
                                       (f2cl-lib:int-mul 4 i0)
                                       pp)
                                      3))
                                    ((1 *))
                                    z-%offset%)
                     (f2cl-lib:fref z-%data%
                                    ((f2cl-lib:int-add
                                      (f2cl-lib:int-mul 4 i0)
                                      pp
                                      1))
                                    ((1 *))
                                    z-%offset%)))
          (setf dmin (- zero))))))
    (cond
      ((or (< dmin zero)
           (< (* safmin qmax)
              (min
               (f2cl-lib:fref z
                              ((f2cl-lib:int-add (f2cl-lib:int-mul 4 n0)
```

```
                                                pp
                                                (f2cl-lib:int-sub 1)))
                                ((1 *)))
                        (f2cl-lib:fref z
                                ((f2cl-lib:int-add (f2cl-lib:int-mul 4 n0)
                                                pp
                                                (f2cl-lib:int-sub 9)))
                                ((1 *)))
                        (+ dmin2
                           (f2cl-lib:fref z
                                        ((f2cl-lib:int-add
                                          (f2cl-lib:int-mul 4 n0)
                                          (f2cl-lib:int-sub pp)))
                                        ((1 *)))))))
                (tagbody
                  (multiple-value-bind
                        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                         var-9 var-10 var-11 var-12)
                      (dlasq4 i0 n0 z pp n0in dmin f2cl-lib:dmin1 dmin2 dn dn1 dn2
                       tau ttype)
                    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                                     var-7 var-8 var-9 var-10))
                    (setf tau var-11)
                    (setf ttype var-12))
label80
                  (multiple-value-bind
                        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                         var-9 var-10 var-11)
                      (dlasq5 i0 n0 z pp tau dmin f2cl-lib:dmin1 dmin2 dn dn1 dn2
                       ieee)
                    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-6 var-11))
                    (setf dmin var-5)
                    (setf dmin2 var-7)
                    (setf dn var-8)
                    (setf dn1 var-9)
                    (setf dn2 var-10))
                  (setf ndiv
                          (f2cl-lib:int-add ndiv
                                            (f2cl-lib:int-add
                                             (f2cl-lib:int-sub n0 i0)
                                             2)))
                  (setf iter (f2cl-lib:int-add iter 1))
                  (cond
                    ((and (>= dmin zero) (> f2cl-lib:dmin1 zero))
                     (go label100))
                    ((and (< dmin zero)
                          (> f2cl-lib:dmin1 zero)
                          (<
                           (f2cl-lib:fref z
                                        ((f2cl-lib:int-add
```

```
                                      (f2cl-lib:int-mul 4
                                        (f2cl-lib:int-add n0
                                          (f2cl-lib:int-sub
                                            1)))
                                      (f2cl-lib:int-sub pp)))
                                    ((1 *)))
                          (* tol (+ sigma dn1)))
                         (< (abs dn) (* tol sigma)))
                 (setf (f2cl-lib:fref z-%data%
                                      ((f2cl-lib:int-add
                                        (f2cl-lib:int-sub
                                         (f2cl-lib:int-mul 4
                                                           (f2cl-lib:int-sub
                                                            n0
                                                            1))
                                         pp)
                                        2))
                                      ((1 *))
                                      z-%offset%)
                         zero)
                 (setf dmin zero)
                 (go label100))
                ((< dmin zero)
                 (setf nfail (f2cl-lib:int-add nfail 1))
                 (cond
                   ((< ttype (f2cl-lib:int-sub 22))
                    (setf tau zero))
                   ((> f2cl-lib:dmin1 zero)
                    (setf tau (* (+ tau dmin) (- one (* two eps))))
                    (setf ttype (f2cl-lib:int-sub ttype 11)))
                   (t
                    (setf tau (* qurtr tau))
                    (setf ttype (f2cl-lib:int-sub ttype 12))))
                 (go label80))
                ((/= dmin dmin)
                 (setf tau zero)
                 (go label80))
                (t
                 (go label90))))))
label90
          (multiple-value-bind
                (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
              (dlasq6 i0 n0 z pp dmin f2cl-lib:dmin1 dmin2 dn dn1 dn2)
            (declare (ignore var-0 var-1 var-2 var-3 var-5))
            (setf dmin var-4)
            (setf dmin2 var-6)
            (setf dn var-7)
            (setf dn1 var-8)
            (setf dn2 var-9))
          (setf ndiv
```

```
                (f2cl-lib:int-add ndiv
                                  (f2cl-lib:int-add (f2cl-lib:int-sub n0 i0)
                                                    2)))
         (setf iter (f2cl-lib:int-add iter 1))
         (setf tau zero)
 label100
         (cond
           ((< tau sigma)
            (setf desig (+ desig tau))
            (setf t$ (+ sigma desig))
            (setf desig (- desig (- t$ sigma))))
           (t
            (setf t$ (+ sigma tau))
            (setf desig (+ (- sigma (- t$ tau)) desig))))
         (setf sigma t$)
 end_label
         (return
          (values nil
                  n0
                  nil
                  nil
                  dmin
                  sigma
                  desig
                  qmax
                  nfail
                  iter
                  ndiv
                  nil)))))))
```

———-

6.73 dlasq4 LAPACK

— dlasq4.input —

```
)set break resume
)sys rm -f dlasq4.output
)spool dlasq4.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dlasq4.help —

```
=====================================================================
dlasq4 examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DLASQ4  -  an approximation TAU to the smallest eigenvalue using values
       of d from the previous transform

SYNOPSIS
       SUBROUTINE DLASQ4( I0, N0, Z, PP, NOIN, DMIN, DMIN1,  DMIN2,  DN,  DN1,
                          DN2, TAU, TTYPE )

           INTEGER        I0, N0, NOIN, PP, TTYPE

           DOUBLE         PRECISION DMIN, DMIN1, DMIN2, DN, DN1, DN2, TAU

           DOUBLE         PRECISION Z( * )

  Purpose
  =======

  DLASQ4 computes an approximation TAU to the smallest eigenvalue
  using values of d from the previous transform.

  I0    (input) INTEGER
        First index.

  N0    (input) INTEGER
        Last index.

  Z     (input) DOUBLE PRECISION array, dimension ( 4*N )
        Z holds the qd array.

  PP    (input) INTEGER
        PP=0 for ping, PP=1 for pong.

  NOIN  (input) INTEGER
        The value of N0 at start of EIGTEST.

  DMIN  (input) DOUBLE PRECISION
        Minimum value of d.
```

```
  DMIN1 (input) DOUBLE PRECISION
        Minimum value of d, excluding D( N0 ).

  DMIN2 (input) DOUBLE PRECISION
        Minimum value of d, excluding D( N0 ) and D( N0-1 ).

  DN    (input) DOUBLE PRECISION
        d(N)

  DN1   (input) DOUBLE PRECISION
        d(N-1)

  DN2   (input) DOUBLE PRECISION
        d(N-2)

  TAU   (output) DOUBLE PRECISION
        This is the shift.

  TTYPE (output) INTEGER
        Shift type.

  Further Details
  ===============
  CNST1 = 9/16
```

— dlasq4.f —

```
      SUBROUTINE DLASQ4( I0, N0, Z, PP, N0IN, DMIN, DMIN1, DMIN2, DN,
     $                   DN1, DN2, TAU, TTYPE )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1999
*
*     .. Scalar Arguments ..
      INTEGER            I0, N0, N0IN, PP, TTYPE
      DOUBLE PRECISION   DMIN, DMIN1, DMIN2, DN, DN1, DN2, TAU
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   Z( * )
*     ..
*
*  =====================================================================
*
```

```
*     .. Parameters ..
      DOUBLE PRECISION   CNST1, CNST2, CNST3
      PARAMETER          ( CNST1 = 0.5630D0, CNST2 = 1.010D0,
     $                   CNST3 = 1.050D0 )
      DOUBLE PRECISION   QURTR, THIRD, HALF, ZERO, ONE, TWO, HUNDRD
      PARAMETER          ( QURTR = 0.250D0, THIRD = 0.3330D0,
     $                   HALF = 0.50D0, ZERO = 0.0D0, ONE = 1.0D0,
     $                   TWO = 2.0D0, HUNDRD = 100.0D0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I4, NN, NP
      DOUBLE PRECISION   A2, B1, B2, G, GAM, GAP1, GAP2, S
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN, SQRT
*     ..
*     .. Save statement ..
      SAVE               G
*     ..
*     .. Data statement ..
      DATA               G / ZERO /
*     ..
*     .. Executable Statements ..
*
*     A negative DMIN forces the shift to take that absolute value
*     TTYPE records the type of shift.
*
      IF( DMIN.LE.ZERO ) THEN
         TAU = -DMIN
         TTYPE = -1
         RETURN
      END IF
*
      NN = 4*N0 + PP
      IF( N0IN.EQ.N0 ) THEN
*
*        No eigenvalues deflated.
*
         IF( DMIN.EQ.DN .OR. DMIN.EQ.DN1 ) THEN
*
            B1 = SQRT( Z( NN-3 ) )*SQRT( Z( NN-5 ) )
            B2 = SQRT( Z( NN-7 ) )*SQRT( Z( NN-9 ) )
            A2 = Z( NN-7 ) + Z( NN-5 )
*
*           Cases 2 and 3.
*
            IF( DMIN.EQ.DN .AND. DMIN1.EQ.DN1 ) THEN
               GAP2 = DMIN2 - A2 - DMIN2*QURTR
               IF( GAP2.GT.ZERO .AND. GAP2.GT.B2 ) THEN
                  GAP1 = A2 - DN - ( B2 / GAP2 )*B2
```

```
               ELSE
                  GAP1 = A2 - DN - ( B1+B2 )
               END IF
               IF( GAP1.GT.ZERO .AND. GAP1.GT.B1 ) THEN
                  S = MAX( DN-( B1 / GAP1 )*B1, HALF*DMIN )
                  TTYPE = -2
               ELSE
                  S = ZERO
                  IF( DN.GT.B1 )
     $               S = DN - B1
                  IF( A2.GT.( B1+B2 ) )
     $               S = MIN( S, A2-( B1+B2 ) )
                  S = MAX( S, THIRD*DMIN )
                  TTYPE = -3
               END IF
            ELSE
*
*              Case 4.
*
               TTYPE = -4
               S = QURTR*DMIN
               IF( DMIN.EQ.DN ) THEN
                  GAM = DN
                  A2 = ZERO
                  IF( Z( NN-5 ) .GT. Z( NN-7 ) )
     $               RETURN
                  B2 = Z( NN-5 ) / Z( NN-7 )
                  NP = NN - 9
               ELSE
                  NP = NN - 2*PP
                  B2 = Z( NP-2 )
                  GAM = DN1
                  IF( Z( NP-4 ) .GT. Z( NP-2 ) )
     $               RETURN
                  A2 = Z( NP-4 ) / Z( NP-2 )
                  IF( Z( NN-9 ) .GT. Z( NN-11 ) )
     $               RETURN
                  B2 = Z( NN-9 ) / Z( NN-11 )
                  NP = NN - 13
               END IF
*
*              Approximate contribution to norm squared from I < NN-1.
*
               A2 = A2 + B2
               DO 10 I4 = NP, 4*I0 - 1 + PP, -4
                  IF( B2.EQ.ZERO )
     $               GO TO 20
                  B1 = B2
                  IF( Z( I4 ) .GT. Z( I4-2 ) )
     $               RETURN
```

```
                  B2 = B2*( Z( I4 ) / Z( I4-2 ) )
                  A2 = A2 + B2
                  IF( HUNDRD*MAX( B2, B1 ).LT.A2 .OR. CNST1.LT.A2 )
     $               GO TO 20
   10          CONTINUE
   20          CONTINUE
               A2 = CNST3*A2
*
*              Rayleigh quotient residual bound.
*
               IF( A2.LT.CNST1 )
     $            S = GAM*( ONE-SQRT( A2 ) ) / ( ONE+A2 )
            END IF
         ELSE IF( DMIN.EQ.DN2 ) THEN
*
*           Case 5.
*
            TTYPE = -5
            S = QURTR*DMIN
*
*           Compute contribution to norm squared from I > NN-2.
*
            NP = NN - 2*PP
            B1 = Z( NP-2 )
            B2 = Z( NP-6 )
            GAM = DN2
            IF( Z( NP-8 ).GT.B2 .OR. Z( NP-4 ).GT.B1 )
     $         RETURN
            A2 = ( Z( NP-8 ) / B2 )*( ONE+Z( NP-4 ) / B1 )
*
*           Approximate contribution to norm squared from I < NN-2.
*
            IF( N0-I0.GT.2 ) THEN
               B2 = Z( NN-13 ) / Z( NN-15 )
               A2 = A2 + B2
               DO 30 I4 = NN - 17, 4*I0 - 1 + PP, -4
                  IF( B2.EQ.ZERO )
     $               GO TO 40
                  B1 = B2
                  IF( Z( I4 ) .GT. Z( I4-2 ) )
     $               RETURN
                  B2 = B2*( Z( I4 ) / Z( I4-2 ) )
                  A2 = A2 + B2
                  IF( HUNDRD*MAX( B2, B1 ).LT.A2 .OR. CNST1.LT.A2 )
     $               GO TO 40
   30          CONTINUE
   40          CONTINUE
               A2 = CNST3*A2
            END IF
*
```

```
            IF( A2.LT.CNST1 )
     $         S = GAM*( ONE-SQRT( A2 ) ) / ( ONE+A2 )
          ELSE
*
*            Case 6, no information to guide us.
*
            IF( TTYPE.EQ.-6 ) THEN
               G = G + THIRD*( ONE-G )
            ELSE IF( TTYPE.EQ.-18 ) THEN
               G = QURTR*THIRD
            ELSE
               G = QURTR
            END IF
            S = G*DMIN
            TTYPE = -6
          END IF
*
       ELSE IF( NOIN.EQ.( NO+1 ) ) THEN
*
*          One eigenvalue just deflated. Use DMIN1, DN1 for DMIN and DN.
*
          IF( DMIN1.EQ.DN1 .AND. DMIN2.EQ.DN2 ) THEN
*
*            Cases 7 and 8.
*
            TTYPE = -7
            S = THIRD*DMIN1
            IF( Z( NN-5 ).GT.Z( NN-7 ) )
     $         RETURN
            B1 = Z( NN-5 ) / Z( NN-7 )
            B2 = B1
            IF( B2.EQ.ZERO )
     $         GO TO 60
            DO 50 I4 = 4*NO - 9 + PP, 4*IO - 1 + PP, -4
               A2 = B1
               IF( Z( I4 ).GT.Z( I4-2 ) )
     $            RETURN
               B1 = B1*( Z( I4 ) / Z( I4-2 ) )
               B2 = B2 + B1
               IF( HUNDRD*MAX( B1, A2 ).LT.B2 )
     $            GO TO 60
   50       CONTINUE
   60       CONTINUE
            B2 = SQRT( CNST3*B2 )
            A2 = DMIN1 / ( ONE+B2**2 )
            GAP2 = HALF*DMIN2 - A2
            IF( GAP2.GT.ZERO .AND. GAP2.GT.B2*A2 ) THEN
               S = MAX( S, A2*( ONE-CNST2*A2*( B2 / GAP2 )*B2 ) )
            ELSE
               S = MAX( S, A2*( ONE-CNST2*B2 ) )
```

```
               TTYPE = -8
            END IF
         ELSE
*
*           Case 9.
*
            S = QURTR*DMIN1
            IF( DMIN1.EQ.DN1 )
     $         S = HALF*DMIN1
            TTYPE = -9
         END IF
*
      ELSE IF( NOIN.EQ.( NO+2 ) ) THEN
*
*        Two eigenvalues deflated. Use DMIN2, DN2 for DMIN and DN.
*
*        Cases 10 and 11.
*
         IF( DMIN2.EQ.DN2 .AND. TWO*Z( NN-5 ).LT.Z( NN-7 ) ) THEN
            TTYPE = -10
            S = THIRD*DMIN2
            IF( Z( NN-5 ).GT.Z( NN-7 ) )
     $         RETURN
            B1 = Z( NN-5 ) / Z( NN-7 )
            B2 = B1
            IF( B2.EQ.ZERO )
     $         GO TO 80
            DO 70 I4 = 4*N0 - 9 + PP, 4*I0 - 1 + PP, -4
               IF( Z( I4 ).GT.Z( I4-2 ) )
     $            RETURN
               B1 = B1*( Z( I4 ) / Z( I4-2 ) )
               B2 = B2 + B1
               IF( HUNDRD*B1.LT.B2 )
     $            GO TO 80
   70       CONTINUE
   80       CONTINUE
            B2 = SQRT( CNST3*B2 )
            A2 = DMIN2 / ( ONE+B2**2 )
            GAP2 = Z( NN-7 ) + Z( NN-9 ) -
     $             SQRT( Z( NN-11 ) )*SQRT( Z( NN-9 ) ) - A2
            IF( GAP2.GT.ZERO .AND. GAP2.GT.B2*A2 ) THEN
               S = MAX( S, A2*( ONE-CNST2*A2*( B2 / GAP2 )*B2 ) )
            ELSE
               S = MAX( S, A2*( ONE-CNST2*B2 ) )
            END IF
         ELSE
            S = QURTR*DMIN2
            TTYPE = -11
         END IF
      ELSE IF( NOIN.GT.( NO+2 ) ) THEN
```

```
*
*        Case 12, more than two eigenvalues deflated. No information.
*
         S = ZERO
         TTYPE = -12
      END IF
*
      TAU = S
      RETURN
*
*     End of DLASQ4
*
      END
```

———-

— LAPACK dlasq4 —

```
(let* ((cnst1 0.563)
       (cnst2 1.01)
       (cnst3 1.05)
       (qurtr 0.25)
       (third$ 0.333)
       (half 0.5)
       (zero 0.0)
       (one 1.0)
       (two 2.0)
       (hundrd 100.0))
  (declare (type (double-float 0.563 0.563) cnst1)
           (type (double-float 1.01 1.01) cnst2)
           (type (double-float 1.05 1.05) cnst3)
           (type (double-float 0.25 0.25) qurtr)
           (type (double-float 0.333 0.333) third$)
           (type (double-float 0.5 0.5) half)
           (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one)
           (type (double-float 2.0 2.0) two)
           (type (double-float 100.0 100.0) hundrd))
  (let ((g zero))
    (declare (type (double-float) g))
    (defun dlasq4
           (i0 n0 z pp n0in dmin f2cl-lib:dmin1 dmin2 dn dn1 dn2 tau ttype)
      (declare (type (double-float) tau dn2 dn1 dn dmin2 f2cl-lib:dmin1 dmin)
               (type (simple-array double-float (*)) z)
               (type fixnum ttype n0in pp n0 i0))
      (f2cl-lib:with-multi-array-data
          ((z double-float z-%data% z-%offset%))
        (prog ((a2 0.0) (b1 0.0) (b2 0.0) (gam 0.0) (gap1 0.0) (gap2 0.0)
```

```
     (s 0.0) (i4 0) (nn 0) (np 0) (sqrt$ 0.0f0))
(declare (type (single-float) sqrt$)
         (type (double-float) a2 b1 b2 gam gap1 gap2 s)
         (type fixnum i4 nn np))
(cond
  ((<= dmin zero)
   (setf tau (- dmin))
   (setf ttype -1)
   (go end_label)))
(setf nn (f2cl-lib:int-add (f2cl-lib:int-mul 4 n0) pp))
(cond
  ((= n0in n0)
   (cond
     ((or (= dmin dn) (= dmin dn1))
      (setf b1
              (*
               (f2cl-lib:fsqrt
                (f2cl-lib:fref z-%data%
                               ((f2cl-lib:int-sub nn 3))
                               ((1 *))
                               z-%offset%))
               (f2cl-lib:fsqrt
                (f2cl-lib:fref z-%data%
                               ((f2cl-lib:int-sub nn 5))
                               ((1 *))
                               z-%offset%))))
      (setf b2
              (*
               (f2cl-lib:fsqrt
                (f2cl-lib:fref z-%data%
                               ((f2cl-lib:int-sub nn 7))
                               ((1 *))
                               z-%offset%))
               (f2cl-lib:fsqrt
                (f2cl-lib:fref z-%data%
                               ((f2cl-lib:int-sub nn 9))
                               ((1 *))
                               z-%offset%))))
      (setf a2
              (+
               (f2cl-lib:fref z-%data%
                             ((f2cl-lib:int-sub nn 7))
                             ((1 *))
                             z-%offset%)
               (f2cl-lib:fref z-%data%
                             ((f2cl-lib:int-sub nn 5))
                             ((1 *))
                             z-%offset%)))
      (cond
        ((and (= dmin dn) (= f2cl-lib:dmin1 dn1))
```

```
 (setf gap2 (- dmin2 a2 (* dmin2 qurtr)))
 (cond
   ((and (> gap2 zero) (> gap2 b2))
    (setf gap1 (- a2 dn (* (/ b2 gap2) b2))))
   (t
    (setf gap1 (- a2 dn (+ b1 b2)))))
 (cond
   ((and (> gap1 zero) (> gap1 b1))
    (setf s (max (- dn (* (/ b1 gap1) b1)) (* half dmin)))
    (setf ttype -2))
   (t
    (setf s zero)
    (if (> dn b1) (setf s (- dn b1)))
    (if (> a2 (+ b1 b2)) (setf s (min s (- a2 (+ b1 b2)))))
    (setf s (max s (* third$ dmin)))
    (setf ttype -3))))
(t
 (tagbody
   (setf ttype -4)
   (setf s (* qurtr dmin))
   (cond
     ((= dmin dn)
      (setf gam dn)
      (setf a2 zero)
      (if
       (>
        (f2cl-lib:fref z-%data%
                       ((f2cl-lib:int-sub nn 5))
                       ((1 *))
                       z-%offset%)
        (f2cl-lib:fref z-%data%
                       ((f2cl-lib:int-sub nn 7))
                       ((1 *))
                       z-%offset%))
       (go end_label))
      (setf b2
              (/
               (f2cl-lib:fref z-%data%
                              ((f2cl-lib:int-sub nn 5))
                              ((1 *))
                              z-%offset%)
               (f2cl-lib:fref z-%data%
                              ((f2cl-lib:int-sub nn 7))
                              ((1 *))
                              z-%offset%)))
      (setf np (f2cl-lib:int-sub nn 9)))
     (t
      (setf np (f2cl-lib:int-sub nn (f2cl-lib:int-mul 2 pp)))
      (setf b2
              (f2cl-lib:fref z-%data%
```

```
                        ((f2cl-lib:int-sub np 2))
                        ((1 *))
                        z-%offset%))
    (setf gam dn1)
    (if
     (>
      (f2cl-lib:fref z-%data%
                     ((f2cl-lib:int-sub np 4))
                     ((1 *))
                     z-%offset%)
      (f2cl-lib:fref z-%data%
                     ((f2cl-lib:int-sub np 2))
                     ((1 *))
                     z-%offset%))
     (go end_label))
    (setf a2
          (/
           (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-sub np 4))
                          ((1 *))
                          z-%offset%)
           (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-sub np 2))
                          ((1 *))
                          z-%offset%)))
    (if
     (>
      (f2cl-lib:fref z-%data%
                     ((f2cl-lib:int-sub nn 9))
                     ((1 *))
                     z-%offset%)
      (f2cl-lib:fref z-%data%
                     ((f2cl-lib:int-sub nn 11))
                     ((1 *))
                     z-%offset%))
     (go end_label))
    (setf b2
          (/
           (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-sub nn 9))
                          ((1 *))
                          z-%offset%)
           (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-sub nn 11))
                          ((1 *))
                          z-%offset%)))
    (setf np (f2cl-lib:int-sub nn 13))))
(setf a2 (+ a2 b2))
(f2cl-lib:fdo (i4 np
               (f2cl-lib:int-add i4 (f2cl-lib:int-sub 4)))
```

```
                                ((> i4
                                    (f2cl-lib:int-add
                                     (f2cl-lib:int-mul 4 i0)
                                     (f2cl-lib:int-sub 1)
                                     pp))
                                 nil)
                           (tagbody
                             (if (= b2 zero) (go label20))
                             (setf b1 b2)
                             (if
                              (> (f2cl-lib:fref z-%data% (i4) ((1 *)) z-%offset%)
                                 (f2cl-lib:fref z-%data%
                                                ((f2cl-lib:int-sub i4 2))
                                                ((1 *))
                                                z-%offset%))
                              (go end_label))
                             (setf b2
                                     (* b2
                                        (/
                                         (f2cl-lib:fref z-%data%
                                                        (i4)
                                                        ((1 *))
                                                        z-%offset%)
                                         (f2cl-lib:fref z-%data%
                                                        ((f2cl-lib:int-sub i4 2))
                                                        ((1 *))
                                                        z-%offset%))))
                             (setf a2 (+ a2 b2))
                             (if (or (< (* hundrd (max b2 b1)) a2) (< cnst1 a2))
                                 (go label20))))
label20
                      (setf a2 (* cnst3 a2))
                      (if (< a2 cnst1)
                          (setf s
                                  (/ (* gam (- one (f2cl-lib:fsqrt a2)))
                                     (+ one a2))))))))
                 ((= dmin dn2)
                  (setf ttype -5)
                  (setf s (* qurtr dmin))
                  (setf np (f2cl-lib:int-sub nn (f2cl-lib:int-mul 2 pp)))
                  (setf b1
                          (f2cl-lib:fref z-%data%
                                         ((f2cl-lib:int-sub np 2))
                                         ((1 *))
                                         z-%offset%))
                  (setf b2
                          (f2cl-lib:fref z-%data%
                                         ((f2cl-lib:int-sub np 6))
                                         ((1 *))
                                         z-%offset%))
```

```
(setf gam dn2)
(if
 (or
  (>
   (f2cl-lib:fref z-%data%
                  ((f2cl-lib:int-sub np 8))
                  ((1 *))
                  z-%offset%)
   b2)
  (>
   (f2cl-lib:fref z-%data%
                  ((f2cl-lib:int-sub np 4))
                  ((1 *))
                  z-%offset%)
   b1))
 (go end_label))
(setf a2
        (*
         (/
          (f2cl-lib:fref z-%data%
                         ((f2cl-lib:int-sub np 8))
                         ((1 *))
                         z-%offset%)
          b2)
         (+ one
            (/
             (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-sub np 4))
                            ((1 *))
                            z-%offset%)
             b1))))
(cond
  ((> (f2cl-lib:int-add n0 (f2cl-lib:int-sub i0)) 2)
   (tagbody
     (setf b2
             (/
              (f2cl-lib:fref z-%data%
                             ((f2cl-lib:int-sub nn 13))
                             ((1 *))
                             z-%offset%)
              (f2cl-lib:fref z-%data%
                             ((f2cl-lib:int-sub nn 15))
                             ((1 *))
                             z-%offset%)))
     (setf a2 (+ a2 b2))
     (f2cl-lib:fdo (i4
                    (f2cl-lib:int-add nn (f2cl-lib:int-sub 17))
                    (f2cl-lib:int-add i4 (f2cl-lib:int-sub 4)))
                   ((> i4
                       (f2cl-lib:int-add
```

```
                                    (f2cl-lib:int-mul 4 i0)
                                    (f2cl-lib:int-sub 1)
                                    pp))
                                nil)
                        (tagbody
                          (if (= b2 zero) (go label40))
                          (setf b1 b2)
                          (if
                           (> (f2cl-lib:fref z-%data% (i4) ((1 *)) z-%offset%)
                              (f2cl-lib:fref z-%data%
                                             ((f2cl-lib:int-sub i4 2))
                                             ((1 *))
                                             z-%offset%))
                           (go end_label))
                          (setf b2
                                  (* b2
                                     (/
                                      (f2cl-lib:fref z-%data%
                                                     (i4)
                                                     ((1 *))
                                                     z-%offset%)
                                      (f2cl-lib:fref z-%data%
                                                     ((f2cl-lib:int-sub i4 2))
                                                     ((1 *))
                                                     z-%offset%))))
                          (setf a2 (+ a2 b2))
                          (if (or (< (* hundrd (max b2 b1)) a2) (< cnst1 a2))
                              (go label40))))
label40
                       (setf a2 (* cnst3 a2)))))
                   (if (< a2 cnst1)
                       (setf s
                             (/ (* gam (- one (f2cl-lib:fsqrt a2)))
                                (+ one a2)))))
                  (t
                   (cond
                     ((= ttype (f2cl-lib:int-sub 6))
                      (setf g (+ g (* third$ (- one g)))))
                     ((= ttype (f2cl-lib:int-sub 18))
                      (setf g (* qurtr third$)))
                     (t
                      (setf g qurtr)))
                   (setf s (* g dmin))
                   (setf ttype -6))))
                ((= n0in (f2cl-lib:int-add n0 1))
                 (cond
                   ((and (= f2cl-lib:dmin1 dn1) (= dmin2 dn2))
                    (tagbody
                      (setf ttype -7)
                      (setf s (* third$ f2cl-lib:dmin1))
```

```
(if
 (>
  (f2cl-lib:fref z-%data%
                 ((f2cl-lib:int-sub nn 5))
                 ((1 *))
                 z-%offset%)
  (f2cl-lib:fref z-%data%
                 ((f2cl-lib:int-sub nn 7))
                 ((1 *))
                 z-%offset%))
 (go end_label))
(setf b1
        (/
         (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub nn 5))
                        ((1 *))
                        z-%offset%)
         (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-sub nn 7))
                        ((1 *))
                        z-%offset%)))
(setf b2 b1)
(if (= b2 zero) (go label60))
(f2cl-lib:fdo (i4
               (f2cl-lib:int-add (f2cl-lib:int-mul 4 n0)
                                 (f2cl-lib:int-sub 9)
                                 pp)
               (f2cl-lib:int-add i4 (f2cl-lib:int-sub 4)))
              ((> i4
                  (f2cl-lib:int-add (f2cl-lib:int-mul 4 i0)
                                    (f2cl-lib:int-sub 1)
                                    pp))
               nil)
  (tagbody
    (setf a2 b1)
    (if
     (> (f2cl-lib:fref z-%data% (i4) ((1 *)) z-%offset%)
        (f2cl-lib:fref z-%data%
                       ((f2cl-lib:int-sub i4 2))
                       ((1 *))
                       z-%offset%))
     (go end_label))
    (setf b1
            (* b1
               (/
                (f2cl-lib:fref z-%data%
                               (i4)
                               ((1 *))
                               z-%offset%)
                (f2cl-lib:fref z-%data%
```

```
                                          ((f2cl-lib:int-sub i4 2))
                                          ((1 *))
                                          z-%offset%))))
                    (setf b2 (+ b2 b1))
                    (if (< (* hundrd (max b1 a2)) b2) (go label60))))
label60
                  (setf b2 (f2cl-lib:fsqrt (* cnst3 b2)))
                  (setf a2 (/ f2cl-lib:dmin1 (+ one (expt b2 2))))
                  (setf gap2 (- (* half dmin2) a2))
                  (cond
                    ((and (> gap2 zero) (> gap2 (* b2 a2)))
                     (setf s
                             (max s
                                  (* a2
                                     (+ one (* (- cnst2) a2 (/ b2 gap2) b2))))))
                    (t
                     (setf s (max s (* a2 (- one (* cnst2 b2)))))
                     (setf ttype -8)))))
                 (t
                  (setf s (* qurtr f2cl-lib:dmin1))
                  (if (= f2cl-lib:dmin1 dn1) (setf s (* half f2cl-lib:dmin1)))
                  (setf ttype -9))))
               ((= n0in (f2cl-lib:int-add n0 2))
                (cond
                  ((and (= dmin2 dn2)
                        (<
                         (* two
                            (f2cl-lib:fref z
                                           ((f2cl-lib:int-add nn
                                                              (f2cl-lib:int-sub
                                                               5)))
                                           ((1 *))))
                         (f2cl-lib:fref z
                                        ((f2cl-lib:int-add nn
                                                           (f2cl-lib:int-sub 7)))
                                        ((1 *)))))
                   (tagbody
                     (setf ttype -10)
                     (setf s (* third$ dmin2))
                     (if
                      (>
                       (f2cl-lib:fref z-%data%
                                      ((f2cl-lib:int-sub nn 5))
                                      ((1 *))
                                      z-%offset%)
                       (f2cl-lib:fref z-%data%
                                      ((f2cl-lib:int-sub nn 7))
                                      ((1 *))
                                      z-%offset%))
                      (go end_label))
```

```
                (setf b1
                        (/
                         (f2cl-lib:fref z-%data%
                                        ((f2cl-lib:int-sub nn 5))
                                        ((1 *))
                                        z-%offset%)
                         (f2cl-lib:fref z-%data%
                                        ((f2cl-lib:int-sub nn 7))
                                        ((1 *))
                                        z-%offset%)))
                (setf b2 b1)
                (if (= b2 zero) (go label80))
                (f2cl-lib:fdo (i4
                               (f2cl-lib:int-add (f2cl-lib:int-mul 4 n0)
                                                 (f2cl-lib:int-sub 9)
                                                 pp)
                               (f2cl-lib:int-add i4 (f2cl-lib:int-sub 4)))
                              ((> i4
                                  (f2cl-lib:int-add (f2cl-lib:int-mul 4 i0)
                                                    (f2cl-lib:int-sub 1)
                                                    pp))
                               nil)
                  (tagbody
                    (if
                     (> (f2cl-lib:fref z-%data% (i4) ((1 *)) z-%offset%)
                        (f2cl-lib:fref z-%data%
                                       ((f2cl-lib:int-sub i4 2))
                                       ((1 *))
                                       z-%offset%))
                     (go end_label))
                    (setf b1
                            (* b1
                               (/
                                (f2cl-lib:fref z-%data%
                                               (i4)
                                               ((1 *))
                                               z-%offset%)
                                (f2cl-lib:fref z-%data%
                                               ((f2cl-lib:int-sub i4 2))
                                               ((1 *))
                                               z-%offset%))))
                    (setf b2 (+ b2 b1))
                    (if (< (* hundrd b1) b2) (go label80))))
label80
                (setf b2 (f2cl-lib:fsqrt (* cnst3 b2)))
                (setf a2 (/ dmin2 (+ one (expt b2 2))))
                (setf gap2
                        (-
                         (+
                          (f2cl-lib:fref z-%data%
```

```
                                        ((f2cl-lib:int-sub nn 7))
                                        ((1 *))
                                        z-%offset%)
                               (f2cl-lib:fref z-%data%
                                        ((f2cl-lib:int-sub nn 9))
                                        ((1 *))
                                        z-%offset%))
                              (*
                               (f2cl-lib:fsqrt
                                (f2cl-lib:fref z-%data%
                                        ((f2cl-lib:int-sub nn 11))
                                        ((1 *))
                                        z-%offset%))
                               (f2cl-lib:fsqrt
                                (f2cl-lib:fref z-%data%
                                        ((f2cl-lib:int-sub nn 9))
                                        ((1 *))
                                        z-%offset%)))
                              a2))
                    (cond
                      ((and (> gap2 zero) (> gap2 (* b2 a2)))
                       (setf s
                             (max s
                                  (* a2
                                     (+ one (* (- cnst2) a2 (/ b2 gap2) b2))))))
                      (t
                       (setf s (max s (* a2 (- one (* cnst2 b2))))))))
                  (t
                   (setf s (* qurtr dmin2))
                   (setf ttype -11))))
                ((> n0in (f2cl-lib:int-add n0 2))
                 (setf s zero)
                 (setf ttype -12)))
               (setf tau s)
 end_label
               (return
                (values nil nil nil nil nil nil nil nil nil nil nil tau ttype)))))))
```

———-

6.74 dlasq5 LAPACK

— dlasq5.input —

```
)set break resume
)sys rm -f dlasq5.output
```

```
)spool dlasq5.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dlasq5.help —

```
========================================================================
dlasq5 examples
========================================================================

========================================================================
Man Page Details
========================================================================

NAME
       DLASQ5  -  one  dqds  transform in ping-pong form, one version for IEEE
       machines another for non IEEE machines

SYNOPSIS
       SUBROUTINE DLASQ5( I0, N0, Z, PP, TAU, DMIN, DMIN1,  DMIN2,  DN,  DNM1,
                          DNM2, IEEE )

           LOGICAL        IEEE

           INTEGER        I0, N0, PP

           DOUBLE         PRECISION DMIN, DMIN1, DMIN2, DN, DNM1, DNM2, TAU

           DOUBLE         PRECISION Z( * )

  Purpose
  =======

  DLASQ5 computes one dqds transform in ping-pong form, one
  version for IEEE machines another for non IEEE machines.

  Arguments
  =========

  I0    (input) INTEGER
        First index.

  N0    (input) INTEGER
```

```
       Last index.

  Z     (input) DOUBLE PRECISION array, dimension ( 4*N )
       Z holds the qd array. EMIN is stored in Z(4*N0) to avoid
       an extra argument.

  PP    (input) INTEGER
       PP=0 for ping, PP=1 for pong.

  TAU   (input) DOUBLE PRECISION
       This is the shift.

  DMIN  (output) DOUBLE PRECISION
       Minimum value of d.

  DMIN1 (output) DOUBLE PRECISION
       Minimum value of d, excluding D( N0 ).

  DMIN2 (output) DOUBLE PRECISION
       Minimum value of d, excluding D( N0 ) and D( N0-1 ).

  DN    (output) DOUBLE PRECISION
       d(N0), the last value of d.

  DNM1  (output) DOUBLE PRECISION
       d(N0-1).

  DNM2  (output) DOUBLE PRECISION
       d(N0-2).

  IEEE  (input) LOGICAL
       Flag for IEEE or non IEEE arithmetic.
```

———-

— dlasq5.f —

```
      SUBROUTINE DLASQ5( I0, N0, Z, PP, TAU, DMIN, DMIN1, DMIN2, DN,
     $                   DNM1, DNM2, IEEE )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     May 17, 2000
*
*     .. Scalar Arguments ..
      LOGICAL            IEEE
      INTEGER            I0, N0, PP
```

```
      DOUBLE PRECISION   DMIN, DMIN1, DMIN2, DN, DNM1, DNM2, TAU
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   Z( * )
*     ..
*
*  =====================================================================
*
*     .. Parameter ..
      DOUBLE PRECISION   ZERO
      PARAMETER          ( ZERO = 0.0D0 )
*     ..
*     .. Local Scalars ..
      INTEGER            J4, J4P2
      DOUBLE PRECISION   D, EMIN, TEMP
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MIN
*     ..
*     .. Executable Statements ..
*
      IF( ( N0-I0-1 ).LE.0 )
     $   RETURN
*
      J4 = 4*I0 + PP - 3
      EMIN = Z( J4+4 )
      D = Z( J4 ) - TAU
      DMIN = D
      DMIN1 = -Z( J4 )
*
      IF( IEEE ) THEN
*
*        Code for IEEE arithmetic.
*
         IF( PP.EQ.0 ) THEN
            DO 10 J4 = 4*I0, 4*( N0-3 ), 4
               Z( J4-2 ) = D + Z( J4-1 )
               TEMP = Z( J4+1 ) / Z( J4-2 )
               D = D*TEMP - TAU
               DMIN = MIN( DMIN, D )
               Z( J4 ) = Z( J4-1 )*TEMP
               EMIN = MIN( Z( J4 ), EMIN )
   10       CONTINUE
         ELSE
            DO 20 J4 = 4*I0, 4*( N0-3 ), 4
               Z( J4-3 ) = D + Z( J4 )
               TEMP = Z( J4+2 ) / Z( J4-3 )
               D = D*TEMP - TAU
               DMIN = MIN( DMIN, D )
               Z( J4-1 ) = Z( J4 )*TEMP
```

```
               EMIN = MIN( Z( J4-1 ), EMIN )
   20       CONTINUE
         END IF
*
*        Unroll last two steps.
*
         DNM2 = D
         DMIN2 = DMIN
         J4 = 4*( N0-2 ) - PP
         J4P2 = J4 + 2*PP - 1
         Z( J4-2 ) = DNM2 + Z( J4P2 )
         Z( J4 ) = Z( J4P2+2 )*( Z( J4P2 ) / Z( J4-2 ) )
         DNM1 = Z( J4P2+2 )*( DNM2 / Z( J4-2 ) ) - TAU
         DMIN = MIN( DMIN, DNM1 )
*
         DMIN1 = DMIN
         J4 = J4 + 4
         J4P2 = J4 + 2*PP - 1
         Z( J4-2 ) = DNM1 + Z( J4P2 )
         Z( J4 ) = Z( J4P2+2 )*( Z( J4P2 ) / Z( J4-2 ) )
         DN = Z( J4P2+2 )*( DNM1 / Z( J4-2 ) ) - TAU
         DMIN = MIN( DMIN, DN )
*
      ELSE
*
*        Code for non IEEE arithmetic.
*
         IF( PP.EQ.0 ) THEN
            DO 30 J4 = 4*I0, 4*( N0-3 ), 4
               Z( J4-2 ) = D + Z( J4-1 )
               IF( D.LT.ZERO ) THEN
                  RETURN
               ELSE
                  Z( J4 ) = Z( J4+1 )*( Z( J4-1 ) / Z( J4-2 ) )
                  D = Z( J4+1 )*( D / Z( J4-2 ) ) - TAU
               END IF
               DMIN = MIN( DMIN, D )
               EMIN = MIN( EMIN, Z( J4 ) )
   30       CONTINUE
         ELSE
            DO 40 J4 = 4*I0, 4*( N0-3 ), 4
               Z( J4-3 ) = D + Z( J4 )
               IF( D.LT.ZERO ) THEN
                  RETURN
               ELSE
                  Z( J4-1 ) = Z( J4+2 )*( Z( J4 ) / Z( J4-3 ) )
                  D = Z( J4+2 )*( D / Z( J4-3 ) ) - TAU
               END IF
               DMIN = MIN( DMIN, D )
               EMIN = MIN( EMIN, Z( J4-1 ) )
```

```
   40       CONTINUE
         END IF
*
*        Unroll last two steps.
*
         DNM2 = D
         DMIN2 = DMIN
         J4 = 4*( N0-2 ) - PP
         J4P2 = J4 + 2*PP - 1
         Z( J4-2 ) = DNM2 + Z( J4P2 )
         IF( DNM2.LT.ZERO ) THEN
            RETURN
         ELSE
            Z( J4 ) = Z( J4P2+2 )*( Z( J4P2 ) / Z( J4-2 ) )
            DNM1 = Z( J4P2+2 )*( DNM2 / Z( J4-2 ) ) - TAU
         END IF
         DMIN = MIN( DMIN, DNM1 )
*
         DMIN1 = DMIN
         J4 = J4 + 4
         J4P2 = J4 + 2*PP - 1
         Z( J4-2 ) = DNM1 + Z( J4P2 )
         IF( DNM1.LT.ZERO ) THEN
            RETURN
         ELSE
            Z( J4 ) = Z( J4P2+2 )*( Z( J4P2 ) / Z( J4-2 ) )
            DN = Z( J4P2+2 )*( DNM1 / Z( J4-2 ) ) - TAU
         END IF
         DMIN = MIN( DMIN, DN )
*
      END IF
*
      Z( J4+2 ) = DN
      Z( 4*N0-PP ) = EMIN
      RETURN
*
*     End of DLASQ5
*
      END
```

———-

— LAPACK dlasq5 —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dlasq5 (i0 n0 z pp tau dmin f2cl-lib:dmin1 dmin2 dn dnm1 dnm2 ieee)
    (declare (type (member t nil) ieee)
```

```
          (type (double-float) dnm2 dnm1 dn dmin2 f2cl-lib:dmin1 dmin tau)
          (type (simple-array double-float (*)) z)
          (type fixnum pp n0 i0))
    (f2cl-lib:with-multi-array-data
        ((z double-float z-%data% z-%offset%))
      (prog ((d 0.0) (emin 0.0) (temp 0.0) (j4 0) (j4p2 0))
        (declare (type (double-float) d emin temp)
                 (type fixnum j4 j4p2))
        (if (<= (f2cl-lib:int-sub n0 i0 1) 0) (go end_label))
        (setf j4
                (f2cl-lib:int-sub (f2cl-lib:int-add (f2cl-lib:int-mul 4 i0) pp)
                                  3))
        (setf emin
                (f2cl-lib:fref z-%data%
                               ((f2cl-lib:int-add j4 4))
                               ((1 *))
                               z-%offset%))
        (setf d (- (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%) tau))
        (setf dmin d)
        (setf f2cl-lib:dmin1
                (- (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)))
        (cond
          (ieee
           (cond
             ((= pp 0)
             (f2cl-lib:fdo (j4 (f2cl-lib:int-mul 4 i0) (f2cl-lib:int-add j4 4))
                           ((> j4
                               (f2cl-lib:int-mul 4
                                                 (f2cl-lib:int-add n0
                                                     (f2cl-lib:int-sub
                                                                   3))))
                            nil)
               (tagbody
                 (setf (f2cl-lib:fref z-%data%
                                      ((f2cl-lib:int-sub j4 2))
                                      ((1 *))
                                      z-%offset%)
                         (+ d
                            (f2cl-lib:fref z-%data%
                                           ((f2cl-lib:int-sub j4 1))
                                           ((1 *))
                                           z-%offset%)))
                 (setf temp
                         (/
                          (f2cl-lib:fref z-%data%
                                         ((f2cl-lib:int-add j4 1))
                                         ((1 *))
                                         z-%offset%)
                          (f2cl-lib:fref z-%data%
                                         ((f2cl-lib:int-sub j4 2))
```

```
                              ((1 *))
                              z-%offset%)))
      (setf d (- (* d temp) tau))
      (setf dmin (min dmin d))
      (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
              (*
               (f2cl-lib:fref z-%data%
                              ((f2cl-lib:int-sub j4 1))
                              ((1 *))
                              z-%offset%)
               temp))
      (setf emin
              (min (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
                   emin)))))
(t
(f2cl-lib:fdo (j4 (f2cl-lib:int-mul 4 i0) (f2cl-lib:int-add j4 4))
               ((> j4
                   (f2cl-lib:int-mul 4
                                     (f2cl-lib:int-add n0
                                           (f2cl-lib:int-sub
                                                       3))))
                nil)
   (tagbody
     (setf (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-sub j4 3))
                          ((1 *))
                          z-%offset%)
             (+ d
                (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)))
     (setf temp
             (/
              (f2cl-lib:fref z-%data%
                              ((f2cl-lib:int-add j4 2))
                              ((1 *))
                              z-%offset%)
              (f2cl-lib:fref z-%data%
                              ((f2cl-lib:int-sub j4 3))
                              ((1 *))
                              z-%offset%)))
     (setf d (- (* d temp) tau))
     (setf dmin (min dmin d))
     (setf (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-sub j4 1))
                          ((1 *))
                          z-%offset%)
             (* (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
                temp))
     (setf emin
             (min
              (f2cl-lib:fref z-%data%
```

```
                                ((f2cl-lib:int-sub j4 1))
                                ((1 *))
                                z-%offset%)
                  emin))))))
(setf dnm2 d)
(setf dmin2 dmin)
(setf j4
        (f2cl-lib:int-sub
         (f2cl-lib:int-mul 4 (f2cl-lib:int-sub n0 2))
         pp))
(setf j4p2
        (f2cl-lib:int-sub
         (f2cl-lib:int-add j4 (f2cl-lib:int-mul 2 pp))
         1))
(setf (f2cl-lib:fref z-%data%
                     ((f2cl-lib:int-sub j4 2))
                     ((1 *))
                     z-%offset%)
        (+ dnm2 (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)))
(setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
        (*
         (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-add j4p2 2))
                        ((1 *))
                        z-%offset%)
         (/ (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub j4 2))
                           ((1 *))
                           z-%offset%))))
(setf dnm1
        (-
         (*
          (f2cl-lib:fref z-%data%
                         ((f2cl-lib:int-add j4p2 2))
                         ((1 *))
                         z-%offset%)
          (/ dnm2
             (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-sub j4 2))
                            ((1 *))
                            z-%offset%)))
         tau))
(setf dmin (min dmin dnm1))
(setf f2cl-lib:dmin1 dmin)
(setf j4 (f2cl-lib:int-add j4 4))
(setf j4p2
        (f2cl-lib:int-sub
         (f2cl-lib:int-add j4 (f2cl-lib:int-mul 2 pp))
         1))
```

```
(setf (f2cl-lib:fref z-%data%
                     ((f2cl-lib:int-sub j4 2))
                     ((1 *))
                     z-%offset%)
        (+ dnm1 (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)))
(setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
        (*
         (f2cl-lib:fref z-%data%
                        ((f2cl-lib:int-add j4p2 2))
                        ((1 *))
                        z-%offset%)
         (/ (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub j4 2))
                           ((1 *))
                           z-%offset%))))
(setf dn
        (-
         (*
          (f2cl-lib:fref z-%data%
                         ((f2cl-lib:int-add j4p2 2))
                         ((1 *))
                         z-%offset%)
          (/ dnm1
             (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-sub j4 2))
                            ((1 *))
                            z-%offset%)))
         tau))
(setf dmin (min dmin dn)))
(t
 (cond
   ((= pp 0)
   (f2cl-lib:fdo (j4 (f2cl-lib:int-mul 4 i0) (f2cl-lib:int-add j4 4))
                 ((> j4
                     (f2cl-lib:int-mul 4
                                       (f2cl-lib:int-add n0
                                            (f2cl-lib:int-sub
                                                        3))))
                  nil)
      (tagbody
        (setf (f2cl-lib:fref z-%data%
                             ((f2cl-lib:int-sub j4 2))
                             ((1 *))
                             z-%offset%)
              (+ d
                 (f2cl-lib:fref z-%data%
                                ((f2cl-lib:int-sub j4 1))
                                ((1 *))
                                z-%offset%)))
```

```
                (cond
                  ((< d zero)
                   (go end_label))
                  (t
                   (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
                           (*
                            (f2cl-lib:fref z-%data%
                                           ((f2cl-lib:int-add j4 1))
                                           ((1 *))
                                           z-%offset%)
                            (/
                             (f2cl-lib:fref z-%data%
                                            ((f2cl-lib:int-sub j4 1))
                                            ((1 *))
                                            z-%offset%)
                             (f2cl-lib:fref z-%data%
                                            ((f2cl-lib:int-sub j4 2))
                                            ((1 *))
                                            z-%offset%))))
                   (setf d
                           (-
                            (*
                             (f2cl-lib:fref z-%data%
                                            ((f2cl-lib:int-add j4 1))
                                            ((1 *))
                                            z-%offset%)
                             (/ d
                                (f2cl-lib:fref z-%data%
                                               ((f2cl-lib:int-sub j4 2))
                                               ((1 *))
                                               z-%offset%)))
                            tau))))
                (setf dmin (min dmin d))
                (setf emin
                        (min emin
                             (f2cl-lib:fref z-%data%
                                            (j4)
                                            ((1 *))
                                            z-%offset%))))))
          (t
          (f2cl-lib:fdo (j4 (f2cl-lib:int-mul 4 i0) (f2cl-lib:int-add j4 4))
                        ((> j4
                            (f2cl-lib:int-mul 4
                               (f2cl-lib:int-add n0
                                 (f2cl-lib:int-sub
                                                                    3))))
                         nil)
            (tagbody
              (setf (f2cl-lib:fref z-%data%
                                   ((f2cl-lib:int-sub j4 3))
```

```
                              ((1 *))
                              z-%offset%)
                    (+ d
                       (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)))
            (cond
              ((< d zero)
               (go end_label))
              (t
               (setf (f2cl-lib:fref z-%data%
                                    ((f2cl-lib:int-sub j4 1))
                                    ((1 *))
                                    z-%offset%)
                     (*
                      (f2cl-lib:fref z-%data%
                                     ((f2cl-lib:int-add j4 2))
                                     ((1 *))
                                     z-%offset%)
                      (/
                       (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
                       (f2cl-lib:fref z-%data%
                                      ((f2cl-lib:int-sub j4 3))
                                      ((1 *))
                                      z-%offset%))))
               (setf d
                     (-
                      (*
                       (f2cl-lib:fref z-%data%
                                      ((f2cl-lib:int-add j4 2))
                                      ((1 *))
                                      z-%offset%)
                       (/ d
                          (f2cl-lib:fref z-%data%
                                         ((f2cl-lib:int-sub j4 3))
                                         ((1 *))
                                         z-%offset%)))
                      tau))))
            (setf dmin (min dmin d))
            (setf emin
                  (min emin
                       (f2cl-lib:fref z-%data%
                                      ((f2cl-lib:int-sub j4 1))
                                      ((1 *))
                                      z-%offset%)))))))
      (setf dnm2 d)
      (setf dmin2 dmin)
      (setf j4
            (f2cl-lib:int-sub
             (f2cl-lib:int-mul 4 (f2cl-lib:int-sub n0 2))
             pp))
      (setf j4p2
```

```
        (f2cl-lib:int-sub
         (f2cl-lib:int-add j4 (f2cl-lib:int-mul 2 pp))
         1))
(setf (f2cl-lib:fref z-%data%
                     ((f2cl-lib:int-sub j4 2))
                     ((1 *))
                     z-%offset%)
        (+ dnm2 (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)))
(cond
  ((< dnm2 zero)
   (go end_label))
  (t
   (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
           (*
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-add j4p2 2))
                           ((1 *))
                           z-%offset%)
            (/ (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)
               (f2cl-lib:fref z-%data%
                              ((f2cl-lib:int-sub j4 2))
                              ((1 *))
                              z-%offset%))))
   (setf dnm1
           (-
            (*
             (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-add j4p2 2))
                            ((1 *))
                            z-%offset%)
             (/ dnm2
                (f2cl-lib:fref z-%data%
                               ((f2cl-lib:int-sub j4 2))
                               ((1 *))
                               z-%offset%)))
            tau))))
(setf dmin (min dmin dnm1))
(setf f2cl-lib:dmin1 dmin)
(setf j4 (f2cl-lib:int-add j4 4))
(setf j4p2
        (f2cl-lib:int-sub
         (f2cl-lib:int-add j4 (f2cl-lib:int-mul 2 pp))
         1))
(setf (f2cl-lib:fref z-%data%
                     ((f2cl-lib:int-sub j4 2))
                     ((1 *))
                     z-%offset%)
        (+ dnm1 (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)))
(cond
  ((< dnm1 zero)
```

```
             (go end_label))
            (t
             (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
                     (*
                      (f2cl-lib:fref z-%data%
                                     ((f2cl-lib:int-add j4p2 2))
                                     ((1 *))
                                     z-%offset%)
                      (/ (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)
                         (f2cl-lib:fref z-%data%
                                        ((f2cl-lib:int-sub j4 2))
                                        ((1 *))
                                        z-%offset%))))
             (setf dn
                     (-
                      (*
                       (f2cl-lib:fref z-%data%
                                      ((f2cl-lib:int-add j4p2 2))
                                      ((1 *))
                                      z-%offset%)
                       (/ dnm1
                          (f2cl-lib:fref z-%data%
                                         ((f2cl-lib:int-sub j4 2))
                                         ((1 *))
                                         z-%offset%)))
                      tau))))
          (setf dmin (min dmin dn))))
       (setf (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-add j4 2))
                            ((1 *))
                            z-%offset%)
             dn)
       (setf (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-sub (f2cl-lib:int-mul 4 n0) pp))
                            ((1 *))
                            z-%offset%)
             emin)
end_label
       (return
        (values nil
                nil
                nil
                nil
                nil
                dmin
                f2cl-lib:dmin1
                dmin2
                dn
                dnm1
                dnm2
```

```
               nil))))))
```

———-

6.75 dlasq6 LAPACK

— **dlasq6.input** —

```
)set break resume
)sys rm -f dlasq6.output
)spool dlasq6.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlasq6.help** —

```
=======================================================================
dlasq6 examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

NAME
       DLASQ6  -  one  dqd  (shift equal to zero) transform in ping-pong form,
       with protection against underflow and overflow

SYNOPSIS
       SUBROUTINE DLASQ6( I0, N0, Z, PP, DMIN, DMIN1, DMIN2, DN, DNM1, DNM2 )

           INTEGER        I0, N0, PP

           DOUBLE         PRECISION DMIN, DMIN1, DMIN2, DN, DNM1, DNM2

           DOUBLE         PRECISION Z( * )

  Purpose
  =======
```

```
  DLASQ6 computes one dqd (shift equal to zero) transform in
  ping-pong form, with protection against underflow and overflow.

  Arguments
  =========

  I0    (input) INTEGER
        First index.

  N0    (input) INTEGER
        Last index.

  Z     (input) DOUBLE PRECISION array, dimension ( 4*N )
        Z holds the qd array. EMIN is stored in Z(4*N0) to avoid
        an extra argument.

  PP    (input) INTEGER
        PP=0 for ping, PP=1 for pong.

  DMIN  (output) DOUBLE PRECISION
        Minimum value of d.

  DMIN1 (output) DOUBLE PRECISION
        Minimum value of d, excluding D( N0 ).

  DMIN2 (output) DOUBLE PRECISION
        Minimum value of d, excluding D( N0 ) and D( N0-1 ).

  DN    (output) DOUBLE PRECISION
        d(N0), the last value of d.

  DNM1  (output) DOUBLE PRECISION
        d(N0-1).

  DNM2  (output) DOUBLE PRECISION
        d(N0-2).
```

———-

— dlasq6.f —

```
      SUBROUTINE DLASQ6( I0, N0, Z, PP, DMIN, DMIN1, DMIN2, DN,
     $                   DNM1, DNM2 )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
```

```
*     October 31, 1999
*
*     .. Scalar Arguments ..
      INTEGER            I0, N0, PP
      DOUBLE PRECISION   DMIN, DMIN1, DMIN2, DN, DNM1, DNM2
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   Z( * )
*     ..
*
*  =====================================================================
*
*     .. Parameter ..
      DOUBLE PRECISION   ZERO
      PARAMETER          ( ZERO = 0.0D0 )
*     ..
*     .. Local Scalars ..
      INTEGER            J4, J4P2
      DOUBLE PRECISION   D, EMIN, SAFMIN, TEMP
*     ..
*     .. External Function ..
      DOUBLE PRECISION   DLAMCH
      EXTERNAL           DLAMCH
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MIN
*     ..
*     .. Executable Statements ..
*
      IF( ( N0-I0-1 ).LE.0 )
     $   RETURN
*
      SAFMIN = DLAMCH( 'Safe minimum' )
      J4 = 4*I0 + PP - 3
      EMIN = Z( J4+4 )
      D = Z( J4 )
      DMIN = D
*
      IF( PP.EQ.0 ) THEN
         DO 10 J4 = 4*I0, 4*( N0-3 ), 4
            Z( J4-2 ) = D + Z( J4-1 )
            IF( Z( J4-2 ).EQ.ZERO ) THEN
               Z( J4 ) = ZERO
               D = Z( J4+1 )
               DMIN = D
               EMIN = ZERO
            ELSE IF( SAFMIN*Z( J4+1 ).LT.Z( J4-2 ) .AND.
     $               SAFMIN*Z( J4-2 ).LT.Z( J4+1 ) ) THEN
               TEMP = Z( J4+1 ) / Z( J4-2 )
               Z( J4 ) = Z( J4-1 )*TEMP
```

```
               D = D*TEMP
            ELSE
               Z( J4 ) = Z( J4+1 )*( Z( J4-1 ) / Z( J4-2 ) )
               D = Z( J4+1 )*( D / Z( J4-2 ) )
            END IF
            DMIN = MIN( DMIN, D )
            EMIN = MIN( EMIN, Z( J4 ) )
   10    CONTINUE
      ELSE
         DO 20 J4 = 4*I0, 4*( N0-3 ), 4
            Z( J4-3 ) = D + Z( J4 )
            IF( Z( J4-3 ).EQ.ZERO ) THEN
               Z( J4-1 ) = ZERO
               D = Z( J4+2 )
               DMIN = D
               EMIN = ZERO
            ELSE IF( SAFMIN*Z( J4+2 ).LT.Z( J4-3 ) .AND.
     $               SAFMIN*Z( J4-3 ).LT.Z( J4+2 ) ) THEN
               TEMP = Z( J4+2 ) / Z( J4-3 )
               Z( J4-1 ) = Z( J4 )*TEMP
               D = D*TEMP
            ELSE
               Z( J4-1 ) = Z( J4+2 )*( Z( J4 ) / Z( J4-3 ) )
               D = Z( J4+2 )*( D / Z( J4-3 ) )
            END IF
            DMIN = MIN( DMIN, D )
            EMIN = MIN( EMIN, Z( J4-1 ) )
   20    CONTINUE
      END IF
*
*     Unroll last two steps.
*
      DNM2 = D
      DMIN2 = DMIN
      J4 = 4*( N0-2 ) - PP
      J4P2 = J4 + 2*PP - 1
      Z( J4-2 ) = DNM2 + Z( J4P2 )
      IF( Z( J4-2 ).EQ.ZERO ) THEN
         Z( J4 ) = ZERO
         DNM1 = Z( J4P2+2 )
         DMIN = DNM1
         EMIN = ZERO
      ELSE IF( SAFMIN*Z( J4P2+2 ).LT.Z( J4-2 ) .AND.
     $         SAFMIN*Z( J4-2 ).LT.Z( J4P2+2 ) ) THEN
         TEMP = Z( J4P2+2 ) / Z( J4-2 )
         Z( J4 ) = Z( J4P2 )*TEMP
         DNM1 = DNM2*TEMP
      ELSE
         Z( J4 ) = Z( J4P2+2 )*( Z( J4P2 ) / Z( J4-2 ) )
         DNM1 = Z( J4P2+2 )*( DNM2 / Z( J4-2 ) )
```

```
      END IF
      DMIN = MIN( DMIN, DNM1 )
*
      DMIN1 = DMIN
      J4 = J4 + 4
      J4P2 = J4 + 2*PP - 1
      Z( J4-2 ) = DNM1 + Z( J4P2 )
      IF( Z( J4-2 ).EQ.ZERO ) THEN
         Z( J4 ) = ZERO
         DN = Z( J4P2+2 )
         DMIN = DN
         EMIN = ZERO
      ELSE IF( SAFMIN*Z( J4P2+2 ).LT.Z( J4-2 ) .AND.
     $         SAFMIN*Z( J4-2 ).LT.Z( J4P2+2 ) ) THEN
         TEMP = Z( J4P2+2 ) / Z( J4-2 )
         Z( J4 ) = Z( J4P2 )*TEMP
         DN = DNM1*TEMP
      ELSE
         Z( J4 ) = Z( J4P2+2 )*( Z( J4P2 ) / Z( J4-2 ) )
         DN = Z( J4P2+2 )*( DNM1 / Z( J4-2 ) )
      END IF
      DMIN = MIN( DMIN, DN )
*
      Z( J4+2 ) = DN
      Z( 4*N0-PP ) = EMIN
      RETURN
*
*     End of DLASQ6
*
      END
```

— LAPACK dlasq6 —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dlasq6 (i0 n0 z pp dmin f2cl-lib:dmin1 dmin2 dn dnm1 dnm2)
    (declare (type (double-float) dnm2 dnm1 dn dmin2 f2cl-lib:dmin1 dmin)
             (type (simple-array double-float (*)) z)
             (type fixnum pp n0 i0))
    (f2cl-lib:with-multi-array-data
        ((z double-float z-%data% z-%offset%))
      (prog ((d 0.0) (emin 0.0) (safmin 0.0) (temp 0.0) (j4 0) (j4p2 0))
        (declare (type (double-float) d emin safmin temp)
                 (type fixnum j4 j4p2))
        (if (<= (f2cl-lib:int-sub n0 i0 1) 0) (go end_label))
        (setf safmin (dlamch "Safe minimum"))
```

```
(setf j4
        (f2cl-lib:int-sub (f2cl-lib:int-add (f2cl-lib:int-mul 4 i0) pp)
                          3))
(setf emin
        (f2cl-lib:fref z-%data%
                       ((f2cl-lib:int-add j4 4))
                       ((1 *))
                       z-%offset%))
(setf d (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%))
(setf dmin d)
(cond
  ((= pp 0)
   (f2cl-lib:fdo (j4 (f2cl-lib:int-mul 4 i0) (f2cl-lib:int-add j4 4))
                 ((> j4
                     (f2cl-lib:int-mul 4
                                       (f2cl-lib:int-add n0
                                                         (f2cl-lib:int-sub
                                                          3))))
                  nil)
     (tagbody
       (setf (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-sub j4 2))
                            ((1 *))
                            z-%offset%)
             (+ d
                (f2cl-lib:fref z-%data%
                               ((f2cl-lib:int-sub j4 1))
                               ((1 *))
                               z-%offset%)))
       (cond
         ((=
           (f2cl-lib:fref z
                          ((f2cl-lib:int-add j4 (f2cl-lib:int-sub 2)))
                          ((1 *)))
           zero)
          (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%) zero)
          (setf d
                (f2cl-lib:fref z-%data%
                               ((f2cl-lib:int-add j4 1))
                               ((1 *))
                               z-%offset%))
          (setf dmin d)
          (setf emin zero))
         ((and
           (<
            (* safmin
               (f2cl-lib:fref z ((f2cl-lib:int-add j4 1)) ((1 *))))
            (f2cl-lib:fref z
                           ((f2cl-lib:int-add j4 (f2cl-lib:int-sub 2)))
                           ((1 *))))
```

```
 (<
  (* safmin
     (f2cl-lib:fref z
                    ((f2cl-lib:int-add j4
                                       (f2cl-lib:int-sub 2)))
                    ((1 *))))
  (f2cl-lib:fref z ((f2cl-lib:int-add j4 1)) ((1 *)))))
 (setf temp
         (/
          (f2cl-lib:fref z-%data%
                         ((f2cl-lib:int-add j4 1))
                         ((1 *))
                         z-%offset%)
          (f2cl-lib:fref z-%data%
                         ((f2cl-lib:int-sub j4 2))
                         ((1 *))
                         z-%offset%)))
 (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
         (*
          (f2cl-lib:fref z-%data%
                         ((f2cl-lib:int-sub j4 1))
                         ((1 *))
                         z-%offset%)
          temp))
 (setf d (* d temp)))
(t
 (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
         (*
          (f2cl-lib:fref z-%data%
                         ((f2cl-lib:int-add j4 1))
                         ((1 *))
                         z-%offset%)
          (/
           (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-sub j4 1))
                          ((1 *))
                          z-%offset%)
           (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-sub j4 2))
                          ((1 *))
                          z-%offset%))))
 (setf d
         (*
          (f2cl-lib:fref z-%data%
                         ((f2cl-lib:int-add j4 1))
                         ((1 *))
                         z-%offset%)
          (/ d
             (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-sub j4 2))
```

```
                                    ((1 *))
                                    z-%offset%))))))
          (setf dmin (min dmin d))
          (setf emin
                (min emin
                     (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%))))))
        (t
         (f2cl-lib:fdo (j4 (f2cl-lib:int-mul 4 i0) (f2cl-lib:int-add j4 4))
                       ((> j4
                           (f2cl-lib:int-mul 4
                                             (f2cl-lib:int-add n0
                                                               (f2cl-lib:int-sub
                                                                3))))
                        nil)
           (tagbody
             (setf (f2cl-lib:fref z-%data%
                                  ((f2cl-lib:int-sub j4 3))
                                  ((1 *))
                                  z-%offset%)
                   (+ d (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)))
             (cond
               ((=
                 (f2cl-lib:fref z
                                ((f2cl-lib:int-add j4 (f2cl-lib:int-sub 3)))
                                ((1 *)))
                 zero)
                (setf (f2cl-lib:fref z-%data%
                                     ((f2cl-lib:int-sub j4 1))
                                     ((1 *))
                                     z-%offset%)
                      zero)
                (setf d
                      (f2cl-lib:fref z-%data%
                                     ((f2cl-lib:int-add j4 2))
                                     ((1 *))
                                     z-%offset%))
                (setf dmin d)
                (setf emin zero))
               ((and
                 (<
                  (* safmin
                     (f2cl-lib:fref z ((f2cl-lib:int-add j4 2)) ((1 *))))
                  (f2cl-lib:fref z
                                 ((f2cl-lib:int-add j4 (f2cl-lib:int-sub 3)))
                                 ((1 *))))
                 (<
                  (* safmin
                     (f2cl-lib:fref z
                                    ((f2cl-lib:int-add j4
                                                       (f2cl-lib:int-sub 3)))
```

```
                                ((1 *))))
                  (f2cl-lib:fref z ((f2cl-lib:int-add j4 2)) ((1 *)))))
                 (setf temp
                       (/
                        (f2cl-lib:fref z-%data%
                                       ((f2cl-lib:int-add j4 2))
                                       ((1 *))
                                       z-%offset%)
                        (f2cl-lib:fref z-%data%
                                       ((f2cl-lib:int-sub j4 3))
                                       ((1 *))
                                       z-%offset%)))
                 (setf (f2cl-lib:fref z-%data%
                                      ((f2cl-lib:int-sub j4 1))
                                      ((1 *))
                                      z-%offset%)
                       (* (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
                          temp))
                 (setf d (* d temp)))
                (t
                 (setf (f2cl-lib:fref z-%data%
                                      ((f2cl-lib:int-sub j4 1))
                                      ((1 *))
                                      z-%offset%)
                       (*
                        (f2cl-lib:fref z-%data%
                                       ((f2cl-lib:int-add j4 2))
                                       ((1 *))
                                       z-%offset%)
                        (/ (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
                           (f2cl-lib:fref z-%data%
                                          ((f2cl-lib:int-sub j4 3))
                                          ((1 *))
                                          z-%offset%))))
                 (setf d
                       (*
                        (f2cl-lib:fref z-%data%
                                       ((f2cl-lib:int-add j4 2))
                                       ((1 *))
                                       z-%offset%)
                        (/ d
                           (f2cl-lib:fref z-%data%
                                          ((f2cl-lib:int-sub j4 3))
                                          ((1 *))
                                          z-%offset%))))))
          (setf dmin (min dmin d))
          (setf emin
                (min emin
                     (f2cl-lib:fref z-%data%
                                    ((f2cl-lib:int-sub j4 1))
```

```
                                    ((1 *))
                                    z-%offset%)))))))
(setf dnm2 d)
(setf dmin2 dmin)
(setf j4
        (f2cl-lib:int-sub (f2cl-lib:int-mul 4 (f2cl-lib:int-sub n0 2))
                          pp))
(setf j4p2
        (f2cl-lib:int-sub (f2cl-lib:int-add j4 (f2cl-lib:int-mul 2 pp))
                          1))
(setf (f2cl-lib:fref z-%data%
                     ((f2cl-lib:int-sub j4 2))
                     ((1 *))
                     z-%offset%)
        (+ dnm2 (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)))
(cond
  ((=
    (f2cl-lib:fref z
                   ((f2cl-lib:int-add j4 (f2cl-lib:int-sub 2)))
                   ((1 *)))
    zero)
   (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%) zero)
   (setf dnm1
           (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-add j4p2 2))
                          ((1 *))
                          z-%offset%))
   (setf dmin dnm1)
   (setf emin zero))
  ((and
    (< (* safmin (f2cl-lib:fref z ((f2cl-lib:int-add j4p2 2)) ((1 *))))
       (f2cl-lib:fref z
                      ((f2cl-lib:int-add j4 (f2cl-lib:int-sub 2)))
                      ((1 *))))
    (<
     (* safmin
        (f2cl-lib:fref z
                       ((f2cl-lib:int-add j4 (f2cl-lib:int-sub 2)))
                       ((1 *))))
     (f2cl-lib:fref z ((f2cl-lib:int-add j4p2 2)) ((1 *)))))
   (setf temp
           (/
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-add j4p2 2))
                           ((1 *))
                           z-%offset%)
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-sub j4 2))
                           ((1 *))
                           z-%offset%)))
```

```
   (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
           (* (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%) temp))
   (setf dnm1 (* dnm2 temp)))
  (t
   (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
           (*
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-add j4p2 2))
                           ((1 *))
                           z-%offset%)
            (/ (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)
               (f2cl-lib:fref z-%data%
                              ((f2cl-lib:int-sub j4 2))
                              ((1 *))
                              z-%offset%))))
   (setf dnm1
           (*
            (f2cl-lib:fref z-%data%
                           ((f2cl-lib:int-add j4p2 2))
                           ((1 *))
                           z-%offset%)
            (/ dnm2
               (f2cl-lib:fref z-%data%
                              ((f2cl-lib:int-sub j4 2))
                              ((1 *))
                              z-%offset%))))))
(setf dmin (min dmin dnm1))
(setf f2cl-lib:dmin1 dmin)
(setf j4 (f2cl-lib:int-add j4 4))
(setf j4p2
        (f2cl-lib:int-sub (f2cl-lib:int-add j4 (f2cl-lib:int-mul 2 pp))
                          1))
(setf (f2cl-lib:fref z-%data%
                     ((f2cl-lib:int-sub j4 2))
                     ((1 *))
                     z-%offset%)
        (+ dnm1 (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)))
(cond
  ((=
    (f2cl-lib:fref z
                   ((f2cl-lib:int-add j4 (f2cl-lib:int-sub 2)))
                   ((1 *)))
    zero)
   (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%) zero)
   (setf dn
           (f2cl-lib:fref z-%data%
                          ((f2cl-lib:int-add j4p2 2))
                          ((1 *))
                          z-%offset%))
   (setf dmin dn)
```

```
          (setf emin zero))
         ((and
           (< (* safmin (f2cl-lib:fref z ((f2cl-lib:int-add j4p2 2)) ((1 *))))
              (f2cl-lib:fref z
                             ((f2cl-lib:int-add j4 (f2cl-lib:int-sub 2)))
                             ((1 *))))
           (<
            (* safmin
               (f2cl-lib:fref z
                              ((f2cl-lib:int-add j4 (f2cl-lib:int-sub 2)))
                              ((1 *))))
            (f2cl-lib:fref z ((f2cl-lib:int-add j4p2 2)) ((1 *)))))
          (setf temp
                (/
                 (f2cl-lib:fref z-%data%
                                ((f2cl-lib:int-add j4p2 2))
                                ((1 *))
                                z-%offset%)
                 (f2cl-lib:fref z-%data%
                                ((f2cl-lib:int-sub j4 2))
                                ((1 *))
                                z-%offset%)))
          (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
                (* (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%) temp))
          (setf dn (* dnm1 temp)))
         (t
          (setf (f2cl-lib:fref z-%data% (j4) ((1 *)) z-%offset%)
                (*
                 (f2cl-lib:fref z-%data%
                                ((f2cl-lib:int-add j4p2 2))
                                ((1 *))
                                z-%offset%)
                 (/ (f2cl-lib:fref z-%data% (j4p2) ((1 *)) z-%offset%)
                    (f2cl-lib:fref z-%data%
                                   ((f2cl-lib:int-sub j4 2))
                                   ((1 *))
                                   z-%offset%))))
          (setf dn
                (*
                 (f2cl-lib:fref z-%data%
                                ((f2cl-lib:int-add j4p2 2))
                                ((1 *))
                                z-%offset%)
                 (/ dnm1
                    (f2cl-lib:fref z-%data%
                                   ((f2cl-lib:int-sub j4 2))
                                   ((1 *))
                                   z-%offset%))))))
    (setf dmin (min dmin dn))
    (setf (f2cl-lib:fref z-%data%
```

```
                            ((f2cl-lib:int-add j4 2))
                            ((1 *))
                            z-%offset%)
                 dn)
         (setf (f2cl-lib:fref z-%data%
                            ((f2cl-lib:int-sub (f2cl-lib:int-mul 4 n0) pp))
                            ((1 *))
                            z-%offset%)
                 emin)
 end_label
         (return
          (values nil nil nil nil dmin f2cl-lib:dmin1 dmin2 dn dnm1 dnm2))))))
```

———-

6.76 dlasr LAPACK

— **dlasr.input** —

```
)set break resume
)sys rm -f dlasr.output
)spool dlasr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlasr.help** —

```
=====================================================================
dlasr examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DLASR - a sequence of plane rotations to a real matrix A,

SYNOPSIS
```

```
      SUBROUTINE DLASR( SIDE, PIVOT, DIRECT, M, N, C, S, A, LDA )

          CHARACTER     DIRECT, PIVOT, SIDE

          INTEGER       LDA, M, N

          DOUBLE        PRECISION A( LDA, * ), C( * ), S( * )

  Purpose
  =======

  DLASR   performs the transformation

     A := P*A,   when SIDE = 'L' or 'l'  (  Left-hand side )

     A := A*P',  when SIDE = 'R' or 'r'  ( Right-hand side )

  where A is an m by n real matrix and P is an orthogonal matrix,
  consisting of a sequence of plane rotations determined by the
  parameters PIVOT and DIRECT as follows ( z = m when SIDE = 'L' or 'l'
  and z = n when SIDE = 'R' or 'r' ):

  When  DIRECT = 'F' or 'f'  ( Forward sequence ) then

     P = P( z - 1 )*...*P( 2 )*P( 1 ),

  and when DIRECT = 'B' or 'b'  ( Backward sequence ) then

     P = P( 1 )*P( 2 )*...*P( z - 1 ),

  where  P( k ) is a plane rotation matrix for the following planes:

     when  PIVOT = 'V' or 'v'  ( Variable pivot ),
        the plane ( k, k + 1 )

     when  PIVOT = 'T' or 't'  ( Top pivot ),
        the plane ( 1, k + 1 )

     when  PIVOT = 'B' or 'b'  ( Bottom pivot ),
        the plane ( k, z )

  c( k ) and s( k )  must contain the  cosine and sine that define the
  matrix  P( k ).  The two by two plane rotation part of the matrix
  P( k ), R( k ), is assumed to be of the form

     R( k ) = (  c( k )  s( k ) ).
              ( -s( k )  c( k ) )

  This version vectorises across rows of the array A when SIDE = 'L'.
```

```
Arguments
=========

SIDE    (input) CHARACTER*1
        Specifies whether the plane rotation matrix P is applied to
        A on the left or the right.
        = 'L':  Left, compute A := P*A
        = 'R':  Right, compute A:= A*P'

DIRECT  (input) CHARACTER*1
        Specifies whether P is a forward or backward sequence of
        plane rotations.
        = 'F':  Forward, P = P( z - 1 )*...*P( 2 )*P( 1 )
        = 'B':  Backward, P = P( 1 )*P( 2 )*...*P( z - 1 )

PIVOT   (input) CHARACTER*1
        Specifies the plane for which P(k) is a plane rotation
        matrix.
        = 'V':  Variable pivot, the plane (k,k+1)
        = 'T':  Top pivot, the plane (1,k+1)
        = 'B':  Bottom pivot, the plane (k,z)

M       (input) INTEGER
        The number of rows of the matrix A.  If m <= 1, an immediate
        return is effected.

N       (input) INTEGER
        The number of columns of the matrix A.  If n <= 1, an
        immediate return is effected.

C, S    (input) DOUBLE PRECISION arrays, dimension
                (M-1) if SIDE = 'L'
                (N-1) if SIDE = 'R'
        c(k) and s(k) contain the cosine and sine that define the
        matrix P(k).  The two by two plane rotation part of the
        matrix P(k), R(k), is assumed to be of the form
        R( k ) = (  c( k )  s( k ) ).
                 ( -s( k )  c( k ) )

A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
        The m by n matrix A.  On exit, A is overwritten by P*A if
        SIDE = 'R' or by A*P' if SIDE = 'L'.

LDA     (input) INTEGER
        The leading dimension of the array A.  LDA >= max(1,M).
```

— **dlasr.f** —

```
      SUBROUTINE DLASR( SIDE, PIVOT, DIRECT, M, N, C, S, A, LDA )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1992
*
*     .. Scalar Arguments ..
      CHARACTER          DIRECT, PIVOT, SIDE
      INTEGER            LDA, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), C( * ), S( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE, ZERO
      PARAMETER          ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I, INFO, J
      DOUBLE PRECISION   CTEMP, STEMP, TEMP
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters
*
      INFO = 0
      IF( .NOT.( LSAME( SIDE, 'L' ) .OR. LSAME( SIDE, 'R' ) ) ) THEN
         INFO = 1
      ELSE IF( .NOT.( LSAME( PIVOT, 'V' ) .OR. LSAME( PIVOT,
     $         'T' ) .OR. LSAME( PIVOT, 'B' ) ) ) THEN
         INFO = 2
      ELSE IF( .NOT.( LSAME( DIRECT, 'F' ) .OR. LSAME( DIRECT, 'B' ) ) )
     $          THEN
         INFO = 3
```

```
      ELSE IF( M.LT.0 ) THEN
         INFO = 4
      ELSE IF( N.LT.0 ) THEN
         INFO = 5
      ELSE IF( LDA.LT.MAX( 1, M ) ) THEN
         INFO = 9
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DLASR ', INFO )
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( ( M.EQ.0 ) .OR. ( N.EQ.0 ) )
     $   RETURN
      IF( LSAME( SIDE, 'L' ) ) THEN
*
*        Form  P * A
*
         IF( LSAME( PIVOT, 'V' ) ) THEN
            IF( LSAME( DIRECT, 'F' ) ) THEN
               DO 20 J = 1, M - 1
                  CTEMP = C( J )
                  STEMP = S( J )
                  IF( ( CTEMP.NE.ONE ) .OR. ( STEMP.NE.ZERO ) ) THEN
                     DO 10 I = 1, N
                        TEMP = A( J+1, I )
                        A( J+1, I ) = CTEMP*TEMP - STEMP*A( J, I )
                        A( J, I ) = STEMP*TEMP + CTEMP*A( J, I )
   10                CONTINUE
                  END IF
   20          CONTINUE
            ELSE IF( LSAME( DIRECT, 'B' ) ) THEN
               DO 40 J = M - 1, 1, -1
                  CTEMP = C( J )
                  STEMP = S( J )
                  IF( ( CTEMP.NE.ONE ) .OR. ( STEMP.NE.ZERO ) ) THEN
                     DO 30 I = 1, N
                        TEMP = A( J+1, I )
                        A( J+1, I ) = CTEMP*TEMP - STEMP*A( J, I )
                        A( J, I ) = STEMP*TEMP + CTEMP*A( J, I )
   30                CONTINUE
                  END IF
   40          CONTINUE
            END IF
         ELSE IF( LSAME( PIVOT, 'T' ) ) THEN
            IF( LSAME( DIRECT, 'F' ) ) THEN
               DO 60 J = 2, M
                  CTEMP = C( J-1 )
```

```
               STEMP = S( J-1 )
               IF( ( CTEMP.NE.ONE ) .OR. ( STEMP.NE.ZERO ) ) THEN
                  DO 50 I = 1, N
                     TEMP = A( J, I )
                     A( J, I ) = CTEMP*TEMP - STEMP*A( 1, I )
                     A( 1, I ) = STEMP*TEMP + CTEMP*A( 1, I )
 50                CONTINUE
               END IF
 60         CONTINUE
         ELSE IF( LSAME( DIRECT, 'B' ) ) THEN
            DO 80 J = M, 2, -1
               CTEMP = C( J-1 )
               STEMP = S( J-1 )
               IF( ( CTEMP.NE.ONE ) .OR. ( STEMP.NE.ZERO ) ) THEN
                  DO 70 I = 1, N
                     TEMP = A( J, I )
                     A( J, I ) = CTEMP*TEMP - STEMP*A( 1, I )
                     A( 1, I ) = STEMP*TEMP + CTEMP*A( 1, I )
 70                CONTINUE
               END IF
 80         CONTINUE
         END IF
      ELSE IF( LSAME( PIVOT, 'B' ) ) THEN
         IF( LSAME( DIRECT, 'F' ) ) THEN
            DO 100 J = 1, M - 1
               CTEMP = C( J )
               STEMP = S( J )
               IF( ( CTEMP.NE.ONE ) .OR. ( STEMP.NE.ZERO ) ) THEN
                  DO 90 I = 1, N
                     TEMP = A( J, I )
                     A( J, I ) = STEMP*A( M, I ) + CTEMP*TEMP
                     A( M, I ) = CTEMP*A( M, I ) - STEMP*TEMP
 90                CONTINUE
               END IF
100         CONTINUE
         ELSE IF( LSAME( DIRECT, 'B' ) ) THEN
            DO 120 J = M - 1, 1, -1
               CTEMP = C( J )
               STEMP = S( J )
               IF( ( CTEMP.NE.ONE ) .OR. ( STEMP.NE.ZERO ) ) THEN
                  DO 110 I = 1, N
                     TEMP = A( J, I )
                     A( J, I ) = STEMP*A( M, I ) + CTEMP*TEMP
                     A( M, I ) = CTEMP*A( M, I ) - STEMP*TEMP
110               CONTINUE
               END IF
120         CONTINUE
         END IF
      END IF
   ELSE IF( LSAME( SIDE, 'R' ) ) THEN
```

```
*
*        Form A * P'
*
         IF( LSAME( PIVOT, 'V' ) ) THEN
            IF( LSAME( DIRECT, 'F' ) ) THEN
               DO 140 J = 1, N - 1
                  CTEMP = C( J )
                  STEMP = S( J )
                  IF( ( CTEMP.NE.ONE ) .OR. ( STEMP.NE.ZERO ) ) THEN
                     DO 130 I = 1, M
                        TEMP = A( I, J+1 )
                        A( I, J+1 ) = CTEMP*TEMP - STEMP*A( I, J )
                        A( I, J ) = STEMP*TEMP + CTEMP*A( I, J )
  130                CONTINUE
                  END IF
  140          CONTINUE
            ELSE IF( LSAME( DIRECT, 'B' ) ) THEN
               DO 160 J = N - 1, 1, -1
                  CTEMP = C( J )
                  STEMP = S( J )
                  IF( ( CTEMP.NE.ONE ) .OR. ( STEMP.NE.ZERO ) ) THEN
                     DO 150 I = 1, M
                        TEMP = A( I, J+1 )
                        A( I, J+1 ) = CTEMP*TEMP - STEMP*A( I, J )
                        A( I, J ) = STEMP*TEMP + CTEMP*A( I, J )
  150                CONTINUE
                  END IF
  160          CONTINUE
            END IF
         ELSE IF( LSAME( PIVOT, 'T' ) ) THEN
            IF( LSAME( DIRECT, 'F' ) ) THEN
               DO 180 J = 2, N
                  CTEMP = C( J-1 )
                  STEMP = S( J-1 )
                  IF( ( CTEMP.NE.ONE ) .OR. ( STEMP.NE.ZERO ) ) THEN
                     DO 170 I = 1, M
                        TEMP = A( I, J )
                        A( I, J ) = CTEMP*TEMP - STEMP*A( I, 1 )
                        A( I, 1 ) = STEMP*TEMP + CTEMP*A( I, 1 )
  170                CONTINUE
                  END IF
  180          CONTINUE
            ELSE IF( LSAME( DIRECT, 'B' ) ) THEN
               DO 200 J = N, 2, -1
                  CTEMP = C( J-1 )
                  STEMP = S( J-1 )
                  IF( ( CTEMP.NE.ONE ) .OR. ( STEMP.NE.ZERO ) ) THEN
                     DO 190 I = 1, M
                        TEMP = A( I, J )
                        A( I, J ) = CTEMP*TEMP - STEMP*A( I, 1 )
```

```
                     A( I, 1 ) = STEMP*TEMP + CTEMP*A( I, 1 )
  190             CONTINUE
                  END IF
  200          CONTINUE
               END IF
            ELSE IF( LSAME( PIVOT, 'B' ) ) THEN
               IF( LSAME( DIRECT, 'F' ) ) THEN
                  DO 220 J = 1, N - 1
                     CTEMP = C( J )
                     STEMP = S( J )
                     IF( ( CTEMP.NE.ONE ) .OR. ( STEMP.NE.ZERO ) ) THEN
                        DO 210 I = 1, M
                           TEMP = A( I, J )
                           A( I, J ) = STEMP*A( I, N ) + CTEMP*TEMP
                           A( I, N ) = CTEMP*A( I, N ) - STEMP*TEMP
  210                   CONTINUE
                     END IF
  220             CONTINUE
               ELSE IF( LSAME( DIRECT, 'B' ) ) THEN
                  DO 240 J = N - 1, 1, -1
                     CTEMP = C( J )
                     STEMP = S( J )
                     IF( ( CTEMP.NE.ONE ) .OR. ( STEMP.NE.ZERO ) ) THEN
                        DO 230 I = 1, M
                           TEMP = A( I, J )
                           A( I, J ) = STEMP*A( I, N ) + CTEMP*TEMP
                           A( I, N ) = CTEMP*A( I, N ) - STEMP*TEMP
  230                   CONTINUE
                     END IF
  240             CONTINUE
               END IF
            END IF
         END IF
*
         RETURN
*
*     End of DLASR
*
         END
```

———-

— LAPACK dlasr —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dlasr (side pivot direct m n c s a lda)
```

```
(declare (type (simple-array double-float (*)) a s c)
         (type fixnum lda n m)
         (type character direct pivot side))
(f2cl-lib:with-multi-array-data
    ((side character side-%data% side-%offset%)
     (pivot character pivot-%data% pivot-%offset%)
     (direct character direct-%data% direct-%offset%)
     (c double-float c-%data% c-%offset%)
     (s double-float s-%data% s-%offset%)
     (a double-float a-%data% a-%offset%))
  (prog ((ctemp 0.0) (stemp 0.0) (temp 0.0) (i 0) (info 0) (j 0))
    (declare (type (double-float) ctemp stemp temp)
             (type fixnum i info j))
    (setf info 0)
    (cond
      ((not (or (char-equal side #\L) (char-equal side #\R)))
       (setf info 1))
      ((not (or (char-equal pivot #\V) (char-equal pivot #\T)
                (char-equal pivot #\B)))
       (setf info 2))
      ((not (or (char-equal direct #\F) (char-equal direct #\B)))
       (setf info 3))
      ((< m 0)
       (setf info 4))
      ((< n 0)
       (setf info 5))
      ((< lda (max (the fixnum 1) (the fixnum m)))
       (setf info 9)))
    (cond
      ((/= info 0)
       (error
        " ** On entry to ~a parameter number ~a had an illegal value~%"
        "DLASR" info)
       (go end_label)))
    (if (or (= m 0) (= n 0)) (go end_label))
    (cond
      ((char-equal side #\L)
       (cond
         ((char-equal pivot #\V)
          (cond
            ((char-equal direct #\F)
             (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                           ((> j (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
                            nil)
               (tagbody
                 (setf ctemp
                         (f2cl-lib:fref c-%data% (j) ((1 *)) c-%offset%))
                 (setf stemp
                         (f2cl-lib:fref s-%data% (j) ((1 *)) s-%offset%))
                 (cond
```

```
          ((or (/= ctemp one) (/= stemp zero))
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i n) nil)
             (tagbody
               (setf temp
                       (f2cl-lib:fref a-%data%
                                      ((f2cl-lib:int-add j 1) i)
                                      ((1 lda) (1 *))
                                      a-%offset%))
               (setf (f2cl-lib:fref a-%data%
                                    ((f2cl-lib:int-add j 1) i)
                                    ((1 lda) (1 *))
                                    a-%offset%)
                       (- (* ctemp temp)
                          (* stemp
                             (f2cl-lib:fref a-%data%
                                            (j i)
                                            ((1 lda) (1 *))
                                            a-%offset%))))
               (setf (f2cl-lib:fref a-%data%
                                    (j i)
                                    ((1 lda) (1 *))
                                    a-%offset%)
                       (+ (* stemp temp)
                          (* ctemp
                             (f2cl-lib:fref a-%data%
                                            (j i)
                                            ((1 lda) (1 *))
                                            a-%offset%)))))))))
    ((char-equal direct #\B)
     (f2cl-lib:fdo (j (f2cl-lib:int-add m (f2cl-lib:int-sub 1))
                    (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                   ((> j 1) nil)
       (tagbody
         (setf ctemp
                 (f2cl-lib:fref c-%data% (j) ((1 *)) c-%offset%))
         (setf stemp
                 (f2cl-lib:fref s-%data% (j) ((1 *)) s-%offset%))
         (cond
           ((or (/= ctemp one) (/= stemp zero))
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          ((> i n) nil)
              (tagbody
                (setf temp
                        (f2cl-lib:fref a-%data%
                                       ((f2cl-lib:int-add j 1) i)
                                       ((1 lda) (1 *))
                                       a-%offset%))
                (setf (f2cl-lib:fref a-%data%
                                     ((f2cl-lib:int-add j 1) i)
```

```
                                        ((1 lda) (1 *))
                                        a-%offset%)
                                (- (* ctemp temp)
                                   (* stemp
                                      (f2cl-lib:fref a-%data%
                                                     (j i)
                                                     ((1 lda) (1 *))
                                                     a-%offset%))))
                            (setf (f2cl-lib:fref a-%data%
                                                 (j i)
                                                 ((1 lda) (1 *))
                                                 a-%offset%)
                                  (+ (* stemp temp)
                                     (* ctemp
                                        (f2cl-lib:fref a-%data%
                                                       (j i)
                                                       ((1 lda) (1 *))
                                                       a-%offset%))))))))))))))
        ((char-equal pivot #\T)
         (cond
           ((char-equal direct #\F)
            (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
                          ((> j m) nil)
              (tagbody
                (setf ctemp
                        (f2cl-lib:fref c-%data%
                                       ((f2cl-lib:int-sub j 1))
                                       ((1 *))
                                       c-%offset%))
                (setf stemp
                        (f2cl-lib:fref s-%data%
                                       ((f2cl-lib:int-sub j 1))
                                       ((1 *))
                                       s-%offset%))
                (cond
                  ((or (/= ctemp one) (/= stemp zero))
                   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                 ((> i n) nil)
                     (tagbody
                       (setf temp
                               (f2cl-lib:fref a-%data%
                                              (j i)
                                              ((1 lda) (1 *))
                                              a-%offset%))
                       (setf (f2cl-lib:fref a-%data%
                                            (j i)
                                            ((1 lda) (1 *))
                                            a-%offset%)
                             (- (* ctemp temp)
                                (* stemp
```

```
                                (f2cl-lib:fref a-%data%
                                               (1 i)
                                               ((1 lda) (1 *))
                                               a-%offset%))))
                        (setf (f2cl-lib:fref a-%data%
                                             (1 i)
                                             ((1 lda) (1 *))
                                             a-%offset%)
                              (+ (* stemp temp)
                                 (* ctemp
                                    (f2cl-lib:fref a-%data%
                                                   (1 i)
                                                   ((1 lda) (1 *))
                                                   a-%offset%)))))))))
          ((char-equal direct #\B)
           (f2cl-lib:fdo (j m (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                         ((> j 2) nil)
             (tagbody
               (setf ctemp
                       (f2cl-lib:fref c-%data%
                                      ((f2cl-lib:int-sub j 1))
                                      ((1 *))
                                      c-%offset%))
               (setf stemp
                       (f2cl-lib:fref s-%data%
                                      ((f2cl-lib:int-sub j 1))
                                      ((1 *))
                                      s-%offset%))
               (cond
                 ((or (/= ctemp one) (/= stemp zero))
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                ((> i n) nil)
                    (tagbody
                      (setf temp
                              (f2cl-lib:fref a-%data%
                                             (j i)
                                             ((1 lda) (1 *))
                                             a-%offset%))
                      (setf (f2cl-lib:fref a-%data%
                                           (j i)
                                           ((1 lda) (1 *))
                                           a-%offset%)
                            (- (* ctemp temp)
                               (* stemp
                                  (f2cl-lib:fref a-%data%
                                                 (1 i)
                                                 ((1 lda) (1 *))
                                                 a-%offset%))))
                      (setf (f2cl-lib:fref a-%data%
                                           (1 i)
```

```
                                        ((1 lda) (1 *))
                                        a-%offset%)
                                (+ (* stemp temp)
                                   (* ctemp
                                      (f2cl-lib:fref a-%data%
                                                     (1 i)
                                                     ((1 lda) (1 *))
                                                     a-%offset%)))))))))))))
        ((char-equal pivot #\B)
         (cond
           ((char-equal direct #\F)
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
                           nil)
              (tagbody
                (setf ctemp
                        (f2cl-lib:fref c-%data% (j) ((1 *)) c-%offset%))
                (setf stemp
                        (f2cl-lib:fref s-%data% (j) ((1 *)) s-%offset%))
                (cond
                  ((or (/= ctemp one) (/= stemp zero))
                   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                 ((> i n) nil)
                     (tagbody
                       (setf temp
                               (f2cl-lib:fref a-%data%
                                              (j i)
                                              ((1 lda) (1 *))
                                              a-%offset%))
                       (setf (f2cl-lib:fref a-%data%
                                            (j i)
                                            ((1 lda) (1 *))
                                            a-%offset%)
                               (+
                                (* stemp
                                   (f2cl-lib:fref a-%data%
                                                  (m i)
                                                  ((1 lda) (1 *))
                                                  a-%offset%))
                                (* ctemp temp)))
                       (setf (f2cl-lib:fref a-%data%
                                            (m i)
                                            ((1 lda) (1 *))
                                            a-%offset%)
                               (-
                                (* ctemp
                                   (f2cl-lib:fref a-%data%
                                                  (m i)
                                                  ((1 lda) (1 *))
                                                  a-%offset%))
```

```
                        (* stemp temp)))))))))))
          ((char-equal direct #\B)
           (f2cl-lib:fdo (j (f2cl-lib:int-add m (f2cl-lib:int-sub 1))
                          (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                         ((> j 1) nil)
             (tagbody
               (setf ctemp
                       (f2cl-lib:fref c-%data% (j) ((1 *)) c-%offset%))
               (setf stemp
                       (f2cl-lib:fref s-%data% (j) ((1 *)) s-%offset%))
               (cond
                 ((or (/= ctemp one) (/= stemp zero))
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                ((> i n) nil)
                    (tagbody
                      (setf temp
                              (f2cl-lib:fref a-%data%
                                             (j i)
                                             ((1 lda) (1 *))
                                             a-%offset%))
                      (setf (f2cl-lib:fref a-%data%
                                           (j i)
                                           ((1 lda) (1 *))
                                           a-%offset%)
                              (+
                               (* stemp
                                  (f2cl-lib:fref a-%data%
                                                 (m i)
                                                 ((1 lda) (1 *))
                                                 a-%offset%))
                               (* ctemp temp)))
                      (setf (f2cl-lib:fref a-%data%
                                           (m i)
                                           ((1 lda) (1 *))
                                           a-%offset%)
                              (-
                               (* ctemp
                                  (f2cl-lib:fref a-%data%
                                                 (m i)
                                                 ((1 lda) (1 *))
                                                 a-%offset%))
                               (* stemp temp)))))))))))))
    ((char-equal side #\R)
     (cond
       ((char-equal pivot #\V)
        (cond
          ((char-equal direct #\F)
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j (f2cl-lib:int-add n (f2cl-lib:int-sub 1)))
                          nil)
```

```
   (tagbody
     (setf ctemp
            (f2cl-lib:fref c-%data% (j) ((1 *)) c-%offset%))
     (setf stemp
            (f2cl-lib:fref s-%data% (j) ((1 *)) s-%offset%))
     (cond
       ((or (/= ctemp one) (/= stemp zero))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i m) nil)
          (tagbody
            (setf temp
                    (f2cl-lib:fref a-%data%
                                   (i (f2cl-lib:int-add j 1))
                                   ((1 lda) (1 *))
                                   a-%offset%))
            (setf (f2cl-lib:fref a-%data%
                                 (i (f2cl-lib:int-add j 1))
                                 ((1 lda) (1 *))
                                 a-%offset%)
                  (- (* ctemp temp)
                     (* stemp
                        (f2cl-lib:fref a-%data%
                                       (i j)
                                       ((1 lda) (1 *))
                                       a-%offset%))))
            (setf (f2cl-lib:fref a-%data%
                                 (i j)
                                 ((1 lda) (1 *))
                                 a-%offset%)
                  (+ (* stemp temp)
                     (* ctemp
                        (f2cl-lib:fref a-%data%
                                       (i j)
                                       ((1 lda) (1 *))
                                       a-%offset%)))))))))
   ((char-equal direct #\B)
    (f2cl-lib:fdo (j (f2cl-lib:int-add n (f2cl-lib:int-sub 1))
                   (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                  ((> j 1) nil)
      (tagbody
        (setf ctemp
                (f2cl-lib:fref c-%data% (j) ((1 *)) c-%offset%))
        (setf stemp
                (f2cl-lib:fref s-%data% (j) ((1 *)) s-%offset%))
        (cond
          ((or (/= ctemp one) (/= stemp zero))
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i m) nil)
             (tagbody
               (setf temp
```

```
                        (f2cl-lib:fref a-%data%
                                       (i (f2cl-lib:int-add j 1))
                                       ((1 lda) (1 *))
                                       a-%offset%))
                 (setf (f2cl-lib:fref a-%data%
                                      (i (f2cl-lib:int-add j 1))
                                      ((1 lda) (1 *))
                                      a-%offset%)
                        (- (* ctemp temp)
                           (* stemp
                              (f2cl-lib:fref a-%data%
                                             (i j)
                                             ((1 lda) (1 *))
                                             a-%offset%))))
                 (setf (f2cl-lib:fref a-%data%
                                      (i j)
                                      ((1 lda) (1 *))
                                      a-%offset%)
                        (+ (* stemp temp)
                           (* ctemp
                              (f2cl-lib:fref a-%data%
                                             (i j)
                                             ((1 lda) (1 *))
                                             a-%offset%))))))))))
((char-equal pivot #\T)
 (cond
   ((char-equal direct #\F)
    (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
                  ((> j n) nil)
      (tagbody
        (setf ctemp
                (f2cl-lib:fref c-%data%
                               ((f2cl-lib:int-sub j 1))
                               ((1 *))
                               c-%offset%))
        (setf stemp
                (f2cl-lib:fref s-%data%
                               ((f2cl-lib:int-sub j 1))
                               ((1 *))
                               s-%offset%))
        (cond
          ((or (/= ctemp one) (/= stemp zero))
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                         ((> i m) nil)
             (tagbody
               (setf temp
                       (f2cl-lib:fref a-%data%
                                      (i j)
                                      ((1 lda) (1 *))
                                      a-%offset%))
```

```
                (setf (f2cl-lib:fref a-%data%
                                     (i j)
                                     ((1 lda) (1 *))
                                     a-%offset%)
                      (- (* ctemp temp)
                         (* stemp
                            (f2cl-lib:fref a-%data%
                                           (i 1)
                                           ((1 lda) (1 *))
                                           a-%offset%))))
                (setf (f2cl-lib:fref a-%data%
                                     (i 1)
                                     ((1 lda) (1 *))
                                     a-%offset%)
                      (+ (* stemp temp)
                         (* ctemp
                            (f2cl-lib:fref a-%data%
                                           (i 1)
                                           ((1 lda) (1 *))
                                           a-%offset%))))))))))
((char-equal direct #\B)
 (f2cl-lib:fdo (j n (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
               ((> j 2) nil)
   (tagbody
     (setf ctemp
             (f2cl-lib:fref c-%data%
                            ((f2cl-lib:int-sub j 1))
                            ((1 *))
                            c-%offset%))
     (setf stemp
             (f2cl-lib:fref s-%data%
                            ((f2cl-lib:int-sub j 1))
                            ((1 *))
                            s-%offset%))
     (cond
       ((or (/= ctemp one) (/= stemp zero))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i m) nil)
          (tagbody
            (setf temp
                    (f2cl-lib:fref a-%data%
                                   (i j)
                                   ((1 lda) (1 *))
                                   a-%offset%))
            (setf (f2cl-lib:fref a-%data%
                                 (i j)
                                 ((1 lda) (1 *))
                                 a-%offset%)
                  (- (* ctemp temp)
                     (* stemp
```

```
                                    (f2cl-lib:fref a-%data%
                                                   (i 1)
                                                   ((1 lda) (1 *))
                                                   a-%offset%))))
                        (setf (f2cl-lib:fref a-%data%
                                             (i 1)
                                             ((1 lda) (1 *))
                                             a-%offset%)
                              (+ (* stemp temp)
                                 (* ctemp
                                    (f2cl-lib:fref a-%data%
                                                   (i 1)
                                                   ((1 lda) (1 *))
                                                   a-%offset%))))))))
      ((char-equal pivot #\B)
       (cond
         ((char-equal direct #\F)
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                        ((> j (f2cl-lib:int-add n (f2cl-lib:int-sub 1)))
                         nil)
            (tagbody
              (setf ctemp
                      (f2cl-lib:fref c-%data% (j) ((1 *)) c-%offset%))
              (setf stemp
                      (f2cl-lib:fref s-%data% (j) ((1 *)) s-%offset%))
              (cond
                ((or (/= ctemp one) (/= stemp zero))
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                               ((> i m) nil)
                   (tagbody
                     (setf temp
                             (f2cl-lib:fref a-%data%
                                            (i j)
                                            ((1 lda) (1 *))
                                            a-%offset%))
                     (setf (f2cl-lib:fref a-%data%
                                          (i j)
                                          ((1 lda) (1 *))
                                          a-%offset%)
                           (+
                            (* stemp
                               (f2cl-lib:fref a-%data%
                                              (i n)
                                              ((1 lda) (1 *))
                                              a-%offset%))
                            (* ctemp temp)))
                     (setf (f2cl-lib:fref a-%data%
                                          (i n)
                                          ((1 lda) (1 *))
                                          a-%offset%)
```

```
                                (-
                                 (* ctemp
                                    (f2cl-lib:fref a-%data%
                                                   (i n)
                                                   ((1 lda) (1 *))
                                                   a-%offset%))
                                 (* stemp temp)))))))))))
                        ((char-equal direct #\B)
                         (f2cl-lib:fdo (j (f2cl-lib:int-add n (f2cl-lib:int-sub 1))
                                        (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                                       ((> j 1) nil)
                           (tagbody
                             (setf ctemp
                                    (f2cl-lib:fref c-%data% (j) ((1 *)) c-%offset%))
                             (setf stemp
                                    (f2cl-lib:fref s-%data% (j) ((1 *)) s-%offset%))
                             (cond
                               ((or (/= ctemp one) (/= stemp zero))
                                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                                              ((> i m) nil)
                                  (tagbody
                                    (setf temp
                                            (f2cl-lib:fref a-%data%
                                                           (i j)
                                                           ((1 lda) (1 *))
                                                           a-%offset%))
                                    (setf (f2cl-lib:fref a-%data%
                                                         (i j)
                                                         ((1 lda) (1 *))
                                                         a-%offset%)
                                            (+
                                             (* stemp
                                                (f2cl-lib:fref a-%data%
                                                               (i n)
                                                               ((1 lda) (1 *))
                                                               a-%offset%))
                                             (* ctemp temp)))
                                    (setf (f2cl-lib:fref a-%data%
                                                         (i n)
                                                         ((1 lda) (1 *))
                                                         a-%offset%)
                                            (-
                                             (* ctemp
                                                (f2cl-lib:fref a-%data%
                                                               (i n)
                                                               ((1 lda) (1 *))
                                                               a-%offset%))
                                             (* stemp temp)))))))))))))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil))))))
```

———-

6.77 dlasrt LAPACK

— **dlasrt.input** —

```
)set break resume
)sys rm -f dlasrt.output
)spool dlasrt.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlasrt.help** —

```
=======================================================================
dlasrt examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

NAME
       DLASRT - number in D in increasing order (if ID = 'I') or in decreasing
       order (if ID = 'D' )

SYNOPSIS
       SUBROUTINE DLASRT( ID, N, D, INFO )

           CHARACTER      ID

           INTEGER        INFO, N

           DOUBLE         PRECISION D( * )

  Purpose
  =======
```

```
  Sort the numbers in D in increasing order (if ID = 'I') or
  in decreasing order (if ID = 'D' ).

  Use Quick Sort, reverting to Insertion sort on arrays of
  size <= 20. Dimension of STACK limits N to about 2**32.

  Arguments
  =========

  ID      (input) CHARACTER*1
          = 'I': sort D in increasing order;
          = 'D': sort D in decreasing order.

  N       (input) INTEGER
          The length of the array D.

  D       (input/output) DOUBLE PRECISION array, dimension (N)
          On entry, the array to be sorted.
          On exit, D has been sorted into increasing order
          (D(1) <= ... <= D(N) ) or into decreasing order
          (D(1) >= ... >= D(N) ), depending on ID.

  INFO    (output) INTEGER
          = 0:  successful exit
          < 0:  if INFO = -i, the i-th argument had an illegal value
```

— dlasrt.f —

```
      SUBROUTINE DLASRT( ID, N, D, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     September 30, 1994
*
*     .. Scalar Arguments ..
      CHARACTER          ID
      INTEGER            INFO, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   D( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
```

```
      INTEGER            SELECT
      PARAMETER          ( SELECT = 20 )
*     ..
*     .. Local Scalars ..
      INTEGER            DIR, ENDD, I, J, START, STKPNT
      DOUBLE PRECISION   D1, D2, D3, DMNMX, TMP
*     ..
*     .. Local Arrays ..
      INTEGER            STACK( 2, 32 )
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     ..
*     .. Executable Statements ..
*
*     Test the input paramters.
*
      INFO = 0
      DIR = -1
      IF( LSAME( ID, 'D' ) ) THEN
         DIR = 0
      ELSE IF( LSAME( ID, 'I' ) ) THEN
         DIR = 1
      END IF
      IF( DIR.EQ.-1 ) THEN
         INFO = -1
      ELSE IF( N.LT.0 ) THEN
         INFO = -2
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DLASRT', -INFO )
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( N.LE.1 )
     $   RETURN
*
      STKPNT = 1
      STACK( 1, 1 ) = 1
      STACK( 2, 1 ) = N
   10 CONTINUE
      START = STACK( 1, STKPNT )
      ENDD = STACK( 2, STKPNT )
      STKPNT = STKPNT - 1
```

```
      IF( ENDD-START.LE.SELECT .AND. ENDD-START.GT.0 ) THEN
*
*        Do Insertion sort on D( START:ENDD )
*
         IF( DIR.EQ.0 ) THEN
*
*           Sort into decreasing order
*
            DO 30 I = START + 1, ENDD
               DO 20 J = I, START + 1, -1
                  IF( D( J ).GT.D( J-1 ) ) THEN
                     DMNMX = D( J )
                     D( J ) = D( J-1 )
                     D( J-1 ) = DMNMX
                  ELSE
                     GO TO 30
                  END IF
   20          CONTINUE
   30       CONTINUE
*
         ELSE
*
*           Sort into increasing order
*
            DO 50 I = START + 1, ENDD
               DO 40 J = I, START + 1, -1
                  IF( D( J ).LT.D( J-1 ) ) THEN
                     DMNMX = D( J )
                     D( J ) = D( J-1 )
                     D( J-1 ) = DMNMX
                  ELSE
                     GO TO 50
                  END IF
   40          CONTINUE
   50       CONTINUE
*
         END IF
*
      ELSE IF( ENDD-START.GT.SELECT ) THEN
*
*        Partition D( START:ENDD ) and stack parts, largest one first
*
*        Choose partition entry as median of 3
*
         D1 = D( START )
         D2 = D( ENDD )
         I = ( START+ENDD ) / 2
         D3 = D( I )
         IF( D1.LT.D2 ) THEN
            IF( D3.LT.D1 ) THEN
```

```
               DMNMX = D1
            ELSE IF( D3.LT.D2 ) THEN
               DMNMX = D3
            ELSE
               DMNMX = D2
            END IF
         ELSE
            IF( D3.LT.D2 ) THEN
               DMNMX = D2
            ELSE IF( D3.LT.D1 ) THEN
               DMNMX = D3
            ELSE
               DMNMX = D1
            END IF
         END IF
*
         IF( DIR.EQ.0 ) THEN
*
*           Sort into decreasing order
*
            I = START - 1
            J = ENDD + 1
   60       CONTINUE
   70       CONTINUE
            J = J - 1
            IF( D( J ).LT.DMNMX )
     $         GO TO 70
   80       CONTINUE
            I = I + 1
            IF( D( I ).GT.DMNMX )
     $         GO TO 80
            IF( I.LT.J ) THEN
               TMP = D( I )
               D( I ) = D( J )
               D( J ) = TMP
               GO TO 60
            END IF
            IF( J-START.GT.ENDD-J-1 ) THEN
               STKPNT = STKPNT + 1
               STACK( 1, STKPNT ) = START
               STACK( 2, STKPNT ) = J
               STKPNT = STKPNT + 1
               STACK( 1, STKPNT ) = J + 1
               STACK( 2, STKPNT ) = ENDD
            ELSE
               STKPNT = STKPNT + 1
               STACK( 1, STKPNT ) = J + 1
               STACK( 2, STKPNT ) = ENDD
               STKPNT = STKPNT + 1
               STACK( 1, STKPNT ) = START
```

```
               STACK( 2, STKPNT ) = J
            END IF
         ELSE
*
*           Sort into increasing order
*
            I = START - 1
            J = ENDD + 1
   90       CONTINUE
  100       CONTINUE
            J = J - 1
            IF( D( J ).GT.DMNMX )
     $         GO TO 100
  110       CONTINUE
            I = I + 1
            IF( D( I ).LT.DMNMX )
     $         GO TO 110
            IF( I.LT.J ) THEN
               TMP = D( I )
               D( I ) = D( J )
               D( J ) = TMP
               GO TO 90
            END IF
            IF( J-START.GT.ENDD-J-1 ) THEN
               STKPNT = STKPNT + 1
               STACK( 1, STKPNT ) = START
               STACK( 2, STKPNT ) = J
               STKPNT = STKPNT + 1
               STACK( 1, STKPNT ) = J + 1
               STACK( 2, STKPNT ) = ENDD
            ELSE
               STKPNT = STKPNT + 1
               STACK( 1, STKPNT ) = J + 1
               STACK( 2, STKPNT ) = ENDD
               STKPNT = STKPNT + 1
               STACK( 1, STKPNT ) = START
               STACK( 2, STKPNT ) = J
            END IF
         END IF
      END IF
      IF( STKPNT.GT.0 )
     $   GO TO 10
      RETURN
*
*     End of DLASRT
*
      END
```

— LAPACK dlasrt —

```
(let* ((select 20))
  (declare (type (fixnum 20 20) select))
  (defun dlasrt (id n d info)
    (declare (type (simple-array double-float (*)) d)
             (type fixnum info n)
             (type character id))
    (f2cl-lib:with-multi-array-data
        ((id character id-%data% id-%offset%)
         (d double-float d-%data% d-%offset%))
      (prog ((stack (make-array 64 :element-type 'fixnum)) (d1 0.0)
             (d2 0.0) (d3 0.0) (dmnmx 0.0) (tmp 0.0) (dir 0) (endd 0) (i 0)
             (j 0) (start 0) (stkpnt 0))
        (declare (type (simple-array fixnum (64)) stack)
                 (type (double-float) d1 d2 d3 dmnmx tmp)
                 (type fixnum dir endd i j start stkpnt))
        (setf info 0)
        (setf dir -1)
        (cond
          ((char-equal id #\D)
           (setf dir 0))
          ((char-equal id #\I)
           (setf dir 1)))
        (cond
          ((= dir (f2cl-lib:int-sub 1))
           (setf info -1))
          ((< n 0)
           (setf info -2)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DLASRT" (f2cl-lib:int-sub info))
           (go end_label)))
        (if (<= n 1) (go end_label))
        (setf stkpnt 1)
        (setf (f2cl-lib:fref stack (1 1) ((1 2) (1 32))) 1)
        (setf (f2cl-lib:fref stack (2 1) ((1 2) (1 32))) n)
 label10
        (setf start (f2cl-lib:fref stack (1 stkpnt) ((1 2) (1 32))))
        (setf endd (f2cl-lib:fref stack (2 stkpnt) ((1 2) (1 32))))
        (setf stkpnt (f2cl-lib:int-sub stkpnt 1))
        (cond
          ((and (<= (f2cl-lib:int-add endd (f2cl-lib:int-sub start)) select)
                (> (f2cl-lib:int-add endd (f2cl-lib:int-sub start)) 0))
           (cond
             ((= dir 0)
              (f2cl-lib:fdo (i (f2cl-lib:int-add start 1)
```

```
                          (f2cl-lib:int-add i 1))
                         ((> i endd) nil)
                (tagbody
                  (f2cl-lib:fdo (j i (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                                ((> j (f2cl-lib:int-add start 1)) nil)
                    (tagbody
                      (cond
                        ((> (f2cl-lib:fref d (j) ((1 *)))
                            (f2cl-lib:fref d
                                           ((f2cl-lib:int-add j
                                                              (f2cl-lib:int-sub
                                                               1)))
                                           ((1 *))))
                         (setf dmnmx
                                 (f2cl-lib:fref d-%data%
                                                (j)
                                                ((1 *))
                                                d-%offset%))
                         (setf (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
                                 (f2cl-lib:fref d-%data%
                                                ((f2cl-lib:int-sub j 1))
                                                ((1 *))
                                                d-%offset%))
                         (setf (f2cl-lib:fref d-%data%
                                              ((f2cl-lib:int-sub j 1))
                                              ((1 *))
                                              d-%offset%)
                                 dmnmx))
                        (t
                         (go label30)))))
label30)))
             (t
              (f2cl-lib:fdo (i (f2cl-lib:int-add start 1)
                               (f2cl-lib:int-add i 1))
                            ((> i endd) nil)
                (tagbody
                  (f2cl-lib:fdo (j i (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                                ((> j (f2cl-lib:int-add start 1)) nil)
                    (tagbody
                      (cond
                        ((< (f2cl-lib:fref d (j) ((1 *)))
                            (f2cl-lib:fref d
                                           ((f2cl-lib:int-add j
                                                              (f2cl-lib:int-sub
                                                               1)))
                                           ((1 *))))
                         (setf dmnmx
                                 (f2cl-lib:fref d-%data%
                                                (j)
                                                ((1 *))
```

```
                                        d-%offset%))
                        (setf (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%)
                                (f2cl-lib:fref d-%data%
                                        ((f2cl-lib:int-sub j 1))
                                        ((1 *))
                                        d-%offset%))
                        (setf (f2cl-lib:fref d-%data%
                                             ((f2cl-lib:int-sub j 1))
                                             ((1 *))
                                             d-%offset%)
                                dmnmx))
                       (t
                        (go label50)))))
label50)))))
         ((> (f2cl-lib:int-add endd (f2cl-lib:int-sub start)) select)
          (setf d1 (f2cl-lib:fref d-%data% (start) ((1 *)) d-%offset%))
          (setf d2 (f2cl-lib:fref d-%data% (endd) ((1 *)) d-%offset%))
          (setf i (the fixnum (truncate (+ start endd) 2)))
          (setf d3 (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
          (cond
            ((< d1 d2)
             (cond
               ((< d3 d1)
                (setf dmnmx d1))
               ((< d3 d2)
                (setf dmnmx d3))
               (t
                (setf dmnmx d2))))
            (t
             (cond
               ((< d3 d2)
                (setf dmnmx d2))
               ((< d3 d1)
                (setf dmnmx d3))
               (t
                (setf dmnmx d1)))))
          (cond
            ((= dir 0)
             (tagbody
               (setf i (f2cl-lib:int-sub start 1))
               (setf j (f2cl-lib:int-add endd 1))
label60
               (setf j (f2cl-lib:int-sub j 1))
               (if (< (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%) dmnmx)
                   (go label60))
label80
               (setf i (f2cl-lib:int-add i 1))
               (if (> (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) dmnmx)
                   (go label80))
               (cond
```

```
                ((< i j)
                 (setf tmp (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
                 (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
                         (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%))
                 (setf (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%) tmp)
                 (go label60)))
               (cond
                 ((> (f2cl-lib:int-add j (f2cl-lib:int-sub start))
                     (f2cl-lib:int-add endd
                                       (f2cl-lib:int-sub j)
                                       (f2cl-lib:int-sub 1)))
                  (setf stkpnt (f2cl-lib:int-add stkpnt 1))
                  (setf (f2cl-lib:fref stack (1 stkpnt) ((1 2) (1 32))) start)
                  (setf (f2cl-lib:fref stack (2 stkpnt) ((1 2) (1 32))) j)
                  (setf stkpnt (f2cl-lib:int-add stkpnt 1))
                  (setf (f2cl-lib:fref stack (1 stkpnt) ((1 2) (1 32)))
                          (f2cl-lib:int-add j 1))
                  (setf (f2cl-lib:fref stack (2 stkpnt) ((1 2) (1 32))) endd))
                 (t
                  (setf stkpnt (f2cl-lib:int-add stkpnt 1))
                  (setf (f2cl-lib:fref stack (1 stkpnt) ((1 2) (1 32)))
                          (f2cl-lib:int-add j 1))
                  (setf (f2cl-lib:fref stack (2 stkpnt) ((1 2) (1 32))) endd)
                  (setf stkpnt (f2cl-lib:int-add stkpnt 1))
                  (setf (f2cl-lib:fref stack (1 stkpnt) ((1 2) (1 32))) start)
                  (setf (f2cl-lib:fref stack (2 stkpnt) ((1 2) (1 32))) j)))))
             (t
              (tagbody
                (setf i (f2cl-lib:int-sub start 1))
                (setf j (f2cl-lib:int-add endd 1))
label90
                (setf j (f2cl-lib:int-sub j 1))
                (if (> (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%) dmnmx)
                    (go label90))
label110
                (setf i (f2cl-lib:int-add i 1))
                (if (< (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%) dmnmx)
                    (go label110))
                (cond
                  ((< i j)
                   (setf tmp (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%))
                   (setf (f2cl-lib:fref d-%data% (i) ((1 *)) d-%offset%)
                           (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%))
                   (setf (f2cl-lib:fref d-%data% (j) ((1 *)) d-%offset%) tmp)
                   (go label90)))
                (cond
                  ((> (f2cl-lib:int-add j (f2cl-lib:int-sub start))
                      (f2cl-lib:int-add endd
                                        (f2cl-lib:int-sub j)
                                        (f2cl-lib:int-sub 1)))
```

```
                  (setf stkpnt (f2cl-lib:int-add stkpnt 1))
                  (setf (f2cl-lib:fref stack (1 stkpnt) ((1 2) (1 32))) start)
                  (setf (f2cl-lib:fref stack (2 stkpnt) ((1 2) (1 32))) j)
                  (setf stkpnt (f2cl-lib:int-add stkpnt 1))
                  (setf (f2cl-lib:fref stack (1 stkpnt) ((1 2) (1 32)))
                          (f2cl-lib:int-add j 1))
                  (setf (f2cl-lib:fref stack (2 stkpnt) ((1 2) (1 32))) endd))
                 (t
                  (setf stkpnt (f2cl-lib:int-add stkpnt 1))
                  (setf (f2cl-lib:fref stack (1 stkpnt) ((1 2) (1 32)))
                          (f2cl-lib:int-add j 1))
                  (setf (f2cl-lib:fref stack (2 stkpnt) ((1 2) (1 32))) endd)
                  (setf stkpnt (f2cl-lib:int-add stkpnt 1))
                  (setf (f2cl-lib:fref stack (1 stkpnt) ((1 2) (1 32))) start)
                  (setf (f2cl-lib:fref stack (2 stkpnt) ((1 2) (1 32)))
                          j))))))))
        (if (> stkpnt 0) (go label10))
 end_label
        (return (values nil nil nil info))))))
```

———-

6.78 dlassq LAPACK

— **dlassq.input** —

```
)set break resume
)sys rm -f dlassq.output
)spool dlassq.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlassq.help** —

```
====================================================================
dlassq examples
====================================================================

====================================================================
```

```
Man Page Details
=================================================================

NAME
       DLASSQ  -  the  values  scl and smsq such that   ( scl**2 )*smsq = x( 1
       )**2 +...+ x( n )**2 + ( scale**2 )*sumsq,

SYNOPSIS
       SUBROUTINE DLASSQ( N, X, INCX, SCALE, SUMSQ )

           INTEGER        INCX, N

           DOUBLE         PRECISION SCALE, SUMSQ

           DOUBLE         PRECISION X( * )

  Purpose
  =======

  DLASSQ  returns the values  scl  and  smsq  such that

     ( scl**2 )*smsq = x( 1 )**2 +...+ x( n )**2 + ( scale**2 )*sumsq,

  where  x( i ) = X( 1 + ( i - 1 )*INCX ). The value of  sumsq  is
  assumed to be non-negative and  scl  returns the value

     scl = max( scale, abs( x( i ) ) ).

  scale and sumsq must be supplied in SCALE and SUMSQ and
  scl and smsq are overwritten on SCALE and SUMSQ respectively.

  The routine makes only one pass through the vector x.

  Arguments
  =========

  N       (input) INTEGER
          The number of elements to be used from the vector X.

  X       (input) DOUBLE PRECISION array, dimension (N)
          The vector for which a scaled sum of squares is computed.
             x( i )  = X( 1 + ( i - 1 )*INCX ), 1 <= i <= n.

  INCX    (input) INTEGER
          The increment between successive values of the vector X.
          INCX > 0.

  SCALE   (input/output) DOUBLE PRECISION
          On entry, the value  scale  in the equation above.
          On exit, SCALE is overwritten with  scl , the scaling factor
```

```
          for the sum of squares.

  SUMSQ   (input/output) DOUBLE PRECISION
          On entry, the value  sumsq  in the equation above.
          On exit, SUMSQ is overwritten with  smsq , the basic sum of
          squares from which  scl  has been factored out.
```

— dlassq.f —

```
      SUBROUTINE DLASSQ( N, X, INCX, SCALE, SUMSQ )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      INTEGER            INCX, N
      DOUBLE PRECISION   SCALE, SUMSQ
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   X( * )
*     ..
*
* =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER          ( ZERO = 0.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            IX
      DOUBLE PRECISION   ABSXI
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS
*     ..
*     .. Executable Statements ..
*
      IF( N.GT.0 ) THEN
         DO 10 IX = 1, 1 + ( N-1 )*INCX, INCX
            IF( X( IX ).NE.ZERO ) THEN
               ABSXI = ABS( X( IX ) )
               IF( SCALE.LT.ABSXI ) THEN
                  SUMSQ = 1 + SUMSQ*( SCALE / ABSXI )**2
                  SCALE = ABSXI
```

```
              ELSE
                 SUMSQ = SUMSQ + ( ABSXI / SCALE )**2
              END IF
            END IF
   10    CONTINUE
      END IF
      RETURN
*
*     End of DLASSQ
*
      END
```

———-

— LAPACK dlassq —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dlassq (n x incx scale sumsq)
    (declare (type (double-float) sumsq scale)
             (type (simple-array double-float (*)) x)
             (type fixnum incx n))
    (f2cl-lib:with-multi-array-data
        ((x double-float x-%data% x-%offset%))
      (prog ((absxi 0.0) (ix 0))
        (declare (type (double-float) absxi) (type fixnum ix))
        (cond
          ((> n 0)
           (f2cl-lib:fdo (ix 1 (f2cl-lib:int-add ix incx))
                         ((> ix
                             (f2cl-lib:int-add 1
                                               (f2cl-lib:int-mul
                                                (f2cl-lib:int-add n
                                                 (f2cl-lib:int-sub 1))
                                                incx)))
                          nil)
             (tagbody
               (cond
                 ((/= (f2cl-lib:fref x (ix) ((1 *))) zero)
                  (setf absxi
                          (abs
                           (f2cl-lib:fref x-%data% (ix) ((1 *)) x-%offset%)))
                  (cond
                    ((< scale absxi)
                     (setf sumsq (+ 1 (* sumsq (expt (/ scale absxi) 2))))
                     (setf scale absxi))
                    (t
                     (setf sumsq (+ sumsq (expt (/ absxi scale) 2))))))))))))
```

```
        (return (values nil nil nil scale sumsq))))))
```

———-

6.79 dlasv2 LAPACK

— **dlasv2.input** —

```
)set break resume
)sys rm -f dlasv2.output
)spool dlasv2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlasv2.help** —

```
====================================================================
dlasv2 examples
====================================================================

====================================================================
Man Page Details
====================================================================

NAME
       DLASV2 - the singular value decomposition of a 2-by-2 triangular matrix
       [ F G ]  [ 0 H ]

SYNOPSIS
       SUBROUTINE DLASV2( F, G, H, SSMIN, SSMAX, SNR, CSR, SNL, CSL )

           DOUBLE         PRECISION CSL, CSR, F, G, H, SNL, SNR, SSMAX, SSMIN

  Purpose
  =======

  DLASV2 computes the singular value decomposition of a 2-by-2
  triangular matrix
     [  F   G  ]
```

```
   [  0   H  ].
On return, abs(SSMAX) is the larger singular value, abs(SSMIN) is the
smaller singular value, and (CSL,SNL) and (CSR,SNR) are the left and
right singular vectors for abs(SSMAX), giving the decomposition

   [ CSL  SNL ] [  F   G  ] [ CSR -SNR ]  =  [ SSMAX   0   ]
   [-SNL  CSL ] [  0   H  ] [ SNR  CSR ]     [  0    SSMIN ].

Arguments
=========

F       (input) DOUBLE PRECISION
        The (1,1) element of the 2-by-2 matrix.

G       (input) DOUBLE PRECISION
        The (1,2) element of the 2-by-2 matrix.

H       (input) DOUBLE PRECISION
        The (2,2) element of the 2-by-2 matrix.

SSMIN   (output) DOUBLE PRECISION
        abs(SSMIN) is the smaller singular value.

SSMAX   (output) DOUBLE PRECISION
        abs(SSMAX) is the larger singular value.

SNL     (output) DOUBLE PRECISION
CSL     (output) DOUBLE PRECISION
        The vector (CSL, SNL) is a unit left singular vector for the
        singular value abs(SSMAX).

SNR     (output) DOUBLE PRECISION
CSR     (output) DOUBLE PRECISION
        The vector (CSR, SNR) is a unit right singular vector for the
        singular value abs(SSMAX).

Further Details
===============

Any input parameter may be aliased with any output parameter.

Barring over/underflow and assuming a guard digit in subtraction, all
output quantities are correct to within a few units in the last
place (ulps).

In IEEE arithmetic, the code works correctly if one matrix element is
infinite.

Overflow will not occur unless the largest singular value itself
overflows or is within a few ulps of overflow. (On machines with
```

```
  partial overflow, like the Cray, overflow may occur if the largest
  singular value is within a factor of 2 of overflow.)

  Underflow is harmless if underflow is gradual. Otherwise, results
  may correspond to a matrix modified by perturbations of size near
  the underflow threshold.
```

— dlasv2.f —

```
      SUBROUTINE DLASV2( F, G, H, SSMIN, SSMAX, SNR, CSR, SNL, CSL )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1992
*
*     .. Scalar Arguments ..
      DOUBLE PRECISION   CSL, CSR, F, G, H, SNL, SNR, SSMAX, SSMIN
*     ..
*
* =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER          ( ZERO = 0.0D0 )
      DOUBLE PRECISION   HALF
      PARAMETER          ( HALF = 0.5D0 )
      DOUBLE PRECISION   ONE
      PARAMETER          ( ONE = 1.0D0 )
      DOUBLE PRECISION   TWO
      PARAMETER          ( TWO = 2.0D0 )
      DOUBLE PRECISION   FOUR
      PARAMETER          ( FOUR = 4.0D0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            GASMAL, SWAP
      INTEGER            PMAX
      DOUBLE PRECISION   A, CLT, CRT, D, FA, FT, GA, GT, HA, HT, L, M,
     $                   MM, R, S, SLT, SRT, T, TEMP, TSIGN, TT
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, SIGN, SQRT
*     ..
*     .. External Functions ..
      DOUBLE PRECISION   DLAMCH
      EXTERNAL           DLAMCH
```

```
*     ..
*     .. Executable Statements ..
*
      FT = F
      FA = ABS( FT )
      HT = H
      HA = ABS( H )
*
*     PMAX points to the maximum absolute element of matrix
*       PMAX = 1 if F largest in absolute values
*       PMAX = 2 if G largest in absolute values
*       PMAX = 3 if H largest in absolute values
*
      PMAX = 1
      SWAP = ( HA.GT.FA )
      IF( SWAP ) THEN
         PMAX = 3
         TEMP = FT
         FT = HT
         HT = TEMP
         TEMP = FA
         FA = HA
         HA = TEMP
*
*        Now FA .ge. HA
*
      END IF
      GT = G
      GA = ABS( GT )
      IF( GA.EQ.ZERO ) THEN
*
*        Diagonal matrix
*
         SSMIN = HA
         SSMAX = FA
         CLT = ONE
         CRT = ONE
         SLT = ZERO
         SRT = ZERO
      ELSE
         GASMAL = .TRUE.
         IF( GA.GT.FA ) THEN
            PMAX = 2
            IF( ( FA / GA ).LT.DLAMCH( 'EPS' ) ) THEN
*
*              Case of very large GA
*
               GASMAL = .FALSE.
               SSMAX = GA
               IF( HA.GT.ONE ) THEN
```

```
                  SSMIN = FA / ( GA / HA )
               ELSE
                  SSMIN = ( FA / GA )*HA
               END IF
               CLT = ONE
               SLT = HT / GT
               SRT = ONE
               CRT = FT / GT
            END IF
         END IF
         IF( GASMAL ) THEN
*
*           Normal case
*
            D = FA - HA
            IF( D.EQ.FA ) THEN
*
*              Copes with infinite F or H
*
               L = ONE
            ELSE
               L = D / FA
            END IF
*
*           Note that 0 .le. L .le. 1
*
            M = GT / FT
*
*           Note that abs(M) .le. 1/macheps
*
            T = TWO - L
*
*           Note that T .ge. 1
*
            MM = M*M
            TT = T*T
            S = SQRT( TT+MM )
*
*           Note that 1 .le. S .le. 1 + 1/macheps
*
            IF( L.EQ.ZERO ) THEN
               R = ABS( M )
            ELSE
               R = SQRT( L*L+MM )
            END IF
*
*           Note that 0 .le. R .le. 1 + 1/macheps
*
            A = HALF*( S+R )
*
```

```
*           Note that 1 .le. A .le. 1 + abs(M)
*
            SSMIN = HA / A
            SSMAX = FA*A
            IF( MM.EQ.ZERO ) THEN
*
*              Note that M is very tiny
*
               IF( L.EQ.ZERO ) THEN
                  T = SIGN( TWO, FT )*SIGN( ONE, GT )
               ELSE
                  T = GT / SIGN( D, FT ) + M / T
               END IF
            ELSE
               T = ( M / ( S+T )+M / ( R+L ) )*( ONE+A )
            END IF
            L = SQRT( T*T+FOUR )
            CRT = TWO / L
            SRT = T / L
            CLT = ( CRT+SRT*M ) / A
            SLT = ( HT / FT )*SRT / A
         END IF
      END IF
      IF( SWAP ) THEN
         CSL = SRT
         SNL = CRT
         CSR = SLT
         SNR = CLT
      ELSE
         CSL = CLT
         SNL = SLT
         CSR = CRT
         SNR = SRT
      END IF
*
*     Correct signs of SSMAX and SSMIN
*
      IF( PMAX.EQ.1 )
     $   TSIGN = SIGN( ONE, CSR )*SIGN( ONE, CSL )*SIGN( ONE, F )
      IF( PMAX.EQ.2 )
     $   TSIGN = SIGN( ONE, SNR )*SIGN( ONE, CSL )*SIGN( ONE, G )
      IF( PMAX.EQ.3 )
     $   TSIGN = SIGN( ONE, SNR )*SIGN( ONE, SNL )*SIGN( ONE, H )
      SSMAX = SIGN( SSMAX, TSIGN )
      SSMIN = SIGN( SSMIN, TSIGN*SIGN( ONE, F )*SIGN( ONE, H ) )
      RETURN
*
*     End of DLASV2
*
      END
```

———-

— LAPACK dlasv2 —

```
(let* ((zero 0.0) (half 0.5) (one 1.0) (two 2.0) (four 4.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 0.5 0.5) half)
           (type (double-float 1.0 1.0) one)
           (type (double-float 2.0 2.0) two)
           (type (double-float 4.0 4.0) four))
  (defun dlasv2 (f g h ssmin ssmax snr csr snl csl)
    (declare (type (double-float) csl snl csr snr ssmax ssmin h g f))
    (prog ((a 0.0) (clt 0.0) (crt 0.0) (d 0.0) (fa 0.0) (ft 0.0) (ga 0.0)
           (gt 0.0) (ha 0.0) (ht 0.0) (l 0.0) (m 0.0) (mm 0.0) (r 0.0) (s 0.0)
           (slt 0.0) (srt 0.0) (t$ 0.0) (temp 0.0) (tsign 0.0) (tt 0.0)
           (pmax 0) (gasmal nil) (swap nil))
      (declare (type (double-float) a clt crt d fa ft ga gt ha ht l m mm r s
                                    slt srt t$ temp tsign tt)
               (type fixnum pmax)
               (type (member t nil) gasmal swap))
      (setf ft f)
      (setf fa (abs ft))
      (setf ht h)
      (setf ha (abs h))
      (setf pmax 1)
      (setf swap (> ha fa))
      (cond
        (swap
         (setf pmax 3)
         (setf temp ft)
         (setf ft ht)
         (setf ht temp)
         (setf temp fa)
         (setf fa ha)
         (setf ha temp)))
      (setf gt g)
      (setf ga (abs gt))
      (cond
        ((= ga zero)
         (setf ssmin ha)
         (setf ssmax fa)
         (setf clt one)
         (setf crt one)
         (setf slt zero)
         (setf srt zero))
        (t
         (setf gasmal t)
```

```
(cond
  ((> ga fa)
   (setf pmax 2)
   (cond
     ((< (f2cl-lib:f2cl/ fa ga) (dlamch "EPS"))
      (setf gasmal nil)
      (setf ssmax ga)
      (cond
        ((> ha one)
         (setf ssmin (/ fa (/ ga ha))))
        (t
         (setf ssmin (* (/ fa ga) ha))))
      (setf clt one)
      (setf slt (/ ht gt))
      (setf srt one)
      (setf crt (/ ft gt))))))
(cond
  (gasmal
   (setf d (- fa ha))
   (cond
     ((= d fa)
      (setf l one))
     (t
      (setf l (/ d fa))))
   (setf m (/ gt ft))
   (setf t$ (- two l))
   (setf mm (* m m))
   (setf tt (* t$ t$))
   (setf s (f2cl-lib:fsqrt (+ tt mm)))
   (cond
     ((= l zero)
      (setf r (abs m)))
     (t
      (setf r (f2cl-lib:fsqrt (+ (* l l) mm)))))
   (setf a (* half (+ s r)))
   (setf ssmin (/ ha a))
   (setf ssmax (* fa a))
   (cond
     ((= mm zero)
      (cond
        ((= l zero)
         (setf t$ (* (f2cl-lib:sign two ft) (f2cl-lib:sign one gt))))
        (t
         (setf t$ (+ (/ gt (f2cl-lib:sign d ft)) (/ m t$))))))
     (t
      (setf t$ (* (+ (/ m (+ s t$)) (/ m (+ r l))) (+ one a)))))
   (setf l (f2cl-lib:fsqrt (+ (* t$ t$) four)))
   (setf crt (/ two l))
   (setf srt (/ t$ l))
   (setf clt (/ (+ crt (* srt m)) a))
```

```
          (setf slt (/ (* (/ ht ft) srt) a))))))
      (cond
        (swap
         (setf csl srt)
         (setf snl crt)
         (setf csr slt)
         (setf snr clt))
        (t
         (setf csl clt)
         (setf snl slt)
         (setf csr crt)
         (setf snr srt)))
      (if (= pmax 1)
          (setf tsign
                  (* (f2cl-lib:sign one csr)
                     (f2cl-lib:sign one csl)
                     (f2cl-lib:sign one f))))
      (if (= pmax 2)
          (setf tsign
                  (* (f2cl-lib:sign one snr)
                     (f2cl-lib:sign one csl)
                     (f2cl-lib:sign one g))))
      (if (= pmax 3)
          (setf tsign
                  (* (f2cl-lib:sign one snr)
                     (f2cl-lib:sign one snl)
                     (f2cl-lib:sign one h))))
      (setf ssmax (f2cl-lib:sign ssmax tsign))
      (setf ssmin
              (f2cl-lib:sign ssmin
                             (* tsign
                                (f2cl-lib:sign one f)
                                (f2cl-lib:sign one h))))
      (return (values nil nil nil ssmin ssmax snr csr snl csl)))))
```

———-

6.80 dlaswp LAPACK

— dlaswp.input —

```
)set break resume
)sys rm -f dlaswp.output
)spool dlaswp.output
)set message test on
)set message auto off
```

```
)clear all

)spool
)lisp (bye)
```

———-

— dlaswp.help —

```
===========================================================================
dlaswp examples
===========================================================================

===========================================================================
Man Page Details
===========================================================================

NAME
       DLASWP - a series of row interchanges on the matrix A

SYNOPSIS
       SUBROUTINE DLASWP( N, A, LDA, K1, K2, IPIV, INCX )

           INTEGER        INCX, K1, K2, LDA, N

           INTEGER        IPIV( * )

           DOUBLE         PRECISION A( LDA, * )

  Purpose
  =======

  DLASWP performs a series of row interchanges on the matrix A.
  One row interchange is initiated for each of rows K1 through K2 of A.

  Arguments
  =========

  N       (input) INTEGER
          The number of columns of the matrix A.

  A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
          On entry, the matrix of column dimension N to which the row
          interchanges will be applied.
          On exit, the permuted matrix.

  LDA     (input) INTEGER
          The leading dimension of the array A.
```

```
  K1      (input) INTEGER
          The first element of IPIV for which a row interchange will
          be done.

  K2      (input) INTEGER
          The last element of IPIV for which a row interchange will
          be done.

  IPIV    (input) INTEGER array, dimension (M*abs(INCX))
          The vector of pivot indices.  Only the elements in positions
          K1 through K2 of IPIV are accessed.
          IPIV(K) = L implies rows K and L are to be interchanged.

  INCX    (input) INTEGER
          The increment between successive values of IPIV.  If IPIV
          is negative, the pivots are applied in reverse order.

  Further Details
  ===============

  Modified by
   R. C. Whaley, Computer Science Dept., Univ. of Tenn., Knoxville, USA
```

———-

— dlaswp.f —

```
      SUBROUTINE DLASWP( N, A, LDA, K1, K2, IPIV, INCX )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      INTEGER            INCX, K1, K2, LDA, N
*     ..
*     .. Array Arguments ..
      INTEGER            IPIV( * )
      DOUBLE PRECISION   A( LDA, * )
*     ..
*
* =====================================================================
*
*     .. Local Scalars ..
      INTEGER            I, I1, I2, INC, IP, IX, IX0, J, K, N32
      DOUBLE PRECISION   TEMP
*     ..
```

```
*     .. Executable Statements ..
*
*     Interchange row I with row IPIV(I) for each of rows K1 through K2.
*
      IF( INCX.GT.0 ) THEN
         IX0 = K1
         I1 = K1
         I2 = K2
         INC = 1
      ELSE IF( INCX.LT.0 ) THEN
         IX0 = 1 + ( 1-K2 )*INCX
         I1 = K2
         I2 = K1
         INC = -1
      ELSE
         RETURN
      END IF
*
      N32 = ( N / 32 )*32
      IF( N32.NE.0 ) THEN
         DO 30 J = 1, N32, 32
            IX = IX0
            DO 20 I = I1, I2, INC
               IP = IPIV( IX )
               IF( IP.NE.I ) THEN
                  DO 10 K = J, J + 31
                     TEMP = A( I, K )
                     A( I, K ) = A( IP, K )
                     A( IP, K ) = TEMP
   10             CONTINUE
               END IF
               IX = IX + INCX
   20       CONTINUE
   30    CONTINUE
      END IF
      IF( N32.NE.N ) THEN
         N32 = N32 + 1
         IX = IX0
         DO 50 I = I1, I2, INC
            IP = IPIV( IX )
            IF( IP.NE.I ) THEN
               DO 40 K = N32, N
                  TEMP = A( I, K )
                  A( I, K ) = A( IP, K )
                  A( IP, K ) = TEMP
   40          CONTINUE
            END IF
            IX = IX + INCX
   50    CONTINUE
      END IF
```

```
*
      RETURN
*
*     End of DLASWP
*
      END
```

— LAPACK dlaswp —

```
(defun dlaswp (n a lda k1 k2 ipiv incx)
  (declare (type (simple-array fixnum (*)) ipiv)
           (type (simple-array double-float (*)) a)
           (type fixnum incx k2 k1 lda n))
  (f2cl-lib:with-multi-array-data
      ((a double-float a-%data% a-%offset%)
       (ipiv fixnum ipiv-%data% ipiv-%offset%))
    (prog ((temp 0.0) (i 0) (i1 0) (i2 0) (inc 0) (ip 0) (ix 0) (ix0 0) (j 0)
           (k 0) (n32 0))
      (declare (type fixnum n32 k j ix0 ix ip inc i2 i1 i)
               (type (double-float) temp))
      (cond
        ((> incx 0)
         (setf ix0 k1)
         (setf i1 k1)
         (setf i2 k2)
         (setf inc 1))
        ((< incx 0)
         (setf ix0
                 (f2cl-lib:int-add 1
                                   (f2cl-lib:int-mul (f2cl-lib:int-sub 1 k2)
                                                     incx)))
         (setf i1 k2)
         (setf i2 k1)
         (setf inc -1))
        (t
         (go end_label)))
      (setf n32 (* (the fixnum (truncate n 32)) 32))
      (cond
        ((/= n32 0)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 32))
                       ((> j n32) nil)
           (tagbody
             (setf ix ix0)
             (f2cl-lib:fdo (i i1 (f2cl-lib:int-add i inc))
                           ((> i i2) nil)
               (tagbody
```

```
              (setf ip
                      (f2cl-lib:fref ipiv-%data%
                                     (ix)
                                     ((1 *))
                                     ipiv-%offset%))
              (cond
                ((/= ip i)
                 (f2cl-lib:fdo (k j (f2cl-lib:int-add k 1))
                               ((> k (f2cl-lib:int-add j 31)) nil)
                   (tagbody
                     (setf temp
                             (f2cl-lib:fref a-%data%
                                            (i k)
                                            ((1 lda) (1 *))
                                            a-%offset%))
                     (setf (f2cl-lib:fref a-%data%
                                          (i k)
                                          ((1 lda) (1 *))
                                          a-%offset%)
                             (f2cl-lib:fref a-%data%
                                            (ip k)
                                            ((1 lda) (1 *))
                                            a-%offset%))
                     (setf (f2cl-lib:fref a-%data%
                                          (ip k)
                                          ((1 lda) (1 *))
                                          a-%offset%)
                           temp)))))
              (setf ix (f2cl-lib:int-add ix incx))))))))
(cond
  ((/= n32 n)
   (setf n32 (f2cl-lib:int-add n32 1))
   (setf ix ix0)
   (f2cl-lib:fdo (i i1 (f2cl-lib:int-add i inc))
                 ((> i i2) nil)
     (tagbody
       (setf ip (f2cl-lib:fref ipiv-%data% (ix) ((1 *)) ipiv-%offset%))
       (cond
         ((/= ip i)
          (f2cl-lib:fdo (k n32 (f2cl-lib:int-add k 1))
                        ((> k n) nil)
            (tagbody
              (setf temp
                      (f2cl-lib:fref a-%data%
                                     (i k)
                                     ((1 lda) (1 *))
                                     a-%offset%))
              (setf (f2cl-lib:fref a-%data%
                                   (i k)
                                   ((1 lda) (1 *))
```

```
                                        a-%offset%)
                                (f2cl-lib:fref a-%data%
                                               (ip k)
                                               ((1 lda) (1 *))
                                               a-%offset%))
                        (setf (f2cl-lib:fref a-%data%
                                             (ip k)
                                             ((1 lda) (1 *))
                                             a-%offset%)
                                temp)))))
                  (setf ix (f2cl-lib:int-add ix incx))))))
 end_label
      (return (values nil nil nil nil nil nil nil)))))
```

———-

6.81 dlasy2 LAPACK

— **dlasy2.input** —

```
)set break resume
)sys rm -f dlasy2.output
)spool dlasy2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dlasy2.help** —

```
========================================================================
dlasy2 examples
========================================================================

========================================================================
Man Page Details
========================================================================

NAME
       DLASY2  -  for  the N1 by N2 matrix X, 1 <= N1,N2 <= 2, in   op(TL)*X +
       ISGN*X*op(TR) = SCALE*B,
```

```
SYNOPSIS
      SUBROUTINE DLASY2( LTRANL, LTRANR, ISGN, N1, N2, TL, LDTL, TR, LDTR, B,
                         LDB, SCALE, X, LDX, XNORM, INFO )

          LOGICAL        LTRANL, LTRANR

          INTEGER        INFO, ISGN, LDB, LDTL, LDTR, LDX, N1, N2

          DOUBLE         PRECISION SCALE, XNORM

          DOUBLE         PRECISION B( LDB, * ), TL( LDTL, * ), TR( LDTR, * ),
                         X( LDX, * )

  Purpose
  =======

  DLASY2 solves for the N1 by N2 matrix X, 1 <= N1,N2 <= 2, in

         op(TL)*X + ISGN*X*op(TR) = SCALE*B,

  where TL is N1 by N1, TR is N2 by N2, B is N1 by N2, and ISGN = 1 or
  -1.  op(T) = T or T', where T' denotes the transpose of T.

  Arguments
  =========

  LTRANL  (input) LOGICAL
          On entry, LTRANL specifies the op(TL):
             = .FALSE., op(TL) = TL,
             = .TRUE., op(TL) = TL'.

  LTRANR  (input) LOGICAL
          On entry, LTRANR specifies the op(TR):
            = .FALSE., op(TR) = TR,
            = .TRUE., op(TR) = TR'.

  ISGN    (input) INTEGER
          On entry, ISGN specifies the sign of the equation
          as described before. ISGN may only be 1 or -1.

  N1      (input) INTEGER
          On entry, N1 specifies the order of matrix TL.
          N1 may only be 0, 1 or 2.

  N2      (input) INTEGER
          On entry, N2 specifies the order of matrix TR.
          N2 may only be 0, 1 or 2.

  TL      (input) DOUBLE PRECISION array, dimension (LDTL,2)
```

```
          On entry, TL contains an N1 by N1 matrix.

  LDTL    (input) INTEGER
          The leading dimension of the matrix TL. LDTL >= max(1,N1).

  TR      (input) DOUBLE PRECISION array, dimension (LDTR,2)
          On entry, TR contains an N2 by N2 matrix.

  LDTR    (input) INTEGER
          The leading dimension of the matrix TR. LDTR >= max(1,N2).

  B       (input) DOUBLE PRECISION array, dimension (LDB,2)
          On entry, the N1 by N2 matrix B contains the right-hand
          side of the equation.

  LDB     (input) INTEGER
          The leading dimension of the matrix B. LDB >= max(1,N1).

  SCALE   (output) DOUBLE PRECISION
          On exit, SCALE contains the scale factor. SCALE is chosen
          less than or equal to 1 to prevent the solution overflowing.

  X       (output) DOUBLE PRECISION array, dimension (LDX,2)
          On exit, X contains the N1 by N2 solution.

  LDX     (input) INTEGER
          The leading dimension of the matrix X. LDX >= max(1,N1).

  XNORM   (output) DOUBLE PRECISION
          On exit, XNORM is the infinity-norm of the solution.

  INFO    (output) INTEGER
          On exit, INFO is set to
             0: successful exit.
             1: TL and TR have too close eigenvalues, so TL or
                TR is perturbed to get a nonsingular equation.
          NOTE: In the interests of speed, this routine does not
                check the inputs for errors.
```

— dlasy2.f —

```
      SUBROUTINE DLASY2( LTRANL, LTRANR, ISGN, N1, N2, TL, LDTL, TR,
     $                   LDTR, B, LDB, SCALE, X, LDX, XNORM, INFO )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
```

```
*     Courant Institute, Argonne National Lab, and Rice University
*     October 31, 1992
*
*     .. Scalar Arguments ..
      LOGICAL            LTRANL, LTRANR
      INTEGER            INFO, ISGN, LDB, LDTL, LDTR, LDX, N1, N2
      DOUBLE PRECISION   SCALE, XNORM
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   B( LDB, * ), TL( LDTL, * ), TR( LDTR, * ),
     $                   X( LDX, * )
*     ..
*
* =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0 )
      DOUBLE PRECISION   TWO, HALF, EIGHT
      PARAMETER          ( TWO = 2.0D+0, HALF = 0.5D+0, EIGHT = 8.0D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            BSWAP, XSWAP
      INTEGER            I, IP, IPIV, IPSV, J, JP, JPSV, K
      DOUBLE PRECISION   BET, EPS, GAM, L21, SGN, SMIN, SMLNUM, TAU1,
     $                   TEMP, U11, U12, U22, XMAX
*     ..
*     .. Local Arrays ..
      LOGICAL            BSWPIV( 4 ), XSWPIV( 4 )
      INTEGER            JPIV( 4 ), LOCL21( 4 ), LOCU12( 4 ),
     $                   LOCU22( 4 )
      DOUBLE PRECISION   BTMP( 4 ), T16( 4, 4 ), TMP( 4 ), X2( 2 )
*     ..
*     .. External Functions ..
      INTEGER            IDAMAX
      DOUBLE PRECISION   DLAMCH
      EXTERNAL           IDAMAX, DLAMCH
*     ..
*     .. External Subroutines ..
      EXTERNAL           DCOPY, DSWAP
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX
*     ..
*     .. Data statements ..
      DATA               LOCU12 / 3, 4, 1, 2 / , LOCL21 / 2, 1, 4, 3 / ,
     $                   LOCU22 / 4, 3, 2, 1 /
      DATA               XSWPIV / .FALSE., .FALSE., .TRUE., .TRUE. /
      DATA               BSWPIV / .FALSE., .TRUE., .FALSE., .TRUE. /
*     ..
```

```
*     .. Executable Statements ..
*
*     Do not check the input parameters for errors
*
      INFO = 0
*
*     Quick return if possible
*
      IF( N1.EQ.0 .OR. N2.EQ.0 )
     $   RETURN
*
*     Set constants to control overflow
*
      EPS = DLAMCH( 'P' )
      SMLNUM = DLAMCH( 'S' ) / EPS
      SGN = ISGN
*
      K = N1 + N1 + N2 - 2
      GO TO ( 10, 20, 30, 50 )K
*
*     1 by 1: TL11*X + SGN*X*TR11 = B11
*
   10 CONTINUE
      TAU1 = TL( 1, 1 ) + SGN*TR( 1, 1 )
      BET = ABS( TAU1 )
      IF( BET.LE.SMLNUM ) THEN
         TAU1 = SMLNUM
         BET = SMLNUM
         INFO = 1
      END IF
*
      SCALE = ONE
      GAM = ABS( B( 1, 1 ) )
      IF( SMLNUM*GAM.GT.BET )
     $   SCALE = ONE / GAM
*
      X( 1, 1 ) = ( B( 1, 1 )*SCALE ) / TAU1
      XNORM = ABS( X( 1, 1 ) )
      RETURN
*
*     1 by 2:
*     TL11*[X11 X12] + ISGN*[X11 X12]*op[TR11 TR12]  = [B11 B12]
*                                       [TR21 TR22]
*
   20 CONTINUE
*
      SMIN = MAX( EPS*MAX( ABS( TL( 1, 1 ) ), ABS( TR( 1, 1 ) ),
     $       ABS( TR( 1, 2 ) ), ABS( TR( 2, 1 ) ), ABS( TR( 2, 2 ) ) ),
     $       SMLNUM )
      TMP( 1 ) = TL( 1, 1 ) + SGN*TR( 1, 1 )
```

```
      TMP( 4 ) = TL( 1, 1 ) + SGN*TR( 2, 2 )
      IF( LTRANR ) THEN
         TMP( 2 ) = SGN*TR( 2, 1 )
         TMP( 3 ) = SGN*TR( 1, 2 )
      ELSE
         TMP( 2 ) = SGN*TR( 1, 2 )
         TMP( 3 ) = SGN*TR( 2, 1 )
      END IF
      BTMP( 1 ) = B( 1, 1 )
      BTMP( 2 ) = B( 1, 2 )
      GO TO 40
*
*     2 by 1:
*          op[TL11 TL12]*[X11] + ISGN* [X11]*TR11  = [B11]
*            [TL21 TL22] [X21]         [X21]         [B21]
*
   30 CONTINUE
      SMIN = MAX( EPS*MAX( ABS( TR( 1, 1 ) ), ABS( TL( 1, 1 ) ),
     $       ABS( TL( 1, 2 ) ), ABS( TL( 2, 1 ) ), ABS( TL( 2, 2 ) ) ),
     $       SMLNUM )
      TMP( 1 ) = TL( 1, 1 ) + SGN*TR( 1, 1 )
      TMP( 4 ) = TL( 2, 2 ) + SGN*TR( 1, 1 )
      IF( LTRANL ) THEN
         TMP( 2 ) = TL( 1, 2 )
         TMP( 3 ) = TL( 2, 1 )
      ELSE
         TMP( 2 ) = TL( 2, 1 )
         TMP( 3 ) = TL( 1, 2 )
      END IF
      BTMP( 1 ) = B( 1, 1 )
      BTMP( 2 ) = B( 2, 1 )
   40 CONTINUE
*
*     Solve 2 by 2 system using complete pivoting.
*     Set pivots less than SMIN to SMIN.
*
      IPIV = IDAMAX( 4, TMP, 1 )
      U11 = TMP( IPIV )
      IF( ABS( U11 ).LE.SMIN ) THEN
         INFO = 1
         U11 = SMIN
      END IF
      U12 = TMP( LOCU12( IPIV ) )
      L21 = TMP( LOCL21( IPIV ) ) / U11
      U22 = TMP( LOCU22( IPIV ) ) - U12*L21
      XSWAP = XSWPIV( IPIV )
      BSWAP = BSWPIV( IPIV )
      IF( ABS( U22 ).LE.SMIN ) THEN
         INFO = 1
         U22 = SMIN
```

```
      END IF
      IF( BSWAP ) THEN
         TEMP = BTMP( 2 )
         BTMP( 2 ) = BTMP( 1 ) - L21*TEMP
         BTMP( 1 ) = TEMP
      ELSE
         BTMP( 2 ) = BTMP( 2 ) - L21*BTMP( 1 )
      END IF
      SCALE = ONE
      IF( ( TWO*SMLNUM )*ABS( BTMP( 2 ) ).GT.ABS( U22 ) .OR.
     $    ( TWO*SMLNUM )*ABS( BTMP( 1 ) ).GT.ABS( U11 ) ) THEN
         SCALE = HALF / MAX( ABS( BTMP( 1 ) ), ABS( BTMP( 2 ) ) )
         BTMP( 1 ) = BTMP( 1 )*SCALE
         BTMP( 2 ) = BTMP( 2 )*SCALE
      END IF
      X2( 2 ) = BTMP( 2 ) / U22
      X2( 1 ) = BTMP( 1 ) / U11 - ( U12 / U11 )*X2( 2 )
      IF( XSWAP ) THEN
         TEMP = X2( 2 )
         X2( 2 ) = X2( 1 )
         X2( 1 ) = TEMP
      END IF
      X( 1, 1 ) = X2( 1 )
      IF( N1.EQ.1 ) THEN
         X( 1, 2 ) = X2( 2 )
         XNORM = ABS( X( 1, 1 ) ) + ABS( X( 1, 2 ) )
      ELSE
         X( 2, 1 ) = X2( 2 )
         XNORM = MAX( ABS( X( 1, 1 ) ), ABS( X( 2, 1 ) ) )
      END IF
      RETURN
*
*     2 by 2:
*     op[TL11 TL12]*[X11 X12] +ISGN* [X11 X12]*op[TR11 TR12] = [B11 B12]
*       [TL21 TL22] [X21 X22]        [X21 X22]   [TR21 TR22]   [B21 B22]
*
*     Solve equivalent 4 by 4 system using complete pivoting.
*     Set pivots less than SMIN to SMIN.
*
   50 CONTINUE
      SMIN = MAX( ABS( TR( 1, 1 ) ), ABS( TR( 1, 2 ) ),
     $       ABS( TR( 2, 1 ) ), ABS( TR( 2, 2 ) ) )
      SMIN = MAX( SMIN, ABS( TL( 1, 1 ) ), ABS( TL( 1, 2 ) ),
     $       ABS( TL( 2, 1 ) ), ABS( TL( 2, 2 ) ) )
      SMIN = MAX( EPS*SMIN, SMLNUM )
      BTMP( 1 ) = ZERO
      CALL DCOPY( 16, BTMP, 0, T16, 1 )
      T16( 1, 1 ) = TL( 1, 1 ) + SGN*TR( 1, 1 )
      T16( 2, 2 ) = TL( 2, 2 ) + SGN*TR( 1, 1 )
      T16( 3, 3 ) = TL( 1, 1 ) + SGN*TR( 2, 2 )
```

```
      T16( 4, 4 ) = TL( 2, 2 ) + SGN*TR( 2, 2 )
      IF( LTRANL ) THEN
         T16( 1, 2 ) = TL( 2, 1 )
         T16( 2, 1 ) = TL( 1, 2 )
         T16( 3, 4 ) = TL( 2, 1 )
         T16( 4, 3 ) = TL( 1, 2 )
      ELSE
         T16( 1, 2 ) = TL( 1, 2 )
         T16( 2, 1 ) = TL( 2, 1 )
         T16( 3, 4 ) = TL( 1, 2 )
         T16( 4, 3 ) = TL( 2, 1 )
      END IF
      IF( LTRANR ) THEN
         T16( 1, 3 ) = SGN*TR( 1, 2 )
         T16( 2, 4 ) = SGN*TR( 1, 2 )
         T16( 3, 1 ) = SGN*TR( 2, 1 )
         T16( 4, 2 ) = SGN*TR( 2, 1 )
      ELSE
         T16( 1, 3 ) = SGN*TR( 2, 1 )
         T16( 2, 4 ) = SGN*TR( 2, 1 )
         T16( 3, 1 ) = SGN*TR( 1, 2 )
         T16( 4, 2 ) = SGN*TR( 1, 2 )
      END IF
      BTMP( 1 ) = B( 1, 1 )
      BTMP( 2 ) = B( 2, 1 )
      BTMP( 3 ) = B( 1, 2 )
      BTMP( 4 ) = B( 2, 2 )
*
*     Perform elimination
*
      DO 100 I = 1, 3
         XMAX = ZERO
         DO 70 IP = I, 4
            DO 60 JP = I, 4
               IF( ABS( T16( IP, JP ) ).GE.XMAX ) THEN
                  XMAX = ABS( T16( IP, JP ) )
                  IPSV = IP
                  JPSV = JP
               END IF
   60       CONTINUE
   70    CONTINUE
         IF( IPSV.NE.I ) THEN
            CALL DSWAP( 4, T16( IPSV, 1 ), 4, T16( I, 1 ), 4 )
            TEMP = BTMP( I )
            BTMP( I ) = BTMP( IPSV )
            BTMP( IPSV ) = TEMP
         END IF
         IF( JPSV.NE.I )
     $      CALL DSWAP( 4, T16( 1, JPSV ), 1, T16( 1, I ), 1 )
         JPIV( I ) = JPSV
```

```
         IF( ABS( T16( I, I ) ).LT.SMIN ) THEN
            INFO = 1
            T16( I, I ) = SMIN
         END IF
         DO 90 J = I + 1, 4
            T16( J, I ) = T16( J, I ) / T16( I, I )
            BTMP( J ) = BTMP( J ) - T16( J, I )*BTMP( I )
            DO 80 K = I + 1, 4
               T16( J, K ) = T16( J, K ) - T16( J, I )*T16( I, K )
   80       CONTINUE
   90    CONTINUE
  100 CONTINUE
      IF( ABS( T16( 4, 4 ) ).LT.SMIN )
     $   T16( 4, 4 ) = SMIN
      SCALE = ONE
      IF( ( EIGHT*SMLNUM )*ABS( BTMP( 1 ) ).GT.ABS( T16( 1, 1 ) ) .OR.
     $    ( EIGHT*SMLNUM )*ABS( BTMP( 2 ) ).GT.ABS( T16( 2, 2 ) ) .OR.
     $    ( EIGHT*SMLNUM )*ABS( BTMP( 3 ) ).GT.ABS( T16( 3, 3 ) ) .OR.
     $    ( EIGHT*SMLNUM )*ABS( BTMP( 4 ) ).GT.ABS( T16( 4, 4 ) ) ) THEN
         SCALE = ( ONE / EIGHT ) / MAX( ABS( BTMP( 1 ) ),
     $           ABS( BTMP( 2 ) ), ABS( BTMP( 3 ) ), ABS( BTMP( 4 ) ) )
         BTMP( 1 ) = BTMP( 1 )*SCALE
         BTMP( 2 ) = BTMP( 2 )*SCALE
         BTMP( 3 ) = BTMP( 3 )*SCALE
         BTMP( 4 ) = BTMP( 4 )*SCALE
      END IF
      DO 120 I = 1, 4
         K = 5 - I
         TEMP = ONE / T16( K, K )
         TMP( K ) = BTMP( K )*TEMP
         DO 110 J = K + 1, 4
            TMP( K ) = TMP( K ) - ( TEMP*T16( K, J ) )*TMP( J )
  110    CONTINUE
  120 CONTINUE
      DO 130 I = 1, 3
         IF( JPIV( 4-I ).NE.4-I ) THEN
            TEMP = TMP( 4-I )
            TMP( 4-I ) = TMP( JPIV( 4-I ) )
            TMP( JPIV( 4-I ) ) = TEMP
         END IF
  130 CONTINUE
      X( 1, 1 ) = TMP( 1 )
      X( 2, 1 ) = TMP( 2 )
      X( 1, 2 ) = TMP( 3 )
      X( 2, 2 ) = TMP( 4 )
      XNORM = MAX( ABS( TMP( 1 ) )+ABS( TMP( 3 ) ),
     $        ABS( TMP( 2 ) )+ABS( TMP( 4 ) ) )
      RETURN
*
*     End of DLASY2
```

```
*
      END
```

———-

— LAPACK dlasy2 —

```
(let* ((zero 0.0) (one 1.0) (two 2.0) (half 0.5) (eight 8.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one)
           (type (double-float 2.0 2.0) two)
           (type (double-float 0.5 0.5) half)
           (type (double-float 8.0 8.0) eight))
  (let ((locu12
         (make-array 4
                     :element-type 'fixnum
                     :initial-contents '(3 4 1 2)))
        (locl21
         (make-array 4
                     :element-type 'fixnum
                     :initial-contents '(2 1 4 3)))
        (locu22
         (make-array 4
                     :element-type 'fixnum
                     :initial-contents '(4 3 2 1)))
        (xswpiv
         (make-array 4 :element-type 't :initial-contents '(nil nil t t)))
        (bswpiv
         (make-array 4 :element-type 't :initial-contents '(nil t nil t))))
    (declare (type (simple-array (member t nil) (4)) bswpiv xswpiv)
             (type (simple-array fixnum (4)) locu22 locl21 locu12))
    (defun dlasy2
           (ltranl ltranr isgn n1 n2 tl ldtl tr ldtr b ldb$ scale x ldx xnorm
            info)
      (declare (type (double-float) xnorm scale)
               (type (simple-array double-float (*)) x b tr tl)
               (type fixnum info ldx ldb$ ldtr ldtl n2 n1 isgn)
               (type (member t nil) ltranr ltranl))
      (f2cl-lib:with-multi-array-data
          ((tl double-float tl-%data% tl-%offset%)
           (tr double-float tr-%data% tr-%offset%)
           (b double-float b-%data% b-%offset%)
           (x double-float x-%data% x-%offset%))
        (prog ((btmp (make-array 4 :element-type 'double-float))
               (t16 (make-array 16 :element-type 'double-float))
               (tmp (make-array 4 :element-type 'double-float))
               (x2 (make-array 2 :element-type 'double-float))
               (jpiv (make-array 4 :element-type 'fixnum)) (bet 0.0)
```

```
             (eps 0.0) (gam 0.0) (l21 0.0) (sgn 0.0) (smin 0.0) (smlnum 0.0)
             (tau1 0.0) (temp 0.0) (u11 0.0) (u12 0.0) (u22 0.0) (xmax 0.0)
             (i 0) (ip 0) (ipiv 0) (ipsv 0) (j 0) (jp 0) (jpsv 0) (k 0)
             (bswap nil) (xswap nil))
         (declare (type (simple-array double-float (16)) t16)
                  (type (simple-array double-float (4)) btmp tmp)
                  (type (simple-array double-float (2)) x2)
                  (type (simple-array fixnum (4)) jpiv)
                  (type (double-float) bet eps gam l21 sgn smin smlnum tau1
                                       temp u11 u12 u22 xmax)
                  (type fixnum i ip ipiv ipsv j jp jpsv k)
                  (type (member t nil) bswap xswap))
         (setf info 0)
         (if (or (= n1 0) (= n2 0)) (go end_label))
         (setf eps (dlamch "P"))
         (setf smlnum (/ (dlamch "S") eps))
         (setf sgn (coerce (the fixnum isgn) 'double-float))
         (setf k (f2cl-lib:int-sub (f2cl-lib:int-add n1 n1 n2) 2))
         (f2cl-lib:computed-goto (label10 label20 label30 label50) k)
label10
         (setf tau1
                 (+
                  (f2cl-lib:fref tl-%data% (1 1) ((1 ldtl) (1 *)) tl-%offset%)
                  (* sgn
                     (f2cl-lib:fref tr-%data%
                                    (1 1)
                                    ((1 ldtr) (1 *))
                                    tr-%offset%))))
         (setf bet (abs tau1))
         (cond
           ((<= bet smlnum)
            (setf tau1 smlnum)
            (setf bet smlnum)
            (setf info 1)))
         (setf scale one)
         (setf gam
                 (abs
                  (f2cl-lib:fref b-%data% (1 1) ((1 ldb$) (1 *)) b-%offset%)))
         (if (> (* smlnum gam) bet) (setf scale (/ one gam)))
         (setf (f2cl-lib:fref x-%data% (1 1) ((1 ldx) (1 *)) x-%offset%)
                 (/
                  (*
                   (f2cl-lib:fref b-%data% (1 1) ((1 ldb$) (1 *)) b-%offset%)
                   scale)
                  tau1))
         (setf xnorm
                 (abs
                  (f2cl-lib:fref x-%data% (1 1) ((1 ldx) (1 *)) x-%offset%)))
         (go end_label)
label20
```

```
(setf smin
        (max
         (* eps
            (max
             (abs
              (f2cl-lib:fref tl-%data%
                             (1 1)
                             ((1 ldtl) (1 *))
                             tl-%offset%))
             (abs
              (f2cl-lib:fref tr-%data%
                             (1 1)
                             ((1 ldtr) (1 *))
                             tr-%offset%))
             (abs
              (f2cl-lib:fref tr-%data%
                             (1 2)
                             ((1 ldtr) (1 *))
                             tr-%offset%))
             (abs
              (f2cl-lib:fref tr-%data%
                             (2 1)
                             ((1 ldtr) (1 *))
                             tr-%offset%))
             (abs
              (f2cl-lib:fref tr-%data%
                             (2 2)
                             ((1 ldtr) (1 *))
                             tr-%offset%))))
         smlnum))
(setf (f2cl-lib:fref tmp (1) ((1 4)))
        (+
         (f2cl-lib:fref tl-%data% (1 1) ((1 ldtl) (1 *)) tl-%offset%)
         (* sgn
            (f2cl-lib:fref tr-%data%
                           (1 1)
                           ((1 ldtr) (1 *))
                           tr-%offset%))))
(setf (f2cl-lib:fref tmp (4) ((1 4)))
        (+
         (f2cl-lib:fref tl-%data% (1 1) ((1 ldtl) (1 *)) tl-%offset%)
         (* sgn
            (f2cl-lib:fref tr-%data%
                           (2 2)
                           ((1 ldtr) (1 *))
                           tr-%offset%))))
(cond
  (ltranr
   (setf (f2cl-lib:fref tmp (2) ((1 4)))
         (* sgn
```

```
                        (f2cl-lib:fref tr-%data%
                                       (2 1)
                                       ((1 ldtr) (1 *))
                                       tr-%offset%)))
              (setf (f2cl-lib:fref tmp (3) ((1 4)))
                      (* sgn
                         (f2cl-lib:fref tr-%data%
                                       (1 2)
                                       ((1 ldtr) (1 *))
                                       tr-%offset%))))
             (t
              (setf (f2cl-lib:fref tmp (2) ((1 4)))
                      (* sgn
                         (f2cl-lib:fref tr-%data%
                                       (1 2)
                                       ((1 ldtr) (1 *))
                                       tr-%offset%)))
              (setf (f2cl-lib:fref tmp (3) ((1 4)))
                      (* sgn
                         (f2cl-lib:fref tr-%data%
                                       (2 1)
                                       ((1 ldtr) (1 *))
                                       tr-%offset%)))))
            (setf (f2cl-lib:fref btmp (1) ((1 4)))
                  (f2cl-lib:fref b-%data% (1 1) ((1 ldb$) (1 *)) b-%offset%))
            (setf (f2cl-lib:fref btmp (2) ((1 4)))
                  (f2cl-lib:fref b-%data% (1 2) ((1 ldb$) (1 *)) b-%offset%))
            (go label40)
label30
            (setf smin
                  (max
                   (* eps
                      (max
                       (abs
                        (f2cl-lib:fref tr-%data%
                                       (1 1)
                                       ((1 ldtr) (1 *))
                                       tr-%offset%))
                       (abs
                        (f2cl-lib:fref tl-%data%
                                       (1 1)
                                       ((1 ldtl) (1 *))
                                       tl-%offset%))
                       (abs
                        (f2cl-lib:fref tl-%data%
                                       (1 2)
                                       ((1 ldtl) (1 *))
                                       tl-%offset%))
                       (abs
                        (f2cl-lib:fref tl-%data%
```

```
                                (2 1)
                                ((1 ldtl) (1 *))
                                tl-%offset%))
                    (abs
                     (f2cl-lib:fref tl-%data%
                                (2 2)
                                ((1 ldtl) (1 *))
                                tl-%offset%))))
                 smlnum))
          (setf (f2cl-lib:fref tmp (1) ((1 4)))
                (+
                 (f2cl-lib:fref tl-%data% (1 1) ((1 ldtl) (1 *)) tl-%offset%)
                 (* sgn
                    (f2cl-lib:fref tr-%data%
                                   (1 1)
                                   ((1 ldtr) (1 *))
                                   tr-%offset%))))
          (setf (f2cl-lib:fref tmp (4) ((1 4)))
                (+
                 (f2cl-lib:fref tl-%data% (2 2) ((1 ldtl) (1 *)) tl-%offset%)
                 (* sgn
                    (f2cl-lib:fref tr-%data%
                                   (1 1)
                                   ((1 ldtr) (1 *))
                                   tr-%offset%))))
          (cond
            (ltranl
             (setf (f2cl-lib:fref tmp (2) ((1 4)))
                   (f2cl-lib:fref tl-%data%
                                  (1 2)
                                  ((1 ldtl) (1 *))
                                  tl-%offset%))
             (setf (f2cl-lib:fref tmp (3) ((1 4)))
                   (f2cl-lib:fref tl-%data%
                                  (2 1)
                                  ((1 ldtl) (1 *))
                                  tl-%offset%)))
            (t
             (setf (f2cl-lib:fref tmp (2) ((1 4)))
                   (f2cl-lib:fref tl-%data%
                                  (2 1)
                                  ((1 ldtl) (1 *))
                                  tl-%offset%))
             (setf (f2cl-lib:fref tmp (3) ((1 4)))
                   (f2cl-lib:fref tl-%data%
                                  (1 2)
                                  ((1 ldtl) (1 *))
                                  tl-%offset%))))
          (setf (f2cl-lib:fref btmp (1) ((1 4)))
                (f2cl-lib:fref b-%data% (1 1) ((1 ldb$) (1 *)) b-%offset%))
```

```
          (setf (f2cl-lib:fref btmp (2) ((1 4)))
                  (f2cl-lib:fref b-%data% (2 1) ((1 ldb$) (1 *)) b-%offset%))
 label40
          (setf ipiv (idamax 4 tmp 1))
          (setf u11 (f2cl-lib:fref tmp (ipiv) ((1 4))))
          (cond
            ((<= (abs u11) smin)
             (setf info 1)
             (setf u11 smin)))
          (setf u12
                  (f2cl-lib:fref tmp
                                 ((f2cl-lib:fref locu12 (ipiv) ((1 4))))
                                 ((1 4))))
          (setf l21
                  (/
                   (f2cl-lib:fref tmp
                                  ((f2cl-lib:fref locl21 (ipiv) ((1 4))))
                                  ((1 4)))
                   u11))
          (setf u22
                  (-
                   (f2cl-lib:fref tmp
                                  ((f2cl-lib:fref locu22 (ipiv) ((1 4))))
                                  ((1 4)))
                   (* u12 l21)))
          (setf xswap (f2cl-lib:fref xswpiv (ipiv) ((1 4))))
          (setf bswap (f2cl-lib:fref bswpiv (ipiv) ((1 4))))
          (cond
            ((<= (abs u22) smin)
             (setf info 1)
             (setf u22 smin)))
          (cond
            (bswap
             (setf temp (f2cl-lib:fref btmp (2) ((1 4))))
             (setf (f2cl-lib:fref btmp (2) ((1 4)))
                     (- (f2cl-lib:fref btmp (1) ((1 4))) (* l21 temp)))
             (setf (f2cl-lib:fref btmp (1) ((1 4))) temp))
            (t
             (setf (f2cl-lib:fref btmp (2) ((1 4)))
                     (- (f2cl-lib:fref btmp (2) ((1 4)))
                        (* l21 (f2cl-lib:fref btmp (1) ((1 4))))))))
          (setf scale one)
          (cond
            ((or
              (> (* two smlnum (abs (f2cl-lib:fref btmp (2) ((1 4)))))
                 (abs u22))
              (> (* two smlnum (abs (f2cl-lib:fref btmp (1) ((1 4)))))
                 (abs u11)))
             (setf scale
                     (/ half
```

```
              (max (abs (f2cl-lib:fref btmp (1) ((1 4))))
                   (abs (f2cl-lib:fref btmp (2) ((1 4)))))))
   (setf (f2cl-lib:fref btmp (1) ((1 4)))
           (* (f2cl-lib:fref btmp (1) ((1 4))) scale))
   (setf (f2cl-lib:fref btmp (2) ((1 4)))
           (* (f2cl-lib:fref btmp (2) ((1 4))) scale))))
(setf (f2cl-lib:fref x2 (2) ((1 2)))
        (/ (f2cl-lib:fref btmp (2) ((1 4))) u22))
(setf (f2cl-lib:fref x2 (1) ((1 2)))
        (- (/ (f2cl-lib:fref btmp (1) ((1 4))) u11)
           (* (/ u12 u11) (f2cl-lib:fref x2 (2) ((1 2))))))
(cond
  (xswap
   (setf temp (f2cl-lib:fref x2 (2) ((1 2))))
   (setf (f2cl-lib:fref x2 (2) ((1 2)))
           (f2cl-lib:fref x2 (1) ((1 2))))
   (setf (f2cl-lib:fref x2 (1) ((1 2))) temp)))
(setf (f2cl-lib:fref x-%data% (1 1) ((1 ldx) (1 *)) x-%offset%)
        (f2cl-lib:fref x2 (1) ((1 2))))
(cond
  ((= n1 1)
   (setf (f2cl-lib:fref x-%data% (1 2) ((1 ldx) (1 *)) x-%offset%)
           (f2cl-lib:fref x2 (2) ((1 2))))
   (setf xnorm
           (+
            (abs
             (f2cl-lib:fref x-%data%
                            (1 1)
                            ((1 ldx) (1 *))
                            x-%offset%))
            (abs
             (f2cl-lib:fref x-%data%
                            (1 2)
                            ((1 ldx) (1 *))
                            x-%offset%)))))
  (t
   (setf (f2cl-lib:fref x-%data% (2 1) ((1 ldx) (1 *)) x-%offset%)
           (f2cl-lib:fref x2 (2) ((1 2))))
   (setf xnorm
           (max
            (abs
             (f2cl-lib:fref x-%data%
                            (1 1)
                            ((1 ldx) (1 *))
                            x-%offset%))
            (abs
             (f2cl-lib:fref x-%data%
                            (2 1)
                            ((1 ldx) (1 *))
                            x-%offset%)))))))
```

```
          (go end_label)
 label50
          (setf smin
                 (max
                  (abs
                   (f2cl-lib:fref tr-%data%
                                  (1 1)
                                  ((1 ldtr) (1 *))
                                  tr-%offset%))
                  (abs
                   (f2cl-lib:fref tr-%data%
                                  (1 2)
                                  ((1 ldtr) (1 *))
                                  tr-%offset%))
                  (abs
                   (f2cl-lib:fref tr-%data%
                                  (2 1)
                                  ((1 ldtr) (1 *))
                                  tr-%offset%))
                  (abs
                   (f2cl-lib:fref tr-%data%
                                  (2 2)
                                  ((1 ldtr) (1 *))
                                  tr-%offset%))))
          (setf smin
                 (max smin
                      (abs
                       (f2cl-lib:fref tl-%data%
                                      (1 1)
                                      ((1 ldtl) (1 *))
                                      tl-%offset%))
                      (abs
                       (f2cl-lib:fref tl-%data%
                                      (1 2)
                                      ((1 ldtl) (1 *))
                                      tl-%offset%))
                      (abs
                       (f2cl-lib:fref tl-%data%
                                      (2 1)
                                      ((1 ldtl) (1 *))
                                      tl-%offset%))
                      (abs
                       (f2cl-lib:fref tl-%data%
                                      (2 2)
                                      ((1 ldtl) (1 *))
                                      tl-%offset%))))
          (setf smin (max (* eps smin) smlnum))
          (setf (f2cl-lib:fref btmp (1) ((1 4))) zero)
          (dcopy 16 btmp 0 t16 1)
          (setf (f2cl-lib:fref t16 (1 1) ((1 4) (1 4)))
```

```
        (+
         (f2cl-lib:fref tl-%data% (1 1) ((1 ldtl) (1 *)) tl-%offset%)
         (* sgn
            (f2cl-lib:fref tr-%data%
                           (1 1)
                           ((1 ldtr) (1 *))
                           tr-%offset%))))
(setf (f2cl-lib:fref t16 (2 2) ((1 4) (1 4)))
        (+
         (f2cl-lib:fref tl-%data% (2 2) ((1 ldtl) (1 *)) tl-%offset%)
         (* sgn
            (f2cl-lib:fref tr-%data%
                           (1 1)
                           ((1 ldtr) (1 *))
                           tr-%offset%))))
(setf (f2cl-lib:fref t16 (3 3) ((1 4) (1 4)))
        (+
         (f2cl-lib:fref tl-%data% (1 1) ((1 ldtl) (1 *)) tl-%offset%)
         (* sgn
            (f2cl-lib:fref tr-%data%
                           (2 2)
                           ((1 ldtr) (1 *))
                           tr-%offset%))))
(setf (f2cl-lib:fref t16 (4 4) ((1 4) (1 4)))
        (+
         (f2cl-lib:fref tl-%data% (2 2) ((1 ldtl) (1 *)) tl-%offset%)
         (* sgn
            (f2cl-lib:fref tr-%data%
                           (2 2)
                           ((1 ldtr) (1 *))
                           tr-%offset%))))
(cond
  (ltranl
   (setf (f2cl-lib:fref t16 (1 2) ((1 4) (1 4)))
           (f2cl-lib:fref tl-%data%
                          (2 1)
                          ((1 ldtl) (1 *))
                          tl-%offset%))
   (setf (f2cl-lib:fref t16 (2 1) ((1 4) (1 4)))
           (f2cl-lib:fref tl-%data%
                          (1 2)
                          ((1 ldtl) (1 *))
                          tl-%offset%))
   (setf (f2cl-lib:fref t16 (3 4) ((1 4) (1 4)))
           (f2cl-lib:fref tl-%data%
                          (2 1)
                          ((1 ldtl) (1 *))
                          tl-%offset%))
   (setf (f2cl-lib:fref t16 (4 3) ((1 4) (1 4)))
           (f2cl-lib:fref tl-%data%
```

```
                          (1 2)
                          ((1 ldtl) (1 *))
                          tl-%offset%)))
  (t
   (setf (f2cl-lib:fref t16 (1 2) ((1 4) (1 4)))
         (f2cl-lib:fref tl-%data%
                        (1 2)
                        ((1 ldtl) (1 *))
                        tl-%offset%))
   (setf (f2cl-lib:fref t16 (2 1) ((1 4) (1 4)))
         (f2cl-lib:fref tl-%data%
                        (2 1)
                        ((1 ldtl) (1 *))
                        tl-%offset%))
   (setf (f2cl-lib:fref t16 (3 4) ((1 4) (1 4)))
         (f2cl-lib:fref tl-%data%
                        (1 2)
                        ((1 ldtl) (1 *))
                        tl-%offset%))
   (setf (f2cl-lib:fref t16 (4 3) ((1 4) (1 4)))
         (f2cl-lib:fref tl-%data%
                        (2 1)
                        ((1 ldtl) (1 *))
                        tl-%offset%))))
(cond
  (ltranr
   (setf (f2cl-lib:fref t16 (1 3) ((1 4) (1 4)))
         (* sgn
            (f2cl-lib:fref tr-%data%
                           (1 2)
                           ((1 ldtr) (1 *))
                           tr-%offset%)))
   (setf (f2cl-lib:fref t16 (2 4) ((1 4) (1 4)))
         (* sgn
            (f2cl-lib:fref tr-%data%
                           (1 2)
                           ((1 ldtr) (1 *))
                           tr-%offset%)))
   (setf (f2cl-lib:fref t16 (3 1) ((1 4) (1 4)))
         (* sgn
            (f2cl-lib:fref tr-%data%
                           (2 1)
                           ((1 ldtr) (1 *))
                           tr-%offset%)))
   (setf (f2cl-lib:fref t16 (4 2) ((1 4) (1 4)))
         (* sgn
            (f2cl-lib:fref tr-%data%
                           (2 1)
                           ((1 ldtr) (1 *))
                           tr-%offset%))))
```

```
  (t
   (setf (f2cl-lib:fref t16 (1 3) ((1 4) (1 4)))
         (* sgn
            (f2cl-lib:fref tr-%data%
                           (2 1)
                           ((1 ldtr) (1 *))
                           tr-%offset%)))
   (setf (f2cl-lib:fref t16 (2 4) ((1 4) (1 4)))
         (* sgn
            (f2cl-lib:fref tr-%data%
                           (2 1)
                           ((1 ldtr) (1 *))
                           tr-%offset%)))
   (setf (f2cl-lib:fref t16 (3 1) ((1 4) (1 4)))
         (* sgn
            (f2cl-lib:fref tr-%data%
                           (1 2)
                           ((1 ldtr) (1 *))
                           tr-%offset%)))
   (setf (f2cl-lib:fref t16 (4 2) ((1 4) (1 4)))
         (* sgn
            (f2cl-lib:fref tr-%data%
                           (1 2)
                           ((1 ldtr) (1 *))
                           tr-%offset%)))))
(setf (f2cl-lib:fref btmp (1) ((1 4)))
        (f2cl-lib:fref b-%data% (1 1) ((1 ldb$) (1 *)) b-%offset%))
(setf (f2cl-lib:fref btmp (2) ((1 4)))
        (f2cl-lib:fref b-%data% (2 1) ((1 ldb$) (1 *)) b-%offset%))
(setf (f2cl-lib:fref btmp (3) ((1 4)))
        (f2cl-lib:fref b-%data% (1 2) ((1 ldb$) (1 *)) b-%offset%))
(setf (f2cl-lib:fref btmp (4) ((1 4)))
        (f2cl-lib:fref b-%data% (2 2) ((1 ldb$) (1 *)) b-%offset%))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i 3) nil)
  (tagbody
    (setf xmax zero)
    (f2cl-lib:fdo (ip i (f2cl-lib:int-add ip 1))
                  ((> ip 4) nil)
      (tagbody
        (f2cl-lib:fdo (jp i (f2cl-lib:int-add jp 1))
                      ((> jp 4) nil)
          (tagbody
            (cond
              ((>= (abs (f2cl-lib:fref t16 (ip jp) ((1 4) (1 4))))
                   xmax)
               (setf xmax
                       (abs
                        (f2cl-lib:fref t16 (ip jp) ((1 4) (1 4)))))
               (setf ipsv ip)
```

```
            (setf jpsv jp)))))))
      (cond
        ((/= ipsv i)
         (dswap 4
          (f2cl-lib:array-slice t16
                                double-float
                                (ipsv 1)
                                ((1 4) (1 4)))
          4 (f2cl-lib:array-slice t16 double-float (i 1) ((1 4) (1 4)))
          4)
         (setf temp (f2cl-lib:fref btmp (i) ((1 4))))
         (setf (f2cl-lib:fref btmp (i) ((1 4)))
                (f2cl-lib:fref btmp (ipsv) ((1 4))))
         (setf (f2cl-lib:fref btmp (ipsv) ((1 4))) temp)))
      (if (/= jpsv i)
          (dswap 4
           (f2cl-lib:array-slice t16
                                 double-float
                                 (1 jpsv)
                                 ((1 4) (1 4)))
           1
           (f2cl-lib:array-slice t16 double-float (1 i) ((1 4) (1 4)))
           1))
      (setf (f2cl-lib:fref jpiv (i) ((1 4))) jpsv)
      (cond
        ((< (abs (f2cl-lib:fref t16 (i i) ((1 4) (1 4)))) smin)
         (setf info 1)
         (setf (f2cl-lib:fref t16 (i i) ((1 4) (1 4))) smin)))
      (f2cl-lib:fdo (j (f2cl-lib:int-add i 1) (f2cl-lib:int-add j 1))
                    ((> j 4) nil)
        (tagbody
          (setf (f2cl-lib:fref t16 (j i) ((1 4) (1 4)))
                 (/ (f2cl-lib:fref t16 (j i) ((1 4) (1 4)))
                    (f2cl-lib:fref t16 (i i) ((1 4) (1 4)))))
          (setf (f2cl-lib:fref btmp (j) ((1 4)))
                 (- (f2cl-lib:fref btmp (j) ((1 4)))
                    (* (f2cl-lib:fref t16 (j i) ((1 4) (1 4)))
                       (f2cl-lib:fref btmp (i) ((1 4))))))
          (f2cl-lib:fdo (k (f2cl-lib:int-add i 1)
                           (f2cl-lib:int-add k 1))
                        ((> k 4) nil)
            (tagbody
              (setf (f2cl-lib:fref t16 (j k) ((1 4) (1 4)))
                    (- (f2cl-lib:fref t16 (j k) ((1 4) (1 4)))
                       (* (f2cl-lib:fref t16 (j i) ((1 4) (1 4)))
                          (f2cl-lib:fref t16 (i k) ((1 4) (1 4))))))))))))
    (if (< (abs (f2cl-lib:fref t16 (4 4) ((1 4) (1 4)))) smin)
        (setf (f2cl-lib:fref t16 (4 4) ((1 4) (1 4))) smin))
    (setf scale one)
    (cond
```

```
  ((or
    (> (* eight smlnum (abs (f2cl-lib:fref btmp (1) ((1 4)))))
       (abs (f2cl-lib:fref t16 (1 1) ((1 4) (1 4)))))
    (> (* eight smlnum (abs (f2cl-lib:fref btmp (2) ((1 4)))))
       (abs (f2cl-lib:fref t16 (2 2) ((1 4) (1 4)))))
    (> (* eight smlnum (abs (f2cl-lib:fref btmp (3) ((1 4)))))
       (abs (f2cl-lib:fref t16 (3 3) ((1 4) (1 4)))))
    (> (* eight smlnum (abs (f2cl-lib:fref btmp (4) ((1 4)))))
       (abs (f2cl-lib:fref t16 (4 4) ((1 4) (1 4))))))
   (setf scale
         (/ (/ one eight)
            (max (abs (f2cl-lib:fref btmp (1) ((1 4))))
                 (abs (f2cl-lib:fref btmp (2) ((1 4))))
                 (abs (f2cl-lib:fref btmp (3) ((1 4))))
                 (abs (f2cl-lib:fref btmp (4) ((1 4))))))))
   (setf (f2cl-lib:fref btmp (1) ((1 4)))
         (* (f2cl-lib:fref btmp (1) ((1 4))) scale))
   (setf (f2cl-lib:fref btmp (2) ((1 4)))
         (* (f2cl-lib:fref btmp (2) ((1 4))) scale))
   (setf (f2cl-lib:fref btmp (3) ((1 4)))
         (* (f2cl-lib:fref btmp (3) ((1 4))) scale))
   (setf (f2cl-lib:fref btmp (4) ((1 4)))
         (* (f2cl-lib:fref btmp (4) ((1 4))) scale))))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i 4) nil)
  (tagbody
    (setf k (f2cl-lib:int-sub 5 i))
    (setf temp (/ one (f2cl-lib:fref t16 (k k) ((1 4) (1 4)))))
    (setf (f2cl-lib:fref tmp (k) ((1 4)))
          (* (f2cl-lib:fref btmp (k) ((1 4))) temp))
    (f2cl-lib:fdo (j (f2cl-lib:int-add k 1) (f2cl-lib:int-add j 1))
                  ((> j 4) nil)
      (tagbody
        (setf (f2cl-lib:fref tmp (k) ((1 4)))
              (- (f2cl-lib:fref tmp (k) ((1 4)))
                 (* temp
                    (f2cl-lib:fref t16 (k j) ((1 4) (1 4)))
                    (f2cl-lib:fref tmp (j) ((1 4)))))))))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i 3) nil)
  (tagbody
    (cond
      ((/=
        (f2cl-lib:fref jpiv
                       ((f2cl-lib:int-add 4 (f2cl-lib:int-sub i)))
                       ((1 4)))
        (f2cl-lib:int-add 4 (f2cl-lib:int-sub i)))
       (setf temp
             (f2cl-lib:fref tmp ((f2cl-lib:int-sub 4 i)) ((1 4))))
       (setf (f2cl-lib:fref tmp ((f2cl-lib:int-sub 4 i)) ((1 4)))
```

```
                        (f2cl-lib:fref tmp
                                       ((f2cl-lib:fref jpiv
                                                       ((f2cl-lib:int-sub 4
                                                                          i))
                                                       ((1 4))))
                                       ((1 4))))
                 (setf (f2cl-lib:fref tmp
                                      ((f2cl-lib:fref jpiv
                                                      ((f2cl-lib:int-sub 4 i))
                                                      ((1 4))))
                                      ((1 4)))
                       temp)))))
          (setf (f2cl-lib:fref x-%data% (1 1) ((1 ldx) (1 *)) x-%offset%)
                  (f2cl-lib:fref tmp (1) ((1 4))))
          (setf (f2cl-lib:fref x-%data% (2 1) ((1 ldx) (1 *)) x-%offset%)
                  (f2cl-lib:fref tmp (2) ((1 4))))
          (setf (f2cl-lib:fref x-%data% (1 2) ((1 ldx) (1 *)) x-%offset%)
                  (f2cl-lib:fref tmp (3) ((1 4))))
          (setf (f2cl-lib:fref x-%data% (2 2) ((1 ldx) (1 *)) x-%offset%)
                  (f2cl-lib:fref tmp (4) ((1 4))))
          (setf xnorm
                  (max
                   (+ (abs (f2cl-lib:fref tmp (1) ((1 4))))
                      (abs (f2cl-lib:fref tmp (3) ((1 4)))))
                   (+ (abs (f2cl-lib:fref tmp (2) ((1 4))))
                      (abs (f2cl-lib:fref tmp (4) ((1 4)))))))
 end_label
          (return
           (values nil
                   nil
                   nil
                   nil
                   nil
                   nil
                   nil
                   nil
                   nil
                   nil
                   nil
                   nil
                   scale
                   nil
                   nil
                   xnorm
                   info)))))))
```

6.82 dorg2r LAPACK

— **dorg2r.input** —

```
)set break resume
)sys rm -f dorg2r.output
)spool dorg2r.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dorg2r.help** —

```
==========================================================================
dorg2r examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

NAME
       DORG2R - an m by n real matrix Q with orthonormal columns,

SYNOPSIS
       SUBROUTINE DORG2R( M, N, K, A, LDA, TAU, WORK, INFO )

           INTEGER        INFO, K, LDA, M, N

           DOUBLE         PRECISION A( LDA, * ), TAU( * ), WORK( * )

  Purpose
  =======

  DORG2R generates an m by n real matrix Q with orthonormal columns,
  which is defined as the first n columns of a product of k elementary
  reflectors of order m

        Q  =  H(1) H(2) . . . H(k)

  as returned by DGEQRF.

  Arguments
```

```
  =========

  M       (input) INTEGER
          The number of rows of the matrix Q. M >= 0.

  N       (input) INTEGER
          The number of columns of the matrix Q. M >= N >= 0.

  K       (input) INTEGER
          The number of elementary reflectors whose product defines the
          matrix Q. N >= K >= 0.

  A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
          On entry, the i-th column must contain the vector which
          defines the elementary reflector H(i), for i = 1,2,...,k, as
          returned by DGEQRF in the first k columns of its array
          argument A.
          On exit, the m-by-n matrix Q.

  LDA     (input) INTEGER
          The first dimension of the array A. LDA >= max(1,M).

  TAU     (input) DOUBLE PRECISION array, dimension (K)
          TAU(i) must contain the scalar factor of the elementary
          reflector H(i), as returned by DGEQRF.

  WORK    (workspace) DOUBLE PRECISION array, dimension (N)

  INFO    (output) INTEGER
          = 0: successful exit
          < 0: if INFO = -i, the i-th argument has an illegal value
```

———-

— dorg2r.f —

```
      SUBROUTINE DORG2R( M, N, K, A, LDA, TAU, WORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     February 29, 1992
*
*     .. Scalar Arguments ..
      INTEGER            INFO, K, LDA, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), TAU( * ), WORK( * )
```

```
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE, ZERO
      PARAMETER          ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I, J, L
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLARF, DSCAL, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      IF( M.LT.0 ) THEN
         INFO = -1
      ELSE IF( N.LT.0 .OR. N.GT.M ) THEN
         INFO = -2
      ELSE IF( K.LT.0 .OR. K.GT.N ) THEN
         INFO = -3
      ELSE IF( LDA.LT.MAX( 1, M ) ) THEN
         INFO = -5
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DORG2R', -INFO )
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( N.LE.0 )
     $   RETURN
*
*     Initialise columns k+1:n to columns of the unit matrix
*
      DO 20 J = K + 1, N
         DO 10 L = 1, M
            A( L, J ) = ZERO
   10    CONTINUE
         A( J, J ) = ONE
   20 CONTINUE
*
```

```
      DO 40 I = K, 1, -1
*
*        Apply H(i) to A(i:m,i:n) from the left
*
         IF( I.LT.N ) THEN
            A( I, I ) = ONE
            CALL DLARF( 'Left', M-I+1, N-I, A( I, I ), 1, TAU( I ),
     $                  A( I, I+1 ), LDA, WORK )
         END IF
         IF( I.LT.M )
     $      CALL DSCAL( M-I, -TAU( I ), A( I+1, I ), 1 )
         A( I, I ) = ONE - TAU( I )
*
*        Set A(1:i-1,i) to zero
*
         DO 30 L = 1, I - 1
            A( L, I ) = ZERO
   30    CONTINUE
   40 CONTINUE
      RETURN
*
*     End of DORG2R
*
      END
```

———-

— LAPACK dorg2r —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dorg2r (m n k a lda tau work info)
    (declare (type (simple-array double-float (*)) work tau a)
             (type fixnum info lda k n m))
    (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((i 0) (j 0) (l 0))
        (declare (type fixnum i j l))
        (setf info 0)
        (cond
          ((< m 0)
           (setf info -1))
          ((or (< n 0) (> n m))
           (setf info -2))
          ((or (< k 0) (> k n))
```

```
   (setf info -3))
  ((< lda (max (the fixnum 1) (the fixnum m)))
   (setf info -5)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DORG2R" (f2cl-lib:int-sub info))
   (go end_label)))
(if (<= n 0) (go end_label))
(f2cl-lib:fdo (j (f2cl-lib:int-add k 1) (f2cl-lib:int-add j 1))
              ((> j n) nil)
  (tagbody
    (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                  ((> l m) nil)
      (tagbody
        (setf (f2cl-lib:fref a-%data% (l j) ((1 lda) (1 *)) a-%offset%)
                zero)))
    (setf (f2cl-lib:fref a-%data% (j j) ((1 lda) (1 *)) a-%offset%)
          one)))
(f2cl-lib:fdo (i k (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
              ((> i 1) nil)
  (tagbody
    (cond
      ((< i n)
       (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
             one)
       (dlarf "Left" (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
        (f2cl-lib:int-sub n i)
        (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) 1
        (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)
        (f2cl-lib:array-slice a
                              double-float
                              (i (f2cl-lib:int-add i 1))
                              ((1 lda) (1 *)))
        lda work)))
    (if (< i m)
        (dscal (f2cl-lib:int-sub m i)
         (- (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%))
         (f2cl-lib:array-slice a
                               double-float
                               ((+ i 1) i)
                               ((1 lda) (1 *)))
         1))
    (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
          (- one
             (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)))
    (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                  ((> l (f2cl-lib:int-add i (f2cl-lib:int-sub 1))) nil)
      (tagbody
```

```
               (setf (f2cl-lib:fref a-%data% (1 i) ((1 lda) (1 *)) a-%offset%)
                     zero)))))
 end_label
        (return (values nil nil nil nil nil nil nil info))))))
```

———-

6.83 dorgbr LAPACK

— **dorgbr.input** —

```
)set break resume
)sys rm -f dorgbr.output
)spool dorgbr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dorgbr.help** —

```
=======================================================================
dorgbr examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

NAME
       DORGBR  -  one  of the real orthogonal matrices Q or P**T determined by
       DGEBRD when reducing a real matrix A to bidiagonal form

SYNOPSIS
       SUBROUTINE DORGBR( VECT, M, N, K, A, LDA, TAU, WORK, LWORK, INFO )

           CHARACTER      VECT

           INTEGER        INFO, K, LDA, LWORK, M, N

           DOUBLE         PRECISION A( LDA, * ), TAU( * ), WORK( * )
```

```
Purpose
=======

DORGBR generates one of the real orthogonal matrices Q or P**T
determined by DGEBRD when reducing a real matrix A to bidiagonal
form: A = Q * B * P**T.  Q and P**T are defined as products of
elementary reflectors H(i) or G(i) respectively.

If VECT = 'Q', A is assumed to have been an M-by-K matrix, and Q
is of order M:
if m >= k, Q = H(1) H(2) . . . H(k) and DORGBR returns the first n
columns of Q, where m >= n >= k;
if m < k, Q = H(1) H(2) . . . H(m-1) and DORGBR returns Q as an
M-by-M matrix.

If VECT = 'P', A is assumed to have been a K-by-N matrix, and P**T
is of order N:
if k < n, P**T = G(k) . . . G(2) G(1) and DORGBR returns the first m
rows of P**T, where n >= m >= k;
if k >= n, P**T = G(n-1) . . . G(2) G(1) and DORGBR returns P**T as
an N-by-N matrix.

Arguments
=========

VECT    (input) CHARACTER*1
        Specifies whether the matrix Q or the matrix P**T is
        required, as defined in the transformation applied by DGEBRD:
        = 'Q':  generate Q;
        = 'P':  generate P**T.

M       (input) INTEGER
        The number of rows of the matrix Q or P**T to be returned.
        M >= 0.

N       (input) INTEGER
        The number of columns of the matrix Q or P**T to be returned.
        N >= 0.
        If VECT = 'Q', M >= N >= min(M,K);
        if VECT = 'P', N >= M >= min(N,K).

K       (input) INTEGER
        If VECT = 'Q', the number of columns in the original M-by-K
        matrix reduced by DGEBRD.
        If VECT = 'P', the number of rows in the original K-by-N
        matrix reduced by DGEBRD.
        K >= 0.

A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
```

```
          On entry, the vectors which define the elementary reflectors,
          as returned by DGEBRD.
          On exit, the M-by-N matrix Q or P**T.

  LDA     (input) INTEGER
          The leading dimension of the array A. LDA >= max(1,M).

  TAU     (input) DOUBLE PRECISION array, dimension
                                (min(M,K)) if VECT = 'Q'
                                (min(N,K)) if VECT = 'P'
          TAU(i) must contain the scalar factor of the elementary
          reflector H(i) or G(i), which determines Q or P**T, as
          returned by DGEBRD in its array argument TAUQ or TAUP.

  WORK    (workspace/output) DOUBLE PRECISION array, dimension (LWORK)
          On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

  LWORK   (input) INTEGER
          The dimension of the array WORK. LWORK >= max(1,min(M,N)).
          For optimum performance LWORK >= min(M,N)*NB, where NB
          is the optimal blocksize.

          If LWORK = -1, then a workspace query is assumed; the routine
          only calculates the optimal size of the WORK array, returns
          this value as the first entry of the WORK array, and no error
          message related to LWORK is issued by XERBLA.

  INFO    (output) INTEGER
          = 0:  successful exit
          < 0:  if INFO = -i, the i-th argument had an illegal value
```

———-

— **dorgbr.f** —

```
      SUBROUTINE DORGBR( VECT, M, N, K, A, LDA, TAU, WORK, LWORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      CHARACTER          VECT
      INTEGER            INFO, K, LDA, LWORK, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), TAU( * ), WORK( * )
```

```
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            LQUERY, WANTQ
      INTEGER            I, IINFO, J, LWKOPT, MN, NB
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      INTEGER            ILAENV
      EXTERNAL           LSAME, ILAENV
*     ..
*     .. External Subroutines ..
      EXTERNAL           DORGLQ, DORGQR, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      WANTQ = LSAME( VECT, 'Q' )
      MN = MIN( M, N )
      LQUERY = ( LWORK.EQ.-1 )
      IF( .NOT.WANTQ .AND. .NOT.LSAME( VECT, 'P' ) ) THEN
         INFO = -1
      ELSE IF( M.LT.0 ) THEN
         INFO = -2
      ELSE IF( N.LT.0 .OR. ( WANTQ .AND. ( N.GT.M .OR. N.LT.MIN( M,
     $         K ) ) ) .OR. ( .NOT.WANTQ .AND. ( M.GT.N .OR. M.LT.
     $         MIN( N, K ) ) ) ) THEN
         INFO = -3
      ELSE IF( K.LT.0 ) THEN
         INFO = -4
      ELSE IF( LDA.LT.MAX( 1, M ) ) THEN
         INFO = -6
      ELSE IF( LWORK.LT.MAX( 1, MN ) .AND. .NOT.LQUERY ) THEN
         INFO = -9
      END IF
*
      IF( INFO.EQ.0 ) THEN
         IF( WANTQ ) THEN
            NB = ILAENV( 1, 'DORGQR', ' ', M, N, K, -1 )
```

```
         ELSE
            NB = ILAENV( 1, 'DORGLQ', ' ', M, N, K, -1 )
         END IF
         LWKOPT = MAX( 1, MN )*NB
         WORK( 1 ) = LWKOPT
      END IF
*
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DORGBR', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( M.EQ.0 .OR. N.EQ.0 ) THEN
         WORK( 1 ) = 1
         RETURN
      END IF
*
      IF( WANTQ ) THEN
*
*        Form Q, determined by a call to DGEBRD to reduce an m-by-k
*        matrix
*
         IF( M.GE.K ) THEN
*
*           If m >= k, assume m >= n >= k
*
            CALL DORGQR( M, N, K, A, LDA, TAU, WORK, LWORK, IINFO )
*
         ELSE
*
*           If m < k, assume m = n
*
*           Shift the vectors which define the elementary reflectors one
*           column to the right, and set the first row and column of Q
*           to those of the unit matrix
*
            DO 20 J = M, 2, -1
               A( 1, J ) = ZERO
               DO 10 I = J + 1, M
                  A( I, J ) = A( I, J-1 )
   10          CONTINUE
   20       CONTINUE
            A( 1, 1 ) = ONE
            DO 30 I = 2, M
               A( I, 1 ) = ZERO
   30       CONTINUE
```

```
            IF( M.GT.1 ) THEN
*
*              Form Q(2:m,2:m)
*
               CALL DORGQR( M-1, M-1, M-1, A( 2, 2 ), LDA, TAU, WORK,
     $                      LWORK, IINFO )
            END IF
         END IF
      ELSE
*
*        Form P', determined by a call to DGEBRD to reduce a k-by-n
*        matrix
*
         IF( K.LT.N ) THEN
*
*           If k < n, assume k <= m <= n
*
            CALL DORGLQ( M, N, K, A, LDA, TAU, WORK, LWORK, IINFO )
*
         ELSE
*
*           If k >= n, assume m = n
*
*           Shift the vectors which define the elementary reflectors one
*           row downward, and set the first row and column of P' to
*           those of the unit matrix
*
            A( 1, 1 ) = ONE
            DO 40 I = 2, N
               A( I, 1 ) = ZERO
   40       CONTINUE
            DO 60 J = 2, N
               DO 50 I = J - 1, 2, -1
                  A( I, J ) = A( I-1, J )
   50          CONTINUE
               A( 1, J ) = ZERO
   60       CONTINUE
            IF( N.GT.1 ) THEN
*
*              Form P'(2:n,2:n)
*
               CALL DORGLQ( N-1, N-1, N-1, A( 2, 2 ), LDA, TAU, WORK,
     $                      LWORK, IINFO )
            END IF
         END IF
      END IF
      WORK( 1 ) = LWKOPT
      RETURN
*
*     End of DORGBR
```

```
*
      END
```

———-

— LAPACK dorgbr —

```
(let* ((zero 0.0) (one 1.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one))
  (defun dorgbr (vect m n k a lda tau work lwork info)
    (declare (type (simple-array double-float (*)) work tau a)
             (type fixnum info lwork lda k n m)
             (type character vect))
    (f2cl-lib:with-multi-array-data
        ((vect character vect-%data% vect-%offset%)
         (a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((i 0) (iinfo 0) (j 0) (lwkopt 0) (mn 0) (nb 0) (lquery nil)
             (wantq nil))
        (declare (type fixnum i iinfo j lwkopt mn nb)
                 (type (member t nil) lquery wantq))
        (setf info 0)
        (setf wantq (char-equal vect #\Q))
        (setf mn (min (the fixnum m) (the fixnum n)))
        (setf lquery (coerce (= lwork -1) '(member t nil)))
        (cond
          ((and (not wantq) (not (char-equal vect #\P)))
           (setf info -1))
          ((< m 0)
           (setf info -2))
          ((or (< n 0)
               (and wantq
                    (or (> n m)
                        (< n
                           (min (the fixnum m)
                                (the fixnum k)))))
               (and (not wantq)
                    (or (> m n)
                        (< m
                           (min (the fixnum n)
                                (the fixnum k))))))
           (setf info -3))
          ((< k 0)
           (setf info -4))
          ((< lda (max (the fixnum 1) (the fixnum m)))
           (setf info -6))
```

```
          ((and
            (< lwork
               (max (the fixnum 1) (the fixnum mn)))
            (not lquery))
           (setf info -9)))
        (cond
          ((= info 0)
           (cond
             (wantq
              (setf nb (ilaenv 1 "DORGQR" " " m n k -1)))
             (t
              (setf nb (ilaenv 1 "DORGLQ" " " m n k -1))))
           (setf lwkopt
                 (f2cl-lib:int-mul
                  (max (the fixnum 1) (the fixnum mn))
                  nb))
           (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
                 (coerce (the fixnum lwkopt) 'double-float))))
p         (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DORGBR" (f2cl-lib:int-sub info))
           (go end_label))
          (lquery
           (go end_label)))
        (cond
          ((or (= m 0) (= n 0))
           (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
                 (coerce (the fixnum 1) 'double-float))
           (go end_label)))
        (cond
          (wantq
           (cond
             ((>= m k)
              (multiple-value-bind
                    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
                  (dorgqr m n k a lda tau work lwork iinfo)
                (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                                 var-7))
                (setf iinfo var-8)))
             (t
              (f2cl-lib:fdo (j m (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                            ((> j 2) nil)
                (tagbody
                  (setf (f2cl-lib:fref a-%data%
                                       (1 j)
                                       ((1 lda) (1 *))
                                       a-%offset%)
                        zero)
```

```
            (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                            (f2cl-lib:int-add i 1))
                          ((> i m) nil)
              (tagbody
                (setf (f2cl-lib:fref a-%data%
                                     (i j)
                                     ((1 lda) (1 *))
                                     a-%offset%)
                      (f2cl-lib:fref a-%data%
                                     (i (f2cl-lib:int-sub j 1))
                                     ((1 lda) (1 *))
                                     a-%offset%))))))
        (setf (f2cl-lib:fref a-%data% (1 1) ((1 lda) (1 *)) a-%offset%)
              one)
        (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
                      ((> i m) nil)
          (tagbody
            (setf (f2cl-lib:fref a-%data%
                                 (i 1)
                                 ((1 lda) (1 *))
                                 a-%offset%)
                  zero)))
        (cond
          ((> m 1)
           (multiple-value-bind
                 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
               (dorgqr (f2cl-lib:int-sub m 1) (f2cl-lib:int-sub m 1)
                (f2cl-lib:int-sub m 1)
                (f2cl-lib:array-slice a
                                      double-float
                                      (2 2)
                                      ((1 lda) (1 *)))
                lda tau work lwork iinfo)
             (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                              var-7))
             (setf iinfo var-8)))))))
    (t
     (cond
       ((< k n)
        (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
            (dorglq m n k a lda tau work lwork iinfo)
          (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                           var-7))
          (setf iinfo var-8)))
       (t
        (setf (f2cl-lib:fref a-%data% (1 1) ((1 lda) (1 *)) a-%offset%)
              one)
        (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
                      ((> i n) nil)
```

```
                (tagbody
                  (setf (f2cl-lib:fref a-%data%
                                       (i 1)
                                       ((1 lda) (1 *))
                                       a-%offset%)
                        zero)))
              (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
                            ((> j n) nil)
                (tagbody
                  (f2cl-lib:fdo (i (f2cl-lib:int-add j (f2cl-lib:int-sub 1))
                                   (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                                ((> i 2) nil)
                    (tagbody
                      (setf (f2cl-lib:fref a-%data%
                                           (i j)
                                           ((1 lda) (1 *))
                                           a-%offset%)
                            (f2cl-lib:fref a-%data%
                                           ((f2cl-lib:int-sub i 1) j)
                                           ((1 lda) (1 *))
                                           a-%offset%))))
                  (setf (f2cl-lib:fref a-%data%
                                       (1 j)
                                       ((1 lda) (1 *))
                                       a-%offset%)
                        zero)))
              (cond
                ((> n 1)
                 (multiple-value-bind
                       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
                     (dorglq (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1)
                      (f2cl-lib:int-sub n 1)
                      (f2cl-lib:array-slice a
                                            double-float
                                            (2 2)
                                            ((1 lda) (1 *)))
                      lda tau work lwork iinfo)
                   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                                    var-7))
                   (setf iinfo var-8))))))))
        (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
                (coerce (the fixnum lwkopt) 'double-float))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil info))))))
```

6.84 dorghr LAPACK

— **dorghr.input** —

```
)set break resume
)sys rm -f dorghr.output
)spool dorghr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dorghr.help** —

```
==========================================================================
dorghr examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

NAME
       DORGHR  - a real orthogonal matrix Q which is defined as the product of
       IHI-ILO elementary reflectors of order N, as returned by DGEHRD

SYNOPSIS
       SUBROUTINE DORGHR( N, ILO, IHI, A, LDA, TAU, WORK, LWORK, INFO )

           INTEGER        IHI, ILO, INFO, LDA, LWORK, N

           DOUBLE         PRECISION A( LDA, * ), TAU( * ), WORK( * )

  Purpose
  =======

  DORGHR generates a real orthogonal matrix Q which is defined as the
  product of IHI-ILO elementary reflectors of order N, as returned by
  DGEHRD:

  Q = H(ilo) H(ilo+1) . . . H(ihi-1).

  Arguments
  =========
```

```
  N       (input) INTEGER
          The order of the matrix Q. N >= 0.

  ILO     (input) INTEGER
  IHI     (input) INTEGER
          ILO and IHI must have the same values as in the previous call
          of DGEHRD. Q is equal to the unit matrix except in the
          submatrix Q(ilo+1:ihi,ilo+1:ihi).
          1 <= ILO <= IHI <= N, if N > 0; ILO=1 and IHI=0, if N=0.

  A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
          On entry, the vectors which define the elementary reflectors,
          as returned by DGEHRD.
          On exit, the N-by-N orthogonal matrix Q.

  LDA     (input) INTEGER
          The leading dimension of the array A. LDA >= max(1,N).

  TAU     (input) DOUBLE PRECISION array, dimension (N-1)
          TAU(i) must contain the scalar factor of the elementary
          reflector H(i), as returned by DGEHRD.

  WORK    (workspace/output) DOUBLE PRECISION array, dimension (LWORK)
          On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

  LWORK   (input) INTEGER
          The dimension of the array WORK. LWORK >= IHI-ILO.
          For optimum performance LWORK >= (IHI-ILO)*NB, where NB is
          the optimal blocksize.

          If LWORK = -1, then a workspace query is assumed; the routine
          only calculates the optimal size of the WORK array, returns
          this value as the first entry of the WORK array, and no error
          message related to LWORK is issued by XERBLA.

  INFO    (output) INTEGER
          = 0:  successful exit
          < 0:  if INFO = -i, the i-th argument had an illegal value
```

— dorghr.f —

```
      SUBROUTINE DORGHR( N, ILO, IHI, A, LDA, TAU, WORK, LWORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
```

```
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      INTEGER            IHI, ILO, INFO, LDA, LWORK, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            LQUERY
      INTEGER            I, IINFO, J, LWKOPT, NB, NH
*     ..
*     .. External Subroutines ..
      EXTERNAL           DORGQR, XERBLA
*     ..
*     .. External Functions ..
      INTEGER            ILAENV
      EXTERNAL           ILAENV
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      NH = IHI - ILO
      LQUERY = ( LWORK.EQ.-1 )
      IF( N.LT.0 ) THEN
         INFO = -1
      ELSE IF( ILO.LT.1 .OR. ILO.GT.MAX( 1, N ) ) THEN
         INFO = -2
      ELSE IF( IHI.LT.MIN( ILO, N ) .OR. IHI.GT.N ) THEN
         INFO = -3
      ELSE IF( LDA.LT.MAX( 1, N ) ) THEN
         INFO = -5
      ELSE IF( LWORK.LT.MAX( 1, NH ) .AND. .NOT.LQUERY ) THEN
         INFO = -8
      END IF
*
      IF( INFO.EQ.0 ) THEN
```

```
         NB = ILAENV( 1, 'DORGQR', ' ', NH, NH, NH, -1 )
         LWKOPT = MAX( 1, NH )*NB
         WORK( 1 ) = LWKOPT
      END IF
*
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DORGHR', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( N.EQ.0 ) THEN
         WORK( 1 ) = 1
         RETURN
      END IF
*
*     Shift the vectors which define the elementary reflectors one
*     column to the right, and set the first ilo and the last n-ihi
*     rows and columns to those of the unit matrix
*
      DO 40 J = IHI, ILO + 1, -1
         DO 10 I = 1, J - 1
            A( I, J ) = ZERO
   10    CONTINUE
         DO 20 I = J + 1, IHI
            A( I, J ) = A( I, J-1 )
   20    CONTINUE
         DO 30 I = IHI + 1, N
            A( I, J ) = ZERO
   30    CONTINUE
   40 CONTINUE
      DO 60 J = 1, ILO
         DO 50 I = 1, N
            A( I, J ) = ZERO
   50    CONTINUE
         A( J, J ) = ONE
   60 CONTINUE
      DO 80 J = IHI + 1, N
         DO 70 I = 1, N
            A( I, J ) = ZERO
   70    CONTINUE
         A( J, J ) = ONE
   80 CONTINUE
*
      IF( NH.GT.0 ) THEN
*
*        Generate Q(ilo+1:ihi,ilo+1:ihi)
```

```
*
         CALL DORGQR( NH, NH, NH, A( ILO+1, ILO+1 ), LDA, TAU( ILO ),
     $                WORK, LWORK, IINFO )
      END IF
      WORK( 1 ) = LWKOPT
      RETURN
*
*     End of DORGHR
*
      END
```

———-

— LAPACK dorghr —

```
(let* ((zero 0.0) (one 1.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one))
  (defun dorghr (n ilo ihi a lda tau work lwork info)
    (declare (type (simple-array double-float (*)) work tau a)
             (type fixnum info lwork lda ihi ilo n))
    (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((i 0) (iinfo 0) (j 0) (lwkopt 0) (nb 0) (nh 0) (lquery nil))
        (declare (type fixnum i iinfo j lwkopt nb nh)
                 (type (member t nil) lquery))
        (setf info 0)
        (setf nh (f2cl-lib:int-sub ihi ilo))
        (setf lquery (coerce (= lwork -1) '(member t nil)))
        (cond
          ((< n 0)
           (setf info -1))
          ((or (< ilo 1)
               (> ilo
                  (max (the fixnum 1) (the fixnum n))))
           (setf info -2))
          ((or
            (< ihi (min (the fixnum ilo) (the fixnum n)))
            (> ihi n))
           (setf info -3))
          ((< lda (max (the fixnum 1) (the fixnum n)))
           (setf info -5))
          ((and
            (< lwork
               (max (the fixnum 1) (the fixnum nh)))
            (not lquery))
```

```
   (setf info -8)))
(cond
  ((= info 0)
   (setf nb (ilaenv 1 "DORGQR" " " nh nh nh -1))
   (setf lwkopt
           (f2cl-lib:int-mul
            (max (the fixnum 1) (the fixnum nh))
            nb))
   (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
           (coerce (the fixnum lwkopt) 'double-float))))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DORGHR" (f2cl-lib:int-sub info))
   (go end_label))
  (lquery
   (go end_label)))
(cond
  ((= n 0)
   (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
           (coerce (the fixnum 1) 'double-float))
   (go end_label)))
(f2cl-lib:fdo (j ihi (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
              ((> j (f2cl-lib:int-add ilo 1)) nil)
  (tagbody
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  ((> i (f2cl-lib:int-add j (f2cl-lib:int-sub 1))) nil)
      (tagbody
        (setf (f2cl-lib:fref a-%data% (i j) ((1 lda) (1 *)) a-%offset%)
                zero)))
    (f2cl-lib:fdo (i (f2cl-lib:int-add j 1) (f2cl-lib:int-add i 1))
                  ((> i ihi) nil)
      (tagbody
        (setf (f2cl-lib:fref a-%data% (i j) ((1 lda) (1 *)) a-%offset%)
                (f2cl-lib:fref a-%data%
                               (i (f2cl-lib:int-sub j 1))
                               ((1 lda) (1 *))
                               a-%offset%))))
    (f2cl-lib:fdo (i (f2cl-lib:int-add ihi 1) (f2cl-lib:int-add i 1))
                  ((> i n) nil)
      (tagbody
        (setf (f2cl-lib:fref a-%data% (i j) ((1 lda) (1 *)) a-%offset%)
                zero)))))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
              ((> j ilo) nil)
  (tagbody
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  ((> i n) nil)
      (tagbody
```

```
              (setf (f2cl-lib:fref a-%data% (i j) ((1 lda) (1 *)) a-%offset%)
                    zero)))
            (setf (f2cl-lib:fref a-%data% (j j) ((1 lda) (1 *)) a-%offset%)
                  one)))
        (f2cl-lib:fdo (j (f2cl-lib:int-add ihi 1) (f2cl-lib:int-add j 1))
                      ((> j n) nil)
          (tagbody
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          ((> i n) nil)
              (tagbody
                (setf (f2cl-lib:fref a-%data% (i j) ((1 lda) (1 *)) a-%offset%)
                      zero)))
            (setf (f2cl-lib:fref a-%data% (j j) ((1 lda) (1 *)) a-%offset%)
                  one)))
        (cond
          ((> nh 0)
           (multiple-value-bind
                (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
               (dorgqr nh nh nh
                (f2cl-lib:array-slice a
                                      double-float
                                      ((+ ilo 1) (f2cl-lib:int-add ilo 1))
                                      ((1 lda) (1 *)))
                lda (f2cl-lib:array-slice tau double-float (ilo) ((1 *))) work
                lwork iinfo)
             (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7))
             (setf iinfo var-8))))
        (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
              (coerce (the fixnum lwkopt) 'double-float))
 end_label
        (return (values nil nil nil nil nil nil nil nil info))))))
```

———-

6.85 dorgl2 LAPACK

— **dorgl2.input** —

```
)set break resume
)sys rm -f dorgl2.output
)spool dorgl2.output
)set message test on
)set message auto off
)clear all

)spool
```

```
)lisp (bye)
```

———-

— dorgl2.help —

```
==========================================================================
dorgl2 examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

NAME
       DORGL2 - an m by n real matrix Q with orthonormal rows,

SYNOPSIS
       SUBROUTINE DORGL2( M, N, K, A, LDA, TAU, WORK, INFO )

           INTEGER        INFO, K, LDA, M, N

           DOUBLE         PRECISION A( LDA, * ), TAU( * ), WORK( * )

  Purpose
  =======

  DORGL2 generates an m by n real matrix Q with orthonormal rows,
  which is defined as the first m rows of a product of k elementary
  reflectors of order n

        Q  =  H(k) . . . H(2) H(1)

  as returned by DGELQF.

  Arguments
  =========

  M       (input) INTEGER
          The number of rows of the matrix Q. M >= 0.

  N       (input) INTEGER
          The number of columns of the matrix Q. N >= M.

  K       (input) INTEGER
          The number of elementary reflectors whose product defines the
          matrix Q. M >= K >= 0.

  A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
```

```
          On entry, the i-th row must contain the vector which defines
          the elementary reflector H(i), for i = 1,2,...,k, as returned
          by DGELQF in the first k rows of its array argument A.
          On exit, the m-by-n matrix Q.

  LDA     (input) INTEGER
          The first dimension of the array A. LDA >= max(1,M).

  TAU     (input) DOUBLE PRECISION array, dimension (K)
          TAU(i) must contain the scalar factor of the elementary
          reflector H(i), as returned by DGELQF.

  WORK    (workspace) DOUBLE PRECISION array, dimension (M)

  INFO    (output) INTEGER
          = 0: successful exit
          < 0: if INFO = -i, the i-th argument has an illegal value
```

———-

— dorgl2.f —

```
      SUBROUTINE DORGL2( M, N, K, A, LDA, TAU, WORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      INTEGER            INFO, K, LDA, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE, ZERO
      PARAMETER          ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I, J, L
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLARF, DSCAL, XERBLA
*     ..
```

```
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      IF( M.LT.0 ) THEN
         INFO = -1
      ELSE IF( N.LT.M ) THEN
         INFO = -2
      ELSE IF( K.LT.0 .OR. K.GT.M ) THEN
         INFO = -3
      ELSE IF( LDA.LT.MAX( 1, M ) ) THEN
         INFO = -5
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DORGL2', -INFO )
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( M.LE.0 )
     $   RETURN
*
      IF( K.LT.M ) THEN
*
*        Initialise rows k+1:m to rows of the unit matrix
*
         DO 20 J = 1, N
            DO 10 L = K + 1, M
               A( L, J ) = ZERO
   10       CONTINUE
            IF( J.GT.K .AND. J.LE.M )
     $         A( J, J ) = ONE
   20    CONTINUE
      END IF
*
      DO 40 I = K, 1, -1
*
*        Apply H(i) to A(i:m,i:n) from the right
*
         IF( I.LT.N ) THEN
            IF( I.LT.M ) THEN
               A( I, I ) = ONE
               CALL DLARF( 'Right', M-I, N-I+1, A( I, I ), LDA,
     $                     TAU( I ), A( I+1, I ), LDA, WORK )
            END IF
```

```
            CALL DSCAL( N-I, -TAU( I ), A( I, I+1 ), LDA )
         END IF
         A( I, I ) = ONE - TAU( I )
*
*        Set A(i,1:i-1) to zero
*
         DO 30 L = 1, I - 1
            A( I, L ) = ZERO
   30    CONTINUE
   40 CONTINUE
      RETURN
*
*     End of DORGL2
*
      END
```

———-

— LAPACK dorgl2 —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun dorgl2 (m n k a lda tau work info)
    (declare (type (simple-array double-float (*)) work tau a)
             (type fixnum info lda k n m))
    (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((i 0) (j 0) (l 0))
        (declare (type fixnum i j l))
        (setf info 0)
        (cond
          ((< m 0)
           (setf info -1))
          ((< n m)
           (setf info -2))
          ((or (< k 0) (> k m))
           (setf info -3))
          ((< lda (max (the fixnum 1) (the fixnum m)))
           (setf info -5)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DORGL2" (f2cl-lib:int-sub info))
           (go end_label)))
```

```
(if (<= m 0) (go end_label))
(cond
  ((< k m)
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
     (tagbody
       (f2cl-lib:fdo (l (f2cl-lib:int-add k 1) (f2cl-lib:int-add l 1))
                     ((> l m) nil)
         (tagbody
           (setf (f2cl-lib:fref a-%data%
                                (l j)
                                ((1 lda) (1 *))
                                a-%offset%)
                 zero)))
       (if (and (> j k) (<= j m))
           (setf (f2cl-lib:fref a-%data%
                                (j j)
                                ((1 lda) (1 *))
                                a-%offset%)
                 one))))))
(f2cl-lib:fdo (i k (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
              ((> i 1) nil)
  (tagbody
    (cond
      ((< i n)
       (cond
         ((< i m)
          (setf (f2cl-lib:fref a-%data%
                               (i i)
                               ((1 lda) (1 *))
                               a-%offset%)
                one)
          (dlarf "Right" (f2cl-lib:int-sub m i)
           (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1)
           (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
           lda (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)
           (f2cl-lib:array-slice a
                                 double-float
                                 ((+ i 1) i)
                                 ((1 lda) (1 *)))
           lda work)))
       (dscal (f2cl-lib:int-sub n i)
        (- (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%))
        (f2cl-lib:array-slice a
                              double-float
                              (i (f2cl-lib:int-add i 1))
                              ((1 lda) (1 *)))
        lda)))
    (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
          (- one
```

```
                    (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)))
           (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                         ((> l (f2cl-lib:int-add i (f2cl-lib:int-sub 1))) nil)
             (tagbody
               (setf (f2cl-lib:fref a-%data% (i l) ((1 lda) (1 *)) a-%offset%)
                       zero)))))
 end_label
        (return (values nil nil nil nil nil nil nil info))))))
```

———-

6.86 dorglq LAPACK

— **dorglq.input** —

```
)set break resume
)sys rm -f dorglq.output
)spool dorglq.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dorglq.help** —

```
=======================================================================
dorglq examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

NAME
       DORGLQ - an M-by-N real matrix Q with orthonormal rows,

SYNOPSIS
       SUBROUTINE DORGLQ( M, N, K, A, LDA, TAU, WORK, LWORK, INFO )

           INTEGER        INFO, K, LDA, LWORK, M, N
```

```
          DOUBLE         PRECISION A( LDA, * ), TAU( * ), WORK( * )

  Purpose
  =======

  DORGLQ generates an M-by-N real matrix Q with orthonormal rows,
  which is defined as the first M rows of a product of K elementary
  reflectors of order N

        Q  =  H(k) . . . H(2) H(1)

  as returned by DGELQF.

  Arguments
  =========

  M       (input) INTEGER
          The number of rows of the matrix Q. M >= 0.

  N       (input) INTEGER
          The number of columns of the matrix Q. N >= M.

  K       (input) INTEGER
          The number of elementary reflectors whose product defines the
          matrix Q. M >= K >= 0.

  A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
          On entry, the i-th row must contain the vector which defines
          the elementary reflector H(i), for i = 1,2,...,k, as returned
          by DGELQF in the first k rows of its array argument A.
          On exit, the M-by-N matrix Q.

  LDA     (input) INTEGER
          The first dimension of the array A. LDA >= max(1,M).

  TAU     (input) DOUBLE PRECISION array, dimension (K)
          TAU(i) must contain the scalar factor of the elementary
          reflector H(i), as returned by DGELQF.

  WORK    (workspace/output) DOUBLE PRECISION array, dimension (LWORK)
          On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

  LWORK   (input) INTEGER
          The dimension of the array WORK. LWORK >= max(1,M).
          For optimum performance LWORK >= M*NB, where NB is
          the optimal blocksize.

          If LWORK = -1, then a workspace query is assumed; the routine
          only calculates the optimal size of the WORK array, returns
          this value as the first entry of the WORK array, and no error
```

```
         message related to LWORK is issued by XERBLA.

  INFO    (output) INTEGER
          = 0:  successful exit
          < 0:  if INFO = -i, the i-th argument has an illegal value
```

— dorglq.f —

```
      SUBROUTINE DORGLQ( M, N, K, A, LDA, TAU, WORK, LWORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      INTEGER            INFO, K, LDA, LWORK, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER          ( ZERO = 0.0D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            LQUERY
      INTEGER            I, IB, IINFO, IWS, J, KI, KK, L, LDWORK,
     $                   LWKOPT, NB, NBMIN, NX
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLARFB, DLARFT, DORGL2, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. External Functions ..
      INTEGER            ILAENV
      EXTERNAL           ILAENV
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
```

```
*
      INFO = 0
      NB = ILAENV( 1, 'DORGLQ', ' ', M, N, K, -1 )
      LWKOPT = MAX( 1, M )*NB
      WORK( 1 ) = LWKOPT
      LQUERY = ( LWORK.EQ.-1 )
      IF( M.LT.0 ) THEN
         INFO = -1
      ELSE IF( N.LT.M ) THEN
         INFO = -2
      ELSE IF( K.LT.0 .OR. K.GT.M ) THEN
         INFO = -3
      ELSE IF( LDA.LT.MAX( 1, M ) ) THEN
         INFO = -5
      ELSE IF( LWORK.LT.MAX( 1, M ) .AND. .NOT.LQUERY ) THEN
         INFO = -8
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DORGLQ', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( M.LE.0 ) THEN
         WORK( 1 ) = 1
         RETURN
      END IF
*
      NBMIN = 2
      NX = 0
      IWS = M
      IF( NB.GT.1 .AND. NB.LT.K ) THEN
*
*        Determine when to cross over from blocked to unblocked code.
*
         NX = MAX( 0, ILAENV( 3, 'DORGLQ', ' ', M, N, K, -1 ) )
         IF( NX.LT.K ) THEN
*
*           Determine if workspace is large enough for blocked code.
*
            LDWORK = M
            IWS = LDWORK*NB
            IF( LWORK.LT.IWS ) THEN
*
*              Not enough workspace to use optimal NB:  reduce NB and
*              determine the minimum value of NB.
*
```

```
               NB = LWORK / LDWORK
               NBMIN = MAX( 2, ILAENV( 2, 'DORGLQ', ' ', M, N, K, -1 ) )
            END IF
         END IF
      END IF
*
      IF( NB.GE.NBMIN .AND. NB.LT.K .AND. NX.LT.K ) THEN
*
*        Use blocked code after the last block.
*        The first kk rows are handled by the block method.
*
         KI = ( ( K-NX-1 ) / NB )*NB
         KK = MIN( K, KI+NB )
*
*        Set A(kk+1:m,1:kk) to zero.
*
         DO 20 J = 1, KK
            DO 10 I = KK + 1, M
               A( I, J ) = ZERO
   10       CONTINUE
   20    CONTINUE
      ELSE
         KK = 0
      END IF
*
*     Use unblocked code for the last or only block.
*
      IF( KK.LT.M )
     $   CALL DORGL2( M-KK, N-KK, K-KK, A( KK+1, KK+1 ), LDA,
     $                TAU( KK+1 ), WORK, IINFO )
*
      IF( KK.GT.0 ) THEN
*
*        Use blocked code
*
         DO 50 I = KI + 1, 1, -NB
            IB = MIN( NB, K-I+1 )
            IF( I+IB.LE.M ) THEN
*
*              Form the triangular factor of the block reflector
*              H = H(i) H(i+1) . . . H(i+ib-1)
*
               CALL DLARFT( 'Forward', 'Rowwise', N-I+1, IB, A( I, I ),
     $                      LDA, TAU( I ), WORK, LDWORK )
*
*              Apply H' to A(i+ib:m,i:n) from the right
*
               CALL DLARFB( 'Right', 'Transpose', 'Forward', 'Rowwise',
     $                      M-I-IB+1, N-I+1, IB, A( I, I ), LDA, WORK,
     $                      LDWORK, A( I+IB, I ), LDA, WORK( IB+1 ),
```

```
     $                     LDWORK )
           END IF
*
*          Apply H' to columns i:n of current block
*
           CALL DORGL2( IB, N-I+1, IB, A( I, I ), LDA, TAU( I ), WORK,
     $                  IINFO )
*
*          Set columns 1:i-1 of current block to zero
*
           DO 40 J = 1, I - 1
              DO 30 L = I, I + IB - 1
                 A( L, J ) = ZERO
   30         CONTINUE
   40      CONTINUE
   50    CONTINUE
      END IF
*
      WORK( 1 ) = IWS
      RETURN
*
*     End of DORGLQ
*
      END
```

———-

— LAPACK dorglq —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dorglq (m n k a lda tau work lwork info)
    (declare (type (simple-array double-float (*)) work tau a)
             (type fixnum info lwork lda k n m))
    (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((i 0) (ib 0) (iinfo 0) (iws 0) (j 0) (ki 0) (kk 0) (l 0)
             (ldwork 0) (lwkopt 0) (nb 0) (nbmin 0) (nx 0) (lquery nil))
        (declare (type fixnum i ib iinfo iws j ki kk l ldwork
                                          lwkopt nb nbmin nx)
                 (type (member t nil) lquery))
        (setf info 0)
        (setf nb (ilaenv 1 "DORGLQ" " " m n k -1))
        (setf lwkopt
                (f2cl-lib:int-mul
                 (max (the fixnum 1) (the fixnum m))
```

```
         nb))
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
        (coerce (the fixnum lwkopt) 'double-float))
(setf lquery (coerce (= lwork -1) '(member t nil)))
(cond
  ((< m 0)
   (setf info -1))
  ((< n m)
   (setf info -2))
  ((or (< k 0) (> k m))
   (setf info -3))
  ((< lda (max (the fixnum 1) (the fixnum m)))
   (setf info -5))
  ((and
    (< lwork (max (the fixnum 1) (the fixnum m)))
    (not lquery))
   (setf info -8)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DORGLQ" (f2cl-lib:int-sub info))
   (go end_label))
  (lquery
   (go end_label)))
(cond
  ((<= m 0)
   (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
           (coerce (the fixnum 1) 'double-float))
   (go end_label)))
(setf nbmin 2)
(setf nx 0)
(setf iws m)
(cond
  ((and (> nb 1) (< nb k))
   (setf nx
           (max (the fixnum 0)
                (the fixnum
                     (ilaenv 3 "DORGLQ" " " m n k -1))))
   (cond
     ((< nx k)
      (setf ldwork m)
      (setf iws (f2cl-lib:int-mul ldwork nb))
      (cond
        ((< lwork iws)
         (setf nb (the fixnum (truncate lwork ldwork)))
         (setf nbmin
                 (max (the fixnum 2)
                      (the fixnum
                           (ilaenv 2 "DORGLQ" " " m n k -1)))))))))))
```

```
(cond
  ((and (>= nb nbmin) (< nb k) (< nx k))
   (setf ki (* (the fixnum (truncate (- k nx 1) nb)) nb))
   (setf kk
         (min (the fixnum k)
              (the fixnum (f2cl-lib:int-add ki nb))))
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j kk) nil)
     (tagbody
       (f2cl-lib:fdo (i (f2cl-lib:int-add kk 1) (f2cl-lib:int-add i 1))
                     ((> i m) nil)
         (tagbody
           (setf (f2cl-lib:fref a-%data%
                                (i j)
                                ((1 lda) (1 *))
                                a-%offset%)
                 zero))))))
  (t
   (setf kk 0)))
(if (< kk m)
    (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
        (dorgl2 (f2cl-lib:int-sub m kk) (f2cl-lib:int-sub n kk)
         (f2cl-lib:int-sub k kk)
         (f2cl-lib:array-slice a
                               double-float
                               ((+ kk 1) (f2cl-lib:int-add kk 1))
                               ((1 lda) (1 *)))
         lda (f2cl-lib:array-slice tau double-float ((+ kk 1)) ((1 *)))
         work iinfo)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
      (setf iinfo var-7)))
(cond
  ((> kk 0)
   (f2cl-lib:fdo (i (f2cl-lib:int-add ki 1)
                  (f2cl-lib:int-add i (f2cl-lib:int-sub nb)))
                 ((> i 1) nil)
     (tagbody
       (setf ib
             (min (the fixnum nb)
                  (the fixnum
                       (f2cl-lib:int-add (f2cl-lib:int-sub k i) 1))))
       (cond
         ((<= (f2cl-lib:int-add i ib) m)
          (dlarft "Forward" "Rowwise"
           (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1) ib
           (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
           lda (f2cl-lib:array-slice tau double-float (i) ((1 *))) work
           ldwork)
          (dlarfb "Right" "Transpose" "Forward" "Rowwise"
```

```
                (f2cl-lib:int-add (f2cl-lib:int-sub m i ib) 1)
                (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1) ib
                (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
                lda work ldwork
                (f2cl-lib:array-slice a
                                      double-float
                                      ((+ i ib) i)
                                      ((1 lda) (1 *)))
                lda
                (f2cl-lib:array-slice work double-float ((+ ib 1)) ((1 *)))
                ldwork)))
            (multiple-value-bind
                  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
                (dorgl2 ib (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1) ib
                 (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
                 lda (f2cl-lib:array-slice tau double-float (i) ((1 *)))
                 work iinfo)
              (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
              (setf iinfo var-7))
            (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                          ((> j (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                           nil)
              (tagbody
                (f2cl-lib:fdo (l i (f2cl-lib:int-add l 1))
                              ((> l
                                  (f2cl-lib:int-add i
                                                    ib
                                                    (f2cl-lib:int-sub 1)))
                               nil)
                  (tagbody
                    (setf (f2cl-lib:fref a-%data%
                                         (l j)
                                         ((1 lda) (1 *))
                                         a-%offset%)
                          zero)))))))
      (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
            (coerce (the fixnum iws) 'double-float))
end_label
      (return (values nil nil nil nil nil nil nil nil info))))))
```

———-

6.87 dorgqr LAPACK

— **dorgqr.input** —

```
)set break resume
)sys rm -f dorgqr.output
)spool dorgqr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dorgqr.help —

```
==========================================================================
dorgqr examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

NAME
       DORGQR - an M-by-N real matrix Q with orthonormal columns,

SYNOPSIS
       SUBROUTINE DORGQR( M, N, K, A, LDA, TAU, WORK, LWORK, INFO )

           INTEGER        INFO, K, LDA, LWORK, M, N

           DOUBLE         PRECISION A( LDA, * ), TAU( * ), WORK( * )

  Purpose
  =======

  DORGQR generates an M-by-N real matrix Q with orthonormal columns,
  which is defined as the first N columns of a product of K elementary
  reflectors of order M

        Q  =  H(1) H(2) . . . H(k)

  as returned by DGEQRF.

  Arguments
  =========

  M       (input) INTEGER
          The number of rows of the matrix Q. M >= 0.
```

```
  N       (input) INTEGER
          The number of columns of the matrix Q. M >= N >= 0.

  K       (input) INTEGER
          The number of elementary reflectors whose product defines the
          matrix Q. N >= K >= 0.

  A       (input/output) DOUBLE PRECISION array, dimension (LDA,N)
          On entry, the i-th column must contain the vector which
          defines the elementary reflector H(i), for i = 1,2,...,k, as
          returned by DGEQRF in the first k columns of its array
          argument A.
          On exit, the M-by-N matrix Q.

  LDA     (input) INTEGER
          The first dimension of the array A. LDA >= max(1,M).

  TAU     (input) DOUBLE PRECISION array, dimension (K)
          TAU(i) must contain the scalar factor of the elementary
          reflector H(i), as returned by DGEQRF.

  WORK    (workspace/output) DOUBLE PRECISION array, dimension (LWORK)
          On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

  LWORK   (input) INTEGER
          The dimension of the array WORK. LWORK >= max(1,N).
          For optimum performance LWORK >= N*NB, where NB is the
          optimal blocksize.

          If LWORK = -1, then a workspace query is assumed; the routine
          only calculates the optimal size of the WORK array, returns
          this value as the first entry of the WORK array, and no error
          message related to LWORK is issued by XERBLA.

  INFO    (output) INTEGER
          = 0:  successful exit
          < 0:  if INFO = -i, the i-th argument has an illegal value
```

———-

— dorgqr.f —

```
      SUBROUTINE DORGQR( M, N, K, A, LDA, TAU, WORK, LWORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
```

```
*
*     .. Scalar Arguments ..
      INTEGER            INFO, K, LDA, LWORK, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER          ( ZERO = 0.0D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            LQUERY
      INTEGER            I, IB, IINFO, IWS, J, KI, KK, L, LDWORK,
     $                   LWKOPT, NB, NBMIN, NX
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLARFB, DLARFT, DORG2R, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. External Functions ..
      INTEGER            ILAENV
      EXTERNAL           ILAENV
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      NB = ILAENV( 1, 'DORGQR', ' ', M, N, K, -1 )
      LWKOPT = MAX( 1, N )*NB
      WORK( 1 ) = LWKOPT
      LQUERY = ( LWORK.EQ.-1 )
      IF( M.LT.0 ) THEN
         INFO = -1
      ELSE IF( N.LT.0 .OR. N.GT.M ) THEN
         INFO = -2
      ELSE IF( K.LT.0 .OR. K.GT.N ) THEN
         INFO = -3
      ELSE IF( LDA.LT.MAX( 1, M ) ) THEN
         INFO = -5
      ELSE IF( LWORK.LT.MAX( 1, N ) .AND. .NOT.LQUERY ) THEN
         INFO = -8
      END IF
      IF( INFO.NE.0 ) THEN
```

```
         CALL XERBLA( 'DORGQR', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( N.LE.0 ) THEN
         WORK( 1 ) = 1
         RETURN
      END IF
*
      NBMIN = 2
      NX = 0
      IWS = N
      IF( NB.GT.1 .AND. NB.LT.K ) THEN
*
*        Determine when to cross over from blocked to unblocked code.
*
         NX = MAX( 0, ILAENV( 3, 'DORGQR', ' ', M, N, K, -1 ) )
         IF( NX.LT.K ) THEN
*
*           Determine if workspace is large enough for blocked code.
*
            LDWORK = N
            IWS = LDWORK*NB
            IF( LWORK.LT.IWS ) THEN
*
*              Not enough workspace to use optimal NB:  reduce NB and
*              determine the minimum value of NB.
*
               NB = LWORK / LDWORK
               NBMIN = MAX( 2, ILAENV( 2, 'DORGQR', ' ', M, N, K, -1 ) )
            END IF
         END IF
      END IF
*
      IF( NB.GE.NBMIN .AND. NB.LT.K .AND. NX.LT.K ) THEN
*
*        Use blocked code after the last block.
*        The first kk columns are handled by the block method.
*
         KI = ( ( K-NX-1 ) / NB )*NB
         KK = MIN( K, KI+NB )
*
*        Set A(1:kk,kk+1:n) to zero.
*
         DO 20 J = KK + 1, N
            DO 10 I = 1, KK
```

```
               A( I, J ) = ZERO
   10       CONTINUE
   20    CONTINUE
         ELSE
            KK = 0
         END IF
*
*        Use unblocked code for the last or only block.
*
         IF( KK.LT.N )
     $      CALL DORG2R( M-KK, N-KK, K-KK, A( KK+1, KK+1 ), LDA,
     $                   TAU( KK+1 ), WORK, IINFO )
*
         IF( KK.GT.0 ) THEN
*
*           Use blocked code
*
            DO 50 I = KI + 1, 1, -NB
               IB = MIN( NB, K-I+1 )
               IF( I+IB.LE.N ) THEN
*
*                 Form the triangular factor of the block reflector
*                 H = H(i) H(i+1) . . . H(i+ib-1)
*
                  CALL DLARFT( 'Forward', 'Columnwise', M-I+1, IB,
     $                         A( I, I ), LDA, TAU( I ), WORK, LDWORK )
*
*                 Apply H to A(i:m,i+ib:n) from the left
*
                  CALL DLARFB( 'Left', 'No transpose', 'Forward',
     $                         'Columnwise', M-I+1, N-I-IB+1, IB,
     $                         A( I, I ), LDA, WORK, LDWORK, A( I, I+IB ),
     $                         LDA, WORK( IB+1 ), LDWORK )
               END IF
*
*              Apply H to rows i:m of current block
*
               CALL DORG2R( M-I+1, IB, IB, A( I, I ), LDA, TAU( I ), WORK,
     $                      IINFO )
*
*              Set rows 1:i-1 of current block to zero
*
               DO 40 J = I, I + IB - 1
                  DO 30 L = 1, I - 1
                     A( L, J ) = ZERO
   30             CONTINUE
   40          CONTINUE
   50       CONTINUE
         END IF
*
```

```
      WORK( 1 ) = IWS
      RETURN
*
*     End of DORGQR
*
      END
```

— LAPACK dorgqr —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dorgqr (m n k a lda tau work lwork info)
    (declare (type (simple-array double-float (*)) work tau a)
             (type fixnum info lwork lda k n m))
    (f2cl-lib:with-multi-array-data
        ((a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((i 0) (ib 0) (iinfo 0) (iws 0) (j 0) (ki 0) (kk 0) (l 0)
             (ldwork 0) (lwkopt 0) (nb 0) (nbmin 0) (nx 0) (lquery nil))
        (declare (type fixnum i ib iinfo iws j ki kk l ldwork
                                          lwkopt nb nbmin nx)
                 (type (member t nil) lquery))
        (setf info 0)
        (setf nb (ilaenv 1 "DORGQR" " " m n k -1))
        (setf lwkopt
                (f2cl-lib:int-mul
                 (max (the fixnum 1) (the fixnum n))
                 nb))
        (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
                (coerce (the fixnum lwkopt) 'double-float))
        (setf lquery (coerce (= lwork -1) '(member t nil)))
        (cond
          ((< m 0)
           (setf info -1))
          ((or (< n 0) (> n m))
           (setf info -2))
          ((or (< k 0) (> k n))
           (setf info -3))
          ((< lda (max (the fixnum 1) (the fixnum m)))
           (setf info -5))
          ((and
            (< lwork (max (the fixnum 1) (the fixnum n)))
            (not lquery))
           (setf info -8)))
        (cond
```

```
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DORGQR" (f2cl-lib:int-sub info))
   (go end_label))
  (lquery
   (go end_label)))
(cond
  ((<= n 0)
   (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
           (coerce (the fixnum 1) 'double-float))
   (go end_label)))
(setf nbmin 2)
(setf nx 0)
(setf iws n)
(cond
  ((and (> nb 1) (< nb k))
   (setf nx
           (max (the fixnum 0)
                (the fixnum
                     (ilaenv 3 "DORGQR" " " m n k -1))))
   (cond
     ((< nx k)
      (setf ldwork n)
      (setf iws (f2cl-lib:int-mul ldwork nb))
      (cond
        ((< lwork iws)
         (setf nb (the fixnum (truncate lwork ldwork)))
         (setf nbmin
                 (max (the fixnum 2)
                      (the fixnum
                           (ilaenv 2 "DORGQR" " " m n k -1)))))))))
(cond
  ((and (>= nb nbmin) (< nb k) (< nx k))
   (setf ki (* (the fixnum (truncate (- k nx 1) nb)) nb))
   (setf kk
           (min (the fixnum k)
                (the fixnum (f2cl-lib:int-add ki nb))))
   (f2cl-lib:fdo (j (f2cl-lib:int-add kk 1) (f2cl-lib:int-add j 1))
                 ((> j n) nil)
     (tagbody
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                     ((> i kk) nil)
         (tagbody
           (setf (f2cl-lib:fref a-%data%
                                (i j)
                                ((1 lda) (1 *))
                                a-%offset%)
                   zero))))))
  (t
```

```
   (setf kk 0)))
(if (< kk n)
    (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
        (dorg2r (f2cl-lib:int-sub m kk) (f2cl-lib:int-sub n kk)
         (f2cl-lib:int-sub k kk)
         (f2cl-lib:array-slice a
                               double-float
                               ((+ kk 1) (f2cl-lib:int-add kk 1))
                               ((1 lda) (1 *)))
         lda (f2cl-lib:array-slice tau double-float ((+ kk 1)) ((1 *)))
         work iinfo)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
      (setf iinfo var-7)))
(cond
  ((> kk 0)
   (f2cl-lib:fdo (i (f2cl-lib:int-add ki 1)
                  (f2cl-lib:int-add i (f2cl-lib:int-sub nb)))
                 ((> i 1) nil)
     (tagbody
       (setf ib
             (min (the fixnum nb)
                  (the fixnum
                       (f2cl-lib:int-add (f2cl-lib:int-sub k i) 1))))
       (cond
         ((<= (f2cl-lib:int-add i ib) n)
          (dlarft "Forward" "Columnwise"
           (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1) ib
           (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
           lda (f2cl-lib:array-slice tau double-float (i) ((1 *))) work
           ldwork)
          (dlarfb "Left" "No transpose" "Forward" "Columnwise"
           (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
           (f2cl-lib:int-add (f2cl-lib:int-sub n i ib) 1) ib
           (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
           lda work ldwork
           (f2cl-lib:array-slice a
                                 double-float
                                 (i (f2cl-lib:int-add i ib))
                                 ((1 lda) (1 *)))
           lda
           (f2cl-lib:array-slice work double-float ((+ ib 1)) ((1 *)))
           ldwork)))
       (multiple-value-bind
             (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
           (dorg2r (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1) ib ib
            (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *)))
            lda (f2cl-lib:array-slice tau double-float (i) ((1 *)))
            work iinfo)
         (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6))
```

```
                (setf iinfo var-7))
              (f2cl-lib:fdo (j i (f2cl-lib:int-add j 1))
                            ((> j
                                (f2cl-lib:int-add i ib (f2cl-lib:int-sub 1)))
                             nil)
                (tagbody
                  (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                                ((> l
                                    (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                                 nil)
                    (tagbody
                      (setf (f2cl-lib:fref a-%data%
                                           (l j)
                                           ((1 lda) (1 *))
                                           a-%offset%)
                            zero)))))))))
       (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
             (coerce (the fixnum iws) 'double-float))
 end_label
       (return (values nil nil nil nil nil nil nil nil info))))))
```

———-

6.88 dorm2r LAPACK

— **dorm2r.input** —

```
)set break resume
)sys rm -f dorm2r.output
)spool dorm2r.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dorm2r.help** —

```
==========================================================================
dorm2r examples
==========================================================================
```

```
==========================================================================
Man Page Details
==========================================================================

NAME
       DORM2R  -  the  general real m by n matrix C with   Q * C if SIDE = 'L'
       and TRANS = 'N', or   Q'* C if SIDE = 'L' and TRANS = 'T', or   C  *  Q
       if  SIDE  =  'R' and TRANS = 'N', or   C * Q' if SIDE = 'R' and TRANS =
       'T',

SYNOPSIS
       SUBROUTINE DORM2R( SIDE, TRANS, M, N, K, A, LDA,  TAU,  C,  LDC,  WORK,
                          INFO )

           CHARACTER      SIDE, TRANS

           INTEGER        INFO, K, LDA, LDC, M, N

           DOUBLE         PRECISION  A( LDA, * ), C( LDC, * ), TAU( * ), WORK(
                          * )

  Purpose
  =======

  DORM2R overwrites the general real m by n matrix C with

        Q * C  if SIDE = 'L' and TRANS = 'N', or

        Q'* C  if SIDE = 'L' and TRANS = 'T', or

        C * Q  if SIDE = 'R' and TRANS = 'N', or

        C * Q' if SIDE = 'R' and TRANS = 'T',

  where Q is a real orthogonal matrix defined as the product of k
  elementary reflectors

        Q = H(1) H(2) . . . H(k)

  as returned by DGEQRF. Q is of order m if SIDE = 'L' and of order n
  if SIDE = 'R'.

  Arguments
  =========

  SIDE    (input) CHARACTER*1
          = 'L': apply Q or Q' from the Left
          = 'R': apply Q or Q' from the Right

  TRANS   (input) CHARACTER*1
```

```
        = 'N': apply Q  (No transpose)
        = 'T': apply Q' (Transpose)

M       (input) INTEGER
        The number of rows of the matrix C. M >= 0.

N       (input) INTEGER
        The number of columns of the matrix C. N >= 0.

K       (input) INTEGER
        The number of elementary reflectors whose product defines
        the matrix Q.
        If SIDE = 'L', M >= K >= 0;
        if SIDE = 'R', N >= K >= 0.

A       (input) DOUBLE PRECISION array, dimension (LDA,K)
        The i-th column must contain the vector which defines the
        elementary reflector H(i), for i = 1,2,...,k, as returned by
        DGEQRF in the first k columns of its array argument A.
        A is modified by the routine but restored on exit.

LDA     (input) INTEGER
        The leading dimension of the array A.
        If SIDE = 'L', LDA >= max(1,M);
        if SIDE = 'R', LDA >= max(1,N).

TAU     (input) DOUBLE PRECISION array, dimension (K)
        TAU(i) must contain the scalar factor of the elementary
        reflector H(i), as returned by DGEQRF.

C       (input/output) DOUBLE PRECISION array, dimension (LDC,N)
        On entry, the m by n matrix C.
        On exit, C is overwritten by Q*C or Q'*C or C*Q' or C*Q.

LDC     (input) INTEGER
        The leading dimension of the array C. LDC >= max(1,M).

WORK    (workspace) DOUBLE PRECISION array, dimension
                                (N) if SIDE = 'L',
                                (M) if SIDE = 'R'

INFO    (output) INTEGER
        = 0: successful exit
        < 0: if INFO = -i, the i-th argument had an illegal value
```

———-

— dorm2r.f —

```
      SUBROUTINE DORM2R( SIDE, TRANS, M, N, K, A, LDA, TAU, C, LDC,
     $                   WORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     February 29, 1992
*
*     .. Scalar Arguments ..
      CHARACTER          SIDE, TRANS
      INTEGER            INFO, K, LDA, LDC, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), C( LDC, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE
      PARAMETER          ( ONE = 1.0D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            LEFT, NOTRAN
      INTEGER            I, I1, I2, I3, IC, JC, MI, NI, NQ
      DOUBLE PRECISION   AII
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLARF, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      LEFT = LSAME( SIDE, 'L' )
      NOTRAN = LSAME( TRANS, 'N' )
*
*     NQ is the order of Q
*
      IF( LEFT ) THEN
         NQ = M
      ELSE
```

```
         NQ = N
      END IF
      IF( .NOT.LEFT .AND. .NOT.LSAME( SIDE, 'R' ) ) THEN
         INFO = -1
      ELSE IF( .NOT.NOTRAN .AND. .NOT.LSAME( TRANS, 'T' ) ) THEN
         INFO = -2
      ELSE IF( M.LT.0 ) THEN
         INFO = -3
      ELSE IF( N.LT.0 ) THEN
         INFO = -4
      ELSE IF( K.LT.0 .OR. K.GT.NQ ) THEN
         INFO = -5
      ELSE IF( LDA.LT.MAX( 1, NQ ) ) THEN
         INFO = -7
      ELSE IF( LDC.LT.MAX( 1, M ) ) THEN
         INFO = -10
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DORM2R', -INFO )
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( M.EQ.0 .OR. N.EQ.0 .OR. K.EQ.0 )
     $   RETURN
*
      IF( ( LEFT .AND. .NOT.NOTRAN ) .OR. ( .NOT.LEFT .AND. NOTRAN ) )
     $     THEN
         I1 = 1
         I2 = K
         I3 = 1
      ELSE
         I1 = K
         I2 = 1
         I3 = -1
      END IF
*
      IF( LEFT ) THEN
         NI = N
         JC = 1
      ELSE
         MI = M
         IC = 1
      END IF
*
      DO 10 I = I1, I2, I3
         IF( LEFT ) THEN
*
*           H(i) is applied to C(i:m,1:n)
```

```
*
            MI = M - I + 1
            IC = I
         ELSE
*
*           H(i) is applied to C(1:m,i:n)
*
            NI = N - I + 1
            JC = I
         END IF
*
*        Apply H(i)
*
         AII = A( I, I )
         A( I, I ) = ONE
         CALL DLARF( SIDE, MI, NI, A( I, I ), 1, TAU( I ), C( IC, JC ),
     $               LDC, WORK )
         A( I, I ) = AII
   10 CONTINUE
      RETURN
*
*     End of DORM2R
*
      END
```

———-

— LAPACK dorm2r —

```
(let* ((one 1.0))
  (declare (type (double-float 1.0 1.0) one))
  (defun dorm2r (side trans m n k a lda tau c ldc work info)
    (declare (type (simple-array double-float (*)) work c tau a)
             (type fixnum info ldc lda k n m)
             (type character trans side))
    (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (trans character trans-%data% trans-%offset%)
         (a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (c double-float c-%data% c-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((aii 0.0) (i 0) (i1 0) (i2 0) (i3 0) (ic 0) (jc 0) (mi 0) (ni 0)
             (nq 0) (left nil) (notran nil))
        (declare (type (double-float) aii)
                 (type fixnum i i1 i2 i3 ic jc mi ni nq)
                 (type (member t nil) left notran))
        (setf info 0)
```

```
(setf left (char-equal side #\L))
(setf notran (char-equal trans #\N))
(cond
  (left
   (setf nq m))
  (t
   (setf nq n)))
(cond
  ((and (not left) (not (char-equal side #\R)))
   (setf info -1))
  ((and (not notran) (not (char-equal trans #\T)))
   (setf info -2))
  ((< m 0)
   (setf info -3))
  ((< n 0)
   (setf info -4))
  ((or (< k 0) (> k nq))
   (setf info -5))
  ((< lda (max (the fixnum 1) (the fixnum nq)))
   (setf info -7))
  ((< ldc (max (the fixnum 1) (the fixnum m)))
   (setf info -10)))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DORM2R" (f2cl-lib:int-sub info))
   (go end_label)))
(if (or (= m 0) (= n 0) (= k 0)) (go end_label))
(cond
  ((or (and left (not notran)) (and (not left) notran))
   (setf i1 1)
   (setf i2 k)
   (setf i3 1))
  (t
   (setf i1 k)
   (setf i2 1)
   (setf i3 -1)))
(cond
  (left
   (setf ni n)
   (setf jc 1))
  (t
   (setf mi m)
   (setf ic 1)))
(f2cl-lib:fdo (i i1 (f2cl-lib:int-add i i3))
              ((> i i2) nil)
  (tagbody
    (cond
      (left
```

```
               (setf mi (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1))
               (setf ic i))
              (t
               (setf ni (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1))
               (setf jc i)))
             (setf aii
                    (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%))
             (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
                    one)
             (dlarf side mi ni
              (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) 1
              (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)
              (f2cl-lib:array-slice c double-float (ic jc) ((1 ldc) (1 *))) ldc
              work)
             (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
                    aii)))
 end_label
        (return (values nil nil nil nil nil nil nil nil nil nil nil info))))))
```

———-

6.89 dormbr LAPACK

— **dormbr.input** —

```
)set break resume
)sys rm -f dormbr.output
)spool dormbr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dormbr.help** —

```
====================================================================
dormbr examples
====================================================================

====================================================================
Man Page Details
```

```
=====================================================================

NAME
       DORMBR - = 'Q', DORMBR overwrites the general real M-by-N matrix C with
       SIDE = 'L' SIDE = 'R' TRANS = 'N'

SYNOPSIS
       SUBROUTINE DORMBR( VECT, SIDE, TRANS, M, N, K, A,  LDA,  TAU,  C,  LDC,
                          WORK, LWORK, INFO )

           CHARACTER      SIDE, TRANS, VECT

           INTEGER        INFO, K, LDA, LDC, LWORK, M, N

           DOUBLE         PRECISION  A( LDA, * ), C( LDC, * ), TAU( * ), WORK(
                          * )

  Purpose
  =======

  If VECT = 'Q', DORMBR overwrites the general real M-by-N matrix C
  with
                  SIDE = 'L'     SIDE = 'R'
  TRANS = 'N':      Q * C          C * Q
  TRANS = 'T':      Q**T * C       C * Q**T

  If VECT = 'P', DORMBR overwrites the general real M-by-N matrix C
  with
                  SIDE = 'L'     SIDE = 'R'
  TRANS = 'N':      P * C          C * P
  TRANS = 'T':      P**T * C       C * P**T

  Here Q and P**T are the orthogonal matrices determined by DGEBRD when
  reducing a real matrix A to bidiagonal form: A = Q * B * P**T. Q and
  P**T are defined as products of elementary reflectors H(i) and G(i)
  respectively.

  Let nq = m if SIDE = 'L' and nq = n if SIDE = 'R'. Thus nq is the
  order of the orthogonal matrix Q or P**T that is applied.

  If VECT = 'Q', A is assumed to have been an NQ-by-K matrix:
  if nq >= k, Q = H(1) H(2) . . . H(k);
  if nq < k, Q = H(1) H(2) . . . H(nq-1).

  If VECT = 'P', A is assumed to have been a K-by-NQ matrix:
  if k < nq, P = G(1) G(2) . . . G(k);
  if k >= nq, P = G(1) G(2) . . . G(nq-1).

  Arguments
  =========
```

```
VECT    (input) CHARACTER*1
        = 'Q': apply Q or Q**T;
        = 'P': apply P or P**T.

SIDE    (input) CHARACTER*1
        = 'L': apply Q, Q**T, P or P**T from the Left;
        = 'R': apply Q, Q**T, P or P**T from the Right.

TRANS   (input) CHARACTER*1
        = 'N':  No transpose, apply Q  or P;
        = 'T':  Transpose, apply Q**T or P**T.

M       (input) INTEGER
        The number of rows of the matrix C. M >= 0.

N       (input) INTEGER
        The number of columns of the matrix C. N >= 0.

K       (input) INTEGER
        If VECT = 'Q', the number of columns in the original
        matrix reduced by DGEBRD.
        If VECT = 'P', the number of rows in the original
        matrix reduced by DGEBRD.
        K >= 0.

A       (input) DOUBLE PRECISION array, dimension
                              (LDA,min(nq,K)) if VECT = 'Q'
                              (LDA,nq)        if VECT = 'P'
        The vectors which define the elementary reflectors H(i) and
        G(i), whose products determine the matrices Q and P, as
        returned by DGEBRD.

LDA     (input) INTEGER
        The leading dimension of the array A.
        If VECT = 'Q', LDA >= max(1,nq);
        if VECT = 'P', LDA >= max(1,min(nq,K)).

TAU     (input) DOUBLE PRECISION array, dimension (min(nq,K))
        TAU(i) must contain the scalar factor of the elementary
        reflector H(i) or G(i) which determines Q or P, as returned
        by DGEBRD in the array argument TAUQ or TAUP.

C       (input/output) DOUBLE PRECISION array, dimension (LDC,N)
        On entry, the M-by-N matrix C.
        On exit, C is overwritten by Q*C or Q**T*C or C*Q**T or C*Q
        or P*C or P**T*C or C*P or C*P**T.

LDC     (input) INTEGER
        The leading dimension of the array C. LDC >= max(1,M).
```

```
  WORK    (workspace/output) DOUBLE PRECISION array, dimension (LWORK)
          On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

  LWORK   (input) INTEGER
          The dimension of the array WORK.
          If SIDE = 'L', LWORK >= max(1,N);
          if SIDE = 'R', LWORK >= max(1,M).
          For optimum performance LWORK >= N*NB if SIDE = 'L', and
          LWORK >= M*NB if SIDE = 'R', where NB is the optimal
          blocksize.

          If LWORK = -1, then a workspace query is assumed; the routine
          only calculates the optimal size of the WORK array, returns
          this value as the first entry of the WORK array, and no error
          message related to LWORK is issued by XERBLA.

  INFO    (output) INTEGER
          = 0:  successful exit
          < 0:  if INFO = -i, the i-th argument had an illegal value
```

———-

— dormbr.f —

```
      SUBROUTINE DORMBR( VECT, SIDE, TRANS, M, N, K, A, LDA, TAU, C,
     $                   LDC, WORK, LWORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      CHARACTER          SIDE, TRANS, VECT
      INTEGER            INFO, K, LDA, LDC, LWORK, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), C( LDC, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Local Scalars ..
      LOGICAL            APPLYQ, LEFT, LQUERY, NOTRAN
      CHARACTER          TRANST
      INTEGER            I1, I2, IINFO, LWKOPT, MI, NB, NI, NQ, NW
*     ..
```

```
*     .. External Functions ..
      LOGICAL            LSAME
      INTEGER            ILAENV
      EXTERNAL           LSAME, ILAENV
*     ..
*     .. External Subroutines ..
      EXTERNAL           DORMLQ, DORMQR, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      APPLYQ = LSAME( VECT, 'Q' )
      LEFT = LSAME( SIDE, 'L' )
      NOTRAN = LSAME( TRANS, 'N' )
      LQUERY = ( LWORK.EQ.-1 )
*
*     NQ is the order of Q or P and NW is the minimum dimension of WORK
*
      IF( LEFT ) THEN
         NQ = M
         NW = N
      ELSE
         NQ = N
         NW = M
      END IF
      IF( .NOT.APPLYQ .AND. .NOT.LSAME( VECT, 'P' ) ) THEN
         INFO = -1
      ELSE IF( .NOT.LEFT .AND. .NOT.LSAME( SIDE, 'R' ) ) THEN
         INFO = -2
      ELSE IF( .NOT.NOTRAN .AND. .NOT.LSAME( TRANS, 'T' ) ) THEN
         INFO = -3
      ELSE IF( M.LT.0 ) THEN
         INFO = -4
      ELSE IF( N.LT.0 ) THEN
         INFO = -5
      ELSE IF( K.LT.0 ) THEN
         INFO = -6
      ELSE IF( ( APPLYQ .AND. LDA.LT.MAX( 1, NQ ) ) .OR.
     $         ( .NOT.APPLYQ .AND. LDA.LT.MAX( 1, MIN( NQ, K ) ) ) )
     $          THEN
         INFO = -8
      ELSE IF( LDC.LT.MAX( 1, M ) ) THEN
         INFO = -11
      ELSE IF( LWORK.LT.MAX( 1, NW ) .AND. .NOT.LQUERY ) THEN
         INFO = -13
```

```
      END IF
*
      IF( INFO.EQ.0 ) THEN
         IF( APPLYQ ) THEN
            IF( LEFT ) THEN
               NB = ILAENV( 1, 'DORMQR', SIDE // TRANS, M-1, N, M-1,
     $              -1 )
            ELSE
               NB = ILAENV( 1, 'DORMQR', SIDE // TRANS, M, N-1, N-1,
     $              -1 )
            END IF
         ELSE
            IF( LEFT ) THEN
               NB = ILAENV( 1, 'DORMLQ', SIDE // TRANS, M-1, N, M-1,
     $              -1 )
            ELSE
               NB = ILAENV( 1, 'DORMLQ', SIDE // TRANS, M, N-1, N-1,
     $              -1 )
            END IF
         END IF
         LWKOPT = MAX( 1, NW )*NB
         WORK( 1 ) = LWKOPT
      END IF
*
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DORMBR', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Quick return if possible
*
      WORK( 1 ) = 1
      IF( M.EQ.0 .OR. N.EQ.0 )
     $   RETURN
*
      IF( APPLYQ ) THEN
*
*        Apply Q
*
         IF( NQ.GE.K ) THEN
*
*           Q was determined by a call to DGEBRD with nq >= k
*
            CALL DORMQR( SIDE, TRANS, M, N, K, A, LDA, TAU, C, LDC,
     $                   WORK, LWORK, IINFO )
         ELSE IF( NQ.GT.1 ) THEN
*
*           Q was determined by a call to DGEBRD with nq < k
```

```
*
            IF( LEFT ) THEN
               MI = M - 1
               NI = N
               I1 = 2
               I2 = 1
            ELSE
               MI = M
               NI = N - 1
               I1 = 1
               I2 = 2
            END IF
            CALL DORMQR( SIDE, TRANS, MI, NI, NQ-1, A( 2, 1 ), LDA, TAU,
     $                   C( I1, I2 ), LDC, WORK, LWORK, IINFO )
         END IF
      ELSE
*
*        Apply P
*
         IF( NOTRAN ) THEN
            TRANST = 'T'
         ELSE
            TRANST = 'N'
         END IF
         IF( NQ.GT.K ) THEN
*
*           P was determined by a call to DGEBRD with nq > k
*
            CALL DORMLQ( SIDE, TRANST, M, N, K, A, LDA, TAU, C, LDC,
     $                   WORK, LWORK, IINFO )
         ELSE IF( NQ.GT.1 ) THEN
*
*           P was determined by a call to DGEBRD with nq <= k
*
            IF( LEFT ) THEN
               MI = M - 1
               NI = N
               I1 = 2
               I2 = 1
            ELSE
               MI = M
               NI = N - 1
               I1 = 1
               I2 = 2
            END IF
            CALL DORMLQ( SIDE, TRANST, MI, NI, NQ-1, A( 1, 2 ), LDA,
     $                   TAU, C( I1, I2 ), LDC, WORK, LWORK, IINFO )
         END IF
      END IF
      WORK( 1 ) = LWKOPT
```

```
      RETURN
*
*     End of DORMBR
*
      END
```

———-

— LAPACK dormbr —

```
(defun dormbr (vect side trans m n k a lda tau c ldc work lwork info)
  (declare (type (simple-array double-float (*)) work c tau a)
           (type fixnum info lwork ldc lda k n m)
           (type character trans side vect))
  (f2cl-lib:with-multi-array-data
      ((vect character vect-%data% vect-%offset%)
       (side character side-%data% side-%offset%)
       (trans character trans-%data% trans-%offset%)
       (a double-float a-%data% a-%offset%)
       (tau double-float tau-%data% tau-%offset%)
       (c double-float c-%data% c-%offset%)
       (work double-float work-%data% work-%offset%))
    (prog ((i1 0) (i2 0) (iinfo 0) (lwkopt 0) (mi 0) (nb 0) (ni 0) (nq 0)
           (nw 0)
           (transt
            (make-array '(1) :element-type 'character :initial-element #\ ))
           (applyq nil) (left nil) (lquery nil) (notran nil))
      (declare (type (member t nil) notran lquery left applyq)
               (type (simple-array character (1)) transt)
               (type fixnum nw nq ni nb mi lwkopt iinfo i2 i1))
      (setf info 0)
      (setf applyq (char-equal vect #\Q))
      (setf left (char-equal side #\L))
      (setf notran (char-equal trans #\N))
      (setf lquery (coerce (= lwork -1) '(member t nil)))
      (cond
        (left
         (setf nq m)
         (setf nw n))
        (t
         (setf nq n)
         (setf nw m)))
      (cond
        ((and (not applyq) (not (char-equal vect #\P)))
         (setf info -1))
        ((and (not left) (not (char-equal side #\R)))
         (setf info -2))
        ((and (not notran) (not (char-equal trans #\T)))
```

```
   (setf info -3))
  ((< m 0)
   (setf info -4))
  ((< n 0)
   (setf info -5))
  ((< k 0)
   (setf info -6))
  ((or
    (and applyq
         (< lda
            (max (the fixnum 1) (the fixnum nq))))
    (and (not applyq)
         (< lda
            (max (the fixnum 1)
                 (the fixnum
                      (min (the fixnum nq)
                           (the fixnum k)))))))
   (setf info -8))
  ((< ldc (max (the fixnum 1) (the fixnum m)))
   (setf info -11))
  ((and
    (< lwork (max (the fixnum 1) (the fixnum nw)))
    (not lquery))
   (setf info -13)))
(cond
  ((= info 0)
   (cond
     (applyq
      (cond
        (left
         (setf nb
                 (ilaenv 1 "DORMQR" (f2cl-lib:f2cl-// side trans)
                  (f2cl-lib:int-sub m 1) n (f2cl-lib:int-sub m 1) -1)))
        (t
         (setf nb
                 (ilaenv 1 "DORMQR" (f2cl-lib:f2cl-// side trans) m
                  (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1) -1)))))
     (t
      (cond
        (left
         (setf nb
                 (ilaenv 1 "DORMLQ" (f2cl-lib:f2cl-// side trans)
                  (f2cl-lib:int-sub m 1) n (f2cl-lib:int-sub m 1) -1)))
        (t
         (setf nb
                 (ilaenv 1 "DORMLQ" (f2cl-lib:f2cl-// side trans) m
                  (f2cl-lib:int-sub n 1) (f2cl-lib:int-sub n 1) -1))))))
   (setf lwkopt
           (f2cl-lib:int-mul
            (max (the fixnum 1) (the fixnum nw))
```

```
           nb))
   (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
           (coerce (the fixnum lwkopt) 'double-float))))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DORMBR" (f2cl-lib:int-sub info))
   (go end_label))
  (lquery
   (go end_label)))
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
        (coerce (the fixnum 1) 'double-float))
(if (or (= m 0) (= n 0)) (go end_label))
(cond
  (applyq
   (cond
     ((>= nq k)
      (multiple-value-bind
            (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
             var-10 var-11 var-12)
          (dormqr side trans m n k a lda tau c ldc work lwork iinfo)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                         var-8 var-9 var-10 var-11))
        (setf iinfo var-12)))
     ((> nq 1)
      (cond
        (left
         (setf mi (f2cl-lib:int-sub m 1))
         (setf ni n)
         (setf i1 2)
         (setf i2 1))
        (t
         (setf mi m)
         (setf ni (f2cl-lib:int-sub n 1))
         (setf i1 1)
         (setf i2 2)))
      (multiple-value-bind
            (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
             var-10 var-11 var-12)
          (dormqr side trans mi ni (f2cl-lib:int-sub nq 1)
           (f2cl-lib:array-slice a double-float (2 1) ((1 lda) (1 *)))
           lda tau
           (f2cl-lib:array-slice c double-float (i1 i2) ((1 ldc) (1 *)))
           ldc work lwork iinfo)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                         var-8 var-9 var-10 var-11))
        (setf iinfo var-12)))))
  (t
   (cond
```

```
          (notran
           (f2cl-lib:f2cl-set-string transt "T" (string 1)))
          (t
           (f2cl-lib:f2cl-set-string transt "N" (string 1))))
        (cond
          ((> nq k)
           (multiple-value-bind
                 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
                  var-10 var-11 var-12)
               (dormlq side transt m n k a lda tau c ldc work lwork iinfo)
             (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                              var-8 var-9 var-10 var-11))
             (setf iinfo var-12)))
          ((> nq 1)
           (cond
             (left
              (setf mi (f2cl-lib:int-sub m 1))
              (setf ni n)
              (setf i1 2)
              (setf i2 1))
             (t
              (setf mi m)
              (setf ni (f2cl-lib:int-sub n 1))
              (setf i1 1)
              (setf i2 2)))
           (multiple-value-bind
                 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
                  var-10 var-11 var-12)
               (dormlq side transt mi ni (f2cl-lib:int-sub nq 1)
                (f2cl-lib:array-slice a double-float (1 2) ((1 lda) (1 *)))
                lda tau
                (f2cl-lib:array-slice c double-float (i1 i2) ((1 ldc) (1 *)))
                ldc work lwork iinfo)
             (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                              var-8 var-9 var-10 var-11))
             (setf iinfo var-12))))))
    (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
            (coerce (the fixnum lwkopt) 'double-float))
end_label
    (return
     (values nil nil nil nil nil nil nil nil nil nil nil nil nil info)))))
```

6.90 dorml2 LAPACK

— dorml2.input —

```
)set break resume
)sys rm -f dorml2.output
)spool dorml2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dorml2.help —

```
===========================================================================
dorml2 examples
===========================================================================

===========================================================================
Man Page Details
===========================================================================

NAME
       DORML2  -  the  general real m by n matrix C with   Q * C if SIDE = 'L'
       and TRANS = 'N', or   Q'* C if SIDE = 'L' and TRANS = 'T', or   C  *  Q
       if  SIDE  =  'R' and TRANS = 'N', or   C * Q' if SIDE = 'R' and TRANS =
       'T',

SYNOPSIS
       SUBROUTINE DORML2( SIDE, TRANS, M, N, K, A, LDA,  TAU,  C,  LDC,  WORK,
                          INFO )

           CHARACTER      SIDE, TRANS

           INTEGER        INFO, K, LDA, LDC, M, N

           DOUBLE         PRECISION  A( LDA, * ), C( LDC, * ), TAU( * ), WORK(
                          * )

  Purpose
  =======

  DORML2 overwrites the general real m by n matrix C with

        Q * C  if SIDE = 'L' and TRANS = 'N', or

        Q'* C  if SIDE = 'L' and TRANS = 'T', or
```

```
      C * Q  if SIDE = 'R' and TRANS = 'N', or

      C * Q' if SIDE = 'R' and TRANS = 'T',

where Q is a real orthogonal matrix defined as the product of k
elementary reflectors

      Q = H(k) . . . H(2) H(1)

as returned by DGELQF. Q is of order m if SIDE = 'L' and of order n
if SIDE = 'R'.

Arguments
=========

SIDE    (input) CHARACTER*1
        = 'L': apply Q or Q' from the Left
        = 'R': apply Q or Q' from the Right

TRANS   (input) CHARACTER*1
        = 'N': apply Q  (No transpose)
        = 'T': apply Q' (Transpose)

M       (input) INTEGER
        The number of rows of the matrix C. M >= 0.

N       (input) INTEGER
        The number of columns of the matrix C. N >= 0.

K       (input) INTEGER
        The number of elementary reflectors whose product defines
        the matrix Q.
        If SIDE = 'L', M >= K >= 0;
        if SIDE = 'R', N >= K >= 0.

A       (input) DOUBLE PRECISION array, dimension
                             (LDA,M) if SIDE = 'L',
                             (LDA,N) if SIDE = 'R'
        The i-th row must contain the vector which defines the
        elementary reflector H(i), for i = 1,2,...,k, as returned by
        DGELQF in the first k rows of its array argument A.
        A is modified by the routine but restored on exit.

LDA     (input) INTEGER
        The leading dimension of the array A. LDA >= max(1,K).

TAU     (input) DOUBLE PRECISION array, dimension (K)
        TAU(i) must contain the scalar factor of the elementary
        reflector H(i), as returned by DGELQF.
```

```
  C       (input/output) DOUBLE PRECISION array, dimension (LDC,N)
          On entry, the m by n matrix C.
          On exit, C is overwritten by Q*C or Q'*C or C*Q' or C*Q.

  LDC     (input) INTEGER
          The leading dimension of the array C. LDC >= max(1,M).

  WORK    (workspace) DOUBLE PRECISION array, dimension
                                  (N) if SIDE = 'L',
                                  (M) if SIDE = 'R'

  INFO    (output) INTEGER
          = 0: successful exit
          < 0: if INFO = -i, the i-th argument had an illegal value
```

———-

— dorml2.f —

```
      SUBROUTINE DORML2( SIDE, TRANS, M, N, K, A, LDA, TAU, C, LDC,
     $                   WORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     February 29, 1992
*
*     .. Scalar Arguments ..
      CHARACTER          SIDE, TRANS
      INTEGER            INFO, K, LDA, LDC, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), C( LDC, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE
      PARAMETER          ( ONE = 1.0D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            LEFT, NOTRAN
      INTEGER            I, I1, I2, I3, IC, JC, MI, NI, NQ
      DOUBLE PRECISION   AII
*     ..
*     .. External Functions ..
```

```
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLARF, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      LEFT = LSAME( SIDE, 'L' )
      NOTRAN = LSAME( TRANS, 'N' )
*
*     NQ is the order of Q
*
      IF( LEFT ) THEN
         NQ = M
      ELSE
         NQ = N
      END IF
      IF( .NOT.LEFT .AND. .NOT.LSAME( SIDE, 'R' ) ) THEN
         INFO = -1
      ELSE IF( .NOT.NOTRAN .AND. .NOT.LSAME( TRANS, 'T' ) ) THEN
         INFO = -2
      ELSE IF( M.LT.0 ) THEN
         INFO = -3
      ELSE IF( N.LT.0 ) THEN
         INFO = -4
      ELSE IF( K.LT.0 .OR. K.GT.NQ ) THEN
         INFO = -5
      ELSE IF( LDA.LT.MAX( 1, K ) ) THEN
         INFO = -7
      ELSE IF( LDC.LT.MAX( 1, M ) ) THEN
         INFO = -10
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DORML2', -INFO )
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( M.EQ.0 .OR. N.EQ.0 .OR. K.EQ.0 )
     $   RETURN
*
      IF( ( LEFT .AND. NOTRAN ) .OR. ( .NOT.LEFT .AND. .NOT.NOTRAN ) )
```

```
     $     THEN
           I1 = 1
           I2 = K
           I3 = 1
         ELSE
           I1 = K
           I2 = 1
           I3 = -1
         END IF
*
         IF( LEFT ) THEN
           NI = N
           JC = 1
         ELSE
           MI = M
           IC = 1
         END IF
*
         DO 10 I = I1, I2, I3
           IF( LEFT ) THEN
*
*            H(i) is applied to C(i:m,1:n)
*
             MI = M - I + 1
             IC = I
           ELSE
*
*            H(i) is applied to C(1:m,i:n)
*
             NI = N - I + 1
             JC = I
           END IF
*
*          Apply H(i)
*
           AII = A( I, I )
           A( I, I ) = ONE
           CALL DLARF( SIDE, MI, NI, A( I, I ), LDA, TAU( I ),
     $                 C( IC, JC ), LDC, WORK )
           A( I, I ) = AII
      10 CONTINUE
         RETURN
*
*        End of DORML2
*
         END
```

———-

— LAPACK dorml2 —

```
(let* ((one 1.0))
  (declare (type (double-float 1.0 1.0) one))
  (defun dorml2 (side trans m n k a lda tau c ldc work info)
    (declare (type (simple-array double-float (*)) work c tau a)
             (type fixnum info ldc lda k n m)
             (type character trans side))
    (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (trans character trans-%data% trans-%offset%)
         (a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (c double-float c-%data% c-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((aii 0.0) (i 0) (i1 0) (i2 0) (i3 0) (ic 0) (jc 0) (mi 0) (ni 0)
             (nq 0) (left nil) (notran nil))
        (declare (type (double-float) aii)
                 (type fixnum i i1 i2 i3 ic jc mi ni nq)
                 (type (member t nil) left notran))
        (setf info 0)
        (setf left (char-equal side #\L))
        (setf notran (char-equal trans #\N))
        (cond
          (left
           (setf nq m))
          (t
           (setf nq n)))
        (cond
          ((and (not left) (not (char-equal side #\R)))
           (setf info -1))
          ((and (not notran) (not (char-equal trans #\T)))
           (setf info -2))
          ((< m 0)
           (setf info -3))
          ((< n 0)
           (setf info -4))
          ((or (< k 0) (> k nq))
           (setf info -5))
          ((< lda (max (the fixnum 1) (the fixnum k)))
           (setf info -7))
          ((< ldc (max (the fixnum 1) (the fixnum m)))
           (setf info -10)))
        (cond
          ((/= info 0)
           (error
            " ** On entry to ~a parameter number ~a had an illegal value~%"
            "DORML2" (f2cl-lib:int-sub info))
           (go end_label)))
```

```
        (if (or (= m 0) (= n 0) (= k 0)) (go end_label))
        (cond
          ((or (and left notran) (and (not left) (not notran)))
           (setf i1 1)
           (setf i2 k)
           (setf i3 1))
          (t
           (setf i1 k)
           (setf i2 1)
           (setf i3 -1)))
        (cond
          (left
           (setf ni n)
           (setf jc 1))
          (t
           (setf mi m)
           (setf ic 1)))
        (f2cl-lib:fdo (i i1 (f2cl-lib:int-add i i3))
                      ((> i i2) nil)
          (tagbody
            (cond
              (left
               (setf mi (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1))
               (setf ic i))
              (t
               (setf ni (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1))
               (setf jc i)))
            (setf aii
                    (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%))
            (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
                    one)
            (dlarf side mi ni
             (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
             (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)
             (f2cl-lib:array-slice c double-float (ic jc) ((1 ldc) (1 *))) ldc
             work)
            (setf (f2cl-lib:fref a-%data% (i i) ((1 lda) (1 *)) a-%offset%)
                    aii)))
      end_label
        (return (values nil nil nil nil nil nil nil nil nil nil nil info))))))
```

———-

6.91 dormlq LAPACK

— **dormlq.input** —

```
)set break resume
)sys rm -f dormlq.output
)spool dormlq.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dormlq.help —

```
==========================================================================
dormlq examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

NAME
       DORMLQ  - the general real M-by-N matrix C with   SIDE = 'L' SIDE = 'R'
       TRANS = 'N'

SYNOPSIS
       SUBROUTINE DORMLQ( SIDE, TRANS, M, N, K, A, LDA,  TAU,  C,  LDC,  WORK,
                          LWORK, INFO )

           CHARACTER      SIDE, TRANS

           INTEGER        INFO, K, LDA, LDC, LWORK, M, N

           DOUBLE         PRECISION  A( LDA, * ), C( LDC, * ), TAU( * ), WORK(
                          * )

  Purpose
  =======

  DORMLQ overwrites the general real M-by-N matrix C with

                  SIDE = 'L'     SIDE = 'R'
  TRANS = 'N':      Q * C          C * Q
  TRANS = 'T':      Q**T * C       C * Q**T

  where Q is a real orthogonal matrix defined as the product of k
  elementary reflectors
```

```
      Q = H(k) . . . H(2) H(1)

as returned by DGELQF. Q is of order M if SIDE = 'L' and of order N
if SIDE = 'R'.

Arguments
=========

SIDE    (input) CHARACTER*1
        = 'L': apply Q or Q**T from the Left;
        = 'R': apply Q or Q**T from the Right.

TRANS   (input) CHARACTER*1
        = 'N':  No transpose, apply Q;
        = 'T':  Transpose, apply Q**T.

M       (input) INTEGER
        The number of rows of the matrix C. M >= 0.

N       (input) INTEGER
        The number of columns of the matrix C. N >= 0.

K       (input) INTEGER
        The number of elementary reflectors whose product defines
        the matrix Q.
        If SIDE = 'L', M >= K >= 0;
        if SIDE = 'R', N >= K >= 0.

A       (input) DOUBLE PRECISION array, dimension
                             (LDA,M) if SIDE = 'L',
                             (LDA,N) if SIDE = 'R'
        The i-th row must contain the vector which defines the
        elementary reflector H(i), for i = 1,2,...,k, as returned by
        DGELQF in the first k rows of its array argument A.
        A is modified by the routine but restored on exit.

LDA     (input) INTEGER
        The leading dimension of the array A. LDA >= max(1,K).

TAU     (input) DOUBLE PRECISION array, dimension (K)
        TAU(i) must contain the scalar factor of the elementary
        reflector H(i), as returned by DGELQF.

C       (input/output) DOUBLE PRECISION array, dimension (LDC,N)
        On entry, the M-by-N matrix C.
        On exit, C is overwritten by Q*C or Q**T*C or C*Q**T or C*Q.

LDC     (input) INTEGER
        The leading dimension of the array C. LDC >= max(1,M).
```

```
  WORK    (workspace/output) DOUBLE PRECISION array, dimension (LWORK)
          On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

  LWORK   (input) INTEGER
          The dimension of the array WORK.
          If SIDE = 'L', LWORK >= max(1,N);
          if SIDE = 'R', LWORK >= max(1,M).
          For optimum performance LWORK >= N*NB if SIDE = 'L', and
          LWORK >= M*NB if SIDE = 'R', where NB is the optimal
          blocksize.

          If LWORK = -1, then a workspace query is assumed; the routine
          only calculates the optimal size of the WORK array, returns
          this value as the first entry of the WORK array, and no error
          message related to LWORK is issued by XERBLA.

  INFO    (output) INTEGER
          = 0:  successful exit
          < 0:  if INFO = -i, the i-th argument had an illegal value
```

———-

— dormlq.f —

```
      SUBROUTINE DORMLQ( SIDE, TRANS, M, N, K, A, LDA, TAU, C, LDC,
     $                   WORK, LWORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      CHARACTER          SIDE, TRANS
      INTEGER            INFO, K, LDA, LDC, LWORK, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), C( LDC, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      INTEGER            NBMAX, LDT
      PARAMETER          ( NBMAX = 64, LDT = NBMAX+1 )
*     ..
*     .. Local Scalars ..
      LOGICAL            LEFT, LQUERY, NOTRAN
```

```
      CHARACTER          TRANST
      INTEGER            I, I1, I2, I3, IB, IC, IINFO, IWS, JC, LDWORK,
     $                   LWKOPT, MI, NB, NBMIN, NI, NQ, NW
*     ..
*     .. Local Arrays ..
      DOUBLE PRECISION   T( LDT, NBMAX )
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      INTEGER            ILAENV
      EXTERNAL           LSAME, ILAENV
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLARFB, DLARFT, DORML2, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      LEFT = LSAME( SIDE, 'L' )
      NOTRAN = LSAME( TRANS, 'N' )
      LQUERY = ( LWORK.EQ.-1 )
*
*     NQ is the order of Q and NW is the minimum dimension of WORK
*
      IF( LEFT ) THEN
         NQ = M
         NW = N
      ELSE
         NQ = N
         NW = M
      END IF
      IF( .NOT.LEFT .AND. .NOT.LSAME( SIDE, 'R' ) ) THEN
         INFO = -1
      ELSE IF( .NOT.NOTRAN .AND. .NOT.LSAME( TRANS, 'T' ) ) THEN
         INFO = -2
      ELSE IF( M.LT.0 ) THEN
         INFO = -3
      ELSE IF( N.LT.0 ) THEN
         INFO = -4
      ELSE IF( K.LT.0 .OR. K.GT.NQ ) THEN
         INFO = -5
      ELSE IF( LDA.LT.MAX( 1, K ) ) THEN
         INFO = -7
      ELSE IF( LDC.LT.MAX( 1, M ) ) THEN
         INFO = -10
```

```
      ELSE IF( LWORK.LT.MAX( 1, NW ) .AND. .NOT.LQUERY ) THEN
         INFO = -12
      END IF
*
      IF( INFO.EQ.0 ) THEN
*
*        Determine the block size.  NB may be at most NBMAX, where NBMAX
*        is used to define the local array T.
*
         NB = MIN( NBMAX, ILAENV( 1, 'DORMLQ', SIDE // TRANS, M, N, K,
     $        -1 ) )
         LWKOPT = MAX( 1, NW )*NB
         WORK( 1 ) = LWKOPT
      END IF
*
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DORMLQ', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( M.EQ.0 .OR. N.EQ.0 .OR. K.EQ.0 ) THEN
         WORK( 1 ) = 1
         RETURN
      END IF
*
      NBMIN = 2
      LDWORK = NW
      IF( NB.GT.1 .AND. NB.LT.K ) THEN
         IWS = NW*NB
         IF( LWORK.LT.IWS ) THEN
            NB = LWORK / LDWORK
            NBMIN = MAX( 2, ILAENV( 2, 'DORMLQ', SIDE // TRANS, M, N, K,
     $              -1 ) )
         END IF
      ELSE
         IWS = NW
      END IF
*
      IF( NB.LT.NBMIN .OR. NB.GE.K ) THEN
*
*        Use unblocked code
*
         CALL DORML2( SIDE, TRANS, M, N, K, A, LDA, TAU, C, LDC, WORK,
     $                IINFO )
      ELSE
*
```

```
*        Use blocked code
*
         IF( ( LEFT .AND. NOTRAN ) .OR.
     $       ( .NOT.LEFT .AND. .NOT.NOTRAN ) ) THEN
            I1 = 1
            I2 = K
            I3 = NB
         ELSE
            I1 = ( ( K-1 ) / NB )*NB + 1
            I2 = 1
            I3 = -NB
         END IF
*
         IF( LEFT ) THEN
            NI = N
            JC = 1
         ELSE
            MI = M
            IC = 1
         END IF
*
         IF( NOTRAN ) THEN
            TRANST = 'T'
         ELSE
            TRANST = 'N'
         END IF
*
         DO 10 I = I1, I2, I3
            IB = MIN( NB, K-I+1 )
*
*           Form the triangular factor of the block reflector
*           H = H(i) H(i+1) . . . H(i+ib-1)
*
            CALL DLARFT( 'Forward', 'Rowwise', NQ-I+1, IB, A( I, I ),
     $                   LDA, TAU( I ), T, LDT )
            IF( LEFT ) THEN
*
*              H or H' is applied to C(i:m,1:n)
*
               MI = M - I + 1
               IC = I
            ELSE
*
*              H or H' is applied to C(1:m,i:n)
*
               NI = N - I + 1
               JC = I
            END IF
*
*           Apply H or H'
```

```
*
            CALL DLARFB( SIDE, TRANST, 'Forward', 'Rowwise', MI, NI, IB,
     $                   A( I, I ), LDA, T, LDT, C( IC, JC ), LDC, WORK,
     $                   LDWORK )
   10    CONTINUE
      END IF
      WORK( 1 ) = LWKOPT
      RETURN
*
*     End of DORMLQ
*
      END
```

———-

— LAPACK dormlq —

```
(let* ((nbmax 64) (ldt (+ nbmax 1)))
  (declare (type (fixnum 64 64) nbmax)
           (type fixnum ldt))
  (defun dormlq (side trans m n k a lda tau c ldc work lwork info)
    (declare (type (simple-array double-float (*)) work c tau a)
             (type fixnum info lwork ldc lda k n m)
             (type character trans side))
    (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (trans character trans-%data% trans-%offset%)
         (a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (c double-float c-%data% c-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((i 0) (i1 0) (i2 0) (i3 0) (ib 0) (ic 0) (iinfo 0) (iws 0) (jc 0)
             (ldwork 0) (lwkopt 0) (mi 0) (nb 0) (nbmin 0) (ni 0) (nq 0) (nw 0)
             (transt
              (make-array '(1) :element-type 'character :initial-element #\ ))
             (left nil) (lquery nil) (notran nil)
             (t$
              (make-array (the fixnum (reduce #'* (list ldt nbmax)))
                          :element-type 'double-float)))
        (declare (type (simple-array double-float (*)) t$)
                 (type fixnum i i1 i2 i3 ib ic iinfo iws jc ldwork
                                        lwkopt mi nb nbmin ni nq nw)
                 (type (simple-array character (1)) transt)
                 (type (member t nil) left lquery notran))
        (setf info 0)
        (setf left (char-equal side #\L))
        (setf notran (char-equal trans #\N))
        (setf lquery (coerce (= lwork -1) '(member t nil)))
```

```
(cond
  (left
   (setf nq m)
   (setf nw n))
  (t
   (setf nq n)
   (setf nw m)))
(cond
  ((and (not left) (not (char-equal side #\R)))
   (setf info -1))
  ((and (not notran) (not (char-equal trans #\T)))
   (setf info -2))
  ((< m 0)
   (setf info -3))
  ((< n 0)
   (setf info -4))
  ((or (< k 0) (> k nq))
   (setf info -5))
  ((< lda (max (the fixnum 1) (the fixnum k)))
   (setf info -7))
  ((< ldc (max (the fixnum 1) (the fixnum m)))
   (setf info -10))
  ((and
    (< lwork
       (max (the fixnum 1) (the fixnum nw)))
    (not lquery))
   (setf info -12)))
(cond
  ((= info 0)
   (setf nb
           (min (the fixnum nbmax)
                (the fixnum
                     (ilaenv 1 "DORMLQ" (f2cl-lib:f2cl-// side trans) m
                      n k -1))))
   (setf lwkopt
           (f2cl-lib:int-mul
            (max (the fixnum 1) (the fixnum nw))
            nb))
   (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
           (coerce (the fixnum lwkopt) 'double-float))))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DORMLQ" (f2cl-lib:int-sub info))
   (go end_label))
  (lquery
   (go end_label)))
(cond
  ((or (= m 0) (= n 0) (= k 0))
```

```
   (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
           (coerce (the fixnum 1) 'double-float))
   (go end_label)))
 (setf nbmin 2)
 (setf ldwork nw)
 (cond
   ((and (> nb 1) (< nb k))
    (setf iws (f2cl-lib:int-mul nw nb))
    (cond
      ((< lwork iws)
       (setf nb (the fixnum (truncate lwork ldwork)))
       (setf nbmin
             (max (the fixnum 2)
                  (the fixnum
                       (ilaenv 2 "DORMLQ"
                        (f2cl-lib:f2cl-// side trans) m n k -1)))))))
   (t
    (setf iws nw)))
 (cond
   ((or (< nb nbmin) (>= nb k))
    (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
           var-10 var-11)
        (dorml2 side trans m n k a lda tau c ldc work iinfo)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                       var-8 var-9 var-10))
      (setf iinfo var-11)))
   (t
    (cond
      ((or (and left notran) (and (not left) (not notran)))
       (setf i1 1)
       (setf i2 k)
       (setf i3 nb))
      (t
       (setf i1
             (+ (* (the fixnum (truncate (- k 1) nb)) nb)
                1))
       (setf i2 1)
       (setf i3 (f2cl-lib:int-sub nb))))
    (cond
      (left
       (setf ni n)
       (setf jc 1))
      (t
       (setf mi m)
       (setf ic 1)))
    (cond
      (notran
       (f2cl-lib:f2cl-set-string transt "T" (string 1)))
      (t
```

```
            (f2cl-lib:f2cl-set-string transt "N" (string 1))))
          (f2cl-lib:fdo (i i1 (f2cl-lib:int-add i i3))
                        ((> i i2) nil)
            (tagbody
              (setf ib
                      (min (the fixnum nb)
                           (the fixnum
                                (f2cl-lib:int-add (f2cl-lib:int-sub k i) 1))))
              (dlarft "Forward" "Rowwise"
               (f2cl-lib:int-add (f2cl-lib:int-sub nq i) 1) ib
               (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
               (f2cl-lib:array-slice tau double-float (i) ((1 *))) t$ ldt)
              (cond
                (left
                 (setf mi (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1))
                 (setf ic i))
                (t
                 (setf ni (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1))
                 (setf jc i)))
              (dlarfb side transt "Forward" "Rowwise" mi ni ib
               (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
               t$ ldt
               (f2cl-lib:array-slice c double-float (ic jc) ((1 ldc) (1 *)))
               ldc work ldwork)))))
       (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
             (coerce (the fixnum lwkopt) 'double-float))
 end_label
       (return
        (values nil nil nil nil nil nil nil nil nil nil nil nil info))))))
```

———-

6.92 dormqr LAPACK

— **dormqr.input** —

```
)set break resume
)sys rm -f dormqr.output
)spool dormqr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— dormqr.help —

```
========================================================================
dormqr examples
========================================================================

========================================================================
Man Page Details
========================================================================

NAME
       DORMQR  - the general real M-by-N matrix C with   SIDE = 'L' SIDE = 'R'
       TRANS = 'N'

SYNOPSIS
       SUBROUTINE DORMQR( SIDE, TRANS, M, N, K, A, LDA,  TAU,  C,  LDC,  WORK,
                          LWORK, INFO )

           CHARACTER      SIDE, TRANS

           INTEGER        INFO, K, LDA, LDC, LWORK, M, N

           DOUBLE         PRECISION  A( LDA, * ), C( LDC, * ), TAU( * ), WORK(
                          * )

  Purpose
  =======

  DORMQR overwrites the general real M-by-N matrix C with

                  SIDE = 'L'     SIDE = 'R'
  TRANS = 'N':      Q * C          C * Q
  TRANS = 'T':      Q**T * C       C * Q**T

  where Q is a real orthogonal matrix defined as the product of k
  elementary reflectors

        Q = H(1) H(2) . . . H(k)

  as returned by DGEQRF. Q is of order M if SIDE = 'L' and of order N
  if SIDE = 'R'.

  Arguments
  =========

  SIDE    (input) CHARACTER*1
          = 'L': apply Q or Q**T from the Left;
```

```
          = 'R': apply Q or Q**T from the Right.

  TRANS   (input) CHARACTER*1
          = 'N':  No transpose, apply Q;
          = 'T':  Transpose, apply Q**T.

  M       (input) INTEGER
          The number of rows of the matrix C. M >= 0.

  N       (input) INTEGER
          The number of columns of the matrix C. N >= 0.

  K       (input) INTEGER
          The number of elementary reflectors whose product defines
          the matrix Q.
          If SIDE = 'L', M >= K >= 0;
          if SIDE = 'R', N >= K >= 0.

  A       (input) DOUBLE PRECISION array, dimension (LDA,K)
          The i-th column must contain the vector which defines the
          elementary reflector H(i), for i = 1,2,...,k, as returned by
          DGEQRF in the first k columns of its array argument A.
          A is modified by the routine but restored on exit.

  LDA     (input) INTEGER
          The leading dimension of the array A.
          If SIDE = 'L', LDA >= max(1,M);
          if SIDE = 'R', LDA >= max(1,N).

  TAU     (input) DOUBLE PRECISION array, dimension (K)
          TAU(i) must contain the scalar factor of the elementary
          reflector H(i), as returned by DGEQRF.

  C       (input/output) DOUBLE PRECISION array, dimension (LDC,N)
          On entry, the M-by-N matrix C.
          On exit, C is overwritten by Q*C or Q**T*C or C*Q**T or C*Q.

  LDC     (input) INTEGER
          The leading dimension of the array C. LDC >= max(1,M).

  WORK    (workspace/output) DOUBLE PRECISION array, dimension (LWORK)
          On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

  LWORK   (input) INTEGER
          The dimension of the array WORK.
          If SIDE = 'L', LWORK >= max(1,N);
          if SIDE = 'R', LWORK >= max(1,M).
          For optimum performance LWORK >= N*NB if SIDE = 'L', and
          LWORK >= M*NB if SIDE = 'R', where NB is the optimal
          blocksize.
```

```
          If LWORK = -1, then a workspace query is assumed; the routine
          only calculates the optimal size of the WORK array, returns
          this value as the first entry of the WORK array, and no error
          message related to LWORK is issued by XERBLA.

  INFO    (output) INTEGER
          = 0:  successful exit
          < 0:  if INFO = -i, the i-th argument had an illegal value
```

———-

— **dormqr.f** —

```
      SUBROUTINE DORMQR( SIDE, TRANS, M, N, K, A, LDA, TAU, C, LDC,
     $                   WORK, LWORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      CHARACTER          SIDE, TRANS
      INTEGER            INFO, K, LDA, LDC, LWORK, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   A( LDA, * ), C( LDC, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      INTEGER            NBMAX, LDT
      PARAMETER          ( NBMAX = 64, LDT = NBMAX+1 )
*     ..
*     .. Local Scalars ..
      LOGICAL            LEFT, LQUERY, NOTRAN
      INTEGER            I, I1, I2, I3, IB, IC, IINFO, IWS, JC, LDWORK,
     $                   LWKOPT, MI, NB, NBMIN, NI, NQ, NW
*     ..
*     .. Local Arrays ..
      DOUBLE PRECISION   T( LDT, NBMAX )
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      INTEGER            ILAENV
      EXTERNAL           LSAME, ILAENV
```

```
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLARFB, DLARFT, DORM2R, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      LEFT = LSAME( SIDE, 'L' )
      NOTRAN = LSAME( TRANS, 'N' )
      LQUERY = ( LWORK.EQ.-1 )
*
*     NQ is the order of Q and NW is the minimum dimension of WORK
*
      IF( LEFT ) THEN
         NQ = M
         NW = N
      ELSE
         NQ = N
         NW = M
      END IF
      IF( .NOT.LEFT .AND. .NOT.LSAME( SIDE, 'R' ) ) THEN
         INFO = -1
      ELSE IF( .NOT.NOTRAN .AND. .NOT.LSAME( TRANS, 'T' ) ) THEN
         INFO = -2
      ELSE IF( M.LT.0 ) THEN
         INFO = -3
      ELSE IF( N.LT.0 ) THEN
         INFO = -4
      ELSE IF( K.LT.0 .OR. K.GT.NQ ) THEN
         INFO = -5
      ELSE IF( LDA.LT.MAX( 1, NQ ) ) THEN
         INFO = -7
      ELSE IF( LDC.LT.MAX( 1, M ) ) THEN
         INFO = -10
      ELSE IF( LWORK.LT.MAX( 1, NW ) .AND. .NOT.LQUERY ) THEN
         INFO = -12
      END IF
*
      IF( INFO.EQ.0 ) THEN
*
*        Determine the block size.  NB may be at most NBMAX, where NBMAX
*        is used to define the local array T.
*
         NB = MIN( NBMAX, ILAENV( 1, 'DORMQR', SIDE // TRANS, M, N, K,
     $        -1 ) )
```

```
         LWKOPT = MAX( 1, NW )*NB
         WORK( 1 ) = LWKOPT
      END IF
*
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DORMQR', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( M.EQ.0 .OR. N.EQ.0 .OR. K.EQ.0 ) THEN
         WORK( 1 ) = 1
         RETURN
      END IF
*
      NBMIN = 2
      LDWORK = NW
      IF( NB.GT.1 .AND. NB.LT.K ) THEN
         IWS = NW*NB
         IF( LWORK.LT.IWS ) THEN
            NB = LWORK / LDWORK
            NBMIN = MAX( 2, ILAENV( 2, 'DORMQR', SIDE // TRANS, M, N, K,
     $              -1 ) )
         END IF
      ELSE
         IWS = NW
      END IF
*
      IF( NB.LT.NBMIN .OR. NB.GE.K ) THEN
*
*        Use unblocked code
*
         CALL DORM2R( SIDE, TRANS, M, N, K, A, LDA, TAU, C, LDC, WORK,
     $                IINFO )
      ELSE
*
*        Use blocked code
*
         IF( ( LEFT .AND. .NOT.NOTRAN ) .OR.
     $       ( .NOT.LEFT .AND. NOTRAN ) ) THEN
            I1 = 1
            I2 = K
            I3 = NB
         ELSE
            I1 = ( ( K-1 ) / NB )*NB + 1
            I2 = 1
            I3 = -NB
```

```
         END IF
*
         IF( LEFT ) THEN
            NI = N
            JC = 1
         ELSE
            MI = M
            IC = 1
         END IF
*
         DO 10 I = I1, I2, I3
            IB = MIN( NB, K-I+1 )
*
*           Form the triangular factor of the block reflector
*           H = H(i) H(i+1) . . . H(i+ib-1)
*
            CALL DLARFT( 'Forward', 'Columnwise', NQ-I+1, IB, A( I, I ),
     $                   LDA, TAU( I ), T, LDT )
            IF( LEFT ) THEN
*
*              H or H' is applied to C(i:m,1:n)
*
               MI = M - I + 1
               IC = I
            ELSE
*
*              H or H' is applied to C(1:m,i:n)
*
               NI = N - I + 1
               JC = I
            END IF
*
*           Apply H or H'
*
            CALL DLARFB( SIDE, TRANS, 'Forward', 'Columnwise', MI, NI,
     $                   IB, A( I, I ), LDA, T, LDT, C( IC, JC ), LDC,
     $                   WORK, LDWORK )
   10    CONTINUE
      END IF
      WORK( 1 ) = LWKOPT
      RETURN
*
*     End of DORMQR
*
      END
```

— LAPACK dormqr —

```
(let* ((nbmax 64) (ldt (+ nbmax 1)))
  (declare (type (fixnum 64 64) nbmax)
           (type fixnum ldt))
  (defun dormqr (side trans m n k a lda tau c ldc work lwork info)
    (declare (type (simple-array double-float (*)) work c tau a)
             (type fixnum info lwork ldc lda k n m)
             (type character trans side))
    (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (trans character trans-%data% trans-%offset%)
         (a double-float a-%data% a-%offset%)
         (tau double-float tau-%data% tau-%offset%)
         (c double-float c-%data% c-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((i 0) (i1 0) (i2 0) (i3 0) (ib 0) (ic 0) (iinfo 0) (iws 0) (jc 0)
             (ldwork 0) (lwkopt 0) (mi 0) (nb 0) (nbmin 0) (ni 0) (nq 0) (nw 0)
             (left nil) (lquery nil) (notran nil)
             (t$
              (make-array (the fixnum (reduce #'* (list ldt nbmax)))
                          :element-type 'double-float)))
        (declare (type (simple-array double-float (*)) t$)
                 (type fixnum i i1 i2 i3 ib ic iinfo iws jc ldwork
                                        lwkopt mi nb nbmin ni nq nw)
                 (type (member t nil) left lquery notran))
        (setf info 0)
        (setf left (char-equal side #\L))
        (setf notran (char-equal trans #\N))
        (setf lquery (coerce (= lwork -1) '(member t nil)))
        (cond
          (left
           (setf nq m)
           (setf nw n))
          (t
           (setf nq n)
           (setf nw m)))
        (cond
          ((and (not left) (not (char-equal side #\R)))
           (setf info -1))
          ((and (not notran) (not (char-equal trans #\T)))
           (setf info -2))
          ((< m 0)
           (setf info -3))
          ((< n 0)
           (setf info -4))
          ((or (< k 0) (> k nq))
           (setf info -5))
          ((< lda (max (the fixnum 1) (the fixnum nq)))
           (setf info -7))
```

```
  ((< ldc (max (the fixnum 1) (the fixnum m)))
   (setf info -10))
  ((and
    (< lwork
       (max (the fixnum 1) (the fixnum nw)))
    (not lquery))
   (setf info -12)))
(cond
  ((= info 0)
   (setf nb
         (min (the fixnum nbmax)
              (the fixnum
                   (ilaenv 1 "DORMQR" (f2cl-lib:f2cl-// side trans) m
                    n k -1))))
   (setf lwkopt
         (f2cl-lib:int-mul
          (max (the fixnum 1) (the fixnum nw))
          nb))
   (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
         (coerce (the fixnum lwkopt) 'double-float))))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DORMQR" (f2cl-lib:int-sub info))
   (go end_label))
  (lquery
   (go end_label)))
(cond
  ((or (= m 0) (= n 0) (= k 0))
   (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
         (coerce (the fixnum 1) 'double-float))
   (go end_label)))
(setf nbmin 2)
(setf ldwork nw)
(cond
  ((and (> nb 1) (< nb k))
   (setf iws (f2cl-lib:int-mul nw nb))
   (cond
     ((< lwork iws)
      (setf nb (the fixnum (truncate lwork ldwork)))
      (setf nbmin
            (max (the fixnum 2)
                 (the fixnum
                      (ilaenv 2 "DORMQR"
                       (f2cl-lib:f2cl-// side trans) m n k -1)))))))
  (t
   (setf iws nw)))
(cond
  ((or (< nb nbmin) (>= nb k))
```

```
      (multiple-value-bind
            (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
             var-10 var-11)
          (dorm2r side trans m n k a lda tau c ldc work iinfo)
        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                         var-8 var-9 var-10))
        (setf iinfo var-11)))
     (t
      (cond
        ((or (and left (not notran)) (and (not left) notran))
         (setf i1 1)
         (setf i2 k)
         (setf i3 nb))
        (t
         (setf i1
                 (+ (* (the fixnum (truncate (- k 1) nb)) nb)
                    1))
         (setf i2 1)
         (setf i3 (f2cl-lib:int-sub nb))))
      (cond
        (left
         (setf ni n)
         (setf jc 1))
        (t
         (setf mi m)
         (setf ic 1)))
      (f2cl-lib:fdo (i i1 (f2cl-lib:int-add i i3))
                    ((> i i2) nil)
        (tagbody
          (setf ib
                  (min (the fixnum nb)
                       (the fixnum
                            (f2cl-lib:int-add (f2cl-lib:int-sub k i) 1))))
          (dlarft "Forward" "Columnwise"
           (f2cl-lib:int-add (f2cl-lib:int-sub nq i) 1) ib
           (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
           (f2cl-lib:array-slice tau double-float (i) ((1 *))) t$ ldt)
          (cond
            (left
             (setf mi (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1))
             (setf ic i))
            (t
             (setf ni (f2cl-lib:int-add (f2cl-lib:int-sub n i) 1))
             (setf jc i)))
          (dlarfb side trans "Forward" "Columnwise" mi ni ib
           (f2cl-lib:array-slice a double-float (i i) ((1 lda) (1 *))) lda
           t$ ldt
           (f2cl-lib:array-slice c double-float (ic jc) ((1 ldc) (1 *)))
           ldc work ldwork)))))
  (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
```

```
               (coerce (the fixnum lwkopt) 'double-float))
 end_label
        (return
         (values nil nil nil nil nil nil nil nil nil nil nil nil info))))))
```

———-

6.93 dtrevc LAPACK

— **dtrevc.input** —

```
)set break resume
)sys rm -f dtrevc.output
)spool dtrevc.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dtrevc.help** —

```
=====================================================================
dtrevc examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       DTREVC  -  some  or all of the right and/or left eigenvectors of a real
       upper quasi-triangular matrix T

SYNOPSIS
       SUBROUTINE DTREVC( SIDE, HOWMNY, SELECT, N, T, LDT, VL, LDVL, VR, LDVR,
                          MM, M, WORK, INFO )

           CHARACTER      HOWMNY, SIDE

           INTEGER        INFO, LDT, LDVL, LDVR, M, MM, N
```

```
          LOGICAL        SELECT( * )

          DOUBLE         PRECISION T( LDT, * ), VL( LDVL, * ), VR( LDVR, * ),
                         WORK( * )

  Purpose
  =======

  DTREVC computes some or all of the right and/or left eigenvectors of
  a real upper quasi-triangular matrix T.

  The right eigenvector x and the left eigenvector y of T corresponding
  to an eigenvalue w are defined by:

               T*x = w*x,     y'*T = w*y'

  where y' denotes the conjugate transpose of the vector y.

  If all eigenvectors are requested, the routine may either return the
  matrices X and/or Y of right or left eigenvectors of T, or the
  products Q*X and/or Q*Y, where Q is an input orthogonal
  matrix. If T was obtained from the real-Schur factorization of an
  original matrix A = Q*T*Q', then Q*X and Q*Y are the matrices of
  right or left eigenvectors of A.

  T must be in Schur canonical form (as returned by DHSEQR), that is,
  block upper triangular with 1-by-1 and 2-by-2 diagonal blocks; each
  2-by-2 diagonal block has its diagonal elements equal and its
  off-diagonal elements of opposite sign.  Corresponding to each 2-by-2
  diagonal block is a complex conjugate pair of eigenvalues and
  eigenvectors; only one eigenvector of the pair is computed, namely
  the one corresponding to the eigenvalue with positive imaginary part.

  Arguments
  =========

  SIDE    (input) CHARACTER*1
          = 'R':  compute right eigenvectors only;
          = 'L':  compute left eigenvectors only;
          = 'B':  compute both right and left eigenvectors.

  HOWMNY  (input) CHARACTER*1
          = 'A':  compute all right and/or left eigenvectors;
          = 'B':  compute all right and/or left eigenvectors,
                  and backtransform them using the input matrices
                  supplied in VR and/or VL;
          = 'S':  compute selected right and/or left eigenvectors,
                  specified by the logical array SELECT.

  SELECT  (input/output) LOGICAL array, dimension (N)
```

```
        If HOWMNY = 'S', SELECT specifies the eigenvectors to be
        computed.
        If HOWMNY = 'A' or 'B', SELECT is not referenced.
        To select the real eigenvector corresponding to a real
        eigenvalue w(j), SELECT(j) must be set to .TRUE..  To select
        the complex eigenvector corresponding to a complex conjugate
        pair w(j) and w(j+1), either SELECT(j) or SELECT(j+1) must be
        set to .TRUE.; then on exit SELECT(j) is .TRUE. and
        SELECT(j+1) is .FALSE..

N       (input) INTEGER
        The order of the matrix T. N >= 0.

T       (input) DOUBLE PRECISION array, dimension (LDT,N)
        The upper quasi-triangular matrix T in Schur canonical form.

LDT     (input) INTEGER
        The leading dimension of the array T. LDT >= max(1,N).

VL      (input/output) DOUBLE PRECISION array, dimension (LDVL,MM)
        On entry, if SIDE = 'L' or 'B' and HOWMNY = 'B', VL must
        contain an N-by-N matrix Q (usually the orthogonal matrix Q
        of Schur vectors returned by DHSEQR).
        On exit, if SIDE = 'L' or 'B', VL contains:
        if HOWMNY = 'A', the matrix Y of left eigenvectors of T;
                         VL has the same quasi-lower triangular form
                         as T'. If T(i,i) is a real eigenvalue, then
                         the i-th column VL(i) of VL  is its
                         corresponding eigenvector. If T(i:i+1,i:i+1)
                         is a 2-by-2 block whose eigenvalues are
                         complex-conjugate eigenvalues of T, then
                         VL(i)+sqrt(-1)*VL(i+1) is the complex
                         eigenvector corresponding to the eigenvalue
                         with positive real part.
        if HOWMNY = 'B', the matrix Q*Y;
        if HOWMNY = 'S', the left eigenvectors of T specified by
                         SELECT, stored consecutively in the columns
                         of VL, in the same order as their
                         eigenvalues.
        A complex eigenvector corresponding to a complex eigenvalue
        is stored in two consecutive columns, the first holding the
        real part, and the second the imaginary part.
        If SIDE = 'R', VL is not referenced.

LDVL    (input) INTEGER
        The leading dimension of the array VL.  LDVL >= max(1,N) if
        SIDE = 'L' or 'B'; LDVL >= 1 otherwise.

VR      (input/output) DOUBLE PRECISION array, dimension (LDVR,MM)
        On entry, if SIDE = 'R' or 'B' and HOWMNY = 'B', VR must
```

```
          contain an N-by-N matrix Q (usually the orthogonal matrix Q
          of Schur vectors returned by DHSEQR).
          On exit, if SIDE = 'R' or 'B', VR contains:
          if HOWMNY = 'A', the matrix X of right eigenvectors of T;
                           VR has the same quasi-upper triangular form
                           as T. If T(i,i) is a real eigenvalue, then
                           the i-th column VR(i) of VR  is its
                           corresponding eigenvector. If T(i:i+1,i:i+1)
                           is a 2-by-2 block whose eigenvalues are
                           complex-conjugate eigenvalues of T, then
                           VR(i)+sqrt(-1)*VR(i+1) is the complex
                           eigenvector corresponding to the eigenvalue
                           with positive real part.
          if HOWMNY = 'B', the matrix Q*X;
          if HOWMNY = 'S', the right eigenvectors of T specified by
                           SELECT, stored consecutively in the columns
                           of VR, in the same order as their
                           eigenvalues.
          A complex eigenvector corresponding to a complex eigenvalue
          is stored in two consecutive columns, the first holding the
          real part and the second the imaginary part.
          If SIDE = 'L', VR is not referenced.

  LDVR    (input) INTEGER
          The leading dimension of the array VR.  LDVR >= max(1,N) if
          SIDE = 'R' or 'B'; LDVR >= 1 otherwise.

  MM      (input) INTEGER
          The number of columns in the arrays VL and/or VR. MM >= M.

  M       (output) INTEGER
          The number of columns in the arrays VL and/or VR actually
          used to store the eigenvectors.
          If HOWMNY = 'A' or 'B', M is set to N.
          Each selected real eigenvector occupies one column and each
          selected complex eigenvector occupies two columns.

  WORK    (workspace) DOUBLE PRECISION array, dimension (3*N)

  INFO    (output) INTEGER
          = 0:  successful exit
          < 0:  if INFO = -i, the i-th argument had an illegal value

  Further Details
  ===============

  The algorithm used in this program is basically backward (forward)
  substitution, with scaling to make the the code robust against
  possible overflow.
```

```
  Each eigenvector is normalized so that the element of largest
  magnitude has magnitude 1; here the magnitude of a complex number
  (x,y) is taken to be |x| + |y|.
```

— dtrevc.f —

```
      SUBROUTINE DTREVC( SIDE, HOWMNY, SELECT, N, T, LDT, VL, LDVL, VR,
     $                   LDVR, MM, M, WORK, INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
      CHARACTER          HOWMNY, SIDE
      INTEGER            INFO, LDT, LDVL, LDVR, M, MM, N
*     ..
*     .. Array Arguments ..
      LOGICAL            SELECT( * )
      DOUBLE PRECISION   T( LDT, * ), VL( LDVL, * ), VR( LDVR, * ),
     $                   WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            ALLV, BOTHV, LEFTV, OVER, PAIR, RIGHTV, SOMEV
      INTEGER            I, IERR, II, IP, IS, J, J1, J2, JNXT, K, KI, N2
      DOUBLE PRECISION   BETA, BIGNUM, EMAX, OVFL, REC, REMAX, SCALE,
     $                   SMIN, SMLNUM, ULP, UNFL, VCRIT, VMAX, WI, WR,
     $                   XNORM
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      INTEGER            IDAMAX
      DOUBLE PRECISION   DDOT, DLAMCH
      EXTERNAL           LSAME, IDAMAX, DDOT, DLAMCH
*     ..
*     .. External Subroutines ..
      EXTERNAL           DAXPY, DCOPY, DGEMV, DLALN2, DSCAL, XERBLA
*     ..
```

```
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX, SQRT
*     ..
*     .. Local Arrays ..
      DOUBLE PRECISION   X( 2, 2 )
*     ..
*     .. Executable Statements ..
*
*     Decode and test the input parameters
*
      BOTHV = LSAME( SIDE, 'B' )
      RIGHTV = LSAME( SIDE, 'R' ) .OR. BOTHV
      LEFTV = LSAME( SIDE, 'L' ) .OR. BOTHV
*
      ALLV = LSAME( HOWMNY, 'A' )
      OVER = LSAME( HOWMNY, 'B' )
      SOMEV = LSAME( HOWMNY, 'S' )
*
      INFO = 0
      IF( .NOT.RIGHTV .AND. .NOT.LEFTV ) THEN
         INFO = -1
      ELSE IF( .NOT.ALLV .AND. .NOT.OVER .AND. .NOT.SOMEV ) THEN
         INFO = -2
      ELSE IF( N.LT.0 ) THEN
         INFO = -4
      ELSE IF( LDT.LT.MAX( 1, N ) ) THEN
         INFO = -6
      ELSE IF( LDVL.LT.1 .OR. ( LEFTV .AND. LDVL.LT.N ) ) THEN
         INFO = -8
      ELSE IF( LDVR.LT.1 .OR. ( RIGHTV .AND. LDVR.LT.N ) ) THEN
         INFO = -10
      ELSE
*
*        Set M to the number of columns required to store the selected
*        eigenvectors, standardize the array SELECT if necessary, and
*        test MM.
*
         IF( SOMEV ) THEN
            M = 0
            PAIR = .FALSE.
            DO 10 J = 1, N
               IF( PAIR ) THEN
                  PAIR = .FALSE.
                  SELECT( J ) = .FALSE.
               ELSE
                  IF( J.LT.N ) THEN
                     IF( T( J+1, J ).EQ.ZERO ) THEN
                        IF( SELECT( J ) )
     $                     M = M + 1
                     ELSE
```

```
                     PAIR = .TRUE.
                     IF( SELECT( J ) .OR. SELECT( J+1 ) ) THEN
                        SELECT( J ) = .TRUE.
                        M = M + 2
                     END IF
                  END IF
               ELSE
                  IF( SELECT( N ) )
     $               M = M + 1
               END IF
            END IF
   10       CONTINUE
         ELSE
            M = N
         END IF
*
         IF( MM.LT.M ) THEN
            INFO = -11
         END IF
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DTREVC', -INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( N.EQ.0 )
     $   RETURN
*
*     Set the constants to control overflow.
*
      UNFL = DLAMCH( 'Safe minimum' )
      OVFL = ONE / UNFL
      CALL DLABAD( UNFL, OVFL )
      ULP = DLAMCH( 'Precision' )
      SMLNUM = UNFL*( N / ULP )
      BIGNUM = ( ONE-ULP ) / SMLNUM
*
*     Compute 1-norm of each column of strictly upper triangular
*     part of T to control overflow in triangular solver.
*
      WORK( 1 ) = ZERO
      DO 30 J = 2, N
         WORK( J ) = ZERO
         DO 20 I = 1, J - 1
            WORK( J ) = WORK( J ) + ABS( T( I, J ) )
   20    CONTINUE
   30 CONTINUE
*
```

```
*     Index IP is used to specify the real or complex eigenvalue:
*       IP = 0, real eigenvalue,
*            1, first of conjugate complex pair: (wr,wi)
*           -1, second of conjugate complex pair: (wr,wi)
*
      N2 = 2*N
*
      IF( RIGHTV ) THEN
*
*        Compute right eigenvectors.
*
         IP = 0
         IS = M
         DO 140 KI = N, 1, -1
*
            IF( IP.EQ.1 )
     $         GO TO 130
            IF( KI.EQ.1 )
     $         GO TO 40
            IF( T( KI, KI-1 ).EQ.ZERO )
     $         GO TO 40
            IP = -1
*
   40       CONTINUE
            IF( SOMEV ) THEN
               IF( IP.EQ.0 ) THEN
                  IF( .NOT.SELECT( KI ) )
     $               GO TO 130
               ELSE
                  IF( .NOT.SELECT( KI-1 ) )
     $               GO TO 130
               END IF
            END IF
*
*           Compute the KI-th eigenvalue (WR,WI).
*
            WR = T( KI, KI )
            WI = ZERO
            IF( IP.NE.0 )
     $         WI = SQRT( ABS( T( KI, KI-1 ) ) )*
     $              SQRT( ABS( T( KI-1, KI ) ) )
            SMIN = MAX( ULP*( ABS( WR )+ABS( WI ) ), SMLNUM )
*
            IF( IP.EQ.0 ) THEN
*
*              Real right eigenvector
*
               WORK( KI+N ) = ONE
*
*              Form right-hand side
```

```
*
              DO 50 K = 1, KI - 1
                 WORK( K+N ) = -T( K, KI )
   50         CONTINUE
*
*             Solve the upper quasi-triangular system:
*                (T(1:KI-1,1:KI-1) - WR)*X = SCALE*WORK.
*
              JNXT = KI - 1
              DO 60 J = KI - 1, 1, -1
                 IF( J.GT.JNXT )
     $              GO TO 60
                 J1 = J
                 J2 = J
                 JNXT = J - 1
                 IF( J.GT.1 ) THEN
                    IF( T( J, J-1 ).NE.ZERO ) THEN
                       J1 = J - 1
                       JNXT = J - 2
                    END IF
                 END IF
*
                 IF( J1.EQ.J2 ) THEN
*
*                   1-by-1 diagonal block
*
                    CALL DLALN2( .FALSE., 1, 1, SMIN, ONE, T( J, J ),
     $                           LDT, ONE, ONE, WORK( J+N ), N, WR,
     $                           ZERO, X, 2, SCALE, XNORM, IERR )
*
*                   Scale X(1,1) to avoid overflow when updating
*                   the right-hand side.
*
                    IF( XNORM.GT.ONE ) THEN
                       IF( WORK( J ).GT.BIGNUM / XNORM ) THEN
                          X( 1, 1 ) = X( 1, 1 ) / XNORM
                          SCALE = SCALE / XNORM
                       END IF
                    END IF
*
*                   Scale if necessary
*
                    IF( SCALE.NE.ONE )
     $                 CALL DSCAL( KI, SCALE, WORK( 1+N ), 1 )
                    WORK( J+N ) = X( 1, 1 )
*
*                   Update right-hand side
*
                    CALL DAXPY( J-1, -X( 1, 1 ), T( 1, J ), 1,
     $                          WORK( 1+N ), 1 )
```

```
*
                  ELSE
*
*                    2-by-2 diagonal block
*
                     CALL DLALN2( .FALSE., 2, 1, SMIN, ONE,
     $                             T( J-1, J-1 ), LDT, ONE, ONE,
     $                             WORK( J-1+N ), N, WR, ZERO, X, 2,
     $                             SCALE, XNORM, IERR )
*
*                    Scale X(1,1) and X(2,1) to avoid overflow when
*                    updating the right-hand side.
*
                     IF( XNORM.GT.ONE ) THEN
                        BETA = MAX( WORK( J-1 ), WORK( J ) )
                        IF( BETA.GT.BIGNUM / XNORM ) THEN
                           X( 1, 1 ) = X( 1, 1 ) / XNORM
                           X( 2, 1 ) = X( 2, 1 ) / XNORM
                           SCALE = SCALE / XNORM
                        END IF
                     END IF
*
*                    Scale if necessary
*
                     IF( SCALE.NE.ONE )
     $                  CALL DSCAL( KI, SCALE, WORK( 1+N ), 1 )
                     WORK( J-1+N ) = X( 1, 1 )
                     WORK( J+N ) = X( 2, 1 )
*
*                    Update right-hand side
*
                     CALL DAXPY( J-2, -X( 1, 1 ), T( 1, J-1 ), 1,
     $                           WORK( 1+N ), 1 )
                     CALL DAXPY( J-2, -X( 2, 1 ), T( 1, J ), 1,
     $                           WORK( 1+N ), 1 )
                  END IF
   60          CONTINUE
*
*              Copy the vector x or Q*x to VR and normalize.
*
               IF( .NOT.OVER ) THEN
                  CALL DCOPY( KI, WORK( 1+N ), 1, VR( 1, IS ), 1 )
*
                  II = IDAMAX( KI, VR( 1, IS ), 1 )
                  REMAX = ONE / ABS( VR( II, IS ) )
                  CALL DSCAL( KI, REMAX, VR( 1, IS ), 1 )
*
                  DO 70 K = KI + 1, N
                     VR( K, IS ) = ZERO
   70             CONTINUE
```

```
               ELSE
                  IF( KI.GT.1 )
     $               CALL DGEMV( 'N', N, KI-1, ONE, VR, LDVR,
     $                           WORK( 1+N ), 1, WORK( KI+N ),
     $                           VR( 1, KI ), 1 )
*
                  II = IDAMAX( N, VR( 1, KI ), 1 )
                  REMAX = ONE / ABS( VR( II, KI ) )
                  CALL DSCAL( N, REMAX, VR( 1, KI ), 1 )
               END IF
*
            ELSE
*
*              Complex right eigenvector.
*
*              Initial solve
*                [ (T(KI-1,KI-1) T(KI-1,KI) ) - (WR + I* WI)]*X = 0.
*                [ (T(KI,KI-1)   T(KI,KI)   )               ]
*
               IF( ABS( T( KI-1, KI ) ).GE.ABS( T( KI, KI-1 ) ) ) THEN
                  WORK( KI-1+N ) = ONE
                  WORK( KI+N2 ) = WI / T( KI-1, KI )
               ELSE
                  WORK( KI-1+N ) = -WI / T( KI, KI-1 )
                  WORK( KI+N2 ) = ONE
               END IF
               WORK( KI+N ) = ZERO
               WORK( KI-1+N2 ) = ZERO
*
*              Form right-hand side
*
               DO 80 K = 1, KI - 2
                  WORK( K+N ) = -WORK( KI-1+N )*T( K, KI-1 )
                  WORK( K+N2 ) = -WORK( KI+N2 )*T( K, KI )
   80          CONTINUE
*
*              Solve upper quasi-triangular system:
*              (T(1:KI-2,1:KI-2) - (WR+i*WI))*X = SCALE*(WORK+i*WORK2)
*
               JNXT = KI - 2
               DO 90 J = KI - 2, 1, -1
                  IF( J.GT.JNXT )
     $               GO TO 90
                  J1 = J
                  J2 = J
                  JNXT = J - 1
                  IF( J.GT.1 ) THEN
                     IF( T( J, J-1 ).NE.ZERO ) THEN
                        J1 = J - 1
                        JNXT = J - 2
```

```
                  END IF
               END IF
*
               IF( J1.EQ.J2 ) THEN
*
*                 1-by-1 diagonal block
*
                  CALL DLALN2( .FALSE., 1, 2, SMIN, ONE, T( J, J ),
     $                         LDT, ONE, ONE, WORK( J+N ), N, WR, WI,
     $                         X, 2, SCALE, XNORM, IERR )
*
*                 Scale X(1,1) and X(1,2) to avoid overflow when
*                 updating the right-hand side.
*
                  IF( XNORM.GT.ONE ) THEN
                     IF( WORK( J ).GT.BIGNUM / XNORM ) THEN
                        X( 1, 1 ) = X( 1, 1 ) / XNORM
                        X( 1, 2 ) = X( 1, 2 ) / XNORM
                        SCALE = SCALE / XNORM
                     END IF
                  END IF
*
*                 Scale if necessary
*
                  IF( SCALE.NE.ONE ) THEN
                     CALL DSCAL( KI, SCALE, WORK( 1+N ), 1 )
                     CALL DSCAL( KI, SCALE, WORK( 1+N2 ), 1 )
                  END IF
                  WORK( J+N ) = X( 1, 1 )
                  WORK( J+N2 ) = X( 1, 2 )
*
*                 Update the right-hand side
*
                  CALL DAXPY( J-1, -X( 1, 1 ), T( 1, J ), 1,
     $                        WORK( 1+N ), 1 )
                  CALL DAXPY( J-1, -X( 1, 2 ), T( 1, J ), 1,
     $                        WORK( 1+N2 ), 1 )
*
               ELSE
*
*                 2-by-2 diagonal block
*
                  CALL DLALN2( .FALSE., 2, 2, SMIN, ONE,
     $                         T( J-1, J-1 ), LDT, ONE, ONE,
     $                         WORK( J-1+N ), N, WR, WI, X, 2, SCALE,
     $                         XNORM, IERR )
*
*                 Scale X to avoid overflow when updating
*                 the right-hand side.
*
```

```
                  IF( XNORM.GT.ONE ) THEN
                     BETA = MAX( WORK( J-1 ), WORK( J ) )
                     IF( BETA.GT.BIGNUM / XNORM ) THEN
                        REC = ONE / XNORM
                        X( 1, 1 ) = X( 1, 1 )*REC
                        X( 1, 2 ) = X( 1, 2 )*REC
                        X( 2, 1 ) = X( 2, 1 )*REC
                        X( 2, 2 ) = X( 2, 2 )*REC
                        SCALE = SCALE*REC
                     END IF
                  END IF
*
*                 Scale if necessary
*
                  IF( SCALE.NE.ONE ) THEN
                     CALL DSCAL( KI, SCALE, WORK( 1+N ), 1 )
                     CALL DSCAL( KI, SCALE, WORK( 1+N2 ), 1 )
                  END IF
                  WORK( J-1+N ) = X( 1, 1 )
                  WORK( J+N ) = X( 2, 1 )
                  WORK( J-1+N2 ) = X( 1, 2 )
                  WORK( J+N2 ) = X( 2, 2 )
*
*                 Update the right-hand side
*
                  CALL DAXPY( J-2, -X( 1, 1 ), T( 1, J-1 ), 1,
     $                        WORK( 1+N ), 1 )
                  CALL DAXPY( J-2, -X( 2, 1 ), T( 1, J ), 1,
     $                        WORK( 1+N ), 1 )
                  CALL DAXPY( J-2, -X( 1, 2 ), T( 1, J-1 ), 1,
     $                        WORK( 1+N2 ), 1 )
                  CALL DAXPY( J-2, -X( 2, 2 ), T( 1, J ), 1,
     $                        WORK( 1+N2 ), 1 )
               END IF
   90          CONTINUE
*
*              Copy the vector x or Q*x to VR and normalize.
*
               IF( .NOT.OVER ) THEN
                  CALL DCOPY( KI, WORK( 1+N ), 1, VR( 1, IS-1 ), 1 )
                  CALL DCOPY( KI, WORK( 1+N2 ), 1, VR( 1, IS ), 1 )
*
                  EMAX = ZERO
                  DO 100 K = 1, KI
                     EMAX = MAX( EMAX, ABS( VR( K, IS-1 ) )+
     $                       ABS( VR( K, IS ) ) )
  100             CONTINUE
*
                  REMAX = ONE / EMAX
                  CALL DSCAL( KI, REMAX, VR( 1, IS-1 ), 1 )
```

```
                  CALL DSCAL( KI, REMAX, VR( 1, IS ), 1 )
*
                  DO 110 K = KI + 1, N
                     VR( K, IS-1 ) = ZERO
                     VR( K, IS ) = ZERO
  110             CONTINUE
*
               ELSE
*
                  IF( KI.GT.2 ) THEN
                     CALL DGEMV( 'N', N, KI-2, ONE, VR, LDVR,
     $                           WORK( 1+N ), 1, WORK( KI-1+N ),
     $                           VR( 1, KI-1 ), 1 )
                     CALL DGEMV( 'N', N, KI-2, ONE, VR, LDVR,
     $                           WORK( 1+N2 ), 1, WORK( KI+N2 ),
     $                           VR( 1, KI ), 1 )
                  ELSE
                     CALL DSCAL( N, WORK( KI-1+N ), VR( 1, KI-1 ), 1 )
                     CALL DSCAL( N, WORK( KI+N2 ), VR( 1, KI ), 1 )
                  END IF
*
                  EMAX = ZERO
                  DO 120 K = 1, N
                     EMAX = MAX( EMAX, ABS( VR( K, KI-1 ) )+
     $                            ABS( VR( K, KI ) ) )
  120             CONTINUE
                  REMAX = ONE / EMAX
                  CALL DSCAL( N, REMAX, VR( 1, KI-1 ), 1 )
                  CALL DSCAL( N, REMAX, VR( 1, KI ), 1 )
               END IF
            END IF
*
            IS = IS - 1
            IF( IP.NE.0 )
     $         IS = IS - 1
  130       CONTINUE
            IF( IP.EQ.1 )
     $         IP = 0
            IF( IP.EQ.-1 )
     $         IP = 1
  140    CONTINUE
      END IF
*
      IF( LEFTV ) THEN
*
*        Compute left eigenvectors.
*
         IP = 0
         IS = 1
         DO 260 KI = 1, N
```

```
*
            IF( IP.EQ.-1 )
     $         GO TO 250
            IF( KI.EQ.N )
     $         GO TO 150
            IF( T( KI+1, KI ).EQ.ZERO )
     $         GO TO 150
            IP = 1
*
  150       CONTINUE
            IF( SOMEV ) THEN
               IF( .NOT.SELECT( KI ) )
     $            GO TO 250
            END IF
*
*           Compute the KI-th eigenvalue (WR,WI).
*
            WR = T( KI, KI )
            WI = ZERO
            IF( IP.NE.0 )
     $         WI = SQRT( ABS( T( KI, KI+1 ) ) )*
     $              SQRT( ABS( T( KI+1, KI ) ) )
            SMIN = MAX( ULP*( ABS( WR )+ABS( WI ) ), SMLNUM )
*
            IF( IP.EQ.0 ) THEN
*
*              Real left eigenvector.
*
               WORK( KI+N ) = ONE
*
*              Form right-hand side
*
               DO 160 K = KI + 1, N
                  WORK( K+N ) = -T( KI, K )
  160          CONTINUE
*
*              Solve the quasi-triangular system:
*                 (T(KI+1:N,KI+1:N) - WR)'*X = SCALE*WORK
*
               VMAX = ONE
               VCRIT = BIGNUM
*
               JNXT = KI + 1
               DO 170 J = KI + 1, N
                  IF( J.LT.JNXT )
     $               GO TO 170
                  J1 = J
                  J2 = J
                  JNXT = J + 1
                  IF( J.LT.N ) THEN
```

```
                     IF( T( J+1, J ).NE.ZERO ) THEN
                        J2 = J + 1
                        JNXT = J + 2
                     END IF
                  END IF
*
                  IF( J1.EQ.J2 ) THEN
*
*                    1-by-1 diagonal block
*
*                    Scale if necessary to avoid overflow when forming
*                    the right-hand side.
*
                     IF( WORK( J ).GT.VCRIT ) THEN
                        REC = ONE / VMAX
                        CALL DSCAL( N-KI+1, REC, WORK( KI+N ), 1 )
                        VMAX = ONE
                        VCRIT = BIGNUM
                     END IF
*
                     WORK( J+N ) = WORK( J+N ) -
     $                             DDOT( J-KI-1, T( KI+1, J ), 1,
     $                             WORK( KI+1+N ), 1 )
*
*                    Solve (T(J,J)-WR)'*X = WORK
*
                     CALL DLALN2( .FALSE., 1, 1, SMIN, ONE, T( J, J ),
     $                           LDT, ONE, ONE, WORK( J+N ), N, WR,
     $                           ZERO, X, 2, SCALE, XNORM, IERR )
*
*                    Scale if necessary
*
                     IF( SCALE.NE.ONE )
     $                  CALL DSCAL( N-KI+1, SCALE, WORK( KI+N ), 1 )
                     WORK( J+N ) = X( 1, 1 )
                     VMAX = MAX( ABS( WORK( J+N ) ), VMAX )
                     VCRIT = BIGNUM / VMAX
*
                  ELSE
*
*                    2-by-2 diagonal block
*
*                    Scale if necessary to avoid overflow when forming
*                    the right-hand side.
*
                     BETA = MAX( WORK( J ), WORK( J+1 ) )
                     IF( BETA.GT.VCRIT ) THEN
                        REC = ONE / VMAX
                        CALL DSCAL( N-KI+1, REC, WORK( KI+N ), 1 )
                        VMAX = ONE
```

```
                     VCRIT = BIGNUM
                  END IF
*
                  WORK( J+N ) = WORK( J+N ) -
     $                          DDOT( J-KI-1, T( KI+1, J ), 1,
     $                          WORK( KI+1+N ), 1 )
*
                  WORK( J+1+N ) = WORK( J+1+N ) -
     $                            DDOT( J-KI-1, T( KI+1, J+1 ), 1,
     $                            WORK( KI+1+N ), 1 )
*
*                 Solve
*                   [T(J,J)-WR   T(J,J+1)     ]'* X = SCALE*( WORK1 )
*                   [T(J+1,J)    T(J+1,J+1)-WR]             ( WORK2 )
*
                  CALL DLALN2( .TRUE., 2, 1, SMIN, ONE, T( J, J ),
     $                         LDT, ONE, ONE, WORK( J+N ), N, WR,
     $                         ZERO, X, 2, SCALE, XNORM, IERR )
*
*                 Scale if necessary
*
                  IF( SCALE.NE.ONE )
     $               CALL DSCAL( N-KI+1, SCALE, WORK( KI+N ), 1 )
                  WORK( J+N ) = X( 1, 1 )
                  WORK( J+1+N ) = X( 2, 1 )
*
                  VMAX = MAX( ABS( WORK( J+N ) ),
     $                    ABS( WORK( J+1+N ) ), VMAX )
                  VCRIT = BIGNUM / VMAX
*
               END IF
  170          CONTINUE
*
*              Copy the vector x or Q*x to VL and normalize.
*
               IF( .NOT.OVER ) THEN
                  CALL DCOPY( N-KI+1, WORK( KI+N ), 1, VL( KI, IS ), 1 )
*
                  II = IDAMAX( N-KI+1, VL( KI, IS ), 1 ) + KI - 1
                  REMAX = ONE / ABS( VL( II, IS ) )
                  CALL DSCAL( N-KI+1, REMAX, VL( KI, IS ), 1 )
*
                  DO 180 K = 1, KI - 1
                     VL( K, IS ) = ZERO
  180             CONTINUE
*
               ELSE
*
                  IF( KI.LT.N )
     $               CALL DGEMV( 'N', N, N-KI, ONE, VL( 1, KI+1 ), LDVL,
```

```
     $                          WORK( KI+1+N ), 1, WORK( KI+N ),
     $                          VL( 1, KI ), 1 )
*
                  II = IDAMAX( N, VL( 1, KI ), 1 )
                  REMAX = ONE / ABS( VL( II, KI ) )
                  CALL DSCAL( N, REMAX, VL( 1, KI ), 1 )
*
               END IF
*
            ELSE
*
*              Complex left eigenvector.
*
*               Initial solve:
*                 ((T(KI,KI)    T(KI,KI+1) )' - (WR - I* WI))*X = 0.
*                 ((T(KI+1,KI) T(KI+1,KI+1))                )
*
               IF( ABS( T( KI, KI+1 ) ).GE.ABS( T( KI+1, KI ) ) ) THEN
                  WORK( KI+N ) = WI / T( KI, KI+1 )
                  WORK( KI+1+N2 ) = ONE
               ELSE
                  WORK( KI+N ) = ONE
                  WORK( KI+1+N2 ) = -WI / T( KI+1, KI )
               END IF
               WORK( KI+1+N ) = ZERO
               WORK( KI+N2 ) = ZERO
*
*              Form right-hand side
*
               DO 190 K = KI + 2, N
                  WORK( K+N ) = -WORK( KI+N )*T( KI, K )
                  WORK( K+N2 ) = -WORK( KI+1+N2 )*T( KI+1, K )
  190          CONTINUE
*
*              Solve complex quasi-triangular system:
*              ( T(KI+2,N:KI+2,N) - (WR-i*WI) )*X = WORK1+i*WORK2
*
               VMAX = ONE
               VCRIT = BIGNUM
*
               JNXT = KI + 2
               DO 200 J = KI + 2, N
                  IF( J.LT.JNXT )
     $               GO TO 200
                  J1 = J
                  J2 = J
                  JNXT = J + 1
                  IF( J.LT.N ) THEN
                     IF( T( J+1, J ).NE.ZERO ) THEN
                        J2 = J + 1
```

```
                     JNXT = J + 2
                  END IF
               END IF
*
               IF( J1.EQ.J2 ) THEN
*
*                 1-by-1 diagonal block
*
*                 Scale if necessary to avoid overflow when
*                 forming the right-hand side elements.
*
                  IF( WORK( J ).GT.VCRIT ) THEN
                     REC = ONE / VMAX
                     CALL DSCAL( N-KI+1, REC, WORK( KI+N ), 1 )
                     CALL DSCAL( N-KI+1, REC, WORK( KI+N2 ), 1 )
                     VMAX = ONE
                     VCRIT = BIGNUM
                  END IF
*
                  WORK( J+N ) = WORK( J+N ) -
     $                        DDOT( J-KI-2, T( KI+2, J ), 1,
     $                        WORK( KI+2+N ), 1 )
                  WORK( J+N2 ) = WORK( J+N2 ) -
     $                         DDOT( J-KI-2, T( KI+2, J ), 1,
     $                         WORK( KI+2+N2 ), 1 )
*
*                 Solve (T(J,J)-(WR-i*WI))*(X11+i*X12)= WK+I*WK2
*
                  CALL DLALN2( .FALSE., 1, 2, SMIN, ONE, T( J, J ),
     $                        LDT, ONE, ONE, WORK( J+N ), N, WR,
     $                        -WI, X, 2, SCALE, XNORM, IERR )
*
*                 Scale if necessary
*
                  IF( SCALE.NE.ONE ) THEN
                     CALL DSCAL( N-KI+1, SCALE, WORK( KI+N ), 1 )
                     CALL DSCAL( N-KI+1, SCALE, WORK( KI+N2 ), 1 )
                  END IF
                  WORK( J+N ) = X( 1, 1 )
                  WORK( J+N2 ) = X( 1, 2 )
                  VMAX = MAX( ABS( WORK( J+N ) ),
     $                 ABS( WORK( J+N2 ) ), VMAX )
                  VCRIT = BIGNUM / VMAX
*
               ELSE
*
*                 2-by-2 diagonal block
*
*                 Scale if necessary to avoid overflow when forming
*                 the right-hand side elements.
```

```
*
                     BETA = MAX( WORK( J ), WORK( J+1 ) )
                     IF( BETA.GT.VCRIT ) THEN
                        REC = ONE / VMAX
                        CALL DSCAL( N-KI+1, REC, WORK( KI+N ), 1 )
                        CALL DSCAL( N-KI+1, REC, WORK( KI+N2 ), 1 )
                        VMAX = ONE
                        VCRIT = BIGNUM
                     END IF
*
                     WORK( J+N ) = WORK( J+N ) -
     $                              DDOT( J-KI-2, T( KI+2, J ), 1,
     $                              WORK( KI+2+N ), 1 )
*
                     WORK( J+N2 ) = WORK( J+N2 ) -
     $                               DDOT( J-KI-2, T( KI+2, J ), 1,
     $                               WORK( KI+2+N2 ), 1 )
*
                     WORK( J+1+N ) = WORK( J+1+N ) -
     $                               DDOT( J-KI-2, T( KI+2, J+1 ), 1,
     $                               WORK( KI+2+N ), 1 )
*
                     WORK( J+1+N2 ) = WORK( J+1+N2 ) -
     $                                DDOT( J-KI-2, T( KI+2, J+1 ), 1,
     $                                WORK( KI+2+N2 ), 1 )
*
*                    Solve 2-by-2 complex linear equation
*                      ([T(j,j)   T(j,j+1)  ]'-(wr-i*wi)*I)*X = SCALE*B
*                      ([T(j+1,j) T(j+1,j+1)]             )
*
                     CALL DLALN2( .TRUE., 2, 2, SMIN, ONE, T( J, J ),
     $                            LDT, ONE, ONE, WORK( J+N ), N, WR,
     $                            -WI, X, 2, SCALE, XNORM, IERR )
*
*                    Scale if necessary
*
                     IF( SCALE.NE.ONE ) THEN
                        CALL DSCAL( N-KI+1, SCALE, WORK( KI+N ), 1 )
                        CALL DSCAL( N-KI+1, SCALE, WORK( KI+N2 ), 1 )
                     END IF
                     WORK( J+N ) = X( 1, 1 )
                     WORK( J+N2 ) = X( 1, 2 )
                     WORK( J+1+N ) = X( 2, 1 )
                     WORK( J+1+N2 ) = X( 2, 2 )
                     VMAX = MAX( ABS( X( 1, 1 ) ), ABS( X( 1, 2 ) ),
     $                       ABS( X( 2, 1 ) ), ABS( X( 2, 2 ) ), VMAX )
                     VCRIT = BIGNUM / VMAX
*
                  END IF
  200          CONTINUE
```

```
*
*              Copy the vector x or Q*x to VL and normalize.
*
  210          CONTINUE
               IF( .NOT.OVER ) THEN
                  CALL DCOPY( N-KI+1, WORK( KI+N ), 1, VL( KI, IS ), 1 )
                  CALL DCOPY( N-KI+1, WORK( KI+N2 ), 1, VL( KI, IS+1 ),
     $                        1 )
*
                  EMAX = ZERO
                  DO 220 K = KI, N
                     EMAX = MAX( EMAX, ABS( VL( K, IS ) )+
     $                       ABS( VL( K, IS+1 ) ) )
  220             CONTINUE
                  REMAX = ONE / EMAX
                  CALL DSCAL( N-KI+1, REMAX, VL( KI, IS ), 1 )
                  CALL DSCAL( N-KI+1, REMAX, VL( KI, IS+1 ), 1 )
*
                  DO 230 K = 1, KI - 1
                     VL( K, IS ) = ZERO
                     VL( K, IS+1 ) = ZERO
  230             CONTINUE
               ELSE
                  IF( KI.LT.N-1 ) THEN
                     CALL DGEMV( 'N', N, N-KI-1, ONE, VL( 1, KI+2 ),
     $                           LDVL, WORK( KI+2+N ), 1, WORK( KI+N ),
     $                           VL( 1, KI ), 1 )
                     CALL DGEMV( 'N', N, N-KI-1, ONE, VL( 1, KI+2 ),
     $                           LDVL, WORK( KI+2+N2 ), 1,
     $                           WORK( KI+1+N2 ), VL( 1, KI+1 ), 1 )
                  ELSE
                     CALL DSCAL( N, WORK( KI+N ), VL( 1, KI ), 1 )
                     CALL DSCAL( N, WORK( KI+1+N2 ), VL( 1, KI+1 ), 1 )
                  END IF
*
                  EMAX = ZERO
                  DO 240 K = 1, N
                     EMAX = MAX( EMAX, ABS( VL( K, KI ) )+
     $                       ABS( VL( K, KI+1 ) ) )
  240             CONTINUE
                  REMAX = ONE / EMAX
                  CALL DSCAL( N, REMAX, VL( 1, KI ), 1 )
                  CALL DSCAL( N, REMAX, VL( 1, KI+1 ), 1 )
*
               END IF
*
            END IF
*
            IS = IS + 1
            IF( IP.NE.0 )
```

```
     $         IS = IS + 1
  250       CONTINUE
            IF( IP.EQ.-1 )
     $         IP = 0
            IF( IP.EQ.1 )
     $         IP = -1
*
  260    CONTINUE
*
      END IF
*
      RETURN
*
*     End of DTREVC
*
      END
```

———-

— LAPACK dtrevc —

```
(let* ((zero 0.0) (one 1.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one))
  (defun dtrevc (side howmny select n t$ ldt vl ldvl vr ldvr mm m work info)
    (declare (type (simple-array double-float (*)) work vr vl t$)
             (type fixnum info m mm ldvr ldvl ldt n)
             (type (simple-array (member t nil) (*)) select)
             (type character howmny side))
    (f2cl-lib:with-multi-array-data
        ((side character side-%data% side-%offset%)
         (howmny character howmny-%data% howmny-%offset%)
         (select (member t nil) select-%data% select-%offset%)
         (t$ double-float t$-%data% t$-%offset%)
         (vl double-float vl-%data% vl-%offset%)
         (vr double-float vr-%data% vr-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((x (make-array 4 :element-type 'double-float)) (beta 0.0)
             (bignum 0.0) (emax 0.0) (ovfl 0.0) (rec 0.0) (remax 0.0)
             (scale 0.0) (smin 0.0) (smlnum 0.0) (ulp 0.0) (unfl 0.0)
             (vcrit 0.0) (vmax 0.0) (wi 0.0) (wr 0.0) (xnorm 0.0) (i 0)
             (ierr 0) (ii 0) (ip 0) (is 0) (j 0) (j1 0) (j2 0) (jnxt 0) (k 0)
             (ki 0) (n2 0) (allv nil) (bothv nil) (leftv nil) (over nil)
             (pair nil) (rightv nil) (somev nil) (sqrt$ 0.0f0))
        (declare (type (single-float) sqrt$)
                 (type (simple-array double-float (4)) x)
                 (type (double-float) beta bignum emax ovfl rec remax scale
                                      smin smlnum ulp unfl vcrit vmax wi wr
```

```
                                xnorm)
          (type fixnum i ierr ii ip is j j1 j2 jnxt k ki
                                     n2)
          (type (member t nil) allv bothv leftv over pair rightv
                                   somev))
(setf bothv (char-equal side #\B))
(setf rightv (or (char-equal side #\R) bothv))
(setf leftv (or (char-equal side #\L) bothv))
(setf allv (char-equal howmny #\A))
(setf over (char-equal howmny #\B))
(setf somev (char-equal howmny #\S))
(setf info 0)
(cond
  ((and (not rightv) (not leftv))
   (setf info -1))
  ((and (not allv) (not over) (not somev))
   (setf info -2))
  ((< n 0)
   (setf info -4))
  ((< ldt (max (the fixnum 1) (the fixnum n)))
   (setf info -6))
  ((or (< ldvl 1) (and leftv (< ldvl n)))
   (setf info -8))
  ((or (< ldvr 1) (and rightv (< ldvr n)))
   (setf info -10))
  (t
   (cond
     (somev
      (setf m 0)
      (setf pair nil)
      (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                    ((> j n) nil)
        (tagbody
          (cond
            (pair
             (setf pair nil)
             (setf (f2cl-lib:fref select-%data%
                                  (j)
                                  ((1 *))
                                  select-%offset%)
                     nil))
            (t
             (cond
               ((< j n)
                (cond
                  ((=
                    (f2cl-lib:fref t$
                                   ((f2cl-lib:int-add j 1) j)
                                   ((1 ldt) (1 *)))
                    zero)
```

```
                    (if
                     (f2cl-lib:fref select-%data%
                                    (j)
                                    ((1 *))
                                    select-%offset%)
                     (setf m (f2cl-lib:int-add m 1))))
                    (t
                     (setf pair t)
                     (cond
                       ((or (f2cl-lib:fref select (j) ((1 *)))
                            (f2cl-lib:fref select
                                           ((f2cl-lib:int-add j 1))
                                           ((1 *))))
                        (setf (f2cl-lib:fref select-%data%
                                             (j)
                                             ((1 *))
                                             select-%offset%)
                              t)
                        (setf m (f2cl-lib:int-add m 2)))))))
                (t
                 (if
                  (f2cl-lib:fref select-%data%
                                 (n)
                                 ((1 *))
                                 select-%offset%)
                  (setf m (f2cl-lib:int-add m 1)))))))))
      (t
       (setf m n)))
    (cond
      ((< mm m)
       (setf info -11)))))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DTREVC" (f2cl-lib:int-sub info))
   (go end_label)))
(if (= n 0) (go end_label))
(setf unfl (dlamch "Safe minimum"))
(setf ovfl (/ one unfl))
(multiple-value-bind (var-0 var-1)
    (dlabad unfl ovfl)
  (declare (ignore))
  (setf unfl var-0)
  (setf ovfl var-1))
(setf ulp (dlamch "Precision"))
(setf smlnum (* unfl (/ n ulp)))
(setf bignum (/ (- one ulp) smlnum))
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%) zero)
(f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
```

```
                ((> j n) nil)
          (tagbody
            (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%) zero)
            (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                          ((> i (f2cl-lib:int-add j (f2cl-lib:int-sub 1))) nil)
              (tagbody
                (setf (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
                        (+
                         (f2cl-lib:fref work-%data% (j) ((1 *)) work-%offset%)
                         (abs
                          (f2cl-lib:fref t$-%data%
                                         (i j)
                                         ((1 ldt) (1 *))
                                         t$-%offset%))))))))
        (setf n2 (f2cl-lib:int-mul 2 n))
        (cond
          (rightv
           (setf ip 0)
           (setf is m)
           (f2cl-lib:fdo (ki n (f2cl-lib:int-add ki (f2cl-lib:int-sub 1)))
                         ((> ki 1) nil)
             (tagbody
               (if (= ip 1) (go label130))
               (if (= ki 1) (go label40))
               (if
                (=
                 (f2cl-lib:fref t$-%data%
                                (ki (f2cl-lib:int-sub ki 1))
                                ((1 ldt) (1 *))
                                t$-%offset%)
                 zero)
                (go label40))
               (setf ip -1)
label40
               (cond
                 (somev
                  (cond
                    ((= ip 0)
                     (if
                      (not
                       (f2cl-lib:fref select-%data%
                                      (ki)
                                      ((1 *))
                                      select-%offset%))
                      (go label130)))
                    (t
                     (if
                      (not
                       (f2cl-lib:fref select-%data%
                                      ((f2cl-lib:int-sub ki 1))
```

```
                        ((1 *))
                        select-%offset%))
       (go label130))))))
(setf wr
        (f2cl-lib:fref t$-%data%
                       (ki ki)
                       ((1 ldt) (1 *))
                       t$-%offset%))
(setf wi zero)
(if (/= ip 0)
    (setf wi
            (*
             (f2cl-lib:fsqrt
              (abs
               (f2cl-lib:fref t$-%data%
                              (ki (f2cl-lib:int-sub ki 1))
                              ((1 ldt) (1 *))
                              t$-%offset%)))
             (f2cl-lib:fsqrt
              (abs
               (f2cl-lib:fref t$-%data%
                              ((f2cl-lib:int-sub ki 1) ki)
                              ((1 ldt) (1 *))
                              t$-%offset%))))))
(setf smin (max (* ulp (+ (abs wr) (abs wi))) smlnum))
(cond
  ((= ip 0)
   (setf (f2cl-lib:fref work-%data%
                        ((f2cl-lib:int-add ki n))
                        ((1 *))
                        work-%offset%)
         one)
   (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                 ((> k
                     (f2cl-lib:int-add ki (f2cl-lib:int-sub 1)))
                  nil)
     (tagbody
       (setf (f2cl-lib:fref work-%data%
                            ((f2cl-lib:int-add k n))
                            ((1 *))
                            work-%offset%)
             (-
              (f2cl-lib:fref t$-%data%
                             (k ki)
                             ((1 ldt) (1 *))
                             t$-%offset%)))))
   (setf jnxt (f2cl-lib:int-sub ki 1))
   (f2cl-lib:fdo (j (f2cl-lib:int-add ki (f2cl-lib:int-sub 1))
                  (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                 ((> j 1) nil)
```

```
(tagbody
  (if (> j jnxt) (go label60))
  (setf j1 j)
  (setf j2 j)
  (setf jnxt (f2cl-lib:int-sub j 1))
  (cond
    ((> j 1)
     (cond
       ((/=
         (f2cl-lib:fref t$
                        (j
                         (f2cl-lib:int-add j
                                           (f2cl-lib:int-sub
                                            1)))
                        ((1 ldt) (1 *)))
         zero)
        (setf j1 (f2cl-lib:int-sub j 1))
        (setf jnxt (f2cl-lib:int-sub j 2))))))
  (cond
    ((= j1 j2)
     (multiple-value-bind
           (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
            var-8 var-9 var-10 var-11 var-12 var-13 var-14
            var-15 var-16 var-17)
         (dlaln2 nil 1 1 smin one
          (f2cl-lib:array-slice t$
                                double-float
                                (j j)
                                ((1 ldt) (1 *)))
          ldt one one
          (f2cl-lib:array-slice work
                                double-float
                                ((+ j n))
                                ((1 *)))
          n wr zero x 2 scale xnorm ierr)
       (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                        var-6 var-7 var-8 var-9 var-10
                        var-11 var-12 var-13 var-14))
       (setf scale var-15)
       (setf xnorm var-16)
       (setf ierr var-17))
     (cond
       ((> xnorm one)
        (cond
          ((> (f2cl-lib:fref work (j) ((1 *)))
              (f2cl-lib:f2cl/ bignum xnorm))
           (setf (f2cl-lib:fref x (1 1) ((1 2) (1 2)))
                   (/ (f2cl-lib:fref x (1 1) ((1 2) (1 2)))
                      xnorm))
           (setf scale (/ scale xnorm))))))
```

```
(if (/= scale one)
    (dscal ki scale
     (f2cl-lib:array-slice work
                           double-float
                           ((+ 1 n))
                           ((1 *)))
     1))
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add j n))
                     ((1 *))
                     work-%offset%)
        (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
(daxpy (f2cl-lib:int-sub j 1)
 (- (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
 (f2cl-lib:array-slice t$
                       double-float
                       (1 j)
                       ((1 ldt) (1 *)))
 1
 (f2cl-lib:array-slice work
                       double-float
                       ((+ 1 n))
                       ((1 *)))
 1))
(t
 (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14
       var-15 var-16 var-17)
    (dlaln2 nil 2 1 smin one
     (f2cl-lib:array-slice t$
                           double-float
                           ((+ j (f2cl-lib:int-sub 1))
                            (f2cl-lib:int-sub j 1))
                           ((1 ldt) (1 *)))
     ldt one one
     (f2cl-lib:array-slice work
                           double-float
                           ((+ j
                               (f2cl-lib:int-sub 1)
                               n))
                           ((1 *)))
     n wr zero x 2 scale xnorm ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9 var-10
                   var-11 var-12 var-13 var-14))
  (setf scale var-15)
  (setf xnorm var-16)
  (setf ierr var-17))
 (cond
```

```
 ((> xnorm one)
  (setf beta
          (max
           (f2cl-lib:fref work-%data%
                          ((f2cl-lib:int-sub j 1))
                          ((1 *))
                          work-%offset%)
           (f2cl-lib:fref work-%data%
                          (j)
                          ((1 *))
                          work-%offset%)))
  (cond
    ((> beta (f2cl-lib:f2cl/ bignum xnorm))
     (setf (f2cl-lib:fref x (1 1) ((1 2) (1 2)))
             (/ (f2cl-lib:fref x (1 1) ((1 2) (1 2)))
                xnorm))
     (setf (f2cl-lib:fref x (2 1) ((1 2) (1 2)))
             (/ (f2cl-lib:fref x (2 1) ((1 2) (1 2)))
                xnorm))
     (setf scale (/ scale xnorm))))))
(if (/= scale one)
    (dscal ki scale
     (f2cl-lib:array-slice work
                           double-float
                           ((+ 1 n))
                           ((1 *)))
     1))
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add
                       (f2cl-lib:int-sub j 1)
                       n))
                     ((1 *))
                     work-%offset%)
       (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add j n))
                     ((1 *))
                     work-%offset%)
       (f2cl-lib:fref x (2 1) ((1 2) (1 2))))
(daxpy (f2cl-lib:int-sub j 2)
 (- (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
 (f2cl-lib:array-slice t$
                       double-float
                       (1 (f2cl-lib:int-sub j 1))
                       ((1 ldt) (1 *)))
 1
 (f2cl-lib:array-slice work
                       double-float
                       ((+ 1 n))
                       ((1 *)))
```

```
                        1)
                       (daxpy (f2cl-lib:int-sub j 2)
                        (- (f2cl-lib:fref x (2 1) ((1 2) (1 2))))
                        (f2cl-lib:array-slice t$
                                              double-float
                                              (1 j)
                                              ((1 ldt) (1 *)))
                        1
                        (f2cl-lib:array-slice work
                                              double-float
                                              ((+ 1 n))
                                              ((1 *)))
                        1)))
label60))
                 (cond
                   ((not over)
                    (dcopy ki
                     (f2cl-lib:array-slice work
                                           double-float
                                           ((+ 1 n))
                                           ((1 *)))
                     1
                     (f2cl-lib:array-slice vr
                                           double-float
                                           (1 is)
                                           ((1 ldvr) (1 *)))
                     1)
                    (setf ii
                          (idamax ki
                           (f2cl-lib:array-slice vr
                                                 double-float
                                                 (1 is)
                                                 ((1 ldvr) (1 *)))
                           1))
                    (setf remax
                          (/ one
                             (abs
                              (f2cl-lib:fref vr-%data%
                                             (ii is)
                                             ((1 ldvr) (1 *))
                                             vr-%offset%))))
                    (dscal ki remax
                     (f2cl-lib:array-slice vr
                                           double-float
                                           (1 is)
                                           ((1 ldvr) (1 *)))
                     1)
                    (f2cl-lib:fdo (k (f2cl-lib:int-add ki 1)
                                   (f2cl-lib:int-add k 1))
                                  ((> k n) nil)
```

```
          (tagbody
            (setf (f2cl-lib:fref vr-%data%
                                 (k is)
                                 ((1 ldvr) (1 *))
                                 vr-%offset%)
                  zero))))
         (t
          (if (> ki 1)
              (dgemv "N" n (f2cl-lib:int-sub ki 1) one vr ldvr
               (f2cl-lib:array-slice work
                                     double-float
                                     ((+ 1 n))
                                     ((1 *)))
               1
               (f2cl-lib:fref work-%data%
                              ((f2cl-lib:int-add ki n))
                              ((1 *))
                              work-%offset%)
               (f2cl-lib:array-slice vr
                                     double-float
                                     (1 ki)
                                     ((1 ldvr) (1 *)))
               1))
          (setf ii
                (idamax n
                 (f2cl-lib:array-slice vr
                                       double-float
                                       (1 ki)
                                       ((1 ldvr) (1 *)))
                 1))
          (setf remax
                (/ one
                   (abs
                    (f2cl-lib:fref vr-%data%
                                   (ii ki)
                                   ((1 ldvr) (1 *))
                                   vr-%offset%))))
          (dscal n remax
           (f2cl-lib:array-slice vr
                                 double-float
                                 (1 ki)
                                 ((1 ldvr) (1 *)))
           1))))
        (t
         (cond
           ((>=
             (abs
              (f2cl-lib:fref t$
                             ((f2cl-lib:int-add ki
                                                (f2cl-lib:int-sub 1))
```

```
                    ki)
                   ((1 ldt) (1 *))))
     (abs
      (f2cl-lib:fref t$
                   (ki
                    (f2cl-lib:int-add ki
                                      (f2cl-lib:int-sub 1)))
                   ((1 ldt) (1 *)))))
    (setf (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-add
                           (f2cl-lib:int-sub ki 1)
                           n))
                         ((1 *))
                         work-%offset%)
          one)
    (setf (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-add ki n2))
                         ((1 *))
                         work-%offset%)
          (/ wi
             (f2cl-lib:fref t$-%data%
                            ((f2cl-lib:int-sub ki 1) ki)
                            ((1 ldt) (1 *))
                            t$-%offset%))))
   (t
    (setf (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-add
                           (f2cl-lib:int-sub ki 1)
                           n))
                         ((1 *))
                         work-%offset%)
          (/ (- wi)
             (f2cl-lib:fref t$-%data%
                            (ki (f2cl-lib:int-sub ki 1))
                            ((1 ldt) (1 *))
                            t$-%offset%)))
    (setf (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-add ki n2))
                         ((1 *))
                         work-%offset%)
          one)))
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add ki n))
                     ((1 *))
                     work-%offset%)
      zero)
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add
                       (f2cl-lib:int-sub ki 1)
                       n2))
```

```
                    ((1 *))
                    work-%offset%)
          zero)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
              ((> k
                  (f2cl-lib:int-add ki (f2cl-lib:int-sub 2)))
               nil)
  (tagbody
    (setf (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-add k n))
                         ((1 *))
                         work-%offset%)
          (*
           (-
            (f2cl-lib:fref work-%data%
                           ((f2cl-lib:int-add
                             (f2cl-lib:int-sub ki 1)
                             n))
                           ((1 *))
                           work-%offset%))
            (f2cl-lib:fref t$-%data%
                           (k (f2cl-lib:int-sub ki 1))
                           ((1 ldt) (1 *))
                           t$-%offset%)))
    (setf (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-add k n2))
                         ((1 *))
                         work-%offset%)
          (*
           (-
            (f2cl-lib:fref work-%data%
                           ((f2cl-lib:int-add ki n2))
                           ((1 *))
                           work-%offset%))
            (f2cl-lib:fref t$-%data%
                           (k ki)
                           ((1 ldt) (1 *))
                           t$-%offset%)))))
(setf jnxt (f2cl-lib:int-sub ki 2))
(f2cl-lib:fdo (j (f2cl-lib:int-add ki (f2cl-lib:int-sub 2))
               (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
              ((> j 1) nil)
  (tagbody
    (if (> j jnxt) (go label90))
    (setf j1 j)
    (setf j2 j)
    (setf jnxt (f2cl-lib:int-sub j 1))
    (cond
      ((> j 1)
       (cond
```

```
      ((/=
        (f2cl-lib:fref t$
                       (j
                        (f2cl-lib:int-add j
                                          (f2cl-lib:int-sub
                                           1)))
                       ((1 ldt) (1 *)))
        zero)
       (setf j1 (f2cl-lib:int-sub j 1))
       (setf jnxt (f2cl-lib:int-sub j 2))))))
(cond
  ((= j1 j2)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
          var-8 var-9 var-10 var-11 var-12 var-13 var-14
          var-15 var-16 var-17)
       (dlaln2 nil 1 2 smin one
        (f2cl-lib:array-slice t$
                              double-float
                              (j j)
                              ((1 ldt) (1 *)))
        ldt one one
        (f2cl-lib:array-slice work
                              double-float
                              ((+ j n))
                              ((1 *)))
        n wr wi x 2 scale xnorm ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                      var-6 var-7 var-8 var-9 var-10
                      var-11 var-12 var-13 var-14))
     (setf scale var-15)
     (setf xnorm var-16)
     (setf ierr var-17))
   (cond
     ((> xnorm one)
      (cond
        ((> (f2cl-lib:fref work (j) ((1 *)))
            (f2cl-lib:f2cl/ bignum xnorm))
         (setf (f2cl-lib:fref x (1 1) ((1 2) (1 2)))
                 (/ (f2cl-lib:fref x (1 1) ((1 2) (1 2)))
                    xnorm))
         (setf (f2cl-lib:fref x (1 2) ((1 2) (1 2)))
                 (/ (f2cl-lib:fref x (1 2) ((1 2) (1 2)))
                    xnorm))
         (setf scale (/ scale xnorm))))))
   (cond
     ((/= scale one)
      (dscal ki scale
       (f2cl-lib:array-slice work
                             double-float
```

```
                              ((+ 1 n))
                              ((1 *)))
      1)
     (dscal ki scale
      (f2cl-lib:array-slice work
                              double-float
                              ((+ 1 n2))
                              ((1 *)))
      1)))
  (setf (f2cl-lib:fref work-%data%
                       ((f2cl-lib:int-add j n))
                       ((1 *))
                       work-%offset%)
        (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
  (setf (f2cl-lib:fref work-%data%
                       ((f2cl-lib:int-add j n2))
                       ((1 *))
                       work-%offset%)
        (f2cl-lib:fref x (1 2) ((1 2) (1 2))))
  (daxpy (f2cl-lib:int-sub j 1)
   (- (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
   (f2cl-lib:array-slice t$
                         double-float
                         (1 j)
                         ((1 ldt) (1 *)))
   1
   (f2cl-lib:array-slice work
                         double-float
                         ((+ 1 n))
                         ((1 *)))
   1)
  (daxpy (f2cl-lib:int-sub j 1)
   (- (f2cl-lib:fref x (1 2) ((1 2) (1 2))))
   (f2cl-lib:array-slice t$
                         double-float
                         (1 j)
                         ((1 ldt) (1 *)))
   1
   (f2cl-lib:array-slice work
                         double-float
                         ((+ 1 n2))
                         ((1 *)))
   1))
 (t
  (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
         var-8 var-9 var-10 var-11 var-12 var-13 var-14
         var-15 var-16 var-17)
      (dlaln2 nil 2 2 smin one
       (f2cl-lib:array-slice t$
```

```
                              double-float
                              ((+ j (f2cl-lib:int-sub 1))
                               (f2cl-lib:int-sub j 1))
                              ((1 ldt) (1 *)))
        ldt one one
        (f2cl-lib:array-slice work
                              double-float
                              ((+ j
                                  (f2cl-lib:int-sub 1)
                                  n))
                              ((1 *)))
        n wr wi x 2 scale xnorm ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                     var-6 var-7 var-8 var-9 var-10
                     var-11 var-12 var-13 var-14))
    (setf scale var-15)
    (setf xnorm var-16)
    (setf ierr var-17))
  (cond
    ((> xnorm one)
     (setf beta
             (max
              (f2cl-lib:fref work-%data%
                             ((f2cl-lib:int-sub j 1))
                             ((1 *))
                             work-%offset%)
              (f2cl-lib:fref work-%data%
                             (j)
                             ((1 *))
                             work-%offset%)))
     (cond
       ((> beta (f2cl-lib:f2cl/ bignum xnorm))
        (setf rec (/ one xnorm))
        (setf (f2cl-lib:fref x (1 1) ((1 2) (1 2)))
                (* (f2cl-lib:fref x (1 1) ((1 2) (1 2)))
                   rec))
        (setf (f2cl-lib:fref x (1 2) ((1 2) (1 2)))
                (* (f2cl-lib:fref x (1 2) ((1 2) (1 2)))
                   rec))
        (setf (f2cl-lib:fref x (2 1) ((1 2) (1 2)))
                (* (f2cl-lib:fref x (2 1) ((1 2) (1 2)))
                   rec))
        (setf (f2cl-lib:fref x (2 2) ((1 2) (1 2)))
                (* (f2cl-lib:fref x (2 2) ((1 2) (1 2)))
                   rec))
        (setf scale (* scale rec))))))
  (cond
    ((/= scale one)
     (dscal ki scale
      (f2cl-lib:array-slice work
```

```
                          double-float
                          ((+ 1 n))
                          ((1 *)))
    1)
   (dscal ki scale
    (f2cl-lib:array-slice work
                          double-float
                          ((+ 1 n2))
                          ((1 *)))
    1)))
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add
                       (f2cl-lib:int-sub j 1)
                       n))
                     ((1 *))
                     work-%offset%)
       (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add j n))
                     ((1 *))
                     work-%offset%)
       (f2cl-lib:fref x (2 1) ((1 2) (1 2))))
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add
                       (f2cl-lib:int-sub j 1)
                       n2))
                     ((1 *))
                     work-%offset%)
       (f2cl-lib:fref x (1 2) ((1 2) (1 2))))
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add j n2))
                     ((1 *))
                     work-%offset%)
       (f2cl-lib:fref x (2 2) ((1 2) (1 2))))
(daxpy (f2cl-lib:int-sub j 2)
 (- (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
 (f2cl-lib:array-slice t$
                       double-float
                       (1 (f2cl-lib:int-sub j 1))
                       ((1 ldt) (1 *)))
 1
 (f2cl-lib:array-slice work
                       double-float
                       ((+ 1 n))
                       ((1 *)))
 1)
(daxpy (f2cl-lib:int-sub j 2)
 (- (f2cl-lib:fref x (2 1) ((1 2) (1 2))))
 (f2cl-lib:array-slice t$
                       double-float
```

```
                                        (1 j)
                                        ((1 ldt) (1 *)))
                          1
                          (f2cl-lib:array-slice work
                                        double-float
                                        ((+ 1 n))
                                        ((1 *)))
                          1)
                         (daxpy (f2cl-lib:int-sub j 2)
                          (- (f2cl-lib:fref x (1 2) ((1 2) (1 2))))
                          (f2cl-lib:array-slice t$
                                        double-float
                                        (1 (f2cl-lib:int-sub j 1))
                                        ((1 ldt) (1 *)))
                          1
                          (f2cl-lib:array-slice work
                                        double-float
                                        ((+ 1 n2))
                                        ((1 *)))
                          1)
                         (daxpy (f2cl-lib:int-sub j 2)
                          (- (f2cl-lib:fref x (2 2) ((1 2) (1 2))))
                          (f2cl-lib:array-slice t$
                                        double-float
                                        (1 j)
                                        ((1 ldt) (1 *)))
                          1
                          (f2cl-lib:array-slice work
                                        double-float
                                        ((+ 1 n2))
                                        ((1 *)))
                          1)))
label90))
                  (cond
                    ((not over)
                     (dcopy ki
                      (f2cl-lib:array-slice work
                                        double-float
                                        ((+ 1 n))
                                        ((1 *)))
                      1
                      (f2cl-lib:array-slice vr
                                        double-float
                                        (1 (f2cl-lib:int-sub is 1))
                                        ((1 ldvr) (1 *)))
                      1)
                     (dcopy ki
                      (f2cl-lib:array-slice work
                                        double-float
                                        ((+ 1 n2))
```

```
                      ((1 *)))
 1
 (f2cl-lib:array-slice vr
                       double-float
                       (1 is)
                       ((1 ldvr) (1 *)))
 1)
(setf emax zero)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
              ((> k ki) nil)
  (tagbody
    (setf emax
            (max emax
                 (+
                  (abs
                   (f2cl-lib:fref vr-%data%
                                  (k
                                   (f2cl-lib:int-sub is
                                                     1))
                                  ((1 ldvr) (1 *))
                                  vr-%offset%))
                  (abs
                   (f2cl-lib:fref vr-%data%
                                  (k is)
                                  ((1 ldvr) (1 *))
                                  vr-%offset%)))))))
(setf remax (/ one emax))
(dscal ki remax
 (f2cl-lib:array-slice vr
                       double-float
                       (1 (f2cl-lib:int-sub is 1))
                       ((1 ldvr) (1 *)))
 1)
(dscal ki remax
 (f2cl-lib:array-slice vr
                       double-float
                       (1 is)
                       ((1 ldvr) (1 *)))
 1)
(f2cl-lib:fdo (k (f2cl-lib:int-add ki 1)
                 (f2cl-lib:int-add k 1))
              ((> k n) nil)
  (tagbody
    (setf (f2cl-lib:fref vr-%data%
                         (k (f2cl-lib:int-sub is 1))
                         ((1 ldvr) (1 *))
                         vr-%offset%)
            zero)
    (setf (f2cl-lib:fref vr-%data%
                         (k is)
```

```
                          ((1 ldvr) (1 *))
                          vr-%offset%)
                zero))))
          (t
           (cond
             ((> ki 2)
              (dgemv "N" n (f2cl-lib:int-sub ki 2) one vr ldvr
               (f2cl-lib:array-slice work
                                     double-float
                                     ((+ 1 n))
                                     ((1 *)))
               1
               (f2cl-lib:fref work-%data%
                              ((f2cl-lib:int-add
                                (f2cl-lib:int-sub ki 1)
                                n))
                              ((1 *))
                              work-%offset%)
               (f2cl-lib:array-slice vr
                                     double-float
                                     (1 (f2cl-lib:int-sub ki 1))
                                     ((1 ldvr) (1 *)))
               1)
              (dgemv "N" n (f2cl-lib:int-sub ki 2) one vr ldvr
               (f2cl-lib:array-slice work
                                     double-float
                                     ((+ 1 n2))
                                     ((1 *)))
               1
               (f2cl-lib:fref work-%data%
                              ((f2cl-lib:int-add ki n2))
                              ((1 *))
                              work-%offset%)
               (f2cl-lib:array-slice vr
                                     double-float
                                     (1 ki)
                                     ((1 ldvr) (1 *)))
               1))
             (t
              (dscal n
               (f2cl-lib:fref work-%data%
                              ((f2cl-lib:int-add
                                (f2cl-lib:int-sub ki 1)
                                n))
                              ((1 *))
                              work-%offset%)
               (f2cl-lib:array-slice vr
                                     double-float
                                     (1 (f2cl-lib:int-sub ki 1))
                                     ((1 ldvr) (1 *)))
```

```
                        1)
                       (dscal n
                        (f2cl-lib:fref work-%data%
                                       ((f2cl-lib:int-add ki n2))
                                       ((1 *))
                                       work-%offset%)
                        (f2cl-lib:array-slice vr
                                              double-float
                                              (1 ki)
                                              ((1 ldvr) (1 *)))
                        1)))
                     (setf emax zero)
                     (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                                   ((> k n) nil)
                       (tagbody
                         (setf emax
                                 (max emax
                                      (+
                                       (abs
                                        (f2cl-lib:fref vr-%data%
                                                       (k
                                                        (f2cl-lib:int-sub ki
                                                                          1))
                                                       ((1 ldvr) (1 *))
                                                       vr-%offset%))
                                       (abs
                                        (f2cl-lib:fref vr-%data%
                                                       (k ki)
                                                       ((1 ldvr) (1 *))
                                                       vr-%offset%)))))))
                     (setf remax (/ one emax))
                     (dscal n remax
                      (f2cl-lib:array-slice vr
                                            double-float
                                            (1 (f2cl-lib:int-sub ki 1))
                                            ((1 ldvr) (1 *)))
                      1)
                     (dscal n remax
                      (f2cl-lib:array-slice vr
                                            double-float
                                            (1 ki)
                                            ((1 ldvr) (1 *)))
                      1)))))
               (setf is (f2cl-lib:int-sub is 1))
               (if (/= ip 0) (setf is (f2cl-lib:int-sub is 1)))
label130
               (if (= ip 1) (setf ip 0))
               (if (= ip -1) (setf ip 1))))))
       (cond
         (leftv
```

```
          (setf ip 0)
          (setf is 1)
          (f2cl-lib:fdo (ki 1 (f2cl-lib:int-add ki 1))
                        ((> ki n) nil)
            (tagbody
              (if (= ip -1) (go label250))
              (if (= ki n) (go label150))
              (if
               (=
                (f2cl-lib:fref t$-%data%
                               ((f2cl-lib:int-add ki 1) ki)
                               ((1 ldt) (1 *))
                               t$-%offset%)
                zero)
               (go label150))
              (setf ip 1)
label150
              (cond
                (somev
                 (if
                  (not
                   (f2cl-lib:fref select-%data% (ki) ((1 *)) select-%offset%))
                  (go label250))))
              (setf wr
                      (f2cl-lib:fref t$-%data%
                                     (ki ki)
                                     ((1 ldt) (1 *))
                                     t$-%offset%))
              (setf wi zero)
              (if (/= ip 0)
                  (setf wi
                          (*
                           (f2cl-lib:fsqrt
                            (abs
                             (f2cl-lib:fref t$-%data%
                                            (ki (f2cl-lib:int-add ki 1))
                                            ((1 ldt) (1 *))
                                            t$-%offset%)))
                           (f2cl-lib:fsqrt
                            (abs
                             (f2cl-lib:fref t$-%data%
                                            ((f2cl-lib:int-add ki 1) ki)
                                            ((1 ldt) (1 *))
                                            t$-%offset%))))))
              (setf smin (max (* ulp (+ (abs wr) (abs wi))) smlnum))
              (cond
                ((= ip 0)
                 (setf (f2cl-lib:fref work-%data%
                                      ((f2cl-lib:int-add ki n))
                                      ((1 *))
```

```
                    work-%offset%)
        one)
(f2cl-lib:fdo (k (f2cl-lib:int-add ki 1)
                 (f2cl-lib:int-add k 1))
               ((> k n) nil)
  (tagbody
    (setf (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-add k n))
                         ((1 *))
                         work-%offset%)
           (-
            (f2cl-lib:fref t$-%data%
                           (ki k)
                           ((1 ldt) (1 *))
                           t$-%offset%)))))
(setf vmax one)
(setf vcrit bignum)
(setf jnxt (f2cl-lib:int-add ki 1))
(f2cl-lib:fdo (j (f2cl-lib:int-add ki 1)
                 (f2cl-lib:int-add j 1))
               ((> j n) nil)
  (tagbody
    (if (< j jnxt) (go label170))
    (setf j1 j)
    (setf j2 j)
    (setf jnxt (f2cl-lib:int-add j 1))
    (cond
      ((< j n)
       (cond
         ((/=
           (f2cl-lib:fref t$
                         ((f2cl-lib:int-add j 1) j)
                         ((1 ldt) (1 *)))
           zero)
          (setf j2 (f2cl-lib:int-add j 1))
          (setf jnxt (f2cl-lib:int-add j 2))))))
    (cond
      ((= j1 j2)
       (cond
         ((> (f2cl-lib:fref work (j) ((1 *))) vcrit)
          (setf rec (/ one vmax))
          (dscal (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
           rec
           (f2cl-lib:array-slice work
                                 double-float
                                 ((+ ki n))
                                 ((1 *)))
           1)
          (setf vmax one)
          (setf vcrit bignum)))
```

```
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add j n))
                     ((1 *))
                     work-%offset%)
        (-
         (f2cl-lib:fref work-%data%
                        ((f2cl-lib:int-add j n))
                        ((1 *))
                        work-%offset%)
         (ddot (f2cl-lib:int-sub j ki 1)
          (f2cl-lib:array-slice t$
                                double-float
                                ((+ ki 1) j)
                                ((1 ldt) (1 *)))
          1
          (f2cl-lib:array-slice work
                                double-float
                                ((+ ki 1 n))
                                ((1 *)))
          1)))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10 var-11 var-12 var-13 var-14
       var-15 var-16 var-17)
    (dlaln2 nil 1 1 smin one
     (f2cl-lib:array-slice t$
                           double-float
                           (j j)
                           ((1 ldt) (1 *)))
     ldt one one
     (f2cl-lib:array-slice work
                           double-float
                           ((+ j n))
                           ((1 *)))
     n wr zero x 2 scale xnorm ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8 var-9 var-10
                   var-11 var-12 var-13 var-14))
  (setf scale var-15)
  (setf xnorm var-16)
  (setf ierr var-17))
(if (/= scale one)
    (dscal
     (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
     scale
     (f2cl-lib:array-slice work
                           double-float
                           ((+ ki n))
                           ((1 *)))
     1))
```

```
 (setf (f2cl-lib:fref work-%data%
                      ((f2cl-lib:int-add j n))
                      ((1 *))
                      work-%offset%)
       (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
 (setf vmax
       (max
        (abs
         (f2cl-lib:fref work-%data%
                        ((f2cl-lib:int-add j n))
                        ((1 *))
                        work-%offset%))
        vmax))
 (setf vcrit (/ bignum vmax)))
(t
 (setf beta
       (max
        (f2cl-lib:fref work-%data%
                       (j)
                       ((1 *))
                       work-%offset%)
        (f2cl-lib:fref work-%data%
                       ((f2cl-lib:int-add j 1))
                       ((1 *))
                       work-%offset%)))
 (cond
   ((> beta vcrit)
    (setf rec (/ one vmax))
    (dscal (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
     rec
     (f2cl-lib:array-slice work
                           double-float
                           ((+ ki n))
                           ((1 *)))
     1)
    (setf vmax one)
    (setf vcrit bignum)))
 (setf (f2cl-lib:fref work-%data%
                      ((f2cl-lib:int-add j n))
                      ((1 *))
                      work-%offset%)
       (-
        (f2cl-lib:fref work-%data%
                       ((f2cl-lib:int-add j n))
                       ((1 *))
                       work-%offset%)
        (ddot (f2cl-lib:int-sub j ki 1)
         (f2cl-lib:array-slice t$
                               double-float
                               ((+ ki 1) j)
```

```
                                    ((1 ldt) (1 *)))
             1
             (f2cl-lib:array-slice work
                                    double-float
                                    ((+ ki 1 n))
                                    ((1 *)))
             1)))
    (setf (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-add j 1 n))
                         ((1 *))
                         work-%offset%)
          (-
           (f2cl-lib:fref work-%data%
                          ((f2cl-lib:int-add j 1 n))
                          ((1 *))
                          work-%offset%)
           (ddot (f2cl-lib:int-sub j ki 1)
            (f2cl-lib:array-slice t$
                                    double-float
                                    ((+ ki 1)
                                     (f2cl-lib:int-add j
                                                       1))
                                    ((1 ldt) (1 *)))
             1
             (f2cl-lib:array-slice work
                                    double-float
                                    ((+ ki 1 n))
                                    ((1 *)))
             1)))
    (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
          var-8 var-9 var-10 var-11 var-12 var-13 var-14
          var-15 var-16 var-17)
       (dlaln2 t 2 1 smin one
        (f2cl-lib:array-slice t$
                              double-float
                              (j j)
                              ((1 ldt) (1 *)))
        ldt one one
        (f2cl-lib:array-slice work
                              double-float
                              ((+ j n))
                              ((1 *)))
        n wr zero x 2 scale xnorm ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                       var-6 var-7 var-8 var-9 var-10
                       var-11 var-12 var-13 var-14))
      (setf scale var-15)
      (setf xnorm var-16)
      (setf ierr var-17))
```

```
                        (if (/= scale one)
                            (dscal
                             (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
                             scale
                             (f2cl-lib:array-slice work
                                                   double-float
                                                   ((+ ki n))
                                                   ((1 *)))
                             1))
                        (setf (f2cl-lib:fref work-%data%
                                             ((f2cl-lib:int-add j n))
                                             ((1 *))
                                             work-%offset%)
                              (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
                        (setf (f2cl-lib:fref work-%data%
                                             ((f2cl-lib:int-add j 1 n))
                                             ((1 *))
                                             work-%offset%)
                              (f2cl-lib:fref x (2 1) ((1 2) (1 2))))
                        (setf vmax
                              (max
                               (abs
                                (f2cl-lib:fref work-%data%
                                               ((f2cl-lib:int-add j n))
                                               ((1 *))
                                               work-%offset%))
                               (abs
                                (f2cl-lib:fref work-%data%
                                               ((f2cl-lib:int-add j 1 n))
                                               ((1 *))
                                               work-%offset%))
                               vmax))
                        (setf vcrit (/ bignum vmax))))
label170))
                  (cond
                    ((not over)
                     (dcopy (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
                      (f2cl-lib:array-slice work
                                            double-float
                                            ((+ ki n))
                                            ((1 *)))
                      1
                      (f2cl-lib:array-slice vl
                                            double-float
                                            (ki is)
                                            ((1 ldvl) (1 *)))
                      1)
                     (setf ii
                           (f2cl-lib:int-sub
                            (f2cl-lib:int-add
```

```
                (idamax
                 (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
                 (f2cl-lib:array-slice vl
                                       double-float
                                       (ki is)
                                       ((1 ldvl) (1 *)))
                 1)
                ki)
               1))
  (setf remax
          (/ one
             (abs
              (f2cl-lib:fref vl-%data%
                             (ii is)
                             ((1 ldvl) (1 *))
                             vl-%offset%))))
  (dscal (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1) remax
   (f2cl-lib:array-slice vl
                         double-float
                         (ki is)
                         ((1 ldvl) (1 *)))
   1)
  (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                ((> k
                    (f2cl-lib:int-add ki
                                      (f2cl-lib:int-sub 1)))
                 nil)
    (tagbody
      (setf (f2cl-lib:fref vl-%data%
                           (k is)
                           ((1 ldvl) (1 *))
                           vl-%offset%)
            zero))))
 (t
  (if (< ki n)
      (dgemv "N" n (f2cl-lib:int-sub n ki) one
       (f2cl-lib:array-slice vl
                             double-float
                             (1 (f2cl-lib:int-add ki 1))
                             ((1 ldvl) (1 *)))
       ldvl
       (f2cl-lib:array-slice work
                             double-float
                             ((+ ki 1 n))
                             ((1 *)))
       1
       (f2cl-lib:fref work-%data%
                      ((f2cl-lib:int-add ki n))
                      ((1 *))
                      work-%offset%)
```

```
                (f2cl-lib:array-slice vl
                                      double-float
                                      (1 ki)
                                      ((1 ldvl) (1 *)))
                1))
           (setf ii
                 (idamax n
                  (f2cl-lib:array-slice vl
                                        double-float
                                        (1 ki)
                                        ((1 ldvl) (1 *)))
                  1))
           (setf remax
                 (/ one
                    (abs
                     (f2cl-lib:fref vl-%data%
                                    (ii ki)
                                    ((1 ldvl) (1 *))
                                    vl-%offset%))))
           (dscal n remax
            (f2cl-lib:array-slice vl
                                  double-float
                                  (1 ki)
                                  ((1 ldvl) (1 *)))
            1))))
       (t
        (tagbody
          (cond
            ((>=
              (abs
               (f2cl-lib:fref t$
                              (ki (f2cl-lib:int-add ki 1))
                              ((1 ldt) (1 *))))
              (abs
               (f2cl-lib:fref t$
                              ((f2cl-lib:int-add ki 1) ki)
                              ((1 ldt) (1 *)))))
             (setf (f2cl-lib:fref work-%data%
                                  ((f2cl-lib:int-add ki n))
                                  ((1 *))
                                  work-%offset%)
                   (/ wi
                      (f2cl-lib:fref t$-%data%
                                     (ki (f2cl-lib:int-add ki 1))
                                     ((1 ldt) (1 *))
                                     t$-%offset%)))
             (setf (f2cl-lib:fref work-%data%
                                  ((f2cl-lib:int-add ki 1 n2))
                                  ((1 *))
                                  work-%offset%)
```

```
            one))
      (t
       (setf (f2cl-lib:fref work-%data%
                            ((f2cl-lib:int-add ki n))
                            ((1 *))
                            work-%offset%)
            one)
       (setf (f2cl-lib:fref work-%data%
                            ((f2cl-lib:int-add ki 1 n2))
                            ((1 *))
                            work-%offset%)
            (/ (- wi)
               (f2cl-lib:fref t$-%data%
                              ((f2cl-lib:int-add ki 1) ki)
                              ((1 ldt) (1 *))
                              t$-%offset%)))))
    (setf (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-add ki 1 n))
                         ((1 *))
                         work-%offset%)
          zero)
    (setf (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-add ki n2))
                         ((1 *))
                         work-%offset%)
          zero)
    (f2cl-lib:fdo (k (f2cl-lib:int-add ki 2)
                   (f2cl-lib:int-add k 1))
                  ((> k n) nil)
      (tagbody
        (setf (f2cl-lib:fref work-%data%
                             ((f2cl-lib:int-add k n))
                             ((1 *))
                             work-%offset%)
              (*
               (-
                (f2cl-lib:fref work-%data%
                               ((f2cl-lib:int-add ki n))
                               ((1 *))
                               work-%offset%))
               (f2cl-lib:fref t$-%data%
                              (ki k)
                              ((1 ldt) (1 *))
                              t$-%offset%)))
        (setf (f2cl-lib:fref work-%data%
                             ((f2cl-lib:int-add k n2))
                             ((1 *))
                             work-%offset%)
              (*
               (-
```

```
                (f2cl-lib:fref work-%data%
                               ((f2cl-lib:int-add ki 1 n2))
                               ((1 *))
                               work-%offset%))
              (f2cl-lib:fref t$-%data%
                             ((f2cl-lib:int-add ki 1) k)
                             ((1 ldt) (1 *))
                             t$-%offset%)))))
(setf vmax one)
(setf vcrit bignum)
(setf jnxt (f2cl-lib:int-add ki 2))
(f2cl-lib:fdo (j (f2cl-lib:int-add ki 2)
                 (f2cl-lib:int-add j 1))
              ((> j n) nil)
  (tagbody
    (if (< j jnxt) (go label200))
    (setf j1 j)
    (setf j2 j)
    (setf jnxt (f2cl-lib:int-add j 1))
    (cond
      ((< j n)
       (cond
         ((/=
           (f2cl-lib:fref t$
                         ((f2cl-lib:int-add j 1) j)
                         ((1 ldt) (1 *)))
           zero)
          (setf j2 (f2cl-lib:int-add j 1))
          (setf jnxt (f2cl-lib:int-add j 2))))))
    (cond
      ((= j1 j2)
       (cond
         ((> (f2cl-lib:fref work (j) ((1 *))) vcrit)
          (setf rec (/ one vmax))
          (dscal
           (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1) rec
           (f2cl-lib:array-slice work
                                 double-float
                                 ((+ ki n))
                                 ((1 *)))
           1)
          (dscal
           (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1) rec
           (f2cl-lib:array-slice work
                                 double-float
                                 ((+ ki n2))
                                 ((1 *)))
           1)
          (setf vmax one)
          (setf vcrit bignum)))
```

```
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add j n))
                     ((1 *))
                     work-%offset%)
        (-
         (f2cl-lib:fref work-%data%
                        ((f2cl-lib:int-add j n))
                        ((1 *))
                        work-%offset%)
         (ddot (f2cl-lib:int-sub j ki 2)
          (f2cl-lib:array-slice t$
                                double-float
                                ((+ ki 2) j)
                                ((1 ldt) (1 *)))
          1
          (f2cl-lib:array-slice work
                                double-float
                                ((+ ki 2 n))
                                ((1 *)))
          1)))
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add j n2))
                     ((1 *))
                     work-%offset%)
        (-
         (f2cl-lib:fref work-%data%
                        ((f2cl-lib:int-add j n2))
                        ((1 *))
                        work-%offset%)
         (ddot (f2cl-lib:int-sub j ki 2)
          (f2cl-lib:array-slice t$
                                double-float
                                ((+ ki 2) j)
                                ((1 ldt) (1 *)))
          1
          (f2cl-lib:array-slice work
                                double-float
                                ((+ ki 2 n2))
                                ((1 *)))
          1)))
(multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6
       var-7 var-8 var-9 var-10 var-11 var-12 var-13
       var-14 var-15 var-16 var-17)
    (dlaln2 nil 1 2 smin one
     (f2cl-lib:array-slice t$
                           double-float
                           (j j)
                           ((1 ldt) (1 *)))
     ldt one one
```

```
     (f2cl-lib:array-slice work
                           double-float
                           ((+ j n))
                           ((1 *)))
     n wr (- wi) x 2 scale xnorm ierr)
  (declare (ignore var-0 var-1 var-2 var-3 var-4
                   var-5 var-6 var-7 var-8 var-9
                   var-10 var-11 var-12 var-13
                   var-14))
  (setf scale var-15)
  (setf xnorm var-16)
  (setf ierr var-17))
(cond
  ((/= scale one)
   (dscal
    (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
    scale
    (f2cl-lib:array-slice work
                          double-float
                          ((+ ki n))
                          ((1 *)))
    1)
   (dscal
    (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
    scale
    (f2cl-lib:array-slice work
                          double-float
                          ((+ ki n2))
                          ((1 *)))
    1)))
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add j n))
                     ((1 *))
                     work-%offset%)
        (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add j n2))
                     ((1 *))
                     work-%offset%)
        (f2cl-lib:fref x (1 2) ((1 2) (1 2))))
(setf vmax
        (max
         (abs
          (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-add j n))
                         ((1 *))
                         work-%offset%))
         (abs
          (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-add j n2))
```

```
                          ((1 *))
                          work-%offset%))
         vmax))
 (setf vcrit (/ bignum vmax)))
(t
 (setf beta
        (max
         (f2cl-lib:fref work-%data%
                        (j)
                        ((1 *))
                        work-%offset%)
         (f2cl-lib:fref work-%data%
                        ((f2cl-lib:int-add j 1))
                        ((1 *))
                        work-%offset%)))
 (cond
   ((> beta vcrit)
    (setf rec (/ one vmax))
    (dscal
     (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1) rec
     (f2cl-lib:array-slice work
                           double-float
                           ((+ ki n))
                           ((1 *)))
     1)
    (dscal
     (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1) rec
     (f2cl-lib:array-slice work
                           double-float
                           ((+ ki n2))
                           ((1 *)))
     1)
    (setf vmax one)
    (setf vcrit bignum)))
 (setf (f2cl-lib:fref work-%data%
                      ((f2cl-lib:int-add j n))
                      ((1 *))
                      work-%offset%)
       (-
        (f2cl-lib:fref work-%data%
                       ((f2cl-lib:int-add j n))
                       ((1 *))
                       work-%offset%)
        (ddot (f2cl-lib:int-sub j ki 2)
         (f2cl-lib:array-slice t$
                               double-float
                               ((+ ki 2) j)
                               ((1 ldt) (1 *)))
         1
         (f2cl-lib:array-slice work
```

```
                                    double-float
                                    ((+ ki 2 n))
                                    ((1 *)))
             1)))
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add j n2))
                     ((1 *))
                     work-%offset%)
       (-
        (f2cl-lib:fref work-%data%
                       ((f2cl-lib:int-add j n2))
                       ((1 *))
                       work-%offset%)
        (ddot (f2cl-lib:int-sub j ki 2)
         (f2cl-lib:array-slice t$
                               double-float
                               ((+ ki 2) j)
                               ((1 ldt) (1 *)))
         1
         (f2cl-lib:array-slice work
                               double-float
                               ((+ ki 2 n2))
                               ((1 *)))
         1)))
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add j 1 n))
                     ((1 *))
                     work-%offset%)
       (-
        (f2cl-lib:fref work-%data%
                       ((f2cl-lib:int-add j 1 n))
                       ((1 *))
                       work-%offset%)
        (ddot (f2cl-lib:int-sub j ki 2)
         (f2cl-lib:array-slice t$
                               double-float
                               ((+ ki 2)
                                (f2cl-lib:int-add j
                                                  1))
                               ((1 ldt) (1 *)))
         1
         (f2cl-lib:array-slice work
                               double-float
                               ((+ ki 2 n))
                               ((1 *)))
         1)))
(setf (f2cl-lib:fref work-%data%
                     ((f2cl-lib:int-add j 1 n2))
                     ((1 *))
                     work-%offset%)
```

```
          (-
           (f2cl-lib:fref work-%data%
                          ((f2cl-lib:int-add j 1 n2))
                          ((1 *))
                          work-%offset%)
           (ddot (f2cl-lib:int-sub j ki 2)
            (f2cl-lib:array-slice t$
                                  double-float
                                  ((+ ki 2)
                                   (f2cl-lib:int-add j
                                                     1))
                                  ((1 ldt) (1 *)))
            1
            (f2cl-lib:array-slice work
                                  double-float
                                  ((+ ki 2 n2))
                                  ((1 *)))
            1)))
  (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6
         var-7 var-8 var-9 var-10 var-11 var-12 var-13
         var-14 var-15 var-16 var-17)
      (dlaln2 t 2 2 smin one
       (f2cl-lib:array-slice t$
                             double-float
                             (j j)
                             ((1 ldt) (1 *)))
       ldt one one
       (f2cl-lib:array-slice work
                             double-float
                             ((+ j n))
                             ((1 *)))
       n wr (- wi) x 2 scale xnorm ierr)
    (declare (ignore var-0 var-1 var-2 var-3 var-4
                     var-5 var-6 var-7 var-8 var-9
                     var-10 var-11 var-12 var-13
                     var-14))
    (setf scale var-15)
    (setf xnorm var-16)
    (setf ierr var-17))
  (cond
    ((/= scale one)
     (dscal
      (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
      scale
      (f2cl-lib:array-slice work
                            double-float
                            ((+ ki n))
                            ((1 *)))
      1)
```

```
                        (dscal
                         (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
                         scale
                         (f2cl-lib:array-slice work
                                               double-float
                                               ((+ ki n2))
                                               ((1 *)))
                         1)))
                    (setf (f2cl-lib:fref work-%data%
                                         ((f2cl-lib:int-add j n))
                                         ((1 *))
                                         work-%offset%)
                            (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
                    (setf (f2cl-lib:fref work-%data%
                                         ((f2cl-lib:int-add j n2))
                                         ((1 *))
                                         work-%offset%)
                            (f2cl-lib:fref x (1 2) ((1 2) (1 2))))
                    (setf (f2cl-lib:fref work-%data%
                                         ((f2cl-lib:int-add j 1 n))
                                         ((1 *))
                                         work-%offset%)
                            (f2cl-lib:fref x (2 1) ((1 2) (1 2))))
                    (setf (f2cl-lib:fref work-%data%
                                         ((f2cl-lib:int-add j 1 n2))
                                         ((1 *))
                                         work-%offset%)
                            (f2cl-lib:fref x (2 2) ((1 2) (1 2))))
                    (setf vmax
                            (max
                             (abs (f2cl-lib:fref x (1 1) ((1 2) (1 2))))
                             (abs (f2cl-lib:fref x (1 2) ((1 2) (1 2))))
                             (abs (f2cl-lib:fref x (2 1) ((1 2) (1 2))))
                             (abs (f2cl-lib:fref x (2 2) ((1 2) (1 2))))
                             vmax))
                    (setf vcrit (/ bignum vmax))))
label200))
label210
                (cond
                  ((not over)
                   (dcopy (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
                    (f2cl-lib:array-slice work
                                          double-float
                                          ((+ ki n))
                                          ((1 *)))
                    1
                    (f2cl-lib:array-slice vl
                                          double-float
                                          (ki is)
                                          ((1 ldvl) (1 *)))
```

```
 1)
(dcopy (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
 (f2cl-lib:array-slice work
                       double-float
                       ((+ ki n2))
                       ((1 *)))
 1
 (f2cl-lib:array-slice vl
                       double-float
                       (ki (f2cl-lib:int-add is 1))
                       ((1 ldvl) (1 *)))
 1)
(setf emax zero)
(f2cl-lib:fdo (k ki (f2cl-lib:int-add k 1))
              ((> k n) nil)
  (tagbody
    (setf emax
            (max emax
                 (+
                  (abs
                   (f2cl-lib:fref vl-%data%
                                  (k is)
                                  ((1 ldvl) (1 *))
                                  vl-%offset%))
                  (abs
                   (f2cl-lib:fref vl-%data%
                                  (k
                                   (f2cl-lib:int-add is
                                                     1))
                                  ((1 ldvl) (1 *))
                                  vl-%offset%)))))))
(setf remax (/ one emax))
(dscal (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
 remax
 (f2cl-lib:array-slice vl
                       double-float
                       (ki is)
                       ((1 ldvl) (1 *)))
 1)
(dscal (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
 remax
 (f2cl-lib:array-slice vl
                       double-float
                       (ki (f2cl-lib:int-add is 1))
                       ((1 ldvl) (1 *)))
 1)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
              ((> k
                  (f2cl-lib:int-add ki
                                    (f2cl-lib:int-sub
```

```
                                          1)))
                    nil)
      (tagbody
        (setf (f2cl-lib:fref vl-%data%
                             (k is)
                             ((1 ldvl) (1 *))
                             vl-%offset%)
              zero)
        (setf (f2cl-lib:fref vl-%data%
                             (k (f2cl-lib:int-add is 1))
                             ((1 ldvl) (1 *))
                             vl-%offset%)
              zero))))
  (t
   (cond
     ((< ki (f2cl-lib:int-add n (f2cl-lib:int-sub 1)))
      (dgemv "N" n (f2cl-lib:int-sub n ki 1) one
       (f2cl-lib:array-slice vl
                             double-float
                             (1 (f2cl-lib:int-add ki 2))
                             ((1 ldvl) (1 *)))
       ldvl
       (f2cl-lib:array-slice work
                             double-float
                             ((+ ki 2 n))
                             ((1 *)))
       1
       (f2cl-lib:fref work-%data%
                      ((f2cl-lib:int-add ki n))
                      ((1 *))
                      work-%offset%)
       (f2cl-lib:array-slice vl
                             double-float
                             (1 ki)
                             ((1 ldvl) (1 *)))
       1)
      (dgemv "N" n (f2cl-lib:int-sub n ki 1) one
       (f2cl-lib:array-slice vl
                             double-float
                             (1 (f2cl-lib:int-add ki 2))
                             ((1 ldvl) (1 *)))
       ldvl
       (f2cl-lib:array-slice work
                             double-float
                             ((+ ki 2 n2))
                             ((1 *)))
       1
       (f2cl-lib:fref work-%data%
                      ((f2cl-lib:int-add ki 1 n2))
                      ((1 *))
```

```
                    work-%offset%)
     (f2cl-lib:array-slice vl
                           double-float
                           (1 (f2cl-lib:int-add ki 1))
                           ((1 ldvl) (1 *)))
     1))
   (t
    (dscal n
     (f2cl-lib:fref work-%data%
                    ((f2cl-lib:int-add ki n))
                    ((1 *))
                    work-%offset%)
     (f2cl-lib:array-slice vl
                           double-float
                           (1 ki)
                           ((1 ldvl) (1 *)))
     1)
    (dscal n
     (f2cl-lib:fref work-%data%
                    ((f2cl-lib:int-add ki 1 n2))
                    ((1 *))
                    work-%offset%)
     (f2cl-lib:array-slice vl
                           double-float
                           (1 (f2cl-lib:int-add ki 1))
                           ((1 ldvl) (1 *)))
     1)))
(setf emax zero)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
              ((> k n) nil)
  (tagbody
    (setf emax
            (max emax
                 (+
                  (abs
                   (f2cl-lib:fref vl-%data%
                                  (k ki)
                                  ((1 ldvl) (1 *))
                                  vl-%offset%))
                  (abs
                   (f2cl-lib:fref vl-%data%
                                  (k
                                   (f2cl-lib:int-add ki
                                                     1))
                                  ((1 ldvl) (1 *))
                                  vl-%offset%)))))))
(setf remax (/ one emax))
(dscal n remax
 (f2cl-lib:array-slice vl
                       double-float
```

```
                                          (1 ki)
                                          ((1 ldvl) (1 *)))
                      1)
                     (dscal n remax
                      (f2cl-lib:array-slice vl
                                          double-float
                                          (1 (f2cl-lib:int-add ki 1))
                                          ((1 ldvl) (1 *)))
                      1))))))
              (setf is (f2cl-lib:int-add is 1))
              (if (/= ip 0) (setf is (f2cl-lib:int-add is 1)))
 label250
              (if (= ip -1) (setf ip 0))
              (if (= ip 1) (setf ip -1))))))
 end_label
        (return
         (values nil nil nil nil nil nil nil nil nil nil nil m nil info))))))
```

———-

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— **dtrexc.input** —

```
)set break resume
)sys rm -f dtrexc.output
)spool dtrexc.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dtrexc.help** —

```
=====================================================================
dtrexc examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================
```

```
NAME
       DTREXC - the real Schur factorization of a real matrix A = Q*T*Q**T, so
       that the diagonal block of T with row index IFST is moved to row ILST

SYNOPSIS
       SUBROUTINE DTREXC( COMPQ, N, T, LDT, Q, LDQ, IFST, ILST, WORK, INFO )

           CHARACTER      COMPQ

           INTEGER        IFST, ILST, INFO, LDQ, LDT, N

           DOUBLE         PRECISION Q( LDQ, * ), T( LDT, * ), WORK( * )

  Purpose
  =======

  DTREXC reorders the real Schur factorization of a real matrix
  A = Q*T*Q**T, so that the diagonal block of T with row index IFST is
  moved to row ILST.

  The real Schur form T is reordered by an orthogonal similarity
  transformation Z**T*T*Z, and optionally the matrix Q of Schur vectors
  is updated by postmultiplying it with Z.

  T must be in Schur canonical form (as returned by DHSEQR), that is,
  block upper triangular with 1-by-1 and 2-by-2 diagonal blocks; each
  2-by-2 diagonal block has its diagonal elements equal and its
  off-diagonal elements of opposite sign.

  Arguments
  =========

  COMPQ   (input) CHARACTER*1
          = 'V':  update the matrix Q of Schur vectors;
          = 'N':  do not update Q.

  N       (input) INTEGER
          The order of the matrix T. N >= 0.

  T       (input/output) DOUBLE PRECISION array, dimension (LDT,N)
          On entry, the upper quasi-triangular matrix T, in Schur
          Schur canonical form.
          On exit, the reordered upper quasi-triangular matrix, again
          in Schur canonical form.

  LDT     (input) INTEGER
          The leading dimension of the array T. LDT >= max(1,N).

  Q       (input/output) DOUBLE PRECISION array, dimension (LDQ,N)
```

```
          On entry, if COMPQ = 'V', the matrix Q of Schur vectors.
          On exit, if COMPQ = 'V', Q has been postmultiplied by the
          orthogonal transformation matrix Z which reorders T.
          If COMPQ = 'N', Q is not referenced.

  LDQ     (input) INTEGER
          The leading dimension of the array Q.  LDQ >= max(1,N).

  IFST    (input/output) INTEGER
  ILST    (input/output) INTEGER
          Specify the reordering of the diagonal blocks of T.
          The block with row index IFST is moved to row ILST, by a
          sequence of transpositions between adjacent blocks.
          On exit, if IFST pointed on entry to the second row of a
          2-by-2 block, it is changed to point to the first row; ILST
          always points to the first row of the block in its final
          position (which may differ from its input value by +1 or -1).
          1 <= IFST <= N; 1 <= ILST <= N.

  WORK    (workspace) DOUBLE PRECISION array, dimension (N)

  INFO    (output) INTEGER
          = 0:  successful exit
          < 0:  if INFO = -i, the i-th argument had an illegal value
          = 1:  two adjacent blocks were too close to swap (the problem
                is very ill-conditioned); T may have been partially
                reordered, and ILST points to the first row of the
                current position of the block being moved.
```

— dtrexc.f —

```
      SUBROUTINE DTREXC( COMPQ, N, T, LDT, Q, LDQ, IFST, ILST, WORK,
     $                   INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     March 31, 1993
*
*     .. Scalar Arguments ..
      CHARACTER          COMPQ
      INTEGER            IFST, ILST, INFO, LDQ, LDT, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   Q( LDQ, * ), T( LDT, * ), WORK( * )
*     ..
```

```
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER          ( ZERO = 0.0D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            WANTQ
      INTEGER            HERE, NBF, NBL, NBNEXT
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLAEXC, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     ..
*     .. Executable Statements ..
*
*     Decode and test the input arguments.
*
      INFO = 0
      WANTQ = LSAME( COMPQ, 'V' )
      IF( .NOT.WANTQ .AND. .NOT.LSAME( COMPQ, 'N' ) ) THEN
         INFO = -1
      ELSE IF( N.LT.0 ) THEN
         INFO = -2
      ELSE IF( LDT.LT.MAX( 1, N ) ) THEN
         INFO = -4
      ELSE IF( LDQ.LT.1 .OR. ( WANTQ .AND. LDQ.LT.MAX( 1, N ) ) ) THEN
         INFO = -6
      ELSE IF( IFST.LT.1 .OR. IFST.GT.N ) THEN
         INFO = -7
      ELSE IF( ILST.LT.1 .OR. ILST.GT.N ) THEN
         INFO = -8
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DTREXC', -INFO )
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( N.LE.1 )
     $   RETURN
*
```

```
*     Determine the first row of specified block
*     and find out it is 1 by 1 or 2 by 2.
*
      IF( IFST.GT.1 ) THEN
         IF( T( IFST, IFST-1 ).NE.ZERO )
     $      IFST = IFST - 1
      END IF
      NBF = 1
      IF( IFST.LT.N ) THEN
         IF( T( IFST+1, IFST ).NE.ZERO )
     $      NBF = 2
      END IF
*
*     Determine the first row of the final block
*     and find out it is 1 by 1 or 2 by 2.
*
      IF( ILST.GT.1 ) THEN
         IF( T( ILST, ILST-1 ).NE.ZERO )
     $      ILST = ILST - 1
      END IF
      NBL = 1
      IF( ILST.LT.N ) THEN
         IF( T( ILST+1, ILST ).NE.ZERO )
     $      NBL = 2
      END IF
*
      IF( IFST.EQ.ILST )
     $   RETURN
*
      IF( IFST.LT.ILST ) THEN
*
*        Update ILST
*
         IF( NBF.EQ.2 .AND. NBL.EQ.1 )
     $      ILST = ILST - 1
         IF( NBF.EQ.1 .AND. NBL.EQ.2 )
     $      ILST = ILST + 1
*
         HERE = IFST
*
   10    CONTINUE
*
*        Swap block with next one below
*
         IF( NBF.EQ.1 .OR. NBF.EQ.2 ) THEN
*
*           Current block either 1 by 1 or 2 by 2
*
            NBNEXT = 1
            IF( HERE+NBF+1.LE.N ) THEN
```

```
               IF( T( HERE+NBF+1, HERE+NBF ).NE.ZERO )
     $            NBNEXT = 2
            END IF
            CALL DLAEXC( WANTQ, N, T, LDT, Q, LDQ, HERE, NBF, NBNEXT,
     $                   WORK, INFO )
            IF( INFO.NE.0 ) THEN
               ILST = HERE
               RETURN
            END IF
            HERE = HERE + NBNEXT
*
*           Test if 2 by 2 block breaks into two 1 by 1 blocks
*
            IF( NBF.EQ.2 ) THEN
               IF( T( HERE+1, HERE ).EQ.ZERO )
     $            NBF = 3
            END IF
*
         ELSE
*
*           Current block consists of two 1 by 1 blocks each of which
*           must be swapped individually
*
            NBNEXT = 1
            IF( HERE+3.LE.N ) THEN
               IF( T( HERE+3, HERE+2 ).NE.ZERO )
     $            NBNEXT = 2
            END IF
            CALL DLAEXC( WANTQ, N, T, LDT, Q, LDQ, HERE+1, 1, NBNEXT,
     $                   WORK, INFO )
            IF( INFO.NE.0 ) THEN
               ILST = HERE
               RETURN
            END IF
            IF( NBNEXT.EQ.1 ) THEN
*
*              Swap two 1 by 1 blocks, no problems possible
*
               CALL DLAEXC( WANTQ, N, T, LDT, Q, LDQ, HERE, 1, NBNEXT,
     $                      WORK, INFO )
               HERE = HERE + 1
            ELSE
*
*              Recompute NBNEXT in case 2 by 2 split
*
               IF( T( HERE+2, HERE+1 ).EQ.ZERO )
     $            NBNEXT = 1
               IF( NBNEXT.EQ.2 ) THEN
*
*                 2 by 2 Block did not split
```

```
*
                  CALL DLAEXC( WANTQ, N, T, LDT, Q, LDQ, HERE, 1,
     $                         NBNEXT, WORK, INFO )
                  IF( INFO.NE.0 ) THEN
                     ILST = HERE
                     RETURN
                  END IF
                  HERE = HERE + 2
               ELSE
*
*                 2 by 2 Block did split
*
                  CALL DLAEXC( WANTQ, N, T, LDT, Q, LDQ, HERE, 1, 1,
     $                         WORK, INFO )
                  CALL DLAEXC( WANTQ, N, T, LDT, Q, LDQ, HERE+1, 1, 1,
     $                         WORK, INFO )
                  HERE = HERE + 2
               END IF
            END IF
         END IF
         IF( HERE.LT.ILST )
     $      GO TO 10
*
      ELSE
*
         HERE = IFST
   20    CONTINUE
*
*        Swap block with next one above
*
         IF( NBF.EQ.1 .OR. NBF.EQ.2 ) THEN
*
*           Current block either 1 by 1 or 2 by 2
*
            NBNEXT = 1
            IF( HERE.GE.3 ) THEN
               IF( T( HERE-1, HERE-2 ).NE.ZERO )
     $            NBNEXT = 2
            END IF
            CALL DLAEXC( WANTQ, N, T, LDT, Q, LDQ, HERE-NBNEXT, NBNEXT,
     $                   NBF, WORK, INFO )
            IF( INFO.NE.0 ) THEN
               ILST = HERE
               RETURN
            END IF
            HERE = HERE - NBNEXT
*
*           Test if 2 by 2 block breaks into two 1 by 1 blocks
*
            IF( NBF.EQ.2 ) THEN
```

```
               IF( T( HERE+1, HERE ).EQ.ZERO )
     $            NBF = 3
            END IF
*
         ELSE
*
*           Current block consists of two 1 by 1 blocks each of which
*           must be swapped individually
*
            NBNEXT = 1
            IF( HERE.GE.3 ) THEN
               IF( T( HERE-1, HERE-2 ).NE.ZERO )
     $            NBNEXT = 2
            END IF
            CALL DLAEXC( WANTQ, N, T, LDT, Q, LDQ, HERE-NBNEXT, NBNEXT,
     $                   1, WORK, INFO )
            IF( INFO.NE.0 ) THEN
               ILST = HERE
               RETURN
            END IF
            IF( NBNEXT.EQ.1 ) THEN
*
*              Swap two 1 by 1 blocks, no problems possible
*
               CALL DLAEXC( WANTQ, N, T, LDT, Q, LDQ, HERE, NBNEXT, 1,
     $                      WORK, INFO )
               HERE = HERE - 1
            ELSE
*
*              Recompute NBNEXT in case 2 by 2 split
*
               IF( T( HERE, HERE-1 ).EQ.ZERO )
     $            NBNEXT = 1
               IF( NBNEXT.EQ.2 ) THEN
*
*                 2 by 2 Block did not split
*
                  CALL DLAEXC( WANTQ, N, T, LDT, Q, LDQ, HERE-1, 2, 1,
     $                         WORK, INFO )
                  IF( INFO.NE.0 ) THEN
                     ILST = HERE
                     RETURN
                  END IF
                  HERE = HERE - 2
               ELSE
*
*                 2 by 2 Block did split
*
                  CALL DLAEXC( WANTQ, N, T, LDT, Q, LDQ, HERE, 1, 1,
     $                         WORK, INFO )
```

```
                CALL DLAEXC( WANTQ, N, T, LDT, Q, LDQ, HERE-1, 1, 1,
     $                       WORK, INFO )
                HERE = HERE - 2
              END IF
            END IF
          END IF
          IF( HERE.GT.ILST )
     $       GO TO 20
       END IF
       ILST = HERE
*
       RETURN
*
*      End of DTREXC
*
       END
```

— LAPACK dtrexc —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun dtrexc (compq n t$ ldt q ldq ifst ilst work info)
    (declare (type (simple-array double-float (*)) work q t$)
             (type fixnum info ilst ifst ldq ldt n)
             (type character compq))
    (f2cl-lib:with-multi-array-data
        ((compq character compq-%data% compq-%offset%)
         (t$ double-float t$-%data% t$-%offset%)
         (q double-float q-%data% q-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((here 0) (nbf 0) (nbl 0) (nbnext 0) (wantq nil))
        (declare (type fixnum here nbf nbl nbnext)
                 (type (member t nil) wantq))
        (setf info 0)
        (setf wantq (char-equal compq #\V))
        (cond
          ((and (not wantq) (not (char-equal compq #\N)))
           (setf info -1))
          ((< n 0)
           (setf info -2))
          ((< ldt (max (the fixnum 1) (the fixnum n)))
           (setf info -4))
          ((or (< ldq 1)
               (and wantq
                    (< ldq
                       (max (the fixnum 1)
```

```
                    (the fixnum n)))))
    (setf info -6))
   ((or (< ifst 1) (> ifst n))
    (setf info -7))
   ((or (< ilst 1) (> ilst n))
    (setf info -8)))
 (cond
   ((/= info 0)
    (error
     " ** On entry to ~a parameter number ~a had an illegal value~%"
     "DTREXC" (f2cl-lib:int-sub info))
    (go end_label)))
 (if (<= n 1) (go end_label))
 (cond
   ((> ifst 1)
    (if
     (/=
      (f2cl-lib:fref t$-%data%
                     (ifst (f2cl-lib:int-sub ifst 1))
                     ((1 ldt) (1 *))
                     t$-%offset%)
      zero)
     (setf ifst (f2cl-lib:int-sub ifst 1)))))
 (setf nbf 1)
 (cond
   ((< ifst n)
    (if
     (/=
      (f2cl-lib:fref t$-%data%
                     ((f2cl-lib:int-add ifst 1) ifst)
                     ((1 ldt) (1 *))
                     t$-%offset%)
      zero)
     (setf nbf 2))))
 (cond
   ((> ilst 1)
    (if
     (/=
      (f2cl-lib:fref t$-%data%
                     (ilst (f2cl-lib:int-sub ilst 1))
                     ((1 ldt) (1 *))
                     t$-%offset%)
      zero)
     (setf ilst (f2cl-lib:int-sub ilst 1)))))
 (setf nbl 1)
 (cond
   ((< ilst n)
    (if
     (/=
      (f2cl-lib:fref t$-%data%
```

```
                          ((f2cl-lib:int-add ilst 1) ilst)
                          ((1 ldt) (1 *))
                          t$-%offset%)
             zero)
            (setf nbl 2))))
       (if (= ifst ilst) (go end_label))
       (cond
         ((< ifst ilst)
          (tagbody
            (if (and (= nbf 2) (= nbl 1))
                (setf ilst (f2cl-lib:int-sub ilst 1)))
            (if (and (= nbf 1) (= nbl 2))
                (setf ilst (f2cl-lib:int-add ilst 1)))
            (setf here ifst)
label10
            (cond
              ((or (= nbf 1) (= nbf 2))
               (setf nbnext 1)
               (cond
                 ((<= (f2cl-lib:int-add here nbf 1) n)
                  (if
                   (/=
                    (f2cl-lib:fref t$-%data%
                                   ((f2cl-lib:int-add here nbf 1)
                                    (f2cl-lib:int-add here nbf))
                                   ((1 ldt) (1 *))
                                   t$-%offset%)
                    zero)
                   (setf nbnext 2))))
               (multiple-value-bind
                     (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                      var-9 var-10)
                   (dlaexc wantq n t$ ldt q ldq here nbf nbnext work info)
                 (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                                  var-7 var-8 var-9))
                 (setf info var-10))
               (cond
                 ((/= info 0)
                  (setf ilst here)
                  (go end_label)))
               (setf here (f2cl-lib:int-add here nbnext))
               (cond
                 ((= nbf 2)
                  (if
                   (=
                    (f2cl-lib:fref t$-%data%
                                   ((f2cl-lib:int-add here 1) here)
                                   ((1 ldt) (1 *))
                                   t$-%offset%)
                    zero)
```

```
      (setf nbf 3)))))
 (t
  (setf nbnext 1)
  (cond
    ((<= (f2cl-lib:int-add here 3) n)
     (if
      (/=
       (f2cl-lib:fref t$-%data%
                      ((f2cl-lib:int-add here 3)
                       (f2cl-lib:int-add here 2))
                      ((1 ldt) (1 *))
                      t$-%offset%)
       zero)
      (setf nbnext 2))))
  (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
         var-9 var-10)
      (dlaexc wantq n t$ ldt q ldq (f2cl-lib:int-add here 1) 1
       nbnext work info)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                     var-7 var-8 var-9))
    (setf info var-10))
  (cond
    ((/= info 0)
     (setf ilst here)
     (go end_label)))
  (cond
    ((= nbnext 1)
     (multiple-value-bind
           (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
            var-9 var-10)
         (dlaexc wantq n t$ ldt q ldq here 1 nbnext work info)
       (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                        var-7 var-8 var-9))
       (setf info var-10))
     (setf here (f2cl-lib:int-add here 1)))
    (t
     (if
      (=
       (f2cl-lib:fref t$-%data%
                      ((f2cl-lib:int-add here 2)
                       (f2cl-lib:int-add here 1))
                      ((1 ldt) (1 *))
                      t$-%offset%)
       zero)
      (setf nbnext 1))
     (cond
       ((= nbnext 2)
        (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
```

```
                          var-8 var-9 var-10)
                        (dlaexc wantq n t$ ldt q ldq here 1 nbnext work info)
                      (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                                       var-6 var-7 var-8 var-9))
                      (setf info var-10))
                     (cond
                       ((/= info 0)
                        (setf ilst here)
                        (go end_label)))
                     (setf here (f2cl-lib:int-add here 2)))
                    (t
                     (multiple-value-bind
                           (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                            var-8 var-9 var-10)
                         (dlaexc wantq n t$ ldt q ldq here 1 1 work info)
                       (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                                        var-6 var-7 var-8 var-9))
                       (setf info var-10))
                     (multiple-value-bind
                           (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                            var-8 var-9 var-10)
                         (dlaexc wantq n t$ ldt q ldq
                          (f2cl-lib:int-add here 1) 1 1 work info)
                       (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                                        var-6 var-7 var-8 var-9))
                       (setf info var-10))
                     (setf here (f2cl-lib:int-add here 2))))))))
          (if (< here ilst) (go label10))))
        (t
         (tagbody
           (setf here ifst)
label20
           (cond
             ((or (= nbf 1) (= nbf 2))
              (setf nbnext 1)
              (cond
                ((>= here 3)
                 (if
                  (/=
                   (f2cl-lib:fref t$-%data%
                                  ((f2cl-lib:int-sub here 1)
                                   (f2cl-lib:int-sub here 2))
                                  ((1 ldt) (1 *))
                                  t$-%offset%)
                   zero)
                  (setf nbnext 2))))
              (multiple-value-bind
                    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                     var-9 var-10)
                  (dlaexc wantq n t$ ldt q ldq (f2cl-lib:int-sub here nbnext)
```

```
      nbnext nbf work info)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9))
   (setf info var-10))
 (cond
   ((/= info 0)
    (setf ilst here)
    (go end_label)))
 (setf here (f2cl-lib:int-sub here nbnext))
 (cond
   ((= nbf 2)
    (if
     (=
      (f2cl-lib:fref t$-%data%
                     ((f2cl-lib:int-add here 1) here)
                     ((1 ldt) (1 *))
                     t$-%offset%)
      zero)
     (setf nbf 3)))))
(t
 (setf nbnext 1)
 (cond
   ((>= here 3)
    (if
     (/=
      (f2cl-lib:fref t$-%data%
                     ((f2cl-lib:int-sub here 1)
                      (f2cl-lib:int-sub here 2))
                     ((1 ldt) (1 *))
                     t$-%offset%)
      zero)
     (setf nbnext 2))))
 (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
        var-9 var-10)
     (dlaexc wantq n t$ ldt q ldq (f2cl-lib:int-sub here nbnext)
      nbnext 1 work info)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8 var-9))
   (setf info var-10))
 (cond
   ((/= info 0)
    (setf ilst here)
    (go end_label)))
 (cond
   ((= nbnext 1)
    (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
           var-9 var-10)
        (dlaexc wantq n t$ ldt q ldq here nbnext 1 work info)
```

```
                    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6
                                     var-7 var-8 var-9))
                    (setf info var-10))
                   (setf here (f2cl-lib:int-sub here 1)))
                  (t
                   (if
                    (=
                     (f2cl-lib:fref t$-%data%
                                    (here (f2cl-lib:int-sub here 1))
                                    ((1 ldt) (1 *))
                                    t$-%offset%)
                     zero)
                    (setf nbnext 1))
                   (cond
                     ((= nbnext 2)
                      (multiple-value-bind
                            (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                             var-8 var-9 var-10)
                          (dlaexc wantq n t$ ldt q ldq
                           (f2cl-lib:int-sub here 1) 2 1 work info)
                        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                                         var-6 var-7 var-8 var-9))
                        (setf info var-10))
                      (cond
                        ((/= info 0)
                         (setf ilst here)
                         (go end_label)))
                      (setf here (f2cl-lib:int-sub here 2)))
                     (t
                      (multiple-value-bind
                            (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                             var-8 var-9 var-10)
                          (dlaexc wantq n t$ ldt q ldq here 1 1 work info)
                        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                                         var-6 var-7 var-8 var-9))
                        (setf info var-10))
                      (multiple-value-bind
                            (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                             var-8 var-9 var-10)
                          (dlaexc wantq n t$ ldt q ldq
                           (f2cl-lib:int-sub here 1) 1 1 work info)
                        (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                                         var-6 var-7 var-8 var-9))
                        (setf info var-10))
                      (setf here (f2cl-lib:int-sub here 2))))))))
              (if (> here ilst) (go label20)))))
        (setf ilst here)
 end_label
        (return (values nil nil nil nil nil nil ifst ilst nil info))))))
```

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6.95 dtrsna LAPACK

— **dtrsna.input** —

```
)set break resume
)sys rm -f dtrsna.output
)spool dtrsna.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **dtrsna.help** —

```
====================================================================
dtrsna examples
====================================================================

====================================================================
Man Page Details
====================================================================

NAME
       DTRSNA  - reciprocal condition numbers for specified eigenvalues and/or
       right eigenvectors of a real upper quasi-triangular matrix T (or of any
       matrix Q*T*Q**T with Q orthogonal)

SYNOPSIS
       SUBROUTINE DTRSNA( JOB,  HOWMNY, SELECT, N, T, LDT, VL, LDVL, VR, LDVR,
                          S, SEP, MM, M, WORK, LDWORK, IWORK, INFO )

           CHARACTER      HOWMNY, JOB

           INTEGER        INFO, LDT, LDVL, LDVR, LDWORK, M, MM, N

           LOGICAL        SELECT( * )

           INTEGER        IWORK( * )

           DOUBLE         PRECISION S( * ), SEP( * ), T( LDT, * ), VL( LDVL, *
```

```
                        ), VR( LDVR, * ), WORK( LDWORK, * )

Purpose
=======

DTRSNA estimates reciprocal condition numbers for specified
eigenvalues and/or right eigenvectors of a real upper
quasi-triangular matrix T (or of any matrix Q*T*Q**T with Q
orthogonal).

T must be in Schur canonical form (as returned by DHSEQR), that is,
block upper triangular with 1-by-1 and 2-by-2 diagonal blocks; each
2-by-2 diagonal block has its diagonal elements equal and its
off-diagonal elements of opposite sign.

Arguments
=========

JOB     (input) CHARACTER*1
        Specifies whether condition numbers are required for
        eigenvalues (S) or eigenvectors (SEP):
        = 'E': for eigenvalues only (S);
        = 'V': for eigenvectors only (SEP);
        = 'B': for both eigenvalues and eigenvectors (S and SEP).

HOWMNY  (input) CHARACTER*1
        = 'A': compute condition numbers for all eigenpairs;
        = 'S': compute condition numbers for selected eigenpairs
               specified by the array SELECT.

SELECT  (input) LOGICAL array, dimension (N)
        If HOWMNY = 'S', SELECT specifies the eigenpairs for which
        condition numbers are required. To select condition numbers
        for the eigenpair corresponding to a real eigenvalue w(j),
        SELECT(j) must be set to .TRUE.. To select condition numbers
        corresponding to a complex conjugate pair of eigenvalues w(j)
        and w(j+1), either SELECT(j) or SELECT(j+1) or both, must be
        set to .TRUE..
        If HOWMNY = 'A', SELECT is not referenced.

N       (input) INTEGER
        The order of the matrix T. N >= 0.

T       (input) DOUBLE PRECISION array, dimension (LDT,N)
        The upper quasi-triangular matrix T, in Schur canonical form.

LDT     (input) INTEGER
        The leading dimension of the array T. LDT >= max(1,N).

VL      (input) DOUBLE PRECISION array, dimension (LDVL,M)
```

```
          If JOB = 'E' or 'B', VL must contain left eigenvectors of T
          (or of any Q*T*Q**T with Q orthogonal), corresponding to the
          eigenpairs specified by HOWMNY and SELECT. The eigenvectors
          must be stored in consecutive columns of VL, as returned by
          DHSEIN or DTREVC.
          If JOB = 'V', VL is not referenced.

  LDVL    (input) INTEGER
          The leading dimension of the array VL.
          LDVL >= 1; and if JOB = 'E' or 'B', LDVL >= N.

  VR      (input) DOUBLE PRECISION array, dimension (LDVR,M)
          If JOB = 'E' or 'B', VR must contain right eigenvectors of T
          (or of any Q*T*Q**T with Q orthogonal), corresponding to the
          eigenpairs specified by HOWMNY and SELECT. The eigenvectors
          must be stored in consecutive columns of VR, as returned by
          DHSEIN or DTREVC.
          If JOB = 'V', VR is not referenced.

  LDVR    (input) INTEGER
          The leading dimension of the array VR.
          LDVR >= 1; and if JOB = 'E' or 'B', LDVR >= N.

  S       (output) DOUBLE PRECISION array, dimension (MM)
          If JOB = 'E' or 'B', the reciprocal condition numbers of the
          selected eigenvalues, stored in consecutive elements of the
          array. For a complex conjugate pair of eigenvalues two
          consecutive elements of S are set to the same value. Thus
          S(j), SEP(j), and the j-th columns of VL and VR all
          correspond to the same eigenpair (but not in general the
          j-th eigenpair, unless all eigenpairs are selected).
          If JOB = 'V', S is not referenced.

  SEP     (output) DOUBLE PRECISION array, dimension (MM)
          If JOB = 'V' or 'B', the estimated reciprocal condition
          numbers of the selected eigenvectors, stored in consecutive
          elements of the array. For a complex eigenvector two
          consecutive elements of SEP are set to the same value. If
          the eigenvalues cannot be reordered to compute SEP(j), SEP(j)
          is set to 0; this can only occur when the true value would be
          very small anyway.
          If JOB = 'E', SEP is not referenced.

  MM      (input) INTEGER
          The number of elements in the arrays S (if JOB = 'E' or 'B')
           and/or SEP (if JOB = 'V' or 'B'). MM >= M.

  M       (output) INTEGER
          The number of elements of the arrays S and/or SEP actually
          used to store the estimated condition numbers.
```

```
        If HOWMNY = 'A', M is set to N.

WORK    (workspace) DOUBLE PRECISION array, dimension (LDWORK,N+1)
        If JOB = 'E', WORK is not referenced.

LDWORK  (input) INTEGER
        The leading dimension of the array WORK.
        LDWORK >= 1; and if JOB = 'V' or 'B', LDWORK >= N.

IWORK   (workspace) INTEGER array, dimension (N)
        If JOB = 'E', IWORK is not referenced.

INFO    (output) INTEGER
        = 0: successful exit
        < 0: if INFO = -i, the i-th argument had an illegal value

Further Details
===============

The reciprocal of the condition number of an eigenvalue lambda is
defined as

        S(lambda) = |v'*u| / (norm(u)*norm(v))

where u and v are the right and left eigenvectors of T corresponding
to lambda; v' denotes the conjugate-transpose of v, and norm(u)
denotes the Euclidean norm. These reciprocal condition numbers always
lie between zero (very badly conditioned) and one (very well
conditioned). If n = 1, S(lambda) is defined to be 1.

An approximate error bound for a computed eigenvalue W(i) is given by

                    EPS * norm(T) / S(i)

where EPS is the machine precision.

The reciprocal of the condition number of the right eigenvector u
corresponding to lambda is defined as follows. Suppose

            T = ( lambda  c  )
                (   0    T22 )

Then the reciprocal condition number is

        SEP( lambda, T22 ) = sigma-min( T22 - lambda*I )

where sigma-min denotes the smallest singular value. We approximate
the smallest singular value by the reciprocal of an estimate of the
one-norm of the inverse of T22 - lambda*I. If n = 1, SEP(1) is
defined to be abs(T(1,1)).
```

```
  An approximate error bound for a computed right eigenvector VR(i)
  is given by

                     EPS * norm(T) / SEP(i)
```

———-

— dtrsna.f —

```
      SUBROUTINE DTRSNA( JOB, HOWMNY, SELECT, N, T, LDT, VL, LDVL, VR,
     $                   LDVR, S, SEP, MM, M, WORK, LDWORK, IWORK,
     $                   INFO )
*
*  -- LAPACK routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     September 30, 1994
*
*     .. Scalar Arguments ..
      CHARACTER          HOWMNY, JOB
      INTEGER            INFO, LDT, LDVL, LDVR, LDWORK, M, MM, N
*     ..
*     .. Array Arguments ..
      LOGICAL            SELECT( * )
      INTEGER            IWORK( * )
      DOUBLE PRECISION   S( * ), SEP( * ), T( LDT, * ), VL( LDVL, * ),
     $                   VR( LDVR, * ), WORK( LDWORK, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE, TWO
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0, TWO = 2.0D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            PAIR, SOMCON, WANTBH, WANTS, WANTSP
      INTEGER            I, IERR, IFST, ILST, J, K, KASE, KS, N2, NN
      DOUBLE PRECISION   BIGNUM, COND, CS, DELTA, DUMM, EPS, EST, LNRM,
     $                   MU, PROD, PROD1, PROD2, RNRM, SCALE, SMLNUM, SN
*     ..
*     .. Local Arrays ..
      DOUBLE PRECISION   DUMMY( 1 )
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      DOUBLE PRECISION   DDOT, DLAMCH, DLAPY2, DNRM2
```

```
      EXTERNAL           LSAME, DDOT, DLAMCH, DLAPY2, DNRM2
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLACON, DLACPY, DLAQTR, DTREXC, XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX, SQRT
*     ..
*     .. Executable Statements ..
*
*     Decode and test the input parameters
*
      WANTBH = LSAME( JOB, 'B' )
      WANTS = LSAME( JOB, 'E' ) .OR. WANTBH
      WANTSP = LSAME( JOB, 'V' ) .OR. WANTBH
*
      SOMCON = LSAME( HOWMNY, 'S' )
*
      INFO = 0
      IF( .NOT.WANTS .AND. .NOT.WANTSP ) THEN
         INFO = -1
      ELSE IF( .NOT.LSAME( HOWMNY, 'A' ) .AND. .NOT.SOMCON ) THEN
         INFO = -2
      ELSE IF( N.LT.0 ) THEN
         INFO = -4
      ELSE IF( LDT.LT.MAX( 1, N ) ) THEN
         INFO = -6
      ELSE IF( LDVL.LT.1 .OR. ( WANTS .AND. LDVL.LT.N ) ) THEN
         INFO = -8
      ELSE IF( LDVR.LT.1 .OR. ( WANTS .AND. LDVR.LT.N ) ) THEN
         INFO = -10
      ELSE
*
*        Set M to the number of eigenpairs for which condition numbers
*        are required, and test MM.
*
         IF( SOMCON ) THEN
            M = 0
            PAIR = .FALSE.
            DO 10 K = 1, N
               IF( PAIR ) THEN
                  PAIR = .FALSE.
               ELSE
                  IF( K.LT.N ) THEN
                     IF( T( K+1, K ).EQ.ZERO ) THEN
                        IF( SELECT( K ) )
     $                     M = M + 1
                     ELSE
                        PAIR = .TRUE.
                        IF( SELECT( K ) .OR. SELECT( K+1 ) )
```

```
     $                    M = M + 2
                       END IF
                    ELSE
                       IF( SELECT( N ) )
     $                    M = M + 1
                    END IF
                 END IF
   10       CONTINUE
         ELSE
            M = N
         END IF
*
         IF( MM.LT.M ) THEN
            INFO = -13
         ELSE IF( LDWORK.LT.1 .OR. ( WANTSP .AND. LDWORK.LT.N ) ) THEN
            INFO = -16
         END IF
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'DTRSNA', -INFO )
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( N.EQ.0 )
     $   RETURN
*
      IF( N.EQ.1 ) THEN
         IF( SOMCON ) THEN
            IF( .NOT.SELECT( 1 ) )
     $         RETURN
         END IF
         IF( WANTS )
     $      S( 1 ) = ONE
         IF( WANTSP )
     $      SEP( 1 ) = ABS( T( 1, 1 ) )
         RETURN
      END IF
*
*     Get machine constants
*
      EPS = DLAMCH( 'P' )
      SMLNUM = DLAMCH( 'S' ) / EPS
      BIGNUM = ONE / SMLNUM
      CALL DLABAD( SMLNUM, BIGNUM )
*
      KS = 0
      PAIR = .FALSE.
      DO 60 K = 1, N
```

```
*
*        Determine whether T(k,k) begins a 1-by-1 or 2-by-2 block.
*
         IF( PAIR ) THEN
            PAIR = .FALSE.
            GO TO 60
         ELSE
            IF( K.LT.N )
     $         PAIR = T( K+1, K ).NE.ZERO
         END IF
*
*        Determine whether condition numbers are required for the k-th
*        eigenpair.
*
         IF( SOMCON ) THEN
            IF( PAIR ) THEN
               IF( .NOT.SELECT( K ) .AND. .NOT.SELECT( K+1 ) )
     $            GO TO 60
            ELSE
               IF( .NOT.SELECT( K ) )
     $            GO TO 60
            END IF
         END IF
*
         KS = KS + 1
*
         IF( WANTS ) THEN
*
*           Compute the reciprocal condition number of the k-th
*           eigenvalue.
*
            IF( .NOT.PAIR ) THEN
*
*              Real eigenvalue.
*
               PROD = DDOT( N, VR( 1, KS ), 1, VL( 1, KS ), 1 )
               RNRM = DNRM2( N, VR( 1, KS ), 1 )
               LNRM = DNRM2( N, VL( 1, KS ), 1 )
               S( KS ) = ABS( PROD ) / ( RNRM*LNRM )
            ELSE
*
*              Complex eigenvalue.
*
               PROD1 = DDOT( N, VR( 1, KS ), 1, VL( 1, KS ), 1 )
               PROD1 = PROD1 + DDOT( N, VR( 1, KS+1 ), 1, VL( 1, KS+1 ),
     $                       1 )
               PROD2 = DDOT( N, VL( 1, KS ), 1, VR( 1, KS+1 ), 1 )
               PROD2 = PROD2 - DDOT( N, VL( 1, KS+1 ), 1, VR( 1, KS ),
     $                       1 )
               RNRM = DLAPY2( DNRM2( N, VR( 1, KS ), 1 ),
```

```
     $                DNRM2( N, VR( 1, KS+1 ), 1 ) )
                  LNRM = DLAPY2( DNRM2( N, VL( 1, KS ), 1 ),
     $                DNRM2( N, VL( 1, KS+1 ), 1 ) )
                  COND = DLAPY2( PROD1, PROD2 ) / ( RNRM*LNRM )
                  S( KS ) = COND
                  S( KS+1 ) = COND
               END IF
            END IF
*
            IF( WANTSP ) THEN
*
*              Estimate the reciprocal condition number of the k-th
*              eigenvector.
*
*              Copy the matrix T to the array WORK and swap the diagonal
*              block beginning at T(k,k) to the (1,1) position.
*
               CALL DLACPY( 'Full', N, N, T, LDT, WORK, LDWORK )
               IFST = K
               ILST = 1
               CALL DTREXC( 'No Q', N, WORK, LDWORK, DUMMY, 1, IFST, ILST,
     $                      WORK( 1, N+1 ), IERR )
*
               IF( IERR.EQ.1 .OR. IERR.EQ.2 ) THEN
*
*                 Could not swap because blocks not well separated
*
                  SCALE = ONE
                  EST = BIGNUM
               ELSE
*
*                 Reordering successful
*
                  IF( WORK( 2, 1 ).EQ.ZERO ) THEN
*
*                    Form C = T22 - lambda*I in WORK(2:N,2:N).
*
                     DO 20 I = 2, N
                        WORK( I, I ) = WORK( I, I ) - WORK( 1, 1 )
   20                CONTINUE
                     N2 = 1
                     NN = N - 1
                  ELSE
*
*                    Triangularize the 2 by 2 block by unitary
*                    transformation U = [  cs   i*ss ]
*                                       [ i*ss   cs  ].
*                    such that the (1,1) position of WORK is complex
*                    eigenvalue lambda with positive imaginary part. (2,2)
*                    position of WORK is the complex eigenvalue lambda
```

```
*                  with negative imaginary  part.
*
                   MU = SQRT( ABS( WORK( 1, 2 ) ) )*
     $                  SQRT( ABS( WORK( 2, 1 ) ) )
                   DELTA = DLAPY2( MU, WORK( 2, 1 ) )
                   CS = MU / DELTA
                   SN = -WORK( 2, 1 ) / DELTA
*
*                  Form
*
*                  C' = WORK(2:N,2:N) + i*[rwork(1) ..... rwork(n-1) ]
*                                         [   mu                     ]
*                                         [         ..               ]
*                                         [             ..           ]
*                                         [                 mu       ]
*                  where C' is conjugate transpose of complex matrix C,
*                  and RWORK is stored starting in the N+1-st column of
*                  WORK.
*
                   DO 30 J = 3, N
                      WORK( 2, J ) = CS*WORK( 2, J )
                      WORK( J, J ) = WORK( J, J ) - WORK( 1, 1 )
   30              CONTINUE
                   WORK( 2, 2 ) = ZERO
*
                   WORK( 1, N+1 ) = TWO*MU
                   DO 40 I = 2, N - 1
                      WORK( I, N+1 ) = SN*WORK( 1, I+1 )
   40              CONTINUE
                   N2 = 2
                   NN = 2*( N-1 )
                END IF
*
*                  Estimate norm(inv(C'))
*
                EST = ZERO
                KASE = 0
   50           CONTINUE
                CALL DLACON( NN, WORK( 1, N+2 ), WORK( 1, N+4 ), IWORK,
     $                       EST, KASE )
                IF( KASE.NE.0 ) THEN
                   IF( KASE.EQ.1 ) THEN
                      IF( N2.EQ.1 ) THEN
*
*                        Real eigenvalue: solve C'*x = scale*c.
*
                         CALL DLAQTR( .TRUE., .TRUE., N-1, WORK( 2, 2 ),
     $                                LDWORK, DUMMY, DUMM, SCALE,
     $                                WORK( 1, N+4 ), WORK( 1, N+6 ),
     $                                IERR )
```

```
                  ELSE
*
*                    Complex eigenvalue: solve
*                    C'*(p+iq) = scale*(c+id) in real arithmetic.
*
                     CALL DLAQTR( .TRUE., .FALSE., N-1, WORK( 2, 2 ),
     $                             LDWORK, WORK( 1, N+1 ), MU, SCALE,
     $                             WORK( 1, N+4 ), WORK( 1, N+6 ),
     $                             IERR )
                  END IF
               ELSE
                  IF( N2.EQ.1 ) THEN
*
*                    Real eigenvalue: solve C*x = scale*c.
*
                     CALL DLAQTR( .FALSE., .TRUE., N-1, WORK( 2, 2 ),
     $                             LDWORK, DUMMY, DUMM, SCALE,
     $                             WORK( 1, N+4 ), WORK( 1, N+6 ),
     $                             IERR )
                  ELSE
*
*                    Complex eigenvalue: solve
*                    C*(p+iq) = scale*(c+id) in real arithmetic.
*
                     CALL DLAQTR( .FALSE., .FALSE., N-1,
     $                             WORK( 2, 2 ), LDWORK,
     $                             WORK( 1, N+1 ), MU, SCALE,
     $                             WORK( 1, N+4 ), WORK( 1, N+6 ),
     $                             IERR )
*
                  END IF
               END IF
*
               GO TO 50
            END IF
         END IF
*
         SEP( KS ) = SCALE / MAX( EST, SMLNUM )
         IF( PAIR )
     $      SEP( KS+1 ) = SEP( KS )
      END IF
*
      IF( PAIR )
     $   KS = KS + 1
*
   60 CONTINUE
      RETURN
*
*     End of DTRSNA
*
```

```
      END
```

— LAPACK dtrsna —

```
(let* ((zero 0.0) (one 1.0) (two 2.0))
  (declare (type (double-float 0.0 0.0) zero)
           (type (double-float 1.0 1.0) one)
           (type (double-float 2.0 2.0) two))
  (defun dtrsna
         (job howmny select n t$ ldt vl ldvl vr ldvr s sep mm m work ldwork
          iwork info)
    (declare (type (simple-array fixnum (*)) iwork)
             (type (simple-array double-float (*)) work sep s vr vl t$)
             (type fixnum info ldwork m mm ldvr ldvl ldt n)
             (type (simple-array (member t nil) (*)) select)
             (type character howmny job))
    (f2cl-lib:with-multi-array-data
        ((job character job-%data% job-%offset%)
         (howmny character howmny-%data% howmny-%offset%)
         (select (member t nil) select-%data% select-%offset%)
         (t$ double-float t$-%data% t$-%offset%)
         (vl double-float vl-%data% vl-%offset%)
         (vr double-float vr-%data% vr-%offset%)
         (s double-float s-%data% s-%offset%)
         (sep double-float sep-%data% sep-%offset%)
         (work double-float work-%data% work-%offset%)
         (iwork fixnum iwork-%data% iwork-%offset%))
      (prog ((dummy (make-array 1 :element-type 'double-float)) (bignum 0.0)
             (cond$ 0.0) (cs 0.0) (delta 0.0) (dumm 0.0) (eps 0.0) (est 0.0)
             (lnrm 0.0) (mu 0.0) (prod 0.0) (prod1 0.0) (prod2 0.0) (rnrm 0.0)
             (scale 0.0) (smlnum 0.0) (sn 0.0) (i 0) (ierr 0) (ifst 0) (ilst 0)
             (j 0) (k 0) (kase 0) (ks 0) (n2 0) (nn 0) (pair nil) (somcon nil)
             (wantbh nil) (wants nil) (wantsp nil) (/=$ 0.0f0))
        (declare (type (single-float) /=$)
                 (type (simple-array double-float (1)) dummy)
                 (type (double-float) bignum cond$ cs delta dumm eps est lnrm
                                      mu prod prod1 prod2 rnrm scale smlnum sn)
                 (type fixnum i ierr ifst ilst j k kase ks n2 nn)
                 (type (member t nil) pair somcon wantbh wants wantsp))
        (setf wantbh (char-equal job #\B))
        (setf wants (or (char-equal job #\E) wantbh))
        (setf wantsp (or (char-equal job #\V) wantbh))
        (setf somcon (char-equal howmny #\S))
        (setf info 0)
        (cond
          ((and (not wants) (not wantsp))
```

```
 (setf info -1))
((and (not (char-equal howmny #\A)) (not somcon))
 (setf info -2))
((< n 0)
 (setf info -4))
((< ldt (max (the fixnum 1) (the fixnum n)))
 (setf info -6))
((or (< ldvl 1) (and wants (< ldvl n)))
 (setf info -8))
((or (< ldvr 1) (and wants (< ldvr n)))
 (setf info -10))
(t
 (cond
   (somcon
    (setf m 0)
    (setf pair nil)
    (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                  ((> k n) nil)
      (tagbody
        (cond
          (pair
           (setf pair nil))
          (t
           (cond
             ((< k n)
              (cond
                ((=
                  (f2cl-lib:fref t$
                                 ((f2cl-lib:int-add k 1) k)
                                 ((1 ldt) (1 *)))
                  zero)
                 (if
                  (f2cl-lib:fref select-%data%
                                 (k)
                                 ((1 *))
                                 select-%offset%)
                  (setf m (f2cl-lib:int-add m 1))))
                (t
                 (setf pair t)
                 (if
                  (or
                   (f2cl-lib:fref select-%data%
                                  (k)
                                  ((1 *))
                                  select-%offset%)
                   (f2cl-lib:fref select-%data%
                                  ((f2cl-lib:int-add k 1))
                                  ((1 *))
                                  select-%offset%))
                  (setf m (f2cl-lib:int-add m 2))))))))))))
```

```
                (t
                 (if
                  (f2cl-lib:fref select-%data%
                                 (n)
                                 ((1 *))
                                 select-%offset%)
                  (setf m (f2cl-lib:int-add m 1)))))))))))
     (t
      (setf m n)))
   (cond
     ((< mm m)
      (setf info -13))
     ((or (< ldwork 1) (and wantsp (< ldwork n)))
      (setf info -16)))))
(cond
  ((/= info 0)
   (error
    " ** On entry to ~a parameter number ~a had an illegal value~%"
    "DTRSNA" (f2cl-lib:int-sub info))
   (go end_label)))
(if (= n 0) (go end_label))
(cond
  ((= n 1)
   (cond
     (somcon
      (if
       (not (f2cl-lib:fref select-%data% (1) ((1 *)) select-%offset%))
       (go end_label))))
   (if wants (setf (f2cl-lib:fref s-%data% (1) ((1 *)) s-%offset%) one))
   (if wantsp
       (setf (f2cl-lib:fref sep-%data% (1) ((1 *)) sep-%offset%)
               (abs
                (f2cl-lib:fref t$-%data%
                               (1 1)
                               ((1 ldt) (1 *))
                               t$-%offset%))))
   (go end_label)))
(setf eps (dlamch "P"))
(setf smlnum (/ (dlamch "S") eps))
(setf bignum (/ one smlnum))
(multiple-value-bind (var-0 var-1)
    (dlabad smlnum bignum)
  (declare (ignore))
  (setf smlnum var-0)
  (setf bignum var-1))
(setf ks 0)
(setf pair nil)
(f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
              ((> k n) nil)
  (tagbody
```

```
(cond
  (pair
   (setf pair nil)
   (go label60))
  (t
   (if (< k n)
       (setf pair
               (coerce
                (/=
                 (f2cl-lib:fref t$-%data%
                               ((f2cl-lib:int-add k 1) k)
                               ((1 ldt) (1 *))
                               t$-%offset%)
                 zero)
                '(member t nil))))))
(cond
  (somcon
   (cond
     (pair
      (if
       (and
        (not
         (f2cl-lib:fref select-%data% (k) ((1 *)) select-%offset%))
        (not
         (f2cl-lib:fref select-%data%
                        ((f2cl-lib:int-add k 1))
                        ((1 *))
                        select-%offset%)))
       (go label60)))
     (t
      (if
       (not
        (f2cl-lib:fref select-%data% (k) ((1 *)) select-%offset%))
       (go label60))))))
(setf ks (f2cl-lib:int-add ks 1))
(cond
  (wants
   (cond
     ((not pair)
      (setf prod
              (ddot n
               (f2cl-lib:array-slice vr
                                     double-float
                                     (1 ks)
                                     ((1 ldvr) (1 *)))
               1
               (f2cl-lib:array-slice vl
                                     double-float
                                     (1 ks)
                                     ((1 ldvl) (1 *)))
```

```
          1))
 (setf rnrm
         (dnrm2 n
          (f2cl-lib:array-slice vr
                                double-float
                                (1 ks)
                                ((1 ldvr) (1 *)))
          1))
 (setf lnrm
         (dnrm2 n
          (f2cl-lib:array-slice vl
                                double-float
                                (1 ks)
                                ((1 ldvl) (1 *)))
          1))
 (setf (f2cl-lib:fref s-%data% (ks) ((1 *)) s-%offset%)
         (/ (abs prod) (* rnrm lnrm))))
(t
 (setf prod1
         (ddot n
          (f2cl-lib:array-slice vr
                                double-float
                                (1 ks)
                                ((1 ldvr) (1 *)))
          1
          (f2cl-lib:array-slice vl
                                double-float
                                (1 ks)
                                ((1 ldvl) (1 *)))
          1))
 (setf prod1
         (+ prod1
            (ddot n
             (f2cl-lib:array-slice vr
                                   double-float
                                   (1 (f2cl-lib:int-add ks 1))
                                   ((1 ldvr) (1 *)))
             1
             (f2cl-lib:array-slice vl
                                   double-float
                                   (1 (f2cl-lib:int-add ks 1))
                                   ((1 ldvl) (1 *)))
             1)))
 (setf prod2
         (ddot n
          (f2cl-lib:array-slice vl
                                double-float
                                (1 ks)
                                ((1 ldvl) (1 *)))
          1
```

```
         (f2cl-lib:array-slice vr
                               double-float
                               (1 (f2cl-lib:int-add ks 1))
                               ((1 ldvr) (1 *)))
         1))
(setf prod2
        (- prod2
           (ddot n
            (f2cl-lib:array-slice vl
                                  double-float
                                  (1 (f2cl-lib:int-add ks 1))
                                  ((1 ldvl) (1 *)))
            1
            (f2cl-lib:array-slice vr
                                  double-float
                                  (1 ks)
                                  ((1 ldvr) (1 *)))
            1)))
(setf rnrm
        (dlapy2
         (dnrm2 n
          (f2cl-lib:array-slice vr
                               double-float
                               (1 ks)
                               ((1 ldvr) (1 *)))
          1)
         (dnrm2 n
          (f2cl-lib:array-slice vr
                               double-float
                               (1 (f2cl-lib:int-add ks 1))
                               ((1 ldvr) (1 *)))
          1)))
(setf lnrm
        (dlapy2
         (dnrm2 n
          (f2cl-lib:array-slice vl
                               double-float
                               (1 ks)
                               ((1 ldvl) (1 *)))
          1)
         (dnrm2 n
          (f2cl-lib:array-slice vl
                               double-float
                               (1 (f2cl-lib:int-add ks 1))
                               ((1 ldvl) (1 *)))
          1)))
(setf cond$ (/ (dlapy2 prod1 prod2) (* rnrm lnrm)))
(setf (f2cl-lib:fref s-%data% (ks) ((1 *)) s-%offset%) cond$)
(setf (f2cl-lib:fref s-%data%
                     ((f2cl-lib:int-add ks 1))
```

```
                              ((1 *))
                              s-%offset%)
                 cond$)))))
(cond
  (wantsp
   (dlacpy "Full" n n t$ ldt work ldwork)
   (setf ifst k)
   (setf ilst 1)
   (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
          var-9)
       (dtrexc "No Q" n work ldwork dummy 1 ifst ilst
        (f2cl-lib:array-slice work
                              double-float
                              (1 (f2cl-lib:int-add n 1))
                              ((1 ldwork) (1 *)))
        ierr)
     (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-8))
     (setf ifst var-6)
     (setf ilst var-7)
     (setf ierr var-9))
   (cond
     ((or (= ierr 1) (= ierr 2))
      (setf scale one)
      (setf est bignum))
     (t
      (tagbody
        (cond
          ((= (f2cl-lib:fref work (2 1) ((1 ldwork) (1 *))) zero)
           (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
                         ((> i n) nil)
             (tagbody
               (setf (f2cl-lib:fref work-%data%
                                    (i i)
                                    ((1 ldwork) (1 *))
                                    work-%offset%)
                           (-
                            (f2cl-lib:fref work-%data%
                                           (i i)
                                           ((1 ldwork) (1 *))
                                           work-%offset%)
                            (f2cl-lib:fref work-%data%
                                           (1 1)
                                           ((1 ldwork) (1 *))
                                           work-%offset%)))))
           (setf n2 1)
           (setf nn (f2cl-lib:int-sub n 1)))
          (t
           (setf mu
                 (*
```

```
          (f2cl-lib:fsqrt
           (abs
            (f2cl-lib:fref work-%data%
                           (1 2)
                           ((1 ldwork) (1 *))
                           work-%offset%)))
          (f2cl-lib:fsqrt
           (abs
            (f2cl-lib:fref work-%data%
                           (2 1)
                           ((1 ldwork) (1 *))
                           work-%offset%)))))
(setf delta
        (dlapy2 mu
         (f2cl-lib:fref work-%data%
                        (2 1)
                        ((1 ldwork) (1 *))
                        work-%offset%)))
(setf cs (/ mu delta))
(setf sn
        (/
         (-
          (f2cl-lib:fref work-%data%
                         (2 1)
                         ((1 ldwork) (1 *))
                         work-%offset%))
         delta))
(f2cl-lib:fdo (j 3 (f2cl-lib:int-add j 1))
              ((> j n) nil)
  (tagbody
    (setf (f2cl-lib:fref work-%data%
                         (2 j)
                         ((1 ldwork) (1 *))
                         work-%offset%)
            (* cs
               (f2cl-lib:fref work-%data%
                              (2 j)
                              ((1 ldwork) (1 *))
                              work-%offset%)))
    (setf (f2cl-lib:fref work-%data%
                         (j j)
                         ((1 ldwork) (1 *))
                         work-%offset%)
            (-
             (f2cl-lib:fref work-%data%
                            (j j)
                            ((1 ldwork) (1 *))
                            work-%offset%)
             (f2cl-lib:fref work-%data%
                            (1 1)
```

```
                                    ((1 ldwork) (1 *))
                                    work-%offset%)))))
      (setf (f2cl-lib:fref work-%data%
                           (2 2)
                           ((1 ldwork) (1 *))
                           work-%offset%)
            zero)
      (setf (f2cl-lib:fref work-%data%
                           (1 (f2cl-lib:int-add n 1))
                           ((1 ldwork) (1 *))
                           work-%offset%)
            (* two mu))
      (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
                    ((> i
                        (f2cl-lib:int-add n
                                          (f2cl-lib:int-sub
                                           1)))
                     nil)
        (tagbody
          (setf (f2cl-lib:fref work-%data%
                               (i (f2cl-lib:int-add n 1))
                               ((1 ldwork) (1 *))
                               work-%offset%)
                (* sn
                   (f2cl-lib:fref work-%data%
                                  (1 (f2cl-lib:int-add i 1))
                                  ((1 ldwork) (1 *))
                                  work-%offset%)))))
      (setf n2 2)
      (setf nn (f2cl-lib:int-mul 2 (f2cl-lib:int-sub n 1)))))
    (setf est zero)
    (setf kase 0)
label50
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5)
        (dlacon nn
         (f2cl-lib:array-slice work
                               double-float
                               (1 (f2cl-lib:int-add n 2))
                               ((1 ldwork) (1 *)))
         (f2cl-lib:array-slice work
                               double-float
                               (1 (f2cl-lib:int-add n 4))
                               ((1 ldwork) (1 *)))
         iwork est kase)
      (declare (ignore var-0 var-1 var-2 var-3))
      (setf est var-4)
      (setf kase var-5))
    (cond
      ((/= kase 0)
       (cond
```

```
((= kase 1)
 (cond
   ((= n2 1)
    (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6
           var-7 var-8 var-9 var-10)
        (dlaqtr t t
         (f2cl-lib:int-sub n 1)
         (f2cl-lib:array-slice work
                               double-float
                               (2 2)
                               ((1 ldwork) (1 *)))
         ldwork dummy dumm scale
         (f2cl-lib:array-slice work
                               double-float
                               (1
                                (f2cl-lib:int-add n
                                                  4))
                               ((1 ldwork) (1 *)))
         (f2cl-lib:array-slice work
                               double-float
                               (1
                                (f2cl-lib:int-add n
                                                  6))
                               ((1 ldwork) (1 *)))
         ierr)
      (declare (ignore var-0 var-1 var-2 var-3 var-4
                       var-5 var-6 var-8 var-9))
      (setf scale var-7)
      (setf ierr var-10)))
   (t
    (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5 var-6
           var-7 var-8 var-9 var-10)
        (dlaqtr t nil
         (f2cl-lib:int-sub n 1)
         (f2cl-lib:array-slice work
                               double-float
                               (2 2)
                               ((1 ldwork) (1 *)))
         ldwork
         (f2cl-lib:array-slice work
                               double-float
                               (1
                                (f2cl-lib:int-add n
                                                  1))
                               ((1 ldwork) (1 *)))
         mu scale
         (f2cl-lib:array-slice work
                               double-float
```

```
                                    (1
                                     (f2cl-lib:int-add n
                                                       4))
                                    ((1 ldwork) (1 *)))
                          (f2cl-lib:array-slice work
                                    double-float
                                    (1
                                     (f2cl-lib:int-add n
                                                       6))
                                    ((1 ldwork) (1 *)))
                          ierr)
                        (declare (ignore var-0 var-1 var-2 var-3 var-4
                                         var-5 var-6 var-8 var-9))
                        (setf scale var-7)
                        (setf ierr var-10)))))
                  (t
                   (cond
                     ((= n2 1)
                      (multiple-value-bind
                            (var-0 var-1 var-2 var-3 var-4 var-5 var-6
                             var-7 var-8 var-9 var-10)
                          (dlaqtr nil t
                           (f2cl-lib:int-sub n 1)
                           (f2cl-lib:array-slice work
                                    double-float
                                    (2 2)
                                    ((1 ldwork) (1 *)))
                           ldwork dummy dumm scale
                           (f2cl-lib:array-slice work
                                    double-float
                                    (1
                                     (f2cl-lib:int-add n
                                                       4))
                                    ((1 ldwork) (1 *)))
                           (f2cl-lib:array-slice work
                                    double-float
                                    (1
                                     (f2cl-lib:int-add n
                                                       6))
                                    ((1 ldwork) (1 *)))
                           ierr)
                        (declare (ignore var-0 var-1 var-2 var-3 var-4
                                         var-5 var-6 var-8 var-9))
                        (setf scale var-7)
                        (setf ierr var-10)))
                     (t
                      (multiple-value-bind
                            (var-0 var-1 var-2 var-3 var-4 var-5 var-6
                             var-7 var-8 var-9 var-10)
                          (dlaqtr nil nil
```

```
                                (f2cl-lib:int-sub n 1)
                                (f2cl-lib:array-slice work
                                                      double-float
                                                      (2 2)
                                                      ((1 ldwork) (1 *)))
                                ldwork
                                (f2cl-lib:array-slice work
                                                      double-float
                                                      (1
                                                       (f2cl-lib:int-add n
                                                                         1))
                                                      ((1 ldwork) (1 *)))
                                mu scale
                                (f2cl-lib:array-slice work
                                                      double-float
                                                      (1
                                                       (f2cl-lib:int-add n
                                                                         4))
                                                      ((1 ldwork) (1 *)))
                                (f2cl-lib:array-slice work
                                                      double-float
                                                      (1
                                                       (f2cl-lib:int-add n
                                                                         6))
                                                      ((1 ldwork) (1 *)))
                                ierr)
                               (declare (ignore var-0 var-1 var-2 var-3 var-4
                                                var-5 var-6 var-8 var-9))
                               (setf scale var-7)
                               (setf ierr var-10))))))
                        (go label50))))))
                (setf (f2cl-lib:fref sep-%data% (ks) ((1 *)) sep-%offset%)
                        (/ scale (max est smlnum)))
                (if pair
                    (setf (f2cl-lib:fref sep-%data%
                                         ((f2cl-lib:int-add ks 1))
                                         ((1 *))
                                         sep-%offset%)
                          (f2cl-lib:fref sep-%data%
                                         (ks)
                                         ((1 *))
                                         sep-%offset%)))))
           (if pair (setf ks (f2cl-lib:int-add ks 1)))
label60))
end_label
       (return
        (values nil
                nil
                nil
                nil
```

```
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                nil
                m
                nil
                nil
                nil
                info))))))
```

———-

6.96 ieeeck LAPACK

— **ieeeck.input** —

```
)set break resume
)sys rm -f ieeeck.output
)spool ieeeck.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **ieeeck.help** —

```
=====================================================================
ieeeck examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

NAME
       IEEECK  -  called  from the ILAENV to verify that Infinity and possibly
```

```
       NaN arithmetic is safe (i.e

SYNOPSIS
       INTEGER FUNCTION IEEECK( ISPEC, ZERO, ONE )

           INTEGER      ISPEC

           REAL         ONE, ZERO

  Purpose
  =======

  IEEECK is called from the ILAENV to verify that Infinity and
  possibly NaN arithmetic is safe (i.e. will not trap).

  Arguments
  =========

  ISPEC   (input) INTEGER
          Specifies whether to test just for inifinity arithmetic
          or whether to test for infinity and NaN arithmetic.
          = 0: Verify infinity arithmetic only.
          = 1: Verify infinity and NaN arithmetic.

  ZERO    (input) REAL
          Must contain the value 0.0
          This is passed to prevent the compiler from optimizing
          away this code.

  ONE     (input) REAL
          Must contain the value 1.0
          This is passed to prevent the compiler from optimizing
          away this code.

  RETURN VALUE:  INTEGER
          = 0:  Arithmetic failed to produce the correct answers
          = 1:  Arithmetic produced the correct answers
```

———-

— ieeeck.f —

```
      INTEGER          FUNCTION IEEECK( ISPEC, ZERO, ONE )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1998
```

```
*
*     .. Scalar Arguments ..
      INTEGER            ISPEC
      REAL               ONE, ZERO
*     ..
*
*     .. Local Scalars ..
      REAL               NAN1, NAN2, NAN3, NAN4, NAN5, NAN6, NEGINF,
     $                   NEGZRO, NEWZRO, POSINF
*     ..
*     .. Executable Statements ..
      IEEECK = 1
*
      POSINF = ONE / ZERO
      IF( POSINF.LE.ONE ) THEN
         IEEECK = 0
         RETURN
      END IF
*
      NEGINF = -ONE / ZERO
      IF( NEGINF.GE.ZERO ) THEN
         IEEECK = 0
         RETURN
      END IF
*
      NEGZRO = ONE / ( NEGINF+ONE )
      IF( NEGZRO.NE.ZERO ) THEN
         IEEECK = 0
         RETURN
      END IF
*
      NEGINF = ONE / NEGZRO
      IF( NEGINF.GE.ZERO ) THEN
         IEEECK = 0
         RETURN
      END IF
*
      NEWZRO = NEGZRO + ZERO
      IF( NEWZRO.NE.ZERO ) THEN
         IEEECK = 0
         RETURN
      END IF
*
      POSINF = ONE / NEWZRO
      IF( POSINF.LE.ONE ) THEN
         IEEECK = 0
         RETURN
      END IF
*
      NEGINF = NEGINF*POSINF
```

```
      IF( NEGINF.GE.ZERO ) THEN
         IEEECK = 0
         RETURN
      END IF
*
      POSINF = POSINF*POSINF
      IF( POSINF.LE.ONE ) THEN
         IEEECK = 0
         RETURN
      END IF
*
*
*
*
*     Return if we were only asked to check infinity arithmetic
*
      IF( ISPEC.EQ.0 )
     $   RETURN
*
      NAN1 = POSINF + NEGINF
*
      NAN2 = POSINF / NEGINF
*
      NAN3 = POSINF / POSINF
*
      NAN4 = POSINF*ZERO
*
      NAN5 = NEGINF*NEGZRO
*
      NAN6 = NAN5*0.0
*
      IF( NAN1.EQ.NAN1 ) THEN
         IEEECK = 0
         RETURN
      END IF
*
      IF( NAN2.EQ.NAN2 ) THEN
         IEEECK = 0
         RETURN
      END IF
*
      IF( NAN3.EQ.NAN3 ) THEN
         IEEECK = 0
         RETURN
      END IF
*
      IF( NAN4.EQ.NAN4 ) THEN
         IEEECK = 0
         RETURN
      END IF
```

```
*
      IF( NAN5.EQ.NAN5 ) THEN
         IEEECK = 0
         RETURN
      END IF
*
      IF( NAN6.EQ.NAN6 ) THEN
         IEEECK = 0
         RETURN
      END IF
*
      RETURN
      END
```

———-

— LAPACK ieeeck —

```
(defun ieeeck (ispec zero one)
  (declare (type (single-float) one zero) (type fixnum ispec))
  (prog ((nan1 0.0f0) (nan2 0.0f0) (nan3 0.0f0) (nan4 0.0f0) (nan5 0.0f0)
         (nan6 0.0f0) (neginf 0.0f0) (negzro 0.0f0) (newzro 0.0f0)
         (posinf 0.0f0) (ieeeck 0))
    (declare (type fixnum ieeeck)
             (type (single-float) posinf newzro negzro neginf nan6 nan5 nan4
                                  nan3 nan2 nan1))
    (setf ieeeck 1)
    (setf posinf (/ one zero))
    (cond
      ((<= posinf one)
       (setf ieeeck 0)
       (go end_label)))
    (setf neginf (/ (- one) zero))
    (cond
      ((>= neginf zero)
       (setf ieeeck 0)
       (go end_label)))
    (setf negzro (/ one (+ neginf one)))
    (cond
      ((/= negzro zero)
       (setf ieeeck 0)
       (go end_label)))
    (setf neginf (/ one negzro))
    (cond
      ((>= neginf zero)
       (setf ieeeck 0)
       (go end_label)))
    (setf newzro (+ negzro zero))
```

```
(cond
  ((/= newzro zero)
   (setf ieeeck 0)
   (go end_label)))
(setf posinf (/ one newzro))
(cond
  ((<= posinf one)
   (setf ieeeck 0)
   (go end_label)))
(setf neginf (* neginf posinf))
(cond
  ((>= neginf zero)
   (setf ieeeck 0)
   (go end_label)))
(setf posinf (* posinf posinf))
(cond
  ((<= posinf one)
   (setf ieeeck 0)
   (go end_label)))
(if (= ispec 0) (go end_label))
(setf nan1 (+ posinf neginf))
(setf nan2 (/ posinf neginf))
(setf nan3 (/ posinf posinf))
(setf nan4 (* posinf zero))
(setf nan5 (* neginf negzro))
(setf nan6 (* nan5 0.0f0))
(cond
  ((= nan1 nan1)
   (setf ieeeck 0)
   (go end_label)))
(cond
  ((= nan2 nan2)
   (setf ieeeck 0)
   (go end_label)))
(cond
  ((= nan3 nan3)
   (setf ieeeck 0)
   (go end_label)))
(cond
  ((= nan4 nan4)
   (setf ieeeck 0)
   (go end_label)))
(cond
  ((= nan5 nan5)
   (setf ieeeck 0)
   (go end_label)))
(cond
  ((= nan6 nan6)
   (setf ieeeck 0)
   (go end_label)))
```

```
 end_label
    (return (values ieeeck nil nil nil))))
```

———-

6.97 ilaenv LAPACK

— **ilaenv.input** —

```
)set break resume
)sys rm -f ilaenv.output
)spool ilaenv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **ilaenv.help** —

```
=======================================================================
ilaenv examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

NAME
       ILAENV  -  called  from the LAPACK routines to choose problem-dependent
       parameters for the local environment

SYNOPSIS
       INTEGER FUNCTION ILAENV( ISPEC, NAME, OPTS, N1, N2, N3, N4 )

           CHARACTER*(  * ) NAME, OPTS

           INTEGER      ISPEC, N1, N2, N3, N4

  Purpose
  =======
```

```
ILAENV is called from the LAPACK routines to choose problem-dependent
parameters for the local environment.  See ISPEC for a description of
the parameters.

This version provides a set of parameters which should give good,
but not optimal, performance on many of the currently available
computers.  Users are encouraged to modify this subroutine to set
the tuning parameters for their particular machine using the option
and problem size information in the arguments.

This routine will not function correctly if it is converted to all
lower case.  Converting it to all upper case is allowed.

Arguments
=========

ISPEC   (input) INTEGER
        Specifies the parameter to be returned as the value of
        ILAENV.
        = 1: the optimal blocksize; if this value is 1, an unblocked
             algorithm will give the best performance.
        = 2: the minimum block size for which the block routine
             should be used; if the usable block size is less than
             this value, an unblocked routine should be used.
        = 3: the crossover point (in a block routine, for N less
             than this value, an unblocked routine should be used)
        = 4: the number of shifts, used in the nonsymmetric
             eigenvalue routines
        = 5: the minimum column dimension for blocking to be used;
             rectangular blocks must have dimension at least k by m,
             where k is given by ILAENV(2,...) and m by ILAENV(5,...)
        = 6: the crossover point for the SVD (when reducing an m by n
             matrix to bidiagonal form, if max(m,n)/min(m,n) exceeds
             this value, a QR factorization is used first to reduce
             the matrix to a triangular form.)
        = 7: the number of processors
        = 8: the crossover point for the multishift QR and QZ methods
             for nonsymmetric eigenvalue problems.
        = 9: maximum size of the subproblems at the bottom of the
             computation tree in the divide-and-conquer algorithm
             (used by xGELSD and xGESDD)
        =10: ieee NaN arithmetic can be trusted not to trap
        =11: infinity arithmetic can be trusted not to trap

NAME    (input) CHARACTER*(*)
        The name of the calling subroutine, in either upper case or
        lower case.

OPTS    (input) CHARACTER*(*)
        The character options to the subroutine NAME, concatenated
```

```
          into a single character string.  For example, UPLO = 'U',
          TRANS = 'T', and DIAG = 'N' for a triangular routine would
          be specified as OPTS = 'UTN'.

  N1      (input) INTEGER
  N2      (input) INTEGER
  N3      (input) INTEGER
  N4      (input) INTEGER
          Problem dimensions for the subroutine NAME; these may not all
          be required.

 (ILAENV) (output) INTEGER
          >= 0: the value of the parameter specified by ISPEC
          < 0:  if ILAENV = -k, the k-th argument had an illegal value.

  Further Details
  ===============

  The following conventions have been used when calling ILAENV from the
  LAPACK routines:
  1)  OPTS is a concatenation of all of the character options to
      subroutine NAME, in the same order that they appear in the
      argument list for NAME, even if they are not used in determining
      the value of the parameter specified by ISPEC.
  2)  The problem dimensions N1, N2, N3, N4 are specified in the order
      that they appear in the argument list for NAME.  N1 is used
      first, N2 second, and so on, and unused problem dimensions are
      passed a value of -1.
  3)  The parameter value returned by ILAENV is checked for validity in
      the calling subroutine.  For example, ILAENV is used to retrieve
      the optimal blocksize for STRTRI as follows:

      NB = ILAENV( 1, 'STRTRI', UPLO // DIAG, N, -1, -1, -1 )
      IF( NB.LE.1 ) NB = MAX( 1, N )
```

———-

— ilaenv.f —

```
      INTEGER          FUNCTION ILAENV( ISPEC, NAME, OPTS, N1, N2, N3,
     $                 N4 )
*
*  -- LAPACK auxiliary routine (version 3.0) --
*     Univ. of Tennessee, Univ. of California Berkeley, NAG Ltd.,
*     Courant Institute, Argonne National Lab, and Rice University
*     June 30, 1999
*
*     .. Scalar Arguments ..
```

```
      CHARACTER*( * )    NAME, OPTS
      INTEGER            ISPEC, N1, N2, N3, N4
*     ..
*
*  =====================================================================
*
*     .. Local Scalars ..
      LOGICAL            CNAME, SNAME
      CHARACTER*1        C1
      CHARACTER*2        C2, C4
      CHARACTER*3        C3
      CHARACTER*6        SUBNAM
      INTEGER            I, IC, IZ, NB, NBMIN, NX
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          CHAR, ICHAR, INT, MIN, REAL
*     ..
*     .. External Functions ..
      INTEGER            IEEECK
      EXTERNAL           IEEECK
*     ..
*     .. Executable Statements ..
*
      GO TO ( 100, 100, 100, 400, 500, 600, 700, 800, 900, 1000,
     $        1100 ) ISPEC
*
*     Invalid value for ISPEC
*
      ILAENV = -1
      RETURN
*
  100 CONTINUE
*
*     Convert NAME to upper case if the first character is lower case.
*
      ILAENV = 1
      SUBNAM = NAME
      IC = ICHAR( SUBNAM( 1:1 ) )
      IZ = ICHAR( 'Z' )
      IF( IZ.EQ.90 .OR. IZ.EQ.122 ) THEN
*
*        ASCII character set
*
         IF( IC.GE.97 .AND. IC.LE.122 ) THEN
            SUBNAM( 1:1 ) = CHAR( IC-32 )
            DO 10 I = 2, 6
               IC = ICHAR( SUBNAM( I:I ) )
               IF( IC.GE.97 .AND. IC.LE.122 )
     $            SUBNAM( I:I ) = CHAR( IC-32 )
   10       CONTINUE
```

```
         END IF
*
      ELSE IF( IZ.EQ.233 .OR. IZ.EQ.169 ) THEN
*
*        EBCDIC character set
*
         IF( ( IC.GE.129 .AND. IC.LE.137 ) .OR.
     $       ( IC.GE.145 .AND. IC.LE.153 ) .OR.
     $       ( IC.GE.162 .AND. IC.LE.169 ) ) THEN
            SUBNAM( 1:1 ) = CHAR( IC+64 )
            DO 20 I = 2, 6
               IC = ICHAR( SUBNAM( I:I ) )
               IF( ( IC.GE.129 .AND. IC.LE.137 ) .OR.
     $             ( IC.GE.145 .AND. IC.LE.153 ) .OR.
     $             ( IC.GE.162 .AND. IC.LE.169 ) )
     $            SUBNAM( I:I ) = CHAR( IC+64 )
   20       CONTINUE
         END IF
*
      ELSE IF( IZ.EQ.218 .OR. IZ.EQ.250 ) THEN
*
*        Prime machines:  ASCII+128
*
         IF( IC.GE.225 .AND. IC.LE.250 ) THEN
            SUBNAM( 1:1 ) = CHAR( IC-32 )
            DO 30 I = 2, 6
               IC = ICHAR( SUBNAM( I:I ) )
               IF( IC.GE.225 .AND. IC.LE.250 )
     $            SUBNAM( I:I ) = CHAR( IC-32 )
   30       CONTINUE
         END IF
      END IF
*
      C1 = SUBNAM( 1:1 )
      SNAME = C1.EQ.'S' .OR. C1.EQ.'D'
      CNAME = C1.EQ.'C' .OR. C1.EQ.'Z'
      IF( .NOT.( CNAME .OR. SNAME ) )
     $   RETURN
      C2 = SUBNAM( 2:3 )
      C3 = SUBNAM( 4:6 )
      C4 = C3( 2:3 )
*
      GO TO ( 110, 200, 300 ) ISPEC
*
  110 CONTINUE
*
*     ISPEC = 1:  block size
*
*     In these examples, separate code is provided for setting NB for
*     real and complex.  We assume that NB will take the same value in
```

```
*     single or double precision.
*
      NB = 1
*
      IF( C2.EQ.'GE' ) THEN
         IF( C3.EQ.'TRF' ) THEN
            IF( SNAME ) THEN
               NB = 64
            ELSE
               NB = 64
            END IF
         ELSE IF( C3.EQ.'QRF' .OR. C3.EQ.'RQF' .OR. C3.EQ.'LQF' .OR.
     $            C3.EQ.'QLF' ) THEN
            IF( SNAME ) THEN
               NB = 32
            ELSE
               NB = 32
            END IF
         ELSE IF( C3.EQ.'HRD' ) THEN
            IF( SNAME ) THEN
               NB = 32
            ELSE
               NB = 32
            END IF
         ELSE IF( C3.EQ.'BRD' ) THEN
            IF( SNAME ) THEN
               NB = 32
            ELSE
               NB = 32
            END IF
         ELSE IF( C3.EQ.'TRI' ) THEN
            IF( SNAME ) THEN
               NB = 64
            ELSE
               NB = 64
            END IF
         END IF
      ELSE IF( C2.EQ.'PO' ) THEN
         IF( C3.EQ.'TRF' ) THEN
            IF( SNAME ) THEN
               NB = 64
            ELSE
               NB = 64
            END IF
         END IF
      ELSE IF( C2.EQ.'SY' ) THEN
         IF( C3.EQ.'TRF' ) THEN
            IF( SNAME ) THEN
               NB = 64
            ELSE
```

```
            NB = 64
         END IF
      ELSE IF( SNAME .AND. C3.EQ.'TRD' ) THEN
         NB = 32
      ELSE IF( SNAME .AND. C3.EQ.'GST' ) THEN
         NB = 64
      END IF
   ELSE IF( CNAME .AND. C2.EQ.'HE' ) THEN
      IF( C3.EQ.'TRF' ) THEN
         NB = 64
      ELSE IF( C3.EQ.'TRD' ) THEN
         NB = 32
      ELSE IF( C3.EQ.'GST' ) THEN
         NB = 64
      END IF
   ELSE IF( SNAME .AND. C2.EQ.'OR' ) THEN
      IF( C3( 1:1 ).EQ.'G' ) THEN
         IF( C4.EQ.'QR' .OR. C4.EQ.'RQ' .OR. C4.EQ.'LQ' .OR.
     $       C4.EQ.'QL' .OR. C4.EQ.'HR' .OR. C4.EQ.'TR' .OR.
     $       C4.EQ.'BR' ) THEN
            NB = 32
         END IF
      ELSE IF( C3( 1:1 ).EQ.'M' ) THEN
         IF( C4.EQ.'QR' .OR. C4.EQ.'RQ' .OR. C4.EQ.'LQ' .OR.
     $       C4.EQ.'QL' .OR. C4.EQ.'HR' .OR. C4.EQ.'TR' .OR.
     $       C4.EQ.'BR' ) THEN
            NB = 32
         END IF
      END IF
   ELSE IF( CNAME .AND. C2.EQ.'UN' ) THEN
      IF( C3( 1:1 ).EQ.'G' ) THEN
         IF( C4.EQ.'QR' .OR. C4.EQ.'RQ' .OR. C4.EQ.'LQ' .OR.
     $       C4.EQ.'QL' .OR. C4.EQ.'HR' .OR. C4.EQ.'TR' .OR.
     $       C4.EQ.'BR' ) THEN
            NB = 32
         END IF
      ELSE IF( C3( 1:1 ).EQ.'M' ) THEN
         IF( C4.EQ.'QR' .OR. C4.EQ.'RQ' .OR. C4.EQ.'LQ' .OR.
     $       C4.EQ.'QL' .OR. C4.EQ.'HR' .OR. C4.EQ.'TR' .OR.
     $       C4.EQ.'BR' ) THEN
            NB = 32
         END IF
      END IF
   ELSE IF( C2.EQ.'GB' ) THEN
      IF( C3.EQ.'TRF' ) THEN
         IF( SNAME ) THEN
            IF( N4.LE.64 ) THEN
               NB = 1
            ELSE
               NB = 32
```

```
               END IF
            ELSE
               IF( N4.LE.64 ) THEN
                  NB = 1
               ELSE
                  NB = 32
               END IF
            END IF
         END IF
      ELSE IF( C2.EQ.'PB' ) THEN
         IF( C3.EQ.'TRF' ) THEN
            IF( SNAME ) THEN
               IF( N2.LE.64 ) THEN
                  NB = 1
               ELSE
                  NB = 32
               END IF
            ELSE
               IF( N2.LE.64 ) THEN
                  NB = 1
               ELSE
                  NB = 32
               END IF
            END IF
         END IF
      ELSE IF( C2.EQ.'TR' ) THEN
         IF( C3.EQ.'TRI' ) THEN
            IF( SNAME ) THEN
               NB = 64
            ELSE
               NB = 64
            END IF
         END IF
      ELSE IF( C2.EQ.'LA' ) THEN
         IF( C3.EQ.'UUM' ) THEN
            IF( SNAME ) THEN
               NB = 64
            ELSE
               NB = 64
            END IF
         END IF
      ELSE IF( SNAME .AND. C2.EQ.'ST' ) THEN
         IF( C3.EQ.'EBZ' ) THEN
            NB = 1
         END IF
      END IF
      ILAENV = NB
      RETURN
*
  200 CONTINUE
```

```
*
*     ISPEC = 2:  minimum block size
*
      NBMIN = 2
      IF( C2.EQ.'GE' ) THEN
         IF( C3.EQ.'QRF' .OR. C3.EQ.'RQF' .OR. C3.EQ.'LQF' .OR.
     $       C3.EQ.'QLF' ) THEN
            IF( SNAME ) THEN
               NBMIN = 2
            ELSE
               NBMIN = 2
            END IF
         ELSE IF( C3.EQ.'HRD' ) THEN
            IF( SNAME ) THEN
               NBMIN = 2
            ELSE
               NBMIN = 2
            END IF
         ELSE IF( C3.EQ.'BRD' ) THEN
            IF( SNAME ) THEN
               NBMIN = 2
            ELSE
               NBMIN = 2
            END IF
         ELSE IF( C3.EQ.'TRI' ) THEN
            IF( SNAME ) THEN
               NBMIN = 2
            ELSE
               NBMIN = 2
            END IF
         END IF
      ELSE IF( C2.EQ.'SY' ) THEN
         IF( C3.EQ.'TRF' ) THEN
            IF( SNAME ) THEN
               NBMIN = 8
            ELSE
               NBMIN = 8
            END IF
         ELSE IF( SNAME .AND. C3.EQ.'TRD' ) THEN
            NBMIN = 2
         END IF
      ELSE IF( CNAME .AND. C2.EQ.'HE' ) THEN
         IF( C3.EQ.'TRD' ) THEN
            NBMIN = 2
         END IF
      ELSE IF( SNAME .AND. C2.EQ.'OR' ) THEN
         IF( C3( 1:1 ).EQ.'G' ) THEN
            IF( C4.EQ.'QR' .OR. C4.EQ.'RQ' .OR. C4.EQ.'LQ' .OR.
     $          C4.EQ.'QL' .OR. C4.EQ.'HR' .OR. C4.EQ.'TR' .OR.
     $          C4.EQ.'BR' ) THEN
```

```
               NBMIN = 2
            END IF
         ELSE IF( C3( 1:1 ).EQ.'M' ) THEN
            IF( C4.EQ.'QR' .OR. C4.EQ.'RQ' .OR. C4.EQ.'LQ' .OR.
     $          C4.EQ.'QL' .OR. C4.EQ.'HR' .OR. C4.EQ.'TR' .OR.
     $          C4.EQ.'BR' ) THEN
               NBMIN = 2
            END IF
         END IF
      ELSE IF( CNAME .AND. C2.EQ.'UN' ) THEN
         IF( C3( 1:1 ).EQ.'G' ) THEN
            IF( C4.EQ.'QR' .OR. C4.EQ.'RQ' .OR. C4.EQ.'LQ' .OR.
     $          C4.EQ.'QL' .OR. C4.EQ.'HR' .OR. C4.EQ.'TR' .OR.
     $          C4.EQ.'BR' ) THEN
               NBMIN = 2
            END IF
         ELSE IF( C3( 1:1 ).EQ.'M' ) THEN
            IF( C4.EQ.'QR' .OR. C4.EQ.'RQ' .OR. C4.EQ.'LQ' .OR.
     $          C4.EQ.'QL' .OR. C4.EQ.'HR' .OR. C4.EQ.'TR' .OR.
     $          C4.EQ.'BR' ) THEN
               NBMIN = 2
            END IF
         END IF
      END IF
      ILAENV = NBMIN
      RETURN
*
  300 CONTINUE
*
*     ISPEC = 3:  crossover point
*
      NX = 0
      IF( C2.EQ.'GE' ) THEN
         IF( C3.EQ.'QRF' .OR. C3.EQ.'RQF' .OR. C3.EQ.'LQF' .OR.
     $       C3.EQ.'QLF' ) THEN
            IF( SNAME ) THEN
               NX = 128
            ELSE
               NX = 128
            END IF
         ELSE IF( C3.EQ.'HRD' ) THEN
            IF( SNAME ) THEN
               NX = 128
            ELSE
               NX = 128
            END IF
         ELSE IF( C3.EQ.'BRD' ) THEN
            IF( SNAME ) THEN
               NX = 128
            ELSE
```

```
               NX = 128
            END IF
         END IF
      ELSE IF( C2.EQ.'SY' ) THEN
         IF( SNAME .AND. C3.EQ.'TRD' ) THEN
            NX = 32
         END IF
      ELSE IF( CNAME .AND. C2.EQ.'HE' ) THEN
         IF( C3.EQ.'TRD' ) THEN
            NX = 32
         END IF
      ELSE IF( SNAME .AND. C2.EQ.'OR' ) THEN
         IF( C3( 1:1 ).EQ.'G' ) THEN
            IF( C4.EQ.'QR' .OR. C4.EQ.'RQ' .OR. C4.EQ.'LQ' .OR.
     $          C4.EQ.'QL' .OR. C4.EQ.'HR' .OR. C4.EQ.'TR' .OR.
     $          C4.EQ.'BR' ) THEN
               NX = 128
            END IF
         END IF
      ELSE IF( CNAME .AND. C2.EQ.'UN' ) THEN
         IF( C3( 1:1 ).EQ.'G' ) THEN
            IF( C4.EQ.'QR' .OR. C4.EQ.'RQ' .OR. C4.EQ.'LQ' .OR.
     $          C4.EQ.'QL' .OR. C4.EQ.'HR' .OR. C4.EQ.'TR' .OR.
     $          C4.EQ.'BR' ) THEN
               NX = 128
            END IF
         END IF
      END IF
      ILAENV = NX
      RETURN
*
  400 CONTINUE
*
*     ISPEC = 4:  number of shifts (used by xHSEQR)
*
      ILAENV = 6
      RETURN
*
  500 CONTINUE
*
*     ISPEC = 5:  minimum column dimension (not used)
*
      ILAENV = 2
      RETURN
*
  600 CONTINUE
*
*     ISPEC = 6:  crossover point for SVD (used by xGELSS and xGESVD)
*
      ILAENV = INT( REAL( MIN( N1, N2 ) )*1.6E0 )
```

```
      RETURN
*
  700 CONTINUE
*
*     ISPEC = 7:  number of processors (not used)
*
      ILAENV = 1
      RETURN
*
  800 CONTINUE
*
*     ISPEC = 8:  crossover point for multishift (used by xHSEQR)
*
      ILAENV = 50
      RETURN
*
  900 CONTINUE
*
*     ISPEC = 9:  maximum size of the subproblems at the bottom of the
*                 computation tree in the divide-and-conquer algorithm
*                 (used by xGELSD and xGESDD)
*
      ILAENV = 25
      RETURN
*
 1000 CONTINUE
*
*     ISPEC = 10: ieee NaN arithmetic can be trusted not to trap
*
C     ILAENV = 0
      ILAENV = 1
      IF( ILAENV.EQ.1 ) THEN
         ILAENV = IEEECK( 0, 0.0, 1.0 )
      END IF
      RETURN
*
 1100 CONTINUE
*
*     ISPEC = 11: infinity arithmetic can be trusted not to trap
*
C     ILAENV = 0
      ILAENV = 1
      IF( ILAENV.EQ.1 ) THEN
         ILAENV = IEEECK( 1, 0.0, 1.0 )
      END IF
      RETURN
*
*     End of ILAENV
*
      END
```

———-

— LAPACK ilaenv —

```
(defun ilaenv (ispec name opts n1 n2 n3 n4)
  (declare (type character opts name)
           (type fixnum n4 n3 n2 n1 ispec))
  (f2cl-lib:with-multi-array-data
      ((name character name-%data% name-%offset%)
       (opts character opts-%data% opts-%offset%))
    (prog ((i 0) (ic 0) (iz 0) (nb 0) (nbmin 0) (nx 0)
           (subnam
            (make-array '(6) :element-type 'character :initial-element #\ ))
           (c3 (make-array '(3) :element-type 'character :initial-element #\ ))
           (c2 (make-array '(2) :element-type 'character :initial-element #\ ))
           (c4 (make-array '(2) :element-type 'character :initial-element #\ ))
           (c1 (make-array '(1) :element-type 'character :initial-element #\ ))
           (cname nil) (sname nil) (ilaenv 0) (char$ 0.0f0))
      (declare (type (single-float) char$)
               (type (member t nil) sname cname)
               (type (simple-array character (1)) c1)
               (type (simple-array character (2)) c4 c2)
               (type (simple-array character (3)) c3)
               (type (simple-array character (6)) subnam)
               (type fixnum ilaenv nx nbmin nb iz ic i))
      (f2cl-lib:computed-goto
       (label100 label100 label100 label400 label500 label600 label700 label800
        label900 label1000 label1100)
       ispec)
      (setf ilaenv -1)
      (go end_label)
 label100
      (setf ilaenv 1)
      (f2cl-lib:f2cl-set-string subnam name (string 6))
      (setf ic (f2cl-lib:ichar (f2cl-lib:fref-string subnam (1 1))))
      (setf iz (f2cl-lib:ichar "Z"))
      (cond
        ((or (= iz 90) (= iz 122))
         (cond
           ((and (>= ic 97) (<= ic 122))
            (f2cl-lib:fset-string (f2cl-lib:fref-string subnam (1 1))
                                  (code-char (f2cl-lib:int-sub ic 32)))
            (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
                          ((> i 6) nil)
              (tagbody
                (setf ic (f2cl-lib:ichar (f2cl-lib:fref-string subnam (i i))))
                (if (and (>= ic 97) (<= ic 122))
```

```
                (f2cl-lib:fset-string (f2cl-lib:fref-string subnam (i i))
                                      (code-char
                                       (f2cl-lib:int-sub ic 32)))))))))
       ((or (= iz 233) (= iz 169))
        (cond
          ((or (and (>= ic 129) (<= ic 137))
               (and (>= ic 145) (<= ic 153))
               (and (>= ic 162) (<= ic 169)))
           (f2cl-lib:fset-string (f2cl-lib:fref-string subnam (1 1))
                                 (code-char (f2cl-lib:int-add ic 64)))
           (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
                         ((> i 6) nil)
             (tagbody
               (setf ic (f2cl-lib:ichar (f2cl-lib:fref-string subnam (i i))))
               (if
                (or (and (>= ic 129) (<= ic 137))
                    (and (>= ic 145) (<= ic 153))
                    (and (>= ic 162) (<= ic 169)))
                (f2cl-lib:fset-string (f2cl-lib:fref-string subnam (i i))
                                      (code-char
                                       (f2cl-lib:int-add ic 64)))))))))
       ((or (= iz 218) (= iz 250))
        (cond
          ((and (>= ic 225) (<= ic 250))
           (f2cl-lib:fset-string (f2cl-lib:fref-string subnam (1 1))
                                 (code-char (f2cl-lib:int-sub ic 32)))
           (f2cl-lib:fdo (i 2 (f2cl-lib:int-add i 1))
                         ((> i 6) nil)
             (tagbody
               (setf ic (f2cl-lib:ichar (f2cl-lib:fref-string subnam (i i))))
               (if (and (>= ic 225) (<= ic 250))
                   (f2cl-lib:fset-string (f2cl-lib:fref-string subnam (i i))
                                         (code-char
                                          (f2cl-lib:int-sub ic 32)))))))))
     (f2cl-lib:f2cl-set-string c1
                               (f2cl-lib:fref-string subnam (1 1))
                               (string 1))
     (setf sname (or (f2cl-lib:fstring-= c1 "S") (f2cl-lib:fstring-= c1 "D")))
     (setf cname (or (f2cl-lib:fstring-= c1 "C") (f2cl-lib:fstring-= c1 "Z")))
     (if (not (or cname sname)) (go end_label))
     (f2cl-lib:f2cl-set-string c2
                               (f2cl-lib:fref-string subnam (2 3))
                               (string 2))
     (f2cl-lib:f2cl-set-string c3
                               (f2cl-lib:fref-string subnam (4 6))
                               (string 3))
     (f2cl-lib:f2cl-set-string c4 (f2cl-lib:fref-string c3 (2 3)) (string 2))
     (f2cl-lib:computed-goto (label110 label200 label300) ispec)
label110
     (setf nb 1)
```

```
(cond
  ((f2cl-lib:fstring-= c2 "GE")
   (cond
     ((f2cl-lib:fstring-= c3 "TRF")
      (cond
        (sname
         (setf nb 64))
        (t
         (setf nb 64))))
     ((or (f2cl-lib:fstring-= c3 "QRF")
          (f2cl-lib:fstring-= c3 "RQF")
          (f2cl-lib:fstring-= c3 "LQF")
          (f2cl-lib:fstring-= c3 "QLF"))
      (cond
        (sname
         (setf nb 32))
        (t
         (setf nb 32))))
     ((f2cl-lib:fstring-= c3 "HRD")
      (cond
        (sname
         (setf nb 32))
        (t
         (setf nb 32))))
     ((f2cl-lib:fstring-= c3 "BRD")
      (cond
        (sname
         (setf nb 32))
        (t
         (setf nb 32))))
     ((f2cl-lib:fstring-= c3 "TRI")
      (cond
        (sname
         (setf nb 64))
        (t
         (setf nb 64))))))
  ((f2cl-lib:fstring-= c2 "PO")
   (cond
     ((f2cl-lib:fstring-= c3 "TRF")
      (cond
        (sname
         (setf nb 64))
        (t
         (setf nb 64))))))
  ((f2cl-lib:fstring-= c2 "SY")
   (cond
     ((f2cl-lib:fstring-= c3 "TRF")
      (cond
        (sname
         (setf nb 64))
```

```
      (t
       (setf nb 64))))
   ((and sname (f2cl-lib:fstring-= c3 "TRD"))
    (setf nb 32))
   ((and sname (f2cl-lib:fstring-= c3 "GST"))
    (setf nb 64))))
((and cname (f2cl-lib:fstring-= c2 "HE"))
 (cond
   ((f2cl-lib:fstring-= c3 "TRF")
    (setf nb 64))
   ((f2cl-lib:fstring-= c3 "TRD")
    (setf nb 32))
   ((f2cl-lib:fstring-= c3 "GST")
    (setf nb 64))))
((and sname (f2cl-lib:fstring-= c2 "OR"))
 (cond
   ((f2cl-lib:fstring-= (f2cl-lib:fref-string c3 (1 1)) "G")
    (cond
      ((or (f2cl-lib:fstring-= c4 "QR")
           (f2cl-lib:fstring-= c4 "RQ")
           (f2cl-lib:fstring-= c4 "LQ")
           (f2cl-lib:fstring-= c4 "QL")
           (f2cl-lib:fstring-= c4 "HR")
           (f2cl-lib:fstring-= c4 "TR")
           (f2cl-lib:fstring-= c4 "BR"))
       (setf nb 32))))
   ((f2cl-lib:fstring-= (f2cl-lib:fref-string c3 (1 1)) "M")
    (cond
      ((or (f2cl-lib:fstring-= c4 "QR")
           (f2cl-lib:fstring-= c4 "RQ")
           (f2cl-lib:fstring-= c4 "LQ")
           (f2cl-lib:fstring-= c4 "QL")
           (f2cl-lib:fstring-= c4 "HR")
           (f2cl-lib:fstring-= c4 "TR")
           (f2cl-lib:fstring-= c4 "BR"))
       (setf nb 32))))))
((and cname (f2cl-lib:fstring-= c2 "UN"))
 (cond
   ((f2cl-lib:fstring-= (f2cl-lib:fref-string c3 (1 1)) "G")
    (cond
      ((or (f2cl-lib:fstring-= c4 "QR")
           (f2cl-lib:fstring-= c4 "RQ")
           (f2cl-lib:fstring-= c4 "LQ")
           (f2cl-lib:fstring-= c4 "QL")
           (f2cl-lib:fstring-= c4 "HR")
           (f2cl-lib:fstring-= c4 "TR")
           (f2cl-lib:fstring-= c4 "BR"))
       (setf nb 32))))
   ((f2cl-lib:fstring-= (f2cl-lib:fref-string c3 (1 1)) "M")
    (cond
```

```
      ((or (f2cl-lib:fstring-= c4 "QR")
           (f2cl-lib:fstring-= c4 "RQ")
           (f2cl-lib:fstring-= c4 "LQ")
           (f2cl-lib:fstring-= c4 "QL")
           (f2cl-lib:fstring-= c4 "HR")
           (f2cl-lib:fstring-= c4 "TR")
           (f2cl-lib:fstring-= c4 "BR"))
       (setf nb 32))))))
((f2cl-lib:fstring-= c2 "GB")
 (cond
   ((f2cl-lib:fstring-= c3 "TRF")
    (cond
      (sname
       (cond
         ((<= n4 64)
          (setf nb 1))
         (t
          (setf nb 32))))
      (t
       (cond
         ((<= n4 64)
          (setf nb 1))
         (t
          (setf nb 32)))))))))
((f2cl-lib:fstring-= c2 "PB")
 (cond
   ((f2cl-lib:fstring-= c3 "TRF")
    (cond
      (sname
       (cond
         ((<= n2 64)
          (setf nb 1))
         (t
          (setf nb 32))))
      (t
       (cond
         ((<= n2 64)
          (setf nb 1))
         (t
          (setf nb 32)))))))))
((f2cl-lib:fstring-= c2 "TR")
 (cond
   ((f2cl-lib:fstring-= c3 "TRI")
    (cond
      (sname
       (setf nb 64))
      (t
       (setf nb 64))))))
((f2cl-lib:fstring-= c2 "LA")
 (cond
```

```
          ((f2cl-lib:fstring-= c3 "UUM")
           (cond
             (sname
              (setf nb 64))
             (t
              (setf nb 64))))))
       ((and sname (f2cl-lib:fstring-= c2 "ST"))
        (cond
          ((f2cl-lib:fstring-= c3 "EBZ")
           (setf nb 1)))))
     (setf ilaenv nb)
     (go end_label)
label200
     (setf nbmin 2)
     (cond
       ((f2cl-lib:fstring-= c2 "GE")
        (cond
          ((or (f2cl-lib:fstring-= c3 "QRF")
               (f2cl-lib:fstring-= c3 "RQF")
               (f2cl-lib:fstring-= c3 "LQF")
               (f2cl-lib:fstring-= c3 "QLF"))
           (cond
             (sname
              (setf nbmin 2))
             (t
              (setf nbmin 2))))
          ((f2cl-lib:fstring-= c3 "HRD")
           (cond
             (sname
              (setf nbmin 2))
             (t
              (setf nbmin 2))))
          ((f2cl-lib:fstring-= c3 "BRD")
           (cond
             (sname
              (setf nbmin 2))
             (t
              (setf nbmin 2))))
          ((f2cl-lib:fstring-= c3 "TRI")
           (cond
             (sname
              (setf nbmin 2))
             (t
              (setf nbmin 2))))))
       ((f2cl-lib:fstring-= c2 "SY")
        (cond
          ((f2cl-lib:fstring-= c3 "TRF")
           (cond
             (sname
              (setf nbmin 8))
```

```
      (t
       (setf nbmin 8))))
   ((and sname (f2cl-lib:fstring-= c3 "TRD"))
    (setf nbmin 2))))
((and cname (f2cl-lib:fstring-= c2 "HE"))
 (cond
   ((f2cl-lib:fstring-= c3 "TRD")
    (setf nbmin 2))))
((and sname (f2cl-lib:fstring-= c2 "OR"))
 (cond
   ((f2cl-lib:fstring-= (f2cl-lib:fref-string c3 (1 1)) "G")
    (cond
      ((or (f2cl-lib:fstring-= c4 "QR")
           (f2cl-lib:fstring-= c4 "RQ")
           (f2cl-lib:fstring-= c4 "LQ")
           (f2cl-lib:fstring-= c4 "QL")
           (f2cl-lib:fstring-= c4 "HR")
           (f2cl-lib:fstring-= c4 "TR")
           (f2cl-lib:fstring-= c4 "BR"))
       (setf nbmin 2))))
   ((f2cl-lib:fstring-= (f2cl-lib:fref-string c3 (1 1)) "M")
    (cond
      ((or (f2cl-lib:fstring-= c4 "QR")
           (f2cl-lib:fstring-= c4 "RQ")
           (f2cl-lib:fstring-= c4 "LQ")
           (f2cl-lib:fstring-= c4 "QL")
           (f2cl-lib:fstring-= c4 "HR")
           (f2cl-lib:fstring-= c4 "TR")
           (f2cl-lib:fstring-= c4 "BR"))
       (setf nbmin 2))))))
((and cname (f2cl-lib:fstring-= c2 "UN"))
 (cond
   ((f2cl-lib:fstring-= (f2cl-lib:fref-string c3 (1 1)) "G")
    (cond
      ((or (f2cl-lib:fstring-= c4 "QR")
           (f2cl-lib:fstring-= c4 "RQ")
           (f2cl-lib:fstring-= c4 "LQ")
           (f2cl-lib:fstring-= c4 "QL")
           (f2cl-lib:fstring-= c4 "HR")
           (f2cl-lib:fstring-= c4 "TR")
           (f2cl-lib:fstring-= c4 "BR"))
       (setf nbmin 2))))
   ((f2cl-lib:fstring-= (f2cl-lib:fref-string c3 (1 1)) "M")
    (cond
      ((or (f2cl-lib:fstring-= c4 "QR")
           (f2cl-lib:fstring-= c4 "RQ")
           (f2cl-lib:fstring-= c4 "LQ")
           (f2cl-lib:fstring-= c4 "QL")
           (f2cl-lib:fstring-= c4 "HR")
           (f2cl-lib:fstring-= c4 "TR")
```

```
                (f2cl-lib:fstring-= c4 "BR"))
            (setf nbmin 2)))))))
     (setf ilaenv nbmin)
     (go end_label)
 label300
     (setf nx 0)
     (cond
       ((f2cl-lib:fstring-= c2 "GE")
        (cond
          ((or (f2cl-lib:fstring-= c3 "QRF")
               (f2cl-lib:fstring-= c3 "RQF")
               (f2cl-lib:fstring-= c3 "LQF")
               (f2cl-lib:fstring-= c3 "QLF"))
           (cond
             (sname
              (setf nx 128))
             (t
              (setf nx 128))))
          ((f2cl-lib:fstring-= c3 "HRD")
           (cond
             (sname
              (setf nx 128))
             (t
              (setf nx 128))))
          ((f2cl-lib:fstring-= c3 "BRD")
           (cond
             (sname
              (setf nx 128))
             (t
              (setf nx 128))))))
       ((f2cl-lib:fstring-= c2 "SY")
        (cond
          ((and sname (f2cl-lib:fstring-= c3 "TRD"))
           (setf nx 32))))
       ((and cname (f2cl-lib:fstring-= c2 "HE"))
        (cond
          ((f2cl-lib:fstring-= c3 "TRD")
           (setf nx 32))))
       ((and sname (f2cl-lib:fstring-= c2 "OR"))
        (cond
          ((f2cl-lib:fstring-= (f2cl-lib:fref-string c3 (1 1)) "G")
           (cond
             ((or (f2cl-lib:fstring-= c4 "QR")
                  (f2cl-lib:fstring-= c4 "RQ")
                  (f2cl-lib:fstring-= c4 "LQ")
                  (f2cl-lib:fstring-= c4 "QL")
                  (f2cl-lib:fstring-= c4 "HR")
                  (f2cl-lib:fstring-= c4 "TR")
                  (f2cl-lib:fstring-= c4 "BR"))
              (setf nx 128))))))
```

```
        ((and cname (f2cl-lib:fstring-= c2 "UN"))
         (cond
           ((f2cl-lib:fstring-= (f2cl-lib:fref-string c3 (1 1)) "G")
            (cond
              ((or (f2cl-lib:fstring-= c4 "QR")
                   (f2cl-lib:fstring-= c4 "RQ")
                   (f2cl-lib:fstring-= c4 "LQ")
                   (f2cl-lib:fstring-= c4 "QL")
                   (f2cl-lib:fstring-= c4 "HR")
                   (f2cl-lib:fstring-= c4 "TR")
                   (f2cl-lib:fstring-= c4 "BR"))
               (setf nx 128)))))))
     (setf ilaenv nx)
     (go end_label)
label400
     (setf ilaenv 6)
     (go end_label)
label500
     (setf ilaenv 2)
     (go end_label)
label600
     (setf ilaenv
             (f2cl-lib:int
              (*
               (coerce (realpart
                (min (the fixnum n1) (the fixnum n2))) 'single-float)
               1.6f0)))
     (go end_label)
label700
     (setf ilaenv 1)
     (go end_label)
label800
     (setf ilaenv 50)
     (go end_label)
label900
     (setf ilaenv 25)
     (go end_label)
label1000
     (setf ilaenv 0)
     (cond
       ((= ilaenv 1)
        (setf ilaenv (ieeeck 0 0.0f0 1.0f0))))
     (go end_label)
label1100
     (setf ilaenv 0)
     (cond
       ((= ilaenv 1)
        (setf ilaenv (ieeeck 1 0.0f0 1.0f0))))
end_label
     (return (values ilaenv nil nil nil nil nil nil nil)))))
```

———-

6.98 ilazlc LAPACK

— **ilazlc.input** —

```
)set break resume
)sys rm -f ilazlc.output
)spool ilazlc.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **ilazlc.help** —

```
==========================================================================
ilazlc examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       INTEGER FUNCTION ILAZLC( M, N, A, LDA )

       .. Scalar Arguments ..
       INTEGER            M, N, LDA
       ..
       .. Array Arguments ..
       COMPLEX*16         A( LDA, * )
       ..
```

```
 Purpose:
 =============

   ILAZLC scans A for its last non-zero column.

 Arguments:
 ==========

  [in] M
          M is INTEGER
          The number of rows of the matrix A.

  [in] N
          N is INTEGER
          The number of columns of the matrix A.

  [in] A
          A is COMPLEX*16 array, dimension (LDA,N)
          The m by n matrix A.

  [in] LDA
          LDA is INTEGER
          The leading dimension of the array A. LDA >= max(1,M).

 Authors:
 ========

   Univ. of Tennessee
   Univ. of California Berkeley
   Univ. of Colorado Denver
   NAG Ltd.

 November 2011
```

———-

— ilazlc.f —

```
*  =====================================================================
      INTEGER FUNCTION ILAZLC( M, N, A, LDA )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      INTEGER            M, N, LDA
```

```
*     ..
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      COMPLEX*16       ZERO
      PARAMETER ( ZERO = (0.0D+0, 0.0D+0) )
*     ..
*     .. Local Scalars ..
      INTEGER I
*     ..
*     .. Executable Statements ..
*
*     Quick test for the common case where one corner is non-zero.
      IF( N.EQ.0 ) THEN
         ILAZLC = N
      ELSE IF( A(1, N).NE.ZERO .OR. A(M, N).NE.ZERO ) THEN
         ILAZLC = N
      ELSE
*     Now scan each column from the end, returning with the first non-zero.
         DO ILAZLC = N, 1, -1
            DO I = 1, M
               IF( A(I, ILAZLC).NE.ZERO ) RETURN
            END DO
         END DO
      END IF
      RETURN
      END
```

———-

— LAPACK ilazlc —

```
(let* ((zero (coerce (f2cl-lib:cmplx 0.0d0 0.0d0) 'f2cl-lib:complex16)))
 (declare (type (f2cl-lib:complex16) zero) (ignorable zero))
 (defun ilazlc (m n a lda)
  (declare (type (f2cl-lib:integer4) lda n m)
   (type (array f2cl-lib:complex16 (*)) a))
  (f2cl-lib:with-multi-array-data
      ((a f2cl-lib:complex16 a-%data% a-%offset%))
       (prog
        ((i 0) (ilazlc 0)) (declare (type (f2cl-lib:integer4) ilazlc i))
        (cond ((= n 0) (setf ilazlc n))
         ((or (/= (f2cl-lib:fref a (1 n) ((1 lda) (1 *))) zero)
           (/= (f2cl-lib:fref a (m n) ((1 lda) (1 *))) zero))
```

```
          (setf ilazlc n))
         (t
        (f2cl-lib:fdo (ilazlc n (f2cl-lib:int-add ilazlc (f2cl-lib:int-sub 1)))
                ((>
                     ilazlc 1)
                   nil)
                 (tagbody
                     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i m) nil)
                  (tagbody
                       (if
                        (/= (f2cl-lib:fref a-%data% (i ilazlc)
                         ((1 lda) (1 *)) a-%offset%) zero)
                        (go end_label))
                       label100001))
                   label100000))))
        (go end_label) end_label (return (values ilazlc nil nil nil nil))))))
```

———-

6.99 ilazlr LAPACK

— **ilazlr.input** —

```
)set break resume
)sys rm -f ilazlr.output
)spool ilazlr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **ilazlr.help** —

```
==========================================================================
ilazlr examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================
```

```
Online html documentation available at
           http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

      INTEGER FUNCTION ILAZLR( M, N, A, LDA )

      .. Scalar Arguments ..
      INTEGER            M, N, LDA
      ..
      .. Array Arguments ..
      COMPLEX*16         A( LDA, * )
      ..


 Purpose:
 =============

ILAZLR scans A for its last non-zero row.

 Arguments:
 ==========

  [in] M

         M is INTEGER
         The number of rows of the matrix A.

  [in] N
         N is INTEGER
         The number of columns of the matrix A.

  [in] A

         A is COMPLEX*16 array, dimension (LDA,N)
         The m by n matrix A.

  [in] LDA

         LDA is INTEGER
         The leading dimension of the array A. LDA >= max(1,M).

 Authors:
 ========

  Univ. of Tennessee
  Univ. of California Berkeley
  Univ. of Colorado Denver
  NAG Ltd.
```

November 2011

———-

— **ilazlr.f** —

```
*  =====================================================================
      INTEGER FUNCTION ILAZLR( M, N, A, LDA )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      INTEGER            M, N, LDA
*     ..
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      COMPLEX*16       ZERO
      PARAMETER ( ZERO = (0.0D+0, 0.0D+0) )
*     ..
*     .. Local Scalars ..
      INTEGER I, J
*     ..
*     .. Executable Statements ..
*
*     Quick test for the common case where one corner is non-zero.
      IF( M.EQ.0 ) THEN
         ILAZLR = M
      ELSE IF( A(M, 1).NE.ZERO .OR. A(M, N).NE.ZERO ) THEN
         ILAZLR = M
      ELSE
*     Scan up each column tracking the last zero row seen.
         ILAZLR = 0
         DO J = 1, N
            I=M
            DO WHILE ((A(I,J).NE.ZERO).AND.(I.GE.1))
              I=I-1
              IF (I.EQ.0) THEN
                 EXIT
              END IF
```

```
            ENDDO
            ILAZLR = MAX( ILAZLR, I )
         END DO
      END IF
      RETURN
      END
```

———-

— **LAPACK ilazlr** —

```
(let* ((zero (coerce (f2cl-lib:cmplx 0.0d0 0.0d0) 'f2cl-lib:complex16)))
 (declare (type (f2cl-lib:complex16) zero) (ignorable zero))
 (defun ilazlr (m n a lda)
  (declare (type (f2cl-lib:integer4) lda n m)
   (type (array f2cl-lib:complex16 (*)) a))
  (f2cl-lib:with-multi-array-data
      ((a f2cl-lib:complex16 a-%data% a-%offset%))
       (prog
        ((i 0) (j 0) (ilazlr 0))
         (declare (type (f2cl-lib:integer4) ilazlr j i))
        (cond ((= m 0) (setf ilazlr m))
         ((or (/= (f2cl-lib:fref a (m 1) ((1 lda) (1 *))) zero)
           (/= (f2cl-lib:fref a (m n) ((1 lda) (1 *))) zero))
          (setf ilazlr m))
         (t (setf ilazlr 0)
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
                  (tagbody (setf i m)
                      label100001
                      (if
                       (not
                        (and (/= (f2cl-lib:fref a-%data% (i j)
                                    ((1 lda) (1 *)) a-%offset%) zero)
                          (>= i 1)))
                       (go label100002))
                      (setf i (f2cl-lib:int-sub i 1))
                              (cond ((= i 0) (go f2cl-lib::exit)))
                      (go label100001) label100002
                      (setf ilazlr
                       (max (the f2cl-lib:integer4 ilazlr)
                            (the f2cl-lib:integer4 i)))
                      label100000))))
        (go end_label) end_label (return (values ilazlr nil nil nil nil)))))))}
```

———-

6.100 zgebak LAPACK

— zgebak.input —

```
)set break resume
)sys rm -f zgebak.output
)spool zgebak.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— zgebak.help —

```
==========================================================================
zgebak examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/

  Definition:
  ===========

       SUBROUTINE ZGEBAK( JOB, SIDE, N, ILO, IHI, SCALE, M, V, LDV,
                          INFO )

       .. Scalar Arguments ..
       CHARACTER          JOB, SIDE
       INTEGER            IHI, ILO, INFO, LDV, M, N
       ..
       .. Array Arguments ..
       DOUBLE PRECISION   SCALE( * )
       COMPLEX*16         V( LDV, * )
       ..


  Purpose:
  =============
```

```
 ZGEBAK forms the right or left eigenvectors of a complex general
 matrix by backward transformation on the computed eigenvectors of the
 balanced matrix output by ZGEBAL.

Arguments:
==========

[in] JOB

        JOB is CHARACTER*1
        Specifies the type of backward transformation required:
        = 'N', do nothing, return immediately;
        = 'P', do backward transformation for permutation only;
        = 'S', do backward transformation for scaling only;
        = 'B', do backward transformations for both permutation and
               scaling.
        JOB must be the same as the argument JOB supplied to ZGEBAL.

[in] SIDE

        SIDE is CHARACTER*1
        = 'R':  V contains right eigenvectors;
        = 'L':  V contains left eigenvectors.

[in] N

        N is INTEGER
        The number of rows of the matrix V.  N >= 0.

[in] ILO

        ILO is INTEGER

[in] IHI

        IHI is INTEGER
        The integers ILO and IHI determined by ZGEBAL.
        1 <= ILO <= IHI <= N, if N > 0; ILO=1 and IHI=0, if N=0.


[in] SCALE

        SCALE is DOUBLE PRECISION array, dimension (N)
        Details of the permutation and scaling factors, as returned
        by ZGEBAL.


[in] M

        M is INTEGER
```

```
          The number of columns of the matrix V.  M >= 0.

  [in,out] V

          V is COMPLEX*16 array, dimension (LDV,M)
          On entry, the matrix of right or left eigenvectors to be
          transformed, as returned by ZHSEIN or ZTREVC.
          On exit, V is overwritten by the transformed eigenvectors.

  [in] LDV

          LDV is INTEGER
          The leading dimension of the array V. LDV >= max(1,N).

  [out] INFO

          INFO is INTEGER
          = 0:  successful exit
          < 0:  if INFO = -i, the i-th argument had an illegal value.

  Authors:
  ========

   Univ. of Tennessee
   Univ. of California Berkeley
   Univ. of Colorado Denver
   NAG Ltd.

 November 2011
```

———-

— zgebak.f —

```
*  =====================================================================
      SUBROUTINE ZGEBAK( JOB, SIDE, N, ILO, IHI, SCALE, M, V, LDV,
     $                   INFO )
*
*  -- LAPACK computational routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      CHARACTER          JOB, SIDE
      INTEGER            IHI, ILO, INFO, LDV, M, N
*     ..
*     .. Array Arguments ..
```

```
      DOUBLE PRECISION   SCALE( * )
      COMPLEX*16         V( LDV, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE
      PARAMETER          ( ONE = 1.0D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            LEFTV, RIGHTV
      INTEGER            I, II, K
      DOUBLE PRECISION   S
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. External Subroutines ..
      EXTERNAL           XERBLA, ZDSCAL, ZSWAP
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Decode and Test the input parameters
*
      RIGHTV = LSAME( SIDE, 'R' )
      LEFTV = LSAME( SIDE, 'L' )
*
      INFO = 0
      IF( .NOT.LSAME( JOB, 'N' ) .AND. .NOT.LSAME( JOB, 'P' ) .AND.
     $    .NOT.LSAME( JOB, 'S' ) .AND. .NOT.LSAME( JOB, 'B' ) ) THEN
         INFO = -1
      ELSE IF( .NOT.RIGHTV .AND. .NOT.LEFTV ) THEN
         INFO = -2
      ELSE IF( N.LT.0 ) THEN
         INFO = -3
      ELSE IF( ILO.LT.1 .OR. ILO.GT.MAX( 1, N ) ) THEN
         INFO = -4
      ELSE IF( IHI.LT.MIN( ILO, N ) .OR. IHI.GT.N ) THEN
         INFO = -5
      ELSE IF( M.LT.0 ) THEN
         INFO = -7
      ELSE IF( LDV.LT.MAX( 1, N ) ) THEN
         INFO = -9
      END IF
      IF( INFO.NE.0 ) THEN
```

```
         CALL XERBLA( 'ZGEBAK', -INFO )
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( N.EQ.0 )
     $   RETURN
      IF( M.EQ.0 )
     $   RETURN
      IF( LSAME( JOB, 'N' ) )
     $   RETURN
*
      IF( ILO.EQ.IHI )
     $   GO TO 30
*
*     Backward balance
*
      IF( LSAME( JOB, 'S' ) .OR. LSAME( JOB, 'B' ) ) THEN
*
         IF( RIGHTV ) THEN
            DO 10 I = ILO, IHI
               S = SCALE( I )
               CALL ZDSCAL( M, S, V( I, 1 ), LDV )
   10       CONTINUE
         END IF
*
         IF( LEFTV ) THEN
            DO 20 I = ILO, IHI
               S = ONE / SCALE( I )
               CALL ZDSCAL( M, S, V( I, 1 ), LDV )
   20       CONTINUE
         END IF
*
      END IF
*
*     Backward permutation
*
*     For  I = ILO-1 step -1 until 1,
*              IHI+1 step 1 until N do --
*
   30 CONTINUE
      IF( LSAME( JOB, 'P' ) .OR. LSAME( JOB, 'B' ) ) THEN
         IF( RIGHTV ) THEN
            DO 40 II = 1, N
               I = II
               IF( I.GE.ILO .AND. I.LE.IHI )
     $            GO TO 40
               IF( I.LT.ILO )
     $            I = ILO - II
```

```
               K = SCALE( I )
               IF( K.EQ.I )
     $            GO TO 40
               CALL ZSWAP( M, V( I, 1 ), LDV, V( K, 1 ), LDV )
   40       CONTINUE
         END IF
*
         IF( LEFTV ) THEN
            DO 50 II = 1, N
               I = II
               IF( I.GE.ILO .AND. I.LE.IHI )
     $            GO TO 50
               IF( I.LT.ILO )
     $            I = ILO - II
               K = SCALE( I )
               IF( K.EQ.I )
     $            GO TO 50
               CALL ZSWAP( M, V( I, 1 ), LDV, V( K, 1 ), LDV )
   50       CONTINUE
         END IF
      END IF
*
      RETURN
*
*     End of ZGEBAK
*
      END
```

———-

— LAPACK zgebak —

```
(let* ((one 1.0d0))
 (declare (type (double-float 1.0d0 1.0d0) one) (ignorable one))
 (defun zgebak (job side n ilo ihi scale m v ldv info)
  (declare (type (simple-array character (*)) side job)
   (type (f2cl-lib:integer4) info ldv m ihi ilo n)
   (type (array double-float (*)) scale)
   (type (array f2cl-lib:complex16 (*)) v))
  (f2cl-lib:with-multi-array-data
      ((v f2cl-lib:complex16 v-%data% v-%offset%)
       (scale double-float scale-%data% scale-%offset%)
       (job character job-%data% job-%offset%)
       (side character side-%data% side-%offset%))
       (prog
        ((s 0.0d0) (i 0) (ii 0) (k 0) (leftv nil) (rightv nil))
        (declare (type (double-float) s) (type (f2cl-lib:integer4) k ii i)
         (type f2cl-lib:logical rightv leftv))
```

```
(setf rightv
 (multiple-value-bind (ret-val var-0 var-1) (lsame side "R")
  (declare (ignore var-1)) (when var-0 (setf side var-0)) ret-val))
(setf leftv
 (multiple-value-bind (ret-val var-0 var-1) (lsame side "L")
  (declare (ignore var-1)) (when var-0 (setf side var-0)) ret-val))
(setf info 0)
(cond
 ((and
   (not
    (multiple-value-bind (ret-val var-0 var-1) (lsame job "N")
     (declare (ignore var-1)) (when var-0 (setf job var-0)) ret-val))
   (not
    (multiple-value-bind (ret-val var-0 var-1) (lsame job "P")
     (declare (ignore var-1)) (when var-0 (setf job var-0)) ret-val))
   (not
    (multiple-value-bind (ret-val var-0 var-1) (lsame job "S")
     (declare (ignore var-1)) (when var-0 (setf job var-0)) ret-val))
   (not
    (multiple-value-bind (ret-val var-0 var-1) (lsame job "B")
     (declare (ignore var-1)) (when var-0 (setf job var-0)) ret-val)))
  (setf info -1))
 ((and (not rightv) (not leftv))
   (setf info -2)) ((< n 0) (setf info -3))
 ((or (< ilo 1)
   (> ilo (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 n))))
  (setf info -4))
 ((or (< ihi (min (the f2cl-lib:integer4 ilo)
      (the f2cl-lib:integer4 n)))
   (> ihi n))
  (setf info -5))
 ((< m 0) (setf info -7))
 ((< ldv (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 n)))
  (setf info -9)))
(cond ((/= info 0)
   (xerbla "ZGEBAK" (f2cl-lib:int-sub info)) (go end_label)))
(if (= n 0) (go end_label)) (if (= m 0) (go end_label))
(if
 (multiple-value-bind (ret-val var-0 var-1) (lsame job "N")
  (declare (ignore var-1)) (when var-0 (setf job var-0)) ret-val)
 (go end_label))
(if (= ilo ihi) (go label30))
(cond
 ((or
   (multiple-value-bind (ret-val var-0 var-1) (lsame job "S")
    (declare (ignore var-1)) (when var-0 (setf job var-0)) ret-val)
   (multiple-value-bind (ret-val var-0 var-1) (lsame job "B")
    (declare (ignore var-1)) (when var-0 (setf job var-0)) ret-val))
  (cond
   (rightv
```

```
    (f2cl-lib:fdo (i ilo (f2cl-lib:int-add i 1))
           ((> i ihi) nil)
            (tagbody
                  (setf s
                    (f2cl-lib:fref scale-%data% (i) ((1 *))
                     scale-%offset%))
                  (multiple-value-bind (var-0 var-1 var-2 var-3)
                   (zdscal m s
                    (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
                     (i 1) ((1 ldv) (1 *))
                     v-%offset%)
                    ldv)
                   (declare (ignore var-2))
                   (when var-0 (setf m var-0))
                   (when var-1 (setf s var-1))
                   (when var-3 (setf ldv var-3)))
                  label10))))
  (cond
   (leftv
    (f2cl-lib:fdo (i ilo (f2cl-lib:int-add i 1))
           ((> i ihi) nil)
            (tagbody
                  (setf s
                   (/ one
                    (f2cl-lib:fref scale-%data% (i) ((1 *))
                      scale-%offset%)))
                  (multiple-value-bind (var-0 var-1 var-2 var-3)
                   (zdscal m s
                    (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
                     (i 1) ((1 ldv) (1 *))
                     v-%offset%)
                    ldv)
                   (declare (ignore var-2))
                   (when var-0 (setf m var-0))
                   (when var-1 (setf s var-1))
                   (when var-3 (setf ldv var-3)))
                  label20))))))
label30
(cond
 ((or
   (multiple-value-bind (ret-val var-0 var-1) (lsame job "P")
    (declare (ignore var-1)) (when var-0 (setf job var-0)) ret-val)
   (multiple-value-bind (ret-val var-0 var-1) (lsame job "B")
    (declare (ignore var-1)) (when var-0 (setf job var-0)) ret-val))
  (cond
   (rightv
    (f2cl-lib:fdo (ii 1 (f2cl-lib:int-add ii 1))
           ((> ii n) nil)
            (tagbody
                  (setf i ii)
```

```
                    (if (and (>= i ilo) (<= i ihi)) (go label40))
                    (if (< i ilo) (setf i (f2cl-lib:int-sub ilo ii)))
                    (setf k
                     (f2cl-lib:int
                      (f2cl-lib:fref scale-%data% (i) ((1 *))
                       scale-%offset%)))
                    (if (= k i) (go label40))
                    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
                     (zswap m
                      (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
                      (i 1) ((1 ldv) (1 *))
                       v-%offset%)
                      ldv
                      (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
                       (k 1) ((1 ldv) (1 *))
                       v-%offset%)
                      ldv)
                     (declare (ignore var-1 var-3))
                     (when var-0 (setf m var-0))
                     (when var-2 (setf ldv var-2))
                     (when var-4 (setf ldv var-4)))
                    label40))))
          (cond
           (leftv
            (f2cl-lib:fdo (ii 1 (f2cl-lib:int-add ii 1))
                   ((> ii n) nil)
                    (tagbody
                          (setf i ii)
                          (if (and (>= i ilo) (<= i ihi)) (go label50))
                          (if (< i ilo) (setf i (f2cl-lib:int-sub ilo ii)))
                          (setf k
                           (f2cl-lib:int
                            (f2cl-lib:fref scale-%data% (i) ((1 *)
                           ) scale-%offset%)))
                          (if (= k i) (go label50))
                          (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
                           (zswap m
                            (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
                              (i 1) ((1 ldv) (1 *))
                             v-%offset%)
                            ldv
                            (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
                                (k 1) ((1 ldv) (1 *))
                             v-%offset%)
                            ldv)
                           (declare (ignore var-1 var-3))
                           (when var-0 (setf m var-0))
                           (when var-2 (setf ldv var-2))
                           (when var-4 (setf ldv var-4)))
                          label50))))))
```

```
        (go end_label) end_label
        (return (values job side nil nil nil nil m nil ldv info))))))
```

———-

6.101 zgebal LAPACK

— **zgebal.input** —

```
)set break resume
)sys rm -f zgebal.output
)spool zgebal.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zgebal.help** —

```
========================================================================
zgebal examples
========================================================================

========================================================================
Man Page Details
========================================================================

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZGEBAL( JOB, N, A, LDA, ILO, IHI, SCALE, INFO )

       .. Scalar Arguments ..
       CHARACTER          JOB
       INTEGER            IHI, ILO, INFO, LDA, N
       ..
       .. Array Arguments ..
       DOUBLE PRECISION   SCALE( * )
       COMPLEX*16         A( LDA, * )
```

```
      ..

Purpose:
=============

 ZGEBAL balances a general complex matrix A.  This involves, first,
 permuting A by a similarity transformation to isolate eigenvalues
 in the first 1 to ILO-1 and last IHI+1 to N elements on the
 diagonal; and second, applying a diagonal similarity transformation
 to rows and columns ILO to IHI to make the rows and columns as
 close in norm as possible.  Both steps are optional.

 Balancing may reduce the 1-norm of the matrix, and improve the
 accuracy of the computed eigenvalues and/or eigenvectors.

Arguments:
==========

  [in] JOB

         JOB is CHARACTER*1
         Specifies the operations to be performed on A:
         = 'N':  none:  simply set ILO = 1, IHI = N, SCALE(I) = 1.0
                 for i = 1,...,N;
         = 'P':  permute only;
         = 'S':  scale only;
         = 'B':  both permute and scale.

  [in] N

         N is INTEGER
         The order of the matrix A.  N >= 0.

  [in,out] A

         A is COMPLEX*16 array, dimension (LDA,N)
         On entry, the input matrix A.
         On exit,  A is overwritten by the balanced matrix.
         If JOB = 'N', A is not referenced.
         See Further Details.

  [in] LDA

         LDA is INTEGER
         The leading dimension of the array A.  LDA >= max(1,N).

  [out] ILO

  [out] IHI
```

```
          ILO and IHI are set to INTEGER such that on exit
          A(i,j) = 0 if i > j and j = 1,...,ILO-1 or I = IHI+1,...,N.
          If JOB = 'N' or 'S', ILO = 1 and IHI = N.

  [out] SCALE

          SCALE is DOUBLE PRECISION array, dimension (N)
          Details of the permutations and scaling factors applied to
          A.  If P(j) is the index of the row and column interchanged
          with row and column j and D(j) is the scaling factor
          applied to row and column j, then
          SCALE(j) = P(j)    for j = 1,...,ILO-1
                   = D(j)    for j = ILO,...,IHI
                   = P(j)    for j = IHI+1,...,N.
          The order in which the interchanges are made is N to IHI+1,
          then 1 to ILO-1.

  [out] INFO

          INFO is INTEGER
          = 0:  successful exit.
          < 0:  if INFO = -i, the i-th argument had an illegal value.

Authors:
========

  Univ. of Tennessee
  Univ. of California Berkeley
  Univ. of Colorado Denver
  NAG Ltd.

November 2011


Further Details:
====================

 The permutations consist of row and column interchanges which put
 the matrix in the form

            ( T1   X   Y  )
    P A P = (  0   B   Z  )
            (  0   0   T2 )

 where T1 and T2 are upper triangular matrices whose eigenvalues lie
 along the diagonal.  The column indices ILO and IHI mark the starting
 and ending columns of the submatrix B. Balancing consists of applying
 a diagonal similarity transformation inv(D) * B * D to make the
 1-norms of each row of B and its corresponding column nearly equal.
```

```
  The output matrix is

     ( T1     X*D          Y    )
     (  0  inv(D)*B*D  inv(D)*Z ).
     (  0      0          T2   )

  Information about the permutations P and the diagonal matrix D is
  returned in the vector SCALE.

  This subroutine is based on the EISPACK routine CBAL.

  Modified by Tzu-Yi Chen, Computer Science Division, University of
    California at Berkeley, USA
```

———-

— zgebal.f —

```
*  =====================================================================
      SUBROUTINE ZGEBAL( JOB, N, A, LDA, ILO, IHI, SCALE, INFO )
*
*  -- LAPACK computational routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      CHARACTER          JOB
      INTEGER            IHI, ILO, INFO, LDA, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   SCALE( * )
      COMPLEX*16         A( LDA, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0 )
      DOUBLE PRECISION   SCLFAC
      PARAMETER          ( SCLFAC = 2.0D+0 )
      DOUBLE PRECISION   FACTOR
      PARAMETER          ( FACTOR = 0.95D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            NOCONV
      INTEGER            I, ICA, IEXC, IRA, J, K, L, M
```

```
      DOUBLE PRECISION   C, CA, F, G, R, RA, S, SFMAX1, SFMAX2, SFMIN1,
     $                   SFMIN2
      COMPLEX*16         CDUM
*     ..
*     .. External Functions ..
      LOGICAL            DISNAN, LSAME
      INTEGER            IZAMAX
      DOUBLE PRECISION   DLAMCH
      EXTERNAL           DISNAN, LSAME, IZAMAX, DLAMCH
*     ..
*     .. External Subroutines ..
      EXTERNAL           XERBLA, ZDSCAL, ZSWAP
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, DBLE, DIMAG, MAX, MIN
*     ..
*     .. Statement Functions ..
      DOUBLE PRECISION   CABS1
*     ..
*     .. Statement Function definitions ..
      CABS1( CDUM ) = ABS( DBLE( CDUM ) ) + ABS( DIMAG( CDUM ) )
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters
*
      INFO = 0
      IF( .NOT.LSAME( JOB, 'N' ) .AND. .NOT.LSAME( JOB, 'P' ) .AND.
     $    .NOT.LSAME( JOB, 'S' ) .AND. .NOT.LSAME( JOB, 'B' ) ) THEN
         INFO = -1
      ELSE IF( N.LT.0 ) THEN
         INFO = -2
      ELSE IF( LDA.LT.MAX( 1, N ) ) THEN
         INFO = -4
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'ZGEBAL', -INFO )
         RETURN
      END IF
*
      K = 1
      L = N
*
      IF( N.EQ.0 )
     $   GO TO 210
*
      IF( LSAME( JOB, 'N' ) ) THEN
         DO 10 I = 1, N
            SCALE( I ) = ONE
   10    CONTINUE
```

```
         GO TO 210
      END IF
*
      IF( LSAME( JOB, 'S' ) )
     $   GO TO 120
*
*     Permutation to isolate eigenvalues if possible
*
      GO TO 50
*
*     Row and column exchange.
*
   20 CONTINUE
      SCALE( M ) = J
      IF( J.EQ.M )
     $   GO TO 30
*
      CALL ZSWAP( L, A( 1, J ), 1, A( 1, M ), 1 )
      CALL ZSWAP( N-K+1, A( J, K ), LDA, A( M, K ), LDA )
*
   30 CONTINUE
      GO TO ( 40, 80 )IEXC
*
*     Search for rows isolating an eigenvalue and push them down.
*
   40 CONTINUE
      IF( L.EQ.1 )
     $   GO TO 210
      L = L - 1
*
   50 CONTINUE
      DO 70 J = L, 1, -1
*
         DO 60 I = 1, L
            IF( I.EQ.J )
     $         GO TO 60
            IF( DBLE( A( J, I ) ).NE.ZERO .OR. DIMAG( A( J, I ) ).NE.
     $          ZERO )GO TO 70
   60    CONTINUE
*
         M = L
         IEXC = 1
         GO TO 20
   70 CONTINUE
*
      GO TO 90
*
*     Search for columns isolating an eigenvalue and push them left.
*
   80 CONTINUE
```

```
      K = K + 1
*
   90 CONTINUE
      DO 110 J = K, L
*
         DO 100 I = K, L
            IF( I.EQ.J )
     $         GO TO 100
            IF( DBLE( A( I, J ) ).NE.ZERO .OR. DIMAG( A( I, J ) ).NE.
     $          ZERO )GO TO 110
  100    CONTINUE
*
         M = K
         IEXC = 2
         GO TO 20
  110 CONTINUE
*
  120 CONTINUE
      DO 130 I = K, L
         SCALE( I ) = ONE
  130 CONTINUE
*
      IF( LSAME( JOB, 'P' ) )
     $   GO TO 210
*
*     Balance the submatrix in rows K to L.
*
*     Iterative loop for norm reduction
*
      SFMIN1 = DLAMCH( 'S' ) / DLAMCH( 'P' )
      SFMAX1 = ONE / SFMIN1
      SFMIN2 = SFMIN1*SCLFAC
      SFMAX2 = ONE / SFMIN2
  140 CONTINUE
      NOCONV = .FALSE.
*
      DO 200 I = K, L
         C = ZERO
         R = ZERO
*
         DO 150 J = K, L
            IF( J.EQ.I )
     $         GO TO 150
            C = C + CABS1( A( J, I ) )
            R = R + CABS1( A( I, J ) )
  150    CONTINUE
         ICA = IZAMAX( L, A( 1, I ), 1 )
         CA = ABS( A( ICA, I ) )
         IRA = IZAMAX( N-K+1, A( I, K ), LDA )
         RA = ABS( A( I, IRA+K-1 ) )
```

```
*
*        Guard against zero C or R due to underflow.
*
         IF( C.EQ.ZERO .OR. R.EQ.ZERO )
     $      GO TO 200
         G = R / SCLFAC
         F = ONE
         S = C + R
  160    CONTINUE
         IF( C.GE.G .OR. MAX( F, C, CA ).GE.SFMAX2 .OR.
     $       MIN( R, G, RA ).LE.SFMIN2 )GO TO 170
            IF( DISNAN( C+F+CA+R+G+RA ) ) THEN
*
*           Exit if NaN to avoid infinite loop
*
            INFO = -3
            CALL XERBLA( 'ZGEBAL', -INFO )
            RETURN
         END IF
         F = F*SCLFAC
         C = C*SCLFAC
         CA = CA*SCLFAC
         R = R / SCLFAC
         G = G / SCLFAC
         RA = RA / SCLFAC
         GO TO 160
*
  170    CONTINUE
         G = C / SCLFAC
  180    CONTINUE
         IF( G.LT.R .OR. MAX( R, RA ).GE.SFMAX2 .OR.
     $       MIN( F, C, G, CA ).LE.SFMIN2 )GO TO 190
         F = F / SCLFAC
         C = C / SCLFAC
         G = G / SCLFAC
         CA = CA / SCLFAC
         R = R*SCLFAC
         RA = RA*SCLFAC
         GO TO 180
*
*        Now balance.
*
  190    CONTINUE
         IF( ( C+R ).GE.FACTOR*S )
     $      GO TO 200
         IF( F.LT.ONE .AND. SCALE( I ).LT.ONE ) THEN
            IF( F*SCALE( I ).LE.SFMIN1 )
     $         GO TO 200
         END IF
         IF( F.GT.ONE .AND. SCALE( I ).GT.ONE ) THEN
```

```
            IF( SCALE( I ).GE.SFMAX1 / F )
     $         GO TO 200
         END IF
         G = ONE / F
         SCALE( I ) = SCALE( I )*F
         NOCONV = .TRUE.
*
         CALL ZDSCAL( N-K+1, G, A( I, K ), LDA )
         CALL ZDSCAL( L, F, A( 1, I ), 1 )
*
  200 CONTINUE
*
      IF( NOCONV )
     $   GO TO 140
*
  210 CONTINUE
      ILO = K
      IHI = L
*
      RETURN
*
*     End of ZGEBAL
*
      END
```

———-

— LAPACK zgebal —

```
(let* ((zero 0.0d0) (one 1.0d0) (sclfac 2.0d0) (factor 0.95d0))
 (declare (type (double-float 0.0d0 0.0d0) zero)
  (type (double-float 1.0d0 1.0d0) one)
  (type (double-float 2.0d0 2.0d0) sclfac)
  (type (double-float 0.95d0 0.95d0) factor)
  (ignorable zero one sclfac factor))
 (defun zgebal (job n a lda ilo ihi scale info)
  (declare (type (simple-array character (*)) job)
   (type (f2cl-lib:integer4) info ihi ilo lda n)
   (type (array f2cl-lib:complex16 (*)) a)
   (type (array double-float (*)) scale))
  (f2cl-lib:with-multi-array-data
      ((scale double-float scale-%data%
        scale-%offset%)
       (a f2cl-lib:complex16 a-%data% a-%offset%)
       (job character job-%data% job-%offset%))
       (labels
        ((cabs1 (cdum)
           (+ (abs (f2cl-lib:dble cdum)) (abs (f2cl-lib:dimag cdum)))))
```

```
(declare
 (ftype (function (f2cl-lib:complex16)
         (values double-float &rest t)) cabs1))
(prog
 ((cdum #C(0.0d0 0.0d0)) (c 0.0d0) (ca 0.0d0) (f 0.0d0)
         (g 0.0d0) (r 0.0d0)
  (ra 0.0d0) (s 0.0d0) (sfmax1 0.0d0) (sfmax2 0.0d0) (sfmin1 0.0d0)
  (sfmin2 0.0d0) (i 0) (ica 0) (iexc 0) (ira 0) (j 0) (k 0) (l 0) (m 0)
  (noconv nil))
 (declare (type (f2cl-lib:complex16) cdum)
  (type (double-float) sfmin2 sfmin1 sfmax2 sfmax1 s ra r g f ca c)
  (type (f2cl-lib:integer4) m l k j ira iexc ica i)
  (type f2cl-lib:logical noconv))
 (setf info 0)
 (cond
  ((and
    (not
     (multiple-value-bind (ret-val var-0 var-1) (lsame job "N")
      (declare (ignore var-1)) (when var-0 (setf job var-0)) ret-val))
    (not
     (multiple-value-bind (ret-val var-0 var-1) (lsame job "P")
      (declare (ignore var-1)) (when var-0 (setf job var-0)) ret-val))
    (not
     (multiple-value-bind (ret-val var-0 var-1) (lsame job "S")
      (declare (ignore var-1)) (when var-0 (setf job var-0)) ret-val))
    (not
     (multiple-value-bind (ret-val var-0 var-1) (lsame job "B")
      (declare (ignore var-1)) (when var-0 (setf job var-0)) ret-val)))
   (setf info -1))
  ((< n 0) (setf info -2))
  ((< lda (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 n)))
   (setf info -4)))
 (cond ((/= info 0)
   (xerbla "ZGEBAL" (f2cl-lib:int-sub info))
   (go end_label)))
 (setf k 1) (setf l n) (if (= n 0) (go label210))
 (cond
  ((multiple-value-bind (ret-val var-0 var-1) (lsame job "N")
    (declare (ignore var-1)) (when var-0 (setf job var-0)) ret-val)
   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          ((> i n) nil)
           (tagbody
                (setf (f2cl-lib:fref scale-%data% (i) ((1 *))
                  scale-%offset%) one)
                label10))
   (go label210)))
 (if
  (multiple-value-bind (ret-val var-0 var-1) (lsame job "S")
   (declare (ignore var-1)) (when var-0 (setf job var-0)) ret-val)
  (go label120))
```

```
(go label50) label20
(setf (f2cl-lib:fref scale-%data% (m) ((1 *)) scale-%offset%)
 (coerce (the f2cl-lib:integer4 j) 'double-float))
(if (= j m) (go label30))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
 (zswap l
  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
    (1 j) ((1 lda) (1 *))
   a-%offset%)
  1
  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
    (1 m) ((1 lda) (1 *))
   a-%offset%)
  1)
 (declare (ignore var-1 var-2 var-3 var-4))
 (when var-0 (setf l var-0)))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
 (zswap (f2cl-lib:int-add (f2cl-lib:int-sub n k) 1)
  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
    (j k) ((1 lda) (1 *))
   a-%offset%)
  lda
  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
     (m k) ((1 lda) (1 *))
   a-%offset%)
  lda)
 (declare (ignore var-0 var-1 var-3)) (when var-2 (setf lda var-2))
 (when var-4 (setf lda var-4)))
label30 (f2cl-lib:computed-goto (label40 label80) iexc) label40
(if (= l 1) (go label210)) (setf l (f2cl-lib:int-sub l 1)) label50
(f2cl-lib:fdo (j l (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
       ((> j 1) nil)
        (tagbody
           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i l) nil)
         (tagbody
             (if (= i j) (go label60))
             (if
              (or
               (/=
                (f2cl-lib:dble
                 (f2cl-lib:fref a-%data% (j i) ((1 lda) (1 *))
                   a-%offset%))
                zero)
               (/=
                (f2cl-lib:dimag
                 (f2cl-lib:fref a-%data% (j i) ((1 lda) (1 *))
                   a-%offset%))
                zero))
              (go label70))
```

```
            label60))
           (setf m l) (setf iexc 1) (go label20) label70))
(go label90) label80 (setf k (f2cl-lib:int-add k 1)) label90
(f2cl-lib:fdo (j k (f2cl-lib:int-add j 1))
       ((> j l) nil)
        (tagbody
           (f2cl-lib:fdo (i k (f2cl-lib:int-add i 1))
        ((> i l) nil)
         (tagbody
             (if (= i j) (go label100))
             (if
              (or
               (/=
                (f2cl-lib:dble
                 (f2cl-lib:fref a-%data% (i j) ((1 lda) (1 *))
                    a-%offset%))
                zero)
               (/=
                (f2cl-lib:dimag
                 (f2cl-lib:fref a-%data% (i j) ((1 lda) (1 *))
                   a-%offset%))
                zero))
              (go label110))
             label100))
           (setf m k) (setf iexc 2) (go label20) label110))
label120
(f2cl-lib:fdo (i k (f2cl-lib:int-add i 1))
       ((> i l) nil)
        (tagbody
           (setf (f2cl-lib:fref scale-%data% (i) ((1 *))
             scale-%offset%) one) label130)
        )
(if
 (multiple-value-bind (ret-val var-0 var-1) (lsame job "P")
  (declare (ignore var-1)) (when var-0 (setf job var-0)) ret-val)
 (go label210))
(setf sfmin1 (/ (dlamch "S") (dlamch "P")))
(setf sfmax1 (/ one sfmin1))
(setf sfmin2 (* sfmin1 sclfac)) (setf sfmax2 (/ one sfmin2)) label140
(setf noconv f2cl-lib:%false%)
(f2cl-lib:fdo (i k (f2cl-lib:int-add i 1))
       ((> i l) nil)
        (tagbody (setf c zero)
           (setf r zero)
           (f2cl-lib:fdo (j k (f2cl-lib:int-add j 1))
        ((> j l) nil)
         (tagbody
             (if (= j i) (go label150))
             (setf c
              (+ c
```

```
    (cabs1
     (f2cl-lib:fref a-%data% (j i) ((1 lda) (1 *))
      a-%offset%))))
  (setf r
   (+ r
    (cabs1
     (f2cl-lib:fref a-%data% (i j) ((1 lda) (1 *))
      a-%offset%))))
  label150))
(setf ica
 (multiple-value-bind (ret-val var-0 var-1 var-2)
  (izamax l
   (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
     (1 i) ((1 lda) (1 *))
    a-%offset%)
   1)
  (declare (ignore var-1 var-2))
  (when var-0 (setf l var-0)) ret-val))
(setf ca
 (abs
  (f2cl-lib:fref a-%data% (ica i) ((1 lda) (1 *))
   a-%offset%)))
(setf ira
 (multiple-value-bind (ret-val var-0 var-1 var-2)
  (izamax (f2cl-lib:int-add (f2cl-lib:int-sub n k) 1)
   (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
    (i k) ((1 lda) (1 *))
    a-%offset%)
   lda)
  (declare (ignore var-0 var-1))
(when var-2 (setf lda var-2)) ret-val))
(setf ra
 (abs
  (f2cl-lib:fref a-%data%
   (i (f2cl-lib:int-sub (f2cl-lib:int-add ira k) 1))
   ((1 lda) (1 *)) a-%offset%)))
(if (or (= c zero) (= r zero)) (go label200))
(setf g (/ r sclfac))
(setf f one) (setf s (+ c r)) label160
(if (or (>= c g)
        (>= (max f c ca) sfmax2)
        (<= (min r g ra) sfmin2))
 (go label170))
(cond
 ((disnan (+ c f ca r g ra)) (setf info -3)
  (xerbla "ZGEBAL" (f2cl-lib:int-sub info))
  (go end_label)))
(setf f (* f sclfac))
(setf c (* c sclfac))
(setf ca (* ca sclfac))
```

```
                    (setf r (/ r sclfac))
                    (setf g (/ g sclfac))
                    (setf ra (/ ra sclfac))
                    (go label160) label170 (setf g (/ c sclfac)) label180
                    (if (or (< g r)
                            (>= (max r ra) sfmax2)
                            (<= (min f c g ca) sfmin2))
                     (go label190))
                    (setf f (/ f sclfac))
                    (setf c (/ c sclfac))
                    (setf g (/ g sclfac))
                    (setf ca (/ ca sclfac))
                    (setf r (* r sclfac))
                    (setf ra (* ra sclfac))
                    (go label180)
 label190
                    (if (>= (+ c r) (* factor s)) (go label200))
                    (cond
                     ((and (< f one) (< (f2cl-lib:fref scale (i) ((1 *))) one))
                      (if
                       (<= (* f
                              (f2cl-lib:fref scale-%data% (i) ((1 *))
                                scale-%offset%)) sfmin1)
                       (go label200))))
                    (cond
                     ((and (> f one) (> (f2cl-lib:fref scale (i) ((1 *))) one))
                      (if
                       (>= (f2cl-lib:fref scale-%data% (i) ((1 *))
                            scale-%offset%) (/ sfmax1 f))
                       (go label200))))
                    (setf g (/ one f))
                    (setf (f2cl-lib:fref scale-%data% (i) ((1 *))
                            scale-%offset%)
                     (* (f2cl-lib:fref scale-%data% (i) ((1 *))
                         scale-%offset%) f))
                    (setf noconv f2cl-lib:%true%)
                    (multiple-value-bind (var-0 var-1 var-2 var-3)
                     (zdscal (f2cl-lib:int-add (f2cl-lib:int-sub n k) 1) g
                      (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
                       (i k) ((1 lda) (1 *))
                       a-%offset%)
                      lda)
                     (declare (ignore var-0 var-2)) (when var-1 (setf g var-1))
                     (when var-3 (setf lda var-3)))
                    (multiple-value-bind (var-0 var-1 var-2 var-3)
                     (zdscal l f
                      (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
                       (1 i) ((1 lda) (1 *))
                       a-%offset%)
                      1)
```

```
                (declare (ignore var-2 var-3)) (when var-0 (setf l var-0))
                (when var-1 (setf f var-1)))
               label200))
        (if noconv (go label140)) label210
          (setf ilo k) (setf ihi l) (go end_label)
        end_label (return (values job nil nil lda ilo ihi nil info)))))))
```

———-

6.102 zgeev LAPACK

— **zgeev.input** —

```
)set break resume
)sys rm -f zgeev.output
)spool zgeev.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zgeev.help** —

```
=======================================================================
zgeev examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================


ZGEEV computes the eigenvalues and, optionally, the left and/or right
eigenvectors for GE matrices

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZGEEV( JOBVL, JOBVR, N, A, LDA, W, VL, LDVL, VR, LDVR,
```

```
                     WORK, LWORK, RWORK, INFO )

      .. Scalar Arguments ..
      CHARACTER          JOBVL, JOBVR
      INTEGER            INFO, LDA, LDVL, LDVR, LWORK, N
      ..
      .. Array Arguments ..
      DOUBLE PRECISION   RWORK( * )
      COMPLEX*16         A( LDA, * ), VL( LDVL, * ), VR( LDVR, * ),
     $                   W( * ), WORK( * )
      ..


Purpose:
=============

 ZGEEV computes for an N-by-N complex nonsymmetric matrix A, the
 eigenvalues and, optionally, the left and/or right eigenvectors.

 The right eigenvector v(j) of A satisfies
                  A * v(j) = lambda(j) * v(j)
  where lambda(j) is its eigenvalue.
 The left eigenvector u(j) of A satisfies
             u(j)**H * A = lambda(j) * u(j)**H
  where u(j)**H denotes the conjugate transpose of u(j).

The computed eigenvectors are normalized to have Euclidean norm
equal to 1 and largest component real.

Arguments:
==========

 [in] JOBVL

         JOBVL is CHARACTER*1
         = 'N': left eigenvectors of A are not computed;
         = 'V': left eigenvectors of are computed.

 [in] JOBVR

         JOBVR is CHARACTER*1
         = 'N': right eigenvectors of A are not computed;
         = 'V': right eigenvectors of A are computed.

 [in] N

         N is INTEGER
         The order of the matrix A. N >= 0.

 [in,out] A
```

```
          A is COMPLEX*16 array, dimension (LDA,N)
          On entry, the N-by-N matrix A.
          On exit, A has been overwritten.

  [in] LDA

          LDA is INTEGER
          The leading dimension of the array A.  LDA >= max(1,N).

  [out] W

          W is COMPLEX*16 array, dimension (N)
          W contains the computed eigenvalues.

  [out] VL

          VL is COMPLEX*16 array, dimension (LDVL,N)
          If JOBVL = 'V', the left eigenvectors u(j) are stored one
          after another in the columns of VL, in the same order
          as their eigenvalues.
          If JOBVL = 'N', VL is not referenced.
          u(j) = VL(:,j), the j-th column of VL.

  [in] LDVL

          LDVL is INTEGER
          The leading dimension of the array VL.  LDVL >= 1; if
          JOBVL = 'V', LDVL >= N.

  [out] VR

          VR is COMPLEX*16 array, dimension (LDVR,N)
          If JOBVR = 'V', the right eigenvectors v(j) are stored one
          after another in the columns of VR, in the same order
          as their eigenvalues.
          If JOBVR = 'N', VR is not referenced.
          v(j) = VR(:,j), the j-th column of VR.

  [in] LDVR

          LDVR is INTEGER
          The leading dimension of the array VR.  LDVR >= 1; if
          JOBVR = 'V', LDVR >= N.

  [out] WORK

          WORK is COMPLEX*16 array, dimension (MAX(1,LWORK))
          On exit, if INFO = 0, WORK(1) returns the optimal LWORK.
```

```
  [in] LWORK

          LWORK is INTEGER
          The dimension of the array WORK.  LWORK >= max(1,2*N).
          For good performance, LWORK must generally be larger.

          If LWORK = -1, then a workspace query is assumed; the routine
          only calculates the optimal size of the WORK array, returns
          this value as the first entry of the WORK array, and no error
          message related to LWORK is issued by XERBLA.

  [out] RWORK

          RWORK is DOUBLE PRECISION array, dimension (2*N)

  [out] INFO

          INFO is INTEGER
          = 0:  successful exit
          < 0:  if INFO = -i, the i-th argument had an illegal value.
          > 0:  if INFO = i, the QR algorithm failed to compute all the
                eigenvalues, and no eigenvectors have been computed;
                elements and i+1:N of W contain eigenvalues which have
                converged.


Authors:
========

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  Univ. of California Berkeley
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  NAG Ltd.

November 2011
```

———-

— **zgeev.f** —

```
*  =====================================================================
      SUBROUTINE ZGEEV( JOBVL, JOBVR, N, A, LDA, W, VL, LDVL, VR, LDVR,
     $                  WORK, LWORK, RWORK, INFO )
*
*  -- LAPACK driver routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
```

```
*
*     .. Scalar Arguments ..
      CHARACTER          JOBVL, JOBVR
      INTEGER            INFO, LDA, LDVL, LDVR, LWORK, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   RWORK( * )
      COMPLEX*16         A( LDA, * ), VL( LDVL, * ), VR( LDVR, * ),
     $                   W( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D0, ONE = 1.0D0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            LQUERY, SCALEA, WANTVL, WANTVR
      CHARACTER          SIDE
      INTEGER            HSWORK, I, IBAL, IERR, IHI, ILO, IRWORK, ITAU,
     $                   IWRK, K, MAXWRK, MINWRK, NOUT
      DOUBLE PRECISION   ANRM, BIGNUM, CSCALE, EPS, SCL, SMLNUM
      COMPLEX*16         TMP
*     ..
*     .. Local Arrays ..
      LOGICAL            SELECT( 1 )
      DOUBLE PRECISION   DUM( 1 )
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLABAD, XERBLA, ZDSCAL, ZGEBAK, ZGEBAL, ZGEHRD,
     $                   ZHSEQR, ZLACPY, ZLASCL, ZSCAL, ZTREVC, ZUNGHR
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      INTEGER            IDAMAX, ILAENV
      DOUBLE PRECISION   DLAMCH, DZNRM2, ZLANGE
      EXTERNAL           LSAME, IDAMAX, ILAENV, DLAMCH, DZNRM2, ZLANGE
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          DBLE, DCMPLX, DCONJG, DIMAG, MAX, SQRT
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      LQUERY = ( LWORK.EQ.-1 )
      WANTVL = LSAME( JOBVL, 'V' )
      WANTVR = LSAME( JOBVR, 'V' )
```

```
      IF( ( .NOT.WANTVL ) .AND. ( .NOT.LSAME( JOBVL, 'N' ) ) ) THEN
         INFO = -1
      ELSE IF( ( .NOT.WANTVR ) .AND. ( .NOT.LSAME( JOBVR, 'N' ) ) ) THEN
         INFO = -2
      ELSE IF( N.LT.0 ) THEN
         INFO = -3
      ELSE IF( LDA.LT.MAX( 1, N ) ) THEN
         INFO = -5
      ELSE IF( LDVL.LT.1 .OR. ( WANTVL .AND. LDVL.LT.N ) ) THEN
         INFO = -8
      ELSE IF( LDVR.LT.1 .OR. ( WANTVR .AND. LDVR.LT.N ) ) THEN
         INFO = -10
      END IF
*
*     Compute workspace
*      (Note: Comments in the code beginning "Workspace:" describe the
*       minimal amount of workspace needed at that point in the code,
*       as well as the preferred amount for good performance.
*       CWorkspace refers to complex workspace, and RWorkspace to real
*       workspace. NB refers to the optimal block size for the
*       immediately following subroutine, as returned by ILAENV.
*       HSWORK refers to the workspace preferred by ZHSEQR, as
*       calculated below. HSWORK is computed assuming ILO=1 and IHI=N,
*       the worst case.)
*
      IF( INFO.EQ.0 ) THEN
         IF( N.EQ.0 ) THEN
            MINWRK = 1
            MAXWRK = 1
         ELSE
            MAXWRK = N + N*ILAENV( 1, 'ZGEHRD', ' ', N, 1, N, 0 )
            MINWRK = 2*N
            IF( WANTVL ) THEN
               MAXWRK = MAX( MAXWRK, N + ( N - 1 )*ILAENV( 1, 'ZUNGHR',
     $                     ' ', N, 1, N, -1 ) )
               CALL ZHSEQR( 'S', 'V', N, 1, N, A, LDA, W, VL, LDVL,
     $              WORK, -1, INFO )
            ELSE IF( WANTVR ) THEN
               MAXWRK = MAX( MAXWRK, N + ( N - 1 )*ILAENV( 1, 'ZUNGHR',
     $                     ' ', N, 1, N, -1 ) )
               CALL ZHSEQR( 'S', 'V', N, 1, N, A, LDA, W, VR, LDVR,
     $              WORK, -1, INFO )
            ELSE
               CALL ZHSEQR( 'E', 'N', N, 1, N, A, LDA, W, VR, LDVR,
     $              WORK, -1, INFO )
            END IF
            HSWORK = WORK( 1 )
            MAXWRK = MAX( MAXWRK, HSWORK, MINWRK )
         END IF
         WORK( 1 ) = MAXWRK
```

```
*
         IF( LWORK.LT.MINWRK .AND. .NOT.LQUERY ) THEN
            INFO = -12
         END IF
      END IF
*
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'ZGEEV ', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( N.EQ.0 )
     $   RETURN
*
*     Get machine constants
*
      EPS = DLAMCH( 'P' )
      SMLNUM = DLAMCH( 'S' )
      BIGNUM = ONE / SMLNUM
      CALL DLABAD( SMLNUM, BIGNUM )
      SMLNUM = SQRT( SMLNUM ) / EPS
      BIGNUM = ONE / SMLNUM
*
*     Scale A if max element outside range [SMLNUM,BIGNUM]
*
      ANRM = ZLANGE( 'M', N, N, A, LDA, DUM )
      SCALEA = .FALSE.
      IF( ANRM.GT.ZERO .AND. ANRM.LT.SMLNUM ) THEN
         SCALEA = .TRUE.
         CSCALE = SMLNUM
      ELSE IF( ANRM.GT.BIGNUM ) THEN
         SCALEA = .TRUE.
         CSCALE = BIGNUM
      END IF
      IF( SCALEA )
     $   CALL ZLASCL( 'G', 0, 0, ANRM, CSCALE, N, N, A, LDA, IERR )
*
*     Balance the matrix
*     (CWorkspace: none)
*     (RWorkspace: need N)
*
      IBAL = 1
      CALL ZGEBAL( 'B', N, A, LDA, ILO, IHI, RWORK( IBAL ), IERR )
*
*     Reduce to upper Hessenberg form
*     (CWorkspace: need 2*N, prefer N+N*NB)
```

```
*     (RWorkspace: none)
*
      ITAU = 1
      IWRK = ITAU + N
      CALL ZGEHRD( N, ILO, IHI, A, LDA, WORK( ITAU ), WORK( IWRK ),
     $             LWORK-IWRK+1, IERR )
*
      IF( WANTVL ) THEN
*
*        Want left eigenvectors
*        Copy Householder vectors to VL
*
         SIDE = 'L'
         CALL ZLACPY( 'L', N, N, A, LDA, VL, LDVL )
*
*        Generate unitary matrix in VL
*        (CWorkspace: need 2*N-1, prefer N+(N-1)*NB)
*        (RWorkspace: none)
*
         CALL ZUNGHR( N, ILO, IHI, VL, LDVL, WORK( ITAU ), WORK( IWRK ),
     $                LWORK-IWRK+1, IERR )
*
*        Perform QR iteration, accumulating Schur vectors in VL
*        (CWorkspace: need 1, prefer HSWORK (see comments) )
*        (RWorkspace: none)
*
         IWRK = ITAU
         CALL ZHSEQR( 'S', 'V', N, ILO, IHI, A, LDA, W, VL, LDVL,
     $                WORK( IWRK ), LWORK-IWRK+1, INFO )
*
         IF( WANTVR ) THEN
*
*           Want left and right eigenvectors
*           Copy Schur vectors to VR
*
            SIDE = 'B'
            CALL ZLACPY( 'F', N, N, VL, LDVL, VR, LDVR )
         END IF
*
      ELSE IF( WANTVR ) THEN
*
*        Want right eigenvectors
*        Copy Householder vectors to VR
*
         SIDE = 'R'
         CALL ZLACPY( 'L', N, N, A, LDA, VR, LDVR )
*
*        Generate unitary matrix in VR
*        (CWorkspace: need 2*N-1, prefer N+(N-1)*NB)
*        (RWorkspace: none)
```

```
*
         CALL ZUNGHR( N, ILO, IHI, VR, LDVR, WORK( ITAU ), WORK( IWRK ),
     $                LWORK-IWRK+1, IERR )
*
*        Perform QR iteration, accumulating Schur vectors in VR
*        (CWorkspace: need 1, prefer HSWORK (see comments) )
*        (RWorkspace: none)
*
         IWRK = ITAU
         CALL ZHSEQR( 'S', 'V', N, ILO, IHI, A, LDA, W, VR, LDVR,
     $                WORK( IWRK ), LWORK-IWRK+1, INFO )
*
      ELSE
*
*        Compute eigenvalues only
*        (CWorkspace: need 1, prefer HSWORK (see comments) )
*        (RWorkspace: none)
*
         IWRK = ITAU
         CALL ZHSEQR( 'E', 'N', N, ILO, IHI, A, LDA, W, VR, LDVR,
     $                WORK( IWRK ), LWORK-IWRK+1, INFO )
      END IF
*
*     If INFO > 0 from ZHSEQR, then quit
*
      IF( INFO.GT.0 )
     $   GO TO 50
*
      IF( WANTVL .OR. WANTVR ) THEN
*
*        Compute left and/or right eigenvectors
*        (CWorkspace: need 2*N)
*        (RWorkspace: need 2*N)
*
         IRWORK = IBAL + N
         CALL ZTREVC( SIDE, 'B', SELECT, N, A, LDA, VL, LDVL, VR, LDVR,
     $                N, NOUT, WORK( IWRK ), RWORK( IRWORK ), IERR )
      END IF
*
      IF( WANTVL ) THEN
*
*        Undo balancing of left eigenvectors
*        (CWorkspace: none)
*        (RWorkspace: need N)
*
         CALL ZGEBAK( 'B', 'L', N, ILO, IHI, RWORK( IBAL ), N, VL, LDVL,
     $                IERR )
*
*        Normalize left eigenvectors and make largest component real
*
```

```
         DO 20 I = 1, N
            SCL = ONE / DZNRM2( N, VL( 1, I ), 1 )
            CALL ZDSCAL( N, SCL, VL( 1, I ), 1 )
            DO 10 K = 1, N
               RWORK( IRWORK+K-1 ) = DBLE( VL( K, I ) )**2 +
     $                               DIMAG( VL( K, I ) )**2
   10       CONTINUE
            K = IDAMAX( N, RWORK( IRWORK ), 1 )
            TMP = DCONJG( VL( K, I ) ) / SQRT( RWORK( IRWORK+K-1 ) )
            CALL ZSCAL( N, TMP, VL( 1, I ), 1 )
            VL( K, I ) = DCMPLX( DBLE( VL( K, I ) ), ZERO )
   20    CONTINUE
      END IF
*
      IF( WANTVR ) THEN
*
*        Undo balancing of right eigenvectors
*        (CWorkspace: none)
*        (RWorkspace: need N)
*
         CALL ZGEBAK( 'B', 'R', N, ILO, IHI, RWORK( IBAL ), N, VR, LDVR,
     $                IERR )
*
*        Normalize right eigenvectors and make largest component real
*
         DO 40 I = 1, N
            SCL = ONE / DZNRM2( N, VR( 1, I ), 1 )
            CALL ZDSCAL( N, SCL, VR( 1, I ), 1 )
            DO 30 K = 1, N
               RWORK( IRWORK+K-1 ) = DBLE( VR( K, I ) )**2 +
     $                               DIMAG( VR( K, I ) )**2
   30       CONTINUE
            K = IDAMAX( N, RWORK( IRWORK ), 1 )
            TMP = DCONJG( VR( K, I ) ) / SQRT( RWORK( IRWORK+K-1 ) )
            CALL ZSCAL( N, TMP, VR( 1, I ), 1 )
            VR( K, I ) = DCMPLX( DBLE( VR( K, I ) ), ZERO )
   40    CONTINUE
      END IF
*
*     Undo scaling if necessary
*
   50 CONTINUE
      IF( SCALEA ) THEN
         CALL ZLASCL( 'G', 0, 0, CSCALE, ANRM, N-INFO, 1, W( INFO+1 ),
     $                MAX( N-INFO, 1 ), IERR )
         IF( INFO.GT.0 ) THEN
            CALL ZLASCL( 'G', 0, 0, CSCALE, ANRM, ILO-1, 1, W, N, IERR )
         END IF
      END IF
*
```

```
      WORK( 1 ) = MAXWRK
      RETURN
*
*     End of ZGEEV
*
      END
```

———-

— LAPACK zgeev —

```
(let* ((zero 0.0d0) (one 1.0d0))
 (declare (type (double-float 0.0d0 0.0d0) zero)
  (type (double-float 1.0d0 1.0d0) one) (ignorable zero one))
 (defun zgeev (jobvl jobvr n a lda w vl ldvl vr ldvr work lwork rwork info)
  (declare (type (simple-array character (*)) jobvr jobvl)
   (type (f2cl-lib:integer4) info lwork ldvr ldvl lda n)
   (type (array f2cl-lib:complex16 (*)) work vr vl w a)
   (type (array double-float (*)) rwork))
  (f2cl-lib:with-multi-array-data
      ((rwork double-float rwork-%data%
        rwork-%offset%)
       (a f2cl-lib:complex16 a-%data% a-%offset%)
       (w f2cl-lib:complex16 w-%data% w-%offset%)
       (vl f2cl-lib:complex16 vl-%data% vl-%offset%)
       (vr f2cl-lib:complex16 vr-%data% vr-%offset%)
       (work f2cl-lib:complex16 work-%data% work-%offset%)
       (jobvl character jobvl-%data% jobvl-%offset%)
       (jobvr character jobvr-%data% jobvr-%offset%))
       (prog
        ((dum (make-array 1 :element-type 'double-float))
         (select (make-array 1 :element-type 't))
          (tmp #C(0.0d0 0.0d0)) (anrm 0.0d0)
         (bignum 0.0d0) (cscale 0.0d0) (eps 0.0d0) (scl 0.0d0) (smlnum 0.0d0)
         (hswork 0) (i 0) (ibal 0) (ierr 0) (ihi 0) (ilo 0) (irwork 0) (itau 0)
         (iwrk 0) (k 0) (maxwrk 0) (minwrk 0) (nout 0)
         (side (make-array '(1) :element-type 'character
                                :initial-element #\space))
         (lquery nil) (scalea nil) (wantvl nil) (wantvr nil))
        (declare (type (array double-float (1)) dum)
         (type (array f2cl-lib:logical (1)) select)
         (type (f2cl-lib:complex16) tmp)
         (type (double-float) smlnum scl eps cscale bignum anrm)
         (type (f2cl-lib:integer4) nout minwrk maxwrk k iwrk itau irwork
                 ilo ihi ierr
          ibal i hswork)
         (type (simple-array character (1)) side)
         (type f2cl-lib:logical wantvr wantvl scalea lquery))
```

```
(setf info 0) (setf lquery (coerce (= lwork -1) 'f2cl-lib:logical))
(setf wantvl
 (multiple-value-bind (ret-val var-0 var-1) (lsame jobvl "V")
  (declare (ignore var-1)) (when var-0 (setf jobvl var-0)) ret-val))
(setf wantvr
 (multiple-value-bind (ret-val var-0 var-1) (lsame jobvr "V")
  (declare (ignore var-1)) (when var-0 (setf jobvr var-0)) ret-val))
(cond
 ((and (not wantvl)
   (not
    (multiple-value-bind (ret-val var-0 var-1) (lsame jobvl "N")
     (declare (ignore var-1))
        (when var-0 (setf jobvl var-0)) ret-val)))
  (setf info -1))
 ((and (not wantvr)
   (not
    (multiple-value-bind (ret-val var-0 var-1) (lsame jobvr "N")
     (declare (ignore var-1))
       (when var-0 (setf jobvr var-0)) ret-val)))
  (setf info -2))
 ((< n 0) (setf info -3))
 ((< lda (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 n)))
  (setf info -5))
 ((or (< ldvl 1) (and wantvl (< ldvl n))) (setf info -8))
 ((or (< ldvr 1) (and wantvr (< ldvr n))) (setf info -10)))
(cond
 ((= info 0)
  (cond ((= n 0) (setf minwrk 1) (setf maxwrk 1))
   (t
    (setf maxwrk
     (f2cl-lib:int-add n
      (f2cl-lib:int-mul n
       (multiple-value-bind
        (ret-val var-0 var-1 var-2 var-3 var-4 var-5 var-6)
        (ilaenv 1 "ZGEHRD" " " n 1 n 0)
        (declare (ignore var-0 var-1 var-2 var-4 var-6))
        (when var-3 (setf n var-3))
        (when var-5 (setf n var-5)) ret-val))))
    (setf minwrk (f2cl-lib:int-mul 2 n))
    (cond
     (wantvl
      (setf maxwrk
       (max (the f2cl-lib:integer4 maxwrk)
        (the f2cl-lib:integer4
         (f2cl-lib:int-add n
          (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
           (multiple-value-bind
            (ret-val var-0 var-1 var-2 var-3 var-4 var-5 var-6)
            (ilaenv 1 "ZUNGHR" " " n 1 n -1)
            (declare (ignore var-0 var-1 var-2 var-4 var-6))
```

```
          (when var-3 (setf n var-3)) (when var-5 (setf n var-5))
          ret-val))))))
   (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
     var-10
     var-11 var-12)
    (zhseqr "S" "V" n 1 n a lda w vl ldvl work -1 info)
    (declare (ignore var-0 var-1 var-3 var-5 var-7 var-8 var-10
              var-11))
    (when var-2 (setf n var-2)) (when var-4 (setf n var-4))
    (when var-6 (setf lda var-6)) (when var-9 (setf ldvl var-9))
    (when var-12 (setf info var-12))))
  (wantvr
   (setf maxwrk
    (max (the f2cl-lib:integer4 maxwrk)
     (the f2cl-lib:integer4
      (f2cl-lib:int-add n
       (f2cl-lib:int-mul (f2cl-lib:int-sub n 1)
        (multiple-value-bind
         (ret-val var-0 var-1 var-2 var-3 var-4 var-5 var-6)
         (ilaenv 1 "ZUNGHR" " " n 1 n -1)
         (declare (ignore var-0 var-1 var-2 var-4 var-6))
         (when var-3 (setf n var-3)) (when var-5 (setf n var-5))
         ret-val))))))
   (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
     var-10
     var-11 var-12)
    (zhseqr "S" "V" n 1 n a lda w vr ldvr work -1 info)
    (declare (ignore var-0 var-1 var-3 var-5 var-7 var-8 var-10
              var-11))
    (when var-2 (setf n var-2)) (when var-4 (setf n var-4))
    (when var-6 (setf lda var-6)) (when var-9 (setf ldvr var-9))
    (when var-12 (setf info var-12))))
  (t
   (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
     var-10
     var-11 var-12)
    (zhseqr "E" "N" n 1 n a lda w vr ldvr work -1 info)
    (declare (ignore var-0 var-1 var-3 var-5 var-7 var-8 var-10
              var-11))
    (when var-2 (setf n var-2)) (when var-4 (setf n var-4))
    (when var-6 (setf lda var-6)) (when var-9 (setf ldvr var-9))
    (when var-12 (setf info var-12)))))
 (setf hswork
  (f2cl-lib:int (f2cl-lib:fref work-%data% (1) ((1 *))
   work-%offset%)))
 (setf maxwrk
  (max (the f2cl-lib:integer4 maxwrk) (the f2cl-lib:integer4 hswork)
```

```
      (the f2cl-lib:integer4 minwrk)))))
  (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
   (coerce maxwrk 'f2cl-lib:complex16))
  (cond ((and (< lwork minwrk) (not lquery)) (setf info -12)))))
(cond ((/= info 0)
   (xerbla "ZGEEV " (f2cl-lib:int-sub info))
   (go end_label))
 (lquery (go end_label)))
(if (= n 0) (go end_label))
(setf eps (dlamch "P")) (setf smlnum (dlamch "S"))
(setf bignum (/ one smlnum))
(multiple-value-bind (var-0 var-1)
 (dlabad smlnum bignum) (declare (ignore))
 (when var-0 (setf smlnum var-0)) (when var-1 (setf bignum var-1)))
(setf smlnum (/ (f2cl-lib:fsqrt smlnum) eps))
(setf bignum (/ one smlnum))
(setf anrm
 (multiple-value-bind (ret-val var-0 var-1 var-2 var-3 var-4 var-5)
  (zlange "M" n n a lda dum) (declare (ignore var-0 var-3 var-5))
  (when var-1 (setf n var-1)) (when var-2 (setf n var-2))
  (when var-4 (setf lda var-4)) ret-val))
(setf scalea f2cl-lib:%false%)
(cond
 ((and (> anrm zero) (< anrm smlnum)) (setf scalea f2cl-lib:%true%)
  (setf cscale smlnum))
 ((> anrm bignum) (setf scalea f2cl-lib:%true%) (setf cscale bignum)))
(if scalea
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
  (zlascl "G" 0 0 anrm cscale n n a lda ierr)
  (declare (ignore var-0 var-1 var-2 var-7))
  (when var-3 (setf anrm var-3))
  (when var-4 (setf cscale var-4)) (when var-5 (setf n var-5))
  (when var-6 (setf n var-6)) (when var-8 (setf lda var-8))
  (when var-9 (setf ierr var-9))))
(setf ibal 1)
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
 (zgebal "B" n a lda ilo ihi
  (f2cl-lib:array-slice rwork-%data% double-float (ibal) ((1 *))
   rwork-%offset%)
  ierr)
 (declare (ignore var-0 var-1 var-2 var-6))
 (setf lda var-3) (setf ilo var-4)
 (setf ihi var-5) (setf ierr var-7))
(setf itau 1) (setf iwrk (f2cl-lib:int-add itau n))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
 (zgehrd n ilo ihi a lda
  (f2cl-lib:array-slice work-%data% f2cl-lib:complex16 (itau) ((1 *))
   work-%offset%)
```

```
  (f2cl-lib:array-slice work-%data% f2cl-lib:complex16 (iwrk) ((1 *))
   work-%offset%)
  (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) ierr)
 (declare (ignore var-3 var-5 var-6 var-7)) (when var-0 (setf n var-0))
 (when var-1 (setf ilo var-1)) (when var-2 (setf ihi var-2))
 (when var-4 (setf lda var-4)) (when var-8 (setf ierr var-8)))
(cond
 (wantvl (f2cl-lib:f2cl-set-string side "L" (string 1))
  (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
   (zlacpy "L" n n a lda vl ldvl) (declare (ignore var-0 var-3 var-5))
   (when var-1 (setf n var-1)) (when var-2 (setf n var-2))
   (when var-4 (setf lda var-4)) (when var-6 (setf ldvl var-6)))
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
   (zunghr n ilo ihi vl ldvl
    (f2cl-lib:array-slice work-%data% f2cl-lib:complex16 (itau) ((1 *))
     work-%offset%)
    (f2cl-lib:array-slice work-%data% f2cl-lib:complex16 (iwrk) ((1 *))
     work-%offset%)
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) ierr)
   (declare (ignore var-3 var-5 var-6 var-7))
   (when var-0 (setf n var-0))
   (when var-1 (setf ilo var-1)) (when var-2 (setf ihi var-2))
   (when var-4 (setf ldvl var-4)) (when var-8 (setf ierr var-8)))
  (setf iwrk itau)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
    var-10 var-11
    var-12)
   (zhseqr "S" "V" n ilo ihi a lda w vl ldvl
    (f2cl-lib:array-slice work-%data% f2cl-lib:complex16 (iwrk) ((1 *))
     work-%offset%)
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) info)
   (declare (ignore var-0 var-1 var-5 var-7 var-8 var-10 var-11))
   (when var-2 (setf n var-2)) (when var-3 (setf ilo var-3))
   (when var-4 (setf ihi var-4)) (when var-6 (setf lda var-6))
   (when var-9 (setf ldvl var-9)) (when var-12 (setf info var-12)))
  (cond
   (wantvr (f2cl-lib:f2cl-set-string side "B" (string 1))
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
     (zlacpy "F" n n vl ldvl vr ldvr)
     (declare (ignore var-0 var-3 var-5))
     (when var-1 (setf n var-1)) (when var-2 (setf n var-2))
     (when var-4 (setf ldvl var-4)) (when var-6 (setf ldvr var-6))))))
 (wantvr (f2cl-lib:f2cl-set-string side "R" (string 1))
  (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
   (zlacpy "L" n n a lda vr ldvr) (declare (ignore var-0 var-3 var-5))
   (when var-1 (setf n var-1)) (when var-2 (setf n var-2))
   (when var-4 (setf lda var-4)) (when var-6 (setf ldvr var-6)))
  (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6
```

```
   var-7 var-8)
   (zunghr n ilo ihi vr ldvr
    (f2cl-lib:array-slice work-%data% f2cl-lib:complex16 (itau) ((1 *))
     work-%offset%)
    (f2cl-lib:array-slice work-%data% f2cl-lib:complex16 (iwrk) ((1 *))
     work-%offset%)
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) ierr)
   (declare (ignore var-3 var-5 var-6 var-7))
   (when var-0 (setf n var-0))
   (when var-1 (setf ilo var-1)) (when var-2 (setf ihi var-2))
   (when var-4 (setf ldvr var-4)) (when var-8 (setf ierr var-8)))
  (setf iwrk itau)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
    var-10 var-11
    var-12)
   (zhseqr "S" "V" n ilo ihi a lda w vr ldvr
    (f2cl-lib:array-slice work-%data% f2cl-lib:complex16 (iwrk) ((1 *))
     work-%offset%)
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) info)
   (declare (ignore var-0 var-1 var-5 var-7 var-8 var-10 var-11))
   (when var-2 (setf n var-2)) (when var-3 (setf ilo var-3))
   (when var-4 (setf ihi var-4)) (when var-6 (setf lda var-6))
   (when var-9 (setf ldvr var-9)) (when var-12 (setf info var-12))))
 (t (setf iwrk itau)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
    var-10 var-11
    var-12)
   (zhseqr "E" "N" n ilo ihi a lda w vr ldvr
    (f2cl-lib:array-slice work-%data% f2cl-lib:complex16 (iwrk) ((1 *))
     work-%offset%)
    (f2cl-lib:int-add (f2cl-lib:int-sub lwork iwrk) 1) info)
   (declare (ignore var-0 var-1 var-5 var-7 var-8 var-10 var-11))
   (when var-2 (setf n var-2)) (when var-3 (setf ilo var-3))
   (when var-4 (setf ihi var-4)) (when var-6 (setf lda var-6))
   (when var-9 (setf ldvr var-9)) (when var-12 (setf info var-12)))))
(if (> info 0) (go label50))
(cond
 ((or wantvl wantvr) (setf irwork (f2cl-lib:int-add ibal n))
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
    var-9 var-10 var-11
    var-12 var-13 var-14)
   (ztrevc side "B" select n a lda vl ldvl vr ldvr n nout
    (f2cl-lib:array-slice work-%data% f2cl-lib:complex16 (iwrk) ((1 *))
     work-%offset%)
    (f2cl-lib:array-slice rwork-%data% double-float (irwork) ((1 *))
     rwork-%offset%)
    ierr)
```

```
   (declare (ignore var-1 var-2 var-4 var-6 var-8 var-12 var-13))
   (when var-0 (setf side var-0)) (when var-3 (setf n var-3))
   (when var-5 (setf lda var-5)) (when var-7 (setf ldvl var-7))
   (when var-9 (setf ldvr var-9)) (when var-10 (setf n var-10))
   (when var-11 (setf nout var-11)) (when var-14 (setf ierr var-14)))))
(cond
 (wantvl
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
   (zgebak "B" "L" n ilo ihi
    (f2cl-lib:array-slice rwork-%data% double-float (ibal) ((1 *))
     rwork-%offset%)
    n vl ldvl ierr)
   (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-7))
   (setf n var-6)
   (setf ldvl var-8) (setf ierr var-9))
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i n) nil)
         (tagbody
             (setf scl
              (/ one
               (multiple-value-bind (ret-val var-0 var-1 var-2)
                (dznrm2 n
                 (f2cl-lib:array-slice vl-%data% f2cl-lib:complex16 (1 i)
                  ((1 ldvl) (1 *)) vl-%offset%)
                 1)
                (declare (ignore var-1 var-2))
                (when var-0 (setf n var-0)) ret-val)))
             (multiple-value-bind (var-0 var-1 var-2 var-3)
              (zdscal n scl
               (f2cl-lib:array-slice vl-%data% f2cl-lib:complex16
                (1 i) ((1 ldvl) (1 *))
                vl-%offset%)
               1)
              (declare (ignore var-2 var-3))
              (when var-0 (setf n var-0))
              (when var-1 (setf scl var-1)))
             (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
          ((> k n) nil)
           (tagbody
                (setf
                 (f2cl-lib:fref rwork-%data%
                  ((f2cl-lib:int-sub (f2cl-lib:int-add irwork k) 1))
                   ((1 *))
                  rwork-%offset%)
                 (+
                  (expt
                   (f2cl-lib:dble
                    (f2cl-lib:fref vl-%data% (k i) ((1 ldvl) (1 *))
                     vl-%offset%))
```

```
                          2)
                         (expt
                          (f2cl-lib:dimag
                           (f2cl-lib:fref vl-%data% (k i) ((1 ldvl) (1 *))
                           vl-%offset%))
                          2)))
                   label10))
                 (setf k
                  (multiple-value-bind (ret-val var-0 var-1 var-2)
                   (idamax n
                    (f2cl-lib:array-slice rwork-%data% double-float
                     (irwork) ((1 *))
                     rwork-%offset%)
                    1)
                   (declare (ignore var-1 var-2))
                   (when var-0 (setf n var-0)) ret-val))
                 (setf tmp
                  (coerce
                   (/
                    (f2cl-lib:dconjg
                     (f2cl-lib:fref vl-%data% (k i) ((1 ldvl) (1 *))
                      vl-%offset%))
                    (f2cl-lib:fsqrt
                     (f2cl-lib:fref rwork-%data%
                      ((f2cl-lib:int-sub (f2cl-lib:int-add irwork k) 1))
                        ((1 *))
                      rwork-%offset%)))
                   'f2cl-lib:complex16))
                 (multiple-value-bind (var-0 var-1 var-2 var-3)
                  (zscal n tmp
                   (f2cl-lib:array-slice vl-%data% f2cl-lib:complex16
                    (1 i) ((1 ldvl) (1 *))
                    vl-%offset%)
                   1)
                  (declare (ignore var-2 var-3))
                  (when var-0 (setf n var-0))
                  (when var-1 (setf tmp var-1)))
                 (setf (f2cl-lib:fref vl-%data% (k i) ((1 ldvl) (1 *))
                        vl-%offset%)
                  (f2cl-lib:dcmplx
                   (f2cl-lib:dble
                    (f2cl-lib:fref vl-%data% (k i) ((1 ldvl) (1 *))
                    vl-%offset%))
                   zero))
                 label20))))
(cond
 (wantvr
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
   (zgebak "B" "R" n ilo ihi
```

```
  (f2cl-lib:array-slice rwork-%data% double-float (ibal) ((1 *))
   rwork-%offset%)
  n vr ldvr ierr)
 (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-7))
 (setf n var-6)
 (setf ldvr var-8) (setf ierr var-9))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
       ((> i n) nil)
        (tagbody
            (setf scl
             (/ one
              (multiple-value-bind (ret-val var-0 var-1 var-2)
               (dznrm2 n
                (f2cl-lib:array-slice vr-%data% f2cl-lib:complex16
                 (1 i)
                 ((1 ldvr) (1 *)) vr-%offset%)
                1)
               (declare (ignore var-1 var-2))
               (when var-0 (setf n var-0)) ret-val)))
            (multiple-value-bind (var-0 var-1 var-2 var-3)
             (zdscal n scl
              (f2cl-lib:array-slice vr-%data% f2cl-lib:complex16
               (1 i) ((1 ldvr) (1 *))
               vr-%offset%)
              1)
             (declare (ignore var-2 var-3))
             (when var-0 (setf n var-0))
             (when var-1 (setf scl var-1)))
            (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
           ((> k n) nil)
            (tagbody
                 (setf
                  (f2cl-lib:fref rwork-%data%
                   ((f2cl-lib:int-sub (f2cl-lib:int-add irwork k) 1))
                   ((1 *))
                   rwork-%offset%)
                  (+
                   (expt
                    (f2cl-lib:dble
                     (f2cl-lib:fref vr-%data% (k i) ((1 ldvr) (1 *))
                      vr-%offset%))
                    2)
                   (expt
                    (f2cl-lib:dimag
                     (f2cl-lib:fref vr-%data% (k i) ((1 ldvr) (1 *))
                      vr-%offset%))
                    2)))
                 label30))
            (setf k
             (multiple-value-bind (ret-val var-0 var-1 var-2)
```

```
                    (idamax n
                     (f2cl-lib:array-slice rwork-%data% double-float
                      (irwork) ((1 *))
                      rwork-%offset%)
                     1)
                    (declare (ignore var-1 var-2))
                    (when var-0 (setf n var-0)) ret-val))
                  (setf tmp
                   (coerce
                    (/
                     (f2cl-lib:dconjg
                      (f2cl-lib:fref vr-%data% (k i) ((1 ldvr) (1 *))
                        vr-%offset%))
                     (f2cl-lib:fsqrt
                      (f2cl-lib:fref rwork-%data%
                       ((f2cl-lib:int-sub (f2cl-lib:int-add irwork k) 1))
                       ((1 *))
                       rwork-%offset%)))
                    'f2cl-lib:complex16))
                  (multiple-value-bind (var-0 var-1 var-2 var-3)
                   (zscal n tmp
                    (f2cl-lib:array-slice vr-%data% f2cl-lib:complex16
                     (1 i) ((1 ldvr) (1 *))
                     vr-%offset%)
                    1)
                   (declare (ignore var-2 var-3)) (when var-0 (setf n var-0))
                   (when var-1 (setf tmp var-1)))
                  (setf (f2cl-lib:fref vr-%data% (k i) ((1 ldvr) (1 *))
                     vr-%offset%)
                   (f2cl-lib:dcmplx
                    (f2cl-lib:dble
                     (f2cl-lib:fref vr-%data% (k i) ((1 ldvr) (1 *))
                        vr-%offset%))
                    zero))
                  label40))))
          label50
          (cond
           (scalea
            (multiple-value-bind
             (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
             (zlascl "G" 0 0 cscale anrm (f2cl-lib:int-sub n info) 1
              (f2cl-lib:array-slice w-%data% f2cl-lib:complex16
               ((+ info 1)) ((1 *))
               w-%offset%)
              (max (the f2cl-lib:integer4 (f2cl-lib:int-sub n info))
               (the f2cl-lib:integer4 1))
              ierr)
             (declare (ignore var-0 var-1 var-2 var-5 var-6 var-7 var-8))
             (when var-3 (setf cscale var-3)) (when var-4 (setf anrm var-4))
             (when var-9 (setf ierr var-9)))
```

```
          (cond
           ((> info 0)
            (multiple-value-bind
             (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9)
             (zlascl "G" 0 0 cscale anrm (f2cl-lib:int-sub ilo 1) 1 w n ierr)
             (declare (ignore var-0 var-1 var-2 var-5 var-6 var-7))
             (when var-3 (setf cscale var-3)) (when var-4 (setf anrm var-4))
             (when var-8 (setf n var-8)) (when var-9 (setf ierr var-9)))))))
        (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
         (coerce maxwrk 'f2cl-lib:complex16))
        (go end_label) end_label
        (return
         (values jobvl jobvr n nil lda nil nil ldvl nil
                 ldvr nil nil nil info)))
      )))
```

———-

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— **zgehd2.input** —

```
)set break resume
)sys rm -f zgehd2.output
)spool zgehd2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zgehd2.help** —

```
=====================================================================
zgehd2 examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/
```

```
Definition:
===========

      SUBROUTINE ZGEHD2( N, ILO, IHI, A, LDA, TAU, WORK, INFO )

      .. Scalar Arguments ..
      INTEGER            IHI, ILO, INFO, LDA, N
      ..
      .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), TAU( * ), WORK( * )
      ..


Purpose:
=============

 ZGEHD2 reduces a complex general matrix A to upper Hessenberg form H
 by a unitary similarity transformation:  Q**H * A * Q = H .

Arguments:
==========

 [in] N

        N is INTEGER
        The order of the matrix A.  N >= 0.

 [in] ILO

        ILO is INTEGER

 [in] IHI

        IHI is INTEGER

        It is assumed that A is already upper triangular in rows
        and columns 1:ILO-1 and IHI+1:N. ILO and IHI are normally
        set by a previous call to ZGEBAL; otherwise they should be
        set to 1 and N respectively. See Further Details.
        1 <= ILO <= IHI <= max(1,N).

 [in,out] A

        A is COMPLEX*16 array, dimension (LDA,N)
        On entry, the n by n general matrix to be reduced.
        On exit, the upper triangle and the first subdiagonal of A
        are overwritten with the upper Hessenberg matrix H, and the
        elements below the first subdiagonal, with the array TAU,
        represent the unitary matrix Q as a product of elementary
```

```
          reflectors. See Further Details.

  [in] LDA

          LDA is INTEGER
          The leading dimension of the array A.  LDA >= max(1,N).

  [out] TAU

          TAU is COMPLEX*16 array, dimension (N-1)
          The scalar factors of the elementary reflectors (see Further
          Details).

  [out] WORK

          WORK is COMPLEX*16 array, dimension (N)

  [out] INFO

          INFO is INTEGER
          = 0:  successful exit
          < 0:  if INFO = -i, the i-th argument had an illegal value.

Authors:
========

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  NAG Ltd.

November 2011

Further Details:
====================

 The matrix Q is represented as a product of (ihi-ilo) elementary
 reflectors

    Q = H(ilo) H(ilo+1) . . . H(ihi-1).

 Each H(i) has the form

    H(i) = I - tau * v * v**H

 where tau is a complex scalar, and v is a complex vector with
 v(1:i) = 0, v(i+1) = 1 and v(ihi+1:n) = 0; v(i+2:ihi) is stored on
 exit in A(i+2:ihi,i), and tau in TAU(i).

 The contents of A are illustrated by the following example, with
```

```
  n = 7, ilo = 2 and ihi = 6:

  on entry,                       on exit,

  ( a   a   a   a   a   a   a )   (  a   a   h   h   h   h   a )
  (     a   a   a   a   a   a )   (      a   h   h   h   h   a )
  (     a   a   a   a   a   a )   (      h   h   h   h   h   h )
  (     a   a   a   a   a   a )   (      v2  h   h   h   h   h )
  (     a   a   a   a   a   a )   (      v2  v3  h   h   h   h )
  (     a   a   a   a   a   a )   (      v2  v3  v4  h   h   h )
  (                     a   )   (                      a   )

  where a denotes an element of the original matrix A, h denotes a
  modified element of the upper Hessenberg matrix H, and vi denotes an
  element of the vector defining H(i).
```

———-

— zgehd2.f —

```
*  =====================================================================
      SUBROUTINE ZGEHD2( N, ILO, IHI, A, LDA, TAU, WORK, INFO )
*
*  -- LAPACK computational routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      INTEGER            IHI, ILO, INFO, LDA, N
*     ..
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      COMPLEX*16         ONE
      PARAMETER          ( ONE = ( 1.0D+0, 0.0D+0 ) )
*     ..
*     .. Local Scalars ..
      INTEGER            I
      COMPLEX*16         ALPHA
*     ..
*     .. External Subroutines ..
      EXTERNAL           XERBLA, ZLARF, ZLARFG
*     ..
```

```
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG, MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters
*
      INFO = 0
      IF( N.LT.0 ) THEN
         INFO = -1
      ELSE IF( ILO.LT.1 .OR. ILO.GT.MAX( 1, N ) ) THEN
         INFO = -2
      ELSE IF( IHI.LT.MIN( ILO, N ) .OR. IHI.GT.N ) THEN
         INFO = -3
      ELSE IF( LDA.LT.MAX( 1, N ) ) THEN
         INFO = -5
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'ZGEHD2', -INFO )
         RETURN
      END IF
*
      DO 10 I = ILO, IHI - 1
*
*        Compute elementary reflector H(i) to annihilate A(i+2:ihi,i)
*
         ALPHA = A( I+1, I )
         CALL ZLARFG( IHI-I, ALPHA, A( MIN( I+2, N ), I ), 1, TAU( I ) )
         A( I+1, I ) = ONE
*
*        Apply H(i) to A(1:ihi,i+1:ihi) from the right
*
         CALL ZLARF( 'Right', IHI, IHI-I, A( I+1, I ), 1, TAU( I ),
     $               A( 1, I+1 ), LDA, WORK )
*
*        Apply H(i)**H to A(i+1:ihi,i+1:n) from the left
*
         CALL ZLARF( 'Left', IHI-I, N-I, A( I+1, I ), 1,
     $               DCONJG( TAU( I ) ), A( I+1, I+1 ), LDA, WORK )
*
         A( I+1, I ) = ALPHA
   10 CONTINUE
*
      RETURN
*
*     End of ZGEHD2
*
      END
```

———-

— LAPACK zgehd2 —

```
(let* ((one (coerce (f2cl-lib:cmplx 1.0d0 0.0d0) 'f2cl-lib:complex16)))
 (declare (type (f2cl-lib:complex16) one) (ignorable one))
 (defun zgehd2 (n ilo ihi a lda tau work info)
  (declare (type (f2cl-lib:integer4) info lda ihi ilo n)
   (type (array f2cl-lib:complex16 (*)) work tau a))
  (f2cl-lib:with-multi-array-data
      ((a f2cl-lib:complex16 a-%data% a-%offset%)
       (tau f2cl-lib:complex16 tau-%data% tau-%offset%)
       (work f2cl-lib:complex16 work-%data% work-%offset%))
       (prog
        ((alpha #C(0.0d0 0.0d0)) (i 0) (dconjg$ 0.0))
        (declare (type (f2cl-lib:complex16) alpha) (type (f2cl-lib:integer4) i)
         (type (single-float) dconjg$))
        (setf info 0)
        (cond ((< n 0) (setf info -1))
         ((or (< ilo 1)
           (> ilo (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 n))))
          (setf info -2))
         ((or (< ihi (min (the f2cl-lib:integer4 ilo)
                          (the f2cl-lib:integer4 n)))
           (> ihi n))
          (setf info -3))
         ((< lda (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 n)))
          (setf info -5)))
        (cond ((/= info 0)
          (xerbla "ZGEHD2" (f2cl-lib:int-sub info))
          (go end_label)))
        (f2cl-lib:fdo (i ilo (f2cl-lib:int-add i 1))
               ((> i
                   (f2cl-lib:int-add ihi (f2cl-lib:int-sub 1)))
                nil)
                (tagbody
                  (setf alpha
                   (f2cl-lib:fref a-%data% ((f2cl-lib:int-add i 1) i)
                    ((1 lda) (1 *))
                    a-%offset%))
                  (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
                   (zlarfg (f2cl-lib:int-sub ihi i) alpha
                    (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
                     ((min (f2cl-lib:int-add i 2) n) i) ((1 lda) (1 *))
                             a-%offset%)
                    1
                    (f2cl-lib:array-slice tau-%data% f2cl-lib:complex16
                     (i) ((1 *))
                     tau-%offset%))
```

```
                 (declare (ignore var-0 var-2 var-3 var-4))
                 (when var-1 (setf alpha var-1)))
                (setf
                 (f2cl-lib:fref a-%data% ((f2cl-lib:int-add i 1) i)
                  ((1 lda) (1 *))
                  a-%offset%)
                 one)
                (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5
                 var-6 var-7 var-8)
                 (zlarf "Right" ihi (f2cl-lib:int-sub ihi i)
                  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
                   ((+ i 1) i)
                   ((1 lda) (1 *)) a-%offset%)
                  1
                  (f2cl-lib:array-slice tau-%data% f2cl-lib:complex16
                   (i) ((1 *))
                   tau-%offset%)
                  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
                   (1 (f2cl-lib:int-add i 1)) ((1 lda) (1 *)) a-%offset%)
                  lda work)
                 (declare (ignore var-0 var-2 var-3 var-4 var-5 var-6 var-8))
                 (when var-1 (setf ihi var-1)) (when var-7 (setf lda var-7)))
                (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5
                  var-6 var-7 var-8)
                 (zlarf "Left" (f2cl-lib:int-sub ihi i)
                  (f2cl-lib:int-sub n i)
                  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
                   ((+ i 1) i)
                   ((1 lda) (1 *)) a-%offset%)
                  1 (f2cl-lib:dconjg (f2cl-lib:fref tau-%data% (i) ((1 *))
                     tau-%offset%))
                  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
                   ((+ i 1) (f2cl-lib:int-add i 1)) ((1 lda) (1 *))
                    a-%offset%)
                  lda work)
                 (declare (ignore var-0 var-1 var-2 var-3 var-4 var-5
                           var-6 var-8))
                 (when var-7 (setf lda var-7)))
                (setf
                 (f2cl-lib:fref a-%data% ((f2cl-lib:int-add i 1) i)
                  ((1 lda) (1 *))
                  a-%offset%)
                 alpha)
                label10))
       (go end_label)
 end_label
       (return (values nil nil ihi nil lda nil nil info)))
      )))
```

6.104 zgehrd LAPACK

— zgehrd.input —

```
)set break resume
)sys rm -f zgehrd.output
)spool zgehrd.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— zgehrd.help —

```
=====================================================================
zgehrd examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZGEHRD( N, ILO, IHI, A, LDA, TAU, WORK, LWORK, INFO )

       .. Scalar Arguments ..
       INTEGER            IHI, ILO, INFO, LDA, LWORK, N
       ..
       .. Array Arguments ..
       COMPLEX*16         A( LDA, * ), TAU( * ), WORK( * )
       ..


 Purpose:
 =============

  ZGEHRD reduces a complex general matrix A to upper Hessenberg form H by
  an unitary similarity transformation:  Q**H * A * Q = H .
```

```
 Arguments:
 ==========

  [in] N

          N is INTEGER
          The order of the matrix A.  N >= 0.

  [in] ILO

          ILO is INTEGER

  [in] IHI

          IHI is INTEGER

          It is assumed that A is already upper triangular in rows
          and columns 1:ILO-1 and IHI+1:N. ILO and IHI are normally
          set by a previous call to ZGEBAL; otherwise they should be
          set to 1 and N respectively. See Further Details.
          1 <= ILO <= IHI <= N, if N > 0; ILO=1 and IHI=0, if N=0.

  [in,out] A

          A is COMPLEX*16 array, dimension (LDA,N)
          On entry, the N-by-N general matrix to be reduced.
          On exit, the upper triangle and the first subdiagonal of A
          are overwritten with the upper Hessenberg matrix H, and the
          elements below the first subdiagonal, with the array TAU,
          represent the unitary matrix Q as a product of elementary
          reflectors. See Further Details.

  [in] LDA

          LDA is INTEGER
          The leading dimension of the array A.  LDA >= max(1,N).

  [out] TAU

          TAU is COMPLEX*16 array, dimension (N-1)
          The scalar factors of the elementary reflectors (see Further
          Details). Elements 1:ILO-1 and IHI:N-1 of TAU are set to
          zero.

  [out] WORK

          WORK is COMPLEX*16 array, dimension (LWORK)
          On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

  [in] LWORK
```

```
          LWORK is INTEGER
          The length of the array WORK.  LWORK >= max(1,N).
          For optimum performance LWORK >= N*NB, where NB is the
          optimal blocksize.

          If LWORK = -1, then a workspace query is assumed; the routine
          only calculates the optimal size of the WORK array, returns
          this value as the first entry of the WORK array, and no error
          message related to LWORK is issued by XERBLA.

 [out] INFO

          INFO is INTEGER
          = 0:  successful exit
          < 0:  if INFO = -i, the i-th argument had an illegal value.

Authors:
========

 Univ. of Tennessee
 Univ. of California Berkeley
 Univ. of Colorado Denver
 NAG Ltd.

November 2011

Further Details:
=====================

 The matrix Q is represented as a product of (ihi-ilo) elementary
 reflectors

    Q = H(ilo) H(ilo+1) . . . H(ihi-1).

 Each H(i) has the form

    H(i) = I - tau * v * v**H

 where tau is a complex scalar, and v is a complex vector with
 v(1:i) = 0, v(i+1) = 1 and v(ihi+1:n) = 0; v(i+2:ihi) is stored on
 exit in A(i+2:ihi,i), and tau in TAU(i).

 The contents of A are illustrated by the following example, with
 n = 7, ilo = 2 and ihi = 6:

 on entry,                        on exit,

 ( a   a   a   a   a   a   a )    ( a   a   h   h   h   h   a )
 (     a   a   a   a   a   a )    (     a   h   h   h   h   a )
```

```
(     a   a   a   a   a   a )    (      h   h   h   h   h   h )
(     a   a   a   a   a   a )    (      v2  h   h   h   h   h )
(     a   a   a   a   a   a )    (      v2  v3  h   h   h   h )
(     a   a   a   a   a   a )    (      v2  v3  v4  h   h   h )
(                     a )    (                      a )
```

where a denotes an element of the original matrix A, h denotes a modified element of the upper Hessenberg matrix H, and vi denotes an element of the vector defining H(i).

This file is a slight modification of LAPACK-3.0's DGEHRD subroutine incorporating improvements proposed by Quintana-Orti and Van de Geijn (2006). (See DLAHR2.)

———-

— zgehrd.f —

```
*  =====================================================================
      SUBROUTINE ZGEHRD( N, ILO, IHI, A, LDA, TAU, WORK, LWORK, INFO )
*
*  -- LAPACK computational routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      INTEGER            IHI, ILO, INFO, LDA, LWORK, N
*     ..
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      INTEGER            NBMAX, LDT
      PARAMETER          ( NBMAX = 64, LDT = NBMAX+1 )
      COMPLEX*16         ZERO, ONE
      PARAMETER          ( ZERO = ( 0.0D+0, 0.0D+0 ),
     $                     ONE = ( 1.0D+0, 0.0D+0 ) )
*     ..
*     .. Local Scalars ..
      LOGICAL            LQUERY
      INTEGER            I, IB, IINFO, IWS, J, LDWORK, LWKOPT, NB,
     $                   NBMIN, NH, NX
      COMPLEX*16         EI
*     ..
```

```
*     .. Local Arrays ..
      COMPLEX*16        T( LDT, NBMAX )
*     ..
*     .. External Subroutines ..
      EXTERNAL          ZAXPY, ZGEHD2, ZGEMM, ZLAHR2, ZLARFB, ZTRMM,
     $                  XERBLA
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC         MAX, MIN
*     ..
*     .. External Functions ..
      INTEGER           ILAENV
      EXTERNAL          ILAENV
*     ..
*     .. Executable Statements ..
*
*     Test the input parameters
*
      INFO = 0
      NB = MIN( NBMAX, ILAENV( 1, 'ZGEHRD', ' ', N, ILO, IHI, -1 ) )
      LWKOPT = N*NB
      WORK( 1 ) = LWKOPT
      LQUERY = ( LWORK.EQ.-1 )
      IF( N.LT.0 ) THEN
         INFO = -1
      ELSE IF( ILO.LT.1 .OR. ILO.GT.MAX( 1, N ) ) THEN
         INFO = -2
      ELSE IF( IHI.LT.MIN( ILO, N ) .OR. IHI.GT.N ) THEN
         INFO = -3
      ELSE IF( LDA.LT.MAX( 1, N ) ) THEN
         INFO = -5
      ELSE IF( LWORK.LT.MAX( 1, N ) .AND. .NOT.LQUERY ) THEN
         INFO = -8
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'ZGEHRD', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Set elements 1:ILO-1 and IHI:N-1 of TAU to zero
*
      DO 10 I = 1, ILO - 1
         TAU( I ) = ZERO
   10 CONTINUE
      DO 20 I = MAX( 1, IHI ), N - 1
         TAU( I ) = ZERO
   20 CONTINUE
*
```

```
*     Quick return if possible
*
      NH = IHI - ILO + 1
      IF( NH.LE.1 ) THEN
         WORK( 1 ) = 1
         RETURN
      END IF
*
*     Determine the block size
*
      NB = MIN( NBMAX, ILAENV( 1, 'ZGEHRD', ' ', N, ILO, IHI, -1 ) )
      NBMIN = 2
      IWS = 1
      IF( NB.GT.1 .AND. NB.LT.NH ) THEN
*
*        Determine when to cross over from blocked to unblocked code
*        (last block is always handled by unblocked code)
*
         NX = MAX( NB, ILAENV( 3, 'ZGEHRD', ' ', N, ILO, IHI, -1 ) )
         IF( NX.LT.NH ) THEN
*
*           Determine if workspace is large enough for blocked code
*
            IWS = N*NB
            IF( LWORK.LT.IWS ) THEN
*
*              Not enough workspace to use optimal NB:  determine the
*              minimum value of NB, and reduce NB or force use of
*              unblocked code
*
               NBMIN = MAX( 2, ILAENV( 2, 'ZGEHRD', ' ', N, ILO, IHI,
     $                 -1 ) )
               IF( LWORK.GE.N*NBMIN ) THEN
                  NB = LWORK / N
               ELSE
                  NB = 1
               END IF
            END IF
         END IF
      END IF
      LDWORK = N
*
      IF( NB.LT.NBMIN .OR. NB.GE.NH ) THEN
*
*        Use unblocked code below
*
         I = ILO
*
      ELSE
*
```

```
*        Use blocked code
*
         DO 40 I = ILO, IHI - 1 - NX, NB
            IB = MIN( NB, IHI-I )
*
*           Reduce columns i:i+ib-1 to Hessenberg form, returning the
*           matrices V and T of the block reflector H = I - V*T*V**H
*           which performs the reduction, and also the matrix Y = A*V*T
*
            CALL ZLAHR2( IHI, I, IB, A( 1, I ), LDA, TAU( I ), T, LDT,
     $                   WORK, LDWORK )
*
*           Apply the block reflector H to A(1:ihi,i+ib:ihi) from the
*           right, computing  A := A - Y * V**H. V(i+ib,ib-1) must be set
*           to 1
*
            EI = A( I+IB, I+IB-1 )
            A( I+IB, I+IB-1 ) = ONE
            CALL ZGEMM( 'No transpose', 'Conjugate transpose',
     $                  IHI, IHI-I-IB+1,
     $                  IB, -ONE, WORK, LDWORK, A( I+IB, I ), LDA, ONE,
     $                  A( 1, I+IB ), LDA )
            A( I+IB, I+IB-1 ) = EI
*
*           Apply the block reflector H to A(1:i,i+1:i+ib-1) from the
*           right
*
            CALL ZTRMM( 'Right', 'Lower', 'Conjugate transpose',
     $                  'Unit', I, IB-1,
     $                  ONE, A( I+1, I ), LDA, WORK, LDWORK )
            DO 30 J = 0, IB-2
               CALL ZAXPY( I, -ONE, WORK( LDWORK*J+1 ), 1,
     $                     A( 1, I+J+1 ), 1 )
   30       CONTINUE
*
*           Apply the block reflector H to A(i+1:ihi,i+ib:n) from the
*           left
*
            CALL ZLARFB( 'Left', 'Conjugate transpose', 'Forward',
     $                   'Columnwise',
     $                   IHI-I, N-I-IB+1, IB, A( I+1, I ), LDA, T, LDT,
     $                   A( I+1, I+IB ), LDA, WORK, LDWORK )
   40    CONTINUE
      END IF
*
*     Use unblocked code to reduce the rest of the matrix
*
      CALL ZGEHD2( N, I, IHI, A, LDA, TAU, WORK, IINFO )
      WORK( 1 ) = IWS
*
```

```
      RETURN
*
*     End of ZGEHRD
*
      END
```

———-

— LAPACK zgehrd —

```
(let*
 ((nbmax 64) (ldt (+ nbmax 1))
  (zero (coerce (f2cl-lib:cmplx 0.0d0 0.0d0) 'f2cl-lib:complex16))
  (one (coerce (f2cl-lib:cmplx 1.0d0 0.0d0) 'f2cl-lib:complex16)))
 (declare (type (f2cl-lib:integer4 64 64) nbmax) (type (f2cl-lib:integer4) ldt)
  (type (f2cl-lib:complex16) zero) (type (f2cl-lib:complex16) one)
  (ignorable nbmax ldt zero one))
 (defun zgehrd (n ilo ihi a lda tau work lwork info)
  (declare (type (f2cl-lib:integer4) info lwork lda ihi ilo n)
   (type (array f2cl-lib:complex16 (*)) work tau a))
  (f2cl-lib:with-multi-array-data
      ((a f2cl-lib:complex16 a-%data% a-%offset%)
       (tau f2cl-lib:complex16 tau-%data% tau-%offset%)
       (work f2cl-lib:complex16 work-%data% work-%offset%))
       (prog
        ((ei #C(0.0d0 0.0d0)) (i 0) (ib 0) (iinfo 0) (iws 0) (j 0) (ldwork 0)
         (lwkopt 0) (nb 0) (nbmin 0) (nh 0) (nx 0) (lquery nil)
         (t$
          (make-array (the fixnum (reduce #'* (list ldt nbmax))) :element-type
           'f2cl-lib:complex16)))
        (declare (type (f2cl-lib:complex16) ei)
         (type (f2cl-lib:integer4)
            nx nh nbmin nb lwkopt ldwork j iws iinfo ib i)
         (type f2cl-lib:logical lquery)
         (type (array f2cl-lib:complex16 (*)) t$))
        (setf info 0)
        (setf nb
         (min (the f2cl-lib:integer4 nbmax)
          (the f2cl-lib:integer4
           (multiple-value-bind
            (ret-val var-0 var-1 var-2 var-3 var-4 var-5 var-6)
            (ilaenv 1 "ZGEHRD" " " n ilo ihi -1)
            (declare (ignore var-0 var-1 var-2 var-6))
            (when var-3 (setf n var-3))
            (when var-4 (setf ilo var-4))
            (when var-5 (setf ihi var-5)) ret-val))))
        (setf lwkopt (f2cl-lib:int-mul n nb))
        (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
```

```
 (coerce lwkopt 'f2cl-lib:complex16))
(setf lquery (coerce (= lwork -1) 'f2cl-lib:logical))
(cond ((< n 0) (setf info -1))
 ((or (< ilo 1)
   (> ilo (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 n))))
  (setf info -2))
 ((or (< ihi (min (the f2cl-lib:integer4 ilo)
                  (the f2cl-lib:integer4 n)))
   (> ihi n))
  (setf info -3))
 ((< lda (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 n)))
  (setf info -5))
 ((and (< lwork (max (the f2cl-lib:integer4 1)
                     (the f2cl-lib:integer4 n)))
   (not lquery))
  (setf info -8)))
(cond ((/= info 0)
  (xerbla "ZGEHRD" (f2cl-lib:int-sub info))
  (go end_label))
 (lquery (go end_label)))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
       ((> i
          (f2cl-lib:int-add ilo (f2cl-lib:int-sub 1)))
        nil)
        (tagbody
          (setf (f2cl-lib:fref tau-%data% (i) ((1 *))
                 tau-%offset%) zero) label10)
        )
(f2cl-lib:fdo (i (max (the f2cl-lib:integer4 1)
                      (the f2cl-lib:integer4 ihi))
         (f2cl-lib:int-add i 1))
       ((> i (f2cl-lib:int-add n (f2cl-lib:int-sub 1))) nil)
        (tagbody
          (setf (f2cl-lib:fref tau-%data% (i) ((1 *))
                  tau-%offset%) zero) label20)
        )
(setf nh (f2cl-lib:int-add (f2cl-lib:int-sub ihi ilo) 1))
(cond
 ((<= nh 1)
  (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
   (coerce 1 'f2cl-lib:complex16))
  (go end_label)))
(setf nb
 (min (the f2cl-lib:integer4 nbmax)
  (the f2cl-lib:integer4
   (multiple-value-bind (ret-val var-0 var-1 var-2 var-3 var-4
                                 var-5 var-6)
    (ilaenv 1 "ZGEHRD" " " n ilo ihi -1)
    (declare (ignore var-0 var-1 var-2 var-6))
    (when var-3 (setf n var-3))
```

```
    (when var-4 (setf ilo var-4))
    (when var-5 (setf ihi var-5)) ret-val))))
(setf nbmin 2) (setf iws 1)
(cond
 ((and (> nb 1) (< nb nh))
  (setf nx
   (max (the f2cl-lib:integer4 nb)
    (the f2cl-lib:integer4
     (multiple-value-bind (ret-val var-0 var-1 var-2 var-3 var-4
                           var-5 var-6)
      (ilaenv 3 "ZGEHRD" " " n ilo ihi -1)
      (declare (ignore var-0 var-1 var-2 var-6))
      (when var-3 (setf n var-3))
      (when var-4 (setf ilo var-4))
      (when var-5 (setf ihi var-5)) ret-val))))
  (cond
   ((< nx nh) (setf iws (f2cl-lib:int-mul n nb))
    (cond
     ((< lwork iws)
      (setf nbmin
       (max (the f2cl-lib:integer4 2)
        (the f2cl-lib:integer4
         (multiple-value-bind
          (ret-val var-0 var-1 var-2 var-3 var-4 var-5 var-6)
          (ilaenv 2 "ZGEHRD" " " n ilo ihi -1)
          (declare (ignore var-0 var-1 var-2 var-6))
          (when var-3 (setf n var-3)) (when var-4 (setf ilo var-4))
          (when var-5 (setf ihi var-5)) ret-val))))
      (cond
       ((>= lwork (f2cl-lib:int-mul n nbmin))
        (setf nb (the f2cl-lib:integer4 (truncate lwork n))))
       (t (setf nb 1)))))))))
(setf ldwork n)
(cond ((or (< nb nbmin) (>= nb nh)) (setf i ilo))
 (t
  (f2cl-lib:fdo (i ilo (f2cl-lib:int-add i nb))
         ((> i
              (f2cl-lib:int-add ihi
               (f2cl-lib:int-sub 1) (f2cl-lib:int-sub nx)))
             nil)
          (tagbody
              (setf ib
               (min (the f2cl-lib:integer4 nb)
                (the f2cl-lib:integer4 (f2cl-lib:int-sub ihi i))))
              (multiple-value-bind
               (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
                var-8 var-9)
               (zlahr2 ihi i ib
                (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
                 (1 i) ((1 lda) (1 *))
```

```
   a-%offset%)
  lda
  (f2cl-lib:array-slice tau-%data% f2cl-lib:complex16
   (i) ((1 *))
   tau-%offset%)
  t$ ldt work ldwork)
 (declare (ignore var-3 var-5 var-6 var-8))
 (when var-0 (setf ihi var-0))
 (when var-1 (setf i var-1)) (when var-2 (setf ib var-2))
 (when var-4 (setf lda var-4))
 (when var-7 (setf ldt var-7))
 (when var-9 (setf ldwork var-9)))
(setf ei
 (f2cl-lib:fref a-%data%
  ((f2cl-lib:int-add i ib)
   (f2cl-lib:int-sub (f2cl-lib:int-add i ib) 1))
  ((1 lda) (1 *)) a-%offset%))
(setf
 (f2cl-lib:fref a-%data%
  ((f2cl-lib:int-add i ib)
   (f2cl-lib:int-sub (f2cl-lib:int-add i ib) 1))
  ((1 lda) (1 *)) a-%offset%)
 one)
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10 var-11
  var-12)
 (zgemm "No transpose" "Conjugate transpose" ihi
  (f2cl-lib:int-add (f2cl-lib:int-sub ihi i ib) 1)
   ib (- one) work ldwork
  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
   ((+ i ib) i)
   ((1 lda) (1 *)) a-%offset%)
  lda one
  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
   (1 (f2cl-lib:int-add i ib)) ((1 lda) (1 *))
        a-%offset%)
  lda)
 (declare (ignore var-0 var-1 var-3 var-5 var-6
           var-8 var-11))
 (when var-2 (setf ihi var-2))
 (when var-4 (setf ib var-4))
 (when var-7 (setf ldwork var-7))
 (when var-9 (setf lda var-9))
 (when var-10 (setf one var-10))
 (when var-12 (setf lda var-12)))
(setf
 (f2cl-lib:fref a-%data%
  ((f2cl-lib:int-add i ib)
   (f2cl-lib:int-sub (f2cl-lib:int-add i ib) 1))
```

```
      ((1 lda) (1 *)) a-%offset%)
     ei)
    (multiple-value-bind
     (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
      var-8 var-9 var-10)
     (ztrmm "Right" "Lower" "Conjugate transpose" "Unit" i
      (f2cl-lib:int-sub ib 1) one
      (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
       ((+ i 1) i)
       ((1 lda) (1 *)) a-%offset%)
      lda work ldwork)
     (declare (ignore var-0 var-1 var-2 var-3 var-5
               var-7 var-9))
     (when var-4 (setf i var-4))
     (when var-6 (setf one var-6))
     (when var-8 (setf lda var-8))
     (when var-10 (setf ldwork var-10)))
    (f2cl-lib:fdo (j 0 (f2cl-lib:int-add j 1))
((> j
      (f2cl-lib:int-add ib (f2cl-lib:int-sub 2)))
     nil)
 (tagbody
      (multiple-value-bind (var-0 var-1 var-2 var-3 var-4
        var-5)
       (zaxpy i (- one)
        (f2cl-lib:array-slice work-%data% f2cl-lib:complex16
         ((+ (f2cl-lib:int-mul ldwork j) 1)) ((1 *))
           work-%offset%)
        1
        (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
         (1 (f2cl-lib:int-add i j 1)) ((1 lda) (1 *))
          a-%offset%)
        1)
       (declare (ignore var-1 var-2 var-3 var-4 var-5))
       (when var-0 (setf i var-0)))
      label30))
    (multiple-value-bind
     (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
      var-8 var-9 var-10 var-11
      var-12 var-13 var-14)
     (zlarfb "Left" "Conjugate transpose"
             "Forward" "Columnwise"
      (f2cl-lib:int-sub ihi i)
      (f2cl-lib:int-add (f2cl-lib:int-sub n i ib) 1)
      ib
      (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
       ((+ i 1) i)
       ((1 lda) (1 *)) a-%offset%)
      lda t$ ldt
      (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
```

```
                        ((+ i 1) (f2cl-lib:int-add i ib)) ((1 lda) (1 *))
                          a-%offset%)
                         lda work ldwork)
                        (declare
                         (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-7
                           var-9 var-11 var-13))
                        (when var-6 (setf ib var-6))
                        (when var-8 (setf lda var-8))
                        (when var-10 (setf ldt var-10))
                        (when var-12 (setf lda var-12))
                        (when var-14 (setf ldwork var-14)))
                       label40))))
       (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
        (zgehd2 n i ihi a lda tau work iinfo)
        (declare (ignore var-0 var-1 var-3 var-5 var-6)) (setf ihi var-2)
        (setf lda var-4) (setf iinfo var-7))
       (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
        (coerce iws 'f2cl-lib:complex16))
       (go end_label)
  end_label
       (return (values n ilo ihi nil lda nil nil nil info)))
      )))
```

———-

6.105 zhseqr LAPACK

— **zhseqr.input** —

```
)set break resume
)sys rm -f zhseqr.output
)spool zhseqr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zhseqr.help** —

```
==========================================================================
zhseqr examples
==========================================================================
```

```
=====================================================================
Man Page Details
=====================================================================

 Online html documentation available at
           http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZHSEQR( JOB, COMPZ, N, ILO, IHI, H, LDH, W, Z, LDZ,
                          WORK, LWORK, INFO )

       .. Scalar Arguments ..
       INTEGER            IHI, ILO, INFO, LDH, LDZ, LWORK, N
       CHARACTER          COMPZ, JOB
       ..
       .. Array Arguments ..
       COMPLEX*16         H( LDH, * ), W( * ), WORK( * ), Z( LDZ, * )
       ..


 Purpose:
 =============

    ZHSEQR computes the eigenvalues of a Hessenberg matrix H
    and, optionally, the matrices T and Z from the Schur decomposition
    H = Z T Z**H, where T is an upper triangular matrix (the
    Schur form), and Z is the unitary matrix of Schur vectors.

    Optionally Z may be postmultiplied into an input unitary
    matrix Q so that this routine can give the Schur factorization
    of a matrix A which has been reduced to the Hessenberg form H
    by the unitary matrix Q:  A = Q*H*Q**H = (QZ)*H*(QZ)**H.


 Arguments:
 ==========

  [in] JOB

          JOB is CHARACTER*1
           = 'E':  compute eigenvalues only;
           = 'S':  compute eigenvalues and the Schur form T.

  [in] COMPZ

          COMPZ is CHARACTER*1
           = 'N':  no Schur vectors are computed;
```

```
          = 'I':  Z is initialized to the unit matrix and the matrix Z
                  of Schur vectors of H is returned;
          = 'V':  Z must contain an unitary matrix Q on entry, and
                  the product Q*Z is returned.

[in] N

        N is INTEGER
         The order of the matrix H.  N .GE. 0.

[in] ILO

        ILO is INTEGER

[in] IHI

        IHI is INTEGER

         It is assumed that H is already upper triangular in rows
         and columns 1:ILO-1 and IHI+1:N. ILO and IHI are normally
         set by a previous call to ZGEBAL, and then passed to ZGEHRD
         when the matrix output by ZGEBAL is reduced to Hessenberg
         form. Otherwise ILO and IHI should be set to 1 and N
         respectively.  If N.GT.0, then 1.LE.ILO.LE.IHI.LE.N.
         If N = 0, then ILO = 1 and IHI = 0.

[in,out] H

        H is COMPLEX*16 array, dimension (LDH,N)
         On entry, the upper Hessenberg matrix H.
         On exit, if INFO = 0 and JOB = 'S', H contains the upper
         triangular matrix T from the Schur decomposition (the
         Schur form). If INFO = 0 and JOB = 'E', the contents of
         H are unspecified on exit.  (The output value of H when
         INFO.GT.0 is given under the description of INFO below.)

         Unlike earlier versions of ZHSEQR, this subroutine may
         explicitly H(i,j) = 0 for i.GT.j and j = 1, 2, ... ILO-1
         or j = IHI+1, IHI+2, ... N.

[in] LDH

        LDH is INTEGER
         The leading dimension of the array H. LDH .GE. max(1,N).

[out] W

        W is COMPLEX*16 array, dimension (N)
         The computed eigenvalues. If JOB = 'S', the eigenvalues are
         stored in the same order as on the diagonal of the Schur
```

```
          form returned in H, with W(i) = H(i,i).

  [in,out] Z

          Z is COMPLEX*16 array, dimension (LDZ,N)
           If COMPZ = 'N', Z is not referenced.
           If COMPZ = 'I', on entry Z need not be set and on exit,
           if INFO = 0, Z contains the unitary matrix Z of the Schur
           vectors of H.  If COMPZ = 'V', on entry Z must contain an
           N-by-N matrix Q, which is assumed to be equal to the unit
           matrix except for the submatrix Z(ILO:IHI,ILO:IHI). On exit,
           if INFO = 0, Z contains Q*Z.
           Normally Q is the unitary matrix generated by ZUNGHR
           after the call to ZGEHRD which formed the Hessenberg matrix
           H. (The output value of Z when INFO.GT.0 is given under
           the description of INFO below.)

  [in] LDZ

          LDZ is INTEGER
           The leading dimension of the array Z.  if COMPZ = 'I' or
           COMPZ = 'V', then LDZ.GE.MAX(1,N).  Otherwize, LDZ.GE.1.

  [out] WORK

          WORK is COMPLEX*16 array, dimension (LWORK)
           On exit, if INFO = 0, WORK(1) returns an estimate of
           the optimal value for LWORK.

  [in] LWORK

          LWORK is INTEGER
           The dimension of the array WORK.  LWORK .GE. max(1,N)
           is sufficient and delivers very good and sometimes
           optimal performance.  However, LWORK as large as 11*N
           may be required for optimal performance.  A workspace
           query is recommended to determine the optimal workspace
           size.

           If LWORK = -1, then ZHSEQR does a workspace query.
           In this case, ZHSEQR checks the input parameters and
           estimates the optimal workspace size for the given
           values of N, ILO and IHI.  The estimate is returned
           in WORK(1).  No error message related to LWORK is
           issued by XERBLA.  Neither H nor Z are accessed.

  [out] INFO

          INFO is INTEGER
             =  0:  successful exit
```

```
          .LT. 0:  if INFO = -i, the i-th argument had an illegal
                   value
          .GT. 0:  if INFO = i, ZHSEQR failed to compute all of
               the eigenvalues.  Elements 1:ilo-1 and i+1:n of WR
               and WI contain those eigenvalues which have been
               successfully computed.  (Failures are rare.)

               If INFO .GT. 0 and JOB = 'E', then on exit, the
               remaining unconverged eigenvalues are the eigen-
               values of the upper Hessenberg matrix rows and
               columns ILO through INFO of the final, output
               value of H.

               If INFO .GT. 0 and JOB   = 'S', then on exit

          (*)  (initial value of H)*U  = U*(final value of H)

               where U is a unitary matrix.  The final
               value of  H is upper Hessenberg and triangular in
               rows and columns INFO+1 through IHI.

               If INFO .GT. 0 and COMPZ = 'V', then on exit

                 (final value of Z)  =  (initial value of Z)*U

               where U is the unitary matrix in (*) (regard-
               less of the value of JOB.)

               If INFO .GT. 0 and COMPZ = 'I', then on exit
                     (final value of Z)  = U
               where U is the unitary matrix in (*) (regard-
               less of the value of JOB.)

               If INFO .GT. 0 and COMPZ = 'N', then Z is not
               accessed.


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========

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November 2011

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==================
```

```
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      University of Kansas, USA

 Further Details:
 ====================

             Default values supplied by
             ILAENV(ISPEC,'ZHSEQR',JOB(:1)//COMPZ(:1),N,ILO,IHI,LWORK).
             It is suggested that these defaults be adjusted in order
             to attain best performance in each particular
             computational environment.

            ISPEC=12: The ZLAHQR vs ZLAQR0 crossover point.
                      Default: 75. (Must be at least 11.)

            ISPEC=13: Recommended deflation window size.
                      This depends on ILO, IHI and NS.  NS is the
                      number of simultaneous shifts returned
                      by ILAENV(ISPEC=15).  (See ISPEC=15 below.)
                      The default for (IHI-ILO+1).LE.500 is NS.
                      The default for (IHI-ILO+1).GT.500 is 3*NS/2.

            ISPEC=14: Nibble crossover point. (See IPARMQ for
                      details.)  Default: 14% of deflation window
                      size.

            ISPEC=15: Number of simultaneous shifts in a multishift
                      QR iteration.

                      If IHI-ILO+1 is ...

                      greater than      ...but less    ... the
                      or equal to ...      than        default is

                           1               30          NS =   2(+)
                          30               60          NS =   4(+)
                          60              150          NS =  10(+)
                         150              590          NS =  **
                         590             3000          NS =  64
                        3000             6000          NS = 128
                        6000             infinity      NS = 256

                 (+)  By default some or all matrices of this order
                      are passed to the implicit double shift routine
                      ZLAHQR and this parameter is ignored.  See
                      ISPEC=12 above and comments in IPARMQ for
                      details.

                (**)  The asterisks (**) indicate an ad-hoc
                      function of N increasing from 10 to 64.
```

```
           ISPEC=16: Select structured matrix multiply.
                     If the number of simultaneous shifts (specified
                     by ISPEC=15) is less than 14, then the default
                     for ISPEC=16 is 0.  Otherwise the default for
                     ISPEC=16 is 2.

 References:
 ================

       K. Braman, R. Byers and R. Mathias, The Multi-Shift QR
       Algorithm Part I: Maintaining Well Focused Shifts, and Level 3
       Performance, SIAM Journal of Matrix Analysis, volume 23, pages
       929--947, 2002.

       K. Braman, R. Byers and R. Mathias, The Multi-Shift QR
       Algorithm Part II: Aggressive Early Deflation, SIAM Journal
       of Matrix Analysis, volume 23, pages 948--973, 2002.
```

———-

— zhseqr.f —

```
*  =====================================================================
      SUBROUTINE ZHSEQR( JOB, COMPZ, N, ILO, IHI, H, LDH, W, Z, LDZ,
     $                   WORK, LWORK, INFO )
*
*  -- LAPACK computational routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      INTEGER            IHI, ILO, INFO, LDH, LDZ, LWORK, N
      CHARACTER          COMPZ, JOB
*     ..
*     .. Array Arguments ..
      COMPLEX*16         H( LDH, * ), W( * ), WORK( * ), Z( LDZ, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
*
*     ==== Matrices of order NTINY or smaller must be processed by
*     .    ZLAHQR because of insufficient subdiagonal scratch space.
*     .    (This is a hard limit.) ====
      INTEGER            NTINY
```

```
      PARAMETER          ( NTINY = 11 )
*
*     ==== NL allocates some local workspace to help small matrices
*     .    through a rare ZLAHQR failure.  NL .GT. NTINY = 11 is
*     .    required and NL .LE. NMIN = ILAENV(ISPEC=12,...) is recom-
*     .    mended.  (The default value of NMIN is 75.)  Using NL = 49
*     .    allows up to six simultaneous shifts and a 16-by-16
*     .    deflation window.  ====
      INTEGER            NL
      PARAMETER          ( NL = 49 )
      COMPLEX*16         ZERO, ONE
      PARAMETER          ( ZERO = ( 0.0d0, 0.0d0 ),
     $                   ONE = ( 1.0d0, 0.0d0 ) )
      DOUBLE PRECISION   RZERO
      PARAMETER          ( RZERO = 0.0d0 )
*     ..
*     .. Local Arrays ..
      COMPLEX*16         HL( NL, NL ), WORKL( NL )
*     ..
*     .. Local Scalars ..
      INTEGER            KBOT, NMIN
      LOGICAL            INITZ, LQUERY, WANTT, WANTZ
*     ..
*     .. External Functions ..
      INTEGER            ILAENV
      LOGICAL            LSAME
      EXTERNAL           ILAENV, LSAME
*     ..
*     .. External Subroutines ..
      EXTERNAL           XERBLA, ZCOPY, ZLACPY, ZLAHQR, ZLAQR0, ZLASET
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          DBLE, DCMPLX, MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     ==== Decode and check the input parameters. ====
*
      WANTT = LSAME( JOB, 'S' )
      INITZ = LSAME( COMPZ, 'I' )
      WANTZ = INITZ .OR. LSAME( COMPZ, 'V' )
      WORK( 1 ) = DCMPLX( DBLE( MAX( 1, N ) ), RZERO )
      LQUERY = LWORK.EQ.-1
*
      INFO = 0
      IF( .NOT.LSAME( JOB, 'E' ) .AND. .NOT.WANTT ) THEN
         INFO = -1
      ELSE IF( .NOT.LSAME( COMPZ, 'N' ) .AND. .NOT.WANTZ ) THEN
         INFO = -2
      ELSE IF( N.LT.0 ) THEN
```

```
         INFO = -3
      ELSE IF( ILO.LT.1 .OR. ILO.GT.MAX( 1, N ) ) THEN
         INFO = -4
      ELSE IF( IHI.LT.MIN( ILO, N ) .OR. IHI.GT.N ) THEN
         INFO = -5
      ELSE IF( LDH.LT.MAX( 1, N ) ) THEN
         INFO = -7
      ELSE IF( LDZ.LT.1 .OR. ( WANTZ .AND. LDZ.LT.MAX( 1, N ) ) ) THEN
         INFO = -10
      ELSE IF( LWORK.LT.MAX( 1, N ) .AND. .NOT.LQUERY ) THEN
         INFO = -12
      END IF
*
      IF( INFO.NE.0 ) THEN
*
*        ==== Quick return in case of invalid argument. ====
*
         CALL XERBLA( 'ZHSEQR', -INFO )
         RETURN
*
      ELSE IF( N.EQ.0 ) THEN
*
*        ==== Quick return in case N = 0; nothing to do. ====
*
         RETURN
*
      ELSE IF( LQUERY ) THEN
*
*        ==== Quick return in case of a workspace query ====
*
         CALL ZLAQRO( WANTT, WANTZ, N, ILO, IHI, H, LDH, W, ILO, IHI, Z,
     $                LDZ, WORK, LWORK, INFO )
*        ==== Ensure reported workspace size is backward-compatible with
*        .    previous LAPACK versions. ====
         WORK( 1 ) = DCMPLX( MAX( DBLE( WORK( 1 ) ), DBLE( MAX( 1,
     $               N ) ) ), RZERO )
         RETURN
*
      ELSE
*
*        ==== copy eigenvalues isolated by ZGEBAL ====
*
         IF( ILO.GT.1 )
     $      CALL ZCOPY( ILO-1, H, LDH+1, W, 1 )
         IF( IHI.LT.N )
     $      CALL ZCOPY( N-IHI, H( IHI+1, IHI+1 ), LDH+1, W( IHI+1 ), 1 )
*
*        ==== Initialize Z, if requested ====
*
         IF( INITZ )
```

```
     $      CALL ZLASET( 'A', N, N, ZERO, ONE, Z, LDZ )
*
*        ==== Quick return if possible ====
*
         IF( ILO.EQ.IHI ) THEN
            W( ILO ) = H( ILO, ILO )
            RETURN
         END IF
*
*        ==== ZLAHQR/ZLAQR0 crossover point ====
*
         NMIN = ILAENV( 12, 'ZHSEQR', JOB // COMPZ, N,
     $          ILO, IHI, LWORK )
         NMIN = MAX( NTINY, NMIN )
*
*        ==== ZLAQR0 for big matrices; ZLAHQR for small ones ====
*
         IF( N.GT.NMIN ) THEN
            CALL ZLAQR0( WANTT, WANTZ, N, ILO, IHI, H, LDH, W, ILO, IHI,
     $                   Z, LDZ, WORK, LWORK, INFO )
         ELSE
*
*           ==== Small matrix ====
*
            CALL ZLAHQR( WANTT, WANTZ, N, ILO, IHI, H, LDH, W, ILO, IHI,
     $                   Z, LDZ, INFO )
*
            IF( INFO.GT.0 ) THEN
*
*              ==== A rare ZLAHQR failure!  ZLAQR0 sometimes succeeds
*              .    when ZLAHQR fails. ====
*
               KBOT = INFO
*
               IF( N.GE.NL ) THEN
*
*                 ==== Larger matrices have enough subdiagonal scratch
*                 .    space to call ZLAQR0 directly. ====
*
                  CALL ZLAQR0( WANTT, WANTZ, N, ILO, KBOT, H, LDH, W,
     $                         ILO, IHI, Z, LDZ, WORK, LWORK, INFO )
*
               ELSE
*
*                 ==== Tiny matrices don't have enough subdiagonal
*                 .    scratch space to benefit from ZLAQR0.  Hence,
*                 .    tiny matrices must be copied into a larger
*                 .    array before calling ZLAQR0. ====
*
                  CALL ZLACPY( 'A', N, N, H, LDH, HL, NL )
```

```
                HL( N+1, N ) = ZERO
                CALL ZLASET( 'A', NL, NL-N, ZERO, ZERO, HL( 1, N+1 ),
     $                       NL )
                CALL ZLAQR0( WANTT, WANTZ, NL, ILO, KBOT, HL, NL, W,
     $                       ILO, IHI, Z, LDZ, WORKL, NL, INFO )
                IF( WANTT .OR. INFO.NE.0 )
     $             CALL ZLACPY( 'A', N, N, HL, NL, H, LDH )
             END IF
          END IF
       END IF
*
*        ==== Clear out the trash, if necessary. ====
*
         IF( ( WANTT .OR. INFO.NE.0 ) .AND. N.GT.2 )
     $      CALL ZLASET( 'L', N-2, N-2, ZERO, ZERO, H( 3, 1 ), LDH )
*
*        ==== Ensure reported workspace size is backward-compatible with
*        .    previous LAPACK versions. ====
*
         WORK( 1 ) = DCMPLX( MAX( DBLE( MAX( 1, N ) ),
     $               DBLE( WORK( 1 ) ) ), RZERO )
      END IF
*
*     ==== End of ZHSEQR ====
*
      END
```

— LAPACK zhseqr —

```
(let*
 ((ntiny 11) (nl 49)
  (zero (coerce (f2cl-lib:cmplx 0.0d0 0.0d0) 'f2cl-lib:complex16))
  (one (coerce (f2cl-lib:cmplx 1.0d0 0.0d0) 'f2cl-lib:complex16))
  (rzero 0.0d0))
 (declare (type (f2cl-lib:integer4 11 11) ntiny)
  (type (f2cl-lib:integer4 49 49) nl) (type (f2cl-lib:complex16) zero)
  (type (f2cl-lib:complex16) one) (type (double-float 0.0d0 0.0d0) rzero)
  (ignorable ntiny nl zero one rzero))
 (defun zhseqr (job compz n ilo ihi h ldh w z ldz work lwork info)
  (declare (type (simple-array character (*)) compz job)
   (type (f2cl-lib:integer4) info lwork ldz ldh ihi ilo n)
   (type (array f2cl-lib:complex16 (*)) work z w h))
  (f2cl-lib:with-multi-array-data
      ((h f2cl-lib:complex16 h-%data% h-%offset%)
       (w f2cl-lib:complex16 w-%data% w-%offset%)
       (z f2cl-lib:complex16 z-%data% z-%offset%)
```

```
(work f2cl-lib:complex16 work-%data% work-%offset%)
(job character job-%data% job-%offset%)
(compz character compz-%data% compz-%offset%))
(prog
 ((initz nil) (lquery nil) (wantt nil) (wantz nil) (kbot 0) (nmin 0)
  (hl
   (make-array (the fixnum (reduce #'* (list nl nl))) :element-type
    'f2cl-lib:complex16))
  (workl (make-array nl :element-type 'f2cl-lib:complex16)))
 (declare (type f2cl-lib:logical wantz wantt lquery initz)
  (type (f2cl-lib:integer4) nmin kbot)
  (type (array f2cl-lib:complex16 (*)) workl hl))
 (setf wantt
  (multiple-value-bind (ret-val var-0 var-1) (lsame job "S")
   (declare (ignore var-1)) (when var-0 (setf job var-0)) ret-val))
 (setf initz
  (multiple-value-bind (ret-val var-0 var-1) (lsame compz "I")
   (declare (ignore var-1)) (when var-0 (setf compz var-0)) ret-val))
 (setf wantz
  (or initz
   (multiple-value-bind (ret-val var-0 var-1) (lsame compz "V")
    (declare (ignore var-1)) (when var-0 (setf compz var-0)) ret-val)))
 (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
  (f2cl-lib:dcmplx
   (f2cl-lib:dble (max (the f2cl-lib:integer4 1)
                       (the f2cl-lib:integer4 n)))
   rzero))
 (setf lquery (coerce (= lwork -1) 'f2cl-lib:logical)) (setf info 0)
 (cond
  ((and
    (not
     (multiple-value-bind (ret-val var-0 var-1) (lsame job "E")
      (declare (ignore var-1)) (when var-0 (setf job var-0)) ret-val))
    (not wantt))
   (setf info -1))
  ((and
    (not
     (multiple-value-bind (ret-val var-0 var-1) (lsame compz "N")
      (declare (ignore var-1)) (when var-0 (setf compz var-0)) ret-val))
    (not wantz))
   (setf info -2))
  ((< n 0) (setf info -3))
  ((or (< ilo 1)
    (> ilo (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 n))))
   (setf info -4))
  ((or (< ihi (min (the f2cl-lib:integer4 ilo)
                   (the f2cl-lib:integer4 n)))
    (> ihi n))
   (setf info -5))
  ((< ldh (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 n)))
```

```
  (setf info -7))
 ((or (< ldz 1)
   (and wantz
    (< ldz (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 n)))))
  (setf info -10))
 ((and (< lwork (max (the f2cl-lib:integer4 1)
                     (the f2cl-lib:integer4 n)))
   (not lquery))
  (setf info -12)))
(cond ((/= info 0)
   (xerbla "ZHSEQR" (f2cl-lib:int-sub info))
   (go end_label))
 ((= n 0) (go end_label))
 (lquery
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
    var-10 var-11
    var-12 var-13 var-14)
   (zlaqr0 wantt wantz n ilo ihi h ldh w ilo ihi z ldz work lwork info)
   (declare (ignore var-5 var-7 var-10 var-12))
   (when var-0 (setf wantt var-0)) (when var-1 (setf wantz var-1))
   (when var-2 (setf n var-2)) (when var-3 (setf ilo var-3))
   (when var-4 (setf ihi var-4)) (when var-6 (setf ldh var-6))
   (when var-8 (setf ilo var-8)) (when var-9 (setf ihi var-9))
   (when var-11 (setf ldz var-11)) (when var-13 (setf lwork var-13))
   (when var-14 (setf info var-14)))
  (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
   (f2cl-lib:dcmplx
    (max (f2cl-lib:dble (f2cl-lib:fref work-%data% (1) ((1 *))
            work-%offset%))
     (f2cl-lib:dble
      (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 n))))
    rzero))
  (go end_label))
 (t
  (if (> ilo 1)
   (zcopy (f2cl-lib:int-sub ilo 1) h (f2cl-lib:int-add ldh 1) w 1))
  (if (< ihi n)
   (zcopy (f2cl-lib:int-sub n ihi)
    (f2cl-lib:array-slice h-%data% f2cl-lib:complex16
     ((+ ihi 1) (f2cl-lib:int-add ihi 1)) ((1 ldh) (1 *)) h-%offset%)
    (f2cl-lib:int-add ldh 1)
    (f2cl-lib:array-slice w-%data% f2cl-lib:complex16
     ((+ ihi 1)) ((1 *))
     w-%offset%)
    1))
  (if initz
   (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
    (zlaset "A" n n zero one z ldz) (declare (ignore var-0 var-5))
    (when var-1 (setf n var-1)) (when var-2 (setf n var-2))
```

```
  (when var-3 (setf zero var-3)) (when var-4 (setf one var-4))
  (when var-6 (setf ldz var-6))))
(cond
 ((= ilo ihi)
  (setf (f2cl-lib:fref w-%data% (ilo) ((1 *)) w-%offset%)
   (f2cl-lib:fref h-%data% (ilo ilo) ((1 ldh) (1 *)) h-%offset%))
  (go end_label)))
(setf nmin
 (multiple-value-bind (ret-val var-0 var-1 var-2 var-3 var-4
    var-5 var-6)
  (ilaenv 12 "ZHSEQR" (f2cl-lib:f2cl-// job compz) n ilo ihi lwork)
  (declare (ignore var-0 var-1 var-2)) (when var-3 (setf n var-3))
  (when var-4 (setf ilo var-4)) (when var-5 (setf ihi var-5))
  (when var-6 (setf lwork var-6)) ret-val))
(setf nmin (max (the f2cl-lib:integer4 ntiny)
                (the f2cl-lib:integer4 nmin)))
(cond
 ((> n nmin)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
    var-10
    var-11 var-12 var-13 var-14)
   (zlaqr0 wantt wantz n ilo ihi h ldh w ilo ihi z
      ldz work lwork info)
   (declare (ignore var-5 var-7 var-10 var-12))
   (when var-0 (setf wantt var-0)) (when var-1 (setf wantz var-1))
   (when var-2 (setf n var-2)) (when var-3 (setf ilo var-3))
   (when var-4 (setf ihi var-4)) (when var-6 (setf ldh var-6))
   (when var-8 (setf ilo var-8)) (when var-9 (setf ihi var-9))
   (when var-11 (setf ldz var-11)) (when var-13 (setf lwork var-13))
   (when var-14 (setf info var-14))))
 (t
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
    var-10
    var-11 var-12)
   (zlahqr wantt wantz n ilo ihi h ldh w ilo ihi z ldz info)
   (declare (ignore var-5 var-7 var-10))
   (when var-0 (setf wantt var-0))
   (when var-1 (setf wantz var-1)) (when var-2 (setf n var-2))
   (when var-3 (setf ilo var-3)) (when var-4 (setf ihi var-4))
   (when var-6 (setf ldh var-6)) (when var-8 (setf ilo var-8))
   (when var-9 (setf ihi var-9)) (when var-11 (setf ldz var-11))
   (when var-12 (setf info var-12)))
  (cond
   ((> info 0) (setf kbot info)
    (cond
     ((>= n nl)
      (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
```

```
   var-9 var-10
   var-11 var-12 var-13 var-14)
  (zlaqr0 wantt wantz n ilo kbot h ldh w ilo ihi z
    ldz work lwork info)
  (declare (ignore var-5 var-7 var-10 var-12))
  (when var-0 (setf wantt var-0))
  (when var-1 (setf wantz var-1))
  (when var-2 (setf n var-2)) (when var-3 (setf ilo var-3))
  (when var-4 (setf kbot var-4)) (when var-6 (setf ldh var-6))
  (when var-8 (setf ilo var-8)) (when var-9 (setf ihi var-9))
  (when var-11 (setf ldz var-11))
  (when var-13 (setf lwork var-13))
  (when var-14 (setf info var-14))))
(t
 (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
  (zlacpy "A" n n h ldh hl nl)
  (declare (ignore var-0 var-3 var-5))
  (when var-1 (setf n var-1)) (when var-2 (setf n var-2))
  (when var-4 (setf ldh var-4)) (when var-6 (setf nl var-6)))
 (setf (f2cl-lib:fref hl ((f2cl-lib:int-add n 1) n)
        ((1 nl) (1 nl)))
  zero)
 (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
  (zlaset "A" nl (f2cl-lib:int-sub nl n) zero zero
   (f2cl-lib:array-slice hl f2cl-lib:complex16
    (1 (f2cl-lib:int-add n 1)) ((1 nl) (1 nl)))
   nl)
  (declare (ignore var-0 var-2 var-5))
  (when var-1 (setf nl var-1))
  (when var-3 (setf zero var-3)) (when var-4 (setf zero var-4))
  (when var-6 (setf nl var-6)))
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10
   var-11 var-12 var-13 var-14)
  (zlaqr0 wantt wantz nl ilo kbot hl nl w ilo ihi z
          ldz workl nl info)
  (declare (ignore var-5 var-7 var-10 var-12))
  (when var-0 (setf wantt var-0))
  (when var-1 (setf wantz var-1))
  (when var-2 (setf nl var-2)) (when var-3 (setf ilo var-3))
  (when var-4 (setf kbot var-4)) (when var-6 (setf nl var-6))
  (when var-8 (setf ilo var-8)) (when var-9 (setf ihi var-9))
  (when var-11 (setf ldz var-11)) (when var-13 (setf nl var-13))
  (when var-14 (setf info var-14)))
 (if (or wantt (/= info 0))
  (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
```

```
                (zlacpy "A" n n hl nl h ldh)
                (declare (ignore var-0 var-3 var-5))
                (when var-1 (setf n var-1))
                (when var-2 (setf n var-2))
                (when var-4 (setf nl var-4))
                (when var-6 (setf ldh var-6)))))))))))
          (if (and (or wantt (/= info 0)) (> n 2))
           (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
            (zlaset "L" (f2cl-lib:int-sub n 2) (f2cl-lib:int-sub n 2) zero zero
             (f2cl-lib:array-slice h-%data% f2cl-lib:complex16
              (3 1) ((1 ldh) (1 *))
              h-%offset%)
             ldh)
            (declare (ignore var-0 var-1 var-2 var-5))
            (when var-3 (setf zero var-3))
            (when var-4 (setf zero var-4))
            (when var-6 (setf ldh var-6))))
          (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
           (f2cl-lib:dcmplx
            (max
             (f2cl-lib:dble
              (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 n)))
             (f2cl-lib:dble
              (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)))
            rzero))))
         end_label
         (return
          (values job compz n ilo ihi nil ldh nil nil ldz nil lwork info)))
        )))
```

———-

6.106 zlacgv LAPACK

— **zlacgv.input** —

```
)set break resume
)sys rm -f zlacgv.output
)spool zlacgv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— zlacgv.help —

```
=====================================================================
zlacgv examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 Online html documentation available at
           http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZLACGV( N, X, INCX )

       .. Scalar Arguments ..
       INTEGER            INCX, N
       ..
       .. Array Arguments ..
       COMPLEX*16         X( * )
       ..


 Purpose:
 =============

 ZLACGV conjugates a complex vector of length N.

 Arguments:
 ==========

  [in] N

          N is INTEGER
          The length of the vector X.  N >= 0.

  [in,out] X

          X is COMPLEX*16 array, dimension
                        (1+(N-1)*abs(INCX))
          On entry, the vector of length N to be conjugated.
          On exit, X is overwritten with conjg(X).

  [in] INCX

          INCX is INTEGER
```

```
          The spacing between successive elements of X.


 Authors:
 ========

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  Univ. of Colorado Denver
  NAG Ltd.

 November 2011
```

———-

— zlacgv.f —

```
*  =====================================================================
      SUBROUTINE ZLACGV( N, X, INCX )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      INTEGER            INCX, N
*     ..
*     .. Array Arguments ..
      COMPLEX*16         X( * )
*     ..
*
* =====================================================================
*
*     .. Local Scalars ..
      INTEGER            I, IOFF
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG
*     ..
*     .. Executable Statements ..
*
      IF( INCX.EQ.1 ) THEN
         DO 10 I = 1, N
            X( I ) = DCONJG( X( I ) )
   10    CONTINUE
      ELSE
         IOFF = 1
```

```
         IF( INCX.LT.0 )
     $      IOFF = 1 - ( N-1 )*INCX
         DO 20 I = 1, N
            X( IOFF ) = DCONJG( X( IOFF ) )
            IOFF = IOFF + INCX
   20    CONTINUE
      END IF
      RETURN
*
*     End of ZLACGV
*
      END
```

———-

— LAPACK zlacgv —

```
(defun zlacgv (n x incx)
 (declare (type (f2cl-lib:integer4) incx n)
  (type (array f2cl-lib:complex16 (*)) x))
 (f2cl-lib:with-multi-array-data
     ((x f2cl-lib:complex16 x-%data% x-%offset%))
      (prog
       ((i 0) (ioff 0)) (declare (type (f2cl-lib:integer4) ioff i))
       (cond
        ((= incx 1)
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i n) nil)
                  (tagbody
                      (setf (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%)
                       (coerce (f2cl-lib:dconjg
                               (f2cl-lib:fref x-%data% (i) ((1 *)) x-%offset%))
                        'f2cl-lib:complex16))
                      label10)))
        (t (setf ioff 1)
         (if (< incx 0)
          (setf ioff
           (f2cl-lib:int-sub 1
            (f2cl-lib:int-mul (f2cl-lib:int-sub n 1) incx))))
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                 ((> i n) nil)
                  (tagbody
                      (setf (f2cl-lib:fref x-%data% (ioff) ((1 *)) x-%offset%)
                       (coerce
                        (f2cl-lib:dconjg (f2cl-lib:fref x-%data% (ioff)
                           ((1 *)) x-%offset%))
                        'f2cl-lib:complex16))
                      (setf ioff (f2cl-lib:int-add ioff incx)) label20))))
```

```
       (go end_label) end_label (return (values nil nil nil)))))
```

———-

6.107 zlacpy LAPACK

— **zlacpy.input** —

```
)set break resume
)sys rm -f zlacpy.output
)spool zlacpy.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zlacpy.help** —

```
================================================================================
zlacpy examples
================================================================================

================================================================================
Man Page Details
================================================================================

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZLACPY( UPLO, M, N, A, LDA, B, LDB )

       .. Scalar Arguments ..
       CHARACTER          UPLO
       INTEGER            LDA, LDB, M, N
       ..
       .. Array Arguments ..
       COMPLEX*16         A( LDA, * ), B( LDB, * )
       ..
```

```
Purpose:
=============

 ZLACPY copies all or part of a two-dimensional matrix A to another
 matrix B.


Arguments:
==========

 [in] UPLO

         UPLO is CHARACTER*1
         Specifies the part of the matrix A to be copied to B.
         = 'U':      Upper triangular part
         = 'L':      Lower triangular part
         Otherwise:  All of the matrix A

 [in] M

         M is INTEGER
         The number of rows of the matrix A.  M >= 0.

 [in] N

         N is INTEGER
         The number of columns of the matrix A.  N >= 0.

 [in] A

         A is COMPLEX*16 array, dimension (LDA,N)
         The m by n matrix A.  If UPLO = 'U', only the upper trapezium
         is accessed; if UPLO = 'L', only the lower trapezium is
         accessed.

 [in] LDA

         LDA is INTEGER
         The leading dimension of the array A.  LDA >= max(1,M).

 [out] B

         B is COMPLEX*16 array, dimension (LDB,N)
         On exit, B = A in the locations specified by UPLO.

 [in] LDB

         LDB is INTEGER
         The leading dimension of the array B.  LDB >= max(1,M).
```

```
 Authors:
 ========

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  NAG Ltd.

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```

———-

— zlacpy.f —

```
*  =====================================================================
      SUBROUTINE ZLACPY( UPLO, M, N, A, LDA, B, LDB )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      CHARACTER          UPLO
      INTEGER            LDA, LDB, M, N
*     ..
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), B( LDB, * )
*     ..
*
*  =====================================================================
*
*     .. Local Scalars ..
      INTEGER            I, J
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MIN
*     ..
*     .. Executable Statements ..
*
      IF( LSAME( UPLO, 'U' ) ) THEN
         DO 20 J = 1, N
```

```
            DO 10 I = 1, MIN( J, M )
               B( I, J ) = A( I, J )
   10       CONTINUE
   20    CONTINUE
*
      ELSE IF( LSAME( UPLO, 'L' ) ) THEN
         DO 40 J = 1, N
            DO 30 I = J, M
               B( I, J ) = A( I, J )
   30       CONTINUE
   40    CONTINUE
*
      ELSE
         DO 60 J = 1, N
            DO 50 I = 1, M
               B( I, J ) = A( I, J )
   50       CONTINUE
   60    CONTINUE
      END IF
*
      RETURN
*
*     End of ZLACPY
*
      END
```

———-

— LAPACK zlacpy —

```
(defun zlacpy (uplo m n a lda b ldb$)
 (declare (type (simple-array character (*)) uplo)
  (type (f2cl-lib:integer4) ldb$ lda n m)
  (type (array f2cl-lib:complex16 (*)) b a))
 (f2cl-lib:with-multi-array-data
     ((a f2cl-lib:complex16 a-%data% a-%offset%)
      (b f2cl-lib:complex16 b-%data% b-%offset%)
      (uplo character uplo-%data% uplo-%offset%))
      (prog ((i 0) (j 0))
       (declare (type (f2cl-lib:integer4) j i))
       (cond
        ((multiple-value-bind (ret-val var-0 var-1) (lsame uplo "U")
          (declare (ignore var-1)) (when var-0 (setf uplo var-0)) ret-val)
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
                  (tagbody
                      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i
```

```
                    (min (the f2cl-lib:integer4 j)
                         (the f2cl-lib:integer4 m)))
                   nil)
                  (tagbody
                    (setf (f2cl-lib:fref b-%data% (i j) ((1 ldb$) (1 *))
                          b-%offset%)
                     (f2cl-lib:fref a-%data% (i j) ((1 lda) (1 *))
                        a-%offset%))
                    label10))
                  label20)))
      ((multiple-value-bind (ret-val var-0 var-1) (lsame uplo "L")
        (declare (ignore var-1)) (when var-0 (setf uplo var-0)) ret-val)
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
                (tagbody
                    (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
                ((> i m) nil)
                 (tagbody
                    (setf (f2cl-lib:fref b-%data% (i j) ((1 ldb$) (1 *))
                       b-%offset%)
                     (f2cl-lib:fref a-%data% (i j) ((1 lda) (1 *))
                       a-%offset%))
                    label30))
                  label40)))
      (t
       (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
                (tagbody
                    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                ((> i m) nil)
                 (tagbody
                    (setf (f2cl-lib:fref b-%data% (i j) ((1 ldb$) (1 *))
                        b-%offset%)
                     (f2cl-lib:fref a-%data% (i j) ((1 lda) (1 *))
                         a-%offset%))
                    label50))
                  label60))))
    (go end_label)
end_label
   (return (values uplo nil nil nil nil nil nil)))
   ))
```

———-

6.108 zladiv LAPACK

— zladiv.input —

```
)set break resume
)sys rm -f zladiv.output
)spool zladiv.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— zladiv.help —

```
=====================================================================
zladiv examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       COMPLEX*16     FUNCTION ZLADIV( X, Y )

       .. Scalar Arguments ..
       COMPLEX*16         X, Y
       ..


 Purpose:
 =============

  ZLADIV := X / Y, where X and Y are complex.  The computation of X / Y
  will not overflow on an intermediary step unless the results
  overflows.

 Arguments:
 ==========

  [in] X

          X is COMPLEX*16
```

```
  [in] Y

          Y is COMPLEX*16
          The complex scalars X and Y.


 Authors:
 ========

  Univ. of Tennessee
  Univ. of California Berkeley
  Univ. of Colorado Denver
  NAG Ltd.

 November 2011
```

———-

— zladiv.f —

```
*  =====================================================================
      COMPLEX*16     FUNCTION ZLADIV( X, Y )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      COMPLEX*16         X, Y
*     ..
*
*  =====================================================================
*
*     .. Local Scalars ..
      DOUBLE PRECISION   ZI, ZR
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLADIV
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          DBLE, DCMPLX, DIMAG
*     ..
*     .. Executable Statements ..
*
      CALL DLADIV( DBLE( X ), DIMAG( X ), DBLE( Y ), DIMAG( Y ), ZR,
     $             ZI )
      ZLADIV = DCMPLX( ZR, ZI )
```

```
*
      RETURN
*
*     End of ZLADIV
*
      END
```

———-

— LAPACK zladiv —

```
(defun zladiv (x y) (declare (type (f2cl-lib:complex16) y x))
 (prog
  ((zi 0.0d0) (zr 0.0d0) (zladiv #C(0.0d0 0.0d0)) (dble$ 0.0) (dimag$ 0.0))
  (declare (type (double-float) zr zi) (type (f2cl-lib:complex16) zladiv)
   (type (single-float) dimag$ dble$))
  (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5)
   (dladiv (f2cl-lib:dble x) (f2cl-lib:dimag x) (f2cl-lib:dble y)
    (f2cl-lib:dimag y) zr zi)
   (declare (ignore var-0 var-1 var-2 var-3)) (when var-4 (setf zr var-4))
   (when var-5 (setf zi var-5)))
  (setf zladiv (f2cl-lib:dcmplx zr zi)) (go end_label) end_label
  (return (values zladiv nil nil))))
```

———-

6.109 zlahqr LAPACK

— zlahqr.input —

```
)set break resume
)sys rm -f zlahqr.output
)spool zlahqr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— zlahqr.help —

```
=====================================================================
zlahqr examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 Online html documentation available at
           http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZLAHQR( WANTT, WANTZ, N, ILO, IHI, H, LDH, W, ILOZ,
                          IHIZ, Z, LDZ, INFO )

       .. Scalar Arguments ..
       INTEGER            IHI, IHIZ, ILO, ILOZ, INFO, LDH, LDZ, N
       LOGICAL            WANTT, WANTZ
       ..
       .. Array Arguments ..
       COMPLEX*16         H( LDH, * ), W( * ), Z( LDZ, * )
       ..


 Purpose:
 =============

    ZLAHQR is an auxiliary routine called by CHSEQR to update the
    eigenvalues and Schur decomposition already computed by CHSEQR, by
    dealing with the Hessenberg submatrix in rows and columns ILO to
    IHI.


 Arguments:
 ==========

  [in] WANTT

          WANTT is LOGICAL
          = .TRUE. : the full Schur form T is required;
          = .FALSE.: only eigenvalues are required.

  [in] WANTZ

          WANTZ is LOGICAL
          = .TRUE. : the matrix of Schur vectors Z is required;
          = .FALSE.: Schur vectors are not required.
```

```
[in] N

        N is INTEGER
        The order of the matrix H.  N >= 0.

[in] ILO

        ILO is INTEGER

[in] IHI

        IHI is INTEGER
        It is assumed that H is already upper triangular in rows and
        columns IHI+1:N, and that H(ILO,ILO-1) = 0 (unless ILO = 1).
        ZLAHQR works primarily with the Hessenberg submatrix in rows
        and columns ILO to IHI, but applies transformations to all of
        H if WANTT is .TRUE..
        1 <= ILO <= max(1,IHI); IHI <= N.

[in,out] H

        H is COMPLEX*16 array, dimension (LDH,N)
        On entry, the upper Hessenberg matrix H.
        On exit, if INFO is zero and if WANTT is .TRUE., then H
        is upper triangular in rows and columns ILO:IHI.  If INFO
        is zero and if WANTT is .FALSE., then the contents of H
        are unspecified on exit.  The output state of H in case
        INF is positive is below under the description of INFO.

[in] LDH

        LDH is INTEGER
        The leading dimension of the array H. LDH >= max(1,N).

[out] W

        W is COMPLEX*16 array, dimension (N)
        The computed eigenvalues ILO to IHI are stored in the
        corresponding elements of W. If WANTT is .TRUE., the
        eigenvalues are stored in the same order as on the diagonal
        of the Schur form returned in H, with W(i) = H(i,i).

[in] ILOZ

        ILOZ is INTEGER

[in] IHIZ

        IHIZ is INTEGER
        Specify the rows of Z to which transformations must be
```

```
          applied if WANTZ is .TRUE..
          1 <= ILOZ <= ILO; IHI <= IHIZ <= N.

  [in,out] Z

          Z is COMPLEX*16 array, dimension (LDZ,N)
          If WANTZ is .TRUE., on entry Z must contain the current
          matrix Z of transformations accumulated by CHSEQR, and on
          exit Z has been updated; transformations are applied only to
          the submatrix Z(ILOZ:IHIZ,ILO:IHI).
          If WANTZ is .FALSE., Z is not referenced.

  [in] LDZ

          LDZ is INTEGER
          The leading dimension of the array Z. LDZ >= max(1,N).

  [out] INFO

          INFO is INTEGER
           =   0: successful exit
          .GT. 0: if INFO = i, ZLAHQR failed to compute all the
                  eigenvalues ILO to IHI in a total of 30 iterations
                  per eigenvalue; elements i+1:ihi of W contain
                  those eigenvalues which have been successfully
                  computed.

                  If INFO .GT. 0 and WANTT is .FALSE., then on exit,
                  the remaining unconverged eigenvalues are the
                  eigenvalues of the upper Hessenberg matrix
                  rows and columns ILO thorugh INFO of the final,
                  output value of H.

                  If INFO .GT. 0 and WANTT is .TRUE., then on exit
          (*)       (initial value of H)*U  = U*(final value of H)
                  where U is an orthognal matrix.    The final
                  value of H is upper Hessenberg and triangular in
                  rows and columns INFO+1 through IHI.

                  If INFO .GT. 0 and WANTZ is .TRUE., then on exit
                      (final value of Z)  = (initial value of Z)*U
                  where U is the orthogonal matrix in (*)
                  (regardless of the value of WANTT.)

Authors:
========

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```

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 NAG Ltd.

November 2011

Contributors:
==================

    02-96 Based on modifications by
    David Day, Sandia National Laboratory, USA

    12-04 Further modifications by
    Ralph Byers, University of Kansas, USA
    This is a modified version of ZLAHQR from LAPACK version 3.0.
    It is (1) more robust against overflow and underflow and
    (2) adopts the more conservative Ahues & Tisseur stopping
    criterion (LAWN 122, 1997).
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— zlahqr.f —

```
*  =========================================================================
      SUBROUTINE ZLAHQR( WANTT, WANTZ, N, ILO, IHI, H, LDH, W, ILOZ,
     $                   IHIZ, Z, LDZ, INFO )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      INTEGER            IHI, IHIZ, ILO, ILOZ, INFO, LDH, LDZ, N
      LOGICAL            WANTT, WANTZ
*     ..
*     .. Array Arguments ..
      COMPLEX*16         H( LDH, * ), W( * ), Z( LDZ, * )
*     ..
*
*  =========================================================
*
*     .. Parameters ..
      INTEGER            ITMAX
      PARAMETER          ( ITMAX = 30 )
      COMPLEX*16         ZERO, ONE
      PARAMETER          ( ZERO = ( 0.0d0, 0.0d0 ),
     $                   ONE = ( 1.0d0, 0.0d0 ) )
      DOUBLE PRECISION   RZERO, RONE, HALF
      PARAMETER          ( RZERO = 0.0d0, RONE = 1.0d0, HALF = 0.5d0 )
```

```
      DOUBLE PRECISION   DAT1
      PARAMETER          ( DAT1 = 3.0d0 / 4.0d0 )
*     ..
*     .. Local Scalars ..
      COMPLEX*16         CDUM, H11, H11S, H22, SC, SUM, T, T1, TEMP, U,
     $                   V2, X, Y
      DOUBLE PRECISION   AA, AB, BA, BB, H10, H21, RTEMP, S, SAFMAX,
     $                   SAFMIN, SMLNUM, SX, T2, TST, ULP
      INTEGER            I, I1, I2, ITS, J, JHI, JLO, K, L, M, NH, NZ
*     ..
*     .. Local Arrays ..
      COMPLEX*16         V( 2 )
*     ..
*     .. External Functions ..
      COMPLEX*16         ZLADIV
      DOUBLE PRECISION   DLAMCH
      EXTERNAL           ZLADIV, DLAMCH
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLABAD, ZCOPY, ZLARFG, ZSCAL
*     ..
*     .. Statement Functions ..
      DOUBLE PRECISION   CABS1
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, DBLE, DCONJG, DIMAG, MAX, MIN, SQRT
*     ..
*     .. Statement Function definitions ..
      CABS1( CDUM ) = ABS( DBLE( CDUM ) ) + ABS( DIMAG( CDUM ) )
*     ..
*     .. Executable Statements ..
*
      INFO = 0
*
*     Quick return if possible
*
      IF( N.EQ.0 )
     $   RETURN
      IF( ILO.EQ.IHI ) THEN
         W( ILO ) = H( ILO, ILO )
         RETURN
      END IF
*
*     ==== clear out the trash ====
      DO 10 J = ILO, IHI - 3
         H( J+2, J ) = ZERO
         H( J+3, J ) = ZERO
   10 CONTINUE
      IF( ILO.LE.IHI-2 )
     $   H( IHI, IHI-2 ) = ZERO
```

```
*     ==== ensure that subdiagonal entries are real ====
      IF( WANTT ) THEN
         JLO = 1
         JHI = N
      ELSE
         JLO = ILO
         JHI = IHI
      END IF
      DO 20 I = ILO + 1, IHI
         IF( DIMAG( H( I, I-1 ) ).NE.RZERO ) THEN
*           ==== The following redundant normalization
*           .    avoids problems with both gradual and
*           .    sudden underflow in ABS(H(I,I-1)) ====
            SC = H( I, I-1 ) / CABS1( H( I, I-1 ) )
            SC = DCONJG( SC ) / ABS( SC )
            H( I, I-1 ) = ABS( H( I, I-1 ) )
            CALL ZSCAL( JHI-I+1, SC, H( I, I ), LDH )
            CALL ZSCAL( MIN( JHI, I+1 )-JLO+1, DCONJG( SC ),
     $                  H( JLO, I ), 1 )
            IF( WANTZ )
     $         CALL ZSCAL( IHIZ-ILOZ+1, DCONJG( SC ), Z( ILOZ, I ), 1 )
         END IF
   20 CONTINUE
*
      NH = IHI - ILO + 1
      NZ = IHIZ - ILOZ + 1
*
*     Set machine-dependent constants for the stopping criterion.
*
      SAFMIN = DLAMCH( 'SAFE MINIMUM' )
      SAFMAX = RONE / SAFMIN
      CALL DLABAD( SAFMIN, SAFMAX )
      ULP = DLAMCH( 'PRECISION' )
      SMLNUM = SAFMIN*( DBLE( NH ) / ULP )
*
*     I1 and I2 are the indices of the first row and last column of H
*     to which transformations must be applied. If eigenvalues only are
*     being computed, I1 and I2 are set inside the main loop.
*
      IF( WANTT ) THEN
         I1 = 1
         I2 = N
      END IF
*
*     The main loop begins here. I is the loop index and decreases from
*     IHI to ILO in steps of 1. Each iteration of the loop works
*     with the active submatrix in rows and columns L to I.
*     Eigenvalues I+1 to IHI have already converged. Either L = ILO, or
*     H(L,L-1) is negligible so that the matrix splits.
*
```

```
      I = IHI
   30 CONTINUE
      IF( I.LT.ILO )
     $   GO TO 150
*
*     Perform QR iterations on rows and columns ILO to I until a
*     submatrix of order 1 splits off at the bottom because a
*     subdiagonal element has become negligible.
*
      L = ILO
      DO 130 ITS = 0, ITMAX
*
*        Look for a single small subdiagonal element.
*
         DO 40 K = I, L + 1, -1
            IF( CABS1( H( K, K-1 ) ).LE.SMLNUM )
     $         GO TO 50
            TST = CABS1( H( K-1, K-1 ) ) + CABS1( H( K, K ) )
            IF( TST.EQ.ZERO ) THEN
               IF( K-2.GE.ILO )
     $            TST = TST + ABS( DBLE( H( K-1, K-2 ) ) )
               IF( K+1.LE.IHI )
     $            TST = TST + ABS( DBLE( H( K+1, K ) ) )
            END IF
*           ==== The following is a conservative small subdiagonal
*           .    deflation criterion due to Ahues & Tisseur (LAWN 122,
*           .    1997). It has better mathematical foundation and
*           .    improves accuracy in some examples.  ====
            IF( ABS( DBLE( H( K, K-1 ) ) ).LE.ULP*TST ) THEN
               AB = MAX( CABS1( H( K, K-1 ) ), CABS1( H( K-1, K ) ) )
               BA = MIN( CABS1( H( K, K-1 ) ), CABS1( H( K-1, K ) ) )
               AA = MAX( CABS1( H( K, K ) ),
     $              CABS1( H( K-1, K-1 )-H( K, K ) ) )
               BB = MIN( CABS1( H( K, K ) ),
     $              CABS1( H( K-1, K-1 )-H( K, K ) ) )
               S = AA + AB
               IF( BA*( AB / S ).LE.MAX( SMLNUM,
     $             ULP*( BB*( AA / S ) ) ) )GO TO 50
            END IF
   40    CONTINUE
   50    CONTINUE
         L = K
         IF( L.GT.ILO ) THEN
*
*           H(L,L-1) is negligible
*
            H( L, L-1 ) = ZERO
         END IF
*
*        Exit from loop if a submatrix of order 1 has split off.
```

```
*
         IF( L.GE.I )
     $      GO TO 140
*
*        Now the active submatrix is in rows and columns L to I. If
*        eigenvalues only are being computed, only the active submatrix
*        need be transformed.
*
         IF( .NOT.WANTT ) THEN
            I1 = L
            I2 = I
         END IF
*
         IF( ITS.EQ.10 ) THEN
*
*           Exceptional shift.
*
            S = DAT1*ABS( DBLE( H( L+1, L ) ) )
            T = S + H( L, L )
         ELSE IF( ITS.EQ.20 ) THEN
*
*           Exceptional shift.
*
            S = DAT1*ABS( DBLE( H( I, I-1 ) ) )
            T = S + H( I, I )
         ELSE
*
*           Wilkinson's shift.
*
            T = H( I, I )
            U = SQRT( H( I-1, I ) )*SQRT( H( I, I-1 ) )
            S = CABS1( U )
            IF( S.NE.RZERO ) THEN
               X = HALF*( H( I-1, I-1 )-T )
               SX = CABS1( X )
               S = MAX( S, CABS1( X ) )
               Y = S*SQRT( ( X / S )**2+( U / S )**2 )
               IF( SX.GT.RZERO ) THEN
                  IF( DBLE( X / SX )*DBLE( Y )+DIMAG( X / SX )*
     $                DIMAG( Y ).LT.RZERO )Y = -Y
               END IF
               T = T - U*ZLADIV( U, ( X+Y ) )
            END IF
         END IF
*
*        Look for two consecutive small subdiagonal elements.
*
         DO 60 M = I - 1, L + 1, -1
*
*           Determine the effect of starting the single-shift QR
```

```
*           iteration at row M, and see if this would make H(M,M-1)
*           negligible.
*
            H11 = H( M, M )
            H22 = H( M+1, M+1 )
            H11S = H11 - T
            H21 = DBLE( H( M+1, M ) )
            S = CABS1( H11S ) + ABS( H21 )
            H11S = H11S / S
            H21 = H21 / S
            V( 1 ) = H11S
            V( 2 ) = H21
            H10 = DBLE( H( M, M-1 ) )
            IF( ABS( H10 )*ABS( H21 ).LE.ULP*
     $          ( CABS1( H11S )*( CABS1( H11 )+CABS1( H22 ) ) ) )
     $          GO TO 70
   60    CONTINUE
         H11 = H( L, L )
         H22 = H( L+1, L+1 )
         H11S = H11 - T
         H21 = DBLE( H( L+1, L ) )
         S = CABS1( H11S ) + ABS( H21 )
         H11S = H11S / S
         H21 = H21 / S
         V( 1 ) = H11S
         V( 2 ) = H21
   70    CONTINUE
*
*        Single-shift QR step
*
         DO 120 K = M, I - 1
*
*           The first iteration of this loop determines a reflection G
*           from the vector V and applies it from left and right to H,
*           thus creating a nonzero bulge below the subdiagonal.
*
*           Each subsequent iteration determines a reflection G to
*           restore the Hessenberg form in the (K-1)th column, and thus
*           chases the bulge one step toward the bottom of the active
*           submatrix.
*
*           V(2) is always real before the call to ZLARFG, and hence
*           after the call T2 ( = T1*V(2) ) is also real.
*
            IF( K.GT.M )
     $         CALL ZCOPY( 2, H( K, K-1 ), 1, V, 1 )
            CALL ZLARFG( 2, V( 1 ), V( 2 ), 1, T1 )
            IF( K.GT.M ) THEN
               H( K, K-1 ) = V( 1 )
               H( K+1, K-1 ) = ZERO
```

```
            END IF
            V2 = V( 2 )
            T2 = DBLE( T1*V2 )
*
*           Apply G from the left to transform the rows of the matrix
*           in columns K to I2.
*
            DO 80 J = K, I2
               SUM = DCONJG( T1 )*H( K, J ) + T2*H( K+1, J )
               H( K, J ) = H( K, J ) - SUM
               H( K+1, J ) = H( K+1, J ) - SUM*V2
   80       CONTINUE
*
*           Apply G from the right to transform the columns of the
*           matrix in rows I1 to min(K+2,I).
*
            DO 90 J = I1, MIN( K+2, I )
               SUM = T1*H( J, K ) + T2*H( J, K+1 )
               H( J, K ) = H( J, K ) - SUM
               H( J, K+1 ) = H( J, K+1 ) - SUM*DCONJG( V2 )
   90       CONTINUE
*
            IF( WANTZ ) THEN
*
*              Accumulate transformations in the matrix Z
*
               DO 100 J = ILOZ, IHIZ
                  SUM = T1*Z( J, K ) + T2*Z( J, K+1 )
                  Z( J, K ) = Z( J, K ) - SUM
                  Z( J, K+1 ) = Z( J, K+1 ) - SUM*DCONJG( V2 )
  100          CONTINUE
            END IF
*
            IF( K.EQ.M .AND. M.GT.L ) THEN
*
*              If the QR step was started at row M > L because two
*              consecutive small subdiagonals were found, then extra
*              scaling must be performed to ensure that H(M,M-1) remains
*              real.
*
               TEMP = ONE - T1
               TEMP = TEMP / ABS( TEMP )
               H( M+1, M ) = H( M+1, M )*DCONJG( TEMP )
               IF( M+2.LE.I )
     $            H( M+2, M+1 ) = H( M+2, M+1 )*TEMP
               DO 110 J = M, I
                  IF( J.NE.M+1 ) THEN
                     IF( I2.GT.J )
     $                  CALL ZSCAL( I2-J, TEMP, H( J, J+1 ), LDH )
                     CALL ZSCAL( J-I1, DCONJG( TEMP ), H( I1, J ), 1 )
```

```
                  IF( WANTZ ) THEN
                     CALL ZSCAL( NZ, DCONJG( TEMP ), Z( ILOZ, J ),
     $                           1 )
                  END IF
               END IF
  110          CONTINUE
            END IF
  120    CONTINUE
*
*        Ensure that H(I,I-1) is real.
*
         TEMP = H( I, I-1 )
         IF( DIMAG( TEMP ).NE.RZERO ) THEN
            RTEMP = ABS( TEMP )
            H( I, I-1 ) = RTEMP
            TEMP = TEMP / RTEMP
            IF( I2.GT.I )
     $         CALL ZSCAL( I2-I, DCONJG( TEMP ), H( I, I+1 ), LDH )
            CALL ZSCAL( I-I1, TEMP, H( I1, I ), 1 )
            IF( WANTZ ) THEN
               CALL ZSCAL( NZ, TEMP, Z( ILOZ, I ), 1 )
            END IF
         END IF
*
  130 CONTINUE
*
*     Failure to converge in remaining number of iterations
*
      INFO = I
      RETURN
*
  140 CONTINUE
*
*     H(I,I-1) is negligible: one eigenvalue has converged.
*
      W( I ) = H( I, I )
*
*     return to start of the main loop with new value of I.
*
      I = L - 1
      GO TO 30
*
  150 CONTINUE
      RETURN
*
*     End of ZLAHQR
*
      END
```

———-

— LAPACK zlahqr —

```
(let*
 ((itmax 30) (zero (coerce (f2cl-lib:cmplx 0.0d0 0.0d0) 'f2cl-lib:complex16))
  (one (coerce (f2cl-lib:cmplx 1.0d0 0.0d0) 'f2cl-lib:complex16)) (rzero 0.0d0)
  (rone 1.0d0) (half 0.5d0) (dat1 (f2cl-lib:f2cl/ 3.0d0 4.0d0)))
 (declare (type (f2cl-lib:integer4 30 30) itmax)
  (type (f2cl-lib:complex16) zero) (type (f2cl-lib:complex16) one)
  (type (double-float 0.0d0 0.0d0) rzero)
  (type (double-float 1.0d0 1.0d0) rone) (type (double-float 0.5d0 0.5d0) half)
  (type (double-float) dat1) (ignorable itmax zero one rzero rone half dat1))
 (defun zlahqr (wantt wantz n ilo ihi h ldh w iloz ihiz z ldz info)
  (declare (type f2cl-lib:logical wantz wantt)
   (type (f2cl-lib:integer4) info ldz ihiz iloz ldh ihi ilo n)
   (type (array f2cl-lib:complex16 (*)) z w h))
  (f2cl-lib:with-multi-array-data
      ((h f2cl-lib:complex16 h-%data% h-%offset%)
       (w f2cl-lib:complex16 w-%data% w-%offset%)
       (z f2cl-lib:complex16 z-%data% z-%offset%))
       (labels
        ((cabs1 (cdum)
          (+ (abs (f2cl-lib:dble cdum)) (abs (f2cl-lib:dimag cdum)))))
        (declare
         (ftype (function (f2cl-lib:complex16)
                 (values double-float &rest t)) cabs1))
        (prog
         ((v (make-array 2 :element-type 'f2cl-lib:complex16)) (i 0) (i1 0)
          (i2 0)
          (its 0) (j 0) (jhi 0) (jlo 0) (k 0) (l 0) (m 0) (nh 0) (nz 0)
          (aa 0.0d0)
          (ab 0.0d0) (ba 0.0d0) (bb 0.0d0) (h10 0.0d0) (h21 0.0d0)
          (rtemp 0.0d0)
          (s 0.0d0) (safmax 0.0d0) (safmin 0.0d0) (smlnum 0.0d0)
          (sx 0.0d0) (t2 0.0d0)
          (tst 0.0d0) (ulp 0.0d0) (cdum #C(0.0d0 0.0d0)) (h11 #C(0.0d0 0.0d0))
          (h11s #C(0.0d0 0.0d0)) (h22 #C(0.0d0 0.0d0)) (sc #C(0.0d0 0.0d0))
          (sum #C(0.0d0 0.0d0)) (t$ #C(0.0d0 0.0d0)) (t1 #C(0.0d0 0.0d0))
          (temp #C(0.0d0 0.0d0)) (u #C(0.0d0 0.0d0)) (v2 #C(0.0d0 0.0d0))
          (x #C(0.0d0 0.0d0)) (y #C(0.0d0 0.0d0)) (dconjg$ 0.0))
         (declare (type (array f2cl-lib:complex16 (2)) v)
          (type (f2cl-lib:integer4) nz nh m l k jlo jhi j its i2 i1 i)
          (type (double-float)
           ulp tst t2 sx smlnum safmin safmax s rtemp h21 h10 bb
           ba ab aa)
          (type (f2cl-lib:complex16)
            y x v2 u temp t1 t$ sum sc h22 h11s h11 cdum)
          (type (single-float) dconjg$))
```

```
(setf info 0) (if (= n 0) (go end_label))
(cond
 ((= ilo ihi)
  (setf (f2cl-lib:fref w-%data% (ilo) ((1 *)) w-%offset%)
   (f2cl-lib:fref h-%data% (ilo ilo) ((1 ldh) (1 *)) h-%offset%))
  (go end_label)))
(f2cl-lib:fdo (j ilo (f2cl-lib:int-add j 1))
       ((> j
           (f2cl-lib:int-add ihi (f2cl-lib:int-sub 3)))
          nil)
        (tagbody
           (setf
            (f2cl-lib:fref h-%data% ((f2cl-lib:int-add j 2) j)
             ((1 ldh) (1 *))
             h-%offset%)
            zero)
           (setf
            (f2cl-lib:fref h-%data% ((f2cl-lib:int-add j 3) j)
             ((1 ldh) (1 *))
             h-%offset%)
            zero)
           label10))
(if (<= ilo (f2cl-lib:int-sub ihi 2))
 (setf
  (f2cl-lib:fref h-%data%
   (ihi (f2cl-lib:int-sub ihi 2)) ((1 ldh) (1 *))
   h-%offset%)
  zero))
(cond (wantt (setf jlo 1) (setf jhi n))
      (t (setf jlo ilo) (setf jhi ihi)))
(f2cl-lib:fdo (i (f2cl-lib:int-add ilo 1) (f2cl-lib:int-add i 1))
       ((> i ihi)
          nil)
        (tagbody
           (cond
            ((/=
              (f2cl-lib:dimag
               (f2cl-lib:fref h (i (f2cl-lib:int-add i
                (f2cl-lib:int-sub 1)))
                ((1 ldh) (1 *))))
              rzero)
             (setf sc
              (/
               (f2cl-lib:fref h-%data% (i (f2cl-lib:int-sub i 1))
                ((1 ldh) (1 *))
                h-%offset%)
               (cabs1
                (f2cl-lib:fref h-%data% (i (f2cl-lib:int-sub i 1))
                 ((1 ldh) (1 *))
                 h-%offset%))))
```

```
                    (setf sc (coerce (/ (f2cl-lib:dconjg sc) (abs sc))
                              'f2cl-lib:complex16))
                    (setf
                     (f2cl-lib:fref h-%data% (i (f2cl-lib:int-sub i 1))
                      ((1 ldh) (1 *))
                      h-%offset%)
                     (coerce
                      (abs
                       (f2cl-lib:fref h-%data% (i (f2cl-lib:int-sub i 1))
                        ((1 ldh) (1 *))
                        h-%offset%))
                      'f2cl-lib:complex16))
                    (multiple-value-bind (var-0 var-1 var-2 var-3)
                     (zscal (f2cl-lib:int-add (f2cl-lib:int-sub jhi i) 1) sc
                      (f2cl-lib:array-slice h-%data% f2cl-lib:complex16
                      (i i) ((1 ldh) (1 *))
                       h-%offset%)
                      ldh)
                     (declare (ignore var-0 var-2))
                     (when var-1 (setf sc var-1))
                     (when var-3 (setf ldh var-3)))
                    (zscal
                     (f2cl-lib:int-add
                      (f2cl-lib:int-sub
                       (min (the f2cl-lib:integer4 jhi)
                        (the f2cl-lib:integer4 (f2cl-lib:int-add i 1)))
                       jlo)
                      1)
                     (f2cl-lib:dconjg sc)
                     (f2cl-lib:array-slice h-%data% f2cl-lib:complex16
                      (jlo i) ((1 ldh) (1 *))
                      h-%offset%)
                     1)
                    (if wantz
                     (zscal (f2cl-lib:int-add (f2cl-lib:int-sub ihiz iloz) 1)
                      (f2cl-lib:dconjg sc)
                      (f2cl-lib:array-slice z-%data% f2cl-lib:complex16
                       (iloz i)
                       ((1 ldz) (1 *)) z-%offset%)
                      1))))
                  label20))
(setf nh (f2cl-lib:int-add (f2cl-lib:int-sub ihi ilo) 1))
(setf nz (f2cl-lib:int-add (f2cl-lib:int-sub ihiz iloz) 1))
(setf safmin (dlamch "SAFE MINIMUM")) (setf safmax (/ rone safmin))
(multiple-value-bind (var-0 var-1) (dlabad safmin safmax)
 (declare (ignore))
 (when var-0 (setf safmin var-0)) (when var-1 (setf safmax var-1)))
(setf ulp (dlamch "PRECISION"))
(setf smlnum (* safmin (/ (f2cl-lib:dble nh) ulp)))
(cond (wantt (setf i1 1) (setf i2 n))) (setf i ihi) label30
```

```
(if (< i ilo) (go label150)) (setf l ilo)
(f2cl-lib:fdo (its 0 (f2cl-lib:int-add its 1))
       ((> its itmax) nil)
        (tagbody
           (f2cl-lib:fdo (k i (f2cl-lib:int-add k
               (f2cl-lib:int-sub 1)))
        ((> k
             (f2cl-lib:int-add l 1))
            nil)
         (tagbody
             (if
              (<=
               (cabs1
                (f2cl-lib:fref h-%data% (k (f2cl-lib:int-sub k 1))
                ((1 ldh) (1 *))
                 h-%offset%))
               smlnum)
              (go label50))
             (setf tst
              (+
               (cabs1
                (f2cl-lib:fref h-%data% ((f2cl-lib:int-sub k 1)
                 (f2cl-lib:int-sub k 1))
                 ((1 ldh) (1 *)) h-%offset%))
               (cabs1 (f2cl-lib:fref h-%data% (k k) ((1 ldh) (1 *))
                        h-%offset%))))
             (cond
              ((= tst zero)
               (if (>= (f2cl-lib:int-sub k 2) ilo)
                (setf tst
                 (+ tst
                  (abs
                   (f2cl-lib:dble
                    (f2cl-lib:fref h-%data%
                     ((f2cl-lib:int-sub k 1)
                      (f2cl-lib:int-sub k 2)) ((1 ldh) (1 *))
                     h-%offset%))))))
               (if (<= (f2cl-lib:int-add k 1) ihi)
                (setf tst
                 (+ tst
                  (abs
                   (f2cl-lib:dble
                    (f2cl-lib:fref h-%data%
                     ((f2cl-lib:int-add k 1) k) ((1 ldh) (1 *))
                     h-%offset%)))))))
             (cond
              ((<=
                (abs
                 (f2cl-lib:dble
                  (f2cl-lib:fref h
```

```
      (k (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
      ((1 ldh) (1 *)))))
   (* ulp tst))
  (setf ab
   (max
    (cabs1
     (f2cl-lib:fref h-%data% (k (f2cl-lib:int-sub k 1))
      ((1 ldh) (1 *))
      h-%offset%))
    (cabs1
     (f2cl-lib:fref h-%data% ((f2cl-lib:int-sub k 1) k)
      ((1 ldh) (1 *))
      h-%offset%))))
  (setf ba
   (min
    (cabs1
     (f2cl-lib:fref h-%data% (k (f2cl-lib:int-sub k 1))
      ((1 ldh) (1 *))
      h-%offset%))
    (cabs1
     (f2cl-lib:fref h-%data% ((f2cl-lib:int-sub k 1) k)
      ((1 ldh) (1 *))
      h-%offset%))))
  (setf aa
   (max (cabs1 (f2cl-lib:fref h-%data% (k k) ((1 ldh)
     (1 *)) h-%offset%))
    (cabs1
     (-
      (f2cl-lib:fref h-%data%
       ((f2cl-lib:int-sub k 1) (f2cl-lib:int-sub k 1))
       ((1 ldh) (1 *))
       h-%offset%)
      (f2cl-lib:fref h-%data% (k k) ((1 ldh) (1 *))
        h-%offset%)))))
  (setf bb
   (min (cabs1 (f2cl-lib:fref h-%data% (k k) ((1 ldh)
         (1 *)) h-%offset%))
    (cabs1
     (-
      (f2cl-lib:fref h-%data%
       ((f2cl-lib:int-sub k 1) (f2cl-lib:int-sub k 1))
       ((1 ldh) (1 *))
       h-%offset%)
      (f2cl-lib:fref h-%data% (k k) ((1 ldh) (1 *))
        h-%offset%)))))
  (setf s (+ aa ab))
  (if (<= (* ba (/ ab s))
    (max smlnum (* ulp (* bb (/ aa s)))))
   (go label50))))
label40))
```

```
label50 (setf l k)
(cond
 ((> l ilo)
  (setf
   (f2cl-lib:fref h-%data% (l (f2cl-lib:int-sub l 1))
    ((1 ldh) (1 *))
    h-%offset%)
   zero)))
(if (>= l i) (go label140))
(cond ((not wantt) (setf i1 l) (setf i2 i)))
(cond
 ((= its 10)
  (setf s
   (* dat1
    (abs
     (f2cl-lib:dble
      (f2cl-lib:fref h-%data%
       ((f2cl-lib:int-add l 1) l) ((1 ldh) (1 *))
       h-%offset%)))))
  (setf t$ (+ s (f2cl-lib:fref h-%data% (l l) ((1 ldh)
                                (1 *)) h-%offset%))))
 ((= its 20)
  (setf s
   (* dat1
    (abs
     (f2cl-lib:dble
      (f2cl-lib:fref h-%data%
       (i (f2cl-lib:int-sub i 1)) ((1 ldh) (1 *))
       h-%offset%)))))
  (setf t$ (+ s (f2cl-lib:fref h-%data%
              (i i) ((1 ldh) (1 *)) h-%offset%))))
 (t (setf t$ (f2cl-lib:fref h-%data%
              (i i) ((1 ldh) (1 *)) h-%offset%))
  (setf u
   (*
    (f2cl-lib:fsqrt
     (f2cl-lib:fref h-%data%
      ((f2cl-lib:int-sub i 1) i) ((1 ldh) (1 *))
      h-%offset%))
    (f2cl-lib:fsqrt
     (f2cl-lib:fref h-%data%
      (i (f2cl-lib:int-sub i 1)) ((1 ldh) (1 *))
      h-%offset%))))
  (setf s (cabs1 u))
  (cond
   ((/= s rzero)
    (setf x
     (* half
      (-
       (f2cl-lib:fref h-%data%
```

```
                ((f2cl-lib:int-sub i 1) (f2cl-lib:int-sub i 1))
                ((1 ldh) (1 *))
                h-%offset%)
               t$)))
          (setf sx (cabs1 x)) (setf s (max s (cabs1 x)))
          (setf y (* s (f2cl-lib:fsqrt (+ (expt (/ x s) 2)
                                          (expt (/ u s) 2)))))
          (cond
           ((> sx rzero)
            (if
             (<
              (+ (* (f2cl-lib:dble (/ x sx)) (f2cl-lib:dble y))
               (* (f2cl-lib:dimag (/ x sx)) (f2cl-lib:dimag y)))
              rzero)
             (setf y (- y)))))
          (setf t$ (- t$ (* u (zladiv u (+ x y)))))))))
     (f2cl-lib:fdo (m (f2cl-lib:int-add i (f2cl-lib:int-sub 1))
      (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
     ((> m (f2cl-lib:int-add l 1))
      nil)
   (tagbody
       (setf h11
         (f2cl-lib:fref h-%data% (m m) ((1 ldh) (1 *))
           h-%offset%))
       (setf h22
        (f2cl-lib:fref h-%data%
         ((f2cl-lib:int-add m 1) (f2cl-lib:int-add m 1))
         ((1 ldh) (1 *)) h-%offset%))
       (setf h11s (- h11 t$))
       (setf h21
        (f2cl-lib:dble
         (f2cl-lib:fref h-%data%
          ((f2cl-lib:int-add m 1) m) ((1 ldh) (1 *))
          h-%offset%)))
       (setf s (+ (cabs1 h11s) (abs h21)))
       (setf h11s (/ h11s s))
       (setf h21 (/ h21 s))
       (setf (f2cl-lib:fref v (1) ((1 2))) h11s)
       (setf (f2cl-lib:fref v (2) ((1 2)))
          (coerce h21 'f2cl-lib:complex16))
       (setf h10
        (f2cl-lib:dble
         (f2cl-lib:fref h-%data%
          (m (f2cl-lib:int-sub m 1)) ((1 ldh) (1 *))
          h-%offset%)))
       (if
        (<= (* (abs h10) (abs h21))
         (* ulp (* (cabs1 h11s) (+ (cabs1 h11) (cabs1 h22)))))
        (go label70))
       label60))
```

```
   (setf h11
    (f2cl-lib:fref h-%data% (l l) ((1 ldh) (1 *)) h-%offset%))
   (setf h22
    (f2cl-lib:fref h-%data%
     ((f2cl-lib:int-add l 1) (f2cl-lib:int-add l 1))
     ((1 ldh) (1 *)) h-%offset%))
   (setf h11s (- h11 t$))
   (setf h21
    (f2cl-lib:dble
     (f2cl-lib:fref h-%data%
      ((f2cl-lib:int-add l 1) l) ((1 ldh) (1 *))
      h-%offset%)))
   (setf s (+ (cabs1 h11s) (abs h21))) (setf h11s (/ h11s s))
   (setf h21 (/ h21 s))
   (setf (f2cl-lib:fref v (1) ((1 2))) h11s)
   (setf (f2cl-lib:fref v (2) ((1 2)))
      (coerce h21 'f2cl-lib:complex16))
   label70
   (f2cl-lib:fdo (k m (f2cl-lib:int-add k 1))
((> k
    (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
   nil)
 (tagbody
    (if (> k m)
     (zcopy 2
      (f2cl-lib:array-slice h-%data% f2cl-lib:complex16
       (k (f2cl-lib:int-sub k 1)) ((1 ldh) (1 *)) h-%offset%)
      1 v 1))
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
     (zlarfg 2 (f2cl-lib:array-slice v f2cl-lib:complex16
                 (1) ((1 2)))
      (f2cl-lib:array-slice v f2cl-lib:complex16
        (2) ((1 2))) 1 t1)
     (declare (ignore var-0 var-1 var-2 var-3))
    (when var-4 (setf t1 var-4)))
    (cond
     ((> k m)
      (setf
       (f2cl-lib:fref h-%data%
        (k (f2cl-lib:int-sub k 1)) ((1 ldh) (1 *))
        h-%offset%)
       (f2cl-lib:fref v (1) ((1 2))))
      (setf
       (f2cl-lib:fref h-%data%
        ((f2cl-lib:int-add k 1) (f2cl-lib:int-sub k 1))
        ((1 ldh) (1 *)) h-%offset%)
       zero)))
    (setf v2 (f2cl-lib:fref v (2) ((1 2))))
    (setf t2 (f2cl-lib:dble (* t1 v2)))
    (f2cl-lib:fdo (j k (f2cl-lib:int-add j 1))
```

```
((> j i2) nil)
 (tagbody
      (setf sum
       (+
        (* (f2cl-lib:dconjg t1)
         (f2cl-lib:fref h-%data% (k j)
          ((1 ldh) (1 *)) h-%offset%))
        (* t2
         (f2cl-lib:fref h-%data%
          ((f2cl-lib:int-add k 1) j) ((1 ldh) (1 *))
          h-%offset%))))
      (setf (f2cl-lib:fref h-%data% (k j)
           ((1 ldh) (1 *)) h-%offset%)
       (- (f2cl-lib:fref h-%data% (k j)
           ((1 ldh) (1 *)) h-%offset%) sum))
      (setf
       (f2cl-lib:fref h-%data%
        ((f2cl-lib:int-add k 1) j) ((1 ldh) (1 *))
        h-%offset%)
       (-
        (f2cl-lib:fref h-%data%
         ((f2cl-lib:int-add k 1) j) ((1 ldh) (1 *))
         h-%offset%)
        (* sum v2)))
      label80))
    (f2cl-lib:fdo (j i1 (f2cl-lib:int-add j 1))
((> j
      (min (the f2cl-lib:integer4 (f2cl-lib:int-add k 2))
       (the f2cl-lib:integer4 i)))
     nil)
 (tagbody
      (setf sum
       (+ (* t1 (f2cl-lib:fref h-%data%
              (j k) ((1 ldh) (1 *)) h-%offset%))
        (* t2
         (f2cl-lib:fref h-%data%
              (j (f2cl-lib:int-add k 1)) ((1 ldh) (1 *))
          h-%offset%))))
      (setf (f2cl-lib:fref h-%data%
              (j k) ((1 ldh) (1 *)) h-%offset%)
       (- (f2cl-lib:fref h-%data% (j k)
           ((1 ldh) (1 *)) h-%offset%) sum))
      (setf
       (f2cl-lib:fref h-%data%
        (j (f2cl-lib:int-add k 1)) ((1 ldh) (1 *))
        h-%offset%)
       (-
        (f2cl-lib:fref h-%data%
         (j (f2cl-lib:int-add k 1)) ((1 ldh) (1 *))
         h-%offset%)
```

```
      (* sum (f2cl-lib:dconjg v2))))
    label90))
  (cond
   (wantz
    (f2cl-lib:fdo (j iloz (f2cl-lib:int-add j 1))
((> j ihiz) nil)
 (tagbody
       (setf sum
        (+ (* t1 (f2cl-lib:fref z-%data%
             (j k) ((1 ldz) (1 *)) z-%offset%))
         (* t2
          (f2cl-lib:fref z-%data%
             (j (f2cl-lib:int-add k 1)) ((1 ldz) (1 *))
           z-%offset%))))
       (setf (f2cl-lib:fref z-%data%
             (j k) ((1 ldz) (1 *)) z-%offset%)
        (- (f2cl-lib:fref z-%data%
             (j k) ((1 ldz) (1 *)) z-%offset%) sum))
       (setf
        (f2cl-lib:fref z-%data%
         (j (f2cl-lib:int-add k 1)) ((1 ldz) (1 *))
         z-%offset%)
        (-
         (f2cl-lib:fref z-%data%
          (j (f2cl-lib:int-add k 1)) ((1 ldz) (1 *))
          z-%offset%)
         (* sum (f2cl-lib:dconjg v2))))
       label100))))
  (cond
   ((and (= k m) (> m l)) (setf temp (- one t1))
    (setf temp (/ temp (abs temp)))
    (setf
     (f2cl-lib:fref h-%data%
      ((f2cl-lib:int-add m 1) m) ((1 ldh) (1 *))
      h-%offset%)
     (coerce
      (*
       (f2cl-lib:fref h-%data%
        ((f2cl-lib:int-add m 1) m) ((1 ldh) (1 *))
        h-%offset%)
       (f2cl-lib:dconjg temp))
      'f2cl-lib:complex16))
    (if (<= (f2cl-lib:int-add m 2) i)
     (setf
      (f2cl-lib:fref h-%data%
       ((f2cl-lib:int-add m 2) (f2cl-lib:int-add m 1))
       ((1 ldh) (1 *)) h-%offset%)
      (*
       (f2cl-lib:fref h-%data%
        ((f2cl-lib:int-add m 2)
```

```
          (f2cl-lib:int-add m 1)) ((1 ldh) (1 *))
        h-%offset%)
       temp)))
    (f2cl-lib:fdo (j m (f2cl-lib:int-add j 1))
((> j i) nil)
 (tagbody
        (cond
         ((/= j (f2cl-lib:int-add m 1))
          (if (> i2 j)
           (multiple-value-bind (var-0 var-1 var-2 var-3)
            (zscal (f2cl-lib:int-sub i2 j) temp
             (f2cl-lib:array-slice h-%data%
              f2cl-lib:complex16
              (j (f2cl-lib:int-add j 1))
                 ((1 ldh) (1 *)) h-%offset%)
             ldh)
            (declare (ignore var-0 var-2))
            (when var-1 (setf temp var-1))
            (when var-3 (setf ldh var-3))))
           (zscal (f2cl-lib:int-sub j i1)
            (f2cl-lib:dconjg temp)
            (f2cl-lib:array-slice h-%data%
             f2cl-lib:complex16 (i1 j)
             ((1 ldh) (1 *)) h-%offset%)
            1)
           (cond
            (wantz
             (multiple-value-bind (var-0 var-1 var-2 var-3)
              (zscal nz (f2cl-lib:dconjg temp)
               (f2cl-lib:array-slice z-%data%
                f2cl-lib:complex16 (iloz j)
                ((1 ldz) (1 *)) z-%offset%)
               1)
              (declare (ignore var-1 var-2 var-3))
              (when var-0 (setf nz var-0)))))))
        label110))))
  label120))
(setf temp
 (f2cl-lib:fref h-%data%
  (i (f2cl-lib:int-sub i 1)) ((1 ldh) (1 *))
  h-%offset%))
(cond
 ((/= (f2cl-lib:dimag temp) rzero) (setf rtemp (abs temp))
  (setf
   (f2cl-lib:fref h-%data%
   (i (f2cl-lib:int-sub i 1)) ((1 ldh) (1 *))
    h-%offset%)
   (coerce rtemp 'f2cl-lib:complex16))
  (setf temp (/ temp rtemp))
  (if (> i2 i)
```

```
                     (multiple-value-bind (var-0 var-1 var-2 var-3)
                      (zscal (f2cl-lib:int-sub i2 i) (f2cl-lib:dconjg temp)
                       (f2cl-lib:array-slice h-%data% f2cl-lib:complex16
                        (i (f2cl-lib:int-add i 1)) ((1 ldh) (1 *)) h-%offset%)
                       ldh)
                      (declare (ignore var-0 var-1 var-2))
                     (when var-3 (setf ldh var-3))))
                     (multiple-value-bind (var-0 var-1 var-2 var-3)
                      (zscal (f2cl-lib:int-sub i i1) temp
                       (f2cl-lib:array-slice h-%data% f2cl-lib:complex16
                        (i1 i) ((1 ldh) (1 *))
                        h-%offset%)
                       1)
                      (declare (ignore var-0 var-2 var-3))
                     (when var-1 (setf temp var-1)))
                     (cond
                      (wantz
                       (multiple-value-bind (var-0 var-1 var-2 var-3)
                        (zscal nz temp
                         (f2cl-lib:array-slice z-%data% f2cl-lib:complex16
                          (iloz i)
                          ((1 ldz) (1 *)) z-%offset%)
                         1)
                        (declare (ignore var-2 var-3))
                        (when var-0 (setf nz var-0))
                        (when var-1 (setf temp var-1)))))))
                   label130))
      (setf info i) (go end_label) label140
      (setf (f2cl-lib:fref w-%data% (i) ((1 *)) w-%offset%)
       (f2cl-lib:fref h-%data% (i i) ((1 ldh) (1 *)) h-%offset%))
      (setf i (f2cl-lib:int-sub l 1)) (go label30) label150 (go end_label)
      end_label
      (return
        (values nil nil nil nil nil nil ldh nil nil nil nil nil info))))
    )))
```

———-

6.110 zlahr2 LAPACK

— **zlahr2.input** —

```
)set break resume
)sys rm -f zlahr2.output
)spool zlahr2.output
)set message test on
)set message auto off
```

```
)clear all

)spool
)lisp (bye)
```

———-

— zlahr2.help —

```
==========================================================================
zlahr2 examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 Online html documentation available at
           http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZLAHR2( N, K, NB, A, LDA, TAU, T, LDT, Y, LDY )

       .. Scalar Arguments ..
       INTEGER            K, LDA, LDT, LDY, N, NB
       ..
       .. Array Arguments ..
       COMPLEX*16         A( LDA, * ), T( LDT, NB ), TAU( NB ),
      $                   Y( LDY, NB )
       ..


 Purpose:
 =============

  ZLAHR2 reduces the first NB columns of A complex general n-BY-(n-k+1)
  matrix A so that elements below the k-th subdiagonal are zero. The
  reduction is performed by an unitary similarity transformation
  Q**H * A * Q. The routine returns the matrices V and T which determine
  Q as a block reflector I - V*T*V**H, and also the matrix Y = A * V * T.

  This is an auxiliary routine called by ZGEHRD.

 Arguments:
 ==========

  [in] N
```

```
          N is INTEGER
          The order of the matrix A.

  [in] K

          K is INTEGER
          The offset for the reduction. Elements below the k-th
          subdiagonal in the first NB columns are reduced to zero.
          K < N.

  [in] NB

          NB is INTEGER
          The number of columns to be reduced.

  [in,out] A

          A is COMPLEX*16 array, dimension (LDA,N-K+1)
          On entry, the n-by-(n-k+1) general matrix A.
          On exit, the elements on and above the k-th subdiagonal in
          the first NB columns are overwritten with the corresponding
          elements of the reduced matrix; the elements below the k-th
          subdiagonal, with the array TAU, represent the matrix Q as a
          product of elementary reflectors. The other columns of A are
          unchanged. See Further Details.

  [in] LDA

          LDA is INTEGER
          The leading dimension of the array A.  LDA >= max(1,N).

  [out] TAU

          TAU is COMPLEX*16 array, dimension (NB)
          The scalar factors of the elementary reflectors. See Further
          Details.

  [out] T

          T is COMPLEX*16 array, dimension (LDT,NB)
          The upper triangular matrix T.

  [in] LDT

          LDT is INTEGER
          The leading dimension of the array T.  LDT >= NB.

  [out] Y
```

```
          Y is COMPLEX*16 array, dimension (LDY,NB)
          The n-by-nb matrix Y.

 [in] LDY

          LDY is INTEGER
          The leading dimension of the array Y. LDY >= N.

Authors:
========

 Univ. of Tennessee
 Univ. of California Berkeley
 Univ. of Colorado Denver
 NAG Ltd.

November 2011

Further Details:
====================

 The matrix Q is represented as a product of nb elementary reflectors

    Q = H(1) H(2) . . . H(nb).

 Each H(i) has the form

    H(i) = I - tau * v * v**H

 where tau is a complex scalar, and v is a complex vector with
 v(1:i+k-1) = 0, v(i+k) = 1; v(i+k+1:n) is stored on exit in
 A(i+k+1:n,i), and tau in TAU(i).

 The elements of the vectors v together form the (n-k+1)-by-nb matrix
 V which is needed, with T and Y, to apply the transformation to the
 unreduced part of the matrix, using an update of the form:
 A := (I - V*T*V**H) * (A - Y*V**H).

 The contents of A on exit are illustrated by the following example
 with n = 7, k = 3 and nb = 2:

    ( a   a   a   a   a )
    ( a   a   a   a   a )
    ( a   a   a   a   a )
    ( h   h   a   a   a )
    ( v1  h   a   a   a )
    ( v1  v2  a   a   a )
    ( v1  v2  a   a   a )

 where a denotes an element of the original matrix A, h denotes a
```

```
  modified element of the upper Hessenberg matrix H, and vi denotes an
  element of the vector defining H(i).

  This subroutine is a slight modification of LAPACK-3.0's DLAHRD
  incorporating improvements proposed by Quintana-Orti and Van de
  Gejin. Note that the entries of A(1:K,2:NB) differ from those
  returned by the original LAPACK-3.0's DLAHRD routine. (This
  subroutine is not backward compatible with LAPACK-3.0's DLAHRD.)

 References:
 ================

  Gregorio Quintana-Orti and Robert van de Geijn, "Improving the
  performance of reduction to Hessenberg form," ACM Transactions on
  Mathematical Software, 32(2):180-194, June 2006.
```

———-

— zlahr2.f —

```
*  =====================================================================
      SUBROUTINE ZLAHR2( N, K, NB, A, LDA, TAU, T, LDT, Y, LDY )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      INTEGER            K, LDA, LDT, LDY, N, NB
*     ..
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), T( LDT, NB ), TAU( NB ),
     $                   Y( LDY, NB )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      COMPLEX*16         ZERO, ONE
      PARAMETER          ( ZERO = ( 0.0D+0, 0.0D+0 ),
     $                     ONE = ( 1.0D+0, 0.0D+0 ) )
*     ..
*     .. Local Scalars ..
      INTEGER            I
      COMPLEX*16         EI
*     ..
*     .. External Subroutines ..
```

```
      EXTERNAL           ZAXPY, ZCOPY, ZGEMM, ZGEMV, ZLACPY,
     $                   ZLARFG, ZSCAL, ZTRMM, ZTRMV, ZLACGV
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MIN
*     ..
*     .. Executable Statements ..
*
*     Quick return if possible
*
      IF( N.LE.1 )
     $   RETURN
*
      DO 10 I = 1, NB
         IF( I.GT.1 ) THEN
*
*           Update A(K+1:N,I)
*
*           Update I-th column of A - Y * V**H
*
            CALL ZLACGV( I-1, A( K+I-1, 1 ), LDA )
            CALL ZGEMV( 'NO TRANSPOSE', N-K, I-1, -ONE, Y(K+1,1), LDY,
     $                  A( K+I-1, 1 ), LDA, ONE, A( K+1, I ), 1 )
            CALL ZLACGV( I-1, A( K+I-1, 1 ), LDA )
*
*           Apply I - V * T**H * V**H to this column (call it b) from the
*           left, using the last column of T as workspace
*
*           Let  V = ( V1 )   and   b = ( b1 )   (first I-1 rows)
*                    ( V2 )             ( b2 )
*
*           where V1 is unit lower triangular
*
*           w := V1**H * b1
*
            CALL ZCOPY( I-1, A( K+1, I ), 1, T( 1, NB ), 1 )
            CALL ZTRMV( 'Lower', 'Conjugate transpose', 'UNIT',
     $                  I-1, A( K+1, 1 ),
     $                  LDA, T( 1, NB ), 1 )
*
*           w := w + V2**H * b2
*
            CALL ZGEMV( 'Conjugate transpose', N-K-I+1, I-1,
     $                  ONE, A( K+I, 1 ),
     $                  LDA, A( K+I, I ), 1, ONE, T( 1, NB ), 1 )
*
*           w := T**H * w
*
            CALL ZTRMV( 'Upper', 'Conjugate transpose', 'NON-UNIT',
     $                  I-1, T, LDT,
```

```
     $                 T( 1, NB ), 1 )
*
*          b2 := b2 - V2*w
*
           CALL ZGEMV( 'NO TRANSPOSE', N-K-I+1, I-1, -ONE,
     $                 A( K+I, 1 ),
     $                 LDA, T( 1, NB ), 1, ONE, A( K+I, I ), 1 )
*
*          b1 := b1 - V1*w
*
           CALL ZTRMV( 'Lower', 'NO TRANSPOSE',
     $                 'UNIT', I-1,
     $                 A( K+1, 1 ), LDA, T( 1, NB ), 1 )
           CALL ZAXPY( I-1, -ONE, T( 1, NB ), 1, A( K+1, I ), 1 )
*
           A( K+I-1, I-1 ) = EI
         END IF
*
*        Generate the elementary reflector H(I) to annihilate
*        A(K+I+1:N,I)
*
         CALL ZLARFG( N-K-I+1, A( K+I, I ), A( MIN( K+I+1, N ), I ), 1,
     $                TAU( I ) )
         EI = A( K+I, I )
         A( K+I, I ) = ONE
*
*        Compute  Y(K+1:N,I)
*
         CALL ZGEMV( 'NO TRANSPOSE', N-K, N-K-I+1,
     $               ONE, A( K+1, I+1 ),
     $               LDA, A( K+I, I ), 1, ZERO, Y( K+1, I ), 1 )
         CALL ZGEMV( 'Conjugate transpose', N-K-I+1, I-1,
     $               ONE, A( K+I, 1 ), LDA,
     $               A( K+I, I ), 1, ZERO, T( 1, I ), 1 )
         CALL ZGEMV( 'NO TRANSPOSE', N-K, I-1, -ONE,
     $               Y( K+1, 1 ), LDY,
     $               T( 1, I ), 1, ONE, Y( K+1, I ), 1 )
         CALL ZSCAL( N-K, TAU( I ), Y( K+1, I ), 1 )
*
*        Compute T(1:I,I)
*
         CALL ZSCAL( I-1, -TAU( I ), T( 1, I ), 1 )
         CALL ZTRMV( 'Upper', 'No Transpose', 'NON-UNIT',
     $               I-1, T, LDT,
     $               T( 1, I ), 1 )
         T( I, I ) = TAU( I )
*
   10 CONTINUE
      A( K+NB, NB ) = EI
*
```

```
*     Compute Y(1:K,1:NB)
*
      CALL ZLACPY( 'ALL', K, NB, A( 1, 2 ), LDA, Y, LDY )
      CALL ZTRMM( 'RIGHT', 'Lower', 'NO TRANSPOSE',
     $            'UNIT', K, NB,
     $            ONE, A( K+1, 1 ), LDA, Y, LDY )
      IF( N.GT.K+NB )
     $   CALL ZGEMM( 'NO TRANSPOSE', 'NO TRANSPOSE', K,
     $               NB, N-K-NB, ONE,
     $               A( 1, 2+NB ), LDA, A( K+1+NB, 1 ), LDA, ONE, Y,
     $               LDY )
      CALL ZTRMM( 'RIGHT', 'Upper', 'NO TRANSPOSE',
     $            'NON-UNIT', K, NB,
     $            ONE, T, LDT, Y, LDY )
*
      RETURN
*
*     End of ZLAHR2
*
      END
```

———-

— LAPACK zlahr2 —

```
(let*
 ((zero (coerce (f2cl-lib:cmplx 0.0d0 0.0d0) 'f2cl-lib:complex16))
  (one (coerce (f2cl-lib:cmplx 1.0d0 0.0d0) 'f2cl-lib:complex16)))
 (declare (type (f2cl-lib:complex16) zero) (type (f2cl-lib:complex16) one)
  (ignorable zero one))
 (defun zlahr2 (n k nb a lda tau t$ ldt y ldy)
  (declare (type (f2cl-lib:integer4) ldy ldt lda nb k n)
   (type (array f2cl-lib:complex16 (*)) y t$ tau a))
  (f2cl-lib:with-multi-array-data
      ((a f2cl-lib:complex16 a-%data% a-%offset%)
       (tau f2cl-lib:complex16 tau-%data% tau-%offset%)
       (t$ f2cl-lib:complex16 t$-%data% t$-%offset%)
       (y f2cl-lib:complex16 y-%data% y-%offset%))
       (prog ((ei #C(0.0d0 0.0d0)) (i 0))
        (declare (type (f2cl-lib:complex16) ei) (type (f2cl-lib:integer4) i))
        (if (<= n 1) (go end_label))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
               ((> i nb) nil)
                (tagbody
                  (cond
                   ((> i 1)
                    (zlacgv (f2cl-lib:int-sub i 1)
                     (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
```

```
  ((+ k i (f2cl-lib:int-sub 1)) 1) ((1 lda) (1 *))
   a-%offset%)
 lda)
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
 (zgemv "NO TRANSPOSE"
  (f2cl-lib:int-sub n k) (f2cl-lib:int-sub i 1)
  (- one)
  (f2cl-lib:array-slice y-%data% f2cl-lib:complex16
   ((+ k 1) 1)
   ((1 ldy) (1 nb)) y-%offset%)
  ldy
  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
   ((+ k i (f2cl-lib:int-sub 1)) 1) ((1 lda) (1 *))
    a-%offset%)
  lda one
  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
   ((+ k 1) i)
   ((1 lda) (1 *)) a-%offset%)
  1)
 (declare (ignore var-0 var-1 var-2 var-3 var-4 var-6
           var-9 var-10))
 (when var-5 (setf ldy var-5))
 (when var-7 (setf lda var-7))
 (when var-8 (setf one var-8)))
(zlacgv (f2cl-lib:int-sub i 1)
 (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
  ((+ k i (f2cl-lib:int-sub 1)) 1) ((1 lda) (1 *))
   a-%offset%)
 lda)
(zcopy (f2cl-lib:int-sub i 1)
 (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
  ((+ k 1) i)
  ((1 lda) (1 *)) a-%offset%)
 1
 (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16
  (1 nb) ((1 ldt) (1 nb))
  t$-%offset%)
 1)
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4
  var-5 var-6 var-7)
 (ztrmv "Lower" "Conjugate transpose" "UNIT"
  (f2cl-lib:int-sub i 1)
  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
   ((+ k 1) 1)
   ((1 lda) (1 *)) a-%offset%)
  lda
  (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16 (1 nb)
   ((1 ldt) (1 nb)) t$-%offset%)
```

```
 1)
 (declare (ignore var-0 var-1 var-2 var-3 var-4
           var-6 var-7))
 (when var-5 (setf lda var-5)))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
 (zgemv "Conjugate transpose"
  (f2cl-lib:int-add (f2cl-lib:int-sub n k i) 1)
  (f2cl-lib:int-sub i 1) one
  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
   ((+ k i) 1)
   ((1 lda) (1 *)) a-%offset%)
  lda
  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
   ((+ k i) i)
   ((1 lda) (1 *)) a-%offset%)
  1 one
  (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16 (1 nb)
   ((1 ldt) (1 nb)) t$-%offset%)
  1)
 (declare (ignore var-0 var-1 var-2 var-4 var-6
           var-7 var-9 var-10))
 (when var-3 (setf one var-3))
 (when var-5 (setf lda var-5))
 (when var-8 (setf one var-8)))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4
 var-5 var-6 var-7)
 (ztrmv "Upper" "Conjugate transpose" "NON-UNIT"
  (f2cl-lib:int-sub i 1) t$
  ldt
  (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16 (1 nb)
   ((1 ldt) (1 nb)) t$-%offset%)
  1)
 (declare (ignore var-0 var-1 var-2 var-3 var-4
           var-6 var-7))
 (when var-5 (setf ldt var-5)))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
 var-8 var-9 var-10)
 (zgemv "NO TRANSPOSE"
  (f2cl-lib:int-add (f2cl-lib:int-sub n k i) 1)
  (f2cl-lib:int-sub i 1) (- one)
  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
   ((+ k i) 1)
   ((1 lda) (1 *)) a-%offset%)
  lda
  (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16 (1 nb)
   ((1 ldt) (1 nb)) t$-%offset%)
  1 one
```

```
     (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
      ((+ k i) i)
      ((1 lda) (1 *)) a-%offset%)
     1)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-6
              var-7 var-9 var-10))
    (when var-5 (setf lda var-5))
    (when var-8 (setf one var-8)))
   (multiple-value-bind (var-0 var-1 var-2 var-3 var-4
    var-5 var-6 var-7)
    (ztrmv "Lower" "NO TRANSPOSE" "UNIT"
     (f2cl-lib:int-sub i 1)
     (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
      ((+ k 1) 1)
      ((1 lda) (1 *)) a-%offset%)
     lda
     (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16 (1 nb)
      ((1 ldt) (1 nb)) t$-%offset%)
     1)
    (declare (ignore var-0 var-1 var-2 var-3 var-4 var-6
              var-7))
    (when var-5 (setf lda var-5)))
   (zaxpy (f2cl-lib:int-sub i 1) (- one)
    (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16
     (1 nb) ((1 ldt) (1 nb))
     t$-%offset%)
    1
    (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
     ((+ k 1) i)
     ((1 lda) (1 *)) a-%offset%)
    1)
   (setf
    (f2cl-lib:fref a-%data%
     ((f2cl-lib:int-sub (f2cl-lib:int-add k i) 1)
     (f2cl-lib:int-sub i 1))
     ((1 lda) (1 *)) a-%offset%)
    ei)))
 (zlarfg (f2cl-lib:int-add (f2cl-lib:int-sub n k i) 1)
  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
   ((+ k i) i)
   ((1 lda) (1 *)) a-%offset%)
  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
   ((min (f2cl-lib:int-add k i 1) n) i) ((1 lda) (1 *))
    a-%offset%)
  1
  (f2cl-lib:array-slice tau-%data% f2cl-lib:complex16
   (i) ((1 nb))
   tau-%offset%))
 (setf ei
  (f2cl-lib:fref a-%data% ((f2cl-lib:int-add k i) i)
```

```
  ((1 lda) (1 *))
  a-%offset%))
(setf
 (f2cl-lib:fref a-%data% ((f2cl-lib:int-add k i) i)
  ((1 lda) (1 *))
  a-%offset%)
 one)
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
 var-9 var-10)
 (zgemv "NO TRANSPOSE" (f2cl-lib:int-sub n k)
  (f2cl-lib:int-add (f2cl-lib:int-sub n k i) 1) one
  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
   ((+ k 1) (f2cl-lib:int-add i 1)) ((1 lda) (1 *)) a-%offset%)
  lda
  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
   ((+ k i) i)
   ((1 lda) (1 *)) a-%offset%)
  1 zero
  (f2cl-lib:array-slice y-%data% f2cl-lib:complex16
   ((+ k 1) i)
   ((1 ldy) (1 nb)) y-%offset%)
  1)
 (declare (ignore var-0 var-1 var-2 var-4 var-6 var-7
 var-9 var-10))
 (when var-3 (setf one var-3)) (when var-5 (setf lda var-5))
 (when var-8 (setf zero var-8)))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
 var-9 var-10)
 (zgemv "Conjugate transpose"
  (f2cl-lib:int-add (f2cl-lib:int-sub n k i) 1)
  (f2cl-lib:int-sub i 1) one
  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
   ((+ k i) 1)
   ((1 lda) (1 *)) a-%offset%)
  lda
  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
   ((+ k i) i)
   ((1 lda) (1 *)) a-%offset%)
  1 zero
  (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16
   (1 i) ((1 ldt) (1 nb))
   t$-%offset%)
  1)
 (declare (ignore var-0 var-1 var-2 var-4 var-6 var-7
           var-9 var-10))
 (when var-3 (setf one var-3)) (when var-5 (setf lda var-5))
 (when var-8 (setf zero var-8)))
(multiple-value-bind
```

```
                (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
                 var-9 var-10)
                (zgemv "NO TRANSPOSE" (f2cl-lib:int-sub n k)
                                      (f2cl-lib:int-sub i 1) (- one)
                 (f2cl-lib:array-slice y-%data% f2cl-lib:complex16
                  ((+ k 1) 1)
                  ((1 ldy) (1 nb)) y-%offset%)
                 ldy
                 (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16
                  (1 i) ((1 ldt) (1 nb))
                  t$-%offset%)
                 1 one
                 (f2cl-lib:array-slice y-%data% f2cl-lib:complex16
                  ((+ k 1) i)
                  ((1 ldy) (1 nb)) y-%offset%)
                 1)
                (declare (ignore var-0 var-1 var-2 var-3 var-4 var-6
                var-7 var-9 var-10))
                (when var-5 (setf ldy var-5)) (when var-8 (setf one var-8)))
               (zscal (f2cl-lib:int-sub n k)
                (f2cl-lib:array-slice tau-%data% f2cl-lib:complex16
                 (i) ((1 nb))
                 tau-%offset%)
                (f2cl-lib:array-slice y-%data% f2cl-lib:complex16
                 ((+ k 1) i)
                 ((1 ldy) (1 nb)) y-%offset%)
                1)
               (zscal (f2cl-lib:int-sub i 1)
                (- (f2cl-lib:fref tau-%data% (i) ((1 nb)) tau-%offset%))
                (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16
                 (1 i) ((1 ldt) (1 nb))
                 t$-%offset%)
                1)
               (multiple-value-bind
                (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
                (ztrmv "Upper" "No Transpose" "NON-UNIT"
                 (f2cl-lib:int-sub i 1) t$ ldt
                 (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16
                  (1 i) ((1 ldt) (1 nb))
                  t$-%offset%)
                 1)
                (declare (ignore var-0 var-1 var-2 var-3 var-4 var-6 var-7))
                (when var-5 (setf ldt var-5)))
               (setf (f2cl-lib:fref t$-%data% (i i) ((1 ldt) (1 nb))
                t$-%offset%)
                (f2cl-lib:fref tau-%data% (i) ((1 nb)) tau-%offset%))
               label10))
          (setf
           (f2cl-lib:fref a-%data% ((f2cl-lib:int-add k nb) nb) ((1 lda) (1 *))
            a-%offset%)
```

```
 ei)
(zlacpy "ALL" k nb
 (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
  (1 2) ((1 lda) (1 *))
  a-%offset%)
 lda y ldy)
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9 var-10)
 (ztrmm "RIGHT" "Lower" "NO TRANSPOSE" "UNIT" k nb one
  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16 ((+ k 1) 1)
   ((1 lda) (1 *)) a-%offset%)
  lda y ldy)
 (declare (ignore var-0 var-1 var-2 var-3 var-7 var-9))
 (when var-4 (setf k var-4)) (when var-5 (setf nb var-5))
 (when var-6 (setf one var-6)) (when var-8 (setf lda var-8))
 (when var-10 (setf ldy var-10)))
(if (> n (f2cl-lib:int-add k nb))
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
   var-10 var-11
   var-12)
  (zgemm "NO TRANSPOSE" "NO TRANSPOSE"
     k nb (f2cl-lib:int-sub n k nb) one
   (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
    (1 (f2cl-lib:int-add 2 nb)) ((1 lda) (1 *)) a-%offset%)
   lda
   (f2cl-lib:array-slice a-%data% f2cl-lib:complex16 ((+ k 1 nb) 1)
    ((1 lda) (1 *)) a-%offset%)
   lda one y ldy)
  (declare (ignore var-0 var-1 var-4 var-6 var-8 var-11))
  (when var-2 (setf k var-2)) (when var-3 (setf nb var-3))
  (when var-5 (setf one var-5)) (when var-7 (setf lda var-7))
  (when var-9 (setf lda var-9)) (when var-10 (setf one var-10))
  (when var-12 (setf ldy var-12))))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9 var-10)
 (ztrmm "RIGHT" "Upper" "NO TRANSPOSE" "NON-UNIT" k nb one
   t$ ldt y ldy)
 (declare (ignore var-0 var-1 var-2 var-3 var-7 var-9))
 (when var-4 (setf k var-4)) (when var-5 (setf nb var-5))
 (when var-6 (setf one var-6)) (when var-8 (setf ldt var-8))
 (when var-10 (setf ldy var-10)))
(go end_label) end_label
(return (values nil k nb nil lda nil nil ldt nil ldy))))))
```

———-

6.111 zlange LAPACK

— zlange.input —

```
)set break resume
)sys rm -f zlange.output
)spool zlange.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

————-

— zlange.help —

```
==========================================================================
zlange examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       DOUBLE PRECISION FUNCTION ZLANGE( NORM, M, N, A, LDA, WORK )

      .. Scalar Arguments ..
       CHARACTER          NORM
       INTEGER            LDA, M, N
       ..
       .. Array Arguments ..
       DOUBLE PRECISION   WORK( * )
       COMPLEX*16         A( LDA, * )
       ..


 Purpose:
 =============

 ZLANGE  returns the value of the one norm,  or the Frobenius norm, or
```

```
the  infinity norm,  or the  element of  largest absolute value  of a
complex matrix A.


   ZLANGE = ( max(abs(A(i,j))), NORM = 'M' or 'm'
            (
            ( norm1(A),         NORM = '1', 'O' or 'o'
            (
            ( normI(A),         NORM = 'I' or 'i'
            (
            ( normF(A),         NORM = 'F', 'f', 'E' or 'e'

where  norm1  denotes the  one norm of a matrix (maximum column sum),
normI  denotes the  infinity norm  of a matrix  (maximum row sum) and
normF  denotes the  Frobenius norm of a matrix (square root of sum of
squares).  Note that  max(abs(A(i,j)))  is not a consistent matrix norm.

Arguments:
==========

 [in] NORM

         NORM is CHARACTER*1
         Specifies the value to be returned in ZLANGE as described
         above.

 [in] M

         M is INTEGER
         The number of rows of the matrix A.  M >= 0.  When M = 0,
         ZLANGE is set to zero.

 [in] N

         N is INTEGER
         The number of columns of the matrix A.  N >= 0.  When N = 0,
         ZLANGE is set to zero.

 [in] A

         A is COMPLEX*16 array, dimension (LDA,N)
         The m by n matrix A.

 [in] LDA

         LDA is INTEGER
         The leading dimension of the array A.  LDA >= max(M,1).

 [out] WORK
```

```
          WORK is DOUBLE PRECISION array, dimension (MAX(1,LWORK)),
          where LWORK >= M when NORM = 'I'; otherwise, WORK is not
          referenced.

 Authors:
 ========

  Univ. of Tennessee
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  NAG Ltd.

 November 2011
```

———-

— zlange.f —

```
*  =====================================================================
      DOUBLE PRECISION FUNCTION ZLANGE( NORM, M, N, A, LDA, WORK )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      CHARACTER          NORM
      INTEGER            LDA, M, N
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   WORK( * )
      COMPLEX*16         A( LDA, * )
*     ..
*
* =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE, ZERO
      PARAMETER          ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            I, J
      DOUBLE PRECISION   SCALE, SUM, VALUE
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
```

```
*     ..
*     .. External Subroutines ..
      EXTERNAL           ZLASSQ
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX, MIN, SQRT
*     ..
*     .. Executable Statements ..
*
      IF( MIN( M, N ).EQ.0 ) THEN
         VALUE = ZERO
      ELSE IF( LSAME( NORM, 'M' ) ) THEN
*
*        Find max(abs(A(i,j))).
*
         VALUE = ZERO
         DO 20 J = 1, N
            DO 10 I = 1, M
               VALUE = MAX( VALUE, ABS( A( I, J ) ) )
   10       CONTINUE
   20    CONTINUE
      ELSE IF( ( LSAME( NORM, 'O' ) ) .OR. ( NORM.EQ.'1' ) ) THEN
*
*        Find norm1(A).
*
         VALUE = ZERO
         DO 40 J = 1, N
            SUM = ZERO
            DO 30 I = 1, M
               SUM = SUM + ABS( A( I, J ) )
   30       CONTINUE
            VALUE = MAX( VALUE, SUM )
   40    CONTINUE
      ELSE IF( LSAME( NORM, 'I' ) ) THEN
*
*        Find normI(A).
*
         DO 50 I = 1, M
            WORK( I ) = ZERO
   50    CONTINUE
         DO 70 J = 1, N
            DO 60 I = 1, M
               WORK( I ) = WORK( I ) + ABS( A( I, J ) )
   60       CONTINUE
   70    CONTINUE
         VALUE = ZERO
         DO 80 I = 1, M
            VALUE = MAX( VALUE, WORK( I ) )
   80    CONTINUE
      ELSE IF( ( LSAME( NORM, 'F' ) ) .OR. ( LSAME( NORM, 'E' ) ) ) THEN
```

```
*
*        Find normF(A).
*
         SCALE = ZERO
         SUM = ONE
         DO 90 J = 1, N
            CALL ZLASSQ( M, A( 1, J ), 1, SCALE, SUM )
   90    CONTINUE
         VALUE = SCALE*SQRT( SUM )
      END IF
*
      ZLANGE = VALUE
      RETURN
*
*     End of ZLANGE
*
      END
```

———-

— LAPACK zlange —

```
(let* ((one 1.0) (zero 0.0))
  (declare (type (double-float 1.0 1.0) one)
           (type (double-float 0.0 0.0) zero))
  (defun zlange (norm m n a lda work)
    (declare (type (simple-array double-float (*)) work)
             (type (simple-array (complex double-float) (*)) a)
             (type fixnum lda n m)
             (type character norm))
    (f2cl-lib:with-multi-array-data
        ((norm character norm-%data% norm-%offset%)
         (a (complex double-float) a-%data% a-%offset%)
         (work double-float work-%data% work-%offset%))
      (prog ((scale 0.0) (sum 0.0) (value 0.0) (i 0) (j 0) (zlange 0.0))
        (declare (type fixnum i j)
                 (type (double-float) scale sum value zlange))
        (cond
          ((= (min (the fixnum m) (the fixnum n)) 0)
           (setf value zero))
          ((char-equal norm #\M)
           (setf value zero)
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                             ((> i m) nil)
                 (tagbody
```

```
          (setf value
                  (max value
                       (abs
                        (f2cl-lib:fref a-%data%
                                       (i j)
                                       ((1 lda) (1 *))
                                       a-%offset%)))))))))
((or (char-equal norm #\O) (f2cl-lib:fstring-= norm "1"))
 (setf value zero)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (setf sum zero)
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                   ((> i m) nil)
       (tagbody
         (setf sum
                 (+ sum
                    (abs
                     (f2cl-lib:fref a-%data%
                                    (i j)
                                    ((1 lda) (1 *))
                                    a-%offset%))))))
     (setf value (max value sum)))))
((char-equal norm #\I)
 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
               ((> i m) nil)
   (tagbody
     (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
             zero)))
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j n) nil)
   (tagbody
     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                   ((> i m) nil)
       (tagbody
         (setf (f2cl-lib:fref work-%data% (i) ((1 *)) work-%offset%)
                 (+
                  (f2cl-lib:fref work-%data%
                                 (i)
                                 ((1 *))
                                 work-%offset%)
                  (abs
                   (f2cl-lib:fref a-%data%
                                  (i j)
                                  ((1 lda) (1 *))
                                  a-%offset%))))))))
 (setf value zero)
 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
               ((> i m) nil)
```

```
            (tagbody
              (setf value
                      (max value
                           (f2cl-lib:fref work-%data%
                                          (i)
                                          ((1 *))
                                          work-%offset%))))))
          ((or (char-equal norm #\F) (char-equal norm #\E))
           (setf scale zero)
           (setf sum one)
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                         ((> j n) nil)
             (tagbody
               (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
                   (zlassq m
                    (f2cl-lib:array-slice a
                                          (complex double-float)
                                          (1 j)
                                          ((1 lda) (1 *)))
                    1 scale sum)
                 (declare (ignore var-0 var-1 var-2))
                 (setf scale var-3)
                 (setf sum var-4))))
             (setf value (* scale (f2cl-lib:fsqrt sum)))))
        (setf zlange value)
        (return (values zlange nil nil nil nil nil nil))))))
```

———-

6.112 zlaqr0 LAPACK

— **zlaqr0.input** —

```
)set break resume
)sys rm -f zlaqr0.output
)spool zlaqr0.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zlaqr0.help** —

```
=============================================================
zlaqr0 examples
=============================================================

=============================================================
Man Page Details
=============================================================

 Online html documentation available at
           http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZLAQR0( WANTT, WANTZ, N, ILO, IHI, H, LDH, W, ILOZ,
                          IHIZ, Z, LDZ, WORK, LWORK, INFO )

       .. Scalar Arguments ..
       INTEGER            IHI, IHIZ, ILO, ILOZ, INFO, LDH, LDZ, LWORK, N
       LOGICAL            WANTT, WANTZ
       ..
       .. Array Arguments ..
       COMPLEX*16         H( LDH, * ), W( * ), WORK( * ), Z( LDZ, * )
       ..


 Purpose:
 =============

    ZLAQR0 computes the eigenvalues of a Hessenberg matrix H
    and, optionally, the matrices T and Z from the Schur decomposition
    H = Z T Z**H, where T is an upper triangular matrix (the
    Schur form), and Z is the unitary matrix of Schur vectors.

    Optionally Z may be postmultiplied into an input unitary
    matrix Q so that this routine can give the Schur factorization
    of a matrix A which has been reduced to the Hessenberg form H
    by the unitary matrix Q:  A = Q*H*Q**H = (QZ)*H*(QZ)**H.

 Arguments:
 ==========

  [in] WANTT

          WANTT is LOGICAL
          = .TRUE. : the full Schur form T is required;
          = .FALSE.: only eigenvalues are required.

  [in] WANTZ
```

```
          WANTZ is LOGICAL
          = .TRUE. : the matrix of Schur vectors Z is required;
          = .FALSE.: Schur vectors are not required.

  [in] N

          N is INTEGER
           The order of the matrix H.  N .GE. 0.

  [in] ILO

          ILO is INTEGER

  [in] IHI

          IHI is INTEGER

           It is assumed that H is already upper triangular in rows
           and columns 1:ILO-1 and IHI+1:N and, if ILO.GT.1,
           H(ILO,ILO-1) is zero. ILO and IHI are normally set by a
           previous call to ZGEBAL, and then passed to ZGEHRD when the
           matrix output by ZGEBAL is reduced to Hessenberg form.
           Otherwise, ILO and IHI should be set to 1 and N,
           respectively.  If N.GT.0, then 1.LE.ILO.LE.IHI.LE.N.
           If N = 0, then ILO = 1 and IHI = 0.

  [in,out] H

          H is COMPLEX*16 array, dimension (LDH,N)
           On entry, the upper Hessenberg matrix H.
           On exit, if INFO = 0 and WANTT is .TRUE., then H
           contains the upper triangular matrix T from the Schur
           decomposition (the Schur form). If INFO = 0 and WANT is
           .FALSE., then the contents of H are unspecified on exit.
           (The output value of H when INFO.GT.0 is given under the
           description of INFO below.)

           This subroutine may explicitly set H(i,j) = 0 for i.GT.j and
           j = 1, 2, ... ILO-1 or j = IHI+1, IHI+2, ... N.

  [in] LDH

          LDH is INTEGER
           The leading dimension of the array H. LDH .GE. max(1,N).

  [out] W

          W is COMPLEX*16 array, dimension (N)
           The computed eigenvalues of H(ILO:IHI,ILO:IHI) are stored
           in W(ILO:IHI). If WANTT is .TRUE., then the eigenvalues are
```

```
          stored in the same order as on the diagonal of the Schur
          form returned in H, with W(i) = H(i,i).

  [in] ILOZ

         ILOZ is INTEGER

  [in] IHIZ

         IHIZ is INTEGER
          Specify the rows of Z to which transformations must be
          applied if WANTZ is .TRUE..
          1 .LE. ILOZ .LE. ILO; IHI .LE. IHIZ .LE. N.

  [in,out] Z

         Z is COMPLEX*16 array, dimension (LDZ,IHI)
          If WANTZ is .FALSE., then Z is not referenced.
          If WANTZ is .TRUE., then Z(ILO:IHI,ILOZ:IHIZ) is
          replaced by Z(ILO:IHI,ILOZ:IHIZ)*U where U is the
          orthogonal Schur factor of H(ILO:IHI,ILO:IHI).
          (The output value of Z when INFO.GT.0 is given under
          the description of INFO below.)

  [in] LDZ

         LDZ is INTEGER
          The leading dimension of the array Z.  if WANTZ is .TRUE.
          then LDZ.GE.MAX(1,IHIZ).  Otherwize, LDZ.GE.1.

  [out] WORK

         WORK is COMPLEX*16 array, dimension LWORK
          On exit, if LWORK = -1, WORK(1) returns an estimate of
          the optimal value for LWORK.

  [in] LWORK

         LWORK is INTEGER
          The dimension of the array WORK.  LWORK .GE. max(1,N)
          is sufficient, but LWORK typically as large as 6*N may
          be required for optimal performance.  A workspace query
          to determine the optimal workspace size is recommended.

          If LWORK = -1, then ZLAQR0 does a workspace query.
          In this case, ZLAQR0 checks the input parameters and
          estimates the optimal workspace size for the given
          values of N, ILO and IHI.  The estimate is returned
          in WORK(1).  No error message related to LWORK is
          issued by XERBLA.  Neither H nor Z are accessed.
```

```
 [out] INFO

          INFO is INTEGER
             =  0:  successful exit
           .GT. 0:  if INFO = i, ZLAQR0 failed to compute all of
                the eigenvalues.  Elements 1:ilo-1 and i+1:n of WR
                and WI contain those eigenvalues which have been
                successfully computed.  (Failures are rare.)

                If INFO .GT. 0 and WANT is .FALSE., then on exit,
                the remaining unconverged eigenvalues are the eigen-
                values of the upper Hessenberg matrix rows and
                columns ILO through INFO of the final, output
                value of H.

                If INFO .GT. 0 and WANTT is .TRUE., then on exit

           (*)  (initial value of H)*U  = U*(final value of H)

                where U is a unitary matrix.  The final
                value of  H is upper Hessenberg and triangular in
                rows and columns INFO+1 through IHI.

                If INFO .GT. 0 and WANTZ is .TRUE., then on exit

                  (final value of Z(ILO:IHI,ILOZ:IHIZ)
                   =  (initial value of Z(ILO:IHI,ILOZ:IHIZ)*U

                where U is the unitary matrix in (*) (regard-
                less of the value of WANTT.)

                If INFO .GT. 0 and WANTZ is .FALSE., then Z is not
                accessed.

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========

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November 2011

Contributors:
==================

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      University of Kansas, USA
```

```
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 ================

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       Algorithm Part I: Maintaining Well Focused Shifts, and Level 3
       Performance, SIAM Journal of Matrix Analysis, volume 23, pages
       929--947, 2002.

       K. Braman, R. Byers and R. Mathias, The Multi-Shift QR
       Algorithm Part II: Aggressive Early Deflation, SIAM Journal
       of Matrix Analysis, volume 23, pages 948--973, 2002.
```

— zlaqr0.f —

```
*  =====================================================================
      SUBROUTINE ZLAQR0( WANTT, WANTZ, N, ILO, IHI, H, LDH, W, ILOZ,
     $                   IHIZ, Z, LDZ, WORK, LWORK, INFO )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      INTEGER            IHI, IHIZ, ILO, ILOZ, INFO, LDH, LDZ, LWORK, N
      LOGICAL            WANTT, WANTZ
*     ..
*     .. Array Arguments ..
      COMPLEX*16         H( LDH, * ), W( * ), WORK( * ), Z( LDZ, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
*
*     ==== Matrices of order NTINY or smaller must be processed by
*     .    ZLAHQR because of insufficient subdiagonal scratch space.
*     .    (This is a hard limit.) ====
      INTEGER            NTINY
      PARAMETER          ( NTINY = 11 )
*
*     ==== Exceptional deflation windows:  try to cure rare
*     .    slow convergence by varying the size of the
*     .    deflation window after KEXNW iterations. ====
      INTEGER            KEXNW
```

```
      PARAMETER          ( KEXNW = 5 )
*
*     ==== Exceptional shifts: try to cure rare slow convergence
*     .    with ad-hoc exceptional shifts every KEXSH iterations.
*     .    ====
      INTEGER            KEXSH
      PARAMETER          ( KEXSH = 6 )
*
*     ==== The constant WILK1 is used to form the exceptional
*     .    shifts. ====
      DOUBLE PRECISION   WILK1
      PARAMETER          ( WILK1 = 0.75d0 )
      COMPLEX*16         ZERO, ONE
      PARAMETER          ( ZERO = ( 0.0d0, 0.0d0 ),
     $                   ONE = ( 1.0d0, 0.0d0 ) )
      DOUBLE PRECISION   TWO
      PARAMETER          ( TWO = 2.0d0 )
*     ..
*     .. Local Scalars ..
      COMPLEX*16         AA, BB, CC, CDUM, DD, DET, RTDISC, SWAP, TR2
      DOUBLE PRECISION   S
      INTEGER            I, INF, IT, ITMAX, K, KACC22, KBOT, KDU, KS,
     $                   KT, KTOP, KU, KV, KWH, KWTOP, KWV, LD, LS,
     $                   LWKOPT, NDEC, NDFL, NH, NHO, NIBBLE, NMIN, NS,
     $                   NSMAX, NSR, NVE, NW, NWMAX, NWR, NWUPBD
      LOGICAL            SORTED
      CHARACTER          JBCMPZ*2
*     ..
*     .. External Functions ..
      INTEGER            ILAENV
      EXTERNAL           ILAENV
*     ..
*     .. Local Arrays ..
      COMPLEX*16         ZDUM( 1, 1 )
*     ..
*     .. External Subroutines ..
      EXTERNAL           ZLACPY, ZLAHQR, ZLAQR3, ZLAQR4, ZLAQR5
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, DBLE, DCMPLX, DIMAG, INT, MAX, MIN, MOD,
     $                   SQRT
*     ..
*     .. Statement Functions ..
      DOUBLE PRECISION   CABS1
*     ..
*     .. Statement Function definitions ..
      CABS1( CDUM ) = ABS( DBLE( CDUM ) ) + ABS( DIMAG( CDUM ) )
*     ..
*     .. Executable Statements ..
      INFO = 0
```

```
*
*     ==== Quick return for N = 0: nothing to do. ====
*
      IF( N.EQ.0 ) THEN
         WORK( 1 ) = ONE
         RETURN
      END IF
*
      IF( N.LE.NTINY ) THEN
*
*        ==== Tiny matrices must use ZLAHQR. ====
*
         LWKOPT = 1
         IF( LWORK.NE.-1 )
     $      CALL ZLAHQR( WANTT, WANTZ, N, ILO, IHI, H, LDH, W, ILOZ,
     $                   IHIZ, Z, LDZ, INFO )
      ELSE
*
*        ==== Use small bulge multi-shift QR with aggressive early
*        .    deflation on larger-than-tiny matrices. ====
*
*        ==== Hope for the best. ====
*
         INFO = 0
*
*        ==== Set up job flags for ILAENV. ====
*
         IF( WANTT ) THEN
            JBCMPZ( 1: 1 ) = 'S'
         ELSE
            JBCMPZ( 1: 1 ) = 'E'
         END IF
         IF( WANTZ ) THEN
            JBCMPZ( 2: 2 ) = 'V'
         ELSE
            JBCMPZ( 2: 2 ) = 'N'
         END IF
*
*        ==== NWR = recommended deflation window size.  At this
*        .    point,  N .GT. NTINY = 11, so there is enough
*        .    subdiagonal workspace for NWR.GE.2 as required.
*        .    (In fact, there is enough subdiagonal space for
*        .    NWR.GE.3.) ====
*
         NWR = ILAENV( 13, 'ZLAQR0', JBCMPZ, N, ILO, IHI, LWORK )
         NWR = MAX( 2, NWR )
         NWR = MIN( IHI-ILO+1, ( N-1 ) / 3, NWR )
*
*        ==== NSR = recommended number of simultaneous shifts.
*        .    At this point N .GT. NTINY = 11, so there is at
```

```
*        .    enough subdiagonal workspace for NSR to be even
*        .    and greater than or equal to two as required. ====
*
         NSR = ILAENV( 15, 'ZLAQR0', JBCMPZ, N, ILO, IHI, LWORK )
         NSR = MIN( NSR, ( N+6 ) / 9, IHI-ILO )
         NSR = MAX( 2, NSR-MOD( NSR, 2 ) )
*
*        ==== Estimate optimal workspace ====
*
*        ==== Workspace query call to ZLAQR3 ====
*
         CALL ZLAQR3( WANTT, WANTZ, N, ILO, IHI, NWR+1, H, LDH, ILOZ,
     $                IHIZ, Z, LDZ, LS, LD, W, H, LDH, N, H, LDH, N, H,
     $                LDH, WORK, -1 )
*
*        ==== Optimal workspace = MAX(ZLAQR5, ZLAQR3) ====
*
         LWKOPT = MAX( 3*NSR / 2, INT( WORK( 1 ) ) )
*
*        ==== Quick return in case of workspace query. ====
*
         IF( LWORK.EQ.-1 ) THEN
            WORK( 1 ) = DCMPLX( LWKOPT, 0 )
            RETURN
         END IF
*
*        ==== ZLAHQR/ZLAQR0 crossover point ====
*
         NMIN = ILAENV( 12, 'ZLAQR0', JBCMPZ, N, ILO, IHI, LWORK )
         NMIN = MAX( NTINY, NMIN )
*
*        ==== Nibble crossover point ====
*
         NIBBLE = ILAENV( 14, 'ZLAQR0', JBCMPZ, N, ILO, IHI, LWORK )
         NIBBLE = MAX( 0, NIBBLE )
*
*        ==== Accumulate reflections during ttswp?  Use block
*        .    2-by-2 structure during matrix-matrix multiply? ====
*
         KACC22 = ILAENV( 16, 'ZLAQR0', JBCMPZ, N, ILO, IHI, LWORK )
         KACC22 = MAX( 0, KACC22 )
         KACC22 = MIN( 2, KACC22 )
*
*        ==== NWMAX = the largest possible deflation window for
*        .    which there is sufficient workspace. ====
*
         NWMAX = MIN( ( N-1 ) / 3, LWORK / 2 )
         NW = NWMAX
*
*        ==== NSMAX = the Largest number of simultaneous shifts
```

```
*        .    for which there is sufficient workspace. ====
*
         NSMAX = MIN( ( N+6 ) / 9, 2*LWORK / 3 )
         NSMAX = NSMAX - MOD( NSMAX, 2 )
*
*        ==== NDFL: an iteration count restarted at deflation. ====
*
         NDFL = 1
*
*        ==== ITMAX = iteration limit ====
*
         ITMAX = MAX( 30, 2*KEXSH )*MAX( 10, ( IHI-ILO+1 ) )
*
*        ==== Last row and column in the active block ====
*
         KBOT = IHI
*
*        ==== Main Loop ====
*
         DO 70 IT = 1, ITMAX
*
*           ==== Done when KBOT falls below ILO ====
*
            IF( KBOT.LT.ILO )
     $         GO TO 80
*
*           ==== Locate active block ====
*
            DO 10 K = KBOT, ILO + 1, -1
               IF( H( K, K-1 ).EQ.ZERO )
     $            GO TO 20
   10       CONTINUE
            K = ILO
   20       CONTINUE
            KTOP = K
*
*           ==== Select deflation window size:
*           .    Typical Case:
*           .      If possible and advisable, nibble the entire
*           .      active block.  If not, use size MIN(NWR,NWMAX)
*           .      or MIN(NWR+1,NWMAX) depending upon which has
*           .      the smaller corresponding subdiagonal entry
*           .      (a heuristic).
*           .
*           .    Exceptional Case:
*           .      If there have been no deflations in KEXNW or
*           .      more iterations, then vary the deflation window
*           .      size.   At first, because, larger windows are,
*           .      in general, more powerful than smaller ones,
*           .      rapidly increase the window to the maximum possible.
```

```
*           .      Then, gradually reduce the window size. ====
*
            NH = KBOT - KTOP + 1
            NWUPBD = MIN( NH, NWMAX )
            IF( NDFL.LT.KEXNW ) THEN
               NW = MIN( NWUPBD, NWR )
            ELSE
               NW = MIN( NWUPBD, 2*NW )
            END IF
            IF( NW.LT.NWMAX ) THEN
               IF( NW.GE.NH-1 ) THEN
                  NW = NH
               ELSE
                  KWTOP = KBOT - NW + 1
                  IF( CABS1( H( KWTOP, KWTOP-1 ) ).GT.
     $                CABS1( H( KWTOP-1, KWTOP-2 ) ) )NW = NW + 1
               END IF
            END IF
            IF( NDFL.LT.KEXNW ) THEN
               NDEC = -1
            ELSE IF( NDEC.GE.0 .OR. NW.GE.NWUPBD ) THEN
               NDEC = NDEC + 1
               IF( NW-NDEC.LT.2 )
     $            NDEC = 0
               NW = NW - NDEC
            END IF
*
*           ==== Aggressive early deflation:
*           .    split workspace under the subdiagonal into
*           .      - an nw-by-nw work array V in the lower
*           .        left-hand-corner,
*           .      - an NW-by-at-least-NW-but-more-is-better
*           .        (NW-by-NHO) horizontal work array along
*           .        the bottom edge,
*           .      - an at-least-NW-but-more-is-better (NHV-by-NW)
*           .        vertical work array along the left-hand-edge.
*           .        ====
*
            KV = N - NW + 1
            KT = NW + 1
            NHO = ( N-NW-1 ) - KT + 1
            KWV = NW + 2
            NVE = ( N-NW ) - KWV + 1
*
*           ==== Aggressive early deflation ====
*
            CALL ZLAQR3( WANTT, WANTZ, N, KTOP, KBOT, NW, H, LDH, ILOZ,
     $                   IHIZ, Z, LDZ, LS, LD, W, H( KV, 1 ), LDH, NHO,
     $                   H( KV, KT ), LDH, NVE, H( KWV, 1 ), LDH, WORK,
     $                   LWORK )
```

```
*
*           ==== Adjust KBOT accounting for new deflations. ====
*
            KBOT = KBOT - LD
*
*           ==== KS points to the shifts. ====
*
            KS = KBOT - LS + 1
*
*           ==== Skip an expensive QR sweep if there is a (partly
*           .    heuristic) reason to expect that many eigenvalues
*           .    will deflate without it.  Here, the QR sweep is
*           .    skipped if many eigenvalues have just been deflated
*           .    or if the remaining active block is small.
*
            IF( ( LD.EQ.0 ) .OR. ( ( 100*LD.LE.NW*NIBBLE ) .AND. ( KBOT-
     $           KTOP+1.GT.MIN( NMIN, NWMAX ) ) ) ) THEN
*
*              ==== NS = nominal number of simultaneous shifts.
*              .    This may be lowered (slightly) if ZLAQR3
*              .    did not provide that many shifts. ====
*
               NS = MIN( NSMAX, NSR, MAX( 2, KBOT-KTOP ) )
               NS = NS - MOD( NS, 2 )
*
*              ==== If there have been no deflations
*              .    in a multiple of KEXSH iterations,
*              .    then try exceptional shifts.
*              .    Otherwise use shifts provided by
*              .    ZLAQR3 above or from the eigenvalues
*              .    of a trailing principal submatrix. ====
*
               IF( MOD( NDFL, KEXSH ).EQ.0 ) THEN
                  KS = KBOT - NS + 1
                  DO 30 I = KBOT, KS + 1, -2
                     W( I ) = H( I, I ) + WILK1*CABS1( H( I, I-1 ) )
                     W( I-1 ) = W( I )
   30             CONTINUE
               ELSE
*
*                 ==== Got NS/2 or fewer shifts? Use ZLAQR4 or
*                 .    ZLAHQR on a trailing principal submatrix to
*                 .    get more. (Since NS.LE.NSMAX.LE.(N+6)/9,
*                 .    there is enough space below the subdiagonal
*                 .    to fit an NS-by-NS scratch array.) ====
*
                  IF( KBOT-KS+1.LE.NS / 2 ) THEN
                     KS = KBOT - NS + 1
                     KT = N - NS + 1
                     CALL ZLACPY( 'A', NS, NS, H( KS, KS ), LDH,
```

```
     $                        H( KT, 1 ), LDH )
                   IF( NS.GT.NMIN ) THEN
                      CALL ZLAQR4( .false., .false., NS, 1, NS,
     $                             H( KT, 1 ), LDH, W( KS ), 1, 1,
     $                             ZDUM, 1, WORK, LWORK, INF )
                   ELSE
                      CALL ZLAHQR( .false., .false., NS, 1, NS,
     $                             H( KT, 1 ), LDH, W( KS ), 1, 1,
     $                             ZDUM, 1, INF )
                   END IF
                   KS = KS + INF
*
*                  ==== In case of a rare QR failure use
*                  .    eigenvalues of the trailing 2-by-2
*                  .    principal submatrix.  Scale to avoid
*                  .    overflows, underflows and subnormals.
*                  .    (The scale factor S can not be zero,
*                  .    because H(KBOT,KBOT-1) is nonzero.) ====
*
                   IF( KS.GE.KBOT ) THEN
                      S = CABS1( H( KBOT-1, KBOT-1 ) ) +
     $                    CABS1( H( KBOT, KBOT-1 ) ) +
     $                    CABS1( H( KBOT-1, KBOT ) ) +
     $                    CABS1( H( KBOT, KBOT ) )
                      AA = H( KBOT-1, KBOT-1 ) / S
                      CC = H( KBOT, KBOT-1 ) / S
                      BB = H( KBOT-1, KBOT ) / S
                      DD = H( KBOT, KBOT ) / S
                      TR2 = ( AA+DD ) / TWO
                      DET = ( AA-TR2 )*( DD-TR2 ) - BB*CC
                      RTDISC = SQRT( -DET )
                      W( KBOT-1 ) = ( TR2+RTDISC )*S
                      W( KBOT ) = ( TR2-RTDISC )*S
*
                      KS = KBOT - 1
                   END IF
                END IF
*
                IF( KBOT-KS+1.GT.NS ) THEN
*
*                  ==== Sort the shifts (Helps a little) ====
*
                   SORTED = .false.
                   DO 50 K = KBOT, KS + 1, -1
                      IF( SORTED )
     $                   GO TO 60
                      SORTED = .true.
                      DO 40 I = KS, K - 1
                         IF( CABS1( W( I ) ).LT.CABS1( W( I+1 ) ) )
     $                        THEN
```

```
                              SORTED = .false.
                              SWAP = W( I )
                              W( I ) = W( I+1 )
                              W( I+1 ) = SWAP
                           END IF
   40                   CONTINUE
   50                CONTINUE
   60                CONTINUE
                  END IF
               END IF
*
*              ==== If there are only two shifts, then use
*              .    only one.  ====
*
               IF( KBOT-KS+1.EQ.2 ) THEN
                  IF( CABS1( W( KBOT )-H( KBOT, KBOT ) ).LT.
     $                CABS1( W( KBOT-1 )-H( KBOT, KBOT ) ) ) THEN
                     W( KBOT-1 ) = W( KBOT )
                  ELSE
                     W( KBOT ) = W( KBOT-1 )
                  END IF
               END IF
*
*              ==== Use up to NS of the the smallest magnatiude
*              .    shifts.  If there aren't NS shifts available,
*              .    then use them all, possibly dropping one to
*              .    make the number of shifts even. ====
*
               NS = MIN( NS, KBOT-KS+1 )
               NS = NS - MOD( NS, 2 )
               KS = KBOT - NS + 1
*
*              ==== Small-bulge multi-shift QR sweep:
*              .    split workspace under the subdiagonal into
*              .    - a KDU-by-KDU work array U in the lower
*              .      left-hand-corner,
*              .    - a KDU-by-at-least-KDU-but-more-is-better
*              .      (KDU-by-NHo) horizontal work array WH along
*              .      the bottom edge,
*              .    - and an at-least-KDU-but-more-is-better-by-KDU
*              .      (NVE-by-KDU) vertical work WV arrow along
*              .      the left-hand-edge. ====
*
               KDU = 3*NS - 3
               KU = N - KDU + 1
               KWH = KDU + 1
               NHO = ( N-KDU+1-4 ) - ( KDU+1 ) + 1
               KWV = KDU + 4
               NVE = N - KDU - KWV + 1
*
```

```
*              ==== Small-bulge multi-shift QR sweep ====
*
               CALL ZLAQR5( WANTT, WANTZ, KACC22, N, KTOP, KBOT, NS,
     $                      W( KS ), H, LDH, ILOZ, IHIZ, Z, LDZ, WORK,
     $                      3, H( KU, 1 ), LDH, NVE, H( KWV, 1 ), LDH,
     $                      NHO, H( KU, KWH ), LDH )
            END IF
*
*           ==== Note progress (or the lack of it). ====
*
            IF( LD.GT.0 ) THEN
               NDFL = 1
            ELSE
               NDFL = NDFL + 1
            END IF
*
*           ==== End of main loop ====
   70    CONTINUE
*
*        ==== Iteration limit exceeded.  Set INFO to show where
*        .    the problem occurred and exit. ====
*
         INFO = KBOT
   80    CONTINUE
      END IF
*
*     ==== Return the optimal value of LWORK. ====
*
      WORK( 1 ) = DCMPLX( LWKOPT, 0 )
*
*     ==== End of ZLAQR0 ====
*
      END
```

———-

— LAPACK zlaqr0 —

```
(let*
 ((ntiny 11) (kexnw 5) (kexsh 6) (wilk1 0.75d0)
  (zero (coerce (f2cl-lib:cmplx 0.0d0 0.0d0) 'f2cl-lib:complex16))
  (one (coerce (f2cl-lib:cmplx 1.0d0 0.0d0) 'f2cl-lib:complex16)) (two 2.0d0))
 (declare (type (f2cl-lib:integer4 11 11) ntiny)
  (type (f2cl-lib:integer4 5 5) kexnw) (type (f2cl-lib:integer4 6 6) kexsh)
  (type (double-float 0.75d0 0.75d0) wilk1) (type (f2cl-lib:complex16) zero)
  (type (f2cl-lib:complex16) one) (type (double-float 2.0d0 2.0d0) two)
  (ignorable ntiny kexnw kexsh wilk1 zero one two))
 (defun zlaqr0 (wantt wantz n ilo ihi h ldh w iloz ihiz z ldz work lwork info)
```

```
(declare (type f2cl-lib:logical wantz wantt)
 (type (f2cl-lib:integer4) info lwork ldz ihiz iloz ldh ihi ilo n)
 (type (array f2cl-lib:complex16 (*)) work z w h))
(f2cl-lib:with-multi-array-data
    ((h f2cl-lib:complex16 h-%data% h-%offset%)
     (w f2cl-lib:complex16 w-%data% w-%offset%)
     (z f2cl-lib:complex16 z-%data% z-%offset%)
     (work f2cl-lib:complex16 work-%data% work-%offset%))
     (labels
      ((cabs1 (cdum) (+ (abs (f2cl-lib:dble cdum))
                        (abs (f2cl-lib:dimag cdum)))))
      (declare
       (ftype (function (f2cl-lib:complex16)
                  (values double-float &rest t)) cabs1))
      (prog
       ((zdum (make-array 1 :element-type 'f2cl-lib:complex16))
        (jbcmpz (make-array '(2) :element-type 'character
                                 :initial-element #\space))
        (sorted nil) (i 0) (inf 0) (it 0) (itmax 0) (k 0) (kacc22 0) (kbot 0)
        (kdu 0) (ks 0) (kt 0) (ktop 0) (ku 0) (kv 0) (kwh 0) (kwtop 0)
        (kwv 0)
        (ld 0) (ls 0) (lwkopt 0) (ndec 0) (ndfl 0) (nh 0) (nho 0) (nibble 0)
        (nmin 0) (ns 0) (nsmax 0) (nsr 0) (nve 0) (nw 0) (nwmax 0) (nwr 0)
        (nwupbd 0) (s 0.0d0) (aa #C(0.0d0 0.0d0)) (bb #C(0.0d0 0.0d0))
        (cc #C(0.0d0 0.0d0)) (cdum #C(0.0d0 0.0d0)) (dd #C(0.0d0 0.0d0))
        (det #C(0.0d0 0.0d0)) (rtdisc #C(0.0d0 0.0d0)) (swap #C(0.0d0 0.0d0))
        (tr2 #C(0.0d0 0.0d0)))
       (declare (type (array f2cl-lib:complex16 (1)) zdum)
        (type (simple-array character (2)) jbcmpz)
        (type f2cl-lib:logical sorted)
        (type (f2cl-lib:integer4) nwupbd nwr nwmax nw nve nsr nsmax ns
         nmin nibble
         nho nh ndfl ndec lwkopt ls ld kwv kwtop kwh kv ku ktop kt ks
         kdu kbot
         kacc22 k itmax it inf i)
        (type (double-float) s)
        (type (f2cl-lib:complex16) tr2 swap rtdisc det dd cdum cc bb aa))
       (setf info 0)
       (cond
        ((= n 0)
         (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%) one)
         (go end_label)))
       (cond
        ((<= n ntiny) (setf lwkopt 1)
         (if (/= lwork -1)
          (multiple-value-bind
           (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
            var-9 var-10
            var-11 var-12)
           (zlahqr wantt wantz n ilo ihi h ldh w iloz ihiz z ldz info)
```

```
   (declare
    (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-7 var-8
     var-9 var-10
     var-11))
   (setf ldh var-6) (setf info var-12))))
(t
 (tagbody (setf info 0)
  (cond
   (wantt (f2cl-lib:fset-string
           (f2cl-lib:fref-string jbcmpz (1 1)) "S"))
   (t (f2cl-lib:fset-string
           (f2cl-lib:fref-string jbcmpz (1 1)) "E")))
  (cond
   (wantz (f2cl-lib:fset-string
           (f2cl-lib:fref-string jbcmpz (2 2)) "V"))
   (t (f2cl-lib:fset-string
           (f2cl-lib:fref-string jbcmpz (2 2)) "N")))
  (setf nwr
   (multiple-value-bind
    (ret-val var-0 var-1 var-2 var-3 var-4 var-5 var-6)
    (ilaenv 13 "ZLAQR0" jbcmpz n ilo ihi lwork)
    (declare (ignore var-0 var-1)) (when var-2 (setf jbcmpz var-2))
    (when var-3 (setf n var-3)) (when var-4 (setf ilo var-4))
    (when var-5 (setf ihi var-5))
    (when var-6 (setf lwork var-6)) ret-val))
  (setf nwr (max (the f2cl-lib:integer4 2)
                 (the f2cl-lib:integer4 nwr)))
  (setf nwr
   (min (f2cl-lib:int-add (f2cl-lib:int-sub ihi ilo) 1)
    (the f2cl-lib:integer4 (truncate (- n 1) 3)) nwr))
  (setf nsr
   (multiple-value-bind
    (ret-val var-0 var-1 var-2 var-3 var-4 var-5 var-6)
    (ilaenv 15 "ZLAQR0" jbcmpz n ilo ihi lwork)
    (declare (ignore var-0 var-1)) (when var-2 (setf jbcmpz var-2))
    (when var-3 (setf n var-3)) (when var-4 (setf ilo var-4))
    (when var-5 (setf ihi var-5))
    (when var-6 (setf lwork var-6)) ret-val))
  (setf nsr
   (min nsr (the f2cl-lib:integer4 (truncate (+ n 6) 9))
    (f2cl-lib:int-sub ihi ilo)))
  (setf nsr
   (max (the f2cl-lib:integer4 2)
    (the f2cl-lib:integer4 (f2cl-lib:int-sub nsr (mod nsr 2)))))
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-9
    var-10
    var-11 var-12 var-13 var-14 var-15 var-16 var-17 var-18 var-19
    var-20
    var-21 var-22 var-23 var-24)
```

```
 (zlaqr3 wantt wantz n ilo ihi (f2cl-lib:int-add nwr 1) h
  ldh iloz ihiz z
  ldz ls ld w h ldh n h ldh n h ldh work -1)
 (declare
  (ignore var-5 var-6 var-10 var-14 var-15 var-18 var-21
    var-23 var-24))
 (when var-0 (setf wantt var-0)) (when var-1 (setf wantz var-1))
 (when var-2 (setf n var-2)) (when var-3 (setf ilo var-3))
 (when var-4 (setf ihi var-4)) (when var-7 (setf ldh var-7))
 (when var-8 (setf iloz var-8)) (when var-9 (setf ihiz var-9))
 (when var-11 (setf ldz var-11)) (when var-12 (setf ls var-12))
 (when var-13 (setf ld var-13)) (when var-16 (setf ldh var-16))
 (when var-17 (setf n var-17)) (when var-19 (setf ldh var-19))
 (when var-20 (setf n var-20)) (when var-22 (setf ldh var-22)))
(setf lwkopt
 (max (the f2cl-lib:integer4 (truncate (* 3 nsr) 2))
  (f2cl-lib:int (f2cl-lib:fref work-%data% (1) ((1 *))
   work-%offset%))))
(cond
 ((= lwork (f2cl-lib:int-sub 1))
  (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
   (f2cl-lib:dcmplx lwkopt 0))
  (go end_label)))
(setf nmin
 (multiple-value-bind
  (ret-val var-0 var-1 var-2 var-3 var-4 var-5 var-6)
  (ilaenv 12 "ZLAQR0" jbcmpz n ilo ihi lwork)
  (declare (ignore var-0 var-1)) (when var-2 (setf jbcmpz var-2))
  (when var-3 (setf n var-3)) (when var-4 (setf ilo var-4))
  (when var-5 (setf ihi var-5))
  (when var-6 (setf lwork var-6)) ret-val))
(setf nmin
 (max (the f2cl-lib:integer4 ntiny) (the f2cl-lib:integer4 nmin)))
(setf nibble
 (multiple-value-bind
  (ret-val var-0 var-1 var-2 var-3 var-4 var-5 var-6)
  (ilaenv 14 "ZLAQR0" jbcmpz n ilo ihi lwork)
  (declare (ignore var-0 var-1)) (when var-2 (setf jbcmpz var-2))
  (when var-3 (setf n var-3)) (when var-4 (setf ilo var-4))
  (when var-5 (setf ihi var-5))
  (when var-6 (setf lwork var-6)) ret-val))
(setf nibble
 (max (the f2cl-lib:integer4 0) (the f2cl-lib:integer4 nibble)))
(setf kacc22
 (multiple-value-bind
  (ret-val var-0 var-1 var-2 var-3 var-4 var-5 var-6)
  (ilaenv 16 "ZLAQR0" jbcmpz n ilo ihi lwork)
  (declare (ignore var-0 var-1)) (when var-2 (setf jbcmpz var-2))
  (when var-3 (setf n var-3)) (when var-4 (setf ilo var-4))
  (when var-5 (setf ihi var-5))
```

```
  (when var-6 (setf lwork var-6)) ret-val))
(setf kacc22
 (max (the f2cl-lib:integer4 0) (the f2cl-lib:integer4 kacc22)))
(setf kacc22
 (min (the f2cl-lib:integer4 2) (the f2cl-lib:integer4 kacc22)))
(setf nwmax
 (min (the f2cl-lib:integer4 (truncate (- n 1) 3))
  (the f2cl-lib:integer4 (truncate lwork 2))))
(setf nw nwmax)
(setf nsmax
 (min (the f2cl-lib:integer4 (truncate (+ n 6) 9))
  (the f2cl-lib:integer4 (truncate (* 2 lwork) 3))))
(setf nsmax (f2cl-lib:int-sub nsmax (mod nsmax 2))) (setf ndfl 1)
(setf itmax
 (f2cl-lib:int-mul
  (max (the f2cl-lib:integer4 30)
   (the f2cl-lib:integer4 (f2cl-lib:int-mul 2 kexsh)))
  (max (the f2cl-lib:integer4 10)
   (the f2cl-lib:integer4
    (f2cl-lib:int-add (f2cl-lib:int-sub ihi ilo) 1)))))
(setf kbot ihi)
(f2cl-lib:fdo (it 1 (f2cl-lib:int-add it 1))
       ((> it itmax) nil)
        (tagbody
              (if (< kbot ilo) (go label80))
              (f2cl-lib:fdo (k kbot
                (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
        ((> k
                (f2cl-lib:int-add ilo 1))
               nil)
         (tagbody
                (if
                 (=
                  (f2cl-lib:fref h-%data% (k
                    (f2cl-lib:int-sub k 1)) ((1 ldh) (1 *))
                   h-%offset%)
                  zero)
                 (go label20))
                label10))
              (setf k ilo) label20 (setf ktop k)
              (setf nh (f2cl-lib:int-add
                        (f2cl-lib:int-sub kbot ktop) 1))
              (setf nwupbd
               (min (the f2cl-lib:integer4 nh)
                    (the f2cl-lib:integer4 nwmax)))
              (cond
               ((< ndfl kexnw)
                (setf nw
                 (min (the f2cl-lib:integer4 nwupbd)
                      (the f2cl-lib:integer4 nwr))))
```

```
 (t
  (setf nw
   (min (the f2cl-lib:integer4 nwupbd)
    (the f2cl-lib:integer4
         (f2cl-lib:int-mul 2 nw))))))
(cond
 ((< nw nwmax)
  (cond ((>= nw (f2cl-lib:int-add nh
                 (f2cl-lib:int-sub 1))) (setf nw nh))
   (t (setf kwtop (f2cl-lib:int-add
                   (f2cl-lib:int-sub kbot nw) 1))
    (if
     (>
      (cabs1
       (f2cl-lib:fref h-%data% (kwtop
                   (f2cl-lib:int-sub kwtop 1))
        ((1 ldh) (1 *)) h-%offset%))
      (cabs1
       (f2cl-lib:fref h-%data%
        ((f2cl-lib:int-sub kwtop 1)
          (f2cl-lib:int-sub kwtop 2))
        ((1 ldh) (1 *)) h-%offset%)))
     (setf nw (f2cl-lib:int-add nw 1)))))))
(cond ((< ndfl kexnw) (setf ndec -1))
 ((or (>= ndec 0) (>= nw nwupbd))
    (setf ndec (f2cl-lib:int-add ndec 1))
  (if (< (f2cl-lib:int-sub nw ndec) 2) (setf ndec 0))
  (setf nw (f2cl-lib:int-sub nw ndec))))
(setf kv (f2cl-lib:int-add
   (f2cl-lib:int-sub n nw) 1))
(setf kt (f2cl-lib:int-add nw 1))
(setf nho (f2cl-lib:int-add
   (f2cl-lib:int-sub n nw 1 kt) 1))
(setf kwv (f2cl-lib:int-add nw 2))
(setf nve
   (f2cl-lib:int-add (f2cl-lib:int-sub n nw kwv) 1))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6
  var-7 var-8 var-9 var-10
  var-11 var-12 var-13 var-14 var-15 var-16
  var-17 var-18 var-19 var-20
  var-21 var-22 var-23 var-24)
 (zlaqr3 wantt wantz n ktop kbot nw h ldh iloz
   ihiz z ldz ls ld w
  (f2cl-lib:array-slice h-%data% f2cl-lib:complex16
   (kv 1)
   ((1 ldh) (1 *)) h-%offset%)
  ldh nho
  (f2cl-lib:array-slice h-%data% f2cl-lib:complex16
   (kv kt)
```

```
   ((1 ldh) (1 *)) h-%offset%)
  ldh nve
  (f2cl-lib:array-slice h-%data% f2cl-lib:complex16
   (kwv 1)
   ((1 ldh) (1 *)) h-%offset%)
  ldh work lwork)
 (declare (ignore var-6 var-10 var-14 var-15
           var-18 var-21 var-23))
 (when var-0 (setf wantt var-0))
 (when var-1 (setf wantz var-1))
 (when var-2 (setf n var-2))
 (when var-3 (setf ktop var-3))
 (when var-4 (setf kbot var-4))
 (when var-5 (setf nw var-5))
 (when var-7 (setf ldh var-7))
 (when var-8 (setf iloz var-8))
 (when var-9 (setf ihiz var-9))
 (when var-11 (setf ldz var-11))
 (when var-12 (setf ls var-12))
 (when var-13 (setf ld var-13))
 (when var-16 (setf ldh var-16))
 (when var-17 (setf nho var-17))
 (when var-19 (setf ldh var-19))
 (when var-20 (setf nve var-20))
 (when var-22 (setf ldh var-22))
 (when var-24 (setf lwork var-24)))
(setf kbot (f2cl-lib:int-sub kbot ld))
(setf ks (f2cl-lib:int-add
            (f2cl-lib:int-sub kbot ls) 1))
(cond
 ((or (= ld 0)
   (and (<= (f2cl-lib:int-mul 100 ld)
            (f2cl-lib:int-mul nw nibble))
    (> (f2cl-lib:int-add kbot
       (f2cl-lib:int-sub ktop) 1)
     (min (the f2cl-lib:integer4 nmin)
          (the f2cl-lib:integer4 nwmax)))))
  (setf ns
   (min (the f2cl-lib:integer4 nsmax)
        (the f2cl-lib:integer4 nsr)
    (the f2cl-lib:integer4
     (max (the f2cl-lib:integer4 2)
      (the f2cl-lib:integer4
        (f2cl-lib:int-sub kbot ktop))))))
  (setf ns (f2cl-lib:int-sub ns (mod ns 2)))
  (cond
   ((= (mod ndfl kexsh) 0)
    (setf ks (f2cl-lib:int-add
              (f2cl-lib:int-sub kbot ns) 1))
    (f2cl-lib:fdo (i kbot (f2cl-lib:int-add i
```

```
                                    (f2cl-lib:int-sub 2)))
((> i
            (f2cl-lib:int-add ks 1))
           nil)
 (tagbody
            (setf (f2cl-lib:fref w-%data% (i)
                   ((1 *)) w-%offset%)
             (+ (f2cl-lib:fref h-%data% (i i)
                   ((1 ldh) (1 *)) h-%offset%)
              (* wilk1
               (cabs1
                (f2cl-lib:fref h-%data%
                 (i (f2cl-lib:int-sub i 1))
                 ((1 ldh) (1 *)) h-%offset%)))))
            (setf
             (f2cl-lib:fref w-%data%
              ((f2cl-lib:int-sub i 1)) ((1 *))
              w-%offset%)
             (f2cl-lib:fref w-%data% (i) ((1 *))
             w-%offset%))
            label30)))
     (t
      (cond
       ((<= (f2cl-lib:int-add kbot
             (f2cl-lib:int-sub ks) 1)
        (f2cl-lib:f2cl/ ns 2))
       (setf ks (f2cl-lib:int-add
                 (f2cl-lib:int-sub kbot ns) 1))
       (setf kt (f2cl-lib:int-add
                 (f2cl-lib:int-sub n ns) 1))
       (zlacpy "A" ns ns
        (f2cl-lib:array-slice h-%data%
         f2cl-lib:complex16 (ks ks)
         ((1 ldh) (1 *)) h-%offset%)
        ldh
        (f2cl-lib:array-slice h-%data%
         f2cl-lib:complex16 (kt 1)
         ((1 ldh) (1 *)) h-%offset%)
        ldh)
       (cond
        ((> ns nmin)
         (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5
           var-6 var-7 var-8 var-9
           var-10 var-11 var-12 var-13 var-14)
          (zlaqr4 f2cl-lib:%false% f2cl-lib:%false%
           ns 1 ns
           (f2cl-lib:array-slice h-%data%
            f2cl-lib:complex16 (kt 1)
            ((1 ldh) (1 *)) h-%offset%)
```

```
    ldh
    (f2cl-lib:array-slice w-%data%
     f2cl-lib:complex16 (ks) ((1 *))
     w-%offset%)
    1 1 zdum 1 work lwork inf)
   (declare
    (ignore var-0 var-1 var-3 var-5 var-7
     var-8 var-9 var-10 var-11
     var-12))
   (when var-2 (setf ns var-2))
   (when var-4 (setf ns var-4))
   (when var-6 (setf ldh var-6))
   (when var-13 (setf lwork var-13))
   (when var-14 (setf inf var-14))))
 (t
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7 var-8 var-9
    var-10 var-11 var-12)
   (zlahqr f2cl-lib:%false% f2cl-lib:%false%
    ns 1 ns
    (f2cl-lib:array-slice h-%data%
     f2cl-lib:complex16 (kt 1)
     ((1 ldh) (1 *)) h-%offset%)
    ldh
    (f2cl-lib:array-slice w-%data%
     f2cl-lib:complex16 (ks) ((1 *))
     w-%offset%)
    1 1 zdum 1 inf)
   (declare
    (ignore var-0 var-1 var-2 var-3 var-4
     var-5 var-7 var-8 var-9
     var-10 var-11))
   (setf ldh var-6) (setf inf var-12))))
(setf ks (f2cl-lib:int-add ks inf))
(cond
 ((>= ks kbot)
  (setf s
   (+
    (cabs1
     (f2cl-lib:fref h-%data%
      ((f2cl-lib:int-sub kbot 1)
       (f2cl-lib:int-sub kbot 1))
      ((1 ldh) (1 *)) h-%offset%))
    (cabs1
     (f2cl-lib:fref h-%data% (kbot
      (f2cl-lib:int-sub kbot 1))
      ((1 ldh) (1 *)) h-%offset%))
    (cabs1
     (f2cl-lib:fref h-%data%
```

```
                    ((f2cl-lib:int-sub kbot 1) kbot)
                    ((1 ldh) (1 *)) h-%offset%))
                  (cabs1
                   (f2cl-lib:fref h-%data% (kbot kbot)
                    ((1 ldh) (1 *))
                    h-%offset%))))
                (setf aa
                 (/
                  (f2cl-lib:fref h-%data%
                   ((f2cl-lib:int-sub kbot 1)
                   (f2cl-lib:int-sub kbot 1))
                   ((1 ldh) (1 *)) h-%offset%)
                  s))
                (setf cc
                 (/
                  (f2cl-lib:fref h-%data% (kbot
                   (f2cl-lib:int-sub kbot 1))
                   ((1 ldh) (1 *)) h-%offset%)
                  s))
                (setf bb
                 (/
                  (f2cl-lib:fref h-%data%
                   ((f2cl-lib:int-sub kbot 1) kbot)
                   ((1 ldh) (1 *)) h-%offset%)
                  s))
                (setf dd
                 (/
                  (f2cl-lib:fref h-%data% (kbot kbot)
                   ((1 ldh) (1 *)) h-%offset%)
                  s))
                (setf tr2 (/ (+ aa dd) two))
                (setf det (- (* (- aa tr2) (- dd tr2))
                             (* bb cc)))
                (setf rtdisc (f2cl-lib:fsqrt (- det)))
                (setf
                 (f2cl-lib:fref w-%data%
                  ((f2cl-lib:int-sub kbot 1)) ((1 *))
                  w-%offset%)
                 (* (+ tr2 rtdisc) s))
                (setf (f2cl-lib:fref w-%data% (kbot)
                       ((1 *)) w-%offset%)
                 (* (- tr2 rtdisc) s))
                (setf ks (f2cl-lib:int-sub kbot 1))))))
           (cond
            ((> (f2cl-lib:int-add kbot
                 (f2cl-lib:int-sub ks) 1) ns)
             (tagbody (setf sorted f2cl-lib:%false%)
              (f2cl-lib:fdo (k kbot
               (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
((>
```

```
                k (f2cl-lib:int-add ks 1))
               nil)
(tagbody (if sorted (go label60))
             (setf sorted f2cl-lib:%true%)
             (f2cl-lib:fdo (i ks
              (f2cl-lib:int-add i 1))
((> i
              (f2cl-lib:int-add k
               (f2cl-lib:int-sub 1)))
             nil)
 (tagbody
              (cond
               ((< (cabs1 (f2cl-lib:fref w (i)
                     ((1 *))))
                  (cabs1 (f2cl-lib:fref w
                    ((f2cl-lib:int-add i 1))
                      ((1 *)))))
                (setf sorted f2cl-lib:%false%)
                (setf swap
                 (f2cl-lib:fref w-%data% (i)
                   ((1 *)) w-%offset%))
                (setf
                 (f2cl-lib:fref w-%data% (i)
                  ((1 *)) w-%offset%)
                 (f2cl-lib:fref w-%data%
                  ((f2cl-lib:int-add i 1))
                  ((1 *))
                  w-%offset%))
                (setf
                 (f2cl-lib:fref w-%data%
                  ((f2cl-lib:int-add i 1))
                   ((1 *))
                  w-%offset%)
                 swap)))
              label40))
             label50))
    label60)))))
(cond
 ((= (f2cl-lib:int-add kbot
      (f2cl-lib:int-sub ks) 1) 2)
  (cond
   ((<
     (cabs1
      (+ (f2cl-lib:fref w (kbot) ((1 *)))
       (- (f2cl-lib:fref h (kbot kbot) ((1 ldh)
            (1 *))))))
     (cabs1
      (+
       (f2cl-lib:fref w ((f2cl-lib:int-add kbot
          (f2cl-lib:int-sub 1)))
```

```
        ((1 *)))
       (- (f2cl-lib:fref h (kbot kbot) ((1 ldh)
           (1 *)))))))
    (setf
     (f2cl-lib:fref w-%data%
      ((f2cl-lib:int-sub kbot 1)) ((1 *))
      w-%offset%)
     (f2cl-lib:fref w-%data% (kbot) ((1 *))
      w-%offset%)))
   (t
    (setf (f2cl-lib:fref w-%data% (kbot) ((1 *))
           w-%offset%)
     (f2cl-lib:fref w-%data%
      ((f2cl-lib:int-sub kbot 1)) ((1 *))
      w-%offset%))))))
(setf ns
 (min (the f2cl-lib:integer4 ns)
  (the f2cl-lib:integer4
   (f2cl-lib:int-add
    (f2cl-lib:int-sub kbot ks) 1))))
(setf ns (f2cl-lib:int-sub ns (mod ns 2)))
(setf ks (f2cl-lib:int-add
          (f2cl-lib:int-sub kbot ns) 1))
(setf kdu (f2cl-lib:int-sub
           (f2cl-lib:int-mul 3 ns) 3))
(setf ku (f2cl-lib:int-add
          (f2cl-lib:int-sub n kdu) 1))
(setf kwh (f2cl-lib:int-add kdu 1))
(setf nho
 (f2cl-lib:int-add
  (f2cl-lib:int-sub (f2cl-lib:int-add
                     (f2cl-lib:int-sub n kdu) 1) 4
   (f2cl-lib:int-add kdu 1))
  1))
(setf kwv (f2cl-lib:int-add kdu 4))
(setf nve (f2cl-lib:int-add
           (f2cl-lib:int-sub n kdu kwv) 1))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6
  var-7 var-8 var-9 var-10
  var-11 var-12 var-13 var-14 var-15 var-16
  var-17 var-18 var-19 var-20
  var-21 var-22 var-23)
 (zlaqr5 wantt wantz kacc22 n ktop kbot ns
  (f2cl-lib:array-slice w-%data%
   f2cl-lib:complex16 (ks) ((1 *))
   w-%offset%)
  h ldh iloz ihiz z ldz work 3
  (f2cl-lib:array-slice h-%data%
   f2cl-lib:complex16 (ku 1)
```

```
                          ((1 ldh) (1 *)) h-%offset%)
                         ldh nve
                         (f2cl-lib:array-slice h-%data%
                          f2cl-lib:complex16 (kwv 1)
                          ((1 ldh) (1 *)) h-%offset%)
                         ldh nho
                         (f2cl-lib:array-slice h-%data%
                          f2cl-lib:complex16 (ku kwh)
                          ((1 ldh) (1 *)) h-%offset%)
                         ldh)
                        (declare
                         (ignore var-7 var-8 var-12 var-14 var-15
                                 var-16 var-19 var-22))
                        (when var-0 (setf wantt var-0))
                        (when var-1 (setf wantz var-1))
                        (when var-2 (setf kacc22 var-2))
                        (when var-3 (setf n var-3))
                        (when var-4 (setf ktop var-4))
                        (when var-5 (setf kbot var-5))
                        (when var-6 (setf ns var-6))
                        (when var-9 (setf ldh var-9))
                        (when var-10 (setf iloz var-10))
                        (when var-11 (setf ihiz var-11))
                        (when var-13 (setf ldz var-13))
                        (when var-17 (setf ldh var-17))
                        (when var-18 (setf nve var-18))
                        (when var-20 (setf ldh var-20))
                        (when var-21 (setf nho var-21))
                        (when var-23 (setf ldh var-23)))))
                      (cond ((> ld 0) (setf ndfl 1))
                            (t (setf ndfl (f2cl-lib:int-add ndfl 1))))
                      label70))
          (setf info kbot) label80)))
       (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
        (f2cl-lib:dcmplx lwkopt 0))
       end_label
       (return
        (values wantt wantz n ilo ihi nil ldh nil iloz ihiz nil ldz nil lwork
         info)))))))
```

———-

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— zlaqr1.input —

```
)set break resume
```

```
)sys rm -f zlaqr1.output
)spool zlaqr1.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— zlaqr1.help —

```
=====================================================================
zlaqr1 examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZLAQR1( N, H, LDH, S1, S2, V )

       .. Scalar Arguments ..
       COMPLEX*16         S1, S2
       INTEGER            LDH, N
       ..
       .. Array Arguments ..
       COMPLEX*16         H( LDH, * ), V( * )
       ..


 Purpose:
 =============

      Given a 2-by-2 or 3-by-3 matrix H, ZLAQR1 sets v to a
      scalar multiple of the first column of the product

      (*)  K = (H - s1*I)*(H - s2*I)

      scaling to avoid overflows and most underflows.

      This is useful for starting double implicit shift bulges
```

```
     in the QR algorithm.

 Arguments:
 ==========

  [in] N

          N is integer
              Order of the matrix H. N must be either 2 or 3.

  [in] H

          H is COMPLEX*16 array of dimension (LDH,N)
              The 2-by-2 or 3-by-3 matrix H in (*).

  [in] LDH

          LDH is integer
              The leading dimension of H as declared in
              the calling procedure.  LDH.GE.N

  [in] S1

          S1 is COMPLEX*16

  [in] S2

          S2 is COMPLEX*16

          S1 and S2 are the shifts defining K in (*) above.

  [out] V

          V is COMPLEX*16 array of dimension N
              A scalar multiple of the first column of the
              matrix K in (*).

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 ========

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 November 2011

 Contributors:
 ==================
```

```
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       University of Kansas, USA
```

— zlaqr1.f —

```
*  =====================================================================
      SUBROUTINE ZLAQR1( N, H, LDH, S1, S2, V )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      COMPLEX*16         S1, S2
      INTEGER            LDH, N
*     ..
*     .. Array Arguments ..
      COMPLEX*16         H( LDH, * ), V( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      COMPLEX*16         ZERO
      PARAMETER          ( ZERO = ( 0.0d0, 0.0d0 ) )
      DOUBLE PRECISION   RZERO
      PARAMETER          ( RZERO = 0.0d0 )
*     ..
*     .. Local Scalars ..
      COMPLEX*16         CDUM, H21S, H31S
      DOUBLE PRECISION   S
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, DBLE, DIMAG
*     ..
*     .. Statement Functions ..
      DOUBLE PRECISION   CABS1
*     ..
*     .. Statement Function definitions ..
      CABS1( CDUM ) = ABS( DBLE( CDUM ) ) + ABS( DIMAG( CDUM ) )
*     ..
*     .. Executable Statements ..
      IF( N.EQ.2 ) THEN
         S = CABS1( H( 1, 1 )-S2 ) + CABS1( H( 2, 1 ) )
         IF( S.EQ.RZERO ) THEN
```

```
            V( 1 ) = ZERO
            V( 2 ) = ZERO
         ELSE
            H21S = H( 2, 1 ) / S
            V( 1 ) = H21S*H( 1, 2 ) + ( H( 1, 1 )-S1 )*
     $               ( ( H( 1, 1 )-S2 ) / S )
            V( 2 ) = H21S*( H( 1, 1 )+H( 2, 2 )-S1-S2 )
         END IF
      ELSE
         S = CABS1( H( 1, 1 )-S2 ) + CABS1( H( 2, 1 ) ) +
     $       CABS1( H( 3, 1 ) )
         IF( S.EQ.ZERO ) THEN
            V( 1 ) = ZERO
            V( 2 ) = ZERO
            V( 3 ) = ZERO
         ELSE
            H21S = H( 2, 1 ) / S
            H31S = H( 3, 1 ) / S
            V( 1 ) = ( H( 1, 1 )-S1 )*( ( H( 1, 1 )-S2 ) / S ) +
     $               H( 1, 2 )*H21S + H( 1, 3 )*H31S
            V( 2 ) = H21S*( H( 1, 1 )+H( 2, 2 )-S1-S2 ) + H( 2, 3 )*H31S
            V( 3 ) = H31S*( H( 1, 1 )+H( 3, 3 )-S1-S2 ) + H21S*H( 3, 2 )
         END IF
      END IF
      END
```

———-

— LAPACK zlaqr1 —

```
(let*
 ((zero (coerce (f2cl-lib:cmplx 0.0d0 0.0d0) 'f2cl-lib:complex16))
  (rzero 0.0d0))
 (declare (type (f2cl-lib:complex16) zero)
  (type (double-float 0.0d0 0.0d0) rzero) (ignorable zero rzero))
 (defun zlaqr1 (n h ldh s1 s2 v)
  (declare (type (f2cl-lib:integer4) ldh n)
   (type (array f2cl-lib:complex16 (*)) v h) (type (f2cl-lib:complex16) s2 s1))
  (f2cl-lib:with-multi-array-data
      ((h f2cl-lib:complex16 h-%data% h-%offset%)
       (v f2cl-lib:complex16 v-%data% v-%offset%))
       (labels
        ((cabs1 (cdum) (+ (abs (f2cl-lib:dble cdum))
                          (abs (f2cl-lib:dimag cdum)))))
        (declare
         (ftype (function (f2cl-lib:complex16)
                 (values double-float &rest t)) cabs1))
        (prog
```

```
((s 0.0d0) (cdum #C(0.0d0 0.0d0)) (h21s #C(0.0d0 0.0d0))
 (h31s #C(0.0d0 0.0d0)))
(declare (type (double-float) s)
         (type (f2cl-lib:complex16) h31s h21s cdum))
(cond
 ((= n 2)
  (setf s
   (+
    (cabs1 (- (f2cl-lib:fref h-%data% (1 1) ((1 ldh) (1 *))
              h-%offset%) s2))
    (cabs1 (f2cl-lib:fref h-%data% (2 1) ((1 ldh) (1 *))
              h-%offset%))))
  (cond
   ((= s rzero)
    (setf (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%) zero)
    (setf (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%) zero))
   (t
    (setf h21s
     (/ (f2cl-lib:fref h-%data% (2 1) ((1 ldh) (1 *)) h-%offset%) s))
    (setf (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%)
     (+ (* h21s (f2cl-lib:fref h-%data% (1 2) ((1 ldh) (1 *))
                h-%offset%))
      (* (- (f2cl-lib:fref h-%data% (1 1) ((1 ldh) (1 *))
                h-%offset%) s1)
       (/ (- (f2cl-lib:fref h-%data% (1 1) ((1 ldh) (1 *))
                h-%offset%) s2)
        s))))
    (setf (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%)
     (* h21s
      (-
       (+ (f2cl-lib:fref h-%data% (1 1) ((1 ldh) (1 *)) h-%offset%)
        (f2cl-lib:fref h-%data% (2 2) ((1 ldh) (1 *)) h-%offset%))
       s1 s2))))))
 (t
  (setf s
   (+
    (cabs1
     (- (f2cl-lib:fref h-%data% (1 1) ((1 ldh) (1 *)) h-%offset%) s2))
    (cabs1 (f2cl-lib:fref h-%data% (2 1) ((1 ldh) (1 *)) h-%offset%))
    (cabs1
      (f2cl-lib:fref h-%data% (3 1) ((1 ldh) (1 *)) h-%offset%))))
  (cond
   ((= s zero)
    (setf (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%) zero)
    (setf (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%) zero)
    (setf (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%) zero))
   (t
    (setf h21s
     (/ (f2cl-lib:fref h-%data% (2 1) ((1 ldh) (1 *)) h-%offset%) s))
    (setf h31s
```

```
            (/ (f2cl-lib:fref h-%data% (3 1) ((1 ldh) (1 *)) h-%offset%) s))
           (setf (f2cl-lib:fref v-%data% (1) ((1 *)) v-%offset%)
            (+
             (* (- (f2cl-lib:fref h-%data% (1 1) ((1 ldh) (1 *))
                      h-%offset%) s1)
              (/ (- (f2cl-lib:fref h-%data% (1 1) ((1 ldh) (1 *))
                      h-%offset%) s2)
               s))
             (* (f2cl-lib:fref h-%data% (1 2) ((1 ldh) (1 *)) h-%offset%)
                h21s)
             (* (f2cl-lib:fref h-%data% (1 3) ((1 ldh) (1 *)) h-%offset%)
                h31s)))
           (setf (f2cl-lib:fref v-%data% (2) ((1 *)) v-%offset%)
            (+
             (* h21s
              (-
               (+ (f2cl-lib:fref h-%data% (1 1) ((1 ldh) (1 *)) h-%offset%)
                (f2cl-lib:fref h-%data% (2 2) ((1 ldh) (1 *)) h-%offset%))
               s1 s2))
             (* (f2cl-lib:fref h-%data% (2 3) ((1 ldh) (1 *)) h-%offset%)
                h31s)))
           (setf (f2cl-lib:fref v-%data% (3) ((1 *)) v-%offset%)
            (+
             (* h31s
              (-
               (+ (f2cl-lib:fref h-%data% (1 1) ((1 ldh) (1 *)) h-%offset%)
                (f2cl-lib:fref h-%data% (3 3) ((1 ldh) (1 *)) h-%offset%))
               s1 s2))
             (* h21s
              (f2cl-lib:fref h-%data% (3 2) ((1 ldh) (1 *)) h-%offset%)))))))))
       end_label (return (values nil nil nil nil nil nil)))))))
```

———-

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— zlaqr2.input —

```
)set break resume
)sys rm -f zlaqr2.output
)spool zlaqr2.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— zlaqr2.help —

```
=====================================================================
zlaqr2 examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 Online html documentation available at
           http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZLAQR2( WANTT, WANTZ, N, KTOP, KBOT, NW, H, LDH, ILOZ,
                          IHIZ, Z, LDZ, NS, ND, SH, V, LDV, NH, T, LDT,
                          NV, WV, LDWV, WORK, LWORK )

       .. Scalar Arguments ..
       INTEGER            IHIZ, ILOZ, KBOT, KTOP, LDH, LDT, LDV, LDWV,
      $                   LDZ, LWORK, N, ND, NH, NS, NV, NW
       LOGICAL            WANTT, WANTZ
       ..
       .. Array Arguments ..
       COMPLEX*16         H( LDH, * ), SH( * ), T( LDT, * ), V( LDV, * ),
      $                   WORK( * ), WV( LDWV, * ), Z( LDZ, * )
       ..

 Purpose:
 =============

    ZLAQR2 is identical to ZLAQR3 except that it avoids
    recursion by calling ZLAHQR instead of ZLAQR4.

    Aggressive early deflation:

    ZLAQR2 accepts as input an upper Hessenberg matrix
    H and performs an unitary similarity transformation
    designed to detect and deflate fully converged eigenvalues from
    a trailing principal submatrix.  On output H has been over-
    written by a new Hessenberg matrix that is a perturbation of
    an unitary similarity transformation of H.  It is to be
    hoped that the final version of H has many zero subdiagonal
    entries.
```

```
 Arguments:
 ==========

  [in] WANTT

          WANTT is LOGICAL
          If .TRUE., then the Hessenberg matrix H is fully updated
          so that the triangular Schur factor may be
          computed (in cooperation with the calling subroutine).
          If .FALSE., then only enough of H is updated to preserve
          the eigenvalues.

  [in] WANTZ

          WANTZ is LOGICAL
          If .TRUE., then the unitary matrix Z is updated so
          so that the unitary Schur factor may be computed
          (in cooperation with the calling subroutine).
          If .FALSE., then Z is not referenced.

  [in] N

          N is INTEGER
          The order of the matrix H and (if WANTZ is .TRUE.) the
          order of the unitary matrix Z.

  [in] KTOP

          KTOP is INTEGER
          It is assumed that either KTOP = 1 or H(KTOP,KTOP-1)=0.
          KBOT and KTOP together determine an isolated block
          along the diagonal of the Hessenberg matrix.

  [in] KBOT

          KBOT is INTEGER
          It is assumed without a check that either
          KBOT = N or H(KBOT+1,KBOT)=0.  KBOT and KTOP together
          determine an isolated block along the diagonal of the
          Hessenberg matrix.

  [in] NW

          NW is INTEGER
          Deflation window size.  1 .LE. NW .LE. (KBOT-KTOP+1).

  [in,out] H

          H is COMPLEX*16 array, dimension (LDH,N)
          On input the initial N-by-N section of H stores the
```

```
          Hessenberg matrix undergoing aggressive early deflation.
          On output H has been transformed by a unitary
          similarity transformation, perturbed, and the returned
          to Hessenberg form that (it is to be hoped) has some
          zero subdiagonal entries.

  [in] LDH

          LDH is integer
          Leading dimension of H just as declared in the calling
          subroutine.  N .LE. LDH

  [in] ILOZ

          ILOZ is INTEGER

  [in] IHIZ

          IHIZ is INTEGER
          Specify the rows of Z to which transformations must be
          applied if WANTZ is .TRUE.. 1 .LE. ILOZ .LE. IHIZ .LE. N.

  [in,out] Z

          Z is COMPLEX*16 array, dimension (LDZ,N)
          IF WANTZ is .TRUE., then on output, the unitary
          similarity transformation mentioned above has been
          accumulated into Z(ILOZ:IHIZ,ILO:IHI) from the right.
          If WANTZ is .FALSE., then Z is unreferenced.

  [in] LDZ

          LDZ is integer
          The leading dimension of Z just as declared in the
          calling subroutine.  1 .LE. LDZ.

  [out] NS

          NS is integer
          The number of unconverged (ie approximate) eigenvalues
          returned in SR and SI that may be used as shifts by the
          calling subroutine.

  [out] ND

          ND is integer
          The number of converged eigenvalues uncovered by this
          subroutine.

  [out] SH
```

```
          SH is COMPLEX*16 array, dimension KBOT
          On output, approximate eigenvalues that may
          be used for shifts are stored in SH(KBOT-ND-NS+1)
          through SR(KBOT-ND).  Converged eigenvalues are
          stored in SH(KBOT-ND+1) through SH(KBOT).

  [out] V

          V is COMPLEX*16 array, dimension (LDV,NW)
          An NW-by-NW work array.

  [in] LDV

          LDV is integer scalar
          The leading dimension of V just as declared in the
          calling subroutine.  NW .LE. LDV

  [in] NH

          NH is integer scalar
          The number of columns of T.  NH.GE.NW.

  [out] T

          T is COMPLEX*16 array, dimension (LDT,NW)

  [in] LDT

          LDT is integer
          The leading dimension of T just as declared in the
          calling subroutine.  NW .LE. LDT

  [in] NV

          NV is integer
          The number of rows of work array WV available for
          workspace.  NV.GE.NW.

  [out] WV

          WV is COMPLEX*16 array, dimension (LDWV,NW)

  [in] LDWV

          LDWV is integer
          The leading dimension of W just as declared in the
          calling subroutine.  NW .LE. LDV

  [out] WORK
```

```
          WORK is COMPLEX*16 array, dimension LWORK.
          On exit, WORK(1) is set to an estimate of the optimal value
          of LWORK for the given values of N, NW, KTOP and KBOT.

  [in] LWORK

          LWORK is integer
          The dimension of the work array WORK.  LWORK = 2*NW
          suffices, but greater efficiency may result from larger
          values of LWORK.

          If LWORK = -1, then a workspace query is assumed; ZLAQR2
          only estimates the optimal workspace size for the given
          values of N, NW, KTOP and KBOT.  The estimate is returned
          in WORK(1).  No error message related to LWORK is issued
          by XERBLA.  Neither H nor Z are accessed.

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November 2011

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```

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— zlaqr2.f —

```
*  =====================================================================
      SUBROUTINE ZLAQR2( WANTT, WANTZ, N, KTOP, KBOT, NW, H, LDH, ILOZ,
     $                   IHIZ, Z, LDZ, NS, ND, SH, V, LDV, NH, T, LDT,
     $                   NV, WV, LDWV, WORK, LWORK )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
```

```
*     .. Scalar Arguments ..
      INTEGER            IHIZ, ILOZ, KBOT, KTOP, LDH, LDT, LDV, LDWV,
     $                   LDZ, LWORK, N, ND, NH, NS, NV, NW
      LOGICAL            WANTT, WANTZ
*     ..
*     .. Array Arguments ..
      COMPLEX*16         H( LDH, * ), SH( * ), T( LDT, * ), V( LDV, * ),
     $                   WORK( * ), WV( LDWV, * ), Z( LDZ, * )
*     ..
*
*  ================================================================
*
*     .. Parameters ..
      COMPLEX*16         ZERO, ONE
      PARAMETER          ( ZERO = ( 0.0d0, 0.0d0 ),
     $                   ONE = ( 1.0d0, 0.0d0 ) )
      DOUBLE PRECISION   RZERO, RONE
      PARAMETER          ( RZERO = 0.0d0, RONE = 1.0d0 )
*     ..
*     .. Local Scalars ..
      COMPLEX*16         BETA, CDUM, S, TAU
      DOUBLE PRECISION   FOO, SAFMAX, SAFMIN, SMLNUM, ULP
      INTEGER            I, IFST, ILST, INFO, INFQR, J, JW, KCOL, KLN,
     $                   KNT, KROW, KWTOP, LTOP, LWK1, LWK2, LWKOPT
*     ..
*     .. External Functions ..
      DOUBLE PRECISION   DLAMCH
      EXTERNAL           DLAMCH
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLABAD, ZCOPY, ZGEHRD, ZGEMM, ZLACPY, ZLAHQR,
     $                   ZLARF, ZLARFG, ZLASET, ZTREXC, ZUNMHR
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, DBLE, DCMPLX, DCONJG, DIMAG, INT, MAX, MIN
*     ..
*     .. Statement Functions ..
      DOUBLE PRECISION   CABS1
*     ..
*     .. Statement Function definitions ..
      CABS1( CDUM ) = ABS( DBLE( CDUM ) ) + ABS( DIMAG( CDUM ) )
*     ..
*     .. Executable Statements ..
*
*     ==== Estimate optimal workspace. ====
*
      JW = MIN( NW, KBOT-KTOP+1 )
      IF( JW.LE.2 ) THEN
         LWKOPT = 1
      ELSE
```

```
*
*        ==== Workspace query call to ZGEHRD ====
*
         CALL ZGEHRD( JW, 1, JW-1, T, LDT, WORK, WORK, -1, INFO )
         LWK1 = INT( WORK( 1 ) )
*
*        ==== Workspace query call to ZUNMHR ====
*
         CALL ZUNMHR( 'R', 'N', JW, JW, 1, JW-1, T, LDT, WORK, V, LDV,
     $                WORK, -1, INFO )
         LWK2 = INT( WORK( 1 ) )
*
*        ==== Optimal workspace ====
*
         LWKOPT = JW + MAX( LWK1, LWK2 )
      END IF
*
*     ==== Quick return in case of workspace query. ====
*
      IF( LWORK.EQ.-1 ) THEN
         WORK( 1 ) = DCMPLX( LWKOPT, 0 )
         RETURN
      END IF
*
*     ==== Nothing to do ...
*     ... for an empty active block ... ====
      NS = 0
      ND = 0
      WORK( 1 ) = ONE
      IF( KTOP.GT.KBOT )
     $   RETURN
*     ... nor for an empty deflation window. ====
      IF( NW.LT.1 )
     $   RETURN
*
*     ==== Machine constants ====
*
      SAFMIN = DLAMCH( 'SAFE MINIMUM' )
      SAFMAX = RONE / SAFMIN
      CALL DLABAD( SAFMIN, SAFMAX )
      ULP = DLAMCH( 'PRECISION' )
      SMLNUM = SAFMIN*( DBLE( N ) / ULP )
*
*     ==== Setup deflation window ====
*
      JW = MIN( NW, KBOT-KTOP+1 )
      KWTOP = KBOT - JW + 1
      IF( KWTOP.EQ.KTOP ) THEN
         S = ZERO
      ELSE
```

```
         S = H( KWTOP, KWTOP-1 )
      END IF
*
      IF( KBOT.EQ.KWTOP ) THEN
*
*        ==== 1-by-1 deflation window: not much to do ====
*
         SH( KWTOP ) = H( KWTOP, KWTOP )
         NS = 1
         ND = 0
         IF( CABS1( S ).LE.MAX( SMLNUM, ULP*CABS1( H( KWTOP,
     $        KWTOP ) ) ) ) THEN
            NS = 0
            ND = 1
            IF( KWTOP.GT.KTOP )
     $         H( KWTOP, KWTOP-1 ) = ZERO
         END IF
         WORK( 1 ) = ONE
         RETURN
      END IF
*
*     ==== Convert to spike-triangular form.  (In case of a
*     .    rare QR failure, this routine continues to do
*     .    aggressive early deflation using that part of
*     .    the deflation window that converged using INFQR
*     .    here and there to keep track.) ====
*
      CALL ZLACPY( 'U', JW, JW, H( KWTOP, KWTOP ), LDH, T, LDT )
      CALL ZCOPY( JW-1, H( KWTOP+1, KWTOP ), LDH+1, T( 2, 1 ), LDT+1 )
*
      CALL ZLASET( 'A', JW, JW, ZERO, ONE, V, LDV )
      CALL ZLAHQR( .true., .true., JW, 1, JW, T, LDT, SH( KWTOP ), 1,
     $             JW, V, LDV, INFQR )
*
*     ==== Deflation detection loop ====
*
      NS = JW
      ILST = INFQR + 1
      DO 10 KNT = INFQR + 1, JW
*
*        ==== Small spike tip deflation test ====
*
         FOO = CABS1( T( NS, NS ) )
         IF( FOO.EQ.RZERO )
     $      FOO = CABS1( S )
         IF( CABS1( S )*CABS1( V( 1, NS ) ).LE.MAX( SMLNUM, ULP*FOO ) )
     $        THEN
*
*           ==== One more converged eigenvalue ====
*
```

```
            NS = NS - 1
         ELSE
*
*           ==== One undeflatable eigenvalue.  Move it up out of the
*           .    way.   (ZTREXC can not fail in this case.) ====
*
            IFST = NS
            CALL ZTREXC( 'V', JW, T, LDT, V, LDV, IFST, ILST, INFO )
            ILST = ILST + 1
         END IF
   10 CONTINUE
*
*        ==== Return to Hessenberg form ====
*
      IF( NS.EQ.0 )
     $   S = ZERO
*
      IF( NS.LT.JW ) THEN
*
*        ==== sorting the diagonal of T improves accuracy for
*        .    graded matrices.  ====
*
         DO 30 I = INFQR + 1, NS
            IFST = I
            DO 20 J = I + 1, NS
               IF( CABS1( T( J, J ) ).GT.CABS1( T( IFST, IFST ) ) )
     $            IFST = J
   20       CONTINUE
            ILST = I
            IF( IFST.NE.ILST )
     $         CALL ZTREXC( 'V', JW, T, LDT, V, LDV, IFST, ILST, INFO )
   30    CONTINUE
      END IF
*
*     ==== Restore shift/eigenvalue array from T ====
*
      DO 40 I = INFQR + 1, JW
         SH( KWTOP+I-1 ) = T( I, I )
   40 CONTINUE
*
*
      IF( NS.LT.JW .OR. S.EQ.ZERO ) THEN
         IF( NS.GT.1 .AND. S.NE.ZERO ) THEN
*
*           ==== Reflect spike back into lower triangle ====
*
            CALL ZCOPY( NS, V, LDV, WORK, 1 )
            DO 50 I = 1, NS
               WORK( I ) = DCONJG( WORK( I ) )
   50       CONTINUE
```

```
            BETA = WORK( 1 )
            CALL ZLARFG( NS, BETA, WORK( 2 ), 1, TAU )
            WORK( 1 ) = ONE
*
            CALL ZLASET( 'L', JW-2, JW-2, ZERO, ZERO, T( 3, 1 ), LDT )
*
            CALL ZLARF( 'L', NS, JW, WORK, 1, DCONJG( TAU ), T, LDT,
     $                  WORK( JW+1 ) )
            CALL ZLARF( 'R', NS, NS, WORK, 1, TAU, T, LDT,
     $                  WORK( JW+1 ) )
            CALL ZLARF( 'R', JW, NS, WORK, 1, TAU, V, LDV,
     $                  WORK( JW+1 ) )
*
            CALL ZGEHRD( JW, 1, NS, T, LDT, WORK, WORK( JW+1 ),
     $                   LWORK-JW, INFO )
         END IF
*
*        ==== Copy updated reduced window into place ====
*
         IF( KWTOP.GT.1 )
     $      H( KWTOP, KWTOP-1 ) = S*DCONJG( V( 1, 1 ) )
         CALL ZLACPY( 'U', JW, JW, T, LDT, H( KWTOP, KWTOP ), LDH )
         CALL ZCOPY( JW-1, T( 2, 1 ), LDT+1, H( KWTOP+1, KWTOP ),
     $               LDH+1 )
*
*        ==== Accumulate orthogonal matrix in order update
*        .    H and Z, if requested.  ====
*
         IF( NS.GT.1 .AND. S.NE.ZERO )
     $      CALL ZUNMHR( 'R', 'N', JW, NS, 1, NS, T, LDT, WORK, V, LDV,
     $                   WORK( JW+1 ), LWORK-JW, INFO )
*
*        ==== Update vertical slab in H ====
*
         IF( WANTT ) THEN
            LTOP = 1
         ELSE
            LTOP = KTOP
         END IF
         DO 60 KROW = LTOP, KWTOP - 1, NV
            KLN = MIN( NV, KWTOP-KROW )
            CALL ZGEMM( 'N', 'N', KLN, JW, JW, ONE, H( KROW, KWTOP ),
     $                  LDH, V, LDV, ZERO, WV, LDWV )
            CALL ZLACPY( 'A', KLN, JW, WV, LDWV, H( KROW, KWTOP ), LDH )
   60    CONTINUE
*
*        ==== Update horizontal slab in H ====
*
         IF( WANTT ) THEN
            DO 70 KCOL = KBOT + 1, N, NH
```

```
               KLN = MIN( NH, N-KCOL+1 )
               CALL ZGEMM( 'C', 'N', JW, KLN, JW, ONE, V, LDV,
     $                     H( KWTOP, KCOL ), LDH, ZERO, T, LDT )
               CALL ZLACPY( 'A', JW, KLN, T, LDT, H( KWTOP, KCOL ),
     $                      LDH )
   70       CONTINUE
         END IF
*
*        ==== Update vertical slab in Z ====
*
         IF( WANTZ ) THEN
            DO 80 KROW = ILOZ, IHIZ, NV
               KLN = MIN( NV, IHIZ-KROW+1 )
               CALL ZGEMM( 'N', 'N', KLN, JW, JW, ONE, Z( KROW, KWTOP ),
     $                     LDZ, V, LDV, ZERO, WV, LDWV )
               CALL ZLACPY( 'A', KLN, JW, WV, LDWV, Z( KROW, KWTOP ),
     $                      LDZ )
   80       CONTINUE
         END IF
      END IF
*
*     ==== Return the number of deflations ... ====
*
      ND = JW - NS
*
*     ==== ... and the number of shifts. (Subtracting
*     .    INFQR from the spike length takes care
*     .    of the case of a rare QR failure while
*     .    calculating eigenvalues of the deflation
*     .    window.)  ====
*
      NS = NS - INFQR
*
*      ==== Return optimal workspace. ====
*
      WORK( 1 ) = DCMPLX( LWKOPT, 0 )
*
*     ==== End of ZLAQR2 ====
*
      END
```

— LAPACK zlaqr2 —

```
(let*
 ((zero (coerce (f2cl-lib:cmplx 0.0d0 0.0d0) 'f2cl-lib:complex16))
  (one (coerce (f2cl-lib:cmplx 1.0d0 0.0d0) 'f2cl-lib:complex16)) (rzero 0.0d0)
```

```
 (rone 1.0d0))
(declare (type (f2cl-lib:complex16) zero) (type (f2cl-lib:complex16) one)
 (type (double-float 0.0d0 0.0d0) rzero)
 (type (double-float 1.0d0 1.0d0) rone) (ignorable zero one rzero rone))
(defun zlaqr2
 (wantt wantz n ktop kbot nw h ldh iloz ihiz z ldz ns nd sh v ldv nh t$ ldt nv
  wv ldwv work lwork)
 (declare (type f2cl-lib:logical wantz wantt)
  (type (f2cl-lib:integer4) lwork ldwv nv ldt nh ldv nd ns ldz ihiz iloz ldh
   nw kbot ktop n)
  (type (array f2cl-lib:complex16 (*)) work wv t$ v sh z h))
 (f2cl-lib:with-multi-array-data
     ((h f2cl-lib:complex16 h-%data% h-%offset%)
      (z f2cl-lib:complex16 z-%data% z-%offset%)
      (sh f2cl-lib:complex16 sh-%data% sh-%offset%)
      (v f2cl-lib:complex16 v-%data% v-%offset%)
      (t$ f2cl-lib:complex16 t$-%data% t$-%offset%)
      (wv f2cl-lib:complex16 wv-%data% wv-%offset%)
      (work f2cl-lib:complex16 work-%data% work-%offset%))
      (labels
       ((cabs1 (cdum)
         (+ (abs (f2cl-lib:dble cdum)) (abs (f2cl-lib:dimag cdum)))))
       (declare
        (ftype (function (f2cl-lib:complex16)
                (values double-float &rest t)) cabs1))
       (prog
        ((i 0) (ifst 0) (ilst 0) (info 0) (infqr 0) (j 0) (jw 0)
         (kcol 0) (kln 0)
         (knt 0) (krow 0) (kwtop 0) (ltop 0) (lwk1 0) (lwk2 0)
         (lwkopt 0) (foo 0.0d0)
         (safmax 0.0d0) (safmin 0.0d0) (smlnum 0.0d0) (ulp 0.0d0)
         (beta #C(0.0d0 0.0d0)) (cdum #C(0.0d0 0.0d0)) (s #C(0.0d0 0.0d0))
         (tau #C(0.0d0 0.0d0)) (dconjg$ 0.0))
        (declare
         (type (f2cl-lib:integer4) lwkopt lwk2 lwk1 ltop kwtop
          krow knt kln kcol jw j
          infqr info ilst ifst i)
         (type (double-float) ulp smlnum safmin safmax foo)
         (type (f2cl-lib:complex16) tau s cdum beta)
         (type (single-float) dconjg$))
        (setf jw
         (min (the f2cl-lib:integer4 nw)
          (the f2cl-lib:integer4
           (f2cl-lib:int-add (f2cl-lib:int-sub kbot ktop) 1))))
        (cond ((<= jw 2) (setf lwkopt 1))
         (t
          (multiple-value-bind
           (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
           (zgehrd jw 1 (f2cl-lib:int-sub jw 1) t$ ldt work work -1 info)
           (declare (ignore var-1 var-2 var-3 var-5 var-6 var-7))
```

```
   (setf jw var-0)
   (setf ldt var-4) (setf info var-8))
  (setf lwk1
   (f2cl-lib:int
    (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)))
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
    var-9 var-10 var-11
    var-12 var-13)
   (zunmhr "R" "N" jw jw 1
    (f2cl-lib:int-sub jw 1) t$ ldt work v ldv work -1
    info)
   (declare (ignore var-0 var-1 var-4 var-5 var-6 var-8 var-9
             var-11 var-12))
   (when var-2 (setf jw var-2)) (when var-3 (setf jw var-3))
   (when var-7 (setf ldt var-7)) (when var-10 (setf ldv var-10))
   (when var-13 (setf info var-13)))
  (setf lwk2
   (f2cl-lib:int (f2cl-lib:fref work-%data% (1) ((1 *))
      work-%offset%)))
  (setf lwkopt
   (f2cl-lib:int-add jw
    (max (the f2cl-lib:integer4 lwk1)
         (the f2cl-lib:integer4 lwk2))))))
(cond
 ((= lwork (f2cl-lib:int-sub 1))
  (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
   (f2cl-lib:dcmplx lwkopt 0))
  (go end_label)))
(setf ns 0) (setf nd 0)
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%) one)
(if (> ktop kbot) (go end_label)) (if (< nw 1) (go end_label))
(setf safmin (dlamch "SAFE MINIMUM")) (setf safmax (/ rone safmin))
(multiple-value-bind (var-0 var-1) (dlabad safmin safmax)
 (declare (ignore))
 (when var-0 (setf safmin var-0)) (when var-1 (setf safmax var-1)))
(setf ulp (dlamch "PRECISION"))
(setf smlnum (* safmin (/ (f2cl-lib:dble n) ulp)))
(setf jw
 (min (the f2cl-lib:integer4 nw)
  (the f2cl-lib:integer4
   (f2cl-lib:int-add (f2cl-lib:int-sub kbot ktop) 1))))
(setf kwtop (f2cl-lib:int-add (f2cl-lib:int-sub kbot jw) 1))
(cond ((= kwtop ktop) (setf s zero))
 (t
  (setf s
   (f2cl-lib:fref h-%data%
    (kwtop (f2cl-lib:int-sub kwtop 1)) ((1 ldh) (1 *))
    h-%offset%))))
(cond
```

```
 ((= kbot kwtop)
  (setf (f2cl-lib:fref sh-%data% (kwtop) ((1 *)) sh-%offset%)
   (f2cl-lib:fref h-%data% (kwtop kwtop) ((1 ldh) (1 *)) h-%offset%))
  (setf ns 1) (setf nd 0)
  (cond
   ((<= (cabs1 s)
     (max smlnum
      (* ulp (cabs1
              (f2cl-lib:fref h (kwtop kwtop) ((1 ldh) (1 *)))))))
    (setf ns 0) (setf nd 1)
    (if (> kwtop ktop)
     (setf
      (f2cl-lib:fref h-%data% (kwtop (f2cl-lib:int-sub kwtop 1))
       ((1 ldh) (1 *)) h-%offset%)
      zero))))
  (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%) one)
  (go end_label)))
(zlacpy "U" jw jw
 (f2cl-lib:array-slice h-%data% f2cl-lib:complex16 (kwtop kwtop)
  ((1 ldh) (1 *)) h-%offset%)
 ldh t$ ldt)
(zcopy (f2cl-lib:int-sub jw 1)
 (f2cl-lib:array-slice h-%data% f2cl-lib:complex16 ((+ kwtop 1) kwtop)
  ((1 ldh) (1 *)) h-%offset%)
 (f2cl-lib:int-add ldh 1)
 (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16 (2 1)
  ((1 ldt) (1 *))
  t$-%offset%)
 (f2cl-lib:int-add ldt 1))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
 (zlaset "A" jw jw zero one v ldv) (declare (ignore var-0 var-5))
 (when var-1 (setf jw var-1)) (when var-2 (setf jw var-2))
 (when var-3 (setf zero var-3)) (when var-4 (setf one var-4))
 (when var-6 (setf ldv var-6)))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
  var-9 var-10 var-11
  var-12)
 (zlahqr f2cl-lib:%true% f2cl-lib:%true% jw 1 jw t$ ldt
  (f2cl-lib:array-slice sh-%data% f2cl-lib:complex16 (kwtop) ((1 *))
   sh-%offset%)
  1 jw v ldv infqr)
 (declare
  (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-7 var-8 var-9 var-10
   var-11))
 (setf ldt var-6) (setf infqr var-12))
(setf ns jw) (setf ilst (f2cl-lib:int-add infqr 1))
(f2cl-lib:fdo (knt (f2cl-lib:int-add infqr 1)
                   (f2cl-lib:int-add knt 1))
       ((>
```

```
                knt jw)
               nil)
              (tagbody
                 (setf foo
                  (cabs1 (f2cl-lib:fref t$-%data% (ns ns)
                            ((1 ldt) (1 *)) t$-%offset%)))
                 (if (= foo rzero) (setf foo (cabs1 s)))
                 (cond
                  ((<= (* (cabs1 s)
                          (cabs1 (f2cl-lib:fref v (1 ns) ((1 ldv) (1 *)))))
                    (max smlnum (* ulp foo)))
                   (setf ns (f2cl-lib:int-sub ns 1)))
                  (t (setf ifst ns)
                   (multiple-value-bind
                    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
                    (ztrexc "V" jw t$ ldt v ldv ifst ilst info)
                    (declare (ignore var-0 var-2 var-4))
                    (when var-1 (setf jw var-1))
                    (when var-3 (setf ldt var-3))
                    (when var-5 (setf ldv var-5))
                    (when var-6 (setf ifst var-6))
                    (when var-7 (setf ilst var-7))
                    (when var-8 (setf info var-8)))
                   (setf ilst (f2cl-lib:int-add ilst 1))))
                  label10))
          (if (= ns 0) (setf s zero))
          (cond
           ((< ns jw)
            (f2cl-lib:fdo (i (f2cl-lib:int-add infqr 1) (f2cl-lib:int-add i 1))
                   ((> i
                       ns)
                      nil)
                    (tagbody (setf ifst i)
                         (f2cl-lib:fdo (j (f2cl-lib:int-add i 1)
                                          (f2cl-lib:int-add j 1))
                                       ((> j ns)
                                        nil)
                                       (tagbody
                                             (if
                                              (> (cabs1 (f2cl-lib:fref t$-%data% (j j)
                                                  ((1 ldt) (1 *)) t$-%offset%))
                                                 (cabs1
                                                  (f2cl-lib:fref t$-%data% (ifst ifst)
                                                    ((1 ldt) (1 *)) t$-%offset%)))
                                              (setf ifst j))
                                             label20))
                                       (setf ilst i)
                                       (if (/= ifst ilst)
                                        (multiple-value-bind
                                         (var-0 var-1 var-2 var-3 var-4 var-5 var-6
```

```
                 var-7 var-8)
                (ztrexc "V" jw t$ ldt v ldv ifst ilst info)
                (declare (ignore var-0 var-2 var-4))
                (when var-1 (setf jw var-1))
                (when var-3 (setf ldt var-3))
                (when var-5 (setf ldv var-5))
                (when var-6 (setf ifst var-6))
                (when var-7 (setf ilst var-7))
                (when var-8 (setf info var-8))))
               label30))))
(f2cl-lib:fdo (i (f2cl-lib:int-add infqr 1) (f2cl-lib:int-add i 1))
       ((> i jw)
          nil)
        (tagbody
           (setf
            (f2cl-lib:fref sh-%data%
             ((f2cl-lib:int-sub (f2cl-lib:int-add kwtop i) 1))
             ((1 *)) sh-%offset%)
            (f2cl-lib:fref t$-%data% (i i) ((1 ldt) (1 *))
              t$-%offset%))
           label40))
(cond
 ((or (< ns jw) (= s zero))
  (cond
   ((and (> ns 1) (/= s zero))
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
     (zcopy ns v ldv work 1) (declare (ignore var-1 var-3 var-4))
     (when var-0 (setf ns var-0)) (when var-2 (setf ldv var-2)))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
           ((> i ns) nil)
            (tagbody
                   (setf (f2cl-lib:fref work-%data% (i) ((1 *))
                           work-%offset%)
                    (coerce
                     (f2cl-lib:dconjg
                      (f2cl-lib:fref work-%data% (i) ((1 *))
                        work-%offset%))
                     'f2cl-lib:complex16))
                   label50))
    (setf beta (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%))
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
     (zlarfg ns beta
      (f2cl-lib:array-slice work-%data% f2cl-lib:complex16 (2) ((1 *))
       work-%offset%)
      1 tau)
     (declare (ignore var-2 var-3)) (when var-0 (setf ns var-0))
     (when var-1 (setf beta var-1)) (when var-4 (setf tau var-4)))
    (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%) one)
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
     (zlaset "L"
```

```
     (f2cl-lib:int-sub jw 2) (f2cl-lib:int-sub jw 2) zero zero
     (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16 (3 1)
      ((1 ldt) (1 *)) t$-%offset%)
     ldt)
    (declare (ignore var-0 var-1 var-2 var-5))
    (when var-3 (setf zero var-3)) (when var-4 (setf zero var-4))
    (when var-6 (setf ldt var-6)))
   (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
    (zlarf "L" ns jw work 1 (f2cl-lib:dconjg tau) t$ ldt
     (f2cl-lib:array-slice work-%data% f2cl-lib:complex16
      ((+ jw 1)) ((1 *))
      work-%offset%))
    (declare (ignore var-0 var-3 var-4 var-5 var-6 var-8))
    (when var-1 (setf ns var-1)) (when var-2 (setf jw var-2))
    (when var-7 (setf ldt var-7)))
   (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
    (zlarf "R" ns ns work 1 tau t$ ldt
     (f2cl-lib:array-slice work-%data% f2cl-lib:complex16
      ((+ jw 1)) ((1 *))
      work-%offset%))
    (declare (ignore var-0 var-3 var-4 var-6 var-8))
    (when var-1 (setf ns var-1)) (when var-2 (setf ns var-2))
    (when var-5 (setf tau var-5)) (when var-7 (setf ldt var-7)))
   (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
    (zlarf "R" jw ns work 1 tau v ldv
     (f2cl-lib:array-slice work-%data% f2cl-lib:complex16
      ((+ jw 1)) ((1 *))
      work-%offset%))
    (declare (ignore var-0 var-3 var-4 var-6 var-8))
    (when var-1 (setf jw var-1)) (when var-2 (setf ns var-2))
    (when var-5 (setf tau var-5)) (when var-7 (setf ldv var-7)))
   (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
    (zgehrd jw 1 ns t$ ldt work
     (f2cl-lib:array-slice work-%data% f2cl-lib:complex16
      ((+ jw 1)) ((1 *))
      work-%offset%)
     (f2cl-lib:int-sub lwork jw) info)
    (declare (ignore var-1 var-3 var-5 var-6 var-7)) (setf jw var-0)
    (setf ns var-2) (setf ldt var-4) (setf info var-8))))
 (if (> kwtop 1)
  (setf
   (f2cl-lib:fref h-%data% (kwtop (f2cl-lib:int-sub kwtop 1))
    ((1 ldh) (1 *)) h-%offset%)
   (coerce
    (* s
     (f2cl-lib:dconjg
```

```
     (f2cl-lib:fref v-%data% (1 1) ((1 ldv) (1 *)) v-%offset%)))
   'f2cl-lib:complex16)))
(zlacpy "U" jw jw t$ ldt
 (f2cl-lib:array-slice h-%data% f2cl-lib:complex16 (kwtop kwtop)
  ((1 ldh) (1 *)) h-%offset%)
 ldh)
(zcopy (f2cl-lib:int-sub jw 1)
 (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16
  (2 1) ((1 ldt) (1 *))
  t$-%offset%)
 (f2cl-lib:int-add ldt 1)
 (f2cl-lib:array-slice h-%data% f2cl-lib:complex16
  ((+ kwtop 1) kwtop)
  ((1 ldh) (1 *)) h-%offset%)
 (f2cl-lib:int-add ldh 1))
(if (and (> ns 1) (/= s zero))
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10
   var-11 var-12 var-13)
  (zunmhr "R" "N" jw ns 1 ns t$ ldt work v ldv
   (f2cl-lib:array-slice work-%data% f2cl-lib:complex16
    ((+ jw 1)) ((1 *))
    work-%offset%)
   (f2cl-lib:int-sub lwork jw) info)
  (declare (ignore var-0 var-1 var-4 var-6 var-8 var-9 var-11
           var-12))
  (when var-2 (setf jw var-2)) (when var-3 (setf ns var-3))
  (when var-5 (setf ns var-5)) (when var-7 (setf ldt var-7))
  (when var-10 (setf ldv var-10)) (when var-13 (setf info var-13))))
(cond (wantt (setf ltop 1)) (t (setf ltop ktop)))
(f2cl-lib:fdo (krow ltop (f2cl-lib:int-add krow nv))
       ((> krow
           (f2cl-lib:int-add kwtop (f2cl-lib:int-sub 1)))
           nil)
        (tagbody
             (setf kln
              (min (the f2cl-lib:integer4 nv)
               (the f2cl-lib:integer4
                (f2cl-lib:int-sub kwtop krow))))
             (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6
               var-7 var-8 var-9 var-10
               var-11 var-12)
              (zgemm "N" "N" kln jw jw one
               (f2cl-lib:array-slice h-%data%
                f2cl-lib:complex16 (krow kwtop)
                ((1 ldh) (1 *)) h-%offset%)
               ldh v ldv zero wv ldwv)
              (declare (ignore var-0 var-1 var-6 var-8 var-11))
```

```
                (when var-2 (setf kln var-2))
                (when var-3 (setf jw var-3))
                (when var-4 (setf jw var-4))
                (when var-5 (setf one var-5))
                (when var-7 (setf ldh var-7))
                (when var-9 (setf ldv var-9))
                (when var-10 (setf zero var-10))
                (when var-12 (setf ldwv var-12)))
               (zlacpy "A" kln jw wv ldwv
                (f2cl-lib:array-slice h-%data%
                 f2cl-lib:complex16 (krow kwtop)
                 ((1 ldh) (1 *)) h-%offset%)
                ldh)
               label60))
(cond
 (wantt
  (f2cl-lib:fdo (kcol (f2cl-lib:int-add kbot 1)
                 (f2cl-lib:int-add kcol nh))
         ((> kcol n) nil)
          (tagbody
                 (setf kln
                  (min (the f2cl-lib:integer4 nh)
                   (the f2cl-lib:integer4
                    (f2cl-lib:int-add
                     (f2cl-lib:int-sub n kcol) 1))))
                 (multiple-value-bind
                  (var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10
                   var-11 var-12)
                  (zgemm "C" "N" jw kln jw one v ldv
                   (f2cl-lib:array-slice h-%data%
                    f2cl-lib:complex16 (kwtop kcol)
                    ((1 ldh) (1 *)) h-%offset%)
                   ldh zero t$ ldt)
                  (declare (ignore var-0 var-1 var-6 var-8 var-11))
                  (when var-2 (setf jw var-2))
                  (when var-3 (setf kln var-3))
                  (when var-4 (setf jw var-4))
                  (when var-5 (setf one var-5))
                  (when var-7 (setf ldv var-7))
                  (when var-9 (setf ldh var-9))
                  (when var-10 (setf zero var-10))
                  (when var-12 (setf ldt var-12)))
                 (zlacpy "A" jw kln t$ ldt
                  (f2cl-lib:array-slice h-%data%
                   f2cl-lib:complex16 (kwtop kcol)
                   ((1 ldh) (1 *)) h-%offset%)
                  ldh)
                 label70))))
(cond
```

```
    (wantz
     (f2cl-lib:fdo (krow iloz (f2cl-lib:int-add krow nv))
            ((> krow ihiz)
                  nil)
             (tagbody
                    (setf kln
                     (min (the f2cl-lib:integer4 nv)
                      (the f2cl-lib:integer4
                       (f2cl-lib:int-add
                        (f2cl-lib:int-sub ihiz krow) 1))))
                    (multiple-value-bind
                     (var-0 var-1 var-2 var-3 var-4 var-5 var-6
                      var-7 var-8 var-9 var-10
                      var-11 var-12)
                     (zgemm "N" "N" kln jw jw one
                      (f2cl-lib:array-slice z-%data%
                       f2cl-lib:complex16 (krow kwtop)
                       ((1 ldz) (1 *)) z-%offset%)
                      ldz v ldv zero wv ldwv)
                     (declare (ignore var-0 var-1 var-6 var-8 var-11))
                     (when var-2 (setf kln var-2))
                     (when var-3 (setf jw var-3))
                     (when var-4 (setf jw var-4))
                     (when var-5 (setf one var-5))
                     (when var-7 (setf ldz var-7))
                     (when var-9 (setf ldv var-9))
                     (when var-10 (setf zero var-10))
                     (when var-12 (setf ldwv var-12)))
                    (zlacpy "A" kln jw wv ldwv
                     (f2cl-lib:array-slice z-%data%
                       f2cl-lib:complex16 (krow kwtop)
                      ((1 ldz) (1 *)) z-%offset%)
                     ldz)
                    label80))))))
(setf nd (f2cl-lib:int-sub jw ns))
(setf ns (f2cl-lib:int-sub ns infqr))
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
 (f2cl-lib:dcmplx lwkopt 0))
end_label
(return
 (values nil nil nil nil nil nil nil ldh nil nil nil ldz ns nd nil
  nil ldv nil nil ldt nil nil ldwv nil nil)))))))
```

———-

6.115 zlaqr3 LAPACK

— zlaqr3.input —

```
)set break resume
)sys rm -f zlaqr3.output
)spool zlaqr3.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

————-

— zlaqr3.help —

```
=======================================================================
zlaqr3 examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

 Online html documentation available at
           http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZLAQR3( WANTT, WANTZ, N, KTOP, KBOT, NW, H, LDH, ILOZ,
                          IHIZ, Z, LDZ, NS, ND, SH, V, LDV, NH, T, LDT,
                          NV, WV, LDWV, WORK, LWORK )

       .. Scalar Arguments ..
       INTEGER            IHIZ, ILOZ, KBOT, KTOP, LDH, LDT, LDV, LDWV,
      $                   LDZ, LWORK, N, ND, NH, NS, NV, NW
       LOGICAL            WANTT, WANTZ
       ..
       .. Array Arguments ..
       COMPLEX*16         H( LDH, * ), SH( * ), T( LDT, * ), V( LDV, * ),
      $                   WORK( * ), WV( LDWV, * ), Z( LDZ, * )
       ..


 Purpose:
 =============

    Aggressive early deflation:
```

```
    ZLAQR3 accepts as input an upper Hessenberg matrix
    H and performs an unitary similarity transformation
    designed to detect and deflate fully converged eigenvalues from
    a trailing principal submatrix.  On output H has been over-
    written by a new Hessenberg matrix that is a perturbation of
    an unitary similarity transformation of H.  It is to be
    hoped that the final version of H has many zero subdiagonal
    entries.

Arguments:
==========

 [in] WANTT

         WANTT is LOGICAL
         If .TRUE., then the Hessenberg matrix H is fully updated
         so that the triangular Schur factor may be
         computed (in cooperation with the calling subroutine).
         If .FALSE., then only enough of H is updated to preserve
         the eigenvalues.

 [in] WANTZ

         WANTZ is LOGICAL
         If .TRUE., then the unitary matrix Z is updated so
         so that the unitary Schur factor may be computed
         (in cooperation with the calling subroutine).
         If .FALSE., then Z is not referenced.

 [in] N

         N is INTEGER
         The order of the matrix H and (if WANTZ is .TRUE.) the
         order of the unitary matrix Z.

 [in] KTOP

         KTOP is INTEGER
         It is assumed that either KTOP = 1 or H(KTOP,KTOP-1)=0.
         KBOT and KTOP together determine an isolated block
         along the diagonal of the Hessenberg matrix.

 [in] KBOT

         KBOT is INTEGER
         It is assumed without a check that either
         KBOT = N or H(KBOT+1,KBOT)=0.  KBOT and KTOP together
         determine an isolated block along the diagonal of the
         Hessenberg matrix.
```

```
[in] NW

        NW is INTEGER
        Deflation window size.  1 .LE. NW .LE. (KBOT-KTOP+1).

[in,out] H

        H is COMPLEX*16 array, dimension (LDH,N)
        On input the initial N-by-N section of H stores the
        Hessenberg matrix undergoing aggressive early deflation.
        On output H has been transformed by a unitary
        similarity transformation, perturbed, and the returned
        to Hessenberg form that (it is to be hoped) has some
        zero subdiagonal entries.

[in] LDH

        LDH is integer
        Leading dimension of H just as declared in the calling
        subroutine.  N .LE. LDH

[in] ILOZ

        ILOZ is INTEGER

[in] IHIZ

        IHIZ is INTEGER
        Specify the rows of Z to which transformations must be
        applied if WANTZ is .TRUE.. 1 .LE. ILOZ .LE. IHIZ .LE. N.

[in,out] Z

        Z is COMPLEX*16 array, dimension (LDZ,N)
        IF WANTZ is .TRUE., then on output, the unitary
        similarity transformation mentioned above has been
        accumulated into Z(ILOZ:IHIZ,ILO:IHI) from the right.
        If WANTZ is .FALSE., then Z is unreferenced.

[in] LDZ

        LDZ is integer
        The leading dimension of Z just as declared in the
        calling subroutine.  1 .LE. LDZ.

[out] NS

        NS is integer
        The number of unconverged (ie approximate) eigenvalues
```

```
          returned in SR and SI that may be used as shifts by the
          calling subroutine.

  [out] ND

          ND is integer
          The number of converged eigenvalues uncovered by this
          subroutine.

  [out] SH

          SH is COMPLEX*16 array, dimension KBOT
          On output, approximate eigenvalues that may
          be used for shifts are stored in SH(KBOT-ND-NS+1)
          through SR(KBOT-ND).  Converged eigenvalues are
          stored in SH(KBOT-ND+1) through SH(KBOT).

  [out] V

          V is COMPLEX*16 array, dimension (LDV,NW)
          An NW-by-NW work array.

  [in] LDV

          LDV is integer scalar
          The leading dimension of V just as declared in the
          calling subroutine.  NW .LE. LDV

  [in] NH

          NH is integer scalar
          The number of columns of T.  NH.GE.NW.

  [out] T

          T is COMPLEX*16 array, dimension (LDT,NW)

  [in] LDT

          LDT is integer
          The leading dimension of T just as declared in the
          calling subroutine.  NW .LE. LDT

  [in] NV

          NV is integer
          The number of rows of work array WV available for
          workspace.  NV.GE.NW.

  [out] WV
```

```
          WV is COMPLEX*16 array, dimension (LDWV,NW)

  [in] LDWV

          LDWV is integer
          The leading dimension of W just as declared in the
          calling subroutine.  NW .LE. LDV

  [out] WORK

          WORK is COMPLEX*16 array, dimension LWORK.
          On exit, WORK(1) is set to an estimate of the optimal value
          of LWORK for the given values of N, NW, KTOP and KBOT.

  [in] LWORK

          LWORK is integer
          The dimension of the work array WORK.  LWORK = 2*NW
          suffices, but greater efficiency may result from larger
          values of LWORK.

          If LWORK = -1, then a workspace query is assumed; ZLAQR3
          only estimates the optimal workspace size for the given
          values of N, NW, KTOP and KBOT.  The estimate is returned
          in WORK(1).  No error message related to LWORK is issued
          by XERBLA.  Neither H nor Z are accessed.


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========

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November 2011

Contributors:
==================

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      University of Kansas, USA
```

— zlaqr3.f —

```
*  =====================================================================
      SUBROUTINE ZLAQR3( WANTT, WANTZ, N, KTOP, KBOT, NW, H, LDH, ILOZ,
     $                   IHIZ, Z, LDZ, NS, ND, SH, V, LDV, NH, T, LDT,
     $                   NV, WV, LDWV, WORK, LWORK )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      INTEGER            IHIZ, ILOZ, KBOT, KTOP, LDH, LDT, LDV, LDWV,
     $                   LDZ, LWORK, N, ND, NH, NS, NV, NW
      LOGICAL            WANTT, WANTZ
*     ..
*     .. Array Arguments ..
      COMPLEX*16         H( LDH, * ), SH( * ), T( LDT, * ), V( LDV, * ),
     $                   WORK( * ), WV( LDWV, * ), Z( LDZ, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      COMPLEX*16         ZERO, ONE
      PARAMETER          ( ZERO = ( 0.0d0, 0.0d0 ),
     $                   ONE = ( 1.0d0, 0.0d0 ) )
      DOUBLE PRECISION   RZERO, RONE
      PARAMETER          ( RZERO = 0.0d0, RONE = 1.0d0 )
*     ..
*     .. Local Scalars ..
      COMPLEX*16         BETA, CDUM, S, TAU
      DOUBLE PRECISION   FOO, SAFMAX, SAFMIN, SMLNUM, ULP
      INTEGER            I, IFST, ILST, INFO, INFQR, J, JW, KCOL, KLN,
     $                   KNT, KROW, KWTOP, LTOP, LWK1, LWK2, LWK3,
     $                   LWKOPT, NMIN
*     ..
*     .. External Functions ..
      DOUBLE PRECISION   DLAMCH
      INTEGER            ILAENV
      EXTERNAL           DLAMCH, ILAENV
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLABAD, ZCOPY, ZGEHRD, ZGEMM, ZLACPY, ZLAHQR,
     $                   ZLAQR4, ZLARF, ZLARFG, ZLASET, ZTREXC, ZUNMHR
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, DBLE, DCMPLX, DCONJG, DIMAG, INT, MAX, MIN
*     ..
*     .. Statement Functions ..
      DOUBLE PRECISION   CABS1
```

```
*     ..
*     .. Statement Function definitions ..
      CABS1( CDUM ) = ABS( DBLE( CDUM ) ) + ABS( DIMAG( CDUM ) )
*     ..
*     .. Executable Statements ..
*
*     ==== Estimate optimal workspace. ====
*
      JW = MIN( NW, KBOT-KTOP+1 )
      IF( JW.LE.2 ) THEN
         LWKOPT = 1
      ELSE
*
*        ==== Workspace query call to ZGEHRD ====
*
         CALL ZGEHRD( JW, 1, JW-1, T, LDT, WORK, WORK, -1, INFO )
         LWK1 = INT( WORK( 1 ) )
*
*        ==== Workspace query call to ZUNMHR ====
*
         CALL ZUNMHR( 'R', 'N', JW, JW, 1, JW-1, T, LDT, WORK, V, LDV,
     $                WORK, -1, INFO )
         LWK2 = INT( WORK( 1 ) )
*
*        ==== Workspace query call to ZLAQR4 ====
*
         CALL ZLAQR4( .true., .true., JW, 1, JW, T, LDT, SH, 1, JW, V,
     $                LDV, WORK, -1, INFQR )
         LWK3 = INT( WORK( 1 ) )
*
*        ==== Optimal workspace ====
*
         LWKOPT = MAX( JW+MAX( LWK1, LWK2 ), LWK3 )
      END IF
*
*     ==== Quick return in case of workspace query. ====
*
      IF( LWORK.EQ.-1 ) THEN
         WORK( 1 ) = DCMPLX( LWKOPT, 0 )
         RETURN
      END IF
*
*     ==== Nothing to do ...
*     ... for an empty active block ... ====
      NS = 0
      ND = 0
      WORK( 1 ) = ONE
      IF( KTOP.GT.KBOT )
     $   RETURN
*     ... nor for an empty deflation window. ====
```

```
      IF( NW.LT.1 )
     $   RETURN
*
*     ==== Machine constants ====
*
      SAFMIN = DLAMCH( 'SAFE MINIMUM' )
      SAFMAX = RONE / SAFMIN
      CALL DLABAD( SAFMIN, SAFMAX )
      ULP = DLAMCH( 'PRECISION' )
      SMLNUM = SAFMIN*( DBLE( N ) / ULP )
*
*     ==== Setup deflation window ====
*
      JW = MIN( NW, KBOT-KTOP+1 )
      KWTOP = KBOT - JW + 1
      IF( KWTOP.EQ.KTOP ) THEN
         S = ZERO
      ELSE
         S = H( KWTOP, KWTOP-1 )
      END IF
*
      IF( KBOT.EQ.KWTOP ) THEN
*
*        ==== 1-by-1 deflation window: not much to do ====
*
         SH( KWTOP ) = H( KWTOP, KWTOP )
         NS = 1
         ND = 0
         IF( CABS1( S ).LE.MAX( SMLNUM, ULP*CABS1( H( KWTOP,
     $        KWTOP ) ) ) ) THEN
            NS = 0
            ND = 1
            IF( KWTOP.GT.KTOP )
     $         H( KWTOP, KWTOP-1 ) = ZERO
         END IF
         WORK( 1 ) = ONE
         RETURN
      END IF
*
*     ==== Convert to spike-triangular form.  (In case of a
*     .    rare QR failure, this routine continues to do
*     .    aggressive early deflation using that part of
*     .    the deflation window that converged using INFQR
*     .    here and there to keep track.) ====
*
      CALL ZLACPY( 'U', JW, JW, H( KWTOP, KWTOP ), LDH, T, LDT )
      CALL ZCOPY( JW-1, H( KWTOP+1, KWTOP ), LDH+1, T( 2, 1 ), LDT+1 )
*
      CALL ZLASET( 'A', JW, JW, ZERO, ONE, V, LDV )
      NMIN = ILAENV( 12, 'ZLAQR3', 'SV', JW, 1, JW, LWORK )
```

```
      IF( JW.GT.NMIN ) THEN
         CALL ZLAQR4( .true., .true., JW, 1, JW, T, LDT, SH( KWTOP ), 1,
     $                JW, V, LDV, WORK, LWORK, INFQR )
      ELSE
         CALL ZLAHQR( .true., .true., JW, 1, JW, T, LDT, SH( KWTOP ), 1,
     $                JW, V, LDV, INFQR )
      END IF
*
*     ==== Deflation detection loop ====
*
      NS = JW
      ILST = INFQR + 1
      DO 10 KNT = INFQR + 1, JW
*
*        ==== Small spike tip deflation test ====
*
         FOO = CABS1( T( NS, NS ) )
         IF( FOO.EQ.RZERO )
     $      FOO = CABS1( S )
         IF( CABS1( S )*CABS1( V( 1, NS ) ).LE.MAX( SMLNUM, ULP*FOO ) )
     $        THEN
*
*           ==== One more converged eigenvalue ====
*
            NS = NS - 1
         ELSE
*
*           ==== One undeflatable eigenvalue.  Move it up out of the
*           .    way.   (ZTREXC can not fail in this case.) ====
*
            IFST = NS
            CALL ZTREXC( 'V', JW, T, LDT, V, LDV, IFST, ILST, INFO )
            ILST = ILST + 1
         END IF
   10 CONTINUE
*
*        ==== Return to Hessenberg form ====
*
      IF( NS.EQ.0 )
     $   S = ZERO
*
      IF( NS.LT.JW ) THEN
*
*        ==== sorting the diagonal of T improves accuracy for
*        .    graded matrices.  ====
*
         DO 30 I = INFQR + 1, NS
            IFST = I
            DO 20 J = I + 1, NS
               IF( CABS1( T( J, J ) ).GT.CABS1( T( IFST, IFST ) ) )
```

```
     $            IFST = J
   20       CONTINUE
            ILST = I
            IF( IFST.NE.ILST )
     $         CALL ZTREXC( 'V', JW, T, LDT, V, LDV, IFST, ILST, INFO )
   30    CONTINUE
      END IF
*
*     ==== Restore shift/eigenvalue array from T ====
*
      DO 40 I = INFQR + 1, JW
         SH( KWTOP+I-1 ) = T( I, I )
   40 CONTINUE
*
*
      IF( NS.LT.JW .OR. S.EQ.ZERO ) THEN
         IF( NS.GT.1 .AND. S.NE.ZERO ) THEN
*
*           ==== Reflect spike back into lower triangle ====
*
            CALL ZCOPY( NS, V, LDV, WORK, 1 )
            DO 50 I = 1, NS
               WORK( I ) = DCONJG( WORK( I ) )
   50       CONTINUE
            BETA = WORK( 1 )
            CALL ZLARFG( NS, BETA, WORK( 2 ), 1, TAU )
            WORK( 1 ) = ONE
*
            CALL ZLASET( 'L', JW-2, JW-2, ZERO, ZERO, T( 3, 1 ), LDT )
*
            CALL ZLARF( 'L', NS, JW, WORK, 1, DCONJG( TAU ), T, LDT,
     $                  WORK( JW+1 ) )
            CALL ZLARF( 'R', NS, NS, WORK, 1, TAU, T, LDT,
     $                  WORK( JW+1 ) )
            CALL ZLARF( 'R', JW, NS, WORK, 1, TAU, V, LDV,
     $                  WORK( JW+1 ) )
*
            CALL ZGEHRD( JW, 1, NS, T, LDT, WORK, WORK( JW+1 ),
     $                   LWORK-JW, INFO )
         END IF
*
*        ==== Copy updated reduced window into place ====
*
         IF( KWTOP.GT.1 )
     $      H( KWTOP, KWTOP-1 ) = S*DCONJG( V( 1, 1 ) )
         CALL ZLACPY( 'U', JW, JW, T, LDT, H( KWTOP, KWTOP ), LDH )
         CALL ZCOPY( JW-1, T( 2, 1 ), LDT+1, H( KWTOP+1, KWTOP ),
     $               LDH+1 )
*
*        ==== Accumulate orthogonal matrix in order update
```

```
*        .    H and Z, if requested.  ====
*
         IF( NS.GT.1 .AND. S.NE.ZERO )
     $      CALL ZUNMHR( 'R', 'N', JW, NS, 1, NS, T, LDT, WORK, V, LDV,
     $                   WORK( JW+1 ), LWORK-JW, INFO )
*
*        ==== Update vertical slab in H ====
*
         IF( WANTT ) THEN
            LTOP = 1
         ELSE
            LTOP = KTOP
         END IF
         DO 60 KROW = LTOP, KWTOP - 1, NV
            KLN = MIN( NV, KWTOP-KROW )
            CALL ZGEMM( 'N', 'N', KLN, JW, JW, ONE, H( KROW, KWTOP ),
     $                  LDH, V, LDV, ZERO, WV, LDWV )
            CALL ZLACPY( 'A', KLN, JW, WV, LDWV, H( KROW, KWTOP ), LDH )
   60    CONTINUE
*
*        ==== Update horizontal slab in H ====
*
         IF( WANTT ) THEN
            DO 70 KCOL = KBOT + 1, N, NH
               KLN = MIN( NH, N-KCOL+1 )
               CALL ZGEMM( 'C', 'N', JW, KLN, JW, ONE, V, LDV,
     $                     H( KWTOP, KCOL ), LDH, ZERO, T, LDT )
               CALL ZLACPY( 'A', JW, KLN, T, LDT, H( KWTOP, KCOL ),
     $                      LDH )
   70       CONTINUE
         END IF
*
*        ==== Update vertical slab in Z ====
*
         IF( WANTZ ) THEN
            DO 80 KROW = ILOZ, IHIZ, NV
               KLN = MIN( NV, IHIZ-KROW+1 )
               CALL ZGEMM( 'N', 'N', KLN, JW, JW, ONE, Z( KROW, KWTOP ),
     $                     LDZ, V, LDV, ZERO, WV, LDWV )
               CALL ZLACPY( 'A', KLN, JW, WV, LDWV, Z( KROW, KWTOP ),
     $                      LDZ )
   80       CONTINUE
         END IF
      END IF
*
*     ==== Return the number of deflations ... ====
*
      ND = JW - NS
*
*     ==== ... and the number of shifts. (Subtracting
```

```
*     .    INFQR from the spike length takes care
*     .    of the case of a rare QR failure while
*     .    calculating eigenvalues of the deflation
*     .    window.)  ====
*
      NS = NS - INFQR
*
*      ==== Return optimal workspace. ====
*
      WORK( 1 ) = DCMPLX( LWKOPT, 0 )
*
*     ==== End of ZLAQR3 ====
*
      END
```

———-

— LAPACK zlaqr3 —

```
(let*
 ((zero (coerce (f2cl-lib:cmplx 0.0d0 0.0d0) 'f2cl-lib:complex16))
  (one (coerce (f2cl-lib:cmplx 1.0d0 0.0d0) 'f2cl-lib:complex16)) (rzero 0.0d0)
  (rone 1.0d0))
 (declare (type (f2cl-lib:complex16) zero) (type (f2cl-lib:complex16) one)
  (type (double-float 0.0d0 0.0d0) rzero)
  (type (double-float 1.0d0 1.0d0) rone) (ignorable zero one rzero rone))
 (defun zlaqr3
  (wantt wantz n ktop kbot nw h ldh iloz ihiz z ldz ns nd sh v ldv nh t$ ldt nv
   wv ldwv work lwork)
  (declare (type f2cl-lib:logical wantz wantt)
   (type (f2cl-lib:integer4) lwork ldwv nv ldt nh ldv nd ns ldz ihiz iloz ldh
    nw kbot ktop n)
   (type (array f2cl-lib:complex16 (*)) work wv t$ v sh z h))
  (f2cl-lib:with-multi-array-data
      ((h f2cl-lib:complex16 h-%data% h-%offset%)
       (z f2cl-lib:complex16 z-%data% z-%offset%)
       (sh f2cl-lib:complex16 sh-%data% sh-%offset%)
       (v f2cl-lib:complex16 v-%data% v-%offset%)
       (t$ f2cl-lib:complex16 t$-%data% t$-%offset%)
       (wv f2cl-lib:complex16 wv-%data% wv-%offset%)
       (work f2cl-lib:complex16 work-%data% work-%offset%))
       (labels
        ((cabs1 (cdum)
                (+ (abs (f2cl-lib:dble cdum)) (abs (f2cl-lib:dimag cdum)))))
        (declare
         (ftype (function (f2cl-lib:complex16)
                (values double-float &rest t)) cabs1))
        (prog
```

```
((i 0) (ifst 0) (ilst 0) (info 0) (infqr 0) (j 0) (jw 0)
 (kcol 0) (kln 0)
 (knt 0) (krow 0) (kwtop 0) (ltop 0) (lwk1 0) (lwk2 0)
 (lwk3 0) (lwkopt 0)
 (nmin 0) (foo 0.0d0) (safmax 0.0d0) (safmin 0.0d0) (smlnum 0.0d0)
 (ulp 0.0d0) (beta #C(0.0d0 0.0d0)) (cdum #C(0.0d0 0.0d0))
 (s #C(0.0d0 0.0d0)) (tau #C(0.0d0 0.0d0)) (dconjg$ 0.0))
(declare
 (type (f2cl-lib:integer4) nmin lwkopt lwk3 lwk2 lwk1 ltop
  kwtop krow knt kln
  kcol jw j infqr info ilst ifst i)
 (type (double-float) ulp smlnum safmin safmax foo)
 (type (f2cl-lib:complex16) tau s cdum beta)
 (type (single-float) dconjg$))
(setf jw
 (min (the f2cl-lib:integer4 nw)
  (the f2cl-lib:integer4
   (f2cl-lib:int-add (f2cl-lib:int-sub kbot ktop) 1))))
(cond ((<= jw 2) (setf lwkopt 1))
 (t
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
   (zgehrd jw 1 (f2cl-lib:int-sub jw 1) t$ ldt work work -1 info)
   (declare (ignore var-1 var-2 var-3 var-5 var-6 var-7))
   (setf jw var-0)
   (setf ldt var-4) (setf info var-8))
  (setf lwk1
   (f2cl-lib:int
    (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)))
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
    var-9 var-10 var-11
    var-12 var-13)
   (zunmhr "R" "N" jw jw 1
    (f2cl-lib:int-sub jw 1) t$ ldt work v ldv work -1
    info)
   (declare (ignore var-0 var-1 var-4 var-5 var-6 var-8
             var-9 var-11 var-12))
   (when var-2 (setf jw var-2)) (when var-3 (setf jw var-3))
   (when var-7 (setf ldt var-7)) (when var-10 (setf ldv var-10))
   (when var-13 (setf info var-13)))
  (setf lwk2
   (f2cl-lib:int
    (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)))
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
    var-9 var-10 var-11
    var-12 var-13 var-14)
   (zlaqr4 f2cl-lib:%true% f2cl-lib:%true%
     jw 1 jw t$ ldt sh 1 jw v ldv work
```

```
     -1 infqr)
    (declare
     (ignore var-0 var-1 var-3 var-5 var-7 var-8 var-10 var-12 var-13))
    (when var-2 (setf jw var-2)) (when var-4 (setf jw var-4))
    (when var-6 (setf ldt var-6)) (when var-9 (setf jw var-9))
    (when var-11 (setf ldv var-11)) (when var-14 (setf infqr var-14)))
   (setf lwk3
    (f2cl-lib:int (f2cl-lib:fref work-%data% (1) ((1 *))
      work-%offset%)))
   (setf lwkopt
    (max
     (the f2cl-lib:integer4
      (f2cl-lib:int-add jw
       (max (the f2cl-lib:integer4 lwk1)
            (the f2cl-lib:integer4 lwk2))))
     (the f2cl-lib:integer4 lwk3)))))
(cond
 ((= lwork (f2cl-lib:int-sub 1))
  (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
   (f2cl-lib:dcmplx lwkopt 0))
  (go end_label)))
(setf ns 0) (setf nd 0)
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%) one)
(if (> ktop kbot) (go end_label)) (if (< nw 1) (go end_label))
(setf safmin (dlamch "SAFE MINIMUM")) (setf safmax (/ rone safmin))
(multiple-value-bind (var-0 var-1)
  (dlabad safmin safmax) (declare (ignore))
 (when var-0 (setf safmin var-0)) (when var-1 (setf safmax var-1)))
(setf ulp (dlamch "PRECISION"))
(setf smlnum (* safmin (/ (f2cl-lib:dble n) ulp)))
(setf jw
 (min (the f2cl-lib:integer4 nw)
  (the f2cl-lib:integer4
    (f2cl-lib:int-add (f2cl-lib:int-sub kbot ktop) 1))))
(setf kwtop (f2cl-lib:int-add (f2cl-lib:int-sub kbot jw) 1))
(cond ((= kwtop ktop) (setf s zero))
 (t
  (setf s
   (f2cl-lib:fref h-%data%
    (kwtop (f2cl-lib:int-sub kwtop 1)) ((1 ldh) (1 *))
    h-%offset%))))
(cond
 ((= kbot kwtop)
  (setf (f2cl-lib:fref sh-%data% (kwtop) ((1 *)) sh-%offset%)
   (f2cl-lib:fref h-%data% (kwtop kwtop) ((1 ldh) (1 *)) h-%offset%))
  (setf ns 1) (setf nd 0)
  (cond
   ((<= (cabs1 s)
     (max smlnum
      (* ulp (cabs1
```

```
                (f2cl-lib:fref h (kwtop kwtop) ((1 ldh) (1 *)))))))
     (setf ns 0) (setf nd 1)
     (if (> kwtop ktop)
      (setf
       (f2cl-lib:fref h-%data% (kwtop (f2cl-lib:int-sub kwtop 1))
        ((1 ldh) (1 *)) h-%offset%)
       zero))))
   (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%) one)
   (go end_label)))
 (zlacpy "U" jw jw
  (f2cl-lib:array-slice h-%data% f2cl-lib:complex16 (kwtop kwtop)
   ((1 ldh) (1 *)) h-%offset%)
  ldh t$ ldt)
 (zcopy (f2cl-lib:int-sub jw 1)
  (f2cl-lib:array-slice h-%data% f2cl-lib:complex16 ((+ kwtop 1) kwtop)
   ((1 ldh) (1 *)) h-%offset%)
  (f2cl-lib:int-add ldh 1)
  (f2cl-lib:array-slice t$-%data%
   f2cl-lib:complex16 (2 1) ((1 ldt) (1 *))
   t$-%offset%)
  (f2cl-lib:int-add ldt 1))
 (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
  (zlaset "A" jw jw zero one v ldv) (declare (ignore var-0 var-5))
  (when var-1 (setf jw var-1)) (when var-2 (setf jw var-2))
  (when var-3 (setf zero var-3)) (when var-4 (setf one var-4))
  (when var-6 (setf ldv var-6)))
 (setf nmin
  (multiple-value-bind (ret-val var-0 var-1 var-2 var-3
     var-4 var-5 var-6)
   (ilaenv 12 "ZLAQR3" "SV" jw 1 jw lwork)
   (declare (ignore var-0 var-1 var-2 var-4))
   (when var-3 (setf jw var-3))
   (when var-5 (setf jw var-5))
   (when var-6 (setf lwork var-6)) ret-val))
 (cond
  ((> jw nmin)
   (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
     var-9 var-10 var-11
     var-12 var-13 var-14)
    (zlaqr4 f2cl-lib:%true% f2cl-lib:%true% jw 1 jw t$ ldt
     (f2cl-lib:array-slice sh-%data% f2cl-lib:complex16 (kwtop) ((1 *))
      sh-%offset%)
     1 jw v ldv work lwork infqr)
    (declare (ignore var-0 var-1 var-3 var-5 var-7 var-8
              var-10 var-12))
    (when var-2 (setf jw var-2)) (when var-4 (setf jw var-4))
    (when var-6 (setf ldt var-6)) (when var-9 (setf jw var-9))
    (when var-11 (setf ldv var-11)) (when var-13 (setf lwork var-13))
    (when var-14 (setf infqr var-14))))
```

```
 (t
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
    var-9 var-10 var-11
    var-12)
   (zlahqr f2cl-lib:%true% f2cl-lib:%true% jw 1 jw t$ ldt
    (f2cl-lib:array-slice sh-%data% f2cl-lib:complex16 (kwtop) ((1 *))
     sh-%offset%)
    1 jw v ldv infqr)
   (declare
    (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-7 var-8
     var-9 var-10
     var-11))
   (setf ldt var-6) (setf infqr var-12))))
(setf ns jw) (setf ilst (f2cl-lib:int-add infqr 1))
(f2cl-lib:fdo (knt (f2cl-lib:int-add infqr 1)
                   (f2cl-lib:int-add knt 1))
       ((>
           knt jw)
         nil)
        (tagbody
           (setf foo
            (cabs1 (f2cl-lib:fref t$-%data% (ns ns)
                    ((1 ldt) (1 *)) t$-%offset%)))
           (if (= foo rzero) (setf foo (cabs1 s)))
           (cond
            ((<= (* (cabs1 s)
                    (cabs1 (f2cl-lib:fref v (1 ns) ((1 ldv) (1 *)))))
              (max smlnum (* ulp foo)))
             (setf ns (f2cl-lib:int-sub ns 1)))
            (t (setf ifst ns)
             (multiple-value-bind
              (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
              (ztrexc "V" jw t$ ldt v ldv ifst ilst info)
              (declare (ignore var-0 var-2 var-4))
              (when var-1 (setf jw var-1))
              (when var-3 (setf ldt var-3))
              (when var-5 (setf ldv var-5))
              (when var-6 (setf ifst var-6))
              (when var-7 (setf ilst var-7))
              (when var-8 (setf info var-8)))
             (setf ilst (f2cl-lib:int-add ilst 1))))
           label10))
(if (= ns 0) (setf s zero))
(cond
 ((< ns jw)
  (f2cl-lib:fdo (i (f2cl-lib:int-add infqr 1) (f2cl-lib:int-add i 1))
         ((> i
               ns)
              nil)
```

```
            (tagbody (setf ifst i)
                 (f2cl-lib:fdo
                   (j (f2cl-lib:int-add i 1) (f2cl-lib:int-add j 1))
            ((> j ns)
                  nil)
             (tagbody
                   (if
                    (> (cabs1 (f2cl-lib:fref t$-%data% (j j)
                                             ((1 ldt) (1 *)) t$-%offset%))
                     (cabs1
                      (f2cl-lib:fref t$-%data% (ifst ifst)
                       ((1 ldt) (1 *)) t$-%offset%)))
                    (setf ifst j))
                   label20))
                 (setf ilst i)
                 (if (/= ifst ilst)
                  (multiple-value-bind
                   (var-0 var-1 var-2 var-3 var-4 var-5 var-6
                    var-7 var-8)
                   (ztrexc "V" jw t$ ldt v ldv ifst ilst info)
                   (declare (ignore var-0 var-2 var-4))
                   (when var-1 (setf jw var-1))
                   (when var-3 (setf ldt var-3))
                   (when var-5 (setf ldv var-5))
                   (when var-6 (setf ifst var-6))
                   (when var-7 (setf ilst var-7))
                   (when var-8 (setf info var-8))))
                 label30))))
(f2cl-lib:fdo (i (f2cl-lib:int-add infqr 1) (f2cl-lib:int-add i 1))
       ((> i jw)
          nil)
        (tagbody
           (setf
            (f2cl-lib:fref sh-%data%
             ((f2cl-lib:int-sub (f2cl-lib:int-add kwtop i) 1))
             ((1 *)) sh-%offset%)
            (f2cl-lib:fref t$-%data% (i i) ((1 ldt) (1 *))
              t$-%offset%))
           label40))
(cond
 ((or (< ns jw) (= s zero))
  (cond
   ((and (> ns 1) (/= s zero))
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
     (zcopy ns v ldv work 1) (declare (ignore var-1 var-3 var-4))
     (when var-0 (setf ns var-0)) (when var-2 (setf ldv var-2)))
    (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
           ((> i ns) nil)
            (tagbody
                   (setf (f2cl-lib:fref work-%data% (i) ((1 *))
```

```
                 work-%offset%)
                (coerce
                 (f2cl-lib:dconjg
                  (f2cl-lib:fref work-%data% (i) ((1 *))
                   work-%offset%))
                 'f2cl-lib:complex16))
               label50))
(setf beta (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
 (zlarfg ns beta
  (f2cl-lib:array-slice work-%data% f2cl-lib:complex16 (2) ((1 *))
   work-%offset%)
  1 tau)
 (declare (ignore var-2 var-3)) (when var-0 (setf ns var-0))
 (when var-1 (setf beta var-1)) (when var-4 (setf tau var-4)))
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%) one)
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
 (zlaset "L"
  (f2cl-lib:int-sub jw 2) (f2cl-lib:int-sub jw 2) zero zero
  (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16 (3 1)
   ((1 ldt) (1 *)) t$-%offset%)
  ldt)
 (declare (ignore var-0 var-1 var-2 var-5))
 (when var-3 (setf zero var-3)) (when var-4 (setf zero var-4))
 (when var-6 (setf ldt var-6)))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
 (zlarf "L" ns jw work 1 (f2cl-lib:dconjg tau) t$ ldt
  (f2cl-lib:array-slice work-%data%
   f2cl-lib:complex16 ((+ jw 1)) ((1 *))
   work-%offset%))
 (declare (ignore var-0 var-3 var-4 var-5 var-6 var-8))
 (when var-1 (setf ns var-1)) (when var-2 (setf jw var-2))
 (when var-7 (setf ldt var-7)))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
 (zlarf "R" ns ns work 1 tau t$ ldt
  (f2cl-lib:array-slice work-%data%
   f2cl-lib:complex16 ((+ jw 1)) ((1 *))
   work-%offset%))
 (declare (ignore var-0 var-3 var-4 var-6 var-8))
 (when var-1 (setf ns var-1)) (when var-2 (setf ns var-2))
 (when var-5 (setf tau var-5)) (when var-7 (setf ldt var-7)))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
 (zlarf "R" jw ns work 1 tau v ldv
  (f2cl-lib:array-slice work-%data%
   f2cl-lib:complex16 ((+ jw 1)) ((1 *))
   work-%offset%))
 (declare (ignore var-0 var-3 var-4 var-6 var-8))
```

```
   (when var-1 (setf jw var-1)) (when var-2 (setf ns var-2))
   (when var-5 (setf tau var-5)) (when var-7 (setf ldv var-7)))
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
   (zgehrd jw 1 ns t$ ldt work
    (f2cl-lib:array-slice work-%data%
     f2cl-lib:complex16 ((+ jw 1)) ((1 *))
     work-%offset%)
    (f2cl-lib:int-sub lwork jw) info)
   (declare (ignore var-1 var-3 var-5 var-6 var-7)) (setf jw var-0)
   (setf ns var-2) (setf ldt var-4) (setf info var-8))))
(if (> kwtop 1)
 (setf
  (f2cl-lib:fref h-%data% (kwtop (f2cl-lib:int-sub kwtop 1))
   ((1 ldh) (1 *)) h-%offset%)
  (coerce
   (* s
    (f2cl-lib:dconjg
     (f2cl-lib:fref v-%data% (1 1) ((1 ldv) (1 *)) v-%offset%)))
   'f2cl-lib:complex16)))
(zlacpy "U" jw jw t$ ldt
 (f2cl-lib:array-slice h-%data% f2cl-lib:complex16 (kwtop kwtop)
  ((1 ldh) (1 *)) h-%offset%)
 ldh)
(zcopy (f2cl-lib:int-sub jw 1)
 (f2cl-lib:array-slice t$-%data%
  f2cl-lib:complex16 (2 1) ((1 ldt) (1 *))
  t$-%offset%)
 (f2cl-lib:int-add ldt 1)
 (f2cl-lib:array-slice h-%data%
   f2cl-lib:complex16 ((+ kwtop 1) kwtop)
  ((1 ldh) (1 *)) h-%offset%)
 (f2cl-lib:int-add ldh 1))
(if (and (> ns 1) (/= s zero))
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10
   var-11 var-12 var-13)
  (zunmhr "R" "N" jw ns 1 ns t$ ldt work v ldv
   (f2cl-lib:array-slice work-%data%
    f2cl-lib:complex16 ((+ jw 1)) ((1 *))
    work-%offset%)
   (f2cl-lib:int-sub lwork jw) info)
  (declare
   (ignore var-0 var-1 var-4 var-6 var-8 var-9 var-11 var-12))
  (when var-2 (setf jw var-2)) (when var-3 (setf ns var-3))
  (when var-5 (setf ns var-5)) (when var-7 (setf ldt var-7))
  (when var-10 (setf ldv var-10)) (when var-13 (setf info var-13))))
(cond (wantt (setf ltop 1)) (t (setf ltop ktop)))
(f2cl-lib:fdo (krow ltop (f2cl-lib:int-add krow nv))
```

```
          ((> krow
              (f2cl-lib:int-add kwtop (f2cl-lib:int-sub 1)))
             nil)
           (tagbody
              (setf kln
               (min (the f2cl-lib:integer4 nv)
                (the f2cl-lib:integer4
                 (f2cl-lib:int-sub kwtop krow))))
              (multiple-value-bind
               (var-0 var-1 var-2 var-3 var-4 var-5 var-6
                var-7 var-8 var-9 var-10
                var-11 var-12)
               (zgemm "N" "N" kln jw jw one
                (f2cl-lib:array-slice h-%data%
                 f2cl-lib:complex16 (krow kwtop)
                 ((1 ldh) (1 *)) h-%offset%)
                ldh v ldv zero wv ldwv)
               (declare (ignore var-0 var-1 var-6 var-8 var-11))
               (when var-2 (setf kln var-2))
               (when var-3 (setf jw var-3))
               (when var-4 (setf jw var-4))
               (when var-5 (setf one var-5))
               (when var-7 (setf ldh var-7))
               (when var-9 (setf ldv var-9))
               (when var-10 (setf zero var-10))
               (when var-12 (setf ldwv var-12)))
              (zlacpy "A" kln jw wv ldwv
               (f2cl-lib:array-slice h-%data%
                f2cl-lib:complex16 (krow kwtop)
                ((1 ldh) (1 *)) h-%offset%)
               ldh)
              label60))
        (cond
         (wantt
          (f2cl-lib:fdo (kcol (f2cl-lib:int-add kbot 1)
                         (f2cl-lib:int-add kcol nh))
                 ((> kcol n) nil)
                  (tagbody
                         (setf kln
                          (min (the f2cl-lib:integer4 nh)
                           (the f2cl-lib:integer4
                            (f2cl-lib:int-add
                             (f2cl-lib:int-sub n kcol) 1))))
                         (multiple-value-bind
                          (var-0 var-1 var-2 var-3 var-4 var-5 var-6
                           var-7 var-8 var-9 var-10
                           var-11 var-12)
                          (zgemm "C" "N" jw kln jw one v ldv
                           (f2cl-lib:array-slice h-%data%
                            f2cl-lib:complex16 (kwtop kcol)
```

```
                          ((1 ldh) (1 *)) h-%offset%)
                         ldh zero t$ ldt)
                        (declare (ignore var-0 var-1 var-6 var-8 var-11))
                        (when var-2 (setf jw var-2))
                        (when var-3 (setf kln var-3))
                        (when var-4 (setf jw var-4))
                        (when var-5 (setf one var-5))
                        (when var-7 (setf ldv var-7))
                        (when var-9 (setf ldh var-9))
                        (when var-10 (setf zero var-10))
                        (when var-12 (setf ldt var-12)))
                       (zlacpy "A" jw kln t$ ldt
                        (f2cl-lib:array-slice h-%data%
                         f2cl-lib:complex16 (kwtop kcol)
                         ((1 ldh) (1 *)) h-%offset%)
                        ldh)
                       label70))))
(cond
 (wantz
  (f2cl-lib:fdo (krow iloz (f2cl-lib:int-add krow nv))
         ((> krow ihiz)
                nil)
          (tagbody
                 (setf kln
                  (min (the f2cl-lib:integer4 nv)
                   (the f2cl-lib:integer4
                    (f2cl-lib:int-add
                     (f2cl-lib:int-sub ihiz krow) 1))))
                 (multiple-value-bind
                  (var-0 var-1 var-2 var-3 var-4 var-5 var-6
                   var-7 var-8 var-9 var-10
                   var-11 var-12)
                  (zgemm "N" "N" kln jw jw one
                   (f2cl-lib:array-slice z-%data%
                    f2cl-lib:complex16 (krow kwtop)
                    ((1 ldz) (1 *)) z-%offset%)
                   ldz v ldv zero wv ldwv)
                  (declare (ignore var-0 var-1 var-6 var-8 var-11))
                  (when var-2 (setf kln var-2))
                  (when var-3 (setf jw var-3))
                  (when var-4 (setf jw var-4))
                  (when var-5 (setf one var-5))
                  (when var-7 (setf ldz var-7))
                  (when var-9 (setf ldv var-9))
                  (when var-10 (setf zero var-10))
                  (when var-12 (setf ldwv var-12)))
                 (zlacpy "A" kln jw wv ldwv
                  (f2cl-lib:array-slice z-%data%
                    f2cl-lib:complex16 (krow kwtop)
                   ((1 ldz) (1 *)) z-%offset%)
```

```
                          ldz)
                         label80))))))
          (setf nd (f2cl-lib:int-sub jw ns))
          (setf ns (f2cl-lib:int-sub ns infqr))
          (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
           (f2cl-lib:dcmplx lwkopt 0))
          end_label
          (return
           (values nil nil nil nil nil nil nil ldh nil nil nil ldz ns nd nil nil ldv
            nil nil ldt nil nil ldwv nil lwork)))))))
```

———-

6.116 zlaqr4 LAPACK

— **zlaqr4.input** —

```
)set break resume
)sys rm -f zlaqr4.output
)spool zlaqr4.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zlaqr4.help** —

```
=======================================================================
zlaqr4 examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZLAQR4( WANTT, WANTZ, N, ILO, IHI, H, LDH, W, ILOZ,
```

```
                        IHIZ, Z, LDZ, WORK, LWORK, INFO )

      .. Scalar Arguments ..
      INTEGER            IHI, IHIZ, ILO, ILOZ, INFO, LDH, LDZ, LWORK, N
      LOGICAL            WANTT, WANTZ
      ..
      .. Array Arguments ..
      COMPLEX*16         H( LDH, * ), W( * ), WORK( * ), Z( LDZ, * )
      ..


Purpose:
=============

   ZLAQR4 implements one level of recursion for ZLAQR0.
   It is a complete implementation of the small bulge multi-shift
   QR algorithm.  It may be called by ZLAQR0 and, for large enough
   deflation window size, it may be called by ZLAQR3.  This
   subroutine is identical to ZLAQR0 except that it calls ZLAQR2
   instead of ZLAQR3.

   ZLAQR4 computes the eigenvalues of a Hessenberg matrix H
   and, optionally, the matrices T and Z from the Schur decomposition
   H = Z T Z**H, where T is an upper triangular matrix (the
   Schur form), and Z is the unitary matrix of Schur vectors.

   Optionally Z may be postmultiplied into an input unitary
   matrix Q so that this routine can give the Schur factorization
   of a matrix A which has been reduced to the Hessenberg form H
   by the unitary matrix Q:  A = Q*H*Q**H = (QZ)*H*(QZ)**H.

Arguments:
==========

 [in] WANTT

         WANTT is LOGICAL
         = .TRUE. : the full Schur form T is required;
         = .FALSE.: only eigenvalues are required.

 [in] WANTZ

         WANTZ is LOGICAL
         = .TRUE. : the matrix of Schur vectors Z is required;
         = .FALSE.: Schur vectors are not required.

 [in] N

         N is INTEGER
          The order of the matrix H.  N .GE. 0.
```

```
[in] ILO

        ILO is INTEGER

[in] IHI

        IHI is INTEGER
         It is assumed that H is already upper triangular in rows
         and columns 1:ILO-1 and IHI+1:N and, if ILO.GT.1,
         H(ILO,ILO-1) is zero. ILO and IHI are normally set by a
         previous call to ZGEBAL, and then passed to ZGEHRD when the
         matrix output by ZGEBAL is reduced to Hessenberg form.
         Otherwise, ILO and IHI should be set to 1 and N,
         respectively.  If N.GT.0, then 1.LE.ILO.LE.IHI.LE.N.
         If N = 0, then ILO = 1 and IHI = 0.

[in,out] H

        H is COMPLEX*16 array, dimension (LDH,N)
         On entry, the upper Hessenberg matrix H.
         On exit, if INFO = 0 and WANTT is .TRUE., then H
         contains the upper triangular matrix T from the Schur
         decomposition (the Schur form). If INFO = 0 and WANT is
         .FALSE., then the contents of H are unspecified on exit.
         (The output value of H when INFO.GT.0 is given under the
         description of INFO below.)

         This subroutine may explicitly set H(i,j) = 0 for i.GT.j and
         j = 1, 2, ... ILO-1 or j = IHI+1, IHI+2, ... N.

[in] LDH

        LDH is INTEGER
         The leading dimension of the array H. LDH .GE. max(1,N).

[out] W

        W is COMPLEX*16 array, dimension (N)
         The computed eigenvalues of H(ILO:IHI,ILO:IHI) are stored
         in W(ILO:IHI). If WANTT is .TRUE., then the eigenvalues are
         stored in the same order as on the diagonal of the Schur
         form returned in H, with W(i) = H(i,i).

[in] ILOZ

        ILOZ is INTEGER

[in] IHIZ
```

```
          IHIZ is INTEGER
           Specify the rows of Z to which transformations must be
           applied if WANTZ is .TRUE..
           1 .LE. ILOZ .LE. ILO; IHI .LE. IHIZ .LE. N.

  [in,out] Z

          Z is COMPLEX*16 array, dimension (LDZ,IHI)
           If WANTZ is .FALSE., then Z is not referenced.
           If WANTZ is .TRUE., then Z(ILO:IHI,ILOZ:IHIZ) is
           replaced by Z(ILO:IHI,ILOZ:IHIZ)*U where U is the
           orthogonal Schur factor of H(ILO:IHI,ILO:IHI).
           (The output value of Z when INFO.GT.0 is given under
           the description of INFO below.)

  [in] LDZ

          LDZ is INTEGER
           The leading dimension of the array Z.  if WANTZ is .TRUE.
           then LDZ.GE.MAX(1,IHIZ).  Otherwize, LDZ.GE.1.

  [out] WORK

          WORK is COMPLEX*16 array, dimension LWORK
           On exit, if LWORK = -1, WORK(1) returns an estimate of
           the optimal value for LWORK.

  [in] LWORK

          LWORK is INTEGER
           The dimension of the array WORK.  LWORK .GE. max(1,N)
           is sufficient, but LWORK typically as large as 6*N may
           be required for optimal performance.  A workspace query
           to determine the optimal workspace size is recommended.

           If LWORK = -1, then ZLAQR4 does a workspace query.
           In this case, ZLAQR4 checks the input parameters and
           estimates the optimal workspace size for the given
           values of N, ILO and IHI.  The estimate is returned
           in WORK(1).  No error message related to LWORK is
           issued by XERBLA.  Neither H nor Z are accessed.

  [out] INFO

          INFO is INTEGER
             =  0:  successful exit
            .GT. 0:  if INFO = i, ZLAQR4 failed to compute all of
                 the eigenvalues.  Elements 1:ilo-1 and i+1:n of WR
                 and WI contain those eigenvalues which have been
                 successfully computed.  (Failures are rare.)
```

```
              If INFO .GT. 0 and WANT is .FALSE., then on exit,
              the remaining unconverged eigenvalues are the eigen-
              values of the upper Hessenberg matrix rows and
              columns ILO through INFO of the final, output
              value of H.

              If INFO .GT. 0 and WANTT is .TRUE., then on exit

          (*)  (initial value of H)*U  = U*(final value of H)

              where U is a unitary matrix.  The final
              value of  H is upper Hessenberg and triangular in
              rows and columns INFO+1 through IHI.

              If INFO .GT. 0 and WANTZ is .TRUE., then on exit

                (final value of Z(ILO:IHI,ILOZ:IHIZ)
                 =  (initial value of Z(ILO:IHI,ILOZ:IHIZ)*U

              where U is the unitary matrix in (*) (regard-
              less of the value of WANTT.)

              If INFO .GT. 0 and WANTZ is .FALSE., then Z is not
              accessed.

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========

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November 2011

Contributors:
==================

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      University of Kansas, USA

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================

      K. Braman, R. Byers and R. Mathias, The Multi-Shift QR
      Algorithm Part I: Maintaining Well Focused Shifts, and Level 3
      Performance, SIAM Journal of Matrix Analysis, volume 23, pages
      929--947, 2002.
```

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       K. Braman, R. Byers and R. Mathias, The Multi-Shift QR
       Algorithm Part II: Aggressive Early Deflation, SIAM Journal
       of Matrix Analysis, volume 23, pages 948--973, 2002.
```

— zlaqr4.f —

```
*  =====================================================================
      SUBROUTINE ZLAQR4( WANTT, WANTZ, N, ILO, IHI, H, LDH, W, ILOZ,
     $                   IHIZ, Z, LDZ, WORK, LWORK, INFO )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      INTEGER            IHI, IHIZ, ILO, ILOZ, INFO, LDH, LDZ, LWORK, N
      LOGICAL            WANTT, WANTZ
*     ..
*     .. Array Arguments ..
      COMPLEX*16         H( LDH, * ), W( * ), WORK( * ), Z( LDZ, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
*
*     ==== Matrices of order NTINY or smaller must be processed by
*     .    ZLAHQR because of insufficient subdiagonal scratch space.
*     .    (This is a hard limit.) ====
      INTEGER            NTINY
      PARAMETER          ( NTINY = 11 )
*
*     ==== Exceptional deflation windows:  try to cure rare
*     .    slow convergence by varying the size of the
*     .    deflation window after KEXNW iterations. ====
      INTEGER            KEXNW
      PARAMETER          ( KEXNW = 5 )
*
*     ==== Exceptional shifts: try to cure rare slow convergence
*     .    with ad-hoc exceptional shifts every KEXSH iterations.
*     .    ====
      INTEGER            KEXSH
      PARAMETER          ( KEXSH = 6 )
*
*     ==== The constant WILK1 is used to form the exceptional
```

```
*     .    shifts. ====
      DOUBLE PRECISION   WILK1
      PARAMETER          ( WILK1 = 0.75d0 )
      COMPLEX*16         ZERO, ONE
      PARAMETER          ( ZERO = ( 0.0d0, 0.0d0 ),
     $                   ONE = ( 1.0d0, 0.0d0 ) )
      DOUBLE PRECISION   TWO
      PARAMETER          ( TWO = 2.0d0 )
*     ..
*     .. Local Scalars ..
      COMPLEX*16         AA, BB, CC, CDUM, DD, DET, RTDISC, SWAP, TR2
      DOUBLE PRECISION   S
      INTEGER            I, INF, IT, ITMAX, K, KACC22, KBOT, KDU, KS,
     $                   KT, KTOP, KU, KV, KWH, KWTOP, KWV, LD, LS,
     $                   LWKOPT, NDEC, NDFL, NH, NHO, NIBBLE, NMIN, NS,
     $                   NSMAX, NSR, NVE, NW, NWMAX, NWR, NWUPBD
      LOGICAL            SORTED
      CHARACTER          JBCMPZ*2
*     ..
*     .. External Functions ..
      INTEGER            ILAENV
      EXTERNAL           ILAENV
*     ..
*     .. Local Arrays ..
      COMPLEX*16         ZDUM( 1, 1 )
*     ..
*     .. External Subroutines ..
      EXTERNAL           ZLACPY, ZLAHQR, ZLAQR2, ZLAQR5
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, DBLE, DCMPLX, DIMAG, INT, MAX, MIN, MOD,
     $                   SQRT
*     ..
*     .. Statement Functions ..
      DOUBLE PRECISION   CABS1
*     ..
*     .. Statement Function definitions ..
      CABS1( CDUM ) = ABS( DBLE( CDUM ) ) + ABS( DIMAG( CDUM ) )
*     ..
*     .. Executable Statements ..
      INFO = 0
*
*     ==== Quick return for N = 0: nothing to do. ====
*
      IF( N.EQ.0 ) THEN
         WORK( 1 ) = ONE
         RETURN
      END IF
*
      IF( N.LE.NTINY ) THEN
```

```
*
*        ==== Tiny matrices must use ZLAHQR. ====
*
         LWKOPT = 1
         IF( LWORK.NE.-1 )
     $      CALL ZLAHQR( WANTT, WANTZ, N, ILO, IHI, H, LDH, W, ILOZ,
     $                   IHIZ, Z, LDZ, INFO )
      ELSE
*
*        ==== Use small bulge multi-shift QR with aggressive early
*        .    deflation on larger-than-tiny matrices. ====
*
*        ==== Hope for the best. ====
*
         INFO = 0
*
*        ==== Set up job flags for ILAENV. ====
*
         IF( WANTT ) THEN
            JBCMPZ( 1: 1 ) = 'S'
         ELSE
            JBCMPZ( 1: 1 ) = 'E'
         END IF
         IF( WANTZ ) THEN
            JBCMPZ( 2: 2 ) = 'V'
         ELSE
            JBCMPZ( 2: 2 ) = 'N'
         END IF
*
*        ==== NWR = recommended deflation window size.  At this
*        .    point,  N .GT. NTINY = 11, so there is enough
*        .    subdiagonal workspace for NWR.GE.2 as required.
*        .    (In fact, there is enough subdiagonal space for
*        .    NWR.GE.3.) ====
*
         NWR = ILAENV( 13, 'ZLAQR4', JBCMPZ, N, ILO, IHI, LWORK )
         NWR = MAX( 2, NWR )
         NWR = MIN( IHI-ILO+1, ( N-1 ) / 3, NWR )
*
*        ==== NSR = recommended number of simultaneous shifts.
*        .    At this point N .GT. NTINY = 11, so there is at
*        .    enough subdiagonal workspace for NSR to be even
*        .    and greater than or equal to two as required. ====
*
         NSR = ILAENV( 15, 'ZLAQR4', JBCMPZ, N, ILO, IHI, LWORK )
         NSR = MIN( NSR, ( N+6 ) / 9, IHI-ILO )
         NSR = MAX( 2, NSR-MOD( NSR, 2 ) )
*
*        ==== Estimate optimal workspace ====
*
```

```
*        ==== Workspace query call to ZLAQR2 ====
*
         CALL ZLAQR2( WANTT, WANTZ, N, ILO, IHI, NWR+1, H, LDH, ILOZ,
     $               IHIZ, Z, LDZ, LS, LD, W, H, LDH, N, H, LDH, N, H,
     $               LDH, WORK, -1 )
*
*        ==== Optimal workspace = MAX(ZLAQR5, ZLAQR2) ====
*
         LWKOPT = MAX( 3*NSR / 2, INT( WORK( 1 ) ) )
*
*        ==== Quick return in case of workspace query. ====
*
         IF( LWORK.EQ.-1 ) THEN
            WORK( 1 ) = DCMPLX( LWKOPT, 0 )
            RETURN
         END IF
*
*        ==== ZLAHQR/ZLAQR0 crossover point ====
*
         NMIN = ILAENV( 12, 'ZLAQR4', JBCMPZ, N, ILO, IHI, LWORK )
         NMIN = MAX( NTINY, NMIN )
*
*        ==== Nibble crossover point ====
*
         NIBBLE = ILAENV( 14, 'ZLAQR4', JBCMPZ, N, ILO, IHI, LWORK )
         NIBBLE = MAX( 0, NIBBLE )
*
*        ==== Accumulate reflections during ttswp?  Use block
*        .    2-by-2 structure during matrix-matrix multiply? ====
*
         KACC22 = ILAENV( 16, 'ZLAQR4', JBCMPZ, N, ILO, IHI, LWORK )
         KACC22 = MAX( 0, KACC22 )
         KACC22 = MIN( 2, KACC22 )
*
*        ==== NWMAX = the largest possible deflation window for
*        .    which there is sufficient workspace. ====
*
         NWMAX = MIN( ( N-1 ) / 3, LWORK / 2 )
         NW = NWMAX
*
*        ==== NSMAX = the Largest number of simultaneous shifts
*        .    for which there is sufficient workspace. ====
*
         NSMAX = MIN( ( N+6 ) / 9, 2*LWORK / 3 )
         NSMAX = NSMAX - MOD( NSMAX, 2 )
*
*        ==== NDFL: an iteration count restarted at deflation. ====
*
         NDFL = 1
*
```

```
*        ==== ITMAX = iteration limit ====
*
         ITMAX = MAX( 30, 2*KEXSH )*MAX( 10, ( IHI-ILO+1 ) )
*
*        ==== Last row and column in the active block ====
*
         KBOT = IHI
*
*        ==== Main Loop ====
*
         DO 70 IT = 1, ITMAX
*
*           ==== Done when KBOT falls below ILO ====
*
            IF( KBOT.LT.ILO )
     $         GO TO 80
*
*           ==== Locate active block ====
*
            DO 10 K = KBOT, ILO + 1, -1
               IF( H( K, K-1 ).EQ.ZERO )
     $            GO TO 20
   10       CONTINUE
            K = ILO
   20       CONTINUE
            KTOP = K
*
*           ==== Select deflation window size:
*           .    Typical Case:
*           .      If possible and advisable, nibble the entire
*           .      active block.  If not, use size MIN(NWR,NWMAX)
*           .      or MIN(NWR+1,NWMAX) depending upon which has
*           .      the smaller corresponding subdiagonal entry
*           .      (a heuristic).
*           .
*           .    Exceptional Case:
*           .      If there have been no deflations in KEXNW or
*           .      more iterations, then vary the deflation window
*           .      size.   At first, because, larger windows are,
*           .      in general, more powerful than smaller ones,
*           .      rapidly increase the window to the maximum possible.
*           .      Then, gradually reduce the window size. ====
*
            NH = KBOT - KTOP + 1
            NWUPBD = MIN( NH, NWMAX )
            IF( NDFL.LT.KEXNW ) THEN
               NW = MIN( NWUPBD, NWR )
            ELSE
               NW = MIN( NWUPBD, 2*NW )
            END IF
```

```
            IF( NW.LT.NWMAX ) THEN
               IF( NW.GE.NH-1 ) THEN
                  NW = NH
               ELSE
                  KWTOP = KBOT - NW + 1
                  IF( CABS1( H( KWTOP, KWTOP-1 ) ).GT.
     $                CABS1( H( KWTOP-1, KWTOP-2 ) ) )NW = NW + 1
               END IF
            END IF
            IF( NDFL.LT.KEXNW ) THEN
               NDEC = -1
            ELSE IF( NDEC.GE.0 .OR. NW.GE.NWUPBD ) THEN
               NDEC = NDEC + 1
               IF( NW-NDEC.LT.2 )
     $            NDEC = 0
               NW = NW - NDEC
            END IF
*
*           ==== Aggressive early deflation:
*           .    split workspace under the subdiagonal into
*           .      - an nw-by-nw work array V in the lower
*           .        left-hand-corner,
*           .      - an NW-by-at-least-NW-but-more-is-better
*           .        (NW-by-NHO) horizontal work array along
*           .        the bottom edge,
*           .      - an at-least-NW-but-more-is-better (NHV-by-NW)
*           .        vertical work array along the left-hand-edge.
*           .        ====
*
            KV = N - NW + 1
            KT = NW + 1
            NHO = ( N-NW-1 ) - KT + 1
            KWV = NW + 2
            NVE = ( N-NW ) - KWV + 1
*
*           ==== Aggressive early deflation ====
*
            CALL ZLAQR2( WANTT, WANTZ, N, KTOP, KBOT, NW, H, LDH, ILOZ,
     $                   IHIZ, Z, LDZ, LS, LD, W, H( KV, 1 ), LDH, NHO,
     $                   H( KV, KT ), LDH, NVE, H( KWV, 1 ), LDH, WORK,
     $                   LWORK )
*
*           ==== Adjust KBOT accounting for new deflations. ====
*
            KBOT = KBOT - LD
*
*           ==== KS points to the shifts. ====
*
            KS = KBOT - LS + 1
*
```

```
*           ==== Skip an expensive QR sweep if there is a (partly
*           .    heuristic) reason to expect that many eigenvalues
*           .    will deflate without it.  Here, the QR sweep is
*           .    skipped if many eigenvalues have just been deflated
*           .    or if the remaining active block is small.
*
            IF( ( LD.EQ.0 ) .OR. ( ( 100*LD.LE.NW*NIBBLE ) .AND. ( KBOT-
     $          KTOP+1.GT.MIN( NMIN, NWMAX ) ) ) ) THEN
*
*              ==== NS = nominal number of simultaneous shifts.
*              .    This may be lowered (slightly) if ZLAQR2
*              .    did not provide that many shifts. ====
*
               NS = MIN( NSMAX, NSR, MAX( 2, KBOT-KTOP ) )
               NS = NS - MOD( NS, 2 )
*
*              ==== If there have been no deflations
*              .    in a multiple of KEXSH iterations,
*              .    then try exceptional shifts.
*              .    Otherwise use shifts provided by
*              .    ZLAQR2 above or from the eigenvalues
*              .    of a trailing principal submatrix. ====
*
               IF( MOD( NDFL, KEXSH ).EQ.0 ) THEN
                  KS = KBOT - NS + 1
                  DO 30 I = KBOT, KS + 1, -2
                     W( I ) = H( I, I ) + WILK1*CABS1( H( I, I-1 ) )
                     W( I-1 ) = W( I )
   30             CONTINUE
               ELSE
*
*                 ==== Got NS/2 or fewer shifts? Use ZLAHQR
*                 .    on a trailing principal submatrix to
*                 .    get more. (Since NS.LE.NSMAX.LE.(N+6)/9,
*                 .    there is enough space below the subdiagonal
*                 .    to fit an NS-by-NS scratch array.) ====
*
                  IF( KBOT-KS+1.LE.NS / 2 ) THEN
                     KS = KBOT - NS + 1
                     KT = N - NS + 1
                     CALL ZLACPY( 'A', NS, NS, H( KS, KS ), LDH,
     $                            H( KT, 1 ), LDH )
                     CALL ZLAHQR( .false., .false., NS, 1, NS,
     $                            H( KT, 1 ), LDH, W( KS ), 1, 1, ZDUM,
     $                            1, INF )
                     KS = KS + INF
*
*                    ==== In case of a rare QR failure use
*                    .    eigenvalues of the trailing 2-by-2
*                    .    principal submatrix.  Scale to avoid
```

```
*                    .    overflows, underflows and subnormals.
*                    .    (The scale factor S can not be zero,
*                    .    because H(KBOT,KBOT-1) is nonzero.) ====
*
                     IF( KS.GE.KBOT ) THEN
                        S = CABS1( H( KBOT-1, KBOT-1 ) ) +
     $                      CABS1( H( KBOT, KBOT-1 ) ) +
     $                      CABS1( H( KBOT-1, KBOT ) ) +
     $                      CABS1( H( KBOT, KBOT ) )
                        AA = H( KBOT-1, KBOT-1 ) / S
                        CC = H( KBOT, KBOT-1 ) / S
                        BB = H( KBOT-1, KBOT ) / S
                        DD = H( KBOT, KBOT ) / S
                        TR2 = ( AA+DD ) / TWO
                        DET = ( AA-TR2 )*( DD-TR2 ) - BB*CC
                        RTDISC = SQRT( -DET )
                        W( KBOT-1 ) = ( TR2+RTDISC )*S
                        W( KBOT ) = ( TR2-RTDISC )*S
*
                        KS = KBOT - 1
                     END IF
                  END IF
*
                  IF( KBOT-KS+1.GT.NS ) THEN
*
*                    ==== Sort the shifts (Helps a little) ====
*
                     SORTED = .false.
                     DO 50 K = KBOT, KS + 1, -1
                        IF( SORTED )
     $                     GO TO 60
                        SORTED = .true.
                        DO 40 I = KS, K - 1
                           IF( CABS1( W( I ) ).LT.CABS1( W( I+1 ) ) )
     $                          THEN
                              SORTED = .false.
                              SWAP = W( I )
                              W( I ) = W( I+1 )
                              W( I+1 ) = SWAP
                           END IF
   40                   CONTINUE
   50                CONTINUE
   60                CONTINUE
                  END IF
               END IF
*
*              ==== If there are only two shifts, then use
*              .    only one.  ====
*
               IF( KBOT-KS+1.EQ.2 ) THEN
```

```
                  IF( CABS1( W( KBOT )-H( KBOT, KBOT ) ).LT.
     $                CABS1( W( KBOT-1 )-H( KBOT, KBOT ) ) ) THEN
                     W( KBOT-1 ) = W( KBOT )
                  ELSE
                     W( KBOT ) = W( KBOT-1 )
                  END IF
               END IF
*
*              ==== Use up to NS of the the smallest magnatiude
*              .    shifts.  If there aren't NS shifts available,
*              .    then use them all, possibly dropping one to
*              .    make the number of shifts even. ====
*
               NS = MIN( NS, KBOT-KS+1 )
               NS = NS - MOD( NS, 2 )
               KS = KBOT - NS + 1
*
*              ==== Small-bulge multi-shift QR sweep:
*              .    split workspace under the subdiagonal into
*              .    - a KDU-by-KDU work array U in the lower
*              .      left-hand-corner,
*              .    - a KDU-by-at-least-KDU-but-more-is-better
*              .      (KDU-by-NHo) horizontal work array WH along
*              .      the bottom edge,
*              .    - and an at-least-KDU-but-more-is-better-by-KDU
*              .      (NVE-by-KDU) vertical work WV arrow along
*              .      the left-hand-edge. ====
*
               KDU = 3*NS - 3
               KU = N - KDU + 1
               KWH = KDU + 1
               NHO = ( N-KDU+1-4 ) - ( KDU+1 ) + 1
               KWV = KDU + 4
               NVE = N - KDU - KWV + 1
*
*              ==== Small-bulge multi-shift QR sweep ====
*
               CALL ZLAQR5( WANTT, WANTZ, KACC22, N, KTOP, KBOT, NS,
     $                      W( KS ), H, LDH, ILOZ, IHIZ, Z, LDZ, WORK,
     $                      3, H( KU, 1 ), LDH, NVE, H( KWV, 1 ), LDH,
     $                      NHO, H( KU, KWH ), LDH )
            END IF
*
*           ==== Note progress (or the lack of it). ====
*
            IF( LD.GT.0 ) THEN
               NDFL = 1
            ELSE
               NDFL = NDFL + 1
            END IF
```

```
*
*           ==== End of main loop ====
   70    CONTINUE
*
*        ==== Iteration limit exceeded.  Set INFO to show where
*        .    the problem occurred and exit. ====
*
         INFO = KBOT
   80    CONTINUE
      END IF
*
*     ==== Return the optimal value of LWORK. ====
*
      WORK( 1 ) = DCMPLX( LWKOPT, 0 )
*
*     ==== End of ZLAQR4 ====
*
      END
```

———-

— LAPACK zlaqr4 —

```
(let*
 ((ntiny 11) (kexnw 5) (kexsh 6) (wilk1 0.75d0)
  (zero (coerce (f2cl-lib:cmplx 0.0d0 0.0d0) 'f2cl-lib:complex16))
  (one (coerce (f2cl-lib:cmplx 1.0d0 0.0d0) 'f2cl-lib:complex16)) (two 2.0d0))
 (declare (type (f2cl-lib:integer4 11 11) ntiny)
  (type (f2cl-lib:integer4 5 5) kexnw) (type (f2cl-lib:integer4 6 6) kexsh)
  (type (double-float 0.75d0 0.75d0) wilk1) (type (f2cl-lib:complex16) zero)
  (type (f2cl-lib:complex16) one) (type (double-float 2.0d0 2.0d0) two)
  (ignorable ntiny kexnw kexsh wilk1 zero one two))
 (defun zlaqr4 (wantt wantz n ilo ihi h ldh w iloz ihiz z ldz work lwork info)
  (declare (type f2cl-lib:logical wantz wantt)
   (type (f2cl-lib:integer4) info lwork ldz ihiz iloz ldh ihi ilo n)
   (type (array f2cl-lib:complex16 (*)) work z w h))
  (f2cl-lib:with-multi-array-data
      ((h f2cl-lib:complex16 h-%data% h-%offset%)
       (w f2cl-lib:complex16 w-%data% w-%offset%)
       (z f2cl-lib:complex16 z-%data% z-%offset%)
       (work f2cl-lib:complex16 work-%data% work-%offset%))
       (labels
        ((cabs1 (cdum)
          (+ (abs (f2cl-lib:dble cdum)) (abs (f2cl-lib:dimag cdum)))))
        (declare
         (ftype (function (f2cl-lib:complex16)
                 (values double-float &rest t)) cabs1))
        (prog
```

```
((zdum (make-array 1 :element-type 'f2cl-lib:complex16))
 (jbcmpz (make-array '(2) :element-type 'character
                          :initial-element #\space))
 (sorted nil) (i 0) (inf 0) (it 0) (itmax 0) (k 0) (kacc22 0) (kbot 0)
(kdu 0) (ks 0) (kt 0) (ktop 0) (ku 0) (kv 0) (kwh 0) (kwtop 0) (kwv 0)
 (ld 0) (ls 0) (lwkopt 0) (ndec 0) (ndfl 0) (nh 0) (nho 0) (nibble 0)
 (nmin 0) (ns 0) (nsmax 0) (nsr 0) (nve 0) (nw 0) (nwmax 0) (nwr 0)
 (nwupbd 0) (s 0.0d0) (aa #C(0.0d0 0.0d0)) (bb #C(0.0d0 0.0d0))
 (cc #C(0.0d0 0.0d0)) (cdum #C(0.0d0 0.0d0)) (dd #C(0.0d0 0.0d0))
 (det #C(0.0d0 0.0d0)) (rtdisc #C(0.0d0 0.0d0)) (swap #C(0.0d0 0.0d0))
 (tr2 #C(0.0d0 0.0d0)))
(declare (type (array f2cl-lib:complex16 (1)) zdum)
 (type (simple-array character (2)) jbcmpz)
 (type f2cl-lib:logical sorted)
 (type (f2cl-lib:integer4) nwupbd nwr nwmax nw nve nsr nsmax
  ns nmin nibble
  nho nh ndfl ndec lwkopt ls ld kwv kwtop kwh kv ku ktop kt
  ks kdu kbot
  kacc22 k itmax it inf i)
 (type (double-float) s)
 (type (f2cl-lib:complex16) tr2 swap rtdisc det dd cdum cc bb aa))
(setf info 0)
(cond
 ((= n 0)
   (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%) one)
  (go end_label)))
(cond
 ((<= n ntiny) (setf lwkopt 1)
  (if (/= lwork -1)
   (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
     var-8 var-9 var-10
     var-11 var-12)
    (zlahqr wantt wantz n ilo ihi h ldh w iloz ihiz z ldz info)
    (declare
     (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-7
      var-8 var-9 var-10
      var-11))
    (setf ldh var-6) (setf info var-12))))
 (t
  (tagbody (setf info 0)
   (cond
    (wantt
     (f2cl-lib:fset-string (f2cl-lib:fref-string jbcmpz (1 1)) "S"))
    (t
     (f2cl-lib:fset-string (f2cl-lib:fref-string jbcmpz (1 1)) "E")))
   (cond
    (wantz
     (f2cl-lib:fset-string (f2cl-lib:fref-string jbcmpz (2 2)) "V"))
    (t
```

```
  (f2cl-lib:fset-string (f2cl-lib:fref-string jbcmpz (2 2)) "N")))
(setf nwr
 (multiple-value-bind
  (ret-val var-0 var-1 var-2 var-3 var-4 var-5 var-6)
  (ilaenv 13 "ZLAQR4" jbcmpz n ilo ihi lwork)
  (declare (ignore var-0 var-1)) (when var-2 (setf jbcmpz var-2))
  (when var-3 (setf n var-3)) (when var-4 (setf ilo var-4))
  (when var-5 (setf ihi var-5))
  (when var-6 (setf lwork var-6)) ret-val))
(setf nwr (max (the f2cl-lib:integer4 2)
               (the f2cl-lib:integer4 nwr)))
(setf nwr
 (min (f2cl-lib:int-add (f2cl-lib:int-sub ihi ilo) 1)
  (the f2cl-lib:integer4 (truncate (- n 1) 3)) nwr))
(setf nsr
 (multiple-value-bind
  (ret-val var-0 var-1 var-2 var-3 var-4 var-5 var-6)
  (ilaenv 15 "ZLAQR4" jbcmpz n ilo ihi lwork)
  (declare (ignore var-0 var-1)) (when var-2 (setf jbcmpz var-2))
  (when var-3 (setf n var-3)) (when var-4 (setf ilo var-4))
  (when var-5 (setf ihi var-5))
  (when var-6 (setf lwork var-6)) ret-val))
(setf nsr
 (min nsr (the f2cl-lib:integer4 (truncate (+ n 6) 9))
  (f2cl-lib:int-sub ihi ilo)))
(setf nsr
 (max (the f2cl-lib:integer4 2)
  (the f2cl-lib:integer4 (f2cl-lib:int-sub nsr (mod nsr 2)))))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10
  var-11 var-12 var-13 var-14 var-15 var-16 var-17
  var-18 var-19 var-20
  var-21 var-22 var-23 var-24)
 (zlaqr2 wantt wantz n ilo ihi
  (f2cl-lib:int-add nwr 1) h ldh iloz ihiz z
  ldz ls ld w h ldh n h ldh n h ldh work -1)
 (declare
  (ignore var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-8
   var-9 var-10
   var-14 var-15 var-17 var-18 var-20 var-21 var-23 var-24))
 (setf ldh var-7)
 (setf ldz var-11)
 (setf ls var-12)
 (setf ld var-13)
 (setf ldh var-16)
 (setf ldh var-19)
 (setf ldh var-22))
(setf lwkopt
 (max (the f2cl-lib:integer4 (truncate (* 3 nsr) 2))
```

```
  (f2cl-lib:int
    (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%))))
(cond
 ((= lwork (f2cl-lib:int-sub 1))
  (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
   (f2cl-lib:dcmplx lwkopt 0))
  (go end_label)))
(setf nmin
 (multiple-value-bind
  (ret-val var-0 var-1 var-2 var-3 var-4 var-5 var-6)
  (ilaenv 12 "ZLAQR4" jbcmpz n ilo ihi lwork)
  (declare (ignore var-0 var-1)) (when var-2 (setf jbcmpz var-2))
  (when var-3 (setf n var-3)) (when var-4 (setf ilo var-4))
  (when var-5 (setf ihi var-5))
  (when var-6 (setf lwork var-6)) ret-val))
(setf nmin
 (max (the f2cl-lib:integer4 ntiny) (the f2cl-lib:integer4 nmin)))
(setf nibble
 (multiple-value-bind
  (ret-val var-0 var-1 var-2 var-3 var-4 var-5 var-6)
  (ilaenv 14 "ZLAQR4" jbcmpz n ilo ihi lwork)
  (declare (ignore var-0 var-1)) (when var-2 (setf jbcmpz var-2))
  (when var-3 (setf n var-3)) (when var-4 (setf ilo var-4))
  (when var-5 (setf ihi var-5))
  (when var-6 (setf lwork var-6)) ret-val))
(setf nibble
 (max (the f2cl-lib:integer4 0) (the f2cl-lib:integer4 nibble)))
(setf kacc22
 (multiple-value-bind
  (ret-val var-0 var-1 var-2 var-3 var-4 var-5 var-6)
  (ilaenv 16 "ZLAQR4" jbcmpz n ilo ihi lwork)
  (declare (ignore var-0 var-1)) (when var-2 (setf jbcmpz var-2))
  (when var-3 (setf n var-3)) (when var-4 (setf ilo var-4))
  (when var-5 (setf ihi var-5))
  (when var-6 (setf lwork var-6)) ret-val))
(setf kacc22
 (max (the f2cl-lib:integer4 0) (the f2cl-lib:integer4 kacc22)))
(setf kacc22
 (min (the f2cl-lib:integer4 2) (the f2cl-lib:integer4 kacc22)))
(setf nwmax
 (min (the f2cl-lib:integer4 (truncate (- n 1) 3))
  (the f2cl-lib:integer4 (truncate lwork 2))))
(setf nw nwmax)
(setf nsmax
 (min (the f2cl-lib:integer4 (truncate (+ n 6) 9))
  (the f2cl-lib:integer4 (truncate (* 2 lwork) 3))))
(setf nsmax (f2cl-lib:int-sub nsmax (mod nsmax 2))) (setf ndfl 1)
(setf itmax
 (f2cl-lib:int-mul
  (max (the f2cl-lib:integer4 30)
```

```
   (the f2cl-lib:integer4 (f2cl-lib:int-mul 2 kexsh)))
  (max (the f2cl-lib:integer4 10)
   (the f2cl-lib:integer4
    (f2cl-lib:int-add (f2cl-lib:int-sub ihi ilo) 1)))))
(setf kbot ihi)
(f2cl-lib:fdo (it 1 (f2cl-lib:int-add it 1))
       ((> it itmax) nil)
        (tagbody
              (if (< kbot ilo) (go label80))
              (f2cl-lib:fdo (k kbot
                (f2cl-lib:int-add k (f2cl-lib:int-sub 1)))
        ((> k
                (f2cl-lib:int-add ilo 1))
               nil)
         (tagbody
                (if
                 (=
                  (f2cl-lib:fref h-%data% (k
                   (f2cl-lib:int-sub k 1)) ((1 ldh) (1 *))
                   h-%offset%)
                  zero)
                 (go label20))
                label10))
              (setf k ilo) label20 (setf ktop k)
              (setf nh (f2cl-lib:int-add
                        (f2cl-lib:int-sub kbot ktop) 1))
              (setf nwupbd
               (min (the f2cl-lib:integer4 nh)
                    (the f2cl-lib:integer4 nwmax)))
              (cond
               ((< ndfl kexnw)
                (setf nw
                 (min (the f2cl-lib:integer4 nwupbd)
                      (the f2cl-lib:integer4 nwr))))
               (t
                (setf nw
                 (min (the f2cl-lib:integer4 nwupbd)
                  (the f2cl-lib:integer4
                    (f2cl-lib:int-mul 2 nw))))))
              (cond
               ((< nw nwmax)
                (cond ((>= nw (f2cl-lib:int-add nh
                                (f2cl-lib:int-sub 1)))
                           (setf nw nh))
                 (t (setf kwtop (f2cl-lib:int-add
                                 (f2cl-lib:int-sub kbot nw) 1))
                  (if
                   (>
                    (cabs1
                     (f2cl-lib:fref h-%data% (kwtop
```

```
        (f2cl-lib:int-sub kwtop 1))
        ((1 ldh) (1 *)) h-%offset%))
      (cabs1
       (f2cl-lib:fref h-%data%
        ((f2cl-lib:int-sub kwtop 1)
         (f2cl-lib:int-sub kwtop 2))
        ((1 ldh) (1 *)) h-%offset%)))
     (setf nw (f2cl-lib:int-add nw 1)))))))
(cond ((< ndfl kexnw) (setf ndec -1))
 ((or (>= ndec 0) (>= nw nwupbd))
   (setf ndec (f2cl-lib:int-add ndec 1))
  (if (< (f2cl-lib:int-sub nw ndec) 2) (setf ndec 0))
  (setf nw (f2cl-lib:int-sub nw ndec))))
(setf kv (f2cl-lib:int-add
           (f2cl-lib:int-sub n nw) 1))
(setf kt (f2cl-lib:int-add nw 1))
(setf nho (f2cl-lib:int-add
            (f2cl-lib:int-sub n nw 1 kt) 1))
(setf kwv (f2cl-lib:int-add nw 2))
(setf nve (f2cl-lib:int-add
            (f2cl-lib:int-sub n nw kwv) 1))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6
  var-7 var-8 var-9 var-10
  var-11 var-12 var-13 var-14 var-15 var-16
  var-17 var-18 var-19 var-20
  var-21 var-22 var-23 var-24)
 (zlaqr2 wantt wantz n ktop kbot nw h ldh
     iloz ihiz z ldz ls ld w
  (f2cl-lib:array-slice h-%data%
   f2cl-lib:complex16 (kv 1)
   ((1 ldh) (1 *)) h-%offset%)
  ldh nho
  (f2cl-lib:array-slice h-%data%
    f2cl-lib:complex16 (kv kt)
   ((1 ldh) (1 *)) h-%offset%)
  ldh nve
  (f2cl-lib:array-slice h-%data%
   f2cl-lib:complex16 (kwv 1)
   ((1 ldh) (1 *)) h-%offset%)
  ldh work lwork)
 (declare
  (ignore var-0 var-1 var-2 var-3 var-4 var-5
   var-6 var-8 var-9 var-10
   var-14 var-15 var-17 var-18 var-20 var-21
   var-23 var-24))
 (setf ldh var-7)
 (setf ldz var-11)
 (setf ls var-12)
 (setf ld var-13)
```

```
          (setf ldh var-16)
          (setf ldh var-19)
          (setf ldh var-22))
         (setf kbot (f2cl-lib:int-sub kbot ld))
         (setf ks (f2cl-lib:int-add
                   (f2cl-lib:int-sub kbot ls) 1))
         (cond
          ((or (= ld 0)
            (and (<= (f2cl-lib:int-mul 100 ld)
                     (f2cl-lib:int-mul nw nibble))
             (> (f2cl-lib:int-add kbot
                   (f2cl-lib:int-sub ktop) 1)
              (min (the f2cl-lib:integer4 nmin)
                   (the f2cl-lib:integer4 nwmax)))))
           (setf ns
            (min (the f2cl-lib:integer4 nsmax)
                 (the f2cl-lib:integer4 nsr)
             (the f2cl-lib:integer4
              (max (the f2cl-lib:integer4 2)
               (the f2cl-lib:integer4
                (f2cl-lib:int-sub kbot ktop))))))
           (setf ns (f2cl-lib:int-sub ns (mod ns 2)))
           (cond
            ((= (mod ndfl kexsh) 0)
             (setf ks (f2cl-lib:int-add
                       (f2cl-lib:int-sub kbot ns) 1))
             (f2cl-lib:fdo (i kbot (f2cl-lib:int-add i
                                     (f2cl-lib:int-sub 2)))
              ((> i
                  (f2cl-lib:int-add ks 1))
                 nil)
               (tagbody
                  (setf (f2cl-lib:fref w-%data% (i)
                                       ((1 *)) w-%offset%)
                   (+ (f2cl-lib:fref h-%data% (i i)
                                     ((1 ldh) (1 *)) h-%offset%)
                    (* wilk1
                     (cabs1
                      (f2cl-lib:fref h-%data% (i
                       (f2cl-lib:int-sub i 1))
                       ((1 ldh) (1 *)) h-%offset%)))))
                  (setf
                   (f2cl-lib:fref w-%data%
                    ((f2cl-lib:int-sub i 1)) ((1 *))
                    w-%offset%)
                   (f2cl-lib:fref w-%data% (i) ((1 *))
                     w-%offset%))
                  label30)))
            (t
             (cond
```

```
((<= (f2cl-lib:int-add kbot
       (f2cl-lib:int-sub ks) 1)
  (f2cl-lib:f2cl/ ns 2))
 (setf ks (f2cl-lib:int-add
           (f2cl-lib:int-sub kbot ns) 1))
 (setf kt (f2cl-lib:int-add
           (f2cl-lib:int-sub n ns) 1))
 (zlacpy "A" ns ns
  (f2cl-lib:array-slice h-%data%
   f2cl-lib:complex16 (ks ks)
   ((1 ldh) (1 *)) h-%offset%)
  ldh
  (f2cl-lib:array-slice h-%data%
   f2cl-lib:complex16 (kt 1)
   ((1 ldh) (1 *)) h-%offset%)
  ldh)
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5
   var-6 var-7 var-8 var-9
   var-10 var-11 var-12)
  (zlahqr f2cl-lib:%false% f2cl-lib:%false%
   ns 1 ns
   (f2cl-lib:array-slice h-%data%
    f2cl-lib:complex16 (kt 1)
    ((1 ldh) (1 *)) h-%offset%)
   ldh
   (f2cl-lib:array-slice w-%data%
    f2cl-lib:complex16 (ks) ((1 *))
    w-%offset%)
   1 1 zdum 1 inf)
  (declare
   (ignore var-0 var-1 var-2 var-3 var-4
    var-5 var-7 var-8 var-9
    var-10 var-11))
  (setf ldh var-6) (setf inf var-12))
 (setf ks (f2cl-lib:int-add ks inf))
 (cond
  ((>= ks kbot)
   (setf s
    (+
     (cabs1
      (f2cl-lib:fref h-%data%
       ((f2cl-lib:int-sub kbot 1)
        (f2cl-lib:int-sub kbot 1))
       ((1 ldh) (1 *)) h-%offset%))
     (cabs1
      (f2cl-lib:fref h-%data% (kbot
        (f2cl-lib:int-sub kbot 1))
       ((1 ldh) (1 *)) h-%offset%))
     (cabs1
```

```
                (f2cl-lib:fref h-%data%
                 ((f2cl-lib:int-sub kbot 1) kbot)
                 ((1 ldh) (1 *)) h-%offset%))
                (cabs1
                 (f2cl-lib:fref h-%data% (kbot kbot)
                  ((1 ldh) (1 *))
                  h-%offset%))))
              (setf aa
               (/
                (f2cl-lib:fref h-%data%
                 ((f2cl-lib:int-sub kbot 1)
                   (f2cl-lib:int-sub kbot 1))
                 ((1 ldh) (1 *)) h-%offset%)
                s))
              (setf cc
               (/
                (f2cl-lib:fref h-%data% (kbot
                  (f2cl-lib:int-sub kbot 1))
                 ((1 ldh) (1 *)) h-%offset%)
                s))
              (setf bb
               (/
                (f2cl-lib:fref h-%data%
                 ((f2cl-lib:int-sub kbot 1) kbot)
                 ((1 ldh) (1 *)) h-%offset%)
                s))
              (setf dd
               (/
                (f2cl-lib:fref h-%data% (kbot kbot)
                 ((1 ldh) (1 *)) h-%offset%)
                s))
              (setf tr2 (/ (+ aa dd) two))
              (setf det (- (* (- aa tr2) (- dd tr2))
                (* bb cc)))
              (setf rtdisc (f2cl-lib:fsqrt (- det)))
              (setf
               (f2cl-lib:fref w-%data%
                 ((f2cl-lib:int-sub kbot 1)) ((1 *))
                w-%offset%)
               (* (+ tr2 rtdisc) s))
              (setf (f2cl-lib:fref w-%data% (kbot)
                     ((1 *)) w-%offset%)
               (* (- tr2 rtdisc) s))
              (setf ks (f2cl-lib:int-sub kbot 1))))))
          (cond
           ((> (f2cl-lib:int-add kbot
                (f2cl-lib:int-sub ks) 1) ns)
            (tagbody (setf sorted f2cl-lib:%false%)
             (f2cl-lib:fdo (k kbot (f2cl-lib:int-add k
              (f2cl-lib:int-sub 1)))
```

```
((>
              k (f2cl-lib:int-add ks 1))
             nil)
 (tagbody (if sorted (go label60))
              (setf sorted f2cl-lib:%true%)
              (f2cl-lib:fdo (i ks
               (f2cl-lib:int-add i 1))
 ((> i
                (f2cl-lib:int-add k
                 (f2cl-lib:int-sub 1)))
               nil)
  (tagbody
                (cond
                 ((< (cabs1 (f2cl-lib:fref w (i)
                      ((1 *))))
                   (cabs1 (f2cl-lib:fref w
                    ((f2cl-lib:int-add i 1))
                     ((1 *)))))
                  (setf sorted f2cl-lib:%false%)
                  (setf swap (f2cl-lib:fref
                    w-%data% (i) ((1 *))
                    w-%offset%))
                  (setf (f2cl-lib:fref w-%data%
                           (i) ((1 *)) w-%offset%)
                   (f2cl-lib:fref w-%data%
                   ((f2cl-lib:int-add i 1)) ((1 *))
                    w-%offset%))
                  (setf
                   (f2cl-lib:fref w-%data%
                   ((f2cl-lib:int-add i 1)) ((1 *))
                    w-%offset%)
                   swap)))
                label40))
              label50))
     label60)))))
 (cond
  ((= (f2cl-lib:int-add kbot
       (f2cl-lib:int-sub ks) 1) 2)
   (cond
    ((<
      (cabs1
       (+ (f2cl-lib:fref w (kbot) ((1 *)))
        (- (f2cl-lib:fref h (kbot kbot)
            ((1 ldh) (1 *))))))
      (cabs1
       (+
        (f2cl-lib:fref w
         ((f2cl-lib:int-add kbot
           (f2cl-lib:int-sub 1)))
         ((1 *)))
```

```
       (- (f2cl-lib:fref h (kbot kbot)
           ((1 ldh) (1 *)))))
    (setf
     (f2cl-lib:fref w-%data%
      ((f2cl-lib:int-sub kbot 1)) ((1 *))
      w-%offset%)
     (f2cl-lib:fref w-%data% (kbot) ((1 *))
       w-%offset%)))
   (t
    (setf (f2cl-lib:fref w-%data% (kbot)
           ((1 *)) w-%offset%)
     (f2cl-lib:fref w-%data%
      ((f2cl-lib:int-sub kbot 1)) ((1 *))
      w-%offset%))))))
(setf ns
 (min (the f2cl-lib:integer4 ns)
  (the f2cl-lib:integer4
   (f2cl-lib:int-add (f2cl-lib:int-sub kbot ks) 1))))
(setf ns (f2cl-lib:int-sub ns (mod ns 2)))
(setf ks (f2cl-lib:int-add
          (f2cl-lib:int-sub kbot ns) 1))
(setf kdu (f2cl-lib:int-sub
          (f2cl-lib:int-mul 3 ns) 3))
(setf ku (f2cl-lib:int-add
          (f2cl-lib:int-sub n kdu) 1))
(setf kwh (f2cl-lib:int-add kdu 1))
(setf nho
 (f2cl-lib:int-add
  (f2cl-lib:int-sub
   (f2cl-lib:int-add (f2cl-lib:int-sub n kdu) 1) 4
   (f2cl-lib:int-add kdu 1))
  1))
(setf kwv (f2cl-lib:int-add kdu 4))
(setf nve
 (f2cl-lib:int-add (f2cl-lib:int-sub n kdu kwv) 1))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6
  var-7 var-8 var-9 var-10
  var-11 var-12 var-13 var-14 var-15 var-16
  var-17 var-18 var-19 var-20
  var-21 var-22 var-23)
 (zlaqr5 wantt wantz kacc22 n ktop kbot ns
  (f2cl-lib:array-slice w-%data%
   f2cl-lib:complex16 (ks) ((1 *))
   w-%offset%)
  h ldh iloz ihiz z ldz work 3
  (f2cl-lib:array-slice h-%data%
   f2cl-lib:complex16 (ku 1)
   ((1 ldh) (1 *)) h-%offset%)
  ldh nve
```

```
                              (f2cl-lib:array-slice h-%data%
                               f2cl-lib:complex16 (kwv 1)
                               ((1 ldh) (1 *)) h-%offset%)
                              ldh nho
                              (f2cl-lib:array-slice h-%data%
                               f2cl-lib:complex16 (ku kwh)
                               ((1 ldh) (1 *)) h-%offset%)
                              ldh)
                             (declare
                              (ignore var-7 var-8 var-12 var-14 var-15
                               var-16 var-19 var-22))
                             (when var-0 (setf wantt var-0))
                             (when var-1 (setf wantz var-1))
                             (when var-2 (setf kacc22 var-2))
                             (when var-3 (setf n var-3))
                             (when var-4 (setf ktop var-4))
                             (when var-5 (setf kbot var-5))
                             (when var-6 (setf ns var-6))
                             (when var-9 (setf ldh var-9))
                             (when var-10 (setf iloz var-10))
                             (when var-11 (setf ihiz var-11))
                             (when var-13 (setf ldz var-13))
                             (when var-17 (setf ldh var-17))
                             (when var-18 (setf nve var-18))
                             (when var-20 (setf ldh var-20))
                             (when var-21 (setf nho var-21))
                             (when var-23 (setf ldh var-23)))))
                           (cond ((> ld 0) (setf ndfl 1))
                                 (t (setf ndfl (f2cl-lib:int-add ndfl 1))))
                           label70))
                  (setf info kbot) label80)))
          (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
           (f2cl-lib:dcmplx lwkopt 0))
          end_label
          (return
           (values wantt wantz n ilo ihi nil ldh nil iloz ihiz nil ldz nil lwork
            info)))))))
```

———-

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— zlaqr5.input —

```
)set break resume
)sys rm -f zlaqr5.output
)spool zlaqr5.output
```

```
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— zlaqr5.help —

```
=====================================================================
zlaqr5 examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 Online html documentation available at
           http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZLAQR5( WANTT, WANTZ, KACC22, N, KTOP, KBOT, NSHFTS, S,
                          H, LDH, ILOZ, IHIZ, Z, LDZ, V, LDV, U, LDU, NV,
                          WV, LDWV, NH, WH, LDWH )

       .. Scalar Arguments ..
       INTEGER            IHIZ, ILOZ, KACC22, KBOT, KTOP, LDH, LDU, LDV,
      $                   LDWH, LDWV, LDZ, N, NH, NSHFTS, NV
       LOGICAL            WANTT, WANTZ
       ..
       .. Array Arguments ..
       COMPLEX*16         H( LDH, * ), S( * ), U( LDU, * ), V( LDV, * ),
      $                   WH( LDWH, * ), WV( LDWV, * ), Z( LDZ, * )
       ..


 Purpose:
 =============

    ZLAQR5, called by ZLAQR0, performs a
    single small-bulge multi-shift QR sweep.

 Arguments:
 ==========
```

```
[in] WANTT

        WANTT is logical scalar
           WANTT = .true. if the triangular Schur factor
           is being computed.  WANTT is set to .false. otherwise.

[in] WANTZ

        WANTZ is logical scalar
           WANTZ = .true. if the unitary Schur factor is being
           computed.  WANTZ is set to .false. otherwise.

[in] KACC22

        KACC22 is integer with value 0, 1, or 2.
           Specifies the computation mode of far-from-diagonal
           orthogonal updates.
      = 0: ZLAQR5 does not accumulate reflections and does not
           use matrix-matrix multiply to update far-from-diagonal
           matrix entries.
      = 1: ZLAQR5 accumulates reflections and uses matrix-matrix
           multiply to update the far-from-diagonal matrix entries.
      = 2: ZLAQR5 accumulates reflections, uses matrix-matrix
           multiply to update the far-from-diagonal matrix entries,
           and takes advantage of 2-by-2 block structure during
           matrix multiplies.

[in] N

        N is integer scalar
           N is the order of the Hessenberg matrix H upon which this
           subroutine operates.

[in] KTOP

        KTOP is integer scalar

[in] KBOT

        KBOT is integer scalar
           These are the first and last rows and columns of an
           isolated diagonal block upon which the QR sweep is to be
           applied. It is assumed without a check that
                     either KTOP = 1  or   H(KTOP,KTOP-1) = 0
           and
                     either KBOT = N  or   H(KBOT+1,KBOT) = 0.

[in] NSHFTS

        NSHFTS is integer scalar
```

```
           NSHFTS gives the number of simultaneous shifts.  NSHFTS
           must be positive and even.

[in,out] S

        S is COMPLEX*16 array of size (NSHFTS)
           S contains the shifts of origin that define the multi-
           shift QR sweep.  On output S may be reordered.

[in,out] H

        H is COMPLEX*16 array of size (LDH,N)
           On input H contains a Hessenberg matrix.  On output a
           multi-shift QR sweep with shifts SR(J)+i*SI(J) is applied
           to the isolated diagonal block in rows and columns KTOP
           through KBOT.

[in] LDH

        LDH is integer scalar
           LDH is the leading dimension of H just as declared in the
           calling procedure.  LDH.GE.MAX(1,N).

[in] ILOZ

        ILOZ is INTEGER

[in] IHIZ

        IHIZ is INTEGER
           Specify the rows of Z to which transformations must be
           applied if WANTZ is .TRUE.. 1 .LE. ILOZ .LE. IHIZ .LE. N

[in,out] Z

        Z is COMPLEX*16 array of size (LDZ,IHI)
           If WANTZ = .TRUE., then the QR Sweep unitary
           similarity transformation is accumulated into
           Z(ILOZ:IHIZ,ILO:IHI) from the right.
           If WANTZ = .FALSE., then Z is unreferenced.

[in] LDZ

        LDZ is integer scalar
           LDA is the leading dimension of Z just as declared in
           the calling procedure. LDZ.GE.N.

[out] V

        V is COMPLEX*16 array of size (LDV,NSHFTS/2)
```

```
[in] LDV

        LDV is integer scalar
           LDV is the leading dimension of V as declared in the
           calling procedure.  LDV.GE.3.

[out] U

        U is COMPLEX*16 array of size
           (LDU,3*NSHFTS-3)

[in] LDU

        LDU is integer scalar
           LDU is the leading dimension of U just as declared in the
           in the calling subroutine.  LDU.GE.3*NSHFTS-3.

[in] NH

        NH is integer scalar
           NH is the number of columns in array WH available for
           workspace. NH.GE.1.

[out] WH

        WH is COMPLEX*16 array of size (LDWH,NH)

[in] LDWH

        LDWH is integer scalar
           Leading dimension of WH just as declared in the
           calling procedure.  LDWH.GE.3*NSHFTS-3.

[in] NV

        NV is integer scalar
           NV is the number of rows in WV agailable for workspace.
           NV.GE.1.

[out] WV

        WV is COMPLEX*16 array of size
           (LDWV,3*NSHFTS-3)

[in] LDWV

        LDWV is integer scalar
           LDWV is the leading dimension of WV as declared in the
           in the calling subroutine.  LDWV.GE.NV.
```

```
 Authors:
 ========

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  NAG Ltd.

 November 2011

 Contributors:
 ==================

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 References:
 ================

       K. Braman, R. Byers and R. Mathias, The Multi-Shift QR
       Algorithm Part I: Maintaining Well Focused Shifts, and Level 3
       Performance, SIAM Journal of Matrix Analysis, volume 23, pages
       929--947, 2002.
```

———-

— zlaqr5.f —

```
*  =====================================================================
      SUBROUTINE ZLAQR5( WANTT, WANTZ, KACC22, N, KTOP, KBOT, NSHFTS, S,
     $                   H, LDH, ILOZ, IHIZ, Z, LDZ, V, LDV, U, LDU, NV,
     $                   WV, LDWV, NH, WH, LDWH )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      INTEGER            IHIZ, ILOZ, KACC22, KBOT, KTOP, LDH, LDU, LDV,
     $                   LDWH, LDWV, LDZ, N, NH, NSHFTS, NV
      LOGICAL            WANTT, WANTZ
*     ..
*     .. Array Arguments ..
      COMPLEX*16         H( LDH, * ), S( * ), U( LDU, * ), V( LDV, * ),
     $                   WH( LDWH, * ), WV( LDWV, * ), Z( LDZ, * )
*     ..
```

```
*
*  =====================================================================
*     .. Parameters ..
      COMPLEX*16         ZERO, ONE
      PARAMETER          ( ZERO = ( 0.0d0, 0.0d0 ),
     $                   ONE = ( 1.0d0, 0.0d0 ) )
      DOUBLE PRECISION   RZERO, RONE
      PARAMETER          ( RZERO = 0.0d0, RONE = 1.0d0 )
*     ..
*     .. Local Scalars ..
      COMPLEX*16         ALPHA, BETA, CDUM, REFSUM
      DOUBLE PRECISION   H11, H12, H21, H22, SAFMAX, SAFMIN, SCL,
     $                   SMLNUM, TST1, TST2, ULP
      INTEGER            I2, I4, INCOL, J, J2, J4, JBOT, JCOL, JLEN,
     $                   JROW, JTOP, K, K1, KDU, KMS, KNZ, KRCOL, KZS,
     $                   M, M22, MBOT, MEND, MSTART, MTOP, NBMPS, NDCOL,
     $                   NS, NU
      LOGICAL            ACCUM, BLK22, BMP22
*     ..
*     .. External Functions ..
      DOUBLE PRECISION   DLAMCH
      EXTERNAL           DLAMCH
*     ..
*     .. Intrinsic Functions ..
*
      INTRINSIC          ABS, DBLE, DCONJG, DIMAG, MAX, MIN, MOD
*     ..
*     .. Local Arrays ..
      COMPLEX*16         VT( 3 )
*     ..
*     .. External Subroutines ..
      EXTERNAL           DLABAD, ZGEMM, ZLACPY, ZLAQR1, ZLARFG, ZLASET,
     $                   ZTRMM
*     ..
*     .. Statement Functions ..
      DOUBLE PRECISION   CABS1
*     ..
*     .. Statement Function definitions ..
      CABS1( CDUM ) = ABS( DBLE( CDUM ) ) + ABS( DIMAG( CDUM ) )
*     ..
*     .. Executable Statements ..
*
*     ==== If there are no shifts, then there is nothing to do. ====
*
      IF( NSHFTS.LT.2 )
     $   RETURN
*
*     ==== If the active block is empty or 1-by-1, then there
*     .    is nothing to do. ====
*
```

```
      IF( KTOP.GE.KBOT )
     $   RETURN
*
*     ==== NSHFTS is supposed to be even, but if it is odd,
*     .    then simply reduce it by one.  ====
*
      NS = NSHFTS - MOD( NSHFTS, 2 )
*
*     ==== Machine constants for deflation ====
*
      SAFMIN = DLAMCH( 'SAFE MINIMUM' )
      SAFMAX = RONE / SAFMIN
      CALL DLABAD( SAFMIN, SAFMAX )
      ULP = DLAMCH( 'PRECISION' )
      SMLNUM = SAFMIN*( DBLE( N ) / ULP )
*
*     ==== Use accumulated reflections to update far-from-diagonal
*     .    entries ? ====
*
      ACCUM = ( KACC22.EQ.1 ) .OR. ( KACC22.EQ.2 )
*
*     ==== If so, exploit the 2-by-2 block structure? ====
*
      BLK22 = ( NS.GT.2 ) .AND. ( KACC22.EQ.2 )
*
*     ==== clear trash ====
*
      IF( KTOP+2.LE.KBOT )
     $   H( KTOP+2, KTOP ) = ZERO
*
*     ==== NBMPS = number of 2-shift bulges in the chain ====
*
      NBMPS = NS / 2
*
*     ==== KDU = width of slab ====
*
      KDU = 6*NBMPS - 3
*
*     ==== Create and chase chains of NBMPS bulges ====
*
      DO 210 INCOL = 3*( 1-NBMPS ) + KTOP - 1, KBOT - 2, 3*NBMPS - 2
         NDCOL = INCOL + KDU
         IF( ACCUM )
     $      CALL ZLASET( 'ALL', KDU, KDU, ZERO, ONE, U, LDU )
*
*        ==== Near-the-diagonal bulge chase.  The following loop
*        .    performs the near-the-diagonal part of a small bulge
*        .    multi-shift QR sweep.  Each 6*NBMPS-2 column diagonal
*        .    chunk extends from column INCOL to column NDCOL
*        .    (including both column INCOL and column NDCOL). The
```

```
*        .    following loop chases a 3*NBMPS column long chain of
*        .    NBMPS bulges 3*NBMPS-2 columns to the right.  (INCOL
*        .    may be less than KTOP and and NDCOL may be greater than
*        .    KBOT indicating phantom columns from which to chase
*        .    bulges before they are actually introduced or to which
*        .    to chase bulges beyond column KBOT.)  ====
*
         DO 140 KRCOL = INCOL, MIN( INCOL+3*NBMPS-3, KBOT-2 )
*
*           ==== Bulges number MTOP to MBOT are active double implicit
*           .    shift bulges.  There may or may not also be small
*           .    2-by-2 bulge, if there is room.  The inactive bulges
*           .    (if any) must wait until the active bulges have moved
*           .    down the diagonal to make room.  The phantom matrix
*           .    paradigm described above helps keep track.  ====
*
            MTOP = MAX( 1, ( ( KTOP-1 )-KRCOL+2 ) / 3+1 )
            MBOT = MIN( NBMPS, ( KBOT-KRCOL ) / 3 )
            M22 = MBOT + 1
            BMP22 = ( MBOT.LT.NBMPS ) .AND. ( KRCOL+3*( M22-1 ) ).EQ.
     $              ( KBOT-2 )
*
*           ==== Generate reflections to chase the chain right
*           .    one column.  (The minimum value of K is KTOP-1.) ====
*
            DO 10 M = MTOP, MBOT
               K = KRCOL + 3*( M-1 )
               IF( K.EQ.KTOP-1 ) THEN
                  CALL ZLAQR1( 3, H( KTOP, KTOP ), LDH, S( 2*M-1 ),
     $                         S( 2*M ), V( 1, M ) )
                  ALPHA = V( 1, M )
                  CALL ZLARFG( 3, ALPHA, V( 2, M ), 1, V( 1, M ) )
               ELSE
                  BETA = H( K+1, K )
                  V( 2, M ) = H( K+2, K )
                  V( 3, M ) = H( K+3, K )
                  CALL ZLARFG( 3, BETA, V( 2, M ), 1, V( 1, M ) )
*
*                 ==== A Bulge may collapse because of vigilant
*                 .    deflation or destructive underflow.  In the
*                 .    underflow case, try the two-small-subdiagonals
*                 .    trick to try to reinflate the bulge.  ====
*
                  IF( H( K+3, K ).NE.ZERO .OR. H( K+3, K+1 ).NE.
     $                ZERO .OR. H( K+3, K+2 ).EQ.ZERO ) THEN
*
*                    ==== Typical case: not collapsed (yet). ====
*
                     H( K+1, K ) = BETA
                     H( K+2, K ) = ZERO
```

```
                     H( K+3, K ) = ZERO
                  ELSE
*
*                    ==== Atypical case: collapsed.  Attempt to
*                    .    reintroduce ignoring H(K+1,K) and H(K+2,K).
*                    .    If the fill resulting from the new
*                    .    reflector is too large, then abandon it.
*                    .    Otherwise, use the new one. ====
*
                     CALL ZLAQR1( 3, H( K+1, K+1 ), LDH, S( 2*M-1 ),
     $                             S( 2*M ), VT )
                     ALPHA = VT( 1 )
                     CALL ZLARFG( 3, ALPHA, VT( 2 ), 1, VT( 1 ) )
                     REFSUM = DCONJG( VT( 1 ) )*
     $                       ( H( K+1, K )+DCONJG( VT( 2 ) )*
     $                       H( K+2, K ) )
*
                     IF( CABS1( H( K+2, K )-REFSUM*VT( 2 ) )+
     $                    CABS1( REFSUM*VT( 3 ) ).GT.ULP*
     $                    ( CABS1( H( K, K ) )+CABS1( H( K+1,
     $                    K+1 ) )+CABS1( H( K+2, K+2 ) ) ) ) THEN
*
*                       ==== Starting a new bulge here would
*                       .    create non-negligible fill.  Use
*                       .    the old one with trepidation. ====
*
                        H( K+1, K ) = BETA
                        H( K+2, K ) = ZERO
                        H( K+3, K ) = ZERO
                     ELSE
*
*                       ==== Stating a new bulge here would
*                       .    create only negligible fill.
*                       .    Replace the old reflector with
*                       .    the new one. ====
*
                        H( K+1, K ) = H( K+1, K ) - REFSUM
                        H( K+2, K ) = ZERO
                        H( K+3, K ) = ZERO
                        V( 1, M ) = VT( 1 )
                        V( 2, M ) = VT( 2 )
                        V( 3, M ) = VT( 3 )
                     END IF
                  END IF
               END IF
   10       CONTINUE
*
*           ==== Generate a 2-by-2 reflection, if needed. ====
*
            K = KRCOL + 3*( M22-1 )
```

```
            IF( BMP22 ) THEN
               IF( K.EQ.KTOP-1 ) THEN
                  CALL ZLAQR1( 2, H( K+1, K+1 ), LDH, S( 2*M22-1 ),
     $                         S( 2*M22 ), V( 1, M22 ) )
                  BETA = V( 1, M22 )
                  CALL ZLARFG( 2, BETA, V( 2, M22 ), 1, V( 1, M22 ) )
               ELSE
                  BETA = H( K+1, K )
                  V( 2, M22 ) = H( K+2, K )
                  CALL ZLARFG( 2, BETA, V( 2, M22 ), 1, V( 1, M22 ) )
                  H( K+1, K ) = BETA
                  H( K+2, K ) = ZERO
               END IF
            END IF
*
*           ==== Multiply H by reflections from the left ====
*
            IF( ACCUM ) THEN
               JBOT = MIN( NDCOL, KBOT )
            ELSE IF( WANTT ) THEN
               JBOT = N
            ELSE
               JBOT = KBOT
            END IF
            DO 30 J = MAX( KTOP, KRCOL ), JBOT
               MEND = MIN( MBOT, ( J-KRCOL+2 ) / 3 )
               DO 20 M = MTOP, MEND
                  K = KRCOL + 3*( M-1 )
                  REFSUM = DCONJG( V( 1, M ) )*
     $                     ( H( K+1, J )+DCONJG( V( 2, M ) )*
     $                     H( K+2, J )+DCONJG( V( 3, M ) )*H( K+3, J ) )
                  H( K+1, J ) = H( K+1, J ) - REFSUM
                  H( K+2, J ) = H( K+2, J ) - REFSUM*V( 2, M )
                  H( K+3, J ) = H( K+3, J ) - REFSUM*V( 3, M )
   20          CONTINUE
   30       CONTINUE
            IF( BMP22 ) THEN
               K = KRCOL + 3*( M22-1 )
               DO 40 J = MAX( K+1, KTOP ), JBOT
                  REFSUM = DCONJG( V( 1, M22 ) )*
     $                     ( H( K+1, J )+DCONJG( V( 2, M22 ) )*
     $                     H( K+2, J ) )
                  H( K+1, J ) = H( K+1, J ) - REFSUM
                  H( K+2, J ) = H( K+2, J ) - REFSUM*V( 2, M22 )
   40          CONTINUE
            END IF
*
*           ==== Multiply H by reflections from the right.
*           .    Delay filling in the last row until the
*           .    vigilant deflation check is complete. ====
```

```
*
            IF( ACCUM ) THEN
               JTOP = MAX( KTOP, INCOL )
            ELSE IF( WANTT ) THEN
               JTOP = 1
            ELSE
               JTOP = KTOP
            END IF
            DO 80 M = MTOP, MBOT
               IF( V( 1, M ).NE.ZERO ) THEN
                  K = KRCOL + 3*( M-1 )
                  DO 50 J = JTOP, MIN( KBOT, K+3 )
                     REFSUM = V( 1, M )*( H( J, K+1 )+V( 2, M )*
     $                       H( J, K+2 )+V( 3, M )*H( J, K+3 ) )
                     H( J, K+1 ) = H( J, K+1 ) - REFSUM
                     H( J, K+2 ) = H( J, K+2 ) -
     $                             REFSUM*DCONJG( V( 2, M ) )
                     H( J, K+3 ) = H( J, K+3 ) -
     $                             REFSUM*DCONJG( V( 3, M ) )
   50             CONTINUE
*
                  IF( ACCUM ) THEN
*
*                    ==== Accumulate U. (If necessary, update Z later
*                    .    with with an efficient matrix-matrix
*                    .    multiply.) ====
*
                     KMS = K - INCOL
                     DO 60 J = MAX( 1, KTOP-INCOL ), KDU
                        REFSUM = V( 1, M )*( U( J, KMS+1 )+V( 2, M )*
     $                          U( J, KMS+2 )+V( 3, M )*U( J, KMS+3 ) )
                        U( J, KMS+1 ) = U( J, KMS+1 ) - REFSUM
                        U( J, KMS+2 ) = U( J, KMS+2 ) -
     $                                  REFSUM*DCONJG( V( 2, M ) )
                        U( J, KMS+3 ) = U( J, KMS+3 ) -
     $                                  REFSUM*DCONJG( V( 3, M ) )
   60                CONTINUE
                  ELSE IF( WANTZ ) THEN
*
*                    ==== U is not accumulated, so update Z
*                    .    now by multiplying by reflections
*                    .    from the right. ====
*
                     DO 70 J = ILOZ, IHIZ
                        REFSUM = V( 1, M )*( Z( J, K+1 )+V( 2, M )*
     $                          Z( J, K+2 )+V( 3, M )*Z( J, K+3 ) )
                        Z( J, K+1 ) = Z( J, K+1 ) - REFSUM
                        Z( J, K+2 ) = Z( J, K+2 ) -
     $                                REFSUM*DCONJG( V( 2, M ) )
                        Z( J, K+3 ) = Z( J, K+3 ) -
```

```
     $                                REFSUM*DCONJG( V( 3, M ) )
   70             CONTINUE
                  END IF
               END IF
   80       CONTINUE
*
*           ==== Special case: 2-by-2 reflection (if needed) ====
*
            K = KRCOL + 3*( M22-1 )
            IF( BMP22 ) THEN
               IF ( V( 1, M22 ).NE.ZERO ) THEN
                  DO 90 J = JTOP, MIN( KBOT, K+3 )
                     REFSUM = V( 1, M22 )*( H( J, K+1 )+V( 2, M22 )*
     $                       H( J, K+2 ) )
                     H( J, K+1 ) = H( J, K+1 ) - REFSUM
                     H( J, K+2 ) = H( J, K+2 ) -
     $                             REFSUM*DCONJG( V( 2, M22 ) )
   90             CONTINUE
*
                  IF( ACCUM ) THEN
                     KMS = K - INCOL
                     DO 100 J = MAX( 1, KTOP-INCOL ), KDU
                        REFSUM = V( 1, M22 )*( U( J, KMS+1 )+
     $                           V( 2, M22 )*U( J, KMS+2 ) )
                        U( J, KMS+1 ) = U( J, KMS+1 ) - REFSUM
                        U( J, KMS+2 ) = U( J, KMS+2 ) -
     $                                  REFSUM*DCONJG( V( 2, M22 ) )
  100                CONTINUE
                  ELSE IF( WANTZ ) THEN
                     DO 110 J = ILOZ, IHIZ
                        REFSUM = V( 1, M22 )*( Z( J, K+1 )+V( 2, M22 )*
     $                           Z( J, K+2 ) )
                        Z( J, K+1 ) = Z( J, K+1 ) - REFSUM
                        Z( J, K+2 ) = Z( J, K+2 ) -
     $                                REFSUM*DCONJG( V( 2, M22 ) )
  110                CONTINUE
                  END IF
               END IF
            END IF
*
*           ==== Vigilant deflation check ====
*
            MSTART = MTOP
            IF( KRCOL+3*( MSTART-1 ).LT.KTOP )
     $         MSTART = MSTART + 1
            MEND = MBOT
            IF( BMP22 )
     $         MEND = MEND + 1
            IF( KRCOL.EQ.KBOT-2 )
     $         MEND = MEND + 1
```

```
            DO 120 M = MSTART, MEND
               K = MIN( KBOT-1, KRCOL+3*( M-1 ) )
*
*              ==== The following convergence test requires that
*              .    the tradition small-compared-to-nearby-diagonals
*              .    criterion and the Ahues & Tisseur (LAWN 122, 1997)
*              .    criteria both be satisfied.  The latter improves
*              .    accuracy in some examples. Falling back on an
*              .    alternate convergence criterion when TST1 or TST2
*              .    is zero (as done here) is traditional but probably
*              .    unnecessary. ====
*
               IF( H( K+1, K ).NE.ZERO ) THEN
                  TST1 = CABS1( H( K, K ) ) + CABS1( H( K+1, K+1 ) )
                  IF( TST1.EQ.RZERO ) THEN
                     IF( K.GE.KTOP+1 )
     $                  TST1 = TST1 + CABS1( H( K, K-1 ) )
                     IF( K.GE.KTOP+2 )
     $                  TST1 = TST1 + CABS1( H( K, K-2 ) )
                     IF( K.GE.KTOP+3 )
     $                  TST1 = TST1 + CABS1( H( K, K-3 ) )
                     IF( K.LE.KBOT-2 )
     $                  TST1 = TST1 + CABS1( H( K+2, K+1 ) )
                     IF( K.LE.KBOT-3 )
     $                  TST1 = TST1 + CABS1( H( K+3, K+1 ) )
                     IF( K.LE.KBOT-4 )
     $                  TST1 = TST1 + CABS1( H( K+4, K+1 ) )
                  END IF
                  IF( CABS1( H( K+1, K ) ).LE.MAX( SMLNUM, ULP*TST1 ) )
     $                THEN
                     H12 = MAX( CABS1( H( K+1, K ) ),
     $                     CABS1( H( K, K+1 ) ) )
                     H21 = MIN( CABS1( H( K+1, K ) ),
     $                     CABS1( H( K, K+1 ) ) )
                     H11 = MAX( CABS1( H( K+1, K+1 ) ),
     $                     CABS1( H( K, K )-H( K+1, K+1 ) ) )
                     H22 = MIN( CABS1( H( K+1, K+1 ) ),
     $                     CABS1( H( K, K )-H( K+1, K+1 ) ) )
                     SCL = H11 + H12
                     TST2 = H22*( H11 / SCL )
*
                     IF( TST2.EQ.RZERO .OR. H21*( H12 / SCL ).LE.
     $                   MAX( SMLNUM, ULP*TST2 ) )H( K+1, K ) = ZERO
                  END IF
               END IF
  120       CONTINUE
*
*           ==== Fill in the last row of each bulge. ====
*
            MEND = MIN( NBMPS, ( KBOT-KRCOL-1 ) / 3 )
```

```
            DO 130 M = MTOP, MEND
               K = KRCOL + 3*( M-1 )
               REFSUM = V( 1, M )*V( 3, M )*H( K+4, K+3 )
               H( K+4, K+1 ) = -REFSUM
               H( K+4, K+2 ) = -REFSUM*DCONJG( V( 2, M ) )
               H( K+4, K+3 ) = H( K+4, K+3 ) -
     $                         REFSUM*DCONJG( V( 3, M ) )
  130       CONTINUE
*
*           ==== End of near-the-diagonal bulge chase. ====
*
  140    CONTINUE
*
*        ==== Use U (if accumulated) to update far-from-diagonal
*        .    entries in H.  If required, use U to update Z as
*        .    well. ====
*
         IF( ACCUM ) THEN
            IF( WANTT ) THEN
               JTOP = 1
               JBOT = N
            ELSE
               JTOP = KTOP
               JBOT = KBOT
            END IF
            IF( ( .NOT.BLK22 ) .OR. ( INCOL.LT.KTOP ) .OR.
     $          ( NDCOL.GT.KBOT ) .OR. ( NS.LE.2 ) ) THEN
*
*              ==== Updates not exploiting the 2-by-2 block
*              .    structure of U.  K1 and NU keep track of
*              .    the location and size of U in the special
*              .    cases of introducing bulges and chasing
*              .    bulges off the bottom.  In these special
*              .    cases and in case the number of shifts
*              .    is NS = 2, there is no 2-by-2 block
*              .    structure to exploit.  ====
*
               K1 = MAX( 1, KTOP-INCOL )
               NU = ( KDU-MAX( 0, NDCOL-KBOT ) ) - K1 + 1
*
*              ==== Horizontal Multiply ====
*
               DO 150 JCOL = MIN( NDCOL, KBOT ) + 1, JBOT, NH
                  JLEN = MIN( NH, JBOT-JCOL+1 )
                  CALL ZGEMM( 'C', 'N', NU, JLEN, NU, ONE, U( K1, K1 ),
     $                        LDU, H( INCOL+K1, JCOL ), LDH, ZERO, WH,
     $                        LDWH )
                  CALL ZLACPY( 'ALL', NU, JLEN, WH, LDWH,
     $                         H( INCOL+K1, JCOL ), LDH )
  150          CONTINUE
```

```
*
*              ==== Vertical multiply ====
*
               DO 160 JROW = JTOP, MAX( KTOP, INCOL ) - 1, NV
                  JLEN = MIN( NV, MAX( KTOP, INCOL )-JROW )
                  CALL ZGEMM( 'N', 'N', JLEN, NU, NU, ONE,
     $                        H( JROW, INCOL+K1 ), LDH, U( K1, K1 ),
     $                        LDU, ZERO, WV, LDWV )
                  CALL ZLACPY( 'ALL', JLEN, NU, WV, LDWV,
     $                         H( JROW, INCOL+K1 ), LDH )
  160          CONTINUE
*
*              ==== Z multiply (also vertical) ====
*
               IF( WANTZ ) THEN
                  DO 170 JROW = ILOZ, IHIZ, NV
                     JLEN = MIN( NV, IHIZ-JROW+1 )
                     CALL ZGEMM( 'N', 'N', JLEN, NU, NU, ONE,
     $                           Z( JROW, INCOL+K1 ), LDZ, U( K1, K1 ),
     $                           LDU, ZERO, WV, LDWV )
                     CALL ZLACPY( 'ALL', JLEN, NU, WV, LDWV,
     $                            Z( JROW, INCOL+K1 ), LDZ )
  170             CONTINUE
               END IF
            ELSE
*
*              ==== Updates exploiting U's 2-by-2 block structure.
*              .    (I2, I4, J2, J4 are the last rows and columns
*              .    of the blocks.) ====
*
               I2 = ( KDU+1 ) / 2
               I4 = KDU
               J2 = I4 - I2
               J4 = KDU
*
*              ==== KZS and KNZ deal with the band of zeros
*              .    along the diagonal of one of the triangular
*              .    blocks. ====
*
               KZS = ( J4-J2 ) - ( NS+1 )
               KNZ = NS + 1
*
*              ==== Horizontal multiply ====
*
               DO 180 JCOL = MIN( NDCOL, KBOT ) + 1, JBOT, NH
                  JLEN = MIN( NH, JBOT-JCOL+1 )
*
*                 ==== Copy bottom of H to top+KZS of scratch ====
*                  (The first KZS rows get multiplied by zero.) ====
*
```

```
                  CALL ZLACPY( 'ALL', KNZ, JLEN, H( INCOL+1+J2, JCOL ),
     $                       LDH, WH( KZS+1, 1 ), LDWH )
*
*                 ==== Multiply by U21**H ====
*
                  CALL ZLASET( 'ALL', KZS, JLEN, ZERO, ZERO, WH, LDWH )
                  CALL ZTRMM( 'L', 'U', 'C', 'N', KNZ, JLEN, ONE,
     $                        U( J2+1, 1+KZS ), LDU, WH( KZS+1, 1 ),
     $                        LDWH )
*
*                 ==== Multiply top of H by U11**H ====
*
                  CALL ZGEMM( 'C', 'N', I2, JLEN, J2, ONE, U, LDU,
     $                        H( INCOL+1, JCOL ), LDH, ONE, WH, LDWH )
*
*                 ==== Copy top of H to bottom of WH ====
*
                  CALL ZLACPY( 'ALL', J2, JLEN, H( INCOL+1, JCOL ), LDH,
     $                         WH( I2+1, 1 ), LDWH )
*
*                 ==== Multiply by U21**H ====
*
                  CALL ZTRMM( 'L', 'L', 'C', 'N', J2, JLEN, ONE,
     $                        U( 1, I2+1 ), LDU, WH( I2+1, 1 ), LDWH )
*
*                 ==== Multiply by U22 ====
*
                  CALL ZGEMM( 'C', 'N', I4-I2, JLEN, J4-J2, ONE,
     $                        U( J2+1, I2+1 ), LDU,
     $                        H( INCOL+1+J2, JCOL ), LDH, ONE,
     $                        WH( I2+1, 1 ), LDWH )
*
*                 ==== Copy it back ====
*
                  CALL ZLACPY( 'ALL', KDU, JLEN, WH, LDWH,
     $                         H( INCOL+1, JCOL ), LDH )
  180          CONTINUE
*
*              ==== Vertical multiply ====
*
               DO 190 JROW = JTOP, MAX( INCOL, KTOP ) - 1, NV
                  JLEN = MIN( NV, MAX( INCOL, KTOP )-JROW )
*
*                 ==== Copy right of H to scratch (the first KZS
*                 .    columns get multiplied by zero) ====
*
                  CALL ZLACPY( 'ALL', JLEN, KNZ, H( JROW, INCOL+1+J2 ),
     $                         LDH, WV( 1, 1+KZS ), LDWV )
*
*                 ==== Multiply by U21 ====
```

```
*
                  CALL ZLASET( 'ALL', JLEN, KZS, ZERO, ZERO, WV, LDWV )
                  CALL ZTRMM( 'R', 'U', 'N', 'N', JLEN, KNZ, ONE,
     $                        U( J2+1, 1+KZS ), LDU, WV( 1, 1+KZS ),
     $                        LDWV )
*
*                 ==== Multiply by U11 ====
*
                  CALL ZGEMM( 'N', 'N', JLEN, I2, J2, ONE,
     $                        H( JROW, INCOL+1 ), LDH, U, LDU, ONE, WV,
     $                        LDWV )
*
*                 ==== Copy left of H to right of scratch ====
*
                  CALL ZLACPY( 'ALL', JLEN, J2, H( JROW, INCOL+1 ), LDH,
     $                         WV( 1, 1+I2 ), LDWV )
*
*                 ==== Multiply by U21 ====
*
                  CALL ZTRMM( 'R', 'L', 'N', 'N', JLEN, I4-I2, ONE,
     $                        U( 1, I2+1 ), LDU, WV( 1, 1+I2 ), LDWV )
*
*                 ==== Multiply by U22 ====
*
                  CALL ZGEMM( 'N', 'N', JLEN, I4-I2, J4-J2, ONE,
     $                        H( JROW, INCOL+1+J2 ), LDH,
     $                        U( J2+1, I2+1 ), LDU, ONE, WV( 1, 1+I2 ),
     $                        LDWV )
*
*                 ==== Copy it back ====
*
                  CALL ZLACPY( 'ALL', JLEN, KDU, WV, LDWV,
     $                         H( JROW, INCOL+1 ), LDH )
  190          CONTINUE
*
*              ==== Multiply Z (also vertical) ====
*
               IF( WANTZ ) THEN
                  DO 200 JROW = ILOZ, IHIZ, NV
                     JLEN = MIN( NV, IHIZ-JROW+1 )
*
*                    ==== Copy right of Z to left of scratch (first
*                    .     KZS columns get multiplied by zero) ====
*
                     CALL ZLACPY( 'ALL', JLEN, KNZ,
     $                            Z( JROW, INCOL+1+J2 ), LDZ,
     $                            WV( 1, 1+KZS ), LDWV )
*
*                    ==== Multiply by U12 ====
*
```

```
                    CALL ZLASET( 'ALL', JLEN, KZS, ZERO, ZERO, WV,
     $                           LDWV )
                    CALL ZTRMM( 'R', 'U', 'N', 'N', JLEN, KNZ, ONE,
     $                          U( J2+1, 1+KZS ), LDU, WV( 1, 1+KZS ),
     $                          LDWV )
*
*                   ==== Multiply by U11 ====
*
                    CALL ZGEMM( 'N', 'N', JLEN, I2, J2, ONE,
     $                          Z( JROW, INCOL+1 ), LDZ, U, LDU, ONE,
     $                          WV, LDWV )
*
*                   ==== Copy left of Z to right of scratch ====
*
                    CALL ZLACPY( 'ALL', JLEN, J2, Z( JROW, INCOL+1 ),
     $                           LDZ, WV( 1, 1+I2 ), LDWV )
*
*                   ==== Multiply by U21 ====
*
                    CALL ZTRMM( 'R', 'L', 'N', 'N', JLEN, I4-I2, ONE,
     $                          U( 1, I2+1 ), LDU, WV( 1, 1+I2 ),
     $                          LDWV )
*
*                   ==== Multiply by U22 ====
*
                    CALL ZGEMM( 'N', 'N', JLEN, I4-I2, J4-J2, ONE,
     $                          Z( JROW, INCOL+1+J2 ), LDZ,
     $                          U( J2+1, I2+1 ), LDU, ONE,
     $                          WV( 1, 1+I2 ), LDWV )
*
*                   ==== Copy the result back to Z ====
*
                    CALL ZLACPY( 'ALL', JLEN, KDU, WV, LDWV,
     $                           Z( JROW, INCOL+1 ), LDZ )
  200             CONTINUE
                END IF
              END IF
            END IF
  210 CONTINUE
*
*     ==== End of ZLAQR5 ====
*
      END
```

———-

— LAPACK zlaqr5 —

```
(let*
 ((zero (coerce (f2cl-lib:cmplx 0.0d0 0.0d0) 'f2cl-lib:complex16))
  (one (coerce (f2cl-lib:cmplx 1.0d0 0.0d0) 'f2cl-lib:complex16)) (rzero 0.0d0)
  (rone 1.0d0))
 (declare (type (f2cl-lib:complex16) zero) (type (f2cl-lib:complex16) one)
  (type (double-float 0.0d0 0.0d0) rzero)
  (type (double-float 1.0d0 1.0d0) rone) (ignorable zero one rzero rone))
 (defun zlaqr5
  (wantt wantz kacc22 n ktop kbot nshfts s h ldh iloz ihiz z ldz v ldv u ldu nv
   wv ldwv nh wh ldwh)
  (declare (type f2cl-lib:logical wantz wantt)
   (type (f2cl-lib:integer4) ldwh nh ldwv nv ldu ldv ldz ihiz iloz ldh nshfts
    kbot ktop n kacc22)
   (type (array f2cl-lib:complex16 (*)) wh wv u v z h s))
  (f2cl-lib:with-multi-array-data
      ((s f2cl-lib:complex16 s-%data% s-%offset%)
       (h f2cl-lib:complex16 h-%data% h-%offset%)
       (z f2cl-lib:complex16 z-%data% z-%offset%)
       (v f2cl-lib:complex16 v-%data% v-%offset%)
       (u f2cl-lib:complex16 u-%data% u-%offset%)
       (wv f2cl-lib:complex16 wv-%data% wv-%offset%)
       (wh f2cl-lib:complex16 wh-%data% wh-%offset%))
       (labels
        ((cabs1 (cdum) (+ (abs (f2cl-lib:dble cdum))
                          (abs (f2cl-lib:dimag cdum)))))
        (declare
         (ftype (function (f2cl-lib:complex16)
                 (values double-float &rest t)) cabs1))
        (prog
         ((vt (make-array 3 :element-type 'f2cl-lib:complex16)) (accum nil)
          (blk22 nil) (bmp22 nil) (i2 0) (i4 0) (incol 0) (j 0) (j2 0) (j4 0)
          (jbot 0)
          (jcol 0) (jlen 0) (jrow 0) (jtop 0) (k 0) (k1 0) (kdu 0) (kms 0)
          (knz 0)
          (krcol 0) (kzs 0) (m 0) (m22 0) (mbot 0) (mend 0) (mstart 0) (mtop 0)
          (nbmps 0) (ndcol 0) (ns 0) (nu 0) (h11 0.0d0) (h12 0.0d0) (h21 0.0d0)
          (h22 0.0d0) (safmax 0.0d0) (safmin 0.0d0) (scl 0.0d0) (smlnum 0.0d0)
          (tst1 0.0d0) (tst2 0.0d0) (ulp 0.0d0) (alpha #C(0.0d0 0.0d0))
          (beta #C(0.0d0 0.0d0)) (cdum #C(0.0d0 0.0d0))
          (refsum #C(0.0d0 0.0d0)))
         (declare (type (array f2cl-lib:complex16 (3)) vt)
          (type f2cl-lib:logical bmp22 blk22 accum)
          (type (f2cl-lib:integer4) nu ns ndcol nbmps mtop mstart
           mend mbot m22 m kzs
           krcol knz kms kdu k1 k jtop jrow jlen jcol jbot j4 j2 j incol i4 i2)
          (type (double-float) ulp tst2 tst1 smlnum scl safmin safmax
            h22 h21 h12 h11)
          (type (f2cl-lib:complex16) refsum cdum beta alpha))
         (if (< nshfts 2) (go end_label)) (if (>= ktop kbot) (go end_label))
         (setf ns (f2cl-lib:int-sub nshfts (mod nshfts 2)))
```

```
(setf safmin (dlamch "SAFE MINIMUM")) (setf safmax (/ rone safmin))
(multiple-value-bind (var-0 var-1)
   (dlabad safmin safmax) (declare (ignore))
 (when var-0 (setf safmin var-0)) (when var-1 (setf safmax var-1)))
(setf ulp (dlamch "PRECISION"))
(setf smlnum (* safmin (/ (f2cl-lib:dble n) ulp)))
(setf accum (or (= kacc22 1) (= kacc22 2)))
(setf blk22 (and (> ns 2) (= kacc22 2)))
(if (<= (f2cl-lib:int-add ktop 2) kbot)
 (setf
  (f2cl-lib:fref h-%data% ((f2cl-lib:int-add ktop 2) ktop)
   ((1 ldh) (1 *))
   h-%offset%)
  zero))
(setf nbmps (the f2cl-lib:integer4 (truncate ns 2)))
(setf kdu (f2cl-lib:int-sub (f2cl-lib:int-mul 6 nbmps) 3))
(f2cl-lib:fdo (incol
          (f2cl-lib:int-add
           (f2cl-lib:int-mul 3 (f2cl-lib:int-add 1
                                 (f2cl-lib:int-sub nbmps))) ktop
           (f2cl-lib:int-sub 1))
          (f2cl-lib:int-add incol
           (f2cl-lib:int-add (f2cl-lib:int-mul 3 nbmps)
                             (f2cl-lib:int-sub 2))))
       ((>
           incol (f2cl-lib:int-add kbot (f2cl-lib:int-sub 2)))
          nil)
        (tagbody (setf ndcol (f2cl-lib:int-add incol kdu))
           (if accum
            (multiple-value-bind
             (var-0 var-1 var-2 var-3 var-4 var-5 var-6)
             (zlaset "ALL" kdu kdu zero one u ldu)
             (declare (ignore var-0 var-5))
             (when var-1 (setf kdu var-1))
             (when var-2 (setf kdu var-2))
             (when var-3 (setf zero var-3))
             (when var-4 (setf one var-4))
             (when var-6 (setf ldu var-6))))
           (f2cl-lib:fdo (krcol incol (f2cl-lib:int-add krcol 1))
          ((> krcol
               (min
                (the f2cl-lib:integer4
                 (f2cl-lib:int-add incol (f2cl-lib:int-mul 3 nbmps)
                  (f2cl-lib:int-sub 3)))
                (the f2cl-lib:integer4
                    (f2cl-lib:int-add kbot (f2cl-lib:int-sub 2)))))
              nil)
           (tagbody
               (setf mtop
                (max 1 (+ (the f2cl-lib:integer4
```

```
                    (truncate (+ (- ktop 1 krcol) 2) 3)) 1)))
     (setf mbot (min nbmps (the f2cl-lib:integer4
                                (truncate (- kbot krcol) 3))))
     (setf m22 (f2cl-lib:int-add mbot 1))
     (setf bmp22
      (and (< mbot nbmps)
       (= (f2cl-lib:int-add krcol
        (f2cl-lib:int-mul 3 (f2cl-lib:int-sub m22 1)))
        (f2cl-lib:int-sub kbot 2))))
     (f2cl-lib:fdo (m mtop (f2cl-lib:int-add m 1))
    ((> m mbot) nil)
     (tagbody
          (setf k
           (f2cl-lib:int-add krcol
             (f2cl-lib:int-mul 3 (f2cl-lib:int-sub m 1))))
          (cond
           ((= k (f2cl-lib:int-add ktop (f2cl-lib:int-sub 1)))
            (zlaqr1 3
             (f2cl-lib:array-slice h-%data%
              f2cl-lib:complex16 (ktop ktop)
              ((1 ldh) (1 *)) h-%offset%)
             ldh
             (f2cl-lib:fref s-%data%
              ((f2cl-lib:int-sub (f2cl-lib:int-mul 2 m) 1))
              ((1 *)) s-%offset%)
             (f2cl-lib:fref s-%data%
               ((f2cl-lib:int-mul 2 m)) ((1 *)) s-%offset%)
             (f2cl-lib:array-slice v-%data%
              f2cl-lib:complex16 (1 m) ((1 ldv) (1 *))
              v-%offset%))
            (setf alpha (f2cl-lib:fref v-%data% (1 m)
              ((1 ldv) (1 *)) v-%offset%))
            (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
             (zlarfg 3 alpha
              (f2cl-lib:array-slice v-%data%
               f2cl-lib:complex16 (2 m)
               ((1 ldv) (1 *)) v-%offset%)
              1
              (f2cl-lib:array-slice v-%data%
               f2cl-lib:complex16 (1 m)
               ((1 ldv) (1 *)) v-%offset%))
             (declare (ignore var-0 var-2 var-3 var-4))
             (when var-1 (setf alpha var-1))))
           (t
            (setf beta
             (f2cl-lib:fref h-%data%
                 ((f2cl-lib:int-add k 1) k) ((1 ldh) (1 *))
              h-%offset%))
            (setf (f2cl-lib:fref v-%data% (2 m)
                 ((1 ldv) (1 *)) v-%offset%)
```

```
 (f2cl-lib:fref h-%data%
     ((f2cl-lib:int-add k 2) k) ((1 ldh) (1 *))
  h-%offset%))
(setf (f2cl-lib:fref v-%data% (3 m)
          ((1 ldv) (1 *)) v-%offset%)
 (f2cl-lib:fref h-%data%
  ((f2cl-lib:int-add k 3) k) ((1 ldh) (1 *))
  h-%offset%))
(multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
 (zlarfg 3 beta
  (f2cl-lib:array-slice v-%data%
     f2cl-lib:complex16 (2 m)
   ((1 ldv) (1 *)) v-%offset%)
  1
  (f2cl-lib:array-slice v-%data%
    f2cl-lib:complex16 (1 m)
   ((1 ldv) (1 *)) v-%offset%))
 (declare (ignore var-0 var-2 var-3 var-4))
 (when var-1 (setf beta var-1)))
(cond
 ((or
   (/= (f2cl-lib:fref h
        ((f2cl-lib:int-add k 3) k) ((1 ldh) (1 *)))
    zero)
   (/=
    (f2cl-lib:fref h
     ((f2cl-lib:int-add k 3) (f2cl-lib:int-add k 1))
     ((1 ldh) (1 *)))
    zero)
   (=
    (f2cl-lib:fref h
     ((f2cl-lib:int-add k 3) (f2cl-lib:int-add k 2))
     ((1 ldh) (1 *)))
    zero))
  (setf
   (f2cl-lib:fref h-%data%
    ((f2cl-lib:int-add k 1) k) ((1 ldh) (1 *))
    h-%offset%)
   beta)
  (setf
   (f2cl-lib:fref h-%data%
    ((f2cl-lib:int-add k 2) k) ((1 ldh) (1 *))
    h-%offset%)
   zero)
  (setf
   (f2cl-lib:fref h-%data%
    ((f2cl-lib:int-add k 3) k) ((1 ldh) (1 *))
    h-%offset%)
   zero))
 (t
```

```
(zlaqr1 3
 (f2cl-lib:array-slice h-%data% f2cl-lib:complex16
  ((+ k 1) (f2cl-lib:int-add k 1))
              ((1 ldh) (1 *)) h-%offset%)
 ldh
 (f2cl-lib:fref s-%data%
  ((f2cl-lib:int-sub (f2cl-lib:int-mul 2 m) 1))
  ((1 *)) s-%offset%)
 (f2cl-lib:fref s-%data%
  ((f2cl-lib:int-mul 2 m)) ((1 *)) s-%offset%)
 vt)
(setf alpha (f2cl-lib:fref vt (1) ((1 3))))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4)
 (zlarfg 3 alpha
  (f2cl-lib:array-slice vt
    f2cl-lib:complex16 (2) ((1 3))) 1
  (f2cl-lib:array-slice vt
    f2cl-lib:complex16 (1) ((1 3))))
 (declare (ignore var-0 var-2 var-3 var-4))
 (when var-1 (setf alpha var-1)))
(setf refsum
 (coerce
  (* (f2cl-lib:dconjg
       (f2cl-lib:fref vt (1) ((1 3))))
   (+
    (f2cl-lib:fref h-%data%
     ((f2cl-lib:int-add k 1) k) ((1 ldh) (1 *))
     h-%offset%)
    (* (f2cl-lib:dconjg
         (f2cl-lib:fref vt (2) ((1 3))))
     (f2cl-lib:fref h-%data%
      ((f2cl-lib:int-add k 2) k)
      ((1 ldh) (1 *)) h-%offset%))))
  'f2cl-lib:complex16))
(cond
 ((>
   (+
    (cabs1
     (+ (f2cl-lib:fref h
          ((f2cl-lib:int-add k 2) k)
          ((1 ldh) (1 *)))
      (* -1 refsum (f2cl-lib:fref vt (2)
                     ((1 3))))))
    (cabs1 (* refsum (f2cl-lib:fref vt (3)
                       ((1 3))))))
   (* ulp
    (+ (cabs1 (f2cl-lib:fref h (k k)
                ((1 ldh) (1 *))))
     (cabs1
```

```
     (f2cl-lib:fref h
      ((f2cl-lib:int-add k 1)
       (f2cl-lib:int-add k 1))
      ((1 ldh) (1 *))))
    (cabs1
     (f2cl-lib:fref h
      ((f2cl-lib:int-add k 2)
       (f2cl-lib:int-add k 2))
      ((1 ldh) (1 *)))))))
 (setf
  (f2cl-lib:fref h-%data%
   ((f2cl-lib:int-add k 1) k) ((1 ldh) (1 *))
   h-%offset%)
  beta)
 (setf
  (f2cl-lib:fref h-%data%
   ((f2cl-lib:int-add k 2) k) ((1 ldh) (1 *))
   h-%offset%)
  zero)
 (setf
  (f2cl-lib:fref h-%data%
   ((f2cl-lib:int-add k 3) k) ((1 ldh) (1 *))
   h-%offset%)
  zero))
(t
 (setf
  (f2cl-lib:fref h-%data%
   ((f2cl-lib:int-add k 1) k) ((1 ldh) (1 *))
   h-%offset%)
  (-
   (f2cl-lib:fref h-%data%
    ((f2cl-lib:int-add k 1) k) ((1 ldh) (1 *))
    h-%offset%)
   refsum))
 (setf
  (f2cl-lib:fref h-%data%
   ((f2cl-lib:int-add k 2) k) ((1 ldh) (1 *))
   h-%offset%)
  zero)
 (setf
  (f2cl-lib:fref h-%data%
   ((f2cl-lib:int-add k 3) k) ((1 ldh) (1 *))
   h-%offset%)
  zero)
 (setf (f2cl-lib:fref v-%data% (1 m)
  ((1 ldv) (1 *)) v-%offset%)
  (f2cl-lib:fref vt (1) ((1 3))))
 (setf (f2cl-lib:fref v-%data% (2 m)
  ((1 ldv) (1 *)) v-%offset%)
  (f2cl-lib:fref vt (2) ((1 3))))
```

```
        (setf (f2cl-lib:fref v-%data% (3 m)
         ((1 ldv) (1 *)) v-%offset%)
         (f2cl-lib:fref vt (3) ((1 3)))))))))))
  label10))
(setf k
 (f2cl-lib:int-add krcol (f2cl-lib:int-mul 3
     (f2cl-lib:int-sub m22 1))))
(cond
 (bmp22
  (cond
   ((= k (f2cl-lib:int-add ktop (f2cl-lib:int-sub 1)))
    (zlaqr1 2
     (f2cl-lib:array-slice h-%data% f2cl-lib:complex16
      ((+ k 1) (f2cl-lib:int-add k 1))
                 ((1 ldh) (1 *)) h-%offset%)
     ldh
     (f2cl-lib:fref s-%data%
      ((f2cl-lib:int-sub (f2cl-lib:int-mul 2 m22) 1))
       ((1 *)) s-%offset%)
     (f2cl-lib:fref s-%data%
      ((f2cl-lib:int-mul 2 m22)) ((1 *)) s-%offset%)
     (f2cl-lib:array-slice v-%data%
       f2cl-lib:complex16 (1 m22)
      ((1 ldv) (1 *)) v-%offset%))
    (setf beta (f2cl-lib:fref v-%data% (1 m22)
                 ((1 ldv) (1 *)) v-%offset%))
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
     (zlarfg 2 beta
      (f2cl-lib:array-slice v-%data%
       f2cl-lib:complex16 (2 m22)
       ((1 ldv) (1 *)) v-%offset%)
      1
      (f2cl-lib:array-slice v-%data%
       f2cl-lib:complex16 (1 m22)
       ((1 ldv) (1 *)) v-%offset%))
     (declare (ignore var-0 var-2 var-3 var-4))
     (when var-1 (setf beta var-1))))
   (t
    (setf beta
     (f2cl-lib:fref h-%data%
      ((f2cl-lib:int-add k 1) k) ((1 ldh) (1 *))
      h-%offset%))
    (setf (f2cl-lib:fref v-%data% (2 m22)
     ((1 ldv) (1 *)) v-%offset%)
     (f2cl-lib:fref h-%data%
      ((f2cl-lib:int-add k 2) k) ((1 ldh) (1 *))
      h-%offset%))
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
     (zlarfg 2 beta
      (f2cl-lib:array-slice v-%data%
```

```
                 f2cl-lib:complex16 (2 m22)
                 ((1 ldv) (1 *)) v-%offset%)
                1
                (f2cl-lib:array-slice v-%data%
                 f2cl-lib:complex16 (1 m22)
                 ((1 ldv) (1 *)) v-%offset%))
               (declare (ignore var-0 var-2 var-3 var-4))
               (when var-1 (setf beta var-1)))
              (setf
               (f2cl-lib:fref h-%data%
                ((f2cl-lib:int-add k 1) k) ((1 ldh) (1 *))
                h-%offset%)
               beta)
              (setf
               (f2cl-lib:fref h-%data%
                ((f2cl-lib:int-add k 2) k) ((1 ldh) (1 *))
                h-%offset%)
               zero)))))
     (cond
      (accum
       (setf jbot
        (min (the f2cl-lib:integer4 ndcol)
             (the f2cl-lib:integer4 kbot))))
      (wantt (setf jbot n)) (t (setf jbot kbot)))
     (f2cl-lib:fdo (j
      (max (the f2cl-lib:integer4 ktop)
           (the f2cl-lib:integer4 krcol))
      (f2cl-lib:int-add j 1))
((> j jbot) nil)
 (tagbody
       (setf mend
        (min mbot
          (the f2cl-lib:integer4
            (truncate (+ (- j krcol) 2) 3))))
       (f2cl-lib:fdo (m mtop (f2cl-lib:int-add m 1))
 ((> m mend) nil)
  (tagbody
        (setf k
         (f2cl-lib:int-add krcol
           (f2cl-lib:int-mul 3 (f2cl-lib:int-sub m 1))))
        (setf refsum
         (coerce
          (*
           (f2cl-lib:dconjg
            (f2cl-lib:fref v-%data% (1 m)
             ((1 ldv) (1 *)) v-%offset%))
           (+
            (f2cl-lib:fref h-%data%
             ((f2cl-lib:int-add k 1) j) ((1 ldh) (1 *))
             h-%offset%)
```

```
                (*
                 (f2cl-lib:dconjg
                  (f2cl-lib:fref v-%data% (2 m)
                   ((1 ldv) (1 *)) v-%offset%))
                 (f2cl-lib:fref h-%data%
                  ((f2cl-lib:int-add k 2) j) ((1 ldh) (1 *))
                  h-%offset%))
                (*
                 (f2cl-lib:dconjg
                  (f2cl-lib:fref v-%data% (3 m)
                   ((1 ldv) (1 *)) v-%offset%))
                 (f2cl-lib:fref h-%data%
                  ((f2cl-lib:int-add k 3) j) ((1 ldh) (1 *))
                  h-%offset%))))
               'f2cl-lib:complex16))
             (setf
              (f2cl-lib:fref h-%data%
               ((f2cl-lib:int-add k 1) j) ((1 ldh) (1 *))
               h-%offset%)
              (-
               (f2cl-lib:fref h-%data%
                ((f2cl-lib:int-add k 1) j) ((1 ldh) (1 *))
                h-%offset%)
               refsum))
             (setf
              (f2cl-lib:fref h-%data%
               ((f2cl-lib:int-add k 2) j) ((1 ldh) (1 *))
               h-%offset%)
              (-
               (f2cl-lib:fref h-%data%
                ((f2cl-lib:int-add k 2) j) ((1 ldh) (1 *))
                h-%offset%)
               (* refsum (f2cl-lib:fref v-%data% (2 m)
                           ((1 ldv) (1 *)) v-%offset%))))
             (setf
              (f2cl-lib:fref h-%data%
               ((f2cl-lib:int-add k 3) j) ((1 ldh) (1 *))
               h-%offset%)
              (-
               (f2cl-lib:fref h-%data%
                ((f2cl-lib:int-add k 3) j) ((1 ldh) (1 *))
                h-%offset%)
               (* refsum (f2cl-lib:fref v-%data% (3 m)
                ((1 ldv) (1 *)) v-%offset%))))
             label20))
           label30))
         (cond
          (bmp22
           (setf k
            (f2cl-lib:int-add krcol
```

```
      (f2cl-lib:int-mul 3 (f2cl-lib:int-sub m22 1))))
    (f2cl-lib:fdo (j
       (max (the f2cl-lib:integer4 (f2cl-lib:int-add k 1))
        (the f2cl-lib:integer4 ktop))
       (f2cl-lib:int-add j 1))
((> j jbot) nil)
 (tagbody
       (setf refsum
        (coerce
         (*
          (f2cl-lib:dconjg
           (f2cl-lib:fref v-%data% (1 m22)
           ((1 ldv) (1 *)) v-%offset%))
          (+
           (f2cl-lib:fref h-%data%
            ((f2cl-lib:int-add k 1) j) ((1 ldh) (1 *))
            h-%offset%)
           (*
            (f2cl-lib:dconjg
             (f2cl-lib:fref v-%data% (2 m22)
             ((1 ldv) (1 *)) v-%offset%))
            (f2cl-lib:fref h-%data%
             ((f2cl-lib:int-add k 2) j) ((1 ldh) (1 *))
             h-%offset%))))
          'f2cl-lib:complex16))
       (setf
        (f2cl-lib:fref h-%data%
         ((f2cl-lib:int-add k 1) j) ((1 ldh) (1 *))
         h-%offset%)
        (-
         (f2cl-lib:fref h-%data%
          ((f2cl-lib:int-add k 1) j) ((1 ldh) (1 *))
          h-%offset%)
         refsum))
       (setf
        (f2cl-lib:fref h-%data%
         ((f2cl-lib:int-add k 2) j) ((1 ldh) (1 *))
         h-%offset%)
        (-
         (f2cl-lib:fref h-%data%
          ((f2cl-lib:int-add k 2) j) ((1 ldh) (1 *))
          h-%offset%)
         (* refsum
          (f2cl-lib:fref v-%data% (2 m22)
           ((1 ldv) (1 *)) v-%offset%))))
       label40))))
  (cond
   (accum
    (setf jtop
     (max (the f2cl-lib:integer4 ktop)
```

```
            (the f2cl-lib:integer4 incol))))
     (wantt (setf jtop 1)) (t (setf jtop ktop)))
    (f2cl-lib:fdo (m mtop (f2cl-lib:int-add m 1))
((> m mbot) nil)
 (tagbody
      (cond
       ((/= (f2cl-lib:fref v (1 m) ((1 ldv) (1 *))) zero)
        (setf k
         (f2cl-lib:int-add krcol
          (f2cl-lib:int-mul 3 (f2cl-lib:int-sub m 1))))
        (f2cl-lib:fdo (j jtop (f2cl-lib:int-add j 1))
  ((> j
           (min (the f2cl-lib:integer4 kbot)
            (the f2cl-lib:integer4 (f2cl-lib:int-add k 3))))
          nil)
   (tagbody
           (setf refsum
            (* (f2cl-lib:fref v-%data% (1 m)
             ((1 ldv) (1 *)) v-%offset%)
             (+
              (f2cl-lib:fref h-%data% (j
               (f2cl-lib:int-add k 1)) ((1 ldh) (1 *))
               h-%offset%)
              (* (f2cl-lib:fref v-%data% (2 m)
               ((1 ldv) (1 *)) v-%offset%)
               (f2cl-lib:fref h-%data% (j
                (f2cl-lib:int-add k 2)) ((1 ldh) (1 *))
                h-%offset%))
              (* (f2cl-lib:fref v-%data% (3 m)
               ((1 ldv) (1 *)) v-%offset%)
               (f2cl-lib:fref h-%data% (j
                (f2cl-lib:int-add k 3)) ((1 ldh) (1 *))
                h-%offset%)))))
           (setf
            (f2cl-lib:fref h-%data% (j
             (f2cl-lib:int-add k 1)) ((1 ldh) (1 *))
             h-%offset%)
            (-
             (f2cl-lib:fref h-%data% (j
              (f2cl-lib:int-add k 1)) ((1 ldh) (1 *))
              h-%offset%)
             refsum))
           (setf
            (f2cl-lib:fref h-%data% (j
             (f2cl-lib:int-add k 2)) ((1 ldh) (1 *))
             h-%offset%)
            (-
             (f2cl-lib:fref h-%data% (j
              (f2cl-lib:int-add k 2)) ((1 ldh) (1 *))
              h-%offset%)
```

```
                (* refsum
                 (f2cl-lib:dconjg
                  (f2cl-lib:fref v-%data% (2 m)
                   ((1 ldv) (1 *)) v-%offset%)))))
               (setf
                (f2cl-lib:fref h-%data% (j
                 (f2cl-lib:int-add k 3)) ((1 ldh) (1 *))
                 h-%offset%)
                (-
                 (f2cl-lib:fref h-%data% (j
                  (f2cl-lib:int-add k 3)) ((1 ldh) (1 *))
                  h-%offset%)
                 (* refsum
                  (f2cl-lib:dconjg
                   (f2cl-lib:fref v-%data% (3 m)
                    ((1 ldv) (1 *)) v-%offset%)))))
               label50))
          (cond
           (accum (setf kms (f2cl-lib:int-sub k incol))
            (f2cl-lib:fdo (j
                 (max (the f2cl-lib:integer4 1)
                  (the f2cl-lib:integer4
                   (f2cl-lib:int-add ktop
                    (f2cl-lib:int-sub incol))))
                 (f2cl-lib:int-add j 1))
((> j kdu) nil)
 (tagbody
           (setf refsum
            (* (f2cl-lib:fref v-%data% (1 m)
             ((1 ldv) (1 *)) v-%offset%)
             (+
              (f2cl-lib:fref u-%data% (j
               (f2cl-lib:int-add kms 1))
               ((1 ldu) (1 *)) u-%offset%)
              (* (f2cl-lib:fref v-%data% (2 m)
               ((1 ldv) (1 *)) v-%offset%)
               (f2cl-lib:fref u-%data% (j
                (f2cl-lib:int-add kms 2))
                ((1 ldu) (1 *)) u-%offset%))
              (* (f2cl-lib:fref v-%data% (3 m)
               ((1 ldv) (1 *)) v-%offset%)
               (f2cl-lib:fref u-%data% (j
                (f2cl-lib:int-add kms 3))
                ((1 ldu) (1 *)) u-%offset%)))))
           (setf
            (f2cl-lib:fref u-%data% (j
             (f2cl-lib:int-add kms 1)) ((1 ldu) (1 *))
             u-%offset%)
            (-
             (f2cl-lib:fref u-%data% (j
```

```
                     (f2cl-lib:int-add kms 1))
                     ((1 ldu) (1 *)) u-%offset%)
                    refsum))
                  (setf
                   (f2cl-lib:fref u-%data% (j
                    (f2cl-lib:int-add kms 2)) ((1 ldu) (1 *))
                    u-%offset%)
                   (-
                    (f2cl-lib:fref u-%data% (j
                     (f2cl-lib:int-add kms 2))
                     ((1 ldu) (1 *)) u-%offset%)
                    (* refsum
                     (f2cl-lib:dconjg
                      (f2cl-lib:fref v-%data% (2 m)
                       ((1 ldv) (1 *)) v-%offset%)))))
                  (setf
                   (f2cl-lib:fref u-%data% (j
                    (f2cl-lib:int-add kms 3)) ((1 ldu) (1 *))
                    u-%offset%)
                   (-
                    (f2cl-lib:fref u-%data% (j
                     (f2cl-lib:int-add kms 3))
                     ((1 ldu) (1 *)) u-%offset%)
                    (* refsum
                     (f2cl-lib:dconjg
                      (f2cl-lib:fref v-%data% (3 m) ((1 ldv)
                       (1 *)) v-%offset%)))))
                  label60)))
      (wantz
       (f2cl-lib:fdo (j iloz (f2cl-lib:int-add j 1))
  ((> j ihiz) nil)
   (tagbody
             (setf refsum
              (* (f2cl-lib:fref v-%data% (1 m)
               ((1 ldv) (1 *)) v-%offset%)
               (+
                (f2cl-lib:fref z-%data% (j
                 (f2cl-lib:int-add k 1)) ((1 ldz) (1 *))
                 z-%offset%)
                (* (f2cl-lib:fref v-%data% (2 m)
                 ((1 ldv) (1 *)) v-%offset%)
                 (f2cl-lib:fref z-%data% (j
                  (f2cl-lib:int-add k 2))
                  ((1 ldz) (1 *)) z-%offset%))
                (* (f2cl-lib:fref v-%data% (3 m)
                 ((1 ldv) (1 *)) v-%offset%)
                 (f2cl-lib:fref z-%data% (j
                  (f2cl-lib:int-add k 3))
                  ((1 ldz) (1 *)) z-%offset%)))))
             (setf
```

```
                (f2cl-lib:fref z-%data% (j
                 (f2cl-lib:int-add k 1)) ((1 ldz) (1 *))
                 z-%offset%)
                (-
                 (f2cl-lib:fref z-%data% (j
                  (f2cl-lib:int-add k 1)) ((1 ldz) (1 *))
                  z-%offset%)
                 refsum))
                (setf
                 (f2cl-lib:fref z-%data% (j
                  (f2cl-lib:int-add k 2)) ((1 ldz) (1 *))
                  z-%offset%)
                 (-
                  (f2cl-lib:fref z-%data% (j
                   (f2cl-lib:int-add k 2)) ((1 ldz) (1 *))
                   z-%offset%)
                  (* refsum
                   (f2cl-lib:dconjg
                    (f2cl-lib:fref v-%data% (2 m)
                     ((1 ldv) (1 *)) v-%offset%)))))
                (setf
                 (f2cl-lib:fref z-%data% (j
                  (f2cl-lib:int-add k 3)) ((1 ldz) (1 *))
                  z-%offset%)
                 (-
                  (f2cl-lib:fref z-%data% (j
                   (f2cl-lib:int-add k 3)) ((1 ldz) (1 *))
                   z-%offset%)
                  (* refsum
                   (f2cl-lib:dconjg
                    (f2cl-lib:fref v-%data% (3 m)
                     ((1 ldv) (1 *)) v-%offset%)))))
                label70))))))
  label80))
(setf k
 (f2cl-lib:int-add krcol
   (f2cl-lib:int-mul 3 (f2cl-lib:int-sub m22 1))))
(cond
 (bmp22
  (cond
   ((/= (f2cl-lib:fref v (1 m22) ((1 ldv) (1 *))) zero)
    (f2cl-lib:fdo (j jtop (f2cl-lib:int-add j 1))
((> j
          (min (the f2cl-lib:integer4 kbot)
           (the f2cl-lib:integer4
             (f2cl-lib:int-add k 3))))
         nil)
 (tagbody
          (setf refsum
           (* (f2cl-lib:fref v-%data% (1 m22)
```

```
                ((1 ldv) (1 *)) v-%offset%)
                (+
                 (f2cl-lib:fref h-%data% (j
                  (f2cl-lib:int-add k 1)) ((1 ldh) (1 *))
                  h-%offset%)
                 (* (f2cl-lib:fref v-%data% (2 m22)
                  ((1 ldv) (1 *)) v-%offset%)
                  (f2cl-lib:fref h-%data% (j
                   (f2cl-lib:int-add k 2)) ((1 ldh) (1 *))
                   h-%offset%)))))
               (setf
                (f2cl-lib:fref h-%data% (j
                 (f2cl-lib:int-add k 1)) ((1 ldh) (1 *))
                 h-%offset%)
                (-
                 (f2cl-lib:fref h-%data% (j
                  (f2cl-lib:int-add k 1)) ((1 ldh) (1 *))
                  h-%offset%)
                 refsum))
               (setf
                (f2cl-lib:fref h-%data% (j
                 (f2cl-lib:int-add k 2)) ((1 ldh) (1 *))
                 h-%offset%)
                (-
                 (f2cl-lib:fref h-%data% (j
                  (f2cl-lib:int-add k 2)) ((1 ldh) (1 *))
                  h-%offset%)
                 (* refsum
                  (f2cl-lib:dconjg
                   (f2cl-lib:fref v-%data% (2 m22)
                    ((1 ldv) (1 *)) v-%offset%)))))
               label90))
  (cond
   (accum (setf kms (f2cl-lib:int-sub k incol))
    (f2cl-lib:fdo (j
           (max (the f2cl-lib:integer4 1)
            (the f2cl-lib:integer4
             (f2cl-lib:int-add ktop
                (f2cl-lib:int-sub incol))))
           (f2cl-lib:int-add j 1))
((> j kdu) nil)
 (tagbody
           (setf refsum
            (* (f2cl-lib:fref v-%data% (1 m22)
               ((1 ldv) (1 *)) v-%offset%)
             (+
              (f2cl-lib:fref u-%data% (j
               (f2cl-lib:int-add kms 1))
               ((1 ldu) (1 *)) u-%offset%)
              (* (f2cl-lib:fref v-%data% (2 m22)
```

```
                                    ((1 ldv) (1 *)) v-%offset%)
                                    (f2cl-lib:fref u-%data% (j
                                     (f2cl-lib:int-add kms 2))
                                     ((1 ldu) (1 *)) u-%offset%)))))
                                (setf
                                 (f2cl-lib:fref u-%data% (j
                                  (f2cl-lib:int-add kms 1))
                                  ((1 ldu) (1 *)) u-%offset%)
                                 (-
                                  (f2cl-lib:fref u-%data% (j
                                   (f2cl-lib:int-add kms 1))
                                   ((1 ldu) (1 *)) u-%offset%)
                                  refsum))
                                (setf
                                 (f2cl-lib:fref u-%data% (j
                                  (f2cl-lib:int-add kms 2))
                                  ((1 ldu) (1 *)) u-%offset%)
                                 (-
                                  (f2cl-lib:fref u-%data% (j
                                   (f2cl-lib:int-add kms 2))
                                   ((1 ldu) (1 *)) u-%offset%)
                                  (* refsum
                                   (f2cl-lib:dconjg
                                    (f2cl-lib:fref v-%data% (2 m22)
                                     ((1 ldv) (1 *)) v-%offset%)))))
                                label100)))
                   (wantz
                    (f2cl-lib:fdo (j iloz (f2cl-lib:int-add j 1))
                ((> j ihiz) nil)
                 (tagbody
                           (setf refsum
                            (* (f2cl-lib:fref v-%data% (1 m22)
                                ((1 ldv) (1 *)) v-%offset%)
                             (+
                              (f2cl-lib:fref z-%data% (j
                               (f2cl-lib:int-add k 1))
                               ((1 ldz) (1 *)) z-%offset%)
                              (* (f2cl-lib:fref v-%data% (2 m22)
                               ((1 ldv) (1 *)) v-%offset%)
                               (f2cl-lib:fref z-%data% (j
                                (f2cl-lib:int-add k 2))
                                ((1 ldz) (1 *)) z-%offset%)))))
                           (setf
                            (f2cl-lib:fref z-%data% (j
                             (f2cl-lib:int-add k 1)) ((1 ldz) (1 *))
                            z-%offset%)
                            (-
                             (f2cl-lib:fref z-%data% (j
                              (f2cl-lib:int-add k 1)) ((1 ldz) (1 *))
                              z-%offset%)
```

```
                          refsum))
                        (setf
                         (f2cl-lib:fref z-%data% (j
                          (f2cl-lib:int-add k 2)) ((1 ldz) (1 *))
                          z-%offset%)
                         (-
                          (f2cl-lib:fref z-%data% (j
                           (f2cl-lib:int-add k 2)) ((1 ldz) (1 *))
                           z-%offset%)
                          (* refsum
                           (f2cl-lib:dconjg
                            (f2cl-lib:fref v-%data% (2 m22)
                             ((1 ldv) (1 *)) v-%offset%)))))
                        label110))))))))
    (setf mstart mtop)
    (if
     (<
      (f2cl-lib:int-add krcol
       (f2cl-lib:int-mul 3 (f2cl-lib:int-sub mstart 1)))
      ktop)
     (setf mstart (f2cl-lib:int-add mstart 1)))
    (setf mend mbot)
    (if bmp22 (setf mend (f2cl-lib:int-add mend 1)))
    (if (= krcol (f2cl-lib:int-sub kbot 2))
     (setf mend (f2cl-lib:int-add mend 1)))
    (f2cl-lib:fdo (m mstart (f2cl-lib:int-add m 1))
((> m mend) nil)
 (tagbody
      (setf k
       (min (the f2cl-lib:integer4 (f2cl-lib:int-sub kbot 1))
        (the f2cl-lib:integer4
         (f2cl-lib:int-add krcol
          (f2cl-lib:int-mul 3 (f2cl-lib:int-sub m 1))))))
      (cond
       ((/= (f2cl-lib:fref h ((f2cl-lib:int-add k 1) k)
                                ((1 ldh) (1 *))) zero)
        (setf tst1
         (+ (cabs1 (f2cl-lib:fref h-%data% (k k)
                    ((1 ldh) (1 *)) h-%offset%))
          (cabs1
           (f2cl-lib:fref h-%data%
            ((f2cl-lib:int-add k 1)
            (f2cl-lib:int-add k 1)) ((1 ldh) (1 *))
            h-%offset%))))
        (cond
         ((= tst1 rzero)
          (if (>= k (f2cl-lib:int-add ktop 1))
           (setf tst1
            (+ tst1
             (cabs1
```

```
      (f2cl-lib:fref h-%data% (k
       (f2cl-lib:int-sub k 1)) ((1 ldh) (1 *))
       h-%offset%)))))
   (if (>= k (f2cl-lib:int-add ktop 2))
    (setf tst1
     (+ tst1
      (cabs1
       (f2cl-lib:fref h-%data% (k
        (f2cl-lib:int-sub k 2)) ((1 ldh) (1 *))
        h-%offset%)))))
   (if (>= k (f2cl-lib:int-add ktop 3))
    (setf tst1
     (+ tst1
      (cabs1
       (f2cl-lib:fref h-%data% (k
        (f2cl-lib:int-sub k 3)) ((1 ldh) (1 *))
        h-%offset%)))))
   (if (<= k (f2cl-lib:int-sub kbot 2))
    (setf tst1
     (+ tst1
      (cabs1
       (f2cl-lib:fref h-%data%
        ((f2cl-lib:int-add k 2)
         (f2cl-lib:int-add k 1)) ((1 ldh) (1 *))
        h-%offset%)))))
   (if (<= k (f2cl-lib:int-sub kbot 3))
    (setf tst1
     (+ tst1
      (cabs1
       (f2cl-lib:fref h-%data%
        ((f2cl-lib:int-add k 3)
         (f2cl-lib:int-add k 1)) ((1 ldh) (1 *))
        h-%offset%)))))
   (if (<= k (f2cl-lib:int-sub kbot 4))
    (setf tst1
     (+ tst1
      (cabs1
       (f2cl-lib:fref h-%data%
        ((f2cl-lib:int-add k 4)
         (f2cl-lib:int-add k 1)) ((1 ldh) (1 *))
        h-%offset%)))))))
(cond
 ((<=
   (cabs1 (f2cl-lib:fref h
        ((f2cl-lib:int-add k 1) k) ((1 ldh) (1 *))))
   (max smlnum (* ulp tst1)))
  (setf h12
   (max
    (cabs1
     (f2cl-lib:fref h-%data%
```

```
    ((f2cl-lib:int-add k 1) k) ((1 ldh) (1 *))
    h-%offset%))
  (cabs1
   (f2cl-lib:fref h-%data% (k
            (f2cl-lib:int-add k 1)) ((1 ldh) (1 *))
    h-%offset%))))
(setf h21
 (min
  (cabs1
   (f2cl-lib:fref h-%data%
    ((f2cl-lib:int-add k 1) k) ((1 ldh) (1 *))
    h-%offset%))
  (cabs1
   (f2cl-lib:fref h-%data% (k
           (f2cl-lib:int-add k 1)) ((1 ldh) (1 *))
    h-%offset%))))
(setf h11
 (max
  (cabs1
   (f2cl-lib:fref h-%data%
    ((f2cl-lib:int-add k 1)
     (f2cl-lib:int-add k 1)) ((1 ldh) (1 *))
    h-%offset%))
  (cabs1
   (- (f2cl-lib:fref h-%data% (k k)
    ((1 ldh) (1 *)) h-%offset%)
    (f2cl-lib:fref h-%data%
     ((f2cl-lib:int-add k 1)
      (f2cl-lib:int-add k 1)) ((1 ldh) (1 *))
     h-%offset%)))))
(setf h22
 (min
  (cabs1
   (f2cl-lib:fref h-%data%
    ((f2cl-lib:int-add k 1)
     (f2cl-lib:int-add k 1)) ((1 ldh) (1 *))
    h-%offset%))
  (cabs1
   (- (f2cl-lib:fref h-%data% (k k)
    ((1 ldh) (1 *)) h-%offset%)
    (f2cl-lib:fref h-%data%
     ((f2cl-lib:int-add k 1)
      (f2cl-lib:int-add k 1)) ((1 ldh) (1 *))
     h-%offset%)))))
(setf scl (+ h11 h12))
(setf tst2 (* h22 (/ h11 scl)))
(if
 (or (= tst2 rzero)
  (<= (* h21 (/ h12 scl))
      (max smlnum (* ulp tst2))))
```

```
                (setf
                 (f2cl-lib:fref h-%data%
                  ((f2cl-lib:int-add k 1) k) ((1 ldh) (1 *))
                  h-%offset%)
                 zero))))))
              label120))
            (setf mend
             (min nbmps
              (the f2cl-lib:integer4 (truncate (- kbot krcol 1) 3))))
            (f2cl-lib:fdo (m mtop (f2cl-lib:int-add m 1))
           ((> m mend) nil)
           (tagbody
                (setf k
                 (f2cl-lib:int-add krcol
                   (f2cl-lib:int-mul 3 (f2cl-lib:int-sub m 1))))
                (setf refsum
                 (* (f2cl-lib:fref v-%data% (1 m) ((1 ldv) (1 *))
                       v-%offset%)
                  (f2cl-lib:fref v-%data% (3 m)
                    ((1 ldv) (1 *)) v-%offset%)
                  (f2cl-lib:fref h-%data%
                   ((f2cl-lib:int-add k 4) (f2cl-lib:int-add k 3))
                   ((1 ldh) (1 *)) h-%offset%)))
                (setf
                 (f2cl-lib:fref h-%data%
                  ((f2cl-lib:int-add k 4) (f2cl-lib:int-add k 1))
                  ((1 ldh) (1 *)) h-%offset%)
                 (- refsum))
                (setf
                 (f2cl-lib:fref h-%data%
                  ((f2cl-lib:int-add k 4) (f2cl-lib:int-add k 2))
                  ((1 ldh) (1 *)) h-%offset%)
                 (coerce
                  (* (- refsum)
                   (f2cl-lib:dconjg
                    (f2cl-lib:fref v-%data% (2 m)
                     ((1 ldv) (1 *)) v-%offset%)))
                  'f2cl-lib:complex16))
                (setf
                 (f2cl-lib:fref h-%data%
                  ((f2cl-lib:int-add k 4) (f2cl-lib:int-add k 3))
                  ((1 ldh) (1 *)) h-%offset%)
                 (-
                  (f2cl-lib:fref h-%data%
                   ((f2cl-lib:int-add k 4) (f2cl-lib:int-add k 3))
                   ((1 ldh) (1 *)) h-%offset%)
                  (* refsum
                   (f2cl-lib:dconjg
                    (f2cl-lib:fref v-%data% (3 m)
                     ((1 ldv) (1 *)) v-%offset%)))))
```

```
    label130))
  label140))
(cond
 (accum
  (cond (wantt (setf jtop 1) (setf jbot n))
   (t (setf jtop ktop) (setf jbot kbot)))
  (cond
   ((or (not blk22) (< incol ktop)
        (> ndcol kbot) (<= ns 2))
    (setf k1
     (max (the f2cl-lib:integer4 1)
      (the f2cl-lib:integer4
       (f2cl-lib:int-sub ktop incol))))
    (setf nu
     (f2cl-lib:int-add
      (f2cl-lib:int-sub kdu
       (max (the f2cl-lib:integer4 0)
        (the f2cl-lib:integer4
         (f2cl-lib:int-sub ndcol kbot)))
       k1)
      1))
    (f2cl-lib:fdo (jcol
         (f2cl-lib:int-add
          (min (the f2cl-lib:integer4 ndcol)
               (the f2cl-lib:integer4 kbot)) 1)
         (f2cl-lib:int-add jcol nh))
 ((> jcol jbot) nil)
  (tagbody
          (setf jlen
           (min (the f2cl-lib:integer4 nh)
            (the f2cl-lib:integer4
             (f2cl-lib:int-add
              (f2cl-lib:int-sub jbot jcol) 1))))
          (multiple-value-bind
           (var-0 var-1 var-2 var-3 var-4 var-5
            var-6 var-7 var-8 var-9 var-10
            var-11 var-12)
           (zgemm "C" "N" nu jlen nu one
            (f2cl-lib:array-slice u-%data%
             f2cl-lib:complex16 (k1 k1)
             ((1 ldu) (1 *)) u-%offset%)
            ldu
            (f2cl-lib:array-slice h-%data%
             f2cl-lib:complex16 ((+ incol k1) jcol)
             ((1 ldh) (1 *)) h-%offset%)
            ldh zero wh ldwh)
           (declare (ignore var-0 var-1 var-6 var-8
                var-11))
           (when var-2 (setf nu var-2))
           (when var-3 (setf jlen var-3))
```

```
                (when var-4 (setf nu var-4))
                (when var-5 (setf one var-5))
                (when var-7 (setf ldu var-7))
                (when var-9 (setf ldh var-9))
                (when var-10 (setf zero var-10))
                (when var-12 (setf ldwh var-12)))
               (zlacpy "ALL" nu jlen wh ldwh
                (f2cl-lib:array-slice h-%data%
                 f2cl-lib:complex16 ((+ incol k1) jcol)
                 ((1 ldh) (1 *)) h-%offset%)
                ldh)
               label150))
     (f2cl-lib:fdo (jrow jtop (f2cl-lib:int-add jrow nv))
  ((> jrow
           (f2cl-lib:int-add
            (max (the f2cl-lib:integer4 ktop)
                 (the f2cl-lib:integer4 incol))
            (f2cl-lib:int-sub 1)))
          nil)
   (tagbody
           (setf jlen
            (min (the f2cl-lib:integer4 nv)
             (the f2cl-lib:integer4
              (f2cl-lib:int-sub
               (max (the f2cl-lib:integer4 ktop)
                    (the f2cl-lib:integer4 incol))
               jrow))))
           (multiple-value-bind
            (var-0 var-1 var-2 var-3 var-4 var-5 var-6
             var-7 var-8 var-9 var-10
             var-11 var-12)
            (zgemm "N" "N" jlen nu nu one
             (f2cl-lib:array-slice h-%data%
              f2cl-lib:complex16
              (jrow (f2cl-lib:int-add incol k1))
              ((1 ldh) (1 *)) h-%offset%)
             ldh
             (f2cl-lib:array-slice u-%data%
              f2cl-lib:complex16 (k1 k1)
              ((1 ldu) (1 *)) u-%offset%)
             ldu zero wv ldwv)
            (declare (ignore var-0 var-1 var-6
                             var-8 var-11))
            (when var-2 (setf jlen var-2))
            (when var-3 (setf nu var-3))
            (when var-4 (setf nu var-4))
            (when var-5 (setf one var-5))
            (when var-7 (setf ldh var-7))
            (when var-9 (setf ldu var-9))
            (when var-10 (setf zero var-10))
```

```
        (when var-12 (setf ldwv var-12)))
       (zlacpy "ALL" jlen nu wv ldwv
        (f2cl-lib:array-slice h-%data%
         f2cl-lib:complex16
         (jrow (f2cl-lib:int-add incol k1))
         ((1 ldh) (1 *)) h-%offset%)
        ldh)
       label160))
 (cond
  (wantz
   (f2cl-lib:fdo (jrow iloz (f2cl-lib:int-add jrow nv))
((> jrow ihiz)
         nil)
 (tagbody
          (setf jlen
           (min (the f2cl-lib:integer4 nv)
            (the f2cl-lib:integer4
             (f2cl-lib:int-add
              (f2cl-lib:int-sub ihiz jrow) 1))))
          (multiple-value-bind
           (var-0 var-1 var-2 var-3 var-4 var-5
            var-6 var-7 var-8 var-9 var-10
            var-11 var-12)
           (zgemm "N" "N" jlen nu nu one
            (f2cl-lib:array-slice z-%data%
             f2cl-lib:complex16
             (jrow (f2cl-lib:int-add incol k1))
              ((1 ldz) (1 *)) z-%offset%)
            ldz
            (f2cl-lib:array-slice u-%data%
             f2cl-lib:complex16 (k1 k1)
             ((1 ldu) (1 *)) u-%offset%)
            ldu zero wv ldwv)
           (declare (ignore var-0 var-1 var-6
               var-8 var-11))
           (when var-2 (setf jlen var-2))
           (when var-3 (setf nu var-3))
           (when var-4 (setf nu var-4))
           (when var-5 (setf one var-5))
           (when var-7 (setf ldz var-7))
           (when var-9 (setf ldu var-9))
           (when var-10 (setf zero var-10))
           (when var-12 (setf ldwv var-12)))
          (zlacpy "ALL" jlen nu wv ldwv
           (f2cl-lib:array-slice z-%data%
            f2cl-lib:complex16
            (jrow (f2cl-lib:int-add incol k1))
                  ((1 ldz) (1 *)) z-%offset%)
           ldz)
          label170)))))
```

```
  (t (setf i2 (the f2cl-lib:integer4
                (truncate (+ kdu 1) 2)))
   (setf i4 kdu)
   (setf j2 (f2cl-lib:int-sub i4 i2))
   (setf j4 kdu)
   (setf kzs (f2cl-lib:int-sub j4 j2
               (f2cl-lib:int-add ns 1)))
   (setf knz (f2cl-lib:int-add ns 1))
   (f2cl-lib:fdo (jcol
         (f2cl-lib:int-add
          (min (the f2cl-lib:integer4 ndcol)
               (the f2cl-lib:integer4 kbot)) 1)
         (f2cl-lib:int-add jcol nh))
((> jcol jbot) nil)
 (tagbody
         (setf jlen
          (min (the f2cl-lib:integer4 nh)
           (the f2cl-lib:integer4
            (f2cl-lib:int-add
             (f2cl-lib:int-sub jbot jcol) 1))))
         (zlacpy "ALL" knz jlen
          (f2cl-lib:array-slice h-%data%
           f2cl-lib:complex16
           ((+ incol 1 j2) jcol) ((1 ldh) (1 *))
           h-%offset%)
          ldh
          (f2cl-lib:array-slice wh-%data%
           f2cl-lib:complex16 ((+ kzs 1) 1)
           ((1 ldwh) (1 *)) wh-%offset%)
          ldwh)
         (multiple-value-bind (var-0 var-1 var-2
             var-3 var-4 var-5 var-6)
          (zlaset "ALL" kzs jlen zero zero wh ldwh)
          (declare (ignore var-0 var-5))
          (when var-1 (setf kzs var-1))
          (when var-2 (setf jlen var-2))
          (when var-3 (setf zero var-3))
          (when var-4 (setf zero var-4))
          (when var-6 (setf ldwh var-6)))
         (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4 var-5
           var-6 var-7 var-8 var-9 var-10)
          (ztrmm "L" "U" "C" "N" knz jlen one
           (f2cl-lib:array-slice u-%data%
            f2cl-lib:complex16
            ((+ j2 1) (f2cl-lib:int-add 1 kzs))
            ((1 ldu) (1 *)) u-%offset%)
           ldu
           (f2cl-lib:array-slice wh-%data%
            f2cl-lib:complex16 ((+ kzs 1) 1)
```

```
   ((1 ldwh) (1 *)) wh-%offset%)
  ldwh)
 (declare (ignore var-0 var-1 var-2 var-3
           var-7 var-9))
 (when var-4 (setf knz var-4))
 (when var-5 (setf jlen var-5))
 (when var-6 (setf one var-6))
 (when var-8 (setf ldu var-8))
 (when var-10 (setf ldwh var-10)))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8 var-9 var-10
  var-11 var-12)
 (zgemm "C" "N" i2 jlen j2 one u ldu
  (f2cl-lib:array-slice h-%data%
   f2cl-lib:complex16 ((+ incol 1) jcol)
   ((1 ldh) (1 *)) h-%offset%)
  ldh one wh ldwh)
 (declare (ignore var-0 var-1 var-6
           var-8 var-11))
 (when var-2 (setf i2 var-2))
 (when var-3 (setf jlen var-3))
 (when var-4 (setf j2 var-4))
 (when var-5 (setf one var-5))
 (when var-7 (setf ldu var-7))
 (when var-9 (setf ldh var-9))
 (when var-10 (setf one var-10))
 (when var-12 (setf ldwh var-12)))
(zlacpy "ALL" j2 jlen
 (f2cl-lib:array-slice h-%data%
  f2cl-lib:complex16 ((+ incol 1) jcol)
  ((1 ldh) (1 *)) h-%offset%)
 ldh
 (f2cl-lib:array-slice wh-%data%
  f2cl-lib:complex16 ((+ i2 1) 1)
  ((1 ldwh) (1 *)) wh-%offset%)
 ldwh)
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6
  var-7 var-8 var-9 var-10)
 (ztrmm "L" "L" "C" "N" j2 jlen one
  (f2cl-lib:array-slice u-%data%
   f2cl-lib:complex16
   (1 (f2cl-lib:int-add i2 1))
   ((1 ldu) (1 *)) u-%offset%)
  ldu
  (f2cl-lib:array-slice wh-%data%
   f2cl-lib:complex16 ((+ i2 1) 1)
   ((1 ldwh) (1 *)) wh-%offset%)
  ldwh)
```

```
                (declare (ignore var-0 var-1 var-2 var-3
                          var-7 var-9))
                (when var-4 (setf j2 var-4))
                (when var-5 (setf jlen var-5))
                (when var-6 (setf one var-6))
                (when var-8 (setf ldu var-8))
                (when var-10 (setf ldwh var-10)))
               (multiple-value-bind
                (var-0 var-1 var-2 var-3 var-4 var-5 var-6
                 var-7 var-8 var-9 var-10
                 var-11 var-12)
                (zgemm "C" "N" (f2cl-lib:int-sub i4 i2)
                 jlen (f2cl-lib:int-sub j4 j2)
                 one
                 (f2cl-lib:array-slice u-%data%
                  f2cl-lib:complex16
                  ((+ j2 1) (f2cl-lib:int-add i2 1))
                  ((1 ldu) (1 *)) u-%offset%)
                 ldu
                 (f2cl-lib:array-slice h-%data%
                  f2cl-lib:complex16
                  ((+ incol 1 j2) jcol) ((1 ldh) (1 *))
                  h-%offset%)
                 ldh one
                 (f2cl-lib:array-slice wh-%data%
                  f2cl-lib:complex16 ((+ i2 1) 1)
                  ((1 ldwh) (1 *)) wh-%offset%)
                 ldwh)
                (declare (ignore var-0 var-1 var-2 var-4
                          var-6 var-8 var-11))
                (when var-3 (setf jlen var-3))
                (when var-5 (setf one var-5))
                (when var-7 (setf ldu var-7))
                (when var-9 (setf ldh var-9))
                (when var-10 (setf one var-10))
                (when var-12 (setf ldwh var-12)))
               (zlacpy "ALL" kdu jlen wh ldwh
                (f2cl-lib:array-slice h-%data%
                 f2cl-lib:complex16 ((+ incol 1) jcol)
                 ((1 ldh) (1 *)) h-%offset%)
                ldh)
               label180))
     (f2cl-lib:fdo (jrow jtop (f2cl-lib:int-add jrow nv))
  ((> jrow
           (f2cl-lib:int-add
            (max (the f2cl-lib:integer4 incol)
                 (the f2cl-lib:integer4 ktop))
            (f2cl-lib:int-sub 1)))
          nil)
   (tagbody
```

```
(setf jlen
 (min (the f2cl-lib:integer4 nv)
  (the f2cl-lib:integer4
   (f2cl-lib:int-sub
    (max (the f2cl-lib:integer4 incol)
         (the f2cl-lib:integer4 ktop))
    jrow))))
(zlacpy "ALL" jlen knz
 (f2cl-lib:array-slice h-%data%
  f2cl-lib:complex16
  (jrow (f2cl-lib:int-add incol 1 j2))
  ((1 ldh) (1 *)) h-%offset%)
 ldh
 (f2cl-lib:array-slice wv-%data%
  f2cl-lib:complex16
  (1 (f2cl-lib:int-add 1 kzs))
  ((1 ldwv) (1 *)) wv-%offset%)
 ldwv)
(multiple-value-bind (var-0 var-1 var-2 var-3
    var-4 var-5 var-6)
 (zlaset "ALL" jlen kzs zero zero wv ldwv)
 (declare (ignore var-0 var-5))
 (when var-1 (setf jlen var-1))
 (when var-2 (setf kzs var-2))
 (when var-3 (setf zero var-3))
 (when var-4 (setf zero var-4))
 (when var-6 (setf ldwv var-6)))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8 var-9 var-10)
 (ztrmm "R" "U" "N" "N" jlen knz one
  (f2cl-lib:array-slice u-%data%
   f2cl-lib:complex16
   ((+ j2 1) (f2cl-lib:int-add 1 kzs))
   ((1 ldu) (1 *)) u-%offset%)
  ldu
  (f2cl-lib:array-slice wv-%data%
   f2cl-lib:complex16
   (1 (f2cl-lib:int-add 1 kzs))
      ((1 ldwv) (1 *)) wv-%offset%)
  ldwv)
 (declare (ignore var-0 var-1 var-2 var-3
           var-7 var-9))
 (when var-4 (setf jlen var-4))
 (when var-5 (setf knz var-5))
 (when var-6 (setf one var-6))
 (when var-8 (setf ldu var-8))
 (when var-10 (setf ldwv var-10)))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6
```

```
 var-7 var-8 var-9 var-10
 var-11 var-12)
(zgemm "N" "N" jlen i2 j2 one
 (f2cl-lib:array-slice h-%data%
  f2cl-lib:complex16
  (jrow (f2cl-lib:int-add incol 1))
        ((1 ldh) (1 *)) h-%offset%)
 ldh u ldu one wv ldwv)
(declare (ignore var-0 var-1 var-6
          var-8 var-11))
(when var-2 (setf jlen var-2))
(when var-3 (setf i2 var-3))
(when var-4 (setf j2 var-4))
(when var-5 (setf one var-5))
(when var-7 (setf ldh var-7))
(when var-9 (setf ldu var-9))
(when var-10 (setf one var-10))
(when var-12 (setf ldwv var-12)))
(zlacpy "ALL" jlen j2
 (f2cl-lib:array-slice h-%data%
  f2cl-lib:complex16
  (jrow (f2cl-lib:int-add incol 1))
        ((1 ldh) (1 *)) h-%offset%)
 ldh
 (f2cl-lib:array-slice wv-%data%
  f2cl-lib:complex16
  (1 (f2cl-lib:int-add 1 i2))
  ((1 ldwv) (1 *)) wv-%offset%)
 ldwv)
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6
  var-7 var-8 var-9 var-10)
 (ztrmm "R" "L" "N" "N" jlen
  (f2cl-lib:int-sub i4 i2) one
  (f2cl-lib:array-slice u-%data%
   f2cl-lib:complex16
   (1 (f2cl-lib:int-add i2 1))
      ((1 ldu) (1 *)) u-%offset%)
  ldu
  (f2cl-lib:array-slice wv-%data%
   f2cl-lib:complex16
   (1 (f2cl-lib:int-add 1 i2))
      ((1 ldwv) (1 *)) wv-%offset%)
  ldwv)
 (declare (ignore var-0 var-1 var-2 var-3
           var-5 var-7 var-9))
 (when var-4 (setf jlen var-4))
 (when var-6 (setf one var-6))
 (when var-8 (setf ldu var-8))
 (when var-10 (setf ldwv var-10)))
```

```
                (multiple-value-bind
                 (var-0 var-1 var-2 var-3 var-4 var-5
                  var-6 var-7 var-8 var-9 var-10
                  var-11 var-12)
                 (zgemm "N" "N" jlen
                  (f2cl-lib:int-sub i4 i2)
                  (f2cl-lib:int-sub j4 j2)
                  one
                  (f2cl-lib:array-slice h-%data%
                   f2cl-lib:complex16
                   (jrow (f2cl-lib:int-add incol 1 j2))
                    ((1 ldh) (1 *)) h-%offset%)
                  ldh
                  (f2cl-lib:array-slice u-%data%
                   f2cl-lib:complex16
                   ((+ j2 1) (f2cl-lib:int-add i2 1))
                   ((1 ldu) (1 *)) u-%offset%)
                  ldu one
                  (f2cl-lib:array-slice wv-%data%
                   f2cl-lib:complex16
                   (1 (f2cl-lib:int-add 1 i2)) ((1 ldwv)
                       (1 *)) wv-%offset%)
                  ldwv)
                 (declare (ignore var-0 var-1 var-3 var-4
                           var-6 var-8 var-11))
                 (when var-2 (setf jlen var-2))
                 (when var-5 (setf one var-5))
                 (when var-7 (setf ldh var-7))
                 (when var-9 (setf ldu var-9))
                 (when var-10 (setf one var-10))
                 (when var-12 (setf ldwv var-12)))
                (zlacpy "ALL" jlen kdu wv ldwv
                 (f2cl-lib:array-slice h-%data%
                  f2cl-lib:complex16
                  (jrow (f2cl-lib:int-add incol 1)) ((1 ldh)
                    (1 *)) h-%offset%)
                 ldh)
                label190))
          (cond
           (wantz
            (f2cl-lib:fdo (jrow iloz (f2cl-lib:int-add jrow nv))
         ((> jrow ihiz)
                  nil)
          (tagbody
                    (setf jlen
                     (min (the f2cl-lib:integer4 nv)
                      (the f2cl-lib:integer4
                       (f2cl-lib:int-add
                        (f2cl-lib:int-sub ihiz jrow) 1))))
                    (zlacpy "ALL" jlen knz
```

```
 (f2cl-lib:array-slice z-%data%
  f2cl-lib:complex16
  (jrow (f2cl-lib:int-add incol 1 j2))
   ((1 ldz) (1 *)) z-%offset%)
 ldz
 (f2cl-lib:array-slice wv-%data%
  f2cl-lib:complex16
  (1 (f2cl-lib:int-add 1 kzs))
     ((1 ldwv) (1 *)) wv-%offset%)
 ldwv)
(multiple-value-bind (var-0 var-1 var-2
   var-3 var-4 var-5 var-6)
 (zlaset "ALL" jlen kzs zero zero wv ldwv)
 (declare (ignore var-0 var-5))
 (when var-1 (setf jlen var-1))
 (when var-2 (setf kzs var-2))
 (when var-3 (setf zero var-3))
 (when var-4 (setf zero var-4))
 (when var-6 (setf ldwv var-6)))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8 var-9 var-10)
 (ztrmm "R" "U" "N" "N" jlen knz one
  (f2cl-lib:array-slice u-%data%
   f2cl-lib:complex16
   ((+ j2 1) (f2cl-lib:int-add 1 kzs))
   ((1 ldu) (1 *)) u-%offset%)
  ldu
  (f2cl-lib:array-slice wv-%data%
   f2cl-lib:complex16
   (1 (f2cl-lib:int-add 1 kzs))
      ((1 ldwv) (1 *)) wv-%offset%)
  ldwv)
 (declare (ignore
    var-0 var-1 var-2 var-3 var-7 var-9))
 (when var-4 (setf jlen var-4))
 (when var-5 (setf knz var-5))
 (when var-6 (setf one var-6))
 (when var-8 (setf ldu var-8))
 (when var-10 (setf ldwv var-10)))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8 var-9 var-10
  var-11 var-12)
 (zgemm "N" "N" jlen i2 j2 one
  (f2cl-lib:array-slice z-%data%
   f2cl-lib:complex16
   (jrow (f2cl-lib:int-add incol 1))
     ((1 ldz) (1 *)) z-%offset%)
  ldz u ldu one wv ldwv)
```

```
 (declare (ignore var-0 var-1 var-6
           var-8 var-11))
 (when var-2 (setf jlen var-2))
 (when var-3 (setf i2 var-3))
 (when var-4 (setf j2 var-4))
 (when var-5 (setf one var-5))
 (when var-7 (setf ldz var-7))
 (when var-9 (setf ldu var-9))
 (when var-10 (setf one var-10))
 (when var-12 (setf ldwv var-12)))
(zlacpy "ALL" jlen j2
 (f2cl-lib:array-slice z-%data%
  f2cl-lib:complex16
  (jrow (f2cl-lib:int-add incol 1))
        ((1 ldz) (1 *)) z-%offset%)
 ldz
 (f2cl-lib:array-slice wv-%data%
  f2cl-lib:complex16
  (1 (f2cl-lib:int-add 1 i2))
  ((1 ldwv) (1 *)) wv-%offset%)
 ldwv)
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8 var-9 var-10)
 (ztrmm "R" "L" "N" "N" jlen
  (f2cl-lib:int-sub i4 i2) one
  (f2cl-lib:array-slice u-%data%
   f2cl-lib:complex16
   (1 (f2cl-lib:int-add i2 1))
       ((1 ldu) (1 *)) u-%offset%)
  ldu
  (f2cl-lib:array-slice wv-%data%
    f2cl-lib:complex16
   (1 (f2cl-lib:int-add 1 i2))
      ((1 ldwv) (1 *)) wv-%offset%)
  ldwv)
 (declare (ignore var-0 var-1 var-2 var-3
           var-5 var-7 var-9))
 (when var-4 (setf jlen var-4))
 (when var-6 (setf one var-6))
 (when var-8 (setf ldu var-8))
 (when var-10 (setf ldwv var-10)))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5
  var-6 var-7 var-8 var-9 var-10
  var-11 var-12)
 (zgemm "N" "N" jlen (f2cl-lib:int-sub i4 i2)
  (f2cl-lib:int-sub j4 j2) one
  (f2cl-lib:array-slice z-%data%
    f2cl-lib:complex16
```

```
                                  (jrow (f2cl-lib:int-add incol 1 j2))
                                          ((1 ldz) (1 *)) z-%offset%)
                                 ldz
                                 (f2cl-lib:array-slice u-%data%
                                  f2cl-lib:complex16
                                  ((+ j2 1) (f2cl-lib:int-add i2 1))
                                  ((1 ldu) (1 *)) u-%offset%)
                                 ldu one
                                 (f2cl-lib:array-slice wv-%data%
                                  f2cl-lib:complex16
                                  (1 (f2cl-lib:int-add 1 i2)) ((1 ldwv)
                                  (1 *)) wv-%offset%)
                                 ldwv)
                                (declare (ignore var-0 var-1 var-3 var-4
                                          var-6 var-8 var-11))
                                (when var-2 (setf jlen var-2))
                                (when var-5 (setf one var-5))
                                (when var-7 (setf ldz var-7))
                                (when var-9 (setf ldu var-9))
                                (when var-10 (setf one var-10))
                                (when var-12 (setf ldwv var-12)))
                               (zlacpy "ALL" jlen kdu wv ldwv
                                (f2cl-lib:array-slice
                                   z-%data% f2cl-lib:complex16
                                  (jrow (f2cl-lib:int-add incol 1))
                                    ((1 ldz) (1 *)) z-%offset%)
                                 ldz)
                               label200))))))))
                    label210))
          end_label
          (return
           (values nil nil nil nil nil nil nil nil nil ldh nil nil nil
            ldz nil nil nil
            ldu nil nil ldwv nil nil ldwh)))))))
```

———-

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— zlarfb.input —

```
)set break resume
)sys rm -f zlarfb.output
)spool zlarfb.output
)set message test on
)set message auto off
)clear all
```

```
)spool
)lisp (bye)
```

———-

— **zlarfb.help** —

```
========================================================================
zlarfb examples
========================================================================

========================================================================
Man Page Details
========================================================================

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZLARFB( SIDE, TRANS, DIRECT, STOREV, M, N, K, V, LDV,
                          T, LDT, C, LDC, WORK, LDWORK )

       .. Scalar Arguments ..
       CHARACTER          DIRECT, SIDE, STOREV, TRANS
       INTEGER            K, LDC, LDT, LDV, LDWORK, M, N
       ..
       .. Array Arguments ..
       COMPLEX*16         C( LDC, * ), T( LDT, * ), V( LDV, * ),
      $                   WORK( LDWORK, * )
       ..


 Purpose:
 =============

 ZLARFB applies a complex block reflector H or its transpose H**H to a
 complex M-by-N matrix C, from either the left or the right.


 Arguments:
 ==========

  [in] SIDE

          SIDE is CHARACTER*1
          = 'L': apply H or H**H from the Left
```

```
          = 'R': apply H or H**H from the Right

  [in] TRANS

          TRANS is CHARACTER*1
          = 'N': apply H (No transpose)
          = 'C': apply H**H (Conjugate transpose)

  [in] DIRECT

          DIRECT is CHARACTER*1
          Indicates how H is formed from a product of elementary
          reflectors
          = 'F': H = H(1) H(2) . . . H(k) (Forward)
          = 'B': H = H(k) . . . H(2) H(1) (Backward)

  [in] STOREV

          STOREV is CHARACTER*1
          Indicates how the vectors which define the elementary
          reflectors are stored:
          = 'C': Columnwise
          = 'R': Rowwise

  [in] M

          M is INTEGER
          The number of rows of the matrix C.

  [in] N

          N is INTEGER
          The number of columns of the matrix C.

  [in] K

          K is INTEGER
          The order of the matrix T (= the number of elementary
          reflectors whose product defines the block reflector).

  [in] V

          V is COMPLEX*16 array, dimension
                                (LDV,K) if STOREV = 'C'
                                (LDV,M) if STOREV = 'R' and SIDE = 'L'
                                (LDV,N) if STOREV = 'R' and SIDE = 'R'
          See Further Details.

  [in] LDV
```

```
          LDV is INTEGER
          The leading dimension of the array V.
          If STOREV = 'C' and SIDE = 'L', LDV >= max(1,M);
          if STOREV = 'C' and SIDE = 'R', LDV >= max(1,N);
          if STOREV = 'R', LDV >= K.

  [in] T

          T is COMPLEX*16 array, dimension (LDT,K)
          The triangular K-by-K matrix T in the representation of the
          block reflector.

  [in] LDT

          LDT is INTEGER
          The leading dimension of the array T. LDT >= K.

  [in,out] C

          C is COMPLEX*16 array, dimension (LDC,N)
          On entry, the M-by-N matrix C.
          On exit, C is overwritten by H*C or H**H*C or C*H or C*H**H.

  [in] LDC

          LDC is INTEGER
          The leading dimension of the array C. LDC >= max(1,M).

  [out] WORK

          WORK is COMPLEX*16 array, dimension (LDWORK,K)

  [in] LDWORK

          LDWORK is INTEGER
          The leading dimension of the array WORK.
          If SIDE = 'L', LDWORK >= max(1,N);
          if SIDE = 'R', LDWORK >= max(1,M).

Authors:
========

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November 2011

Further Details:
```

```
====================

 The shape of the matrix V and the storage of the vectors which define
 the H(i) is best illustrated by the following example with n = 5 and
 k = 3. The elements equal to 1 are not stored; the corresponding
 array elements are modified but restored on exit. The rest of the
 array is not used.

 DIRECT = 'F' and STOREV = 'C':         DIRECT = 'F' and STOREV = 'R':

              V = (  1       )                 V = (  1 v1 v1 v1 v1 )
                  ( v1  1    )                     (     1 v2 v2 v2 )
                  ( v1 v2  1 )                     (        1 v3 v3 )
                  ( v1 v2 v3 )
                  ( v1 v2 v3 )

 DIRECT = 'B' and STOREV = 'C':         DIRECT = 'B' and STOREV = 'R':

              V = ( v1 v2 v3 )                 V = ( v1 v1  1       )
                  ( v1 v2 v3 )                     ( v2 v2 v2  1    )
                  (  1 v2 v3 )                     ( v3 v3 v3 v3  1 )
                  (     1 v3 )
                  (        1 )
```

— zlarfb.f —

```
*  =====================================================================
      SUBROUTINE ZLARFB( SIDE, TRANS, DIRECT, STOREV, M, N, K, V, LDV,
     $                   T, LDT, C, LDC, WORK, LDWORK )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      CHARACTER          DIRECT, SIDE, STOREV, TRANS
      INTEGER            K, LDC, LDT, LDV, LDWORK, M, N
*     ..
*     .. Array Arguments ..
      COMPLEX*16         C( LDC, * ), T( LDT, * ), V( LDV, * ),
     $                   WORK( LDWORK, * )
*     ..
*
*  =====================================================================
*
```

```
*     .. Parameters ..
      COMPLEX*16         ONE
      PARAMETER          ( ONE = ( 1.0D+0, 0.0D+0 ) )
*     ..
*     .. Local Scalars ..
      CHARACTER          TRANST
      INTEGER            I, J, LASTV, LASTC
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      INTEGER            ILAZLR, ILAZLC
      EXTERNAL           LSAME, ILAZLR, ILAZLC
*     ..
*     .. External Subroutines ..
      EXTERNAL           ZCOPY, ZGEMM, ZLACGV, ZTRMM
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG
*     ..
*     .. Executable Statements ..
*
*     Quick return if possible
*
      IF( M.LE.0 .OR. N.LE.0 )
     $   RETURN
*
      IF( LSAME( TRANS, 'N' ) ) THEN
         TRANST = 'C'
      ELSE
         TRANST = 'N'
      END IF
*
      IF( LSAME( STOREV, 'C' ) ) THEN
*
         IF( LSAME( DIRECT, 'F' ) ) THEN
*
*           Let  V =  ( V1 )    (first K rows)
*                     ( V2 )
*           where  V1  is unit lower triangular.
*
            IF( LSAME( SIDE, 'L' ) ) THEN
*
*              Form  H * C  or  H**H * C  where  C = ( C1 )
*                                                    ( C2 )
*
               LASTV = MAX( K, ILAZLR( M, K, V, LDV ) )
               LASTC = ILAZLC( LASTV, N, C, LDC )
*
*              W := C**H * V  =  (C1**H * V1 + C2**H * V2)  (stored in WORK)
*
```

```
*              W := C1**H
*
               DO 10 J = 1, K
                  CALL ZCOPY( LASTC, C( J, 1 ), LDC, WORK( 1, J ), 1 )
                  CALL ZLACGV( LASTC, WORK( 1, J ), 1 )
   10          CONTINUE
*
*              W := W * V1
*
               CALL ZTRMM( 'Right', 'Lower', 'No transpose', 'Unit',
     $              LASTC, K, ONE, V, LDV, WORK, LDWORK )
               IF( LASTV.GT.K ) THEN
*
*                 W := W + C2**H *V2
*
                  CALL ZGEMM( 'Conjugate transpose', 'No transpose',
     $                 LASTC, K, LASTV-K, ONE, C( K+1, 1 ), LDC,
     $                 V( K+1, 1 ), LDV, ONE, WORK, LDWORK )
               END IF
*
*              W := W * T**H  or  W * T
*
               CALL ZTRMM( 'Right', 'Upper', TRANST, 'Non-unit',
     $              LASTC, K, ONE, T, LDT, WORK, LDWORK )
*
*              C := C - V * W**H
*
               IF( M.GT.K ) THEN
*
*                 C2 := C2 - V2 * W**H
*
                  CALL ZGEMM( 'No transpose', 'Conjugate transpose',
     $                 LASTV-K, LASTC, K,
     $                 -ONE, V( K+1, 1 ), LDV, WORK, LDWORK,
     $                 ONE, C( K+1, 1 ), LDC )
               END IF
*
*              W := W * V1**H
*
               CALL ZTRMM( 'Right', 'Lower', 'Conjugate transpose',
     $              'Unit', LASTC, K, ONE, V, LDV, WORK, LDWORK )
*
*              C1 := C1 - W**H
*
               DO 30 J = 1, K
                  DO 20 I = 1, LASTC
                     C( J, I ) = C( J, I ) - DCONJG( WORK( I, J ) )
   20             CONTINUE
   30          CONTINUE
*
```

```
            ELSE IF( LSAME( SIDE, 'R' ) ) THEN
*
*              Form  C * H  or  C * H**H  where  C = ( C1  C2 )
*
               LASTV = MAX( K, ILAZLR( N, K, V, LDV ) )
               LASTC = ILAZLR( M, LASTV, C, LDC )
*
*              W := C * V  =  (C1*V1 + C2*V2)  (stored in WORK)
*
*              W := C1
*
               DO 40 J = 1, K
                  CALL ZCOPY( LASTC, C( 1, J ), 1, WORK( 1, J ), 1 )
   40          CONTINUE
*
*              W := W * V1
*
               CALL ZTRMM( 'Right', 'Lower', 'No transpose', 'Unit',
     $              LASTC, K, ONE, V, LDV, WORK, LDWORK )
               IF( LASTV.GT.K ) THEN
*
*                 W := W + C2 * V2
*
                  CALL ZGEMM( 'No transpose', 'No transpose',
     $                 LASTC, K, LASTV-K,
     $                 ONE, C( 1, K+1 ), LDC, V( K+1, 1 ), LDV,
     $                 ONE, WORK, LDWORK )
               END IF
*
*              W := W * T  or  W * T**H
*
               CALL ZTRMM( 'Right', 'Upper', TRANS, 'Non-unit',
     $              LASTC, K, ONE, T, LDT, WORK, LDWORK )
*
*              C := C - W * V**H
*
               IF( LASTV.GT.K ) THEN
*
*                 C2 := C2 - W * V2**H
*
                  CALL ZGEMM( 'No transpose', 'Conjugate transpose',
     $                 LASTC, LASTV-K, K,
     $                 -ONE, WORK, LDWORK, V( K+1, 1 ), LDV,
     $                 ONE, C( 1, K+1 ), LDC )
               END IF
*
*              W := W * V1**H
*
               CALL ZTRMM( 'Right', 'Lower', 'Conjugate transpose',
     $              'Unit', LASTC, K, ONE, V, LDV, WORK, LDWORK )
```

```
*
*             C1 := C1 - W
*
              DO 60 J = 1, K
                 DO 50 I = 1, LASTC
                    C( I, J ) = C( I, J ) - WORK( I, J )
   50             CONTINUE
   60          CONTINUE
            END IF
*
         ELSE
*
*           Let  V =  ( V1 )
*                     ( V2 )    (last K rows)
*           where  V2  is unit upper triangular.
*
            IF( LSAME( SIDE, 'L' ) ) THEN
*
*              Form  H * C  or  H**H * C  where  C = ( C1 )
*                                                    ( C2 )
*
               LASTV = MAX( K, ILAZLR( M, K, V, LDV ) )
               LASTC = ILAZLC( LASTV, N, C, LDC )
*
*              W := C**H * V  =  (C1**H * V1 + C2**H * V2)  (stored in WORK)
*
*              W := C2**H
*
               DO 70 J = 1, K
                  CALL ZCOPY( LASTC, C( LASTV-K+J, 1 ), LDC,
     $                 WORK( 1, J ), 1 )
                  CALL ZLACGV( LASTC, WORK( 1, J ), 1 )
   70          CONTINUE
*
*              W := W * V2
*
               CALL ZTRMM( 'Right', 'Upper', 'No transpose', 'Unit',
     $              LASTC, K, ONE, V( LASTV-K+1, 1 ), LDV,
     $              WORK, LDWORK )
               IF( LASTV.GT.K ) THEN
*
*                 W := W + C1**H*V1
*
                  CALL ZGEMM( 'Conjugate transpose', 'No transpose',
     $                 LASTC, K, LASTV-K,
     $                 ONE, C, LDC, V, LDV,
     $                 ONE, WORK, LDWORK )
               END IF
*
*              W := W * T**H  or  W * T
```

```
*
               CALL ZTRMM( 'Right', 'Lower', TRANST, 'Non-unit',
     $              LASTC, K, ONE, T, LDT, WORK, LDWORK )
*
*              C := C - V * W**H
*
               IF( LASTV.GT.K ) THEN
*
*                 C1 := C1 - V1 * W**H
*
                  CALL ZGEMM( 'No transpose', 'Conjugate transpose',
     $                 LASTV-K, LASTC, K,
     $                 -ONE, V, LDV, WORK, LDWORK,
     $                 ONE, C, LDC )
               END IF
*
*              W := W * V2**H
*
               CALL ZTRMM( 'Right', 'Upper', 'Conjugate transpose',
     $              'Unit', LASTC, K, ONE, V( LASTV-K+1, 1 ), LDV,
     $              WORK, LDWORK )
*
*              C2 := C2 - W**H
*
               DO 90 J = 1, K
                  DO 80 I = 1, LASTC
                     C( LASTV-K+J, I ) = C( LASTV-K+J, I ) -
     $                                   DCONJG( WORK( I, J ) )
   80             CONTINUE
   90          CONTINUE
*
            ELSE IF( LSAME( SIDE, 'R' ) ) THEN
*
*              Form  C * H  or  C * H**H  where  C = ( C1  C2 )
*
               LASTV = MAX( K, ILAZLR( N, K, V, LDV ) )
               LASTC = ILAZLR( M, LASTV, C, LDC )
*
*              W := C * V  =  (C1*V1 + C2*V2)  (stored in WORK)
*
*              W := C2
*
               DO 100 J = 1, K
                  CALL ZCOPY( LASTC, C( 1, LASTV-K+J ), 1,
     $                 WORK( 1, J ), 1 )
  100          CONTINUE
*
*              W := W * V2
*
               CALL ZTRMM( 'Right', 'Upper', 'No transpose', 'Unit',
```

```
     $              LASTC, K, ONE, V( LASTV-K+1, 1 ), LDV,
     $              WORK, LDWORK )
               IF( LASTV.GT.K ) THEN
*
*                 W := W + C1 * V1
*
                  CALL ZGEMM( 'No transpose', 'No transpose',
     $                 LASTC, K, LASTV-K,
     $                 ONE, C, LDC, V, LDV, ONE, WORK, LDWORK )
               END IF
*
*              W := W * T  or  W * T**H
*
               CALL ZTRMM( 'Right', 'Lower', TRANS, 'Non-unit',
     $              LASTC, K, ONE, T, LDT, WORK, LDWORK )
*
*              C := C - W * V**H
*
               IF( LASTV.GT.K ) THEN
*
*                 C1 := C1 - W * V1**H
*
                  CALL ZGEMM( 'No transpose', 'Conjugate transpose',
     $                 LASTC, LASTV-K, K, -ONE, WORK, LDWORK, V, LDV,
     $                 ONE, C, LDC )
               END IF
*
*              W := W * V2**H
*
               CALL ZTRMM( 'Right', 'Upper', 'Conjugate transpose',
     $              'Unit', LASTC, K, ONE, V( LASTV-K+1, 1 ), LDV,
     $              WORK, LDWORK )
*
*              C2 := C2 - W
*
               DO 120 J = 1, K
                  DO 110 I = 1, LASTC
                     C( I, LASTV-K+J ) = C( I, LASTV-K+J )
     $                    - WORK( I, J )
  110             CONTINUE
  120          CONTINUE
            END IF
         END IF
*
      ELSE IF( LSAME( STOREV, 'R' ) ) THEN
*
         IF( LSAME( DIRECT, 'F' ) ) THEN
*
*           Let  V =  ( V1  V2 )    (V1: first K columns)
*           where  V1  is unit upper triangular.
```

```
*
            IF( LSAME( SIDE, 'L' ) ) THEN
*
*              Form  H * C  or  H**H * C  where  C = ( C1 )
*                                                    ( C2 )
*
               LASTV = MAX( K, ILAZLC( K, M, V, LDV ) )
               LASTC = ILAZLC( LASTV, N, C, LDC )
*
*              W := C**H * V**H  =  (C1**H * V1**H + C2**H * V2**H) (stored in WORK)
*
*              W := C1**H
*
               DO 130 J = 1, K
                  CALL ZCOPY( LASTC, C( J, 1 ), LDC, WORK( 1, J ), 1 )
                  CALL ZLACGV( LASTC, WORK( 1, J ), 1 )
  130          CONTINUE
*
*              W := W * V1**H
*
               CALL ZTRMM( 'Right', 'Upper', 'Conjugate transpose',
     $                     'Unit', LASTC, K, ONE, V, LDV, WORK, LDWORK )
               IF( LASTV.GT.K ) THEN
*
*                 W := W + C2**H*V2**H
*
                  CALL ZGEMM( 'Conjugate transpose',
     $                 'Conjugate transpose', LASTC, K, LASTV-K,
     $                 ONE, C( K+1, 1 ), LDC, V( 1, K+1 ), LDV,
     $                 ONE, WORK, LDWORK )
               END IF
*
*              W := W * T**H  or  W * T
*
               CALL ZTRMM( 'Right', 'Upper', TRANST, 'Non-unit',
     $              LASTC, K, ONE, T, LDT, WORK, LDWORK )
*
*              C := C - V**H * W**H
*
               IF( LASTV.GT.K ) THEN
*
*                 C2 := C2 - V2**H * W**H
*
                  CALL ZGEMM( 'Conjugate transpose',
     $                 'Conjugate transpose', LASTV-K, LASTC, K,
     $                 -ONE, V( 1, K+1 ), LDV, WORK, LDWORK,
     $                 ONE, C( K+1, 1 ), LDC )
               END IF
*
*              W := W * V1
```

```
*
               CALL ZTRMM( 'Right', 'Upper', 'No transpose', 'Unit',
     $                     LASTC, K, ONE, V, LDV, WORK, LDWORK )
*
*              C1 := C1 - W**H
*
               DO 150 J = 1, K
                  DO 140 I = 1, LASTC
                     C( J, I ) = C( J, I ) - DCONJG( WORK( I, J ) )
  140             CONTINUE
  150          CONTINUE
*
            ELSE IF( LSAME( SIDE, 'R' ) ) THEN
*
*              Form  C * H  or  C * H**H  where  C = ( C1  C2 )
*
               LASTV = MAX( K, ILAZLC( K, N, V, LDV ) )
               LASTC = ILAZLR( M, LASTV, C, LDC )
*
*              W := C * V**H  =  (C1*V1**H + C2*V2**H)  (stored in WORK)
*
*              W := C1
*
               DO 160 J = 1, K
                  CALL ZCOPY( LASTC, C( 1, J ), 1, WORK( 1, J ), 1 )
  160          CONTINUE
*
*              W := W * V1**H
*
               CALL ZTRMM( 'Right', 'Upper', 'Conjugate transpose',
     $                     'Unit', LASTC, K, ONE, V, LDV, WORK, LDWORK )
               IF( LASTV.GT.K ) THEN
*
*                 W := W + C2 * V2**H
*
                  CALL ZGEMM( 'No transpose', 'Conjugate transpose',
     $                        LASTC, K, LASTV-K, ONE, C( 1, K+1 ), LDC,
     $                        V( 1, K+1 ), LDV, ONE, WORK, LDWORK )
               END IF
*
*              W := W * T  or  W * T**H
*
               CALL ZTRMM( 'Right', 'Upper', TRANS, 'Non-unit',
     $                     LASTC, K, ONE, T, LDT, WORK, LDWORK )
*
*              C := C - W * V
*
               IF( LASTV.GT.K ) THEN
*
*                 C2 := C2 - W * V2
```

```
*
                  CALL ZGEMM( 'No transpose', 'No transpose',
     $                 LASTC, LASTV-K, K,
     $                 -ONE, WORK, LDWORK, V( 1, K+1 ), LDV,
     $                 ONE, C( 1, K+1 ), LDC )
               END IF
*
*              W := W * V1
*
               CALL ZTRMM( 'Right', 'Upper', 'No transpose', 'Unit',
     $              LASTC, K, ONE, V, LDV, WORK, LDWORK )
*
*              C1 := C1 - W
*
               DO 180 J = 1, K
                  DO 170 I = 1, LASTC
                     C( I, J ) = C( I, J ) - WORK( I, J )
  170             CONTINUE
  180          CONTINUE
*
            END IF
*
         ELSE
*
*           Let  V =  ( V1  V2 )    (V2: last K columns)
*           where  V2  is unit lower triangular.
*
            IF( LSAME( SIDE, 'L' ) ) THEN
*
*              Form  H * C  or  H**H * C  where  C = ( C1 )
*                                                    ( C2 )
*
               LASTV = MAX( K, ILAZLC( K, M, V, LDV ) )
               LASTC = ILAZLC( LASTV, N, C, LDC )
*
*              W := C**H * V**H  =  (C1**H * V1**H + C2**H * V2**H) (stored in WORK)
*
*              W := C2**H
*
               DO 190 J = 1, K
                  CALL ZCOPY( LASTC, C( LASTV-K+J, 1 ), LDC,
     $                 WORK( 1, J ), 1 )
                  CALL ZLACGV( LASTC, WORK( 1, J ), 1 )
  190          CONTINUE
*
*              W := W * V2**H
*
               CALL ZTRMM( 'Right', 'Lower', 'Conjugate transpose',
     $              'Unit', LASTC, K, ONE, V( 1, LASTV-K+1 ), LDV,
     $              WORK, LDWORK )
```

```
               IF( LASTV.GT.K ) THEN
*
*                 W := W + C1**H * V1**H
*
                  CALL ZGEMM( 'Conjugate transpose',
     $                 'Conjugate transpose', LASTC, K, LASTV-K,
     $                 ONE, C, LDC, V, LDV, ONE, WORK, LDWORK )
               END IF
*
*              W := W * T**H  or  W * T
*
               CALL ZTRMM( 'Right', 'Lower', TRANST, 'Non-unit',
     $              LASTC, K, ONE, T, LDT, WORK, LDWORK )
*
*              C := C - V**H * W**H
*
               IF( LASTV.GT.K ) THEN
*
*                 C1 := C1 - V1**H * W**H
*
                  CALL ZGEMM( 'Conjugate transpose',
     $                 'Conjugate transpose', LASTV-K, LASTC, K,
     $                 -ONE, V, LDV, WORK, LDWORK, ONE, C, LDC )
               END IF
*
*              W := W * V2
*
               CALL ZTRMM( 'Right', 'Lower', 'No transpose', 'Unit',
     $              LASTC, K, ONE, V( 1, LASTV-K+1 ), LDV,
     $              WORK, LDWORK )
*
*              C2 := C2 - W**H
*
               DO 210 J = 1, K
                  DO 200 I = 1, LASTC
                     C( LASTV-K+J, I ) = C( LASTV-K+J, I ) -
     $                                   DCONJG( WORK( I, J ) )
  200             CONTINUE
  210          CONTINUE
*
            ELSE IF( LSAME( SIDE, 'R' ) ) THEN
*
*              Form  C * H  or  C * H**H  where  C = ( C1  C2 )
*
               LASTV = MAX( K, ILAZLC( K, N, V, LDV ) )
               LASTC = ILAZLR( M, LASTV, C, LDC )
*
*              W := C * V**H  =  (C1*V1**H + C2*V2**H)  (stored in WORK)
*
*              W := C2
```

```
*
              DO 220 J = 1, K
                 CALL ZCOPY( LASTC, C( 1, LASTV-K+J ), 1,
     $                       WORK( 1, J ), 1 )
  220         CONTINUE
*
*             W := W * V2**H
*
              CALL ZTRMM( 'Right', 'Lower', 'Conjugate transpose',
     $                    'Unit', LASTC, K, ONE, V( 1, LASTV-K+1 ), LDV,
     $                    WORK, LDWORK )
              IF( LASTV.GT.K ) THEN
*
*                W := W + C1 * V1**H
*
                 CALL ZGEMM( 'No transpose', 'Conjugate transpose',
     $                       LASTC, K, LASTV-K, ONE, C, LDC, V, LDV, ONE,
     $                       WORK, LDWORK )
              END IF
*
*             W := W * T  or  W * T**H
*
              CALL ZTRMM( 'Right', 'Lower', TRANS, 'Non-unit',
     $                    LASTC, K, ONE, T, LDT, WORK, LDWORK )
*
*             C := C - W * V
*
              IF( LASTV.GT.K ) THEN
*
*                C1 := C1 - W * V1
*
                 CALL ZGEMM( 'No transpose', 'No transpose',
     $                       LASTC, LASTV-K, K, -ONE, WORK, LDWORK, V, LDV,
     $                       ONE, C, LDC )
              END IF
*
*             W := W * V2
*
              CALL ZTRMM( 'Right', 'Lower', 'No transpose', 'Unit',
     $                    LASTC, K, ONE, V( 1, LASTV-K+1 ), LDV,
     $                    WORK, LDWORK )
*
*             C1 := C1 - W
*
              DO 240 J = 1, K
                 DO 230 I = 1, LASTC
                    C( I, LASTV-K+J ) = C( I, LASTV-K+J )
     $                                - WORK( I, J )
  230            CONTINUE
  240         CONTINUE
```

```
*
            END IF
*
         END IF
      END IF
*
      RETURN
*
*     End of ZLARFB
*
      END
```

— LAPACK zlarfb —

```
(let* ((one (coerce (f2cl-lib:cmplx 1.0d0 0.0d0) 'f2cl-lib:complex16)))
 (declare (type (f2cl-lib:complex16) one) (ignorable one))
 (defun zlarfb (side trans direct storev m n k v ldv t$ ldt c ldc work ldwork)
  (declare (type (simple-array character (*)) storev direct trans side)
   (type (f2cl-lib:integer4) ldwork ldc ldt ldv k n m)
   (type (array f2cl-lib:complex16 (*)) work c t$ v))
  (f2cl-lib:with-multi-array-data
      ((v f2cl-lib:complex16 v-%data% v-%offset%)
       (t$ f2cl-lib:complex16 t$-%data% t$-%offset%)
       (c f2cl-lib:complex16 c-%data% c-%offset%)
       (work f2cl-lib:complex16 work-%data% work-%offset%)
       (side character side-%data% side-%offset%)
       (trans character trans-%data% trans-%offset%)
       (direct character direct-%data% direct-%offset%)
       (storev character storev-%data% storev-%offset%))
       (prog
        ((i 0) (j 0) (lastv 0) (lastc 0)
         (transt (make-array '(1) :element-type 'character
                                  :initial-element #\space)))
        (declare (type (f2cl-lib:integer4) lastc lastv j i)
         (type (simple-array character (1)) transt))
        (if (or (<= m 0) (<= n 0)) (go end_label))
        (cond
         ((multiple-value-bind (ret-val var-0 var-1) (lsame trans "N")
           (declare (ignore var-1)) (when var-0 (setf trans var-0)) ret-val)
          (f2cl-lib:f2cl-set-string transt "C" (string 1)))
         (t (f2cl-lib:f2cl-set-string transt "N" (string 1))))
        (cond
         ((multiple-value-bind (ret-val var-0 var-1) (lsame storev "C")
           (declare (ignore var-1)) (when var-0 (setf storev var-0)) ret-val)
          (cond
           ((multiple-value-bind (ret-val var-0 var-1) (lsame direct "F")
```

```
 (declare (ignore var-1)) (when var-0 (setf direct var-0)) ret-val)
(cond
 ((multiple-value-bind (ret-val var-0 var-1) (lsame side "L")
   (declare (ignore var-1)) (when var-0 (setf side var-0)) ret-val)
  (setf lastv
   (max (the f2cl-lib:integer4 k)
    (the f2cl-lib:integer4 (ilazlr m k v ldv))))
  (setf lastc (ilazlc lastv n c ldc))
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
         ((> j k) nil)
          (tagbody
                  (multiple-value-bind (var-0 var-1 var-2
                                        var-3 var-4)
                   (zcopy lastc
                    (f2cl-lib:array-slice c-%data%
                     f2cl-lib:complex16 (j 1)
                     ((1 ldc) (1 *)) c-%offset%)
                    ldc
                    (f2cl-lib:array-slice work-%data%
                     f2cl-lib:complex16 (1 j)
                     ((1 ldwork) (1 *)) work-%offset%)
                    1)
                   (declare (ignore var-1 var-3 var-4))
                   (when var-0 (setf lastc var-0))
                   (when var-2 (setf ldc var-2)))
                  (zlacgv lastc
                   (f2cl-lib:array-slice work-%data%
                    f2cl-lib:complex16 (1 j)
                    ((1 ldwork) (1 *)) work-%offset%)
                   1)
                  label10))
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8 var-9 var-10)
   (ztrmm "Right" "Lower" "No transpose" "Unit"
    lastc k one v ldv work
    ldwork)
   (declare (ignore var-0 var-1 var-2 var-3 var-7 var-9))
   (when var-4 (setf lastc var-4)) (when var-5 (setf k var-5))
   (when var-6 (setf one var-6)) (when var-8 (setf ldv var-8))
   (when var-10 (setf ldwork var-10)))
  (cond
   ((> lastv k)
    (multiple-value-bind
     (var-0 var-1 var-2 var-3 var-4 var-5 var-6
      var-7 var-8 var-9 var-10
      var-11 var-12)
     (zgemm "Conjugate transpose" "No transpose" lastc k
      (f2cl-lib:int-sub lastv k) one
      (f2cl-lib:array-slice c-%data% f2cl-lib:complex16 ((+ k 1) 1)
```

```
     ((1 ldc) (1 *)) c-%offset%)
    ldc
    (f2cl-lib:array-slice v-%data% f2cl-lib:complex16 ((+ k 1) 1)
     ((1 ldv) (1 *)) v-%offset%)
    ldv one work ldwork)
   (declare (ignore var-0 var-1 var-4 var-6 var-8 var-11))
   (when var-2 (setf lastc var-2)) (when var-3 (setf k var-3))
   (when var-5 (setf one var-5)) (when var-7 (setf ldc var-7))
   (when var-9 (setf ldv var-9)) (when var-10 (setf one var-10))
   (when var-12 (setf ldwork var-12)))))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
 (ztrmm "Right" "Upper" transt "Non-unit" lastc k one t$ ldt work
  ldwork)
 (declare (ignore var-0 var-1 var-3 var-7 var-9))
 (when var-2 (setf transt var-2)) (when var-4 (setf lastc var-4))
 (when var-5 (setf k var-5)) (when var-6 (setf one var-6))
 (when var-8 (setf ldt var-8))
 (when var-10 (setf ldwork var-10)))
(cond
 ((> m k)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8 var-9 var-10
    var-11 var-12)
   (zgemm "No transpose" "Conjugate transpose"
    (f2cl-lib:int-sub lastv k) lastc k (- one)
    (f2cl-lib:array-slice v-%data% f2cl-lib:complex16 ((+ k 1) 1)
     ((1 ldv) (1 *)) v-%offset%)
    ldv work ldwork one
    (f2cl-lib:array-slice c-%data% f2cl-lib:complex16 ((+ k 1) 1)
     ((1 ldc) (1 *)) c-%offset%)
    ldc)
   (declare (ignore var-0 var-1 var-2 var-5 var-6 var-8 var-11))
   (when var-3 (setf lastc var-3)) (when var-4 (setf k var-4))
   (when var-7 (setf ldv var-7)) (when var-9 (setf ldwork var-9))
   (when var-10 (setf one var-10))
   (when var-12 (setf ldc var-12)))))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
 (ztrmm "Right" "Lower" "Conjugate transpose" "Unit"
  lastc k one v ldv
  work ldwork)
 (declare (ignore var-0 var-1 var-2 var-3 var-7 var-9))
 (when var-4 (setf lastc var-4)) (when var-5 (setf k var-5))
 (when var-6 (setf one var-6)) (when var-8 (setf ldv var-8))
 (when var-10 (setf ldwork var-10)))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
```

```
          ((> j k) nil)
           (tagbody
                  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
           ((> i lastc) nil)
            (tagbody
                    (setf (f2cl-lib:fref c-%data% (j i)
                            ((1 ldc) (1 *)) c-%offset%)
                     (coerce
                      (- (f2cl-lib:fref c-%data% (j i)
                       ((1 ldc) (1 *)) c-%offset%)
                       (f2cl-lib:dconjg
                        (f2cl-lib:fref work-%data% (i j)
                         ((1 ldwork) (1 *))
                         work-%offset%)))
                       'f2cl-lib:complex16))
                     label20))
                   label30)))
((multiple-value-bind (ret-val var-0 var-1) (lsame side "R")
  (declare (ignore var-1)) (when var-0 (setf side var-0)) ret-val)
 (setf lastv
  (max (the f2cl-lib:integer4 k)
   (the f2cl-lib:integer4 (ilazlr n k v ldv))))
 (setf lastc (ilazlr m lastv c ldc))
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j k) nil)
         (tagbody
                 (multiple-value-bind (var-0 var-1 var-2
                                       var-3 var-4)
                  (zcopy lastc
                   (f2cl-lib:array-slice c-%data%
                    f2cl-lib:complex16 (1 j)
                    ((1 ldc) (1 *)) c-%offset%)
                   1
                   (f2cl-lib:array-slice work-%data%
                    f2cl-lib:complex16 (1 j)
                    ((1 ldwork) (1 *)) work-%offset%)
                   1)
                  (declare (ignore var-1 var-2 var-3 var-4))
                  (when var-0 (setf lastc var-0)))
                 label40))
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (ztrmm "Right" "Lower" "No transpose" "Unit"
   lastc k one v ldv work
   ldwork)
  (declare (ignore var-0 var-1 var-2 var-3 var-7 var-9))
  (when var-4 (setf lastc var-4)) (when var-5 (setf k var-5))
  (when var-6 (setf one var-6)) (when var-8 (setf ldv var-8))
  (when var-10 (setf ldwork var-10)))
```

```
(cond
 ((> lastv k)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8 var-9 var-10
    var-11 var-12)
   (zgemm "No transpose" "No transpose" lastc k
    (f2cl-lib:int-sub lastv k) one
    (f2cl-lib:array-slice c-%data% f2cl-lib:complex16
     (1 (f2cl-lib:int-add k 1)) ((1 ldc) (1 *)) c-%offset%)
    ldc
    (f2cl-lib:array-slice v-%data% f2cl-lib:complex16 ((+ k 1) 1)
     ((1 ldv) (1 *)) v-%offset%)
    ldv one work ldwork)
   (declare (ignore var-0 var-1 var-4 var-6 var-8 var-11))
   (when var-2 (setf lastc var-2)) (when var-3 (setf k var-3))
   (when var-5 (setf one var-5)) (when var-7 (setf ldc var-7))
   (when var-9 (setf ldv var-9)) (when var-10 (setf one var-10))
   (when var-12 (setf ldwork var-12)))))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
 (ztrmm "Right" "Upper" trans "Non-unit"
   lastc k one t$ ldt work ldwork)
 (declare (ignore var-0 var-1 var-3 var-7 var-9))
 (when var-2 (setf trans var-2)) (when var-4 (setf lastc var-4))
 (when var-5 (setf k var-5)) (when var-6 (setf one var-6))
 (when var-8 (setf ldt var-8))
 (when var-10 (setf ldwork var-10)))
(cond
 ((> lastv k)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8 var-9 var-10
    var-11 var-12)
   (zgemm "No transpose" "Conjugate transpose" lastc
    (f2cl-lib:int-sub lastv k) k (- one) work ldwork
    (f2cl-lib:array-slice v-%data% f2cl-lib:complex16 ((+ k 1) 1)
     ((1 ldv) (1 *)) v-%offset%)
    ldv one
    (f2cl-lib:array-slice c-%data% f2cl-lib:complex16
     (1 (f2cl-lib:int-add k 1)) ((1 ldc) (1 *)) c-%offset%)
    ldc)
   (declare (ignore var-0 var-1 var-3 var-5 var-6 var-8 var-11))
   (when var-2 (setf lastc var-2)) (when var-4 (setf k var-4))
   (when var-7 (setf ldwork var-7)) (when var-9 (setf ldv var-9))
   (when var-10 (setf one var-10))
   (when var-12 (setf ldc var-12)))))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
```

```
       var-8 var-9 var-10)
      (ztrmm "Right" "Lower" "Conjugate transpose" "Unit"
       lastc k one v ldv
       work ldwork)
      (declare (ignore var-0 var-1 var-2 var-3 var-7 var-9))
      (when var-4 (setf lastc var-4)) (when var-5 (setf k var-5))
      (when var-6 (setf one var-6)) (when var-8 (setf ldv var-8))
      (when var-10 (setf ldwork var-10)))
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
            ((> j k) nil)
             (tagbody
                     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
             ((> i lastc) nil)
              (tagbody
                       (setf (f2cl-lib:fref c-%data% (i j)
                          ((1 ldc) (1 *)) c-%offset%)
                        (- (f2cl-lib:fref c-%data% (i j)
                          ((1 ldc) (1 *)) c-%offset%)
                         (f2cl-lib:fref work-%data% (i j)
                          ((1 ldwork) (1 *)) work-%offset%)))
                       label50))
                     label60)))))
(t
 (cond
  ((multiple-value-bind (ret-val var-0 var-1) (lsame side "L")
    (declare (ignore var-1)) (when var-0 (setf side var-0)) ret-val)
   (setf lastv
    (max (the f2cl-lib:integer4 k)
     (the f2cl-lib:integer4 (ilazlr m k v ldv))))
   (setf lastc (ilazlc lastv n c ldc))
   (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
          ((> j k) nil)
           (tagbody
                   (multiple-value-bind (var-0 var-1 var-2
                                         var-3 var-4)
                    (zcopy lastc
                     (f2cl-lib:array-slice c-%data%
                      f2cl-lib:complex16
                      ((+ lastv (f2cl-lib:int-sub k) j) 1)
                      ((1 ldc) (1 *)) c-%offset%)
                     ldc
                     (f2cl-lib:array-slice work-%data%
                      f2cl-lib:complex16 (1 j)
                      ((1 ldwork) (1 *)) work-%offset%)
                     1)
                    (declare (ignore var-1 var-3 var-4))
                    (when var-0 (setf lastc var-0))
                    (when var-2 (setf ldc var-2)))
                   (zlacgv lastc
                    (f2cl-lib:array-slice work-%data%
```

```
                  f2cl-lib:complex16 (1 j)
                  ((1 ldwork) (1 *)) work-%offset%)
                 1)
                label70))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
 (ztrmm "Right" "Upper" "No transpose" "Unit" lastc k one
  (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
   ((+ lastv (f2cl-lib:int-sub k) 1) 1)
   ((1 ldv) (1 *)) v-%offset%)
  ldv work ldwork)
 (declare (ignore var-0 var-1 var-2 var-3 var-7 var-9))
 (when var-4 (setf lastc var-4)) (when var-5 (setf k var-5))
 (when var-6 (setf one var-6)) (when var-8 (setf ldv var-8))
 (when var-10 (setf ldwork var-10)))
(cond
 ((> lastv k)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8 var-9 var-10
    var-11 var-12)
   (zgemm "Conjugate transpose" "No transpose" lastc k
    (f2cl-lib:int-sub lastv k) one c ldc v ldv one work ldwork)
   (declare (ignore var-0 var-1 var-4 var-6 var-8 var-11))
   (when var-2 (setf lastc var-2)) (when var-3 (setf k var-3))
   (when var-5 (setf one var-5)) (when var-7 (setf ldc var-7))
   (when var-9 (setf ldv var-9)) (when var-10 (setf one var-10))
   (when var-12 (setf ldwork var-12)))))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
 (ztrmm "Right" "Lower" transt "Non-unit" lastc k one t$ ldt work
  ldwork)
 (declare (ignore var-0 var-1 var-3 var-7 var-9))
 (when var-2 (setf transt var-2)) (when var-4 (setf lastc var-4))
 (when var-5 (setf k var-5)) (when var-6 (setf one var-6))
 (when var-8 (setf ldt var-8))
 (when var-10 (setf ldwork var-10)))
(cond
 ((> lastv k)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8 var-9 var-10
    var-11 var-12)
   (zgemm "No transpose" "Conjugate transpose"
    (f2cl-lib:int-sub lastv k) lastc k
    (- one) v ldv work ldwork one c
    ldc)
   (declare (ignore var-0 var-1 var-2 var-5 var-6 var-8 var-11))
```

```
    (when var-3 (setf lastc var-3)) (when var-4 (setf k var-4))
    (when var-7 (setf ldv var-7)) (when var-9 (setf ldwork var-9))
    (when var-10 (setf one var-10))
    (when var-12 (setf ldc var-12)))))
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (ztrmm "Right" "Upper" "Conjugate transpose" "Unit" lastc k one
   (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
    ((+ lastv (f2cl-lib:int-sub k) 1) 1)
      ((1 ldv) (1 *)) v-%offset%)
   ldv work ldwork)
  (declare (ignore var-0 var-1 var-2 var-3 var-7 var-9))
  (when var-4 (setf lastc var-4)) (when var-5 (setf k var-5))
  (when var-6 (setf one var-6)) (when var-8 (setf ldv var-8))
  (when var-10 (setf ldwork var-10)))
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
       ((> j k) nil)
        (tagbody
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i lastc) nil)
         (tagbody
                  (setf
                   (f2cl-lib:fref c-%data%
                    ((f2cl-lib:int-add
                      (f2cl-lib:int-sub lastv k) j) i)
                     ((1 ldc) (1 *))
                    c-%offset%)
                   (coerce
                    (-
                     (f2cl-lib:fref c-%data%
                      ((f2cl-lib:int-add
                        (f2cl-lib:int-sub lastv k) j) i)
                      ((1 ldc) (1 *)) c-%offset%)
                     (f2cl-lib:dconjg
                      (f2cl-lib:fref work-%data% (i j)
                       ((1 ldwork) (1 *))
                       work-%offset%)))
                    'f2cl-lib:complex16))
                  label80))
                label90)))
((multiple-value-bind (ret-val var-0 var-1) (lsame side "R")
  (declare (ignore var-1)) (when var-0 (setf side var-0)) ret-val)
 (setf lastv
  (max (the f2cl-lib:integer4 k)
   (the f2cl-lib:integer4 (ilazlr n k v ldv))))
 (setf lastc (ilazlr m lastv c ldc))
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
       ((> j k) nil)
        (tagbody
```

```
                    (multiple-value-bind (var-0 var-1 var-2
                                          var-3 var-4)
                     (zcopy lastc
                      (f2cl-lib:array-slice c-%data%
                       f2cl-lib:complex16
                       (1 (f2cl-lib:int-add
                           (f2cl-lib:int-sub lastv k) j))
                        ((1 ldc) (1 *))
                       c-%offset%)
                      1
                      (f2cl-lib:array-slice work-%data%
                       f2cl-lib:complex16 (1 j)
                       ((1 ldwork) (1 *)) work-%offset%)
                      1)
                     (declare (ignore var-1 var-2 var-3 var-4))
                     (when var-0 (setf lastc var-0)))
                    label100))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
 (ztrmm "Right" "Upper" "No transpose" "Unit" lastc k one
  (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
   ((+ lastv (f2cl-lib:int-sub k) 1) 1)
   ((1 ldv) (1 *)) v-%offset%)
  ldv work ldwork)
 (declare (ignore var-0 var-1 var-2 var-3 var-7 var-9))
 (when var-4 (setf lastc var-4)) (when var-5 (setf k var-5))
 (when var-6 (setf one var-6)) (when var-8 (setf ldv var-8))
 (when var-10 (setf ldwork var-10)))
(cond
 ((> lastv k)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8 var-9 var-10
    var-11 var-12)
   (zgemm "No transpose" "No transpose" lastc k
    (f2cl-lib:int-sub lastv k) one c ldc v ldv one work ldwork)
   (declare (ignore var-0 var-1 var-4 var-6 var-8 var-11))
   (when var-2 (setf lastc var-2)) (when var-3 (setf k var-3))
   (when var-5 (setf one var-5)) (when var-7 (setf ldc var-7))
   (when var-9 (setf ldv var-9)) (when var-10 (setf one var-10))
   (when var-12 (setf ldwork var-12)))))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
 (ztrmm "Right" "Lower" trans "Non-unit"
    lastc k one t$ ldt work ldwork)
 (declare (ignore var-0 var-1 var-3 var-7 var-9))
 (when var-2 (setf trans var-2)) (when var-4 (setf lastc var-4))
 (when var-5 (setf k var-5)) (when var-6 (setf one var-6))
```

```
 (when var-8 (setf ldt var-8))
 (when var-10 (setf ldwork var-10)))
(cond
 ((> lastv k)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
    var-9 var-10
    var-11 var-12)
   (zgemm "No transpose" "Conjugate transpose" lastc
    (f2cl-lib:int-sub lastv k) k (- one) work
      ldwork v ldv one c ldc)
   (declare (ignore var-0 var-1 var-3 var-5 var-6 var-8 var-11))
   (when var-2 (setf lastc var-2)) (when var-4 (setf k var-4))
   (when var-7 (setf ldwork var-7)) (when var-9 (setf ldv var-9))
   (when var-10 (setf one var-10))
   (when var-12 (setf ldc var-12)))))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
 (ztrmm "Right" "Upper" "Conjugate transpose" "Unit" lastc k one
  (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
   ((+ lastv (f2cl-lib:int-sub k) 1) 1)
   ((1 ldv) (1 *)) v-%offset%)
  ldv work ldwork)
 (declare (ignore var-0 var-1 var-2 var-3 var-7 var-9))
 (when var-4 (setf lastc var-4)) (when var-5 (setf k var-5))
 (when var-6 (setf one var-6)) (when var-8 (setf ldv var-8))
 (when var-10 (setf ldwork var-10)))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
       ((> j k) nil)
        (tagbody
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i lastc) nil)
         (tagbody
                  (setf
                   (f2cl-lib:fref c-%data%
                    (i (f2cl-lib:int-add
                         (f2cl-lib:int-sub lastv k) j))
                         ((1 ldc) (1 *))
                    c-%offset%)
                   (-
                    (f2cl-lib:fref c-%data%
                     (i (f2cl-lib:int-add
                         (f2cl-lib:int-sub lastv k) j))
                         ((1 ldc) (1 *))
                     c-%offset%)
                    (f2cl-lib:fref work-%data% (i j)
                      ((1 ldwork) (1 *)) work-%offset%)))
                  label110))
                label120)))))))
```

```
((multiple-value-bind (ret-val var-0 var-1) (lsame storev "R")
  (declare (ignore var-1)) (when var-0 (setf storev var-0)) ret-val)
 (cond
  ((multiple-value-bind (ret-val var-0 var-1) (lsame direct "F")
    (declare (ignore var-1)) (when var-0 (setf direct var-0)) ret-val)
   (cond
    ((multiple-value-bind (ret-val var-0 var-1) (lsame side "L")
      (declare (ignore var-1)) (when var-0 (setf side var-0)) ret-val)
     (setf lastv
      (max (the f2cl-lib:integer4 k)
       (the f2cl-lib:integer4 (ilazlc k m v ldv))))
     (setf lastc (ilazlc lastv n c ldc))
     (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
            ((> j k) nil)
             (tagbody
                     (multiple-value-bind (var-0 var-1 var-2
                                           var-3 var-4)
                      (zcopy lastc
                       (f2cl-lib:array-slice c-%data%
                        f2cl-lib:complex16 (j 1)
                        ((1 ldc) (1 *)) c-%offset%)
                       ldc
                       (f2cl-lib:array-slice work-%data%
                        f2cl-lib:complex16 (1 j)
                        ((1 ldwork) (1 *)) work-%offset%)
                       1)
                      (declare (ignore var-1 var-3 var-4))
                      (when var-0 (setf lastc var-0))
                      (when var-2 (setf ldc var-2)))
                     (zlacgv lastc
                      (f2cl-lib:array-slice work-%data%
                       f2cl-lib:complex16 (1 j)
                       ((1 ldwork) (1 *)) work-%offset%)
                      1)
                     label130))
     (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
       var-8 var-9 var-10)
      (ztrmm "Right" "Upper" "Conjugate transpose" "Unit"
       lastc k one v ldv
       work ldwork)
      (declare (ignore var-0 var-1 var-2 var-3 var-7 var-9))
      (when var-4 (setf lastc var-4)) (when var-5 (setf k var-5))
      (when var-6 (setf one var-6)) (when var-8 (setf ldv var-8))
      (when var-10 (setf ldwork var-10)))
     (cond
      ((> lastv k)
       (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
         var-8 var-9 var-10
```

```
     var-11 var-12)
    (zgemm "Conjugate transpose" "Conjugate transpose" lastc k
     (f2cl-lib:int-sub lastv k) one
     (f2cl-lib:array-slice c-%data% f2cl-lib:complex16 ((+ k 1) 1)
      ((1 ldc) (1 *)) c-%offset%)
     ldc
     (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
      (1 (f2cl-lib:int-add k 1)) ((1 ldv) (1 *)) v-%offset%)
     ldv one work ldwork)
    (declare (ignore var-0 var-1 var-4 var-6 var-8 var-11))
    (when var-2 (setf lastc var-2)) (when var-3 (setf k var-3))
    (when var-5 (setf one var-5)) (when var-7 (setf ldc var-7))
    (when var-9 (setf ldv var-9)) (when var-10 (setf one var-10))
    (when var-12 (setf ldwork var-12)))))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
 (ztrmm "Right" "Upper" transt "Non-unit" lastc k one t$ ldt work
  ldwork)
 (declare (ignore var-0 var-1 var-3 var-7 var-9))
 (when var-2 (setf transt var-2)) (when var-4 (setf lastc var-4))
 (when var-5 (setf k var-5)) (when var-6 (setf one var-6))
 (when var-8 (setf ldt var-8))
 (when var-10 (setf ldwork var-10)))
(cond
 ((> lastv k)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8 var-9 var-10
    var-11 var-12)
   (zgemm "Conjugate transpose" "Conjugate transpose"
    (f2cl-lib:int-sub lastv k) lastc k (- one)
    (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
     (1 (f2cl-lib:int-add k 1)) ((1 ldv) (1 *)) v-%offset%)
    ldv work ldwork one
    (f2cl-lib:array-slice c-%data% f2cl-lib:complex16 ((+ k 1) 1)
     ((1 ldc) (1 *)) c-%offset%)
    ldc)
   (declare (ignore var-0 var-1 var-2 var-5 var-6 var-8 var-11))
   (when var-3 (setf lastc var-3)) (when var-4 (setf k var-4))
   (when var-7 (setf ldv var-7)) (when var-9 (setf ldwork var-9))
   (when var-10 (setf one var-10))
   (when var-12 (setf ldc var-12)))))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
 (ztrmm "Right" "Upper" "No transpose" "Unit"
  lastc k one v ldv work
  ldwork)
 (declare (ignore var-0 var-1 var-2 var-3 var-7 var-9))
```

```
 (when var-4 (setf lastc var-4)) (when var-5 (setf k var-5))
 (when var-6 (setf one var-6)) (when var-8 (setf ldv var-8))
 (when var-10 (setf ldwork var-10)))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
       ((> j k) nil)
        (tagbody
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i lastc) nil)
         (tagbody
                  (setf (f2cl-lib:fref c-%data% (j i)
                         ((1 ldc) (1 *)) c-%offset%)
                   (coerce
                    (- (f2cl-lib:fref c-%data% (j i)
                         ((1 ldc) (1 *)) c-%offset%)
                      (f2cl-lib:dconjg
                       (f2cl-lib:fref work-%data% (i j)
                        ((1 ldwork) (1 *))
                        work-%offset%)))
                     'f2cl-lib:complex16))
                  label140))
                label150)))
((multiple-value-bind (ret-val var-0 var-1) (lsame side "R")
  (declare (ignore var-1)) (when var-0 (setf side var-0)) ret-val)
 (setf lastv
  (max (the f2cl-lib:integer4 k)
   (the f2cl-lib:integer4 (ilazlc k n v ldv))))
 (setf lastc (ilazlr m lastv c ldc))
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j k) nil)
         (tagbody
                 (multiple-value-bind (var-0 var-1 var-2
                                       var-3 var-4)
                  (zcopy lastc
                   (f2cl-lib:array-slice c-%data%
                    f2cl-lib:complex16 (1 j)
                    ((1 ldc) (1 *)) c-%offset%)
                   1
                   (f2cl-lib:array-slice work-%data%
                    f2cl-lib:complex16 (1 j)
                    ((1 ldwork) (1 *)) work-%offset%)
                   1)
                  (declare (ignore var-1 var-2 var-3 var-4))
                  (when var-0 (setf lastc var-0)))
                 label160))
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10)
  (ztrmm "Right" "Upper" "Conjugate transpose" "Unit"
   lastc k one v ldv
   work ldwork)
```

```
 (declare (ignore var-0 var-1 var-2 var-3 var-7 var-9))
 (when var-4 (setf lastc var-4)) (when var-5 (setf k var-5))
 (when var-6 (setf one var-6)) (when var-8 (setf ldv var-8))
 (when var-10 (setf ldwork var-10)))
(cond
 ((> lastv k)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8 var-9 var-10
    var-11 var-12)
   (zgemm "No transpose" "Conjugate transpose" lastc k
    (f2cl-lib:int-sub lastv k) one
    (f2cl-lib:array-slice c-%data% f2cl-lib:complex16
     (1 (f2cl-lib:int-add k 1)) ((1 ldc) (1 *)) c-%offset%)
    ldc
    (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
     (1 (f2cl-lib:int-add k 1)) ((1 ldv) (1 *)) v-%offset%)
    ldv one work ldwork)
   (declare (ignore var-0 var-1 var-4 var-6 var-8 var-11))
   (when var-2 (setf lastc var-2)) (when var-3 (setf k var-3))
   (when var-5 (setf one var-5)) (when var-7 (setf ldc var-7))
   (when var-9 (setf ldv var-9)) (when var-10 (setf one var-10))
   (when var-12 (setf ldwork var-12)))))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
 (ztrmm "Right" "Upper" trans "Non-unit"
    lastc k one t$ ldt work ldwork)
 (declare (ignore var-0 var-1 var-3 var-7 var-9))
 (when var-2 (setf trans var-2)) (when var-4 (setf lastc var-4))
 (when var-5 (setf k var-5)) (when var-6 (setf one var-6))
 (when var-8 (setf ldt var-8))
 (when var-10 (setf ldwork var-10)))
(cond
 ((> lastv k)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8 var-9 var-10
    var-11 var-12)
   (zgemm "No transpose" "No transpose"
    lastc (f2cl-lib:int-sub lastv k)
    k (- one) work ldwork
    (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
     (1 (f2cl-lib:int-add k 1)) ((1 ldv) (1 *)) v-%offset%)
    ldv one
    (f2cl-lib:array-slice c-%data% f2cl-lib:complex16
     (1 (f2cl-lib:int-add k 1)) ((1 ldc) (1 *)) c-%offset%)
    ldc)
   (declare (ignore var-0 var-1 var-3 var-5 var-6 var-8 var-11))
   (when var-2 (setf lastc var-2)) (when var-4 (setf k var-4))
```

```
          (when var-7 (setf ldwork var-7)) (when var-9 (setf ldv var-9))
          (when var-10 (setf one var-10))
          (when var-12 (setf ldc var-12)))))
        (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
         var-8 var-9 var-10)
         (ztrmm "Right" "Upper" "No transpose" "Unit"
          lastc k one v ldv work
          ldwork)
         (declare (ignore var-0 var-1 var-2 var-3 var-7 var-9))
         (when var-4 (setf lastc var-4)) (when var-5 (setf k var-5))
         (when var-6 (setf one var-6)) (when var-8 (setf ldv var-8))
         (when var-10 (setf ldwork var-10)))
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j k) nil)
                (tagbody
                        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                ((> i lastc) nil)
                 (tagbody
                          (setf (f2cl-lib:fref c-%data% (i j)
                             ((1 ldc) (1 *)) c-%offset%)
                           (- (f2cl-lib:fref c-%data% (i j)
                             ((1 ldc) (1 *)) c-%offset%)
                            (f2cl-lib:fref work-%data% (i j)
                             ((1 ldwork) (1 *)) work-%offset%)))
                          label170))
                        label180)))))
      (t
       (cond
        ((multiple-value-bind (ret-val var-0 var-1) (lsame side "L")
          (declare (ignore var-1)) (when var-0 (setf side var-0)) ret-val)
         (setf lastv
          (max (the f2cl-lib:integer4 k)
           (the f2cl-lib:integer4 (ilazlc k m v ldv))))
         (setf lastc (ilazlc lastv n c ldc))
         (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                ((> j k) nil)
                 (tagbody
                         (multiple-value-bind (var-0 var-1 var-2
                                               var-3 var-4)
                          (zcopy lastc
                           (f2cl-lib:array-slice c-%data%
                             f2cl-lib:complex16
                            ((+ lastv (f2cl-lib:int-sub k) j) 1)
                            ((1 ldc) (1 *)) c-%offset%)
                           ldc
                           (f2cl-lib:array-slice work-%data%
                            f2cl-lib:complex16 (1 j)
                            ((1 ldwork) (1 *)) work-%offset%)
                           1)
```

```
                 (declare (ignore var-1 var-3 var-4))
                 (when var-0 (setf lastc var-0))
                 (when var-2 (setf ldc var-2)))
                (zlacgv lastc
                 (f2cl-lib:array-slice work-%data%
                  f2cl-lib:complex16 (1 j)
                  ((1 ldwork) (1 *)) work-%offset%)
                 1)
                label190))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
 (ztrmm "Right" "Lower" "Conjugate transpose" "Unit" lastc k one
  (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
   (1 (f2cl-lib:int-add (f2cl-lib:int-sub lastv k) 1))
      ((1 ldv) (1 *))
   v-%offset%)
  ldv work ldwork)
 (declare (ignore var-0 var-1 var-2 var-3 var-7 var-9))
 (when var-4 (setf lastc var-4)) (when var-5 (setf k var-5))
 (when var-6 (setf one var-6)) (when var-8 (setf ldv var-8))
 (when var-10 (setf ldwork var-10)))
(cond
 ((> lastv k)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8 var-9 var-10
    var-11 var-12)
   (zgemm "Conjugate transpose" "Conjugate transpose" lastc k
    (f2cl-lib:int-sub lastv k) one c ldc v ldv one work ldwork)
   (declare (ignore var-0 var-1 var-4 var-6 var-8 var-11))
   (when var-2 (setf lastc var-2)) (when var-3 (setf k var-3))
   (when var-5 (setf one var-5)) (when var-7 (setf ldc var-7))
   (when var-9 (setf ldv var-9)) (when var-10 (setf one var-10))
   (when var-12 (setf ldwork var-12)))))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
  var-9 var-10)
 (ztrmm "Right" "Lower" transt "Non-unit" lastc k one t$ ldt work
  ldwork)
 (declare (ignore var-0 var-1 var-3 var-7 var-9))
 (when var-2 (setf transt var-2)) (when var-4 (setf lastc var-4))
 (when var-5 (setf k var-5)) (when var-6 (setf one var-6))
 (when var-8 (setf ldt var-8))
 (when var-10 (setf ldwork var-10)))
(cond
 ((> lastv k)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
    var-9 var-10
```

```
     var-11 var-12)
    (zgemm "Conjugate transpose" "Conjugate transpose"
     (f2cl-lib:int-sub lastv k) lastc k (- one)
      v ldv work ldwork one c
     ldc)
    (declare (ignore var-0 var-1 var-2 var-5 var-6 var-8 var-11))
    (when var-3 (setf lastc var-3)) (when var-4 (setf k var-4))
    (when var-7 (setf ldv var-7)) (when var-9 (setf ldwork var-9))
    (when var-10 (setf one var-10))
    (when var-12 (setf ldc var-12)))))
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8
   var-9 var-10)
  (ztrmm "Right" "Lower" "No transpose" "Unit" lastc k one
   (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
    (1 (f2cl-lib:int-add (f2cl-lib:int-sub lastv k) 1))
       ((1 ldv) (1 *))
    v-%offset%)
   ldv work ldwork)
  (declare (ignore var-0 var-1 var-2 var-3 var-7 var-9))
  (when var-4 (setf lastc var-4)) (when var-5 (setf k var-5))
  (when var-6 (setf one var-6)) (when var-8 (setf ldv var-8))
  (when var-10 (setf ldwork var-10)))
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j k) nil)
         (tagbody
                 (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
         ((> i lastc) nil)
          (tagbody
                   (setf
                    (f2cl-lib:fref c-%data%
                     ((f2cl-lib:int-add
                       (f2cl-lib:int-sub lastv k) j) i)
                       ((1 ldc) (1 *))
                     c-%offset%)
                    (coerce
                     (-
                      (f2cl-lib:fref c-%data%
                       ((f2cl-lib:int-add
                         (f2cl-lib:int-sub lastv k) j) i)
                       ((1 ldc) (1 *)) c-%offset%)
                      (f2cl-lib:dconjg
                       (f2cl-lib:fref work-%data% (i j)
                        ((1 ldwork) (1 *))
                        work-%offset%)))
                     'f2cl-lib:complex16))
                   label200))
                  label210)))
((multiple-value-bind (ret-val var-0 var-1) (lsame side "R")
  (declare (ignore var-1)) (when var-0 (setf side var-0)) ret-val)
```

```
(setf lastv
 (max (the f2cl-lib:integer4 k)
  (the f2cl-lib:integer4 (ilazlc k n v ldv))))
(setf lastc (ilazlr m lastv c ldc))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
       ((> j k) nil)
        (tagbody
                (multiple-value-bind (var-0 var-1 var-2
                                      var-3 var-4)
                 (zcopy lastc
                  (f2cl-lib:array-slice c-%data%
                   f2cl-lib:complex16
                   (1 (f2cl-lib:int-add
                       (f2cl-lib:int-sub lastv k) j))
                    ((1 ldc) (1 *))
                   c-%offset%)
                  1
                  (f2cl-lib:array-slice work-%data%
                   f2cl-lib:complex16 (1 j)
                   ((1 ldwork) (1 *)) work-%offset%)
                  1)
                 (declare (ignore var-1 var-2 var-3 var-4))
                 (when var-0 (setf lastc var-0)))
                label220))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
 (ztrmm "Right" "Lower" "Conjugate transpose" "Unit" lastc k one
  (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
   (1 (f2cl-lib:int-add (f2cl-lib:int-sub lastv k) 1))
        ((1 ldv) (1 *))
   v-%offset%)
  ldv work ldwork)
 (declare (ignore var-0 var-1 var-2 var-3 var-7 var-9))
 (when var-4 (setf lastc var-4)) (when var-5 (setf k var-5))
 (when var-6 (setf one var-6)) (when var-8 (setf ldv var-8))
 (when var-10 (setf ldwork var-10)))
(cond
 ((> lastv k)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8 var-9 var-10
    var-11 var-12)
   (zgemm "No transpose" "Conjugate transpose" lastc k
    (f2cl-lib:int-sub lastv k) one c ldc v ldv one work ldwork)
   (declare (ignore var-0 var-1 var-4 var-6 var-8 var-11))
   (when var-2 (setf lastc var-2)) (when var-3 (setf k var-3))
   (when var-5 (setf one var-5)) (when var-7 (setf ldc var-7))
   (when var-9 (setf ldv var-9)) (when var-10 (setf one var-10))
   (when var-12 (setf ldwork var-12)))))
```

```
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
 (ztrmm "Right" "Lower" trans "Non-unit"
     lastc k one t$ ldt work ldwork)
 (declare (ignore var-0 var-1 var-3 var-7 var-9))
 (when var-2 (setf trans var-2)) (when var-4 (setf lastc var-4))
 (when var-5 (setf k var-5)) (when var-6 (setf one var-6))
 (when var-8 (setf ldt var-8))
 (when var-10 (setf ldwork var-10)))
(cond
 ((> lastv k)
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
    var-8 var-9 var-10
    var-11 var-12)
   (zgemm "No transpose" "No transpose" lastc
    (f2cl-lib:int-sub lastv k)
    k (- one) work ldwork v ldv one c ldc)
   (declare (ignore var-0 var-1 var-3 var-5 var-6 var-8 var-11))
   (when var-2 (setf lastc var-2)) (when var-4 (setf k var-4))
   (when var-7 (setf ldwork var-7)) (when var-9 (setf ldv var-9))
   (when var-10 (setf one var-10))
   (when var-12 (setf ldc var-12)))))
(multiple-value-bind
 (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
  var-8 var-9 var-10)
 (ztrmm "Right" "Lower" "No transpose" "Unit" lastc k one
  (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
   (1 (f2cl-lib:int-add (f2cl-lib:int-sub lastv k) 1))
     ((1 ldv) (1 *))
   v-%offset%)
  ldv work ldwork)
 (declare (ignore var-0 var-1 var-2 var-3 var-7 var-9))
 (when var-4 (setf lastc var-4)) (when var-5 (setf k var-5))
 (when var-6 (setf one var-6)) (when var-8 (setf ldv var-8))
 (when var-10 (setf ldwork var-10)))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
       ((> j k) nil)
        (tagbody
                (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i lastc) nil)
         (tagbody
                  (setf
                   (f2cl-lib:fref c-%data%
                    (i (f2cl-lib:int-add (f2cl-lib:int-sub
                                 lastv k) j)) ((1 ldc) (1 *))
                    c-%offset%)
                   (-
                    (f2cl-lib:fref c-%data%
```

```
                                  (i (f2cl-lib:int-add
                                      (f2cl-lib:int-sub lastv k) j))
                                      ((1 ldc) (1 *))
                                  c-%offset%)
                                 (f2cl-lib:fref work-%data% (i j)
                                  ((1 ldwork) (1 *)) work-%offset%)))
                               label230))
                             label240))))))))
        (go end_label) end_label
        (return
         (values side trans direct storev nil nil k nil ldv nil ldt nil ldc nil
          ldwork))))))
```

———-

6.119 zlarf LAPACK

— **zlarf.input** —

```
)set break resume
)sys rm -f zlarf.output
)spool zlarf.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zlarf.help** —

```
=====================================================================
zlarf examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 Online html documentation available at
           http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========
```

```
      SUBROUTINE ZLARF( SIDE, M, N, V, INCV, TAU, C, LDC, WORK )

      .. Scalar Arguments ..
      CHARACTER          SIDE
      INTEGER            INCV, LDC, M, N
      COMPLEX*16         TAU
      ..
      .. Array Arguments ..
      COMPLEX*16         C( LDC, * ), V( * ), WORK( * )
      ..


Purpose:
=============

ZLARF applies a complex elementary reflector H to a complex M-by-N
matrix C, from either the left or the right. H is represented in the
form

      H = I - tau * v * v**H

where tau is a complex scalar and v is a complex vector.

If tau = 0, then H is taken to be the unit matrix.

To apply H**H, supply conjg(tau) instead
tau.

Arguments:
==========

 [in] SIDE

         SIDE is CHARACTER*1
         = 'L': form  H * C
         = 'R': form  C * H

 [in] M

         M is INTEGER
         The number of rows of the matrix C.

 [in] N

         N is INTEGER
         The number of columns of the matrix C.

 [in] V
```

```
          V is COMPLEX*16 array, dimension
                     (1 + (M-1)*abs(INCV)) if SIDE = 'L'
                  or (1 + (N-1)*abs(INCV)) if SIDE = 'R'
          The vector v in the representation of H. V is not used if
          TAU = 0.

  [in] INCV

          INCV is INTEGER
          The increment between elements of v. INCV <> 0.

  [in] TAU

          TAU is COMPLEX*16
          The value tau in the representation of H.

  [in,out] C

          C is COMPLEX*16 array, dimension (LDC,N)
          On entry, the M-by-N matrix C.
          On exit, C is overwritten by the matrix H * C if SIDE = 'L',
          or C * H if SIDE = 'R'.

  [in] LDC

          LDC is INTEGER
          The leading dimension of the array C. LDC >= max(1,M).

  [out] WORK

          WORK is COMPLEX*16 array, dimension
                         (N) if SIDE = 'L'
                      or (M) if SIDE = 'R'

Authors:
========

 Univ. of Tennessee
 Univ. of California Berkeley
 Univ. of Colorado Denver
 NAG Ltd.

November 2011
```

———-

— **zlarf.f** —

```
*  =====================================================================
      SUBROUTINE ZLARF( SIDE, M, N, V, INCV, TAU, C, LDC, WORK )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      CHARACTER          SIDE
      INTEGER            INCV, LDC, M, N
      COMPLEX*16         TAU
*     ..
*     .. Array Arguments ..
      COMPLEX*16         C( LDC, * ), V( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      COMPLEX*16         ONE, ZERO
      PARAMETER          ( ONE = ( 1.0D+0, 0.0D+0 ),
     $                   ZERO = ( 0.0D+0, 0.0D+0 ) )
*     ..
*     .. Local Scalars ..
      LOGICAL            APPLYLEFT
      INTEGER            I, LASTV, LASTC
*     ..
*     .. External Subroutines ..
      EXTERNAL           ZGEMV, ZGERC
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      INTEGER            ILAZLR, ILAZLC
      EXTERNAL           LSAME, ILAZLR, ILAZLC
*     ..
*     .. Executable Statements ..
*
      APPLYLEFT = LSAME( SIDE, 'L' )
      LASTV = 0
      LASTC = 0
      IF( TAU.NE.ZERO ) THEN
*     Set up variables for scanning V.  LASTV begins pointing to the end
*     of V.
         IF( APPLYLEFT ) THEN
            LASTV = M
         ELSE
            LASTV = N
         END IF
         IF( INCV.GT.0 ) THEN
```

```
            I = 1 + (LASTV-1) * INCV
         ELSE
            I = 1
         END IF
*     Look for the last non-zero row in V.
         DO WHILE( LASTV.GT.0 .AND. V( I ).EQ.ZERO )
            LASTV = LASTV - 1
            I = I - INCV
         END DO
         IF( APPLYLEFT ) THEN
*     Scan for the last non-zero column in C(1:lastv,:).
            LASTC = ILAZLC(LASTV, N, C, LDC)
         ELSE
*     Scan for the last non-zero row in C(:,1:lastv).
            LASTC = ILAZLR(M, LASTV, C, LDC)
         END IF
      END IF
*     Note that lastc.eq.0 renders the BLAS operations null; no special
*     case is needed at this level.
      IF( APPLYLEFT ) THEN
*
*        Form  H * C
*
         IF( LASTV.GT.0 ) THEN
*
*           w(1:lastc,1) := C(1:lastv,1:lastc)**H * v(1:lastv,1)
*
            CALL ZGEMV( 'Conjugate transpose', LASTV, LASTC, ONE,
     $           C, LDC, V, INCV, ZERO, WORK, 1 )
*
*           C(1:lastv,1:lastc) := C(...) - v(1:lastv,1) * w(1:lastc,1)**H
*
            CALL ZGERC( LASTV, LASTC, -TAU, V, INCV, WORK, 1, C, LDC )
         END IF
      ELSE
*
*        Form  C * H
*
         IF( LASTV.GT.0 ) THEN
*
*           w(1:lastc,1) := C(1:lastc,1:lastv) * v(1:lastv,1)
*
            CALL ZGEMV( 'No transpose', LASTC, LASTV, ONE, C, LDC,
     $           V, INCV, ZERO, WORK, 1 )
*
*           C(1:lastc,1:lastv) := C(...) - w(1:lastc,1) * v(1:lastv,1)**H
*
            CALL ZGERC( LASTC, LASTV, -TAU, WORK, 1, V, INCV, C, LDC )
         END IF
      END IF
```

```
      RETURN
*
*     End of ZLARF
*
      END
```

— LAPACK zlarf —

```
(let*
 ((one (coerce (f2cl-lib:cmplx 1.0d0 0.0d0) 'f2cl-lib:complex16))
  (zero (coerce (f2cl-lib:cmplx 0.0d0 0.0d0) 'f2cl-lib:complex16)))
 (declare (type (f2cl-lib:complex16) one) (type (f2cl-lib:complex16) zero)
  (ignorable one zero))
 (defun zlarf (side m n v incv tau c ldc work)
  (declare (type (simple-array character (*)) side)
   (type (f2cl-lib:integer4) ldc incv n m)
   (type (array f2cl-lib:complex16 (*)) work c v)
   (type (f2cl-lib:complex16) tau))
  (f2cl-lib:with-multi-array-data
      ((v f2cl-lib:complex16 v-%data% v-%offset%)
       (c f2cl-lib:complex16 c-%data% c-%offset%)
       (work f2cl-lib:complex16 work-%data% work-%offset%)
       (side character side-%data% side-%offset%))
       (prog
        ((i 0) (lastv 0) (lastc 0) (applyleft nil))
        (declare (type (f2cl-lib:integer4) lastc lastv i)
         (type f2cl-lib:logical applyleft))
        (setf applyleft
         (multiple-value-bind (ret-val var-0 var-1) (lsame side "L")
          (declare (ignore var-1)) (when var-0 (setf side var-0)) ret-val))
        (setf lastv 0) (setf lastc 0)
        (cond
         ((/= tau zero)
          (tagbody (cond (applyleft (setf lastv m)) (t (setf lastv n)))
           (cond
            ((> incv 0)
             (setf i
              (f2cl-lib:int-add 1
               (f2cl-lib:int-mul (f2cl-lib:int-sub lastv 1) incv))))
            (t (setf i 1)))
           label100000
           (if
            (not
             (and (> lastv 0)
              (= (f2cl-lib:fref v-%data% (i) ((1 *)) v-%offset%) zero)))
            (go label100001))
```

```
   (setf lastv (f2cl-lib:int-sub lastv 1))
   (setf i (f2cl-lib:int-sub i incv))
   (go label100000) label100001
   (cond (applyleft (setf lastc (ilazlc lastv n c ldc)))
    (t (setf lastc (ilazlr m lastv c ldc)))))))
(cond
 (applyleft
  (cond
   ((> lastv 0)
    (multiple-value-bind
     (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
      var-8 var-9 var-10)
     (zgemv "Conjugate transpose" lastv lastc one c
           ldc v incv zero work 1)
     (declare (ignore var-0 var-4 var-6 var-9 var-10))
     (when var-1 (setf lastv var-1)) (when var-2 (setf lastc var-2))
     (when var-3 (setf one var-3)) (when var-5 (setf ldc var-5))
     (when var-7 (setf incv var-7)) (when var-8 (setf zero var-8)))
    (multiple-value-bind
     (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
     (zgerc lastv lastc (- tau) v incv work 1 c ldc)
     (declare (ignore var-2 var-3 var-5 var-6 var-7))
     (when var-0 (setf lastv var-0)) (when var-1 (setf lastc var-1))
     (when var-4 (setf incv var-4)) (when var-8 (setf ldc var-8))))))
 (t
  (cond
   ((> lastv 0)
    (multiple-value-bind
     (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
      var-8 var-9 var-10)
     (zgemv "No transpose" lastc lastv one c ldc v incv zero work 1)
     (declare (ignore var-0 var-4 var-6 var-9 var-10))
     (when var-1 (setf lastc var-1)) (when var-2 (setf lastv var-2))
     (when var-3 (setf one var-3)) (when var-5 (setf ldc var-5))
     (when var-7 (setf incv var-7)) (when var-8 (setf zero var-8)))
    (multiple-value-bind
     (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
     (zgerc lastc lastv (- tau) work 1 v incv c ldc)
     (declare (ignore var-2 var-3 var-4 var-5 var-7))
     (when var-0 (setf lastc var-0)) (when var-1 (setf lastv var-1))
     (when var-6 (setf incv var-6)) (when var-8 (setf ldc var-8)))))))
(go end_label) end_label
(return (values side nil nil nil incv nil nil ldc nil))))))
```

———-

6.120 zlarfg LAPACK

— **zlarfg.input** —

```
)set break resume
)sys rm -f zlarfg.output
)spool zlarfg.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

————-

— **zlarfg.help** —

```
==========================================================================
zlarfg examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================


 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZLARFG( N, ALPHA, X, INCX, TAU )

       .. Scalar Arguments ..
       INTEGER            INCX, N
       COMPLEX*16         ALPHA, TAU
       ..
       .. Array Arguments ..
       COMPLEX*16         X( * )
       ..


 Purpose:
 =============

 ZLARFG generates a complex elementary reflector H of order n, such
```

```
that

      H**H * ( alpha ) = ( beta ),   H**H * H = I.
             (   x   )   (   0  )

where alpha and beta are scalars, with beta real, and x is an
(n-1)-element complex vector. H is represented in the form

      H = I - tau * ( 1 ) * ( 1 v**H ) ,
                    ( v )

where tau is a complex scalar and v is a complex (n-1)-element
vector. Note that H is not hermitian.

If the elements of x are all zero and alpha is real, then tau = 0
and H is taken to be the unit matrix.

Otherwise  1 <= real(tau) <= 2  and  abs(tau-1) <= 1 .

Arguments:
==========

 [in] N

         N is INTEGER
         The order of the elementary reflector.

 [in,out] ALPHA

         ALPHA is COMPLEX*16
         On entry, the value alpha.
         On exit, it is overwritten with the value beta.

 [in,out] X

         X is COMPLEX*16 array, dimension
                       (1+(N-2)*abs(INCX))
         On entry, the vector x.
         On exit, it is overwritten with the vector v.

 [in] INCX

         INCX is INTEGER
         The increment between elements of X. INCX > 0.

 [out] TAU

         TAU is COMPLEX*16
         The value tau.
```

```
 Authors:
 ========

  Univ. of Tennessee
  Univ. of California Berkeley
  Univ. of Colorado Denver
  NAG Ltd.

 November 2011
```

— zlzrfg.f —

```
*  =====================================================================
      SUBROUTINE ZLARFG( N, ALPHA, X, INCX, TAU )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      INTEGER            INCX, N
      COMPLEX*16         ALPHA, TAU
*     ..
*     .. Array Arguments ..
      COMPLEX*16         X( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ONE, ZERO
      PARAMETER          ( ONE = 1.0D+0, ZERO = 0.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            J, KNT
      DOUBLE PRECISION   ALPHI, ALPHR, BETA, RSAFMN, SAFMIN, XNORM
*     ..
*     .. External Functions ..
      DOUBLE PRECISION   DLAMCH, DLAPY3, DZNRM2
      COMPLEX*16         ZLADIV
      EXTERNAL           DLAMCH, DLAPY3, DZNRM2, ZLADIV
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, DBLE, DCMPLX, DIMAG, SIGN
*     ..
```

```
*     .. External Subroutines ..
      EXTERNAL           ZDSCAL, ZSCAL
*     ..
*     .. Executable Statements ..
*
      IF( N.LE.0 ) THEN
         TAU = ZERO
         RETURN
      END IF
*
      XNORM = DZNRM2( N-1, X, INCX )
      ALPHR = DBLE( ALPHA )
      ALPHI = DIMAG( ALPHA )
*
      IF( XNORM.EQ.ZERO .AND. ALPHI.EQ.ZERO ) THEN
*
*        H  =  I
*
         TAU = ZERO
      ELSE
*
*        general case
*
         BETA = -SIGN( DLAPY3( ALPHR, ALPHI, XNORM ), ALPHR )
         SAFMIN = DLAMCH( 'S' ) / DLAMCH( 'E' )
         RSAFMN = ONE / SAFMIN
*
         KNT = 0
         IF( ABS( BETA ).LT.SAFMIN ) THEN
*
*           XNORM, BETA may be inaccurate; scale X and recompute them
*
   10       CONTINUE
            KNT = KNT + 1
            CALL ZDSCAL( N-1, RSAFMN, X, INCX )
            BETA = BETA*RSAFMN
            ALPHI = ALPHI*RSAFMN
            ALPHR = ALPHR*RSAFMN
            IF( ABS( BETA ).LT.SAFMIN )
     $         GO TO 10
*
*           New BETA is at most 1, at least SAFMIN
*
            XNORM = DZNRM2( N-1, X, INCX )
            ALPHA = DCMPLX( ALPHR, ALPHI )
            BETA = -SIGN( DLAPY3( ALPHR, ALPHI, XNORM ), ALPHR )
         END IF
         TAU = DCMPLX( ( BETA-ALPHR ) / BETA, -ALPHI / BETA )
         ALPHA = ZLADIV( DCMPLX( ONE ), ALPHA-BETA )
         CALL ZSCAL( N-1, ALPHA, X, INCX )
```

```
*
*        If ALPHA is subnormal, it may lose relative accuracy
*
         DO 20 J = 1, KNT
            BETA = BETA*SAFMIN
 20      CONTINUE
         ALPHA = BETA
      END IF
*
      RETURN
*
*     End of ZLARFG
*
      END
```

———-

— LAPACK zlarfg —

```
(let* ((one 1.0d0) (zero 0.0d0))
 (declare (type (double-float 1.0d0 1.0d0) one)
  (type (double-float 0.0d0 0.0d0) zero) (ignorable one zero))
 (defun zlarfg (n alpha x incx tau)
  (declare (type (f2cl-lib:integer4) incx n)
   (type (f2cl-lib:complex16) tau alpha)
   (type (array f2cl-lib:complex16 (*)) x))
  (f2cl-lib:with-multi-array-data
      ((x f2cl-lib:complex16 x-%data% x-%offset%))
       (prog
        ((alphi 0.0d0) (alphr 0.0d0) (beta 0.0d0) (rsafmn 0.0d0) (safmin 0.0d0)
         (xnorm 0.0d0) (j 0) (knt 0))
        (declare (type (double-float) xnorm safmin rsafmn beta alphr alphi)
         (type (f2cl-lib:integer4) knt j))
        (cond ((<= n 0) (setf tau (coerce zero 'f2cl-lib:complex16))
           (go end_label)))
        (setf xnorm
         (multiple-value-bind (ret-val var-0 var-1 var-2)
          (dznrm2 (f2cl-lib:int-sub n 1) x incx) (declare (ignore var-0 var-1))
          (when var-2 (setf incx var-2)) ret-val))
        (setf alphr (f2cl-lib:dble alpha)) (setf alphi (f2cl-lib:dimag alpha))
        (cond
         ((and (= xnorm zero) (= alphi zero))
          (setf tau (coerce zero 'f2cl-lib:complex16)))
         (t (setf beta (- (f2cl-lib:sign (dlapy3 alphr alphi xnorm) alphr)))
          (setf safmin (/ (dlamch "S") (dlamch "E")))
          (setf rsafmn (/ one safmin))
          (setf knt 0)
          (cond
```

```
          ((< (abs beta) safmin)
           (tagbody label10 (setf knt (f2cl-lib:int-add knt 1))
            (multiple-value-bind (var-0 var-1 var-2 var-3)
             (zdscal (f2cl-lib:int-sub n 1) rsafmn x incx)
             (declare (ignore var-0 var-2)) (when var-1 (setf rsafmn var-1))
             (when var-3 (setf incx var-3)))
            (setf beta (* beta rsafmn)) (setf alphi (* alphi rsafmn))
            (setf alphr (* alphr rsafmn))
            (if (< (abs beta) safmin) (go label10))
            (setf xnorm
             (multiple-value-bind (ret-val var-0 var-1 var-2)
              (dznrm2 (f2cl-lib:int-sub n 1) x incx)
              (declare (ignore var-0 var-1))
              (when var-2 (setf incx var-2)) ret-val))
            (setf alpha (f2cl-lib:dcmplx alphr alphi))
            (setf beta
              (- (f2cl-lib:sign (dlapy3 alphr alphi xnorm) alphr))))))
          (setf tau
           (f2cl-lib:dcmplx (/ (- beta alphr) beta) (/ (- alphi) beta)))
          (setf alpha (zladiv (f2cl-lib:dcmplx one) (- alpha beta)))
          (multiple-value-bind (var-0 var-1 var-2 var-3)
           (zscal (f2cl-lib:int-sub n 1) alpha x incx)
           (declare (ignore var-0 var-2))
           (when var-1 (setf alpha var-1)) (when var-3 (setf incx var-3)))
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                 ((> j knt) nil)
                  (tagbody
                      (setf beta (* beta safmin)) label20))
          (setf alpha (coerce beta 'f2cl-lib:complex16))))
        (go end_label) end_label (return (values nil alpha nil incx tau))))))
```

———-

6.121 zlarft LAPACK

— **zlarft.input** —

```
)set break resume
)sys rm -f zlarft.output
)spool zlarft.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— zlarft.help —

```
=====================================================================
zlarft examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZLARFT( DIRECT, STOREV, N, K, V, LDV, TAU, T, LDT )

       .. Scalar Arguments ..
       CHARACTER          DIRECT, STOREV
       INTEGER            K, LDT, LDV, N
       ..
       .. Array Arguments ..
       COMPLEX*16         T( LDT, * ), TAU( * ), V( LDV, * )
       ..


 Purpose:
 =============

 ZLARFT forms the triangular factor T of a complex block reflector H
 of order n, which is defined as a product of k elementary reflectors.

 If DIRECT = 'F', H = H(1) H(2) . . . H(k) and T is upper triangular;

 If DIRECT = 'B', H = H(k) . . . H(2) H(1) and T is lower triangular.

 If STOREV = 'C', the vector which defines the elementary reflector
 H(i) is stored in the i-th column of the array V, and

    H  =  I - V * T * V**H

 If STOREV = 'R', the vector which defines the elementary reflector
 H(i) is stored in the i-th row of the array V, and

    H  =  I - V**H * T * V
```

```
 Arguments:
 ==========

  [in] DIRECT

          DIRECT is CHARACTER*1
          Specifies the order in which the elementary reflectors are
          multiplied to form the block reflector:
          = 'F': H = H(1) H(2) . . . H(k) (Forward)
          = 'B': H = H(k) . . . H(2) H(1) (Backward)

  [in] STOREV

          STOREV is CHARACTER*1
          Specifies how the vectors which define the elementary
          reflectors are stored (see also Further Details):
          = 'C': columnwise
          = 'R': rowwise

  [in] N

          N is INTEGER
          The order of the block reflector H. N >= 0.

  [in] K

          K is INTEGER
          The order of the triangular factor T (= the number of
          elementary reflectors). K >= 1.

  [in,out] V

          V is COMPLEX*16 array, dimension
                               (LDV,K) if STOREV = 'C'
                               (LDV,N) if STOREV = 'R'
          The matrix V. See further details.

  [in] LDV

          LDV is INTEGER
          The leading dimension of the array V.
          If STOREV = 'C', LDV >= max(1,N); if STOREV = 'R', LDV >= K.

  [in] TAU

          TAU is COMPLEX*16 array, dimension (K)
          TAU(i) must contain the scalar factor of the elementary
          reflector H(i).

  [out] T
```

```
          T is COMPLEX*16 array, dimension (LDT,K)
          The k by k triangular factor T of the block reflector.
          If DIRECT = 'F', T is upper triangular; if DIRECT = 'B', T is
          lower triangular. The rest of the array is not used.

 [in] LDT

          LDT is INTEGER
          The leading dimension of the array T. LDT >= K.

Authors:
========

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 Univ. of California Berkeley
 Univ. of Colorado Denver
 NAG Ltd.

November 2011

Further Details:
====================

 The shape of the matrix V and the storage of the vectors which define
 the H(i) is best illustrated by the following example with n = 5 and
 k = 3. The elements equal to 1 are not stored; the corresponding
 array elements are modified but restored on exit. The rest of the
 array is not used.

 DIRECT = 'F' and STOREV = 'C':         DIRECT = 'F' and STOREV = 'R':

              V = (  1       )                 V = (  1 v1 v1 v1 v1 )
                  ( v1  1    )                     (     1 v2 v2 v2 )
                  ( v1 v2  1 )                     (        1 v3 v3 )
                  ( v1 v2 v3 )
                  ( v1 v2 v3 )

 DIRECT = 'B' and STOREV = 'C':         DIRECT = 'B' and STOREV = 'R':

              V = ( v1 v2 v3 )                 V = ( v1 v1  1       )
                  ( v1 v2 v3 )                     ( v2 v2 v2  1    )
                  (  1 v2 v3 )                     ( v3 v3 v3 v3  1 )
                  (     1 v3 )
                  (        1 )
```

— **zlarft.f** —

```
*  =====================================================================
      SUBROUTINE ZLARFT( DIRECT, STOREV, N, K, V, LDV, TAU, T, LDT )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      CHARACTER          DIRECT, STOREV
      INTEGER            K, LDT, LDV, N
*     ..
*     .. Array Arguments ..
      COMPLEX*16         T( LDT, * ), TAU( * ), V( LDV, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      COMPLEX*16         ONE, ZERO
      PARAMETER          ( ONE = ( 1.0D+0, 0.0D+0 ),
     $                   ZERO = ( 0.0D+0, 0.0D+0 ) )
*     ..
*     .. Local Scalars ..
      INTEGER            I, J, PREVLASTV, LASTV
      COMPLEX*16         VII
*     ..
*     .. External Subroutines ..
      EXTERNAL           ZGEMV, ZLACGV, ZTRMV
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. Executable Statements ..
*
*     Quick return if possible
*
      IF( N.EQ.0 )
     $   RETURN
*
      IF( LSAME( DIRECT, 'F' ) ) THEN
         PREVLASTV = N
         DO 20 I = 1, K
            PREVLASTV = MAX( PREVLASTV, I )
            IF( TAU( I ).EQ.ZERO ) THEN
*
*              H(i)  =  I
```

```
*
                DO 10 J = 1, I
                   T( J, I ) = ZERO
   10           CONTINUE
             ELSE
*
*               general case
*
                VII = V( I, I )
                V( I, I ) = ONE
                IF( LSAME( STOREV, 'C' ) ) THEN
!                  Skip any trailing zeros.
                   DO LASTV = N, I+1, -1
                      IF( V( LASTV, I ).NE.ZERO ) EXIT
                   END DO
                   J = MIN( LASTV, PREVLASTV )
*
*                  T(1:i-1,i) := - tau(i) * V(i:j,1:i-1)**H * V(i:j,i)
*
                   CALL ZGEMV( 'Conjugate transpose', J-I+1, I-1,
     $                         -TAU( I ), V( I, 1 ), LDV, V( I, I ), 1,
     $                         ZERO, T( 1, I ), 1 )
                ELSE
!                  Skip any trailing zeros.
                   DO LASTV = N, I+1, -1
                      IF( V( I, LASTV ).NE.ZERO ) EXIT
                   END DO
                   J = MIN( LASTV, PREVLASTV )
*
*                  T(1:i-1,i) := - tau(i) * V(1:i-1,i:j) * V(i,i:j)**H
*
                   IF( I.LT.J )
     $                CALL ZLACGV( J-I, V( I, I+1 ), LDV )
                   CALL ZGEMV( 'No transpose', I-1, J-I+1, -TAU( I ),
     $                         V( 1, I ), LDV, V( I, I ), LDV, ZERO,
     $                         T( 1, I ), 1 )
                   IF( I.LT.J )
     $                CALL ZLACGV( J-I, V( I, I+1 ), LDV )
                END IF
                V( I, I ) = VII
*
*               T(1:i-1,i) := T(1:i-1,1:i-1) * T(1:i-1,i)
*
                CALL ZTRMV( 'Upper', 'No transpose', 'Non-unit', I-1, T,
     $                      LDT, T( 1, I ), 1 )
                T( I, I ) = TAU( I )
                IF( I.GT.1 ) THEN
                   PREVLASTV = MAX( PREVLASTV, LASTV )
                ELSE
                   PREVLASTV = LASTV
```

```
              END IF
            END IF
   20    CONTINUE
      ELSE
         PREVLASTV = 1
         DO 40 I = K, 1, -1
            IF( TAU( I ).EQ.ZERO ) THEN
*
*              H(i)  =  I
*
               DO 30 J = I, K
                  T( J, I ) = ZERO
   30          CONTINUE
            ELSE
*
*              general case
*
               IF( I.LT.K ) THEN
                  IF( LSAME( STOREV, 'C' ) ) THEN
                     VII = V( N-K+I, I )
                     V( N-K+I, I ) = ONE
!                    Skip any leading zeros.
                     DO LASTV = 1, I-1
                        IF( V( LASTV, I ).NE.ZERO ) EXIT
                     END DO
                     J = MAX( LASTV, PREVLASTV )
*
*                    T(i+1:k,i) :=
*                            - tau(i) * V(j:n-k+i,i+1:k)**H * V(j:n-k+i,i)
*
                     CALL ZGEMV( 'Conjugate transpose', N-K+I-J+1, K-I,
     $                           -TAU( I ), V( J, I+1 ), LDV, V( J, I ),
     $                           1, ZERO, T( I+1, I ), 1 )
                     V( N-K+I, I ) = VII
                  ELSE
                     VII = V( I, N-K+I )
                     V( I, N-K+I ) = ONE
!                    Skip any leading zeros.
                     DO LASTV = 1, I-1
                        IF( V( I, LASTV ).NE.ZERO ) EXIT
                     END DO
                     J = MAX( LASTV, PREVLASTV )
*
*                    T(i+1:k,i) :=
*                            - tau(i) * V(i+1:k,j:n-k+i) * V(i,j:n-k+i)**H
*
                     CALL ZLACGV( N-K+I-1-J+1, V( I, J ), LDV )
                     CALL ZGEMV( 'No transpose', K-I, N-K+I-J+1,
     $                    -TAU( I ), V( I+1, J ), LDV, V( I, J ), LDV,
     $                    ZERO, T( I+1, I ), 1 )
```

```
                  CALL ZLACGV( N-K+I-1-J+1, V( I, J ), LDV )
                  V( I, N-K+I ) = VII
               END IF
*
*              T(i+1:k,i) := T(i+1:k,i+1:k) * T(i+1:k,i)
*
               CALL ZTRMV( 'Lower', 'No transpose', 'Non-unit', K-I,
     $                     T( I+1, I+1 ), LDT, T( I+1, I ), 1 )
               IF( I.GT.1 ) THEN
                  PREVLASTV = MIN( PREVLASTV, LASTV )
               ELSE
                  PREVLASTV = LASTV
               END IF
            END IF
            T( I, I ) = TAU( I )
         END IF
   40    CONTINUE
      END IF
      RETURN
*
*     End of ZLARFT
*
      END
```

— LAPACK zlarft —

```
(let*
 ((one (coerce (f2cl-lib:cmplx 1.0d0 0.0d0) 'f2cl-lib:complex16))
  (zero (coerce (f2cl-lib:cmplx 0.0d0 0.0d0) 'f2cl-lib:complex16)))
 (declare (type (f2cl-lib:complex16) one) (type (f2cl-lib:complex16) zero)
  (ignorable one zero))
 (defun zlarft (direct storev n k v ldv tau t$ ldt)
  (declare (type (simple-array character (*)) storev direct)
   (type (f2cl-lib:integer4) ldt ldv k n)
   (type (array f2cl-lib:complex16 (*)) t$ tau v))
  (f2cl-lib:with-multi-array-data
      ((v f2cl-lib:complex16 v-%data% v-%offset%)
       (tau f2cl-lib:complex16 tau-%data% tau-%offset%)
       (t$ f2cl-lib:complex16 t$-%data% t$-%offset%)
       (direct character direct-%data% direct-%offset%)
       (storev character storev-%data% storev-%offset%))
       (prog
        ((vii #C(0.0d0 0.0d0)) (i 0) (j 0) (prevlastv 0) (lastv 0))
        (declare (type (f2cl-lib:complex16) vii)
         (type (f2cl-lib:integer4) lastv prevlastv j i))
        (if (= n 0) (go end_label))
```

```
(cond
 ((multiple-value-bind (ret-val var-0 var-1) (lsame direct "F")
   (declare (ignore var-1)) (when var-0 (setf direct var-0)) ret-val)
  (setf prevlastv n)
  (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
         ((> i k) nil)
          (tagbody
              (setf prevlastv
               (max (the f2cl-lib:integer4 prevlastv)
                    (the f2cl-lib:integer4 i)))
              (cond
               ((= (f2cl-lib:fref tau (i) ((1 *))) zero)
                (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
               ((> j i) nil)
               (tagbody
                     (setf (f2cl-lib:fref t$-%data% (j i)
                     ((1 ldt) (1 *)) t$-%offset%) zero)
                     label10)))
                (t (setf vii (f2cl-lib:fref v-%data% (i i)
                              ((1 ldv) (1 *)) v-%offset%))
                 (setf (f2cl-lib:fref v-%data% (i i)
                        ((1 ldv) (1 *)) v-%offset%) one)
                 (cond
                  ((multiple-value-bind (ret-val var-0 var-1)
                     (lsame storev "C")
                    (declare (ignore var-1))
                    (when var-0 (setf storev var-0)) ret-val)
                   (f2cl-lib:fdo (lastv n (f2cl-lib:int-add lastv
                                           (f2cl-lib:int-sub 1)))
                  ((>
                            lastv (f2cl-lib:int-add i 1))
                           nil)
                   (tagbody
                            (if
                             (/= (f2cl-lib:fref v-%data% (lastv i)
                                  ((1 ldv) (1 *)) v-%offset%)
                              zero)
                             (go f2cl-lib::exit))
                            label100000))
                      (setf j
                       (min (the f2cl-lib:integer4 lastv)
                            (the f2cl-lib:integer4 prevlastv)))
                      (multiple-value-bind
                       (var-0 var-1 var-2 var-3 var-4 var-5
                        var-6 var-7 var-8 var-9 var-10)
                       (zgemv "Conjugate transpose"
                        (f2cl-lib:int-add (f2cl-lib:int-sub j i) 1)
                                          (f2cl-lib:int-sub i 1)
                        (- (f2cl-lib:fref tau-%data% (i) ((1 *))
                             tau-%offset%))
```

```
      (f2cl-lib:array-slice v-%data%
       f2cl-lib:complex16 (i 1)
       ((1 ldv) (1 *)) v-%offset%)
      ldv
      (f2cl-lib:array-slice v-%data%
       f2cl-lib:complex16 (i i)
       ((1 ldv) (1 *)) v-%offset%)
      1 zero
      (f2cl-lib:array-slice t$-%data%
       f2cl-lib:complex16 (1 i)
       ((1 ldt) (1 *)) t$-%offset%)
      1)
     (declare
      (ignore var-0 var-1 var-2 var-3 var-4
              var-6 var-7 var-9 var-10))
     (when var-5 (setf ldv var-5))
     (when var-8 (setf zero var-8))))
   (t
    (f2cl-lib:fdo (lastv n (f2cl-lib:int-add lastv
                            (f2cl-lib:int-sub 1)))
((>
          lastv (f2cl-lib:int-add i 1))
         nil)
 (tagbody
          (if
           (/= (f2cl-lib:fref v-%data% (i lastv)
            ((1 ldv) (1 *)) v-%offset%)
            zero)
           (go f2cl-lib::exit))
          label100001))
    (setf j
     (min (the f2cl-lib:integer4 lastv)
          (the f2cl-lib:integer4 prevlastv)))
    (if (< i j)
     (zlacgv (f2cl-lib:int-sub j i)
      (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
       (i (f2cl-lib:int-add i 1))
           ((1 ldv) (1 *)) v-%offset%)
      ldv))
    (multiple-value-bind
     (var-0 var-1 var-2 var-3 var-4
      var-5 var-6 var-7 var-8 var-9 var-10)
     (zgemv "No transpose" (f2cl-lib:int-sub i 1)
      (f2cl-lib:int-add (f2cl-lib:int-sub j i) 1)
      (- (f2cl-lib:fref tau-%data% (i) ((1 *))
         tau-%offset%))
      (f2cl-lib:array-slice v-%data%
        f2cl-lib:complex16 (1 i)
       ((1 ldv) (1 *)) v-%offset%)
      ldv
```

```
                        (f2cl-lib:array-slice v-%data%
                           f2cl-lib:complex16 (i i)
                         ((1 ldv) (1 *)) v-%offset%)
                        ldv zero
                        (f2cl-lib:array-slice t$-%data%
                           f2cl-lib:complex16 (1 i)
                         ((1 ldt) (1 *)) t$-%offset%)
                        1)
                       (declare (ignore var-0 var-1 var-2 var-3
                                        var-4 var-6 var-9 var-10))
                       (when var-5 (setf ldv var-5))
                       (when var-7 (setf ldv var-7))
                       (when var-8 (setf zero var-8)))
                      (if (< i j)
                       (zlacgv (f2cl-lib:int-sub j i)
                        (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
                         (i (f2cl-lib:int-add i 1))
                              ((1 ldv) (1 *)) v-%offset%)
                        ldv))))
                    (setf (f2cl-lib:fref v-%data% (i i)
                             ((1 ldv) (1 *)) v-%offset%) vii)
                    (multiple-value-bind (var-0 var-1 var-2 var-3
                                          var-4 var-5 var-6 var-7)
                     (ztrmv "Upper" "No transpose" "Non-unit"
                         (f2cl-lib:int-sub i 1) t$ ldt
                      (f2cl-lib:array-slice t$-%data%
                       f2cl-lib:complex16 (1 i)
                       ((1 ldt) (1 *)) t$-%offset%)
                      1)
                     (declare (ignore var-0 var-1 var-2 var-3
                                      var-4 var-6 var-7))
                     (when var-5 (setf ldt var-5)))
                    (setf (f2cl-lib:fref t$-%data% (i i)
                       ((1 ldt) (1 *)) t$-%offset%)
                     (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%))
                    (cond
                     ((> i 1)
                      (setf prevlastv
                       (max (the f2cl-lib:integer4 prevlastv)
                        (the f2cl-lib:integer4 lastv))))
                     (t (setf prevlastv lastv)))))
                  label20)))
          (t (setf prevlastv 1)
           (f2cl-lib:fdo (i k (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                  ((> i 1) nil)
                   (tagbody
                       (cond
                        ((= (f2cl-lib:fref tau (i) ((1 *))) zero)
                         (f2cl-lib:fdo (j i (f2cl-lib:int-add j 1))
                           ((> j k) nil)
```

```
(tagbody
       (setf (f2cl-lib:fref t$-%data% (j i)
       ((1 ldt) (1 *)) t$-%offset%) zero)
       label30)))
  (t
   (cond
    ((< i k)
     (cond
      ((multiple-value-bind (ret-val var-0 var-1)
             (lsame storev "C")
        (declare (ignore var-1))
        (when var-0 (setf storev var-0)) ret-val)
       (setf vii
        (f2cl-lib:fref v-%data%
         ((f2cl-lib:int-add (f2cl-lib:int-sub n k) i) i)
            ((1 ldv) (1 *))
         v-%offset%))
       (setf
        (f2cl-lib:fref v-%data%
         ((f2cl-lib:int-add (f2cl-lib:int-sub n k) i) i)
            ((1 ldv) (1 *))
         v-%offset%)
        one)
       (f2cl-lib:fdo (lastv 1 (f2cl-lib:int-add lastv 1))
   ((> lastv
               (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
              nil)
    (tagbody
               (if
                (/= (f2cl-lib:fref v-%data% (lastv i)
                  ((1 ldv) (1 *)) v-%offset%)
                 zero)
                (go f2cl-lib::exit))
               label100002))
       (setf j
        (max (the f2cl-lib:integer4 lastv)
         (the f2cl-lib:integer4 prevlastv)))
       (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5
         var-6 var-7 var-8 var-9 var-10)
        (zgemv "Conjugate transpose"
         (f2cl-lib:int-add
          (f2cl-lib:int-sub (f2cl-lib:int-add
             (f2cl-lib:int-sub n k) i) j)
          1)
         (f2cl-lib:int-sub k i)
         (- (f2cl-lib:fref tau-%data% (i)
              ((1 *)) tau-%offset%))
         (f2cl-lib:array-slice v-%data% f2cl-lib:complex16
          (j (f2cl-lib:int-add i 1))
```

```
                ((1 ldv) (1 *)) v-%offset%)
       ldv
       (f2cl-lib:array-slice v-%data%
        f2cl-lib:complex16 (j i)
        ((1 ldv) (1 *)) v-%offset%)
       1 zero
       (f2cl-lib:array-slice t$-%data%
        f2cl-lib:complex16 ((+ i 1) i)
        ((1 ldt) (1 *)) t$-%offset%)
       1)
      (declare
       (ignore var-0 var-1 var-2 var-3 var-4
               var-6 var-7 var-9 var-10))
      (when var-5 (setf ldv var-5))
      (when var-8 (setf zero var-8)))
     (setf
      (f2cl-lib:fref v-%data%
       ((f2cl-lib:int-add (f2cl-lib:int-sub n k) i) i)
           ((1 ldv) (1 *))
       v-%offset%)
      vii))
    (t
     (setf vii
      (f2cl-lib:fref v-%data%
       (i (f2cl-lib:int-add (f2cl-lib:int-sub n k) i))
            ((1 ldv) (1 *))
       v-%offset%))
     (setf
      (f2cl-lib:fref v-%data%
       (i (f2cl-lib:int-add (f2cl-lib:int-sub n k) i))
            ((1 ldv) (1 *))
       v-%offset%)
      one)
     (f2cl-lib:fdo (lastv 1 (f2cl-lib:int-add lastv 1))
((> lastv
             (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
            nil)
 (tagbody
            (if
             (/= (f2cl-lib:fref v-%data% (i lastv)
              ((1 ldv) (1 *)) v-%offset%)
              zero)
             (go f2cl-lib::exit))
            label100003))
     (setf j
      (max (the f2cl-lib:integer4 lastv)
       (the f2cl-lib:integer4 prevlastv)))
     (zlacgv
      (f2cl-lib:int-add
       (f2cl-lib:int-sub (f2cl-lib:int-add
```

```
      (f2cl-lib:int-sub n k) i) 1 j)
     1)
    (f2cl-lib:array-slice v-%data%
     f2cl-lib:complex16 (i j)
     ((1 ldv) (1 *)) v-%offset%)
    ldv)
   (multiple-value-bind
    (var-0 var-1 var-2 var-3 var-4 var-5 var-6
     var-7 var-8 var-9 var-10)
    (zgemv "No transpose" (f2cl-lib:int-sub k i)
     (f2cl-lib:int-add
      (f2cl-lib:int-sub (f2cl-lib:int-add
          (f2cl-lib:int-sub n k) i) j)
      1)
     (- (f2cl-lib:fref tau-%data% (i)
           ((1 *)) tau-%offset%))
     (f2cl-lib:array-slice v-%data%
      f2cl-lib:complex16 ((+ i 1) j)
      ((1 ldv) (1 *)) v-%offset%)
     ldv
     (f2cl-lib:array-slice v-%data%
      f2cl-lib:complex16 (i j)
      ((1 ldv) (1 *)) v-%offset%)
     ldv zero
     (f2cl-lib:array-slice t$-%data%
      f2cl-lib:complex16 ((+ i 1) i)
      ((1 ldt) (1 *)) t$-%offset%)
     1)
    (declare (ignore var-0 var-1 var-2 var-3
                     var-4 var-6 var-9 var-10))
    (when var-5 (setf ldv var-5))
    (when var-7 (setf ldv var-7))
    (when var-8 (setf zero var-8)))
   (zlacgv
    (f2cl-lib:int-add
     (f2cl-lib:int-sub
      (f2cl-lib:int-add (f2cl-lib:int-sub n k) i) 1 j)
     1)
    (f2cl-lib:array-slice v-%data%
     f2cl-lib:complex16 (i j)
     ((1 ldv) (1 *)) v-%offset%)
    ldv)
   (setf
    (f2cl-lib:fref v-%data%
     (i (f2cl-lib:int-add
         (f2cl-lib:int-sub n k) i)) ((1 ldv) (1 *))
     v-%offset%)
    vii)))
 (multiple-value-bind (var-0 var-1 var-2 var-3
                       var-4 var-5 var-6 var-7)
```

```
                        (ztrmv "Lower" "No transpose" "Non-unit"
                         (f2cl-lib:int-sub k i)
                         (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16
                          ((+ i 1) (f2cl-lib:int-add i 1))
                          ((1 ldt) (1 *)) t$-%offset%)
                         ldt
                         (f2cl-lib:array-slice t$-%data%
                          f2cl-lib:complex16 ((+ i 1) i)
                          ((1 ldt) (1 *)) t$-%offset%)
                         1)
                        (declare (ignore var-0 var-1 var-2 var-3
                                  var-4 var-6 var-7))
                        (when var-5 (setf ldt var-5)))
                       (cond
                        ((> i 1)
                         (setf prevlastv
                          (min (the f2cl-lib:integer4 prevlastv)
                           (the f2cl-lib:integer4 lastv))))
                        (t (setf prevlastv lastv)))))
                     (setf (f2cl-lib:fref t$-%data% (i i)
                      ((1 ldt) (1 *)) t$-%offset%)
                      (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%))))
                   label40))))
      (go end_label) end_label
      (return (values direct storev nil nil nil ldv nil nil ldt))))))
```

———-

6.122 zlartg LAPACK

— **zlartg.input** —

```
)set break resume
)sys rm -f zlartg.output
)spool zlartg.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zlartg.help** —

```
====================================================================
```

```
zlartg examples
======================================================================

======================================================================
Man Page Details
======================================================================

 Online html documentation available at
           http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZLARTG( F, G, CS, SN, R )

       .. Scalar Arguments ..
       DOUBLE PRECISION   CS
       COMPLEX*16         F, G, R, SN
       ..


 Purpose:
 =============

 ZLARTG generates a plane rotation so that

    [  CS  SN  ]     [ F ]     [ R ]
    [  __      ]  .  [   ]  =  [   ]   where CS**2 + |SN|**2 = 1.
    [ -SN  CS  ]     [ G ]     [ 0 ]

 This is a faster version of the BLAS1 routine ZROTG, except for
 the following differences:
    F and G are unchanged on return.
    If G=0, then CS=1 and SN=0.
    If F=0, then CS=0 and SN is chosen so that R is real.

 Arguments:
 ==========

  [in] F

          F is COMPLEX*16
          The first component of vector to be rotated.

  [in] G

          G is COMPLEX*16
          The second component of vector to be rotated.

  [out] CS
```

```
          CS is DOUBLE PRECISION
          The cosine of the rotation.

  [out] SN

          SN is COMPLEX*16
          The sine of the rotation.

  [out] R

          R is COMPLEX*16
          The nonzero component of the rotated vector.


 Authors:
 ========

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  Univ. of California Berkeley
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  NAG Ltd.

 November 2011

 Further Details:
 ====================

  3-5-96 - Modified with a new algorithm by W. Kahan and J. Demmel

  This version has a few statements commented out for thread safety
  (machine parameters are computed on each entry). 10 feb 03, SJH.
```

———-

— **zlartg.f** —

```
*  =====================================================================
      SUBROUTINE ZLARTG( F, G, CS, SN, R )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      DOUBLE PRECISION   CS
      COMPLEX*16         F, G, R, SN
```

```
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   TWO, ONE, ZERO
      PARAMETER          ( TWO = 2.0D+0, ONE = 1.0D+0, ZERO = 0.0D+0 )
      COMPLEX*16         CZERO
      PARAMETER          ( CZERO = ( 0.0D+0, 0.0D+0 ) )
*     ..
*     .. Local Scalars ..
*     LOGICAL            FIRST
      INTEGER            COUNT, I
      DOUBLE PRECISION   D, DI, DR, EPS, F2, F2S, G2, G2S, SAFMIN,
     $                   SAFMN2, SAFMX2, SCALE
      COMPLEX*16         FF, FS, GS
*     ..
*     .. External Functions ..
      DOUBLE PRECISION   DLAMCH, DLAPY2
      EXTERNAL           DLAMCH, DLAPY2
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, DBLE, DCMPLX, DCONJG, DIMAG, INT, LOG,
     $                   MAX, SQRT
*     ..
*     .. Statement Functions ..
      DOUBLE PRECISION   ABS1, ABSSQ
*     ..
*     .. Save statement ..
*     SAVE               FIRST, SAFMX2, SAFMIN, SAFMN2
*     ..
*     .. Data statements ..
*     DATA               FIRST / .TRUE. /
*     ..
*     .. Statement Function definitions ..
      ABS1( FF ) = MAX( ABS( DBLE( FF ) ), ABS( DIMAG( FF ) ) )
      ABSSQ( FF ) = DBLE( FF )**2 + DIMAG( FF )**2
*     ..
*     .. Executable Statements ..
*
*     IF( FIRST ) THEN
         SAFMIN = DLAMCH( 'S' )
         EPS = DLAMCH( 'E' )
         SAFMN2 = DLAMCH( 'B' )**INT( LOG( SAFMIN / EPS ) /
     $            LOG( DLAMCH( 'B' ) ) / TWO )
         SAFMX2 = ONE / SAFMN2
*        FIRST = .FALSE.
*     END IF
      SCALE = MAX( ABS1( F ), ABS1( G ) )
      FS = F
```

```
      GS = G
      COUNT = 0
      IF( SCALE.GE.SAFMX2 ) THEN
   10    CONTINUE
         COUNT = COUNT + 1
         FS = FS*SAFMN2
         GS = GS*SAFMN2
         SCALE = SCALE*SAFMN2
         IF( SCALE.GE.SAFMX2 )
     $      GO TO 10
      ELSE IF( SCALE.LE.SAFMN2 ) THEN
         IF( G.EQ.CZERO ) THEN
            CS = ONE
            SN = CZERO
            R = F
            RETURN
         END IF
   20    CONTINUE
         COUNT = COUNT - 1
         FS = FS*SAFMX2
         GS = GS*SAFMX2
         SCALE = SCALE*SAFMX2
         IF( SCALE.LE.SAFMN2 )
     $      GO TO 20
      END IF
      F2 = ABSSQ( FS )
      G2 = ABSSQ( GS )
      IF( F2.LE.MAX( G2, ONE )*SAFMIN ) THEN
*
*        This is a rare case: F is very small.
*
         IF( F.EQ.CZERO ) THEN
            CS = ZERO
            R = DLAPY2( DBLE( G ), DIMAG( G ) )
*           Do complex/real division explicitly with two real divisions
            D = DLAPY2( DBLE( GS ), DIMAG( GS ) )
            SN = DCMPLX( DBLE( GS ) / D, -DIMAG( GS ) / D )
            RETURN
         END IF
         F2S = DLAPY2( DBLE( FS ), DIMAG( FS ) )
*        G2 and G2S are accurate
*        G2 is at least SAFMIN, and G2S is at least SAFMN2
         G2S = SQRT( G2 )
*        Error in CS from underflow in F2S is at most
*        UNFL / SAFMN2 .lt. sqrt(UNFL*EPS) .lt. EPS
*        If MAX(G2,ONE)=G2, then F2 .lt. G2*SAFMIN,
*        and so CS .lt. sqrt(SAFMIN)
*        If MAX(G2,ONE)=ONE, then F2 .lt. SAFMIN
*        and so CS .lt. sqrt(SAFMIN)/SAFMN2 = sqrt(EPS)
*        Therefore, CS = F2S/G2S / sqrt( 1 + (F2S/G2S)**2 ) = F2S/G2S
```

```
         CS = F2S / G2S
*        Make sure abs(FF) = 1
*        Do complex/real division explicitly with 2 real divisions
         IF( ABS1( F ).GT.ONE ) THEN
            D = DLAPY2( DBLE( F ), DIMAG( F ) )
            FF = DCMPLX( DBLE( F ) / D, DIMAG( F ) / D )
         ELSE
            DR = SAFMX2*DBLE( F )
            DI = SAFMX2*DIMAG( F )
            D = DLAPY2( DR, DI )
            FF = DCMPLX( DR / D, DI / D )
         END IF
         SN = FF*DCMPLX( DBLE( GS ) / G2S, -DIMAG( GS ) / G2S )
         R = CS*F + SN*G
      ELSE
*
*        This is the most common case.
*        Neither F2 nor F2/G2 are less than SAFMIN
*        F2S cannot overflow, and it is accurate
*
         F2S = SQRT( ONE+G2 / F2 )
*        Do the F2S(real)*FS(complex) multiply with two real multiplies
         R = DCMPLX( F2S*DBLE( FS ), F2S*DIMAG( FS ) )
         CS = ONE / F2S
         D = F2 + G2
*        Do complex/real division explicitly with two real divisions
         SN = DCMPLX( DBLE( R ) / D, DIMAG( R ) / D )
         SN = SN*DCONJG( GS )
         IF( COUNT.NE.0 ) THEN
            IF( COUNT.GT.0 ) THEN
               DO 30 I = 1, COUNT
                  R = R*SAFMX2
   30          CONTINUE
            ELSE
               DO 40 I = 1, -COUNT
                  R = R*SAFMN2
   40          CONTINUE
            END IF
         END IF
      END IF
      RETURN
*
*     End of ZLARTG
*
      END
```

———-

— LAPACK zlartg —

```
(let*
 ((two 2.0d0) (one 1.0d0) (zero 0.0d0)
  (czero (coerce (f2cl-lib:cmplx 0.0d0 0.0d0) 'f2cl-lib:complex16)))
 (declare (type (double-float 2.0d0 2.0d0) two)
  (type (double-float 1.0d0 1.0d0) one) (type (double-float 0.0d0 0.0d0) zero)
  (type (f2cl-lib:complex16) czero) (ignorable two one zero czero))
 (defun zlartg (f g cs sn r)
  (declare (type (f2cl-lib:complex16) r sn g f) (type (double-float) cs))
  (labels
   ((abs1 (ff) (max (abs (f2cl-lib:dble ff)) (abs (f2cl-lib:dimag ff))))
    (abssq (ff) (+ (expt (f2cl-lib:dble ff) 2) (expt (f2cl-lib:dimag ff) 2))))
   (declare
    (ftype (function (f2cl-lib:complex16) (values double-float &rest t)) abs1))
   (declare
    (ftype (function (f2cl-lib:complex16) (values double-float &rest t))
     abssq))
   (prog
    ((ff #C(0.0d0 0.0d0)) (fs #C(0.0d0 0.0d0)) (gs #C(0.0d0 0.0d0)) (d 0.0d0)
     (di 0.0d0) (dr 0.0d0) (eps 0.0d0) (f2 0.0d0) (f2s 0.0d0) (g2 0.0d0)
     (g2s 0.0d0) (safmin 0.0d0) (safmn2 0.0d0) (safmx2 0.0d0) (scale 0.0d0)
     (i 0) (count$ 0))
    (declare (type (f2cl-lib:complex16) gs fs ff)
     (type (double-float) scale safmx2 safmn2 safmin g2s g2 f2s f2 eps dr di d)
     (type (f2cl-lib:integer4) count$ i))
    (setf safmin (dlamch "S")) (setf eps (dlamch "E"))
    (setf safmn2
     (expt (dlamch "B")
      (f2cl-lib:int
       (/ (/ (f2cl-lib:flog (/ safmin eps)) (f2cl-lib:flog (dlamch "B")))
        two))))
    (setf safmx2 (/ one safmn2)) (setf scale (max (abs1 f) (abs1 g)))
    (setf fs f) (setf gs g) (setf count$ 0)
    (cond
     ((>= scale safmx2)
      (tagbody label10 (setf count$ (f2cl-lib:int-add count$ 1))
       (setf fs (* fs safmn2)) (setf gs (* gs safmn2))
       (setf scale (* scale safmn2)) (if (>= scale safmx2) (go label10))))
     ((<= scale safmn2)
      (tagbody
       (cond
        ((= g czero) (setf cs one) (setf sn czero) (setf r f) (go end_label)))
       label20 (setf count$ (f2cl-lib:int-sub count$ 1))
       (setf fs (* fs safmx2)) (setf gs (* gs safmx2))
       (setf scale (* scale safmx2)) (if (<= scale safmn2) (go label20)))))
    (setf f2 (abssq fs)) (setf g2 (abssq gs))
    (cond
     ((<= f2 (* (max g2 one) safmin))
      (cond
```

```
      ((= f czero) (setf cs zero)
       (setf r
        (coerce (dlapy2 (f2cl-lib:dble g) (f2cl-lib:dimag g))
         'f2cl-lib:complex16))
       (setf d (dlapy2 (f2cl-lib:dble gs) (f2cl-lib:dimag gs)))
       (setf sn
        (f2cl-lib:dcmplx (/ (f2cl-lib:dble gs) d)
         (/ (- (f2cl-lib:dimag gs)) d)))
       (go end_label)))
     (setf f2s (dlapy2 (f2cl-lib:dble fs) (f2cl-lib:dimag fs)))
     (setf g2s (f2cl-lib:fsqrt g2)) (setf cs (/ f2s g2s))
     (cond
      ((> (abs1 f) one) (setf d (dlapy2 (f2cl-lib:dble f) (f2cl-lib:dimag f)))
       (setf ff
        (f2cl-lib:dcmplx (/ (f2cl-lib:dble f) d) (/ (f2cl-lib:dimag f) d))))
      (t (setf dr (* safmx2 (f2cl-lib:dble f)))
       (setf di (* safmx2 (f2cl-lib:dimag f)))
       (setf d
        (multiple-value-bind (ret-val var-0 var-1) (dlapy2 dr di)
         (declare (ignore)) (when var-0 (setf dr var-0))
         (when var-1 (setf di var-1)) ret-val))
       (setf ff (f2cl-lib:dcmplx (/ dr d) (/ di d)))))
     (setf sn
      (* ff
       (f2cl-lib:dcmplx (/ (f2cl-lib:dble gs) g2s)
        (/ (- (f2cl-lib:dimag gs)) g2s))))
     (setf r (+ (* cs f) (* sn g))))
    (t (setf f2s (f2cl-lib:fsqrt (+ one (/ g2 f2))))
     (setf r
      (f2cl-lib:dcmplx (* f2s (f2cl-lib:dble fs))
       (* f2s (f2cl-lib:dimag fs))))
     (setf cs (/ one f2s)) (setf d (+ f2 g2))
     (setf sn
      (f2cl-lib:dcmplx (/ (f2cl-lib:dble r) d) (/ (f2cl-lib:dimag r) d)))
     (setf sn (coerce (* sn (f2cl-lib:dconjg gs)) 'f2cl-lib:complex16))
     (cond
      ((/= count$ 0)
       (cond
        ((> count$ 0)
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i count$) nil)
                        (tagbody
                         (setf r (* r safmx2)) label30)))
        (t
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i
                         (f2cl-lib:int-sub count$))
                        nil)
                        (tagbody (setf r (* r safmn2)) label40)))))))
   (go end_label) end_label (return (values nil nil cs sn r))))))
```

———-

6.123 zlascl LAPACK

— **zlascl.input** —

```
)set break resume
)sys rm -f zlascl.output
)spool zlascl.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zlascl.help** —

```
=========================================================================
zlascl examples
=========================================================================

=========================================================================
Man Page Details
=========================================================================

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZLASCL( TYPE, KL, KU, CFROM, CTO, M, N, A, LDA, INFO )

       .. Scalar Arguments ..
       CHARACTER          TYPE
       INTEGER            INFO, KL, KU, LDA, M, N
       DOUBLE PRECISION   CFROM, CTO
       ..
       .. Array Arguments ..
       COMPLEX*16         A( LDA, * )
       ..
```

```
Purpose:
=============

ZLASCL multiplies the M by N complex matrix A by the real scalar
CTO/CFROM.  This is done without over/underflow as long as the final
result CTO*A(I,J)/CFROM does not over/underflow. TYPE specifies that
A may be full, upper triangular, lower triangular, upper Hessenberg,
or banded.

Arguments:
==========

 [in] TYPE

        TYPE is CHARACTER*1
        TYPE indices the storage type of the input matrix.
        = 'G':  A is a full matrix.
        = 'L':  A is a lower triangular matrix.
        = 'U':  A is an upper triangular matrix.
        = 'H':  A is an upper Hessenberg matrix.
        = 'B':  A is a symmetric band matrix with lower bandwidth KL
                and upper bandwidth KU and with the only the lower
                half stored.
        = 'Q':  A is a symmetric band matrix with lower bandwidth KL
                and upper bandwidth KU and with the only the upper
                half stored.
        = 'Z':  A is a band matrix with lower bandwidth KL and upper
                bandwidth KU. See ZGBTRF for storage details.

 [in] KL

        KL is INTEGER
        The lower bandwidth of A.  Referenced only if TYPE = 'B',
        'Q' or 'Z'.

 [in] KU

        KU is INTEGER
        The upper bandwidth of A.  Referenced only if TYPE = 'B',
        'Q' or 'Z'.

 [in] CFROM

        CFROM is DOUBLE PRECISION

 [in] CTO

        CTO is DOUBLE PRECISION

        The matrix A is multiplied by CTO/CFROM. A(I,J) is computed
```

```
          without over/underflow if the final result CTO*A(I,J)/CFROM
          can be represented without over/underflow.  CFROM must be
          nonzero.

  [in] M

          M is INTEGER
          The number of rows of the matrix A.  M >= 0.

  [in] N

          N is INTEGER
          The number of columns of the matrix A.  N >= 0.

  [in,out] A

          A is COMPLEX*16 array, dimension (LDA,N)
          The matrix to be multiplied by CTO/CFROM.  See TYPE for the
          storage type.

  [in] LDA

          LDA is INTEGER
          The leading dimension of the array A.  LDA >= max(1,M).

  [out] INFO

          INFO is INTEGER
          0  - successful exit
          <0 - if INFO = -i, the i-th argument had an illegal value.

 Authors:
 ========

  Univ. of Tennessee
  Univ. of California Berkeley
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  NAG Ltd.

 November 2011
```

— zlascl.f —

```
*  =====================================================================
      SUBROUTINE ZLASCL( TYPE, KL, KU, CFROM, CTO, M, N, A, LDA, INFO )
*
```

```
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      CHARACTER          TYPE
      INTEGER            INFO, KL, KU, LDA, M, N
      DOUBLE PRECISION   CFROM, CTO
*     ..
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D0, ONE = 1.0D0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            DONE
      INTEGER            I, ITYPE, J, K1, K2, K3, K4
      DOUBLE PRECISION   BIGNUM, CFROM1, CFROMC, CTO1, CTOC, MUL, SMLNUM
*     ..
*     .. External Functions ..
      LOGICAL            LSAME, DISNAN
      DOUBLE PRECISION   DLAMCH
      EXTERNAL           LSAME, DLAMCH, DISNAN
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, MAX, MIN
*     ..
*     .. External Subroutines ..
      EXTERNAL           XERBLA
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
*
      IF( LSAME( TYPE, 'G' ) ) THEN
         ITYPE = 0
      ELSE IF( LSAME( TYPE, 'L' ) ) THEN
         ITYPE = 1
      ELSE IF( LSAME( TYPE, 'U' ) ) THEN
         ITYPE = 2
      ELSE IF( LSAME( TYPE, 'H' ) ) THEN
         ITYPE = 3
```

```
      ELSE IF( LSAME( TYPE, 'B' ) ) THEN
         ITYPE = 4
      ELSE IF( LSAME( TYPE, 'Q' ) ) THEN
         ITYPE = 5
      ELSE IF( LSAME( TYPE, 'Z' ) ) THEN
         ITYPE = 6
      ELSE
         ITYPE = -1
      END IF
*
      IF( ITYPE.EQ.-1 ) THEN
         INFO = -1
      ELSE IF( CFROM.EQ.ZERO .OR. DISNAN(CFROM) ) THEN
         INFO = -4
      ELSE IF( DISNAN(CTO) ) THEN
         INFO = -5
      ELSE IF( M.LT.0 ) THEN
         INFO = -6
      ELSE IF( N.LT.0 .OR. ( ITYPE.EQ.4 .AND. N.NE.M ) .OR.
     $         ( ITYPE.EQ.5 .AND. N.NE.M ) ) THEN
         INFO = -7
      ELSE IF( ITYPE.LE.3 .AND. LDA.LT.MAX( 1, M ) ) THEN
         INFO = -9
      ELSE IF( ITYPE.GE.4 ) THEN
         IF( KL.LT.0 .OR. KL.GT.MAX( M-1, 0 ) ) THEN
            INFO = -2
         ELSE IF( KU.LT.0 .OR. KU.GT.MAX( N-1, 0 ) .OR.
     $            ( ( ITYPE.EQ.4 .OR. ITYPE.EQ.5 ) .AND. KL.NE.KU ) )
     $             THEN
            INFO = -3
         ELSE IF( ( ITYPE.EQ.4 .AND. LDA.LT.KL+1 ) .OR.
     $            ( ITYPE.EQ.5 .AND. LDA.LT.KU+1 ) .OR.
     $            ( ITYPE.EQ.6 .AND. LDA.LT.2*KL+KU+1 ) ) THEN
            INFO = -9
         END IF
      END IF
*
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'ZLASCL', -INFO )
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( N.EQ.0 .OR. M.EQ.0 )
     $   RETURN
*
*     Get machine parameters
*
      SMLNUM = DLAMCH( 'S' )
```

```
      BIGNUM = ONE / SMLNUM
*
      CFROMC = CFROM
      CTOC = CTO
*
   10 CONTINUE
      CFROM1 = CFROMC*SMLNUM
      IF( CFROM1.EQ.CFROMC ) THEN
!        CFROMC is an inf.  Multiply by a correctly signed zero for
!        finite CTOC, or a NaN if CTOC is infinite.
         MUL = CTOC / CFROMC
         DONE = .TRUE.
         CTO1 = CTOC
      ELSE
         CTO1 = CTOC / BIGNUM
         IF( CTO1.EQ.CTOC ) THEN
!           CTOC is either 0 or an inf.  In both cases, CTOC itself
!           serves as the correct multiplication factor.
            MUL = CTOC
            DONE = .TRUE.
            CFROMC = ONE
         ELSE IF( ABS( CFROM1 ).GT.ABS( CTOC ) .AND. CTOC.NE.ZERO ) THEN
            MUL = SMLNUM
            DONE = .FALSE.
            CFROMC = CFROM1
         ELSE IF( ABS( CTO1 ).GT.ABS( CFROMC ) ) THEN
            MUL = BIGNUM
            DONE = .FALSE.
            CTOC = CTO1
         ELSE
            MUL = CTOC / CFROMC
            DONE = .TRUE.
         END IF
      END IF
*
      IF( ITYPE.EQ.0 ) THEN
*
*        Full matrix
*
         DO 30 J = 1, N
            DO 20 I = 1, M
               A( I, J ) = A( I, J )*MUL
   20       CONTINUE
   30    CONTINUE
*
      ELSE IF( ITYPE.EQ.1 ) THEN
*
*        Lower triangular matrix
*
         DO 50 J = 1, N
```

```
            DO 40 I = J, M
               A( I, J ) = A( I, J )*MUL
   40       CONTINUE
   50    CONTINUE
*
      ELSE IF( ITYPE.EQ.2 ) THEN
*
*        Upper triangular matrix
*
         DO 70 J = 1, N
            DO 60 I = 1, MIN( J, M )
               A( I, J ) = A( I, J )*MUL
   60       CONTINUE
   70    CONTINUE
*
      ELSE IF( ITYPE.EQ.3 ) THEN
*
*        Upper Hessenberg matrix
*
         DO 90 J = 1, N
            DO 80 I = 1, MIN( J+1, M )
               A( I, J ) = A( I, J )*MUL
   80       CONTINUE
   90    CONTINUE
*
      ELSE IF( ITYPE.EQ.4 ) THEN
*
*        Lower half of a symmetric band matrix
*
         K3 = KL + 1
         K4 = N + 1
         DO 110 J = 1, N
            DO 100 I = 1, MIN( K3, K4-J )
               A( I, J ) = A( I, J )*MUL
  100       CONTINUE
  110    CONTINUE
*
      ELSE IF( ITYPE.EQ.5 ) THEN
*
*        Upper half of a symmetric band matrix
*
         K1 = KU + 2
         K3 = KU + 1
         DO 130 J = 1, N
            DO 120 I = MAX( K1-J, 1 ), K3
               A( I, J ) = A( I, J )*MUL
  120       CONTINUE
  130    CONTINUE
*
      ELSE IF( ITYPE.EQ.6 ) THEN
```

```
*
*        Band matrix
*
         K1 = KL + KU + 2
         K2 = KL + 1
         K3 = 2*KL + KU + 1
         K4 = KL + KU + 1 + M
         DO 150 J = 1, N
            DO 140 I = MAX( K1-J, K2 ), MIN( K3, K4-J )
               A( I, J ) = A( I, J )*MUL
  140       CONTINUE
  150    CONTINUE
*
      END IF
*
      IF( .NOT.DONE )
     $   GO TO 10
*
      RETURN
*
*     End of ZLASCL
*
      END
```

— LAPACK zlascl —

```
(let* ((zero 0.0d0) (one 1.0d0))
 (declare (type (double-float 0.0d0 0.0d0) zero)
  (type (double-float 1.0d0 1.0d0) one) (ignorable zero one))
 (defun zlascl (type kl ku cfrom cto m n a lda info)
  (declare (type (simple-array character (*)) type)
   (type (f2cl-lib:integer4) info lda n m ku kl)
   (type (double-float) cto cfrom) (type (array f2cl-lib:complex16 (*)) a))
  (f2cl-lib:with-multi-array-data
      ((a f2cl-lib:complex16 a-%data% a-%offset%)
       (type character type-%data% type-%offset%))
       (prog
        ((bignum 0.0d0) (cfrom1 0.0d0) (cfromc 0.0d0) (cto1 0.0d0) (ctoc 0.0d0)
         (mul 0.0d0) (smlnum 0.0d0) (i 0) (itype 0) (j 0) (k1 0)
         (k2 0) (k3 0) (k4 0)
         (done nil))
        (declare (type (double-float) smlnum mul ctoc cto1
                                      cfromc cfrom1 bignum)
         (type (f2cl-lib:integer4) k4 k3 k2 k1 j itype i)
         (type f2cl-lib:logical done))
        (setf info 0)
```

```
(cond
 ((multiple-value-bind (ret-val var-0 var-1) (lsame type "G")
   (declare (ignore var-1)) (when var-0 (setf type var-0)) ret-val)
  (setf itype 0))
 ((multiple-value-bind (ret-val var-0 var-1) (lsame type "L")
   (declare (ignore var-1)) (when var-0 (setf type var-0)) ret-val)
  (setf itype 1))
 ((multiple-value-bind (ret-val var-0 var-1) (lsame type "U")
   (declare (ignore var-1)) (when var-0 (setf type var-0)) ret-val)
  (setf itype 2))
 ((multiple-value-bind (ret-val var-0 var-1) (lsame type "H")
   (declare (ignore var-1)) (when var-0 (setf type var-0)) ret-val)
  (setf itype 3))
 ((multiple-value-bind (ret-val var-0 var-1) (lsame type "B")
   (declare (ignore var-1)) (when var-0 (setf type var-0)) ret-val)
  (setf itype 4))
 ((multiple-value-bind (ret-val var-0 var-1) (lsame type "Q")
   (declare (ignore var-1)) (when var-0 (setf type var-0)) ret-val)
  (setf itype 5))
 ((multiple-value-bind (ret-val var-0 var-1) (lsame type "Z")
   (declare (ignore var-1)) (when var-0 (setf type var-0)) ret-val)
  (setf itype 6))
 (t (setf itype -1)))
(cond ((= itype (f2cl-lib:int-sub 1)) (setf info -1))
 ((or (= cfrom zero)
   (multiple-value-bind (ret-val var-0)
      (disnan cfrom) (declare (ignore))
    (when var-0 (setf cfrom var-0)) ret-val))
  (setf info -4))
 ((multiple-value-bind (ret-val var-0) (disnan cto) (declare (ignore))
   (when var-0 (setf cto var-0)) ret-val)
  (setf info -5))
 ((< m 0) (setf info -6))
 ((or (< n 0) (and (= itype 4) (/= n m)) (and (= itype 5) (/= n m)))
  (setf info -7))
 ((and (<= itype 3)
   (< lda (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 m))))
  (setf info -9))
 ((>= itype 4)
  (cond
   ((or (< kl 0)
     (> kl
      (max (the f2cl-lib:integer4
             (f2cl-lib:int-add m (f2cl-lib:int-sub 1)))
       (the f2cl-lib:integer4 0))))
    (setf info -2))
   ((or (< ku 0)
     (> ku
      (max (the f2cl-lib:integer4
            (f2cl-lib:int-add n (f2cl-lib:int-sub 1)))
```

```
       (the f2cl-lib:integer4 0)))
     (and (or (= itype 4) (= itype 5)) (/= kl ku)))
    (setf info -3))
   ((or (and (= itype 4) (< lda (f2cl-lib:int-add kl 1)))
     (and (= itype 5) (< lda (f2cl-lib:int-add ku 1)))
     (and (= itype 6)
      (< lda (f2cl-lib:int-add (f2cl-lib:int-mul 2 kl) ku 1))))
    (setf info -9)))))
(cond ((/= info 0)
  (xerbla "ZLASCL" (f2cl-lib:int-sub info)) (go end_label)))
(if (or (= n 0) (= m 0)) (go end_label)) (setf smlnum (dlamch "S"))
(setf bignum (/ one smlnum))
(setf cfromc cfrom)
(setf ctoc cto) label10
(setf cfrom1 (* cfromc smlnum))
(cond
 ((= cfrom1 cfromc)
  (setf mul (/ ctoc cfromc))
  (setf done f2cl-lib:%true%)
  (setf cto1 ctoc))
 (t (setf cto1 (/ ctoc bignum))
  (cond
   ((= cto1 ctoc) (setf mul ctoc) (setf done f2cl-lib:%true%)
    (setf cfromc one))
   ((and (> (abs cfrom1) (abs ctoc)) (/= ctoc zero)) (setf mul smlnum)
    (setf done f2cl-lib:%false%) (setf cfromc cfrom1))
   ((> (abs cto1) (abs cfromc))
    (setf mul bignum)
    (setf done f2cl-lib:%false%)
    (setf ctoc cto1))
   (t (setf mul (/ ctoc cfromc)) (setf done f2cl-lib:%true%)))))
(cond
 ((= itype 0)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
         ((> j n) nil)
          (tagbody
              (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
          ((> i m) nil)
           (tagbody
                (setf (f2cl-lib:fref a-%data% (i j)
                      ((1 lda) (1 *)) a-%offset%)
                 (* (f2cl-lib:fref a-%data% (i j)
                      ((1 lda) (1 *)) a-%offset%) mul))
                label20))
               label30)))
 ((= itype 1)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
         ((> j n) nil)
          (tagbody
              (f2cl-lib:fdo (i j (f2cl-lib:int-add i 1))
```

```
          ((> i m) nil)
           (tagbody
                (setf (f2cl-lib:fref a-%data% (i j)
                      ((1 lda) (1 *)) a-%offset%)
                 (* (f2cl-lib:fref a-%data% (i j)
                      ((1 lda) (1 *)) a-%offset%) mul))
                label40))
              label50)))
((= itype 2)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
         (tagbody
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
         ((> i
               (min (the f2cl-lib:integer4 j)
                    (the f2cl-lib:integer4 m)))
              nil)
          (tagbody
                (setf (f2cl-lib:fref a-%data% (i j)
                     ((1 lda) (1 *)) a-%offset%)
                 (* (f2cl-lib:fref a-%data% (i j)
                     ((1 lda) (1 *)) a-%offset%) mul))
                label60))
              label70)))
((= itype 3)
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
         (tagbody
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
         ((> i
               (min (the f2cl-lib:integer4 (f2cl-lib:int-add j 1))
                (the f2cl-lib:integer4 m)))
              nil)
           (tagbody
                (setf (f2cl-lib:fref a-%data% (i j)
                     ((1 lda) (1 *)) a-%offset%)
                 (* (f2cl-lib:fref a-%data% (i j)
                     ((1 lda) (1 *)) a-%offset%) mul))
                label80))
              label90)))
((= itype 4) (setf k3 (f2cl-lib:int-add kl 1))
 (setf k4 (f2cl-lib:int-add n 1))
 (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
        ((> j n) nil)
         (tagbody
             (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
         ((> i
               (min (the f2cl-lib:integer4 k3)
                (the f2cl-lib:integer4
                 (f2cl-lib:int-add k4 (f2cl-lib:int-sub j)))))
```

```
                nil)
               (tagbody
                    (setf (f2cl-lib:fref a-%data% (i j)
                          ((1 lda) (1 *)) a-%offset%)
                     (* (f2cl-lib:fref a-%data% (i j)
                          ((1 lda) (1 *)) a-%offset%) mul))
                    label100))
                  label110)))
          ((= itype 5) (setf k1 (f2cl-lib:int-add ku 2))
           (setf k3 (f2cl-lib:int-add ku 1))
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j n) nil)
                   (tagbody
                       (f2cl-lib:fdo (i
                        (max (the f2cl-lib:integer4
                                  (f2cl-lib:int-add k1 (f2cl-lib:int-sub j)))
                         (the f2cl-lib:integer4 1))
                        (f2cl-lib:int-add i 1))
                    ((> i k3) nil)
                     (tagbody
                          (setf (f2cl-lib:fref a-%data% (i j)
                                ((1 lda) (1 *)) a-%offset%)
                           (* (f2cl-lib:fref a-%data% (i j)
                                ((1 lda) (1 *)) a-%offset%) mul))
                          label120))
                     label130)))
          ((= itype 6) (setf k1 (f2cl-lib:int-add kl ku 2))
           (setf k2 (f2cl-lib:int-add kl 1))
           (setf k3 (f2cl-lib:int-add (f2cl-lib:int-mul 2 kl) ku 1))
           (setf k4 (f2cl-lib:int-add kl ku 1 m))
           (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j n) nil)
                   (tagbody
                       (f2cl-lib:fdo (i
                        (max (the f2cl-lib:integer4
                                  (f2cl-lib:int-add k1 (f2cl-lib:int-sub j)))
                         (the f2cl-lib:integer4 k2))
                        (f2cl-lib:int-add i 1))
                    ((> i
                        (min (the f2cl-lib:integer4 k3)
                         (the f2cl-lib:integer4
                           (f2cl-lib:int-add k4 (f2cl-lib:int-sub j)))))
                     nil)
                     (tagbody
                          (setf (f2cl-lib:fref a-%data% (i j)
                                ((1 lda) (1 *)) a-%offset%)
                           (* (f2cl-lib:fref a-%data% (i j) ((1 lda) (1 *))
                                a-%offset%) mul))
                          label140))
                     label150))))
```

```
        (if (not done) (go label10)) (go end_label) end_label
        (return (values type nil nil cfrom cto nil nil nil nil info))))))
```

———-

6.124 zlaset LAPACK

— **zlaset.input** —

```
)set break resume
)sys rm -f zlaset.output
)spool zlaset.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zlaset.help** —

```
========================================================================
zlaset examples
========================================================================

========================================================================
Man Page Details
========================================================================

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZLASET( UPLO, M, N, ALPHA, BETA, A, LDA )

       .. Scalar Arguments ..
       CHARACTER          UPLO
       INTEGER            LDA, M, N
       COMPLEX*16         ALPHA, BETA
       ..
       .. Array Arguments ..
       COMPLEX*16         A( LDA, * )
```

```
      ..


Purpose:
=============

ZLASET initializes a 2-D array A to BETA on the diagonal and
ALPHA on the offdiagonals.

Arguments:
==========

 [in] UPLO

         UPLO is CHARACTER*1
         Specifies the part of the matrix A to be set.
         = 'U':      Upper triangular part is set. The lower triangle
                     is unchanged.
         = 'L':      Lower triangular part is set. The upper triangle
                     is unchanged.
         Otherwise:  All of the matrix A is set.

 [in] M

         M is INTEGER
         On entry, M specifies the number of rows of A.

 [in] N

         N is INTEGER
         On entry, N specifies the number of columns of A.

 [in] ALPHA

         ALPHA is COMPLEX*16
         All the offdiagonal array elements are set to ALPHA.

 [in] BETA

         BETA is COMPLEX*16
         All the diagonal array elements are set to BETA.

 [in,out] A

         A is COMPLEX*16 array, dimension (LDA,N)
         On entry, the m by n matrix A.
         On exit, A(i,j) = ALPHA, 1 <= i <= m, 1 <= j <= n, i.ne.j;
                  A(i,i) = BETA , 1 <= i <= min(m,n)

 [in] LDA
```

```
          LDA is INTEGER
          The leading dimension of the array A.  LDA >= max(1,M).

 Authors:
 ========

  Univ. of Tennessee
  Univ. of California Berkeley
  Univ. of Colorado Denver
  NAG Ltd.

 November 2011
```

———-

— **zlaset.f** —

```
*  =====================================================================
      SUBROUTINE ZLASET( UPLO, M, N, ALPHA, BETA, A, LDA )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      CHARACTER          UPLO
      INTEGER            LDA, M, N
      COMPLEX*16         ALPHA, BETA
*     ..
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * )
*     ..
*
*  =====================================================================
*
*     .. Local Scalars ..
      INTEGER            I, J
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MIN
*     ..
*     .. Executable Statements ..
```

```
*
      IF( LSAME( UPLO, 'U' ) ) THEN
*
*        Set the diagonal to BETA and the strictly upper triangular
*        part of the array to ALPHA.
*
         DO 20 J = 2, N
            DO 10 I = 1, MIN( J-1, M )
               A( I, J ) = ALPHA
   10       CONTINUE
   20    CONTINUE
         DO 30 I = 1, MIN( N, M )
            A( I, I ) = BETA
   30    CONTINUE
*
      ELSE IF( LSAME( UPLO, 'L' ) ) THEN
*
*        Set the diagonal to BETA and the strictly lower triangular
*        part of the array to ALPHA.
*
         DO 50 J = 1, MIN( M, N )
            DO 40 I = J + 1, M
               A( I, J ) = ALPHA
   40       CONTINUE
   50    CONTINUE
         DO 60 I = 1, MIN( N, M )
            A( I, I ) = BETA
   60    CONTINUE
*
      ELSE
*
*        Set the array to BETA on the diagonal and ALPHA on the
*        offdiagonal.
*
         DO 80 J = 1, N
            DO 70 I = 1, M
               A( I, J ) = ALPHA
   70       CONTINUE
   80    CONTINUE
         DO 90 I = 1, MIN( M, N )
            A( I, I ) = BETA
   90    CONTINUE
      END IF
*
      RETURN
*
*     End of ZLASET
*
      END
```

———-

— **LAPACK zlaset** —

```
(defun zlaset (uplo m n alpha beta a lda)
 (declare (type (simple-array character (*)) uplo)
  (type (f2cl-lib:integer4) lda n m) (type (f2cl-lib:complex16) beta alpha)
  (type (array f2cl-lib:complex16 (*)) a))
 (f2cl-lib:with-multi-array-data
     ((a f2cl-lib:complex16 a-%data% a-%offset%)
      (uplo character uplo-%data% uplo-%offset%))
      (prog ((i 0) (j 0))
       (declare (type (f2cl-lib:integer4) j i))
       (cond
        ((multiple-value-bind (ret-val var-0 var-1) (lsame uplo "U")
          (declare (ignore var-1)) (when var-0 (setf uplo var-0)) ret-val)
         (f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
                 ((> j n) nil)
                  (tagbody
                      (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                       ((> i
                             (min (the f2cl-lib:integer4
                                    (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
                              (the f2cl-lib:integer4 m)))
                        nil)
                       (tagbody
                            (setf (f2cl-lib:fref a-%data% (i j)
                                    ((1 lda) (1 *)) a-%offset%) alpha)
                            label10))
                       label20))
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                  ((> i
                       (min (the f2cl-lib:integer4 n)
                            (the f2cl-lib:integer4 m)))
                     nil)
                   (tagbody
                       (setf (f2cl-lib:fref a-%data% (i i)
                               ((1 lda) (1 *)) a-%offset%) beta)
                       label30)))
         ((multiple-value-bind (ret-val var-0 var-1) (lsame uplo "L")
           (declare (ignore var-1)) (when var-0 (setf uplo var-0)) ret-val)
          (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                  ((> j
                       (min (the f2cl-lib:integer4 m)
                            (the f2cl-lib:integer4 n)))
                     nil)
                   (tagbody
                       (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                                        (f2cl-lib:int-add i 1))
```

```
                ((> i m)
                     nil)
                 (tagbody
                      (setf (f2cl-lib:fref a-%data% (i j)
                              ((1 lda) (1 *)) a-%offset%) alpha)
                      label40))
                    label50))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                ((> i
                     (min (the f2cl-lib:integer4 n)
                          (the f2cl-lib:integer4 m)))
                   nil)
                 (tagbody
                     (setf (f2cl-lib:fref a-%data% (i i)
                             ((1 lda) (1 *)) a-%offset%) beta)
                     label60)))
       (t
        (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
                ((> j n) nil)
                 (tagbody
                     (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                      ((> i m) nil)
                       (tagbody
                            (setf (f2cl-lib:fref a-%data% (i j)
                                    ((1 lda) (1 *)) a-%offset%) alpha)
                      label70))
                     label80))
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                ((> i
                     (min (the f2cl-lib:integer4 m)
                          (the f2cl-lib:integer4 n)))
                   nil)
                 (tagbody
                     (setf (f2cl-lib:fref a-%data% (i i)
                            ((1 lda) (1 *)) a-%offset%) beta)
                     label90))))
      (go end_label)
end_label
      (return (values uplo nil nil nil nil nil nil)))
     ))
```

———-

6.125 zlassq LAPACK

— zlassq.input —

```
)set break resume
)sys rm -f zlassq.output
)spool zlassq.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zlassq.help** —

```
==========================================================================
zlassq examples
==========================================================================

==========================================================================
Man Page Details
==========================================================================

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZLASSQ( N, X, INCX, SCALE, SUMSQ )

       .. Scalar Arguments ..
       INTEGER            INCX, N
       DOUBLE PRECISION   SCALE, SUMSQ
       ..
       .. Array Arguments ..
       COMPLEX*16         X( * )
       ..


 Purpose:
 =============

 ZLASSQ returns the values scl and ssq such that

    ( scl**2 )*ssq = x( 1 )**2 +...+ x( n )**2 + ( scale**2 )*sumsq,

 where x( i ) = abs( X( 1 + ( i - 1 )*INCX ) ). The value of sumsq is
 assumed to be at least unity and the value of ssq will then satisfy
```

```
   1.0 .le. ssq .le. ( sumsq + 2*n ).

scale is assumed to be non-negative and scl returns the value

   scl = max( scale, abs( real( x( i ) ) ), abs( aimag( x( i ) ) ) ),
          i

scale and sumsq must be supplied in SCALE and SUMSQ respectively.
SCALE and SUMSQ are overwritten by scl and ssq respectively.

The routine makes only one pass through the vector X.

Arguments:
==========

 [in] N

         N is INTEGER
         The number of elements to be used from the vector X.

 [in] X

         X is COMPLEX*16 array, dimension (N)
         The vector x as described above.
            x( i )  = X( 1 + ( i - 1 )*INCX ), 1 <= i <= n.

 [in] INCX

         INCX is INTEGER
         The increment between successive values of the vector X.
         INCX > 0.

 [in,out] SCALE

         SCALE is DOUBLE PRECISION
         On entry, the value  scale  in the equation above.
         On exit, SCALE is overwritten with the value  scl .

 [in,out] SUMSQ

         SUMSQ is DOUBLE PRECISION
         On entry, the value  sumsq  in the equation above.
         On exit, SUMSQ is overwritten with the value  ssq .

Authors:
========

 Univ. of Tennessee
 Univ. of California Berkeley
 Univ. of Colorado Denver
```

NAG Ltd.

November 2011

———-

— **zlassq.f** —

```
*  =====================================================================
      SUBROUTINE ZLASSQ( N, X, INCX, SCALE, SUMSQ )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      INTEGER            INCX, N
      DOUBLE PRECISION   SCALE, SUMSQ
*     ..
*     .. Array Arguments ..
      COMPLEX*16         X( * )
*     ..
*
* =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO
      PARAMETER          ( ZERO = 0.0D+0 )
*     ..
*     .. Local Scalars ..
      INTEGER            IX
      DOUBLE PRECISION   TEMP1
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, DBLE, DIMAG
*     ..
*     .. Executable Statements ..
*
      IF( N.GT.0 ) THEN
         DO 10 IX = 1, 1 + ( N-1 )*INCX, INCX
            IF( DBLE( X( IX ) ).NE.ZERO ) THEN
               TEMP1 = ABS( DBLE( X( IX ) ) )
               IF( SCALE.LT.TEMP1 ) THEN
                  SUMSQ = 1 + SUMSQ*( SCALE / TEMP1 )**2
                  SCALE = TEMP1
               ELSE
                  SUMSQ = SUMSQ + ( TEMP1 / SCALE )**2
```

```
            END IF
         END IF
         IF( DIMAG( X( IX ) ).NE.ZERO ) THEN
            TEMP1 = ABS( DIMAG( X( IX ) ) )
            IF( SCALE.LT.TEMP1 ) THEN
               SUMSQ = 1 + SUMSQ*( SCALE / TEMP1 )**2
               SCALE = TEMP1
            ELSE
               SUMSQ = SUMSQ + ( TEMP1 / SCALE )**2
            END IF
         END IF
   10    CONTINUE
      END IF
*
      RETURN
*
*     End of ZLASSQ
*
      END
```

———-

— LAPACK zlassq —

```
(let* ((zero 0.0))
  (declare (type (double-float 0.0 0.0) zero))
  (defun zlassq (n x incx scale sumsq)
    (declare (type (double-float) sumsq scale)
             (type (simple-array (complex double-float) (*)) x)
             (type fixnum incx n))
    (f2cl-lib:with-multi-array-data
        ((x (complex double-float) x-%data% x-%offset%))
      (prog ((temp1 0.0) (ix 0))
        (declare (type (double-float) temp1) (type fixnum ix))
        (cond
          ((> n 0)
           (f2cl-lib:fdo (ix 1 (f2cl-lib:int-add ix incx))
                         ((> ix
                             (f2cl-lib:int-add 1
                              (f2cl-lib:int-mul
                               (f2cl-lib:int-add n
                                (f2cl-lib:int-sub 1))
                               incx)))
                          nil)
             (tagbody
               (cond
                 ((/= (coerce (realpart
                        (f2cl-lib:fref x (ix) ((1 *)))) 'double-float) zero)
```

```
                (setf temp1
                        (abs
                         (coerce (realpart
                          (f2cl-lib:fref x-%data% (ix)
                           ((1 *)) x-%offset%)) 'double-float)))
                (cond
                  ((< scale temp1)
                   (setf sumsq (+ 1 (* sumsq (expt (/ scale temp1) 2))))
                   (setf scale temp1))
                  (t
                   (setf sumsq (+ sumsq (expt (/ temp1 scale) 2)))))))
            (cond
              ((/= (f2cl-lib:dimag (f2cl-lib:fref x (ix) ((1 *)))) zero)
               (setf temp1
                       (abs
                        (f2cl-lib:dimag
                         (f2cl-lib:fref x-%data% (ix) ((1 *)) x-%offset%))))
               (cond
                 ((< scale temp1)
                  (setf sumsq (+ 1 (* sumsq (expt (/ scale temp1) 2))))
                  (setf scale temp1))
                 (t
                  (setf sumsq (+ sumsq (expt (/ temp1 scale) 2))))))))))
      (return (values nil nil nil scale sumsq))))))
```

———-

6.126 zlatrs LAPACK

— **zlatrs.input** —

```
)set break resume
)sys rm -f zlatrs.output
)spool zlatrs.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zlatrs.help** —

```
====================================================================
```

```
zlatrs examples
======================================================================

======================================================================
Man Page Details
======================================================================

 Online html documentation available at
           http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZLATRS( UPLO, TRANS, DIAG, NORMIN, N, A, LDA, X, SCALE,
                          CNORM, INFO )

       .. Scalar Arguments ..
       CHARACTER          DIAG, NORMIN, TRANS, UPLO
       INTEGER            INFO, LDA, N
       DOUBLE PRECISION   SCALE
       ..
       .. Array Arguments ..
       DOUBLE PRECISION   CNORM( * )
       COMPLEX*16         A( LDA, * ), X( * )
       ..


 Purpose:
 =============

 ZLATRS solves one of the triangular systems

    A * x = s*b,  A**T * x = s*b,  or  A**H * x = s*b,

 with scaling to prevent overflow.  Here A is an upper or lower
 triangular matrix, A**T denotes the transpose of A, A**H denotes the
 conjugate transpose of A, x and b are n-element vectors, and s is a
 scaling factor, usually less than or equal to 1, chosen so that the
 components of x will be less than the overflow threshold.  If the
 unscaled problem will not cause overflow, the Level 2 BLAS routine
 ZTRSV is called. If the matrix A is singular (A(j,j) = 0 for some j),
 then s is set to 0 and a non-trivial solution to A*x = 0 is returned.

 Arguments:
 ==========

  [in] UPLO

          UPLO is CHARACTER*1
          Specifies whether the matrix A is upper or lower triangular.
```

```
          = 'U':  Upper triangular
          = 'L':  Lower triangular

  [in] TRANS

          TRANS is CHARACTER*1
          Specifies the operation applied to A.
          = 'N':  Solve A * x = s*b     (No transpose)
          = 'T':  Solve A**T * x = s*b  (Transpose)
          = 'C':  Solve A**H * x = s*b  (Conjugate transpose)

  [in] DIAG

          DIAG is CHARACTER*1
          Specifies whether or not the matrix A is unit triangular.
          = 'N':  Non-unit triangular
          = 'U':  Unit triangular

  [in] NORMIN

          NORMIN is CHARACTER*1
          Specifies whether CNORM has been set or not.
          = 'Y':  CNORM contains the column norms on entry
          = 'N':  CNORM is not set on entry.  On exit, the norms will
                  be computed and stored in CNORM.

  [in] N

          N is INTEGER
          The order of the matrix A.  N >= 0.

  [in] A

          A is COMPLEX*16 array, dimension (LDA,N)
          The triangular matrix A.  If UPLO = 'U', the leading n by n
          upper triangular part of the array A contains the upper
          triangular matrix, and the strictly lower triangular part of
          A is not referenced.  If UPLO = 'L', the leading n by n lower
          triangular part of the array A contains the lower triangular
          matrix, and the strictly upper triangular part of A is not
          referenced.  If DIAG = 'U', the diagonal elements of A are
          also not referenced and are assumed to be 1.

  [in] LDA

          LDA is INTEGER
          The leading dimension of the array A.  LDA >= max (1,N).

  [in,out] X
```

```
          X is COMPLEX*16 array, dimension (N)
          On entry, the right hand side b of the triangular system.
          On exit, X is overwritten by the solution vector x.

  [out] SCALE

          SCALE is DOUBLE PRECISION
          The scaling factor s for the triangular system
             A * x = s*b,  A**T * x = s*b,  or  A**H * x = s*b.
          If SCALE = 0, the matrix A is singular or badly scaled, and
          the vector x is an exact or approximate solution to A*x = 0.

  [in,out] CNORM

          CNORM is or output) DOUBLE PRECISION array, dimension (N)

          If NORMIN = 'Y', CNORM is an input argument and CNORM(j)
          contains the norm of the off-diagonal part of the j-th column
          of A.  If TRANS = 'N', CNORM(j) must be greater than or equal
          to the infinity-norm, and if TRANS = 'T' or 'C', CNORM(j)
          must be greater than or equal to the 1-norm.

          If NORMIN = 'N', CNORM is an output argument and CNORM(j)
          returns the 1-norm of the offdiagonal part of the j-th column
          of A.

  [out] INFO

          INFO is INTEGER
          = 0:  successful exit
          < 0:  if INFO = -k, the k-th argument had an illegal value

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Further Details:
=====================

  A rough bound on x is computed; if that is less than overflow, ZTRSV
  is called, otherwise, specific code is used which checks for possible
  overflow or divide-by-zero at every operation.

  A columnwise scheme is used for solving A*x = b.  The basic algorithm
```

```
if A is lower triangular is

     x[1:n] := b[1:n]
     for j = 1, ..., n
          x(j) := x(j) / A(j,j)
          x[j+1:n] := x[j+1:n] - x(j) * A[j+1:n,j]
     end

Define bounds on the components of x after j iterations of the loop:
   M(j) = bound on x[1:j]
   G(j) = bound on x[j+1:n]
Initially, let M(0) = 0 and G(0) = max{x(i), i=1,...,n}.

Then for iteration j+1 we have
   M(j+1) <= G(j) / | A(j+1,j+1) |
   G(j+1) <= G(j) + M(j+1) * | A[j+2:n,j+1] |
          <= G(j) ( 1 + CNORM(j+1) / | A(j+1,j+1) | )

where CNORM(j+1) is greater than or equal to the infinity-norm of
column j+1 of A, not counting the diagonal.  Hence

   G(j) <= G(0) product ( 1 + CNORM(i) / | A(i,i) | )
                1<=i<=j
and

   |x(j)| <= ( G(0) / |A(j,j)| ) product ( 1 + CNORM(i) / |A(i,i)| )
                                  1<=i< j

Since |x(j)| <= M(j), we use the Level 2 BLAS routine ZTRSV if the
reciprocal of the largest M(j), j=1,..,n, is larger than
max(underflow, 1/overflow).

The bound on x(j) is also used to determine when a step in the
columnwise method can be performed without fear of overflow.  If
the computed bound is greater than a large constant, x is scaled to
prevent overflow, but if the bound overflows, x is set to 0, x(j) to
1, and scale to 0, and a non-trivial solution to A*x = 0 is found.

Similarly, a row-wise scheme is used to solve A**T *x = b  or
A**H *x = b.  The basic algorithm for A upper triangular is

     for j = 1, ..., n
          x(j) := ( b(j) - A[1:j-1,j]' * x[1:j-1] ) / A(j,j)
     end

We simultaneously compute two bounds
     G(j) = bound on ( b(i) - A[1:i-1,i]' * x[1:i-1] ), 1<=i<=j
     M(j) = bound on x(i), 1<=i<=j

The initial values are G(0) = 0, M(0) = max{b(i), i=1,..,n}, and we
```

```
  add the constraint G(j) >= G(j-1) and M(j) >= M(j-1) for j >= 1.
  Then the bound on x(j) is

       M(j) <= M(j-1) * ( 1 + CNORM(j) ) / | A(j,j) |

            <= M(0) * product ( ( 1 + CNORM(i) ) / |A(i,i)| )
                      1<=i<=j

  and we can safely call ZTRSV if 1/M(n) and 1/G(n) are both greater
  than max(underflow, 1/overflow).
```

———-

— zlatrs.f —

```
*  =====================================================================
      SUBROUTINE ZLATRS( UPLO, TRANS, DIAG, NORMIN, N, A, LDA, X, SCALE,
     $                   CNORM, INFO )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      CHARACTER          DIAG, NORMIN, TRANS, UPLO
      INTEGER            INFO, LDA, N
      DOUBLE PRECISION   SCALE
*     ..
*     .. Array Arguments ..
      DOUBLE PRECISION   CNORM( * )
      COMPLEX*16         A( LDA, * ), X( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, HALF, ONE, TWO
      PARAMETER          ( ZERO = 0.0D+0, HALF = 0.5D+0, ONE = 1.0D+0,
     $                   TWO = 2.0D+0 )
*     ..
*     .. Local Scalars ..
      LOGICAL            NOTRAN, NOUNIT, UPPER
      INTEGER            I, IMAX, J, JFIRST, JINC, JLAST
      DOUBLE PRECISION   BIGNUM, GROW, REC, SMLNUM, TJJ, TMAX, TSCAL,
     $                   XBND, XJ, XMAX
      COMPLEX*16         CSUMJ, TJJS, USCAL, ZDUM
*     ..
```

```
*     .. External Functions ..
      LOGICAL            LSAME
      INTEGER            IDAMAX, IZAMAX
      DOUBLE PRECISION   DLAMCH, DZASUM
      COMPLEX*16         ZDOTC, ZDOTU, ZLADIV
      EXTERNAL           LSAME, IDAMAX, IZAMAX, DLAMCH, DZASUM, ZDOTC,
     $                   ZDOTU, ZLADIV
*     ..
*     .. External Subroutines ..
      EXTERNAL           DSCAL, XERBLA, ZAXPY, ZDSCAL, ZTRSV
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, DBLE, DCMPLX, DCONJG, DIMAG, MAX, MIN
*     ..
*     .. Statement Functions ..
      DOUBLE PRECISION   CABS1, CABS2
*     ..
*     .. Statement Function definitions ..
      CABS1( ZDUM ) = ABS( DBLE( ZDUM ) ) + ABS( DIMAG( ZDUM ) )
      CABS2( ZDUM ) = ABS( DBLE( ZDUM ) / 2.D0 ) +
     $                ABS( DIMAG( ZDUM ) / 2.D0 )
*     ..
*     .. Executable Statements ..
*
      INFO = 0
      UPPER = LSAME( UPLO, 'U' )
      NOTRAN = LSAME( TRANS, 'N' )
      NOUNIT = LSAME( DIAG, 'N' )
*
*     Test the input parameters.
*
      IF( .NOT.UPPER .AND. .NOT.LSAME( UPLO, 'L' ) ) THEN
         INFO = -1
      ELSE IF( .NOT.NOTRAN .AND. .NOT.LSAME( TRANS, 'T' ) .AND. .NOT.
     $         LSAME( TRANS, 'C' ) ) THEN
         INFO = -2
      ELSE IF( .NOT.NOUNIT .AND. .NOT.LSAME( DIAG, 'U' ) ) THEN
         INFO = -3
      ELSE IF( .NOT.LSAME( NORMIN, 'Y' ) .AND. .NOT.
     $         LSAME( NORMIN, 'N' ) ) THEN
         INFO = -4
      ELSE IF( N.LT.0 ) THEN
         INFO = -5
      ELSE IF( LDA.LT.MAX( 1, N ) ) THEN
         INFO = -7
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'ZLATRS', -INFO )
         RETURN
      END IF
```

```
*
*     Quick return if possible
*
      IF( N.EQ.0 )
     $   RETURN
*
*     Determine machine dependent parameters to control overflow.
*
      SMLNUM = DLAMCH( 'Safe minimum' )
      BIGNUM = ONE / SMLNUM
      CALL DLABAD( SMLNUM, BIGNUM )
      SMLNUM = SMLNUM / DLAMCH( 'Precision' )
      BIGNUM = ONE / SMLNUM
      SCALE = ONE
*
      IF( LSAME( NORMIN, 'N' ) ) THEN
*
*        Compute the 1-norm of each column, not including the diagonal.
*
         IF( UPPER ) THEN
*
*           A is upper triangular.
*
            DO 10 J = 1, N
               CNORM( J ) = DZASUM( J-1, A( 1, J ), 1 )
   10       CONTINUE
         ELSE
*
*           A is lower triangular.
*
            DO 20 J = 1, N - 1
               CNORM( J ) = DZASUM( N-J, A( J+1, J ), 1 )
   20       CONTINUE
            CNORM( N ) = ZERO
         END IF
      END IF
*
*     Scale the column norms by TSCAL if the maximum element in CNORM is
*     greater than BIGNUM/2.
*
      IMAX = IDAMAX( N, CNORM, 1 )
      TMAX = CNORM( IMAX )
      IF( TMAX.LE.BIGNUM*HALF ) THEN
         TSCAL = ONE
      ELSE
         TSCAL = HALF / ( SMLNUM*TMAX )
         CALL DSCAL( N, TSCAL, CNORM, 1 )
      END IF
*
*     Compute a bound on the computed solution vector to see if the
```

```
*     Level 2 BLAS routine ZTRSV can be used.
*
      XMAX = ZERO
      DO 30 J = 1, N
         XMAX = MAX( XMAX, CABS2( X( J ) ) )
   30 CONTINUE
      XBND = XMAX
*
      IF( NOTRAN ) THEN
*
*        Compute the growth in A * x = b.
*
         IF( UPPER ) THEN
            JFIRST = N
            JLAST = 1
            JINC = -1
         ELSE
            JFIRST = 1
            JLAST = N
            JINC = 1
         END IF
*
         IF( TSCAL.NE.ONE ) THEN
            GROW = ZERO
            GO TO 60
         END IF
*
         IF( NOUNIT ) THEN
*
*           A is non-unit triangular.
*
*           Compute GROW = 1/G(j) and XBND = 1/M(j).
*           Initially, G(0) = max{x(i), i=1,...,n}.
*
            GROW = HALF / MAX( XBND, SMLNUM )
            XBND = GROW
            DO 40 J = JFIRST, JLAST, JINC
*
*              Exit the loop if the growth factor is too small.
*
               IF( GROW.LE.SMLNUM )
     $            GO TO 60
*
               TJJS = A( J, J )
               TJJ = CABS1( TJJS )
*
               IF( TJJ.GE.SMLNUM ) THEN
*
*                 M(j) = G(j-1) / abs(A(j,j))
*
```

```
                  XBND = MIN( XBND, MIN( ONE, TJJ )*GROW )
               ELSE
*
*                 M(j) could overflow, set XBND to 0.
*
                  XBND = ZERO
               END IF
*
               IF( TJJ+CNORM( J ).GE.SMLNUM ) THEN
*
*                 G(j) = G(j-1)*( 1 + CNORM(j) / abs(A(j,j)) )
*
                  GROW = GROW*( TJJ / ( TJJ+CNORM( J ) ) )
               ELSE
*
*                 G(j) could overflow, set GROW to 0.
*
                  GROW = ZERO
               END IF
   40       CONTINUE
            GROW = XBND
         ELSE
*
*           A is unit triangular.
*
*           Compute GROW = 1/G(j), where G(0) = max{x(i), i=1,...,n}.
*
            GROW = MIN( ONE, HALF / MAX( XBND, SMLNUM ) )
            DO 50 J = JFIRST, JLAST, JINC
*
*              Exit the loop if the growth factor is too small.
*
               IF( GROW.LE.SMLNUM )
     $            GO TO 60
*
*              G(j) = G(j-1)*( 1 + CNORM(j) )
*
               GROW = GROW*( ONE / ( ONE+CNORM( J ) ) )
   50       CONTINUE
         END IF
   60    CONTINUE
*
      ELSE
*
*        Compute the growth in A**T * x = b  or  A**H * x = b.
*
         IF( UPPER ) THEN
            JFIRST = 1
            JLAST = N
            JINC = 1
```

```
         ELSE
            JFIRST = N
            JLAST = 1
            JINC = -1
         END IF
*
         IF( TSCAL.NE.ONE ) THEN
            GROW = ZERO
            GO TO 90
         END IF
*
         IF( NOUNIT ) THEN
*
*           A is non-unit triangular.
*
*           Compute GROW = 1/G(j) and XBND = 1/M(j).
*           Initially, M(0) = max{x(i), i=1,...,n}.
*
            GROW = HALF / MAX( XBND, SMLNUM )
            XBND = GROW
            DO 70 J = JFIRST, JLAST, JINC
*
*              Exit the loop if the growth factor is too small.
*
               IF( GROW.LE.SMLNUM )
     $            GO TO 90
*
*              G(j) = max( G(j-1), M(j-1)*( 1 + CNORM(j) ) )
*
               XJ = ONE + CNORM( J )
               GROW = MIN( GROW, XBND / XJ )
*
               TJJS = A( J, J )
               TJJ = CABS1( TJJS )
*
               IF( TJJ.GE.SMLNUM ) THEN
*
*                 M(j) = M(j-1)*( 1 + CNORM(j) ) / abs(A(j,j))
*
                  IF( XJ.GT.TJJ )
     $               XBND = XBND*( TJJ / XJ )
               ELSE
*
*                 M(j) could overflow, set XBND to 0.
*
                  XBND = ZERO
               END IF
   70       CONTINUE
            GROW = MIN( GROW, XBND )
         ELSE
```

```
*
*           A is unit triangular.
*
*           Compute GROW = 1/G(j), where G(0) = max{x(i), i=1,...,n}.
*
            GROW = MIN( ONE, HALF / MAX( XBND, SMLNUM ) )
            DO 80 J = JFIRST, JLAST, JINC
*
*              Exit the loop if the growth factor is too small.
*
               IF( GROW.LE.SMLNUM )
     $            GO TO 90
*
*              G(j) = ( 1 + CNORM(j) )*G(j-1)
*
               XJ = ONE + CNORM( J )
               GROW = GROW / XJ
   80       CONTINUE
         END IF
   90    CONTINUE
      END IF
*
      IF( ( GROW*TSCAL ).GT.SMLNUM ) THEN
*
*        Use the Level 2 BLAS solve if the reciprocal of the bound on
*        elements of X is not too small.
*
         CALL ZTRSV( UPLO, TRANS, DIAG, N, A, LDA, X, 1 )
      ELSE
*
*        Use a Level 1 BLAS solve, scaling intermediate results.
*
         IF( XMAX.GT.BIGNUM*HALF ) THEN
*
*           Scale X so that its components are less than or equal to
*           BIGNUM in absolute value.
*
            SCALE = ( BIGNUM*HALF ) / XMAX
            CALL ZDSCAL( N, SCALE, X, 1 )
            XMAX = BIGNUM
         ELSE
            XMAX = XMAX*TWO
         END IF
*
         IF( NOTRAN ) THEN
*
*           Solve A * x = b
*
            DO 120 J = JFIRST, JLAST, JINC
*
```

```
*              Compute x(j) = b(j) / A(j,j), scaling x if necessary.
*
               XJ = CABS1( X( J ) )
               IF( NOUNIT ) THEN
                  TJJS = A( J, J )*TSCAL
               ELSE
                  TJJS = TSCAL
                  IF( TSCAL.EQ.ONE )
     $               GO TO 110
               END IF
               TJJ = CABS1( TJJS )
               IF( TJJ.GT.SMLNUM ) THEN
*
*                    abs(A(j,j)) > SMLNUM:
*
                  IF( TJJ.LT.ONE ) THEN
                     IF( XJ.GT.TJJ*BIGNUM ) THEN
*
*                          Scale x by 1/b(j).
*
                        REC = ONE / XJ
                        CALL ZDSCAL( N, REC, X, 1 )
                        SCALE = SCALE*REC
                        XMAX = XMAX*REC
                     END IF
                  END IF
                  X( J ) = ZLADIV( X( J ), TJJS )
                  XJ = CABS1( X( J ) )
               ELSE IF( TJJ.GT.ZERO ) THEN
*
*                    0 < abs(A(j,j)) <= SMLNUM:
*
                  IF( XJ.GT.TJJ*BIGNUM ) THEN
*
*                       Scale x by (1/abs(x(j)))*abs(A(j,j))*BIGNUM
*                       to avoid overflow when dividing by A(j,j).
*
                     REC = ( TJJ*BIGNUM ) / XJ
                     IF( CNORM( J ).GT.ONE ) THEN
*
*                          Scale by 1/CNORM(j) to avoid overflow when
*                          multiplying x(j) times column j.
*
                        REC = REC / CNORM( J )
                     END IF
                     CALL ZDSCAL( N, REC, X, 1 )
                     SCALE = SCALE*REC
                     XMAX = XMAX*REC
                  END IF
                  X( J ) = ZLADIV( X( J ), TJJS )
```

```
                  XJ = CABS1( X( J ) )
               ELSE
*
*                    A(j,j) = 0:  Set x(1:n) = 0, x(j) = 1, and
*                    scale = 0, and compute a solution to A*x = 0.
*
                  DO 100 I = 1, N
                     X( I ) = ZERO
  100             CONTINUE
                  X( J ) = ONE
                  XJ = ONE
                  SCALE = ZERO
                  XMAX = ZERO
               END IF
  110          CONTINUE
*
*              Scale x if necessary to avoid overflow when adding a
*              multiple of column j of A.
*
               IF( XJ.GT.ONE ) THEN
                  REC = ONE / XJ
                  IF( CNORM( J ).GT.( BIGNUM-XMAX )*REC ) THEN
*
*                    Scale x by 1/(2*abs(x(j))).
*
                     REC = REC*HALF
                     CALL ZDSCAL( N, REC, X, 1 )
                     SCALE = SCALE*REC
                  END IF
               ELSE IF( XJ*CNORM( J ).GT.( BIGNUM-XMAX ) ) THEN
*
*                 Scale x by 1/2.
*
                  CALL ZDSCAL( N, HALF, X, 1 )
                  SCALE = SCALE*HALF
               END IF
*
               IF( UPPER ) THEN
                  IF( J.GT.1 ) THEN
*
*                    Compute the update
*                       x(1:j-1) := x(1:j-1) - x(j) * A(1:j-1,j)
*
                     CALL ZAXPY( J-1, -X( J )*TSCAL, A( 1, J ), 1, X,
     $                            1 )
                     I = IZAMAX( J-1, X, 1 )
                     XMAX = CABS1( X( I ) )
                  END IF
               ELSE
                  IF( J.LT.N ) THEN
```

```
*
*                    Compute the update
*                       x(j+1:n) := x(j+1:n) - x(j) * A(j+1:n,j)
*
                     CALL ZAXPY( N-J, -X( J )*TSCAL, A( J+1, J ), 1,
     $                           X( J+1 ), 1 )
                     I = J + IZAMAX( N-J, X( J+1 ), 1 )
                     XMAX = CABS1( X( I ) )
                  END IF
               END IF
  120       CONTINUE
*
         ELSE IF( LSAME( TRANS, 'T' ) ) THEN
*
*           Solve A**T * x = b
*
            DO 170 J = JFIRST, JLAST, JINC
*
*              Compute x(j) = b(j) - sum A(k,j)*x(k).
*                                    k<>j
*
               XJ = CABS1( X( J ) )
               USCAL = TSCAL
               REC = ONE / MAX( XMAX, ONE )
               IF( CNORM( J ).GT.( BIGNUM-XJ )*REC ) THEN
*
*                 If x(j) could overflow, scale x by 1/(2*XMAX).
*
                  REC = REC*HALF
                  IF( NOUNIT ) THEN
                     TJJS = A( J, J )*TSCAL
                  ELSE
                     TJJS = TSCAL
                  END IF
                  TJJ = CABS1( TJJS )
                  IF( TJJ.GT.ONE ) THEN
*
*                       Divide by A(j,j) when scaling x if A(j,j) > 1.
*
                     REC = MIN( ONE, REC*TJJ )
                     USCAL = ZLADIV( USCAL, TJJS )
                  END IF
                  IF( REC.LT.ONE ) THEN
                     CALL ZDSCAL( N, REC, X, 1 )
                     SCALE = SCALE*REC
                     XMAX = XMAX*REC
                  END IF
               END IF
*
               CSUMJ = ZERO
```

```
            IF( USCAL.EQ.DCMPLX( ONE ) ) THEN
*
*              If the scaling needed for A in the dot product is 1,
*              call ZDOTU to perform the dot product.
*
               IF( UPPER ) THEN
                  CSUMJ = ZDOTU( J-1, A( 1, J ), 1, X, 1 )
               ELSE IF( J.LT.N ) THEN
                  CSUMJ = ZDOTU( N-J, A( J+1, J ), 1, X( J+1 ), 1 )
               END IF
            ELSE
*
*              Otherwise, use in-line code for the dot product.
*
               IF( UPPER ) THEN
                  DO 130 I = 1, J - 1
                     CSUMJ = CSUMJ + ( A( I, J )*USCAL )*X( I )
  130             CONTINUE
               ELSE IF( J.LT.N ) THEN
                  DO 140 I = J + 1, N
                     CSUMJ = CSUMJ + ( A( I, J )*USCAL )*X( I )
  140             CONTINUE
               END IF
            END IF
*
            IF( USCAL.EQ.DCMPLX( TSCAL ) ) THEN
*
*              Compute x(j) := ( x(j) - CSUMJ ) / A(j,j) if 1/A(j,j)
*              was not used to scale the dotproduct.
*
               X( J ) = X( J ) - CSUMJ
               XJ = CABS1( X( J ) )
               IF( NOUNIT ) THEN
                  TJJS = A( J, J )*TSCAL
               ELSE
                  TJJS = TSCAL
                  IF( TSCAL.EQ.ONE )
     $               GO TO 160
               END IF
*
*                 Compute x(j) = x(j) / A(j,j), scaling if necessary.
*
               TJJ = CABS1( TJJS )
               IF( TJJ.GT.SMLNUM ) THEN
*
*                    abs(A(j,j)) > SMLNUM:
*
                  IF( TJJ.LT.ONE ) THEN
                     IF( XJ.GT.TJJ*BIGNUM ) THEN
*
```

```
*                           Scale X by 1/abs(x(j)).
*
                            REC = ONE / XJ
                            CALL ZDSCAL( N, REC, X, 1 )
                            SCALE = SCALE*REC
                            XMAX = XMAX*REC
                         END IF
                      END IF
                      X( J ) = ZLADIV( X( J ), TJJS )
                   ELSE IF( TJJ.GT.ZERO ) THEN
*
*                     0 < abs(A(j,j)) <= SMLNUM:
*
                      IF( XJ.GT.TJJ*BIGNUM ) THEN
*
*                        Scale x by (1/abs(x(j)))*abs(A(j,j))*BIGNUM.
*
                         REC = ( TJJ*BIGNUM ) / XJ
                         CALL ZDSCAL( N, REC, X, 1 )
                         SCALE = SCALE*REC
                         XMAX = XMAX*REC
                      END IF
                      X( J ) = ZLADIV( X( J ), TJJS )
                   ELSE
*
*                     A(j,j) = 0:  Set x(1:n) = 0, x(j) = 1, and
*                     scale = 0 and compute a solution to A**T *x = 0.
*
                      DO 150 I = 1, N
                         X( I ) = ZERO
  150                 CONTINUE
                      X( J ) = ONE
                      SCALE = ZERO
                      XMAX = ZERO
                   END IF
  160              CONTINUE
                ELSE
*
*                  Compute x(j) := x(j) / A(j,j) - CSUMJ if the dot
*                  product has already been divided by 1/A(j,j).
*
                   X( J ) = ZLADIV( X( J ), TJJS ) - CSUMJ
                END IF
                XMAX = MAX( XMAX, CABS1( X( J ) ) )
  170        CONTINUE
*
         ELSE
*
*           Solve A**H * x = b
*
```

```
            DO 220 J = JFIRST, JLAST, JINC
*
*              Compute x(j) = b(j) - sum A(k,j)*x(k).
*                                    k<>j
*
               XJ = CABS1( X( J ) )
               USCAL = TSCAL
               REC = ONE / MAX( XMAX, ONE )
               IF( CNORM( J ).GT.( BIGNUM-XJ )*REC ) THEN
*
*                 If x(j) could overflow, scale x by 1/(2*XMAX).
*
                  REC = REC*HALF
                  IF( NOUNIT ) THEN
                     TJJS = DCONJG( A( J, J ) )*TSCAL
                  ELSE
                     TJJS = TSCAL
                  END IF
                  TJJ = CABS1( TJJS )
                  IF( TJJ.GT.ONE ) THEN
*
*                       Divide by A(j,j) when scaling x if A(j,j) > 1.
*
                     REC = MIN( ONE, REC*TJJ )
                     USCAL = ZLADIV( USCAL, TJJS )
                  END IF
                  IF( REC.LT.ONE ) THEN
                     CALL ZDSCAL( N, REC, X, 1 )
                     SCALE = SCALE*REC
                     XMAX = XMAX*REC
                  END IF
               END IF
*
               CSUMJ = ZERO
               IF( USCAL.EQ.DCMPLX( ONE ) ) THEN
*
*                 If the scaling needed for A in the dot product is 1,
*                 call ZDOTC to perform the dot product.
*
                  IF( UPPER ) THEN
                     CSUMJ = ZDOTC( J-1, A( 1, J ), 1, X, 1 )
                  ELSE IF( J.LT.N ) THEN
                     CSUMJ = ZDOTC( N-J, A( J+1, J ), 1, X( J+1 ), 1 )
                  END IF
               ELSE
*
*                 Otherwise, use in-line code for the dot product.
*
                  IF( UPPER ) THEN
                     DO 180 I = 1, J - 1
```

```
                     CSUMJ = CSUMJ + ( DCONJG( A( I, J ) )*USCAL )*
     $                       X( I )
  180             CONTINUE
                  ELSE IF( J.LT.N ) THEN
                     DO 190 I = J + 1, N
                        CSUMJ = CSUMJ + ( DCONJG( A( I, J ) )*USCAL )*
     $                       X( I )
  190                CONTINUE
                  END IF
               END IF
*
               IF( USCAL.EQ.DCMPLX( TSCAL ) ) THEN
*
*                 Compute x(j) := ( x(j) - CSUMJ ) / A(j,j) if 1/A(j,j)
*                 was not used to scale the dotproduct.
*
                  X( J ) = X( J ) - CSUMJ
                  XJ = CABS1( X( J ) )
                  IF( NOUNIT ) THEN
                     TJJS = DCONJG( A( J, J ) )*TSCAL
                  ELSE
                     TJJS = TSCAL
                     IF( TSCAL.EQ.ONE )
     $                  GO TO 210
                  END IF
*
*                    Compute x(j) = x(j) / A(j,j), scaling if necessary.
*
                  TJJ = CABS1( TJJS )
                  IF( TJJ.GT.SMLNUM ) THEN
*
*                       abs(A(j,j)) > SMLNUM:
*
                     IF( TJJ.LT.ONE ) THEN
                        IF( XJ.GT.TJJ*BIGNUM ) THEN
*
*                             Scale X by 1/abs(x(j)).
*
                           REC = ONE / XJ
                           CALL ZDSCAL( N, REC, X, 1 )
                           SCALE = SCALE*REC
                           XMAX = XMAX*REC
                        END IF
                     END IF
                     X( J ) = ZLADIV( X( J ), TJJS )
                  ELSE IF( TJJ.GT.ZERO ) THEN
*
*                       0 < abs(A(j,j)) <= SMLNUM:
*
                     IF( XJ.GT.TJJ*BIGNUM ) THEN
```

```
*
*                        Scale x by (1/abs(x(j)))*abs(A(j,j))*BIGNUM.
*
                         REC = ( TJJ*BIGNUM ) / XJ
                         CALL ZDSCAL( N, REC, X, 1 )
                         SCALE = SCALE*REC
                         XMAX = XMAX*REC
                      END IF
                      X( J ) = ZLADIV( X( J ), TJJS )
                   ELSE
*
*                        A(j,j) = 0:  Set x(1:n) = 0, x(j) = 1, and
*                        scale = 0 and compute a solution to A**H *x = 0.
*
                      DO 200 I = 1, N
                         X( I ) = ZERO
  200                 CONTINUE
                      X( J ) = ONE
                      SCALE = ZERO
                      XMAX = ZERO
                   END IF
  210              CONTINUE
                ELSE
*
*                  Compute x(j) := x(j) / A(j,j) - CSUMJ if the dot
*                  product has already been divided by 1/A(j,j).
*
                   X( J ) = ZLADIV( X( J ), TJJS ) - CSUMJ
                END IF
                XMAX = MAX( XMAX, CABS1( X( J ) ) )
  220        CONTINUE
          END IF
          SCALE = SCALE / TSCAL
       END IF
*
*     Scale the column norms by 1/TSCAL for return.
*
      IF( TSCAL.NE.ONE ) THEN
         CALL DSCAL( N, ONE / TSCAL, CNORM, 1 )
      END IF
*
      RETURN
*
*     End of ZLATRS
*
      END
```

— LAPACK zlatrs —

```
(let* ((zero 0.0d0) (half 0.5d0) (one 1.0d0) (two 2.0d0))
 (declare (type (double-float 0.0d0 0.0d0) zero)
  (type (double-float 0.5d0 0.5d0) half) (type (double-float 1.0d0 1.0d0) one)
  (type (double-float 2.0d0 2.0d0) two) (ignorable zero half one two))
 (defun zlatrs (uplo trans diag normin n a lda x scale cnorm info)
  (declare (type (simple-array character (*)) normin diag trans uplo)
   (type (f2cl-lib:integer4) info lda n)
   (type (array f2cl-lib:complex16 (*)) x a) (type (double-float) scale)
   (type (array double-float (*)) cnorm))
  (f2cl-lib:with-multi-array-data
      ((cnorm double-float cnorm-%data%
        cnorm-%offset%)
       (a f2cl-lib:complex16 a-%data% a-%offset%)
       (x f2cl-lib:complex16 x-%data% x-%offset%)
       (uplo character uplo-%data% uplo-%offset%)
       (trans character trans-%data% trans-%offset%)
       (diag character diag-%data% diag-%offset%)
       (normin character normin-%data% normin-%offset%))
       (labels
        ((cabs1 (zdum) (+ (abs (f2cl-lib:dble zdum))
                          (abs (f2cl-lib:dimag zdum))))
         (cabs2 (zdum)
          (+ (abs (/ (f2cl-lib:dble zdum) 2.0d0))
           (abs (/ (f2cl-lib:dimag zdum) 2.0d0)))))
        (declare
         (ftype (function (f2cl-lib:complex16)
                 (values double-float &rest t)) cabs1))
        (declare
         (ftype (function (f2cl-lib:complex16)
                (values double-float &rest t)) cabs2))
        (prog
         ((csumj #C(0.0d0 0.0d0)) (tjjs #C(0.0d0 0.0d0))
          (uscal #C(0.0d0 0.0d0))
          (zdum #C(0.0d0 0.0d0)) (bignum 0.0d0) (grow 0.0d0) (rec 0.0d0)
          (smlnum 0.0d0) (tjj 0.0d0) (tmax 0.0d0) (tscal 0.0d0) (xbnd 0.0d0)
          (xj 0.0d0) (xmax 0.0d0) (i 0) (imax 0) (j 0) (jfirst 0)
          (jinc 0) (jlast 0)
          (notran nil) (nounit nil) (upper nil))
         (declare (type (f2cl-lib:complex16) zdum uscal tjjs csumj)
          (type (double-float) xmax xj xbnd tscal tmax tjj
                               smlnum rec grow bignum)
          (type (f2cl-lib:integer4) jlast jinc jfirst j imax i)
          (type f2cl-lib:logical upper nounit notran))
         (setf info 0)
         (setf upper
          (multiple-value-bind (ret-val var-0 var-1) (lsame uplo "U")
           (declare (ignore var-1)) (when var-0 (setf uplo var-0)) ret-val))
```

```
(setf notran
 (multiple-value-bind (ret-val var-0 var-1) (lsame trans "N")
  (declare (ignore var-1)) (when var-0 (setf trans var-0)) ret-val))
(setf nounit
 (multiple-value-bind (ret-val var-0 var-1) (lsame diag "N")
  (declare (ignore var-1)) (when var-0 (setf diag var-0)) ret-val))
(cond
 ((and (not upper)
   (not
    (multiple-value-bind (ret-val var-0 var-1) (lsame uplo "L")
     (declare (ignore var-1))
     (when var-0 (setf uplo var-0)) ret-val)))
  (setf info -1))
 ((and (not notran)
   (not
    (multiple-value-bind (ret-val var-0 var-1) (lsame trans "T")
     (declare (ignore var-1))
     (when var-0 (setf trans var-0)) ret-val))
   (not
    (multiple-value-bind (ret-val var-0 var-1) (lsame trans "C")
     (declare (ignore var-1))
     (when var-0 (setf trans var-0)) ret-val)))
  (setf info -2))
 ((and (not nounit)
   (not
    (multiple-value-bind (ret-val var-0 var-1) (lsame diag "U")
     (declare (ignore var-1))
     (when var-0 (setf diag var-0)) ret-val)))
  (setf info -3))
 ((and
   (not
    (multiple-value-bind (ret-val var-0 var-1) (lsame normin "Y")
     (declare (ignore var-1))
     (when var-0 (setf normin var-0)) ret-val))
   (not
    (multiple-value-bind (ret-val var-0 var-1) (lsame normin "N")
     (declare (ignore var-1))
     (when var-0 (setf normin var-0)) ret-val)))
  (setf info -4))
 ((< n 0) (setf info -5))
 ((< lda (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 n)))
  (setf info -7)))
(cond ((/= info 0)
   (xerbla "ZLATRS" (f2cl-lib:int-sub info)) (go end_label)))
(if (= n 0) (go end_label)) (setf smlnum (dlamch "Safe minimum"))
(setf bignum (/ one smlnum))
(multiple-value-bind (var-0 var-1)
  (dlabad smlnum bignum) (declare (ignore))
 (when var-0 (setf smlnum var-0)) (when var-1 (setf bignum var-1)))
(setf smlnum (/ smlnum (dlamch "Precision")))
```

```
(setf bignum (/ one smlnum))
(setf scale one)
(cond
 ((multiple-value-bind (ret-val var-0 var-1) (lsame normin "N")
   (declare (ignore var-1)) (when var-0 (setf normin var-0)) ret-val)
  (cond
   (upper
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
           ((> j n) nil)
            (tagbody
                   (setf (f2cl-lib:fref cnorm-%data% (j)
                             ((1 *)) cnorm-%offset%)
                    (dzasum (f2cl-lib:int-sub j 1)
                     (f2cl-lib:array-slice a-%data%
                      f2cl-lib:complex16 (1 j)
                      ((1 lda) (1 *)) a-%offset%)
                     1))
                   label10)))
   (t
    (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
           ((> j
                   (f2cl-lib:int-add n (f2cl-lib:int-sub 1)))
                 nil)
            (tagbody
                   (setf (f2cl-lib:fref cnorm-%data% (j)
                           ((1 *)) cnorm-%offset%)
                    (dzasum (f2cl-lib:int-sub n j)
                     (f2cl-lib:array-slice a-%data%
                      f2cl-lib:complex16 ((+ j 1) j)
                      ((1 lda) (1 *)) a-%offset%)
                     1))
                   label20))
    (setf (f2cl-lib:fref cnorm-%data% (n)
            ((1 *)) cnorm-%offset%) zero)))))
(setf imax
 (multiple-value-bind (ret-val var-0 var-1 var-2) (idamax n cnorm 1)
  (declare (ignore var-1 var-2)) (when var-0 (setf n var-0)) ret-val))
(setf tmax (f2cl-lib:fref cnorm-%data% (imax) ((1 *)) cnorm-%offset%))
(cond ((<= tmax (* bignum half)) (setf tscal one))
 (t (setf tscal (/ half (* smlnum tmax)))
  (multiple-value-bind (var-0 var-1 var-2 var-3)
   (dscal n tscal cnorm 1)
   (declare (ignore var-2 var-3)) (when var-0 (setf n var-0))
   (when var-1 (setf tscal var-1)))))
(setf xmax zero)
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
       ((> j n) nil)
        (tagbody
           (setf xmax
            (max xmax (cabs2 (f2cl-lib:fref x-%data% (j)
```

```
                                ((1 *)) x-%offset%))))
           label30))
(setf xbnd xmax)
(cond
 (notran
  (tagbody
   (cond (upper (setf jfirst n) (setf jlast 1) (setf jinc -1))
    (t (setf jfirst 1) (setf jlast n) (setf jinc 1)))
   (cond ((/= tscal one) (setf grow zero) (go label60)))
   (cond
    (nounit (setf grow (/ half (max xbnd smlnum))) (setf xbnd grow)
     (f2cl-lib:fdo (j jfirst (f2cl-lib:int-add j jinc))
            ((> j jlast) nil)
             (tagbody
                     (if (<= grow smlnum) (go label60))
                     (setf tjjs (f2cl-lib:fref a-%data% (j j)
                                 ((1 lda) (1 *)) a-%offset%))
                     (setf tjj (cabs1 tjjs))
                     (cond ((>= tjj smlnum)
                      (setf xbnd (min xbnd (* (min one tjj) grow))))
                      (t (setf xbnd zero)))
                     (cond
                      ((>= (+ tjj (f2cl-lib:fref cnorm (j)
                                   ((1 *)))) smlnum)
                       (setf grow
                        (* grow
                         (/ tjj
                          (+ tjj
                           (f2cl-lib:fref cnorm-%data% (j)
                            ((1 *)) cnorm-%offset%))))))
                      (t (setf grow zero)))
                     label40))
     (setf grow xbnd))
    (t (setf grow (min one (/ half (max xbnd smlnum))))
     (f2cl-lib:fdo (j jfirst (f2cl-lib:int-add j jinc))
            ((> j jlast) nil)
             (tagbody
                     (if (<= grow smlnum) (go label60))
                     (setf grow
                      (* grow
                       (/ one
                        (+ one (f2cl-lib:fref cnorm-%data% (j)
                                 ((1 *)) cnorm-%offset%)))))
                     label50))))
   label60))
 (t
  (tagbody
   (cond (upper (setf jfirst 1) (setf jlast n) (setf jinc 1))
    (t (setf jfirst n) (setf jlast 1) (setf jinc -1)))
   (cond ((/= tscal one) (setf grow zero) (go label90)))
```

```
    (cond
     (nounit (setf grow (/ half (max xbnd smlnum))) (setf xbnd grow)
      (f2cl-lib:fdo (j jfirst (f2cl-lib:int-add j jinc))
             ((> j jlast) nil)
              (tagbody
                      (if (<= grow smlnum) (go label90))
                      (setf xj
                       (+ one (f2cl-lib:fref cnorm-%data% (j)
                                 ((1 *)) cnorm-%offset%)))
                      (setf grow (min grow (/ xbnd xj)))
                      (setf tjjs (f2cl-lib:fref a-%data% (j j)
                                  ((1 lda) (1 *)) a-%offset%))
                      (setf tjj (cabs1 tjjs))
                      (cond ((>= tjj smlnum)
                             (if (> xj tjj)
                               (setf xbnd (* xbnd (/ tjj xj)))))
                       (t (setf xbnd zero)))
                      label70))
      (setf grow (min grow xbnd)))
     (t (setf grow (min one (/ half (max xbnd smlnum))))
      (f2cl-lib:fdo (j jfirst (f2cl-lib:int-add j jinc))
             ((> j jlast) nil)
              (tagbody
                      (if (<= grow smlnum) (go label90))
                      (setf xj
                       (+ one (f2cl-lib:fref cnorm-%data% (j)
                                 ((1 *)) cnorm-%offset%)))
                      (setf grow (/ grow xj)) label80))))
    label90)))
  (cond
   ((> (* grow tscal) smlnum)
    (multiple-value-bind (var-0 var-1 var-2 var-3 var-4
                          var-5 var-6 var-7)
     (ztrsv uplo trans diag n a lda x 1)
     (declare (ignore var-4 var-6 var-7))
     (when var-0 (setf uplo var-0)) (when var-1 (setf trans var-1))
     (when var-2 (setf diag var-2)) (when var-3 (setf n var-3))
     (when var-5 (setf lda var-5))))
   (t
    (cond
     ((> xmax (* bignum half)) (setf scale (/ (* bignum half) xmax))
      (multiple-value-bind (var-0 var-1 var-2 var-3)
       (zdscal n scale x 1)
       (declare (ignore var-2 var-3)) (when var-0 (setf n var-0))
       (when var-1 (setf scale var-1)))
      (setf xmax bignum))
     (t (setf xmax (* xmax two))))
    (cond
     (notran
      (f2cl-lib:fdo (j jfirst (f2cl-lib:int-add j jinc))
```

```
((> j jlast) nil)
 (tagbody
        (setf xj (cabs1 (f2cl-lib:fref x-%data% (j)
                                       ((1 *)) x-%offset%)))
        (cond
         (nounit
          (setf tjjs
           (* (f2cl-lib:fref a-%data% (j j)
                 ((1 lda) (1 *)) a-%offset%) tscal)))
         (t (setf tjjs (coerce tscal 'f2cl-lib:complex16))
          (if (= tscal one) (go label110))))
        (setf tjj (cabs1 tjjs))
        (cond
         ((> tjj smlnum)
          (cond
           ((< tjj one)
            (cond
             ((> xj (* tjj bignum)) (setf rec (/ one xj))
              (multiple-value-bind (var-0 var-1 var-2
                                    var-3)
                  (zdscal n rec x 1)
                (declare (ignore var-2 var-3))
                (when var-0 (setf n var-0))
                (when var-1 (setf rec var-1)))
              (setf scale (* scale rec))
              (setf xmax (* xmax rec))))))
           (setf (f2cl-lib:fref x-%data% (j)
                   ((1 *)) x-%offset%)
            (zladiv (f2cl-lib:fref x-%data% (j)
                      ((1 *)) x-%offset%) tjjs))
           (setf xj (cabs1 (f2cl-lib:fref x-%data% (j)
                             ((1 *)) x-%offset%))))
         ((> tjj zero)
          (cond
           ((> xj (* tjj bignum))
            (setf rec (/ (* tjj bignum) xj))
            (cond
             ((> (f2cl-lib:fref cnorm (j) ((1 *))) one)
              (setf rec
               (/ rec
                (f2cl-lib:fref cnorm-%data% (j)
                  ((1 *)) cnorm-%offset%)))))
            (multiple-value-bind (var-0 var-1 var-2 var-3)
                (zdscal n rec x 1)
              (declare (ignore var-2 var-3))
              (when var-0 (setf n var-0))
              (when var-1 (setf rec var-1)))
            (setf scale (* scale rec))
            (setf xmax (* xmax rec))))
           (setf (f2cl-lib:fref x-%data% (j)
```

```
                ((1 *)) x-%offset%)
         (zladiv (f2cl-lib:fref x-%data% (j)
                   ((1 *)) x-%offset%) tjjs))
        (setf xj (cabs1
                  (f2cl-lib:fref x-%data% (j)
                   ((1 *)) x-%offset%))))
       (t
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
((> i n) nil)
 (tagbody
           (setf (f2cl-lib:fref x-%data% (i)
                   ((1 *)) x-%offset%)
            (coerce zero 'f2cl-lib:complex16))
           label100))
        (setf (f2cl-lib:fref x-%data% (j)
                ((1 *)) x-%offset%)
         (coerce one 'f2cl-lib:complex16))
        (setf xj one)
        (setf scale zero)
        (setf xmax zero)))
      label110
      (cond
       ((> xj one) (setf rec (/ one xj))
        (cond
         ((> (f2cl-lib:fref cnorm (j) ((1 *)))
             (* (+ bignum (- xmax)) rec))
          (setf rec (* rec half))
          (multiple-value-bind (var-0 var-1 var-2 var-3)
           (zdscal n rec x 1)
           (declare (ignore var-2 var-3))
           (when var-0 (setf n var-0))
           (when var-1 (setf rec var-1)))
          (setf scale (* scale rec)))))
       ((> (* xj (f2cl-lib:fref cnorm (j)
                   ((1 *)))) (+ bignum (- xmax)))
        (multiple-value-bind (var-0 var-1 var-2 var-3)
         (zdscal n half x 1)
         (declare (ignore var-2 var-3))
         (when var-0 (setf n var-0))
         (when var-1 (setf half var-1)))
        (setf scale (* scale half))))
      (cond
       (upper
        (cond
         ((> j 1)
          (zaxpy (f2cl-lib:int-sub j 1)
           (* (- (f2cl-lib:fref x-%data% (j)
                   ((1 *)) x-%offset%)) tscal)
           (f2cl-lib:array-slice a-%data%
             f2cl-lib:complex16 (1 j)
```

```
                                ((1 lda) (1 *)) a-%offset%)
                               1 x 1)
                              (setf i (izamax (f2cl-lib:int-sub j 1) x 1))
                              (setf xmax
                               (cabs1 (f2cl-lib:fref x-%data% (i)
                                       ((1 *)) x-%offset%))))))
                             (t
                              (cond
                               ((< j n)
                                (zaxpy (f2cl-lib:int-sub n j)
                                 (* (- (f2cl-lib:fref x-%data% (j)
                                         ((1 *)) x-%offset%)) tscal)
                                 (f2cl-lib:array-slice a-%data%
                                  f2cl-lib:complex16 ((+ j 1) j)
                                  ((1 lda) (1 *)) a-%offset%)
                                 1
                                 (f2cl-lib:array-slice x-%data%
                                  f2cl-lib:complex16 ((+ j 1)) ((1 *))
                                  x-%offset%)
                                 1)
                                (setf i
                                 (f2cl-lib:int-add j
                                  (izamax (f2cl-lib:int-sub n j)
                                   (f2cl-lib:array-slice x-%data%
                                    f2cl-lib:complex16 ((+ j 1))
                                    ((1 *)) x-%offset%)
                                   1)))
                                (setf xmax
                                 (cabs1 (f2cl-lib:fref x-%data% (i)
                                         ((1 *)) x-%offset%)))))))
                            label120)))
                  ((multiple-value-bind (ret-val var-0 var-1) (lsame trans "T")
                    (declare (ignore var-1)) (when var-0 (setf trans var-0)) ret-val)
                   (f2cl-lib:fdo (j jfirst (f2cl-lib:int-add j jinc))
                                 ((> j jlast) nil)
                                  (tagbody
                                         (setf xj (cabs1 (f2cl-lib:fref x-%data% (j)
                                                   ((1 *)) x-%offset%)))
                                         (setf uscal (coerce tscal 'f2cl-lib:complex16))
                                         (setf rec (/ one (max xmax one)))
                                         (cond
                                          ((> (f2cl-lib:fref cnorm (j)
                                                 ((1 *))) (* (+ bignum (- xj)) rec))
                                           (setf rec (* rec half))
                                           (cond
                                            (nounit
                                             (setf tjjs
                                              (* (f2cl-lib:fref a-%data% (j j)
                                                   ((1 lda) (1 *)) a-%offset%)
                                               tscal)))
```

```
      (t (setf tjjs
               (coerce tscal 'f2cl-lib:complex16))))
     (setf tjj (cabs1 tjjs))
     (cond
      ((> tjj one) (setf rec (min one (* rec tjj)))
       (setf uscal (zladiv uscal tjjs))))
     (cond
      ((< rec one)
       (multiple-value-bind (var-0 var-1 var-2 var-3)
        (zdscal n rec x 1)
        (declare (ignore var-2 var-3))
        (when var-0 (setf n var-0))
        (when var-1 (setf rec var-1)))
       (setf scale (* scale rec))
       (setf xmax (* xmax rec))))))
   (setf csumj (coerce zero 'f2cl-lib:complex16))
   (cond
    ((= uscal (f2cl-lib:dcmplx one))
     (cond
      (upper
       (setf csumj
        (zdotu (f2cl-lib:int-sub j 1)
         (f2cl-lib:array-slice a-%data%
          f2cl-lib:complex16 (1 j)
          ((1 lda) (1 *)) a-%offset%)
         1 x 1)))
      ((< j n)
       (setf csumj
        (zdotu (f2cl-lib:int-sub n j)
         (f2cl-lib:array-slice a-%data%
          f2cl-lib:complex16 ((+ j 1) j)
          ((1 lda) (1 *)) a-%offset%)
         1
         (f2cl-lib:array-slice x-%data%
          f2cl-lib:complex16 ((+ j 1))
          ((1 *)) x-%offset%)
         1)))))
    (t
     (cond
      (upper
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
((> i
             (f2cl-lib:int-add j
               (f2cl-lib:int-sub 1)))
            nil)
 (tagbody
             (setf csumj
              (+ csumj
               (* (f2cl-lib:fref a-%data% (i j)
                         ((1 lda) (1 *)) a-%offset%)
```

```
                  uscal (f2cl-lib:fref x-%data% (i)
                           ((1 *)) x-%offset%))))
                label130)))
           ((< j n)
            (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                           (f2cl-lib:int-add i 1))
((> i
                n)
               nil)
 (tagbody
                (setf csumj
                 (+ csumj
                  (* (f2cl-lib:fref a-%data% (i j)
                           ((1 lda) (1 *)) a-%offset%)
                   uscal (f2cl-lib:fref x-%data% (i)
                           ((1 *)) x-%offset%))))
                label140))))))
   (cond
    ((= uscal (f2cl-lib:dcmplx tscal))
     (tagbody
      (setf (f2cl-lib:fref x-%data% (j)
             ((1 *)) x-%offset%)
       (- (f2cl-lib:fref x-%data% (j)
           ((1 *)) x-%offset%) csumj))
      (setf xj (cabs1 (f2cl-lib:fref x-%data% (j)
                 ((1 *)) x-%offset%)))
      (cond
       (nounit
        (setf tjjs
         (* (f2cl-lib:fref a-%data% (j j)
              ((1 lda) (1 *)) a-%offset%)
          tscal)))
       (t (setf tjjs
            (coerce tscal 'f2cl-lib:complex16))
        (if (= tscal one) (go label160))))
      (setf tjj (cabs1 tjjs))
      (cond
       ((> tjj smlnum)
        (cond
         ((< tjj one)
          (cond
           ((> xj (* tjj bignum))
            (setf rec (/ one xj))
            (multiple-value-bind (var-0 var-1
                                  var-2 var-3)
             (zdscal n rec x 1)
             (declare (ignore var-2 var-3))
             (when var-0 (setf n var-0))
             (when var-1 (setf rec var-1)))
            (setf scale (* scale rec))
```

```
                            (setf xmax (* xmax rec))))))
                           (setf (f2cl-lib:fref x-%data% (j)
                                   ((1 *)) x-%offset%)
                            (zladiv (f2cl-lib:fref x-%data% (j)
                                      ((1 *)) x-%offset%) tjjs)))
                          ((> tjj zero)
                           (cond
                            ((> xj (* tjj bignum))
                             (setf rec (/ (* tjj bignum) xj))
                             (multiple-value-bind (var-0 var-1 var-2
                                                   var-3)
                              (zdscal n rec x 1)
                              (declare (ignore var-2 var-3))
                              (when var-0 (setf n var-0))
                              (when var-1 (setf rec var-1)))
                             (setf scale (* scale rec))
                             (setf xmax (* xmax rec))))
                            (setf (f2cl-lib:fref x-%data% (j)
                                    ((1 *)) x-%offset%)
                             (zladiv (f2cl-lib:fref x-%data% (j)
                                       ((1 *)) x-%offset%) tjjs)))
                          (t
                           (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
                        ((> i n) nil)
                         (tagbody
                                     (setf (f2cl-lib:fref x-%data% (i)
                                            ((1 *)) x-%offset%)
                                      (coerce zero 'f2cl-lib:complex16))
                                     label150))
                           (setf (f2cl-lib:fref x-%data% (j)
                                   ((1 *)) x-%offset%)
                            (coerce one 'f2cl-lib:complex16))
                           (setf scale zero) (setf xmax zero)))
                       label160))
                     (t
                      (setf (f2cl-lib:fref x-%data% (j)
                                  ((1 *)) x-%offset%)
                       (- (zladiv (f2cl-lib:fref x-%data% (j)
                                  ((1 *)) x-%offset%) tjjs)
                        csumj))))
                    (setf xmax
                     (max xmax (cabs1
                       (f2cl-lib:fref x-%data% (j)
                        ((1 *)) x-%offset%))))
                    label170)))
(t
 (f2cl-lib:fdo (j jfirst (f2cl-lib:int-add j jinc))
        ((> j jlast) nil)
         (tagbody
                (setf xj (cabs1 (f2cl-lib:fref x-%data% (j)
```

```
          ((1 *)) x-%offset%)))
(setf uscal (coerce tscal 'f2cl-lib:complex16))
(setf rec (/ one (max xmax one)))
(cond
 ((> (f2cl-lib:fref cnorm (j) ((1 *)))
       (* (+ bignum (- xj)) rec))
  (setf rec (* rec half))
  (cond
   (nounit
    (setf tjjs
     (coerce
      (*
       (f2cl-lib:dconjg
        (f2cl-lib:fref a-%data% (j j)
          ((1 lda) (1 *)) a-%offset%))
       tscal)
      'f2cl-lib:complex16)))
   (t
     (setf tjjs
      (coerce tscal 'f2cl-lib:complex16))))
  (setf tjj (cabs1 tjjs))
  (cond
   ((> tjj one) (setf rec (min one (* rec tjj)))
    (setf uscal (zladiv uscal tjjs))))
  (cond
   ((< rec one)
    (multiple-value-bind (var-0 var-1 var-2 var-3)
     (zdscal n rec x 1)
     (declare (ignore var-2 var-3))
     (when var-0 (setf n var-0))
     (when var-1 (setf rec var-1)))
    (setf scale (* scale rec))
    (setf xmax (* xmax rec))))))
(setf csumj (coerce zero 'f2cl-lib:complex16))
(cond
 ((= uscal (f2cl-lib:dcmplx one))
  (cond
   (upper
    (setf csumj
     (zdotc (f2cl-lib:int-sub j 1)
      (f2cl-lib:array-slice a-%data%
       f2cl-lib:complex16 (1 j)
       ((1 lda) (1 *)) a-%offset%)
      1 x 1)))
   ((< j n)
    (setf csumj
     (zdotc (f2cl-lib:int-sub n j)
      (f2cl-lib:array-slice a-%data%
       f2cl-lib:complex16 ((+ j 1) j)
       ((1 lda) (1 *)) a-%offset%)
```

```
          1
          (f2cl-lib:array-slice x-%data%
           f2cl-lib:complex16 ((+ j 1))
           ((1 *)) x-%offset%)
          1)))))
     (t
      (cond
       (upper
        (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
((> i
             (f2cl-lib:int-add j
              (f2cl-lib:int-sub 1)))
            nil)
 (tagbody
             (setf csumj
              (+ csumj
               (*
                (f2cl-lib:dconjg
                 (f2cl-lib:fref a-%data% (i j)
                        ((1 lda) (1 *)) a-%offset%))
                uscal (f2cl-lib:fref x-%data% (i)
                        ((1 *)) x-%offset%))))
             label180)))
       ((< j n)
        (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                         (f2cl-lib:int-add i 1))
((> i
             n)
            nil)
 (tagbody
             (setf csumj
              (+ csumj
               (*
                (f2cl-lib:dconjg
                 (f2cl-lib:fref a-%data% (i j)
                  ((1 lda) (1 *)) a-%offset%))
                uscal (f2cl-lib:fref x-%data% (i)
                        ((1 *)) x-%offset%))))
             label190))))))
   (cond
    ((= uscal (f2cl-lib:dcmplx tscal))
     (tagbody
      (setf (f2cl-lib:fref x-%data% (j)
               ((1 *)) x-%offset%)
       (- (f2cl-lib:fref x-%data% (j)
            ((1 *)) x-%offset%) csumj))
      (setf xj (cabs1 (f2cl-lib:fref x-%data% (j)
                ((1 *)) x-%offset%)))
      (cond
       (nounit
```

```
                (setf tjjs
                 (coerce
                  (*
                   (f2cl-lib:dconjg
                    (f2cl-lib:fref a-%data% (j j)
                      ((1 lda) (1 *)) a-%offset%))
                   tscal)
                  'f2cl-lib:complex16)))
                (t (setf tjjs
                     (coerce tscal 'f2cl-lib:complex16))
                 (if (= tscal one) (go label210))))
               (setf tjj (cabs1 tjjs))
               (cond
                ((> tjj smlnum)
                 (cond
                  ((< tjj one)
                   (cond
                    ((> xj (* tjj bignum))
                     (setf rec (/ one xj))
                     (multiple-value-bind (var-0 var-1
                                           var-2 var-3)
                         (zdscal n rec x 1)
                         (declare (ignore var-2 var-3))
                         (when var-0 (setf n var-0))
                         (when var-1 (setf rec var-1)))
                       (setf scale (* scale rec))
                       (setf xmax (* xmax rec))))))
                  (setf (f2cl-lib:fref x-%data% (j)
                          ((1 *)) x-%offset%)
                   (zladiv (f2cl-lib:fref x-%data% (j)
                              ((1 *)) x-%offset%) tjjs)))
                 ((> tjj zero)
                  (cond
                   ((> xj (* tjj bignum))
                    (setf rec (/ (* tjj bignum) xj))
                    (multiple-value-bind (var-0 var-1 var-2
                                          var-3)
                        (zdscal n rec x 1)
                        (declare (ignore var-2 var-3))
                        (when var-0 (setf n var-0))
                        (when var-1 (setf rec var-1)))
                      (setf scale (* scale rec))
                      (setf xmax (* xmax rec))))
                   (setf (f2cl-lib:fref x-%data% (j)
                           ((1 *)) x-%offset%)
                    (zladiv (f2cl-lib:fref x-%data% (j)
                               ((1 *)) x-%offset%) tjjs)))
                  (t
                   (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i n) nil)
```

```
                        (tagbody
                                    (setf (f2cl-lib:fref x-%data% (i)
                                           ((1 *)) x-%offset%)
                                     (coerce zero 'f2cl-lib:complex16))
                                    label200))
                              (setf (f2cl-lib:fref x-%data% (j)
                                     ((1 *)) x-%offset%)
                               (coerce one 'f2cl-lib:complex16))
                              (setf scale zero) (setf xmax zero)))
                           label210))
                         (t
                          (setf (f2cl-lib:fref x-%data% (j)
                                 ((1 *)) x-%offset%)
                           (- (zladiv (f2cl-lib:fref x-%data% (j)
                                       ((1 *)) x-%offset%) tjjs)
                            csumj))))
                         (setf xmax
                          (max xmax (cabs1 (f2cl-lib:fref x-%data% (j)
                                     ((1 *)) x-%offset%))))
                         label220))))
          (setf scale (/ scale tscal))))
        (cond
         ((/= tscal one)
          (multiple-value-bind (var-0 var-1 var-2 var-3)
           (dscal n (/ one tscal) cnorm 1)
           (declare (ignore var-1 var-2 var-3))
           (when var-0 (setf n var-0)))))
        (go end_label) end_label
        (return
          (values uplo trans diag normin n nil lda nil scale nil info))))
      )))
```

———-

6.127 zrot LAPACK

— zrot.input —

```
)set break resume
)sys rm -f zrot.output
)spool zrot.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— zrot.help —

```
=====================================================================
zrot examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 Online html documentation available at
           http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZROT( N, CX, INCX, CY, INCY, C, S )

       .. Scalar Arguments ..
       INTEGER            INCX, INCY, N
       DOUBLE PRECISION   C
       COMPLEX*16         S
       ..
       .. Array Arguments ..
       COMPLEX*16         CX( * ), CY( * )
       ..


 Purpose:
 =============

 ZROT   applies a plane rotation, where the cos (C) is real and the
 sin (S) is complex, and the vectors CX and CY are complex.

 Arguments:
 ==========

  [in] N

          N is INTEGER
          The number of elements in the vectors CX and CY.

  [in,out] CX

          CX is COMPLEX*16 array, dimension (N)
          On input, the vector X.
          On output, CX is overwritten with C*X + S*Y.
```

```
  [in] INCX

          INCX is INTEGER
          The increment between successive values of CY.  INCX <> 0.

  [in,out] CY

          CY is COMPLEX*16 array, dimension (N)
          On input, the vector Y.
          On output, CY is overwritten with -CONJG(S)*X + C*Y.

  [in] INCY

          INCY is INTEGER
          The increment between successive values of CY.  INCX <> 0.

  [in] C

          C is DOUBLE PRECISION

  [in] S

          S is COMPLEX*16
          C and S define a rotation
             [  C          S  ]
             [ -conjg(S)   C  ]
          where C*C + S*CONJG(S) = 1.0.

 Authors:
 ========

  Univ. of Tennessee
  Univ. of California Berkeley
  Univ. of Colorado Denver
  NAG Ltd.

 November 2011
```

———-

— zrot.f —

```
*  =====================================================================
      SUBROUTINE ZROT( N, CX, INCX, CY, INCY, C, S )
*
*  -- LAPACK auxiliary routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
```

```
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      INTEGER            INCX, INCY, N
      DOUBLE PRECISION   C
      COMPLEX*16         S
*     ..
*     .. Array Arguments ..
      COMPLEX*16         CX( * ), CY( * )
*     ..
*
* =====================================================================
*
*     .. Local Scalars ..
      INTEGER            I, IX, IY
      COMPLEX*16         STEMP
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG
*     ..
*     .. Executable Statements ..
*
      IF( N.LE.0 )
     $   RETURN
      IF( INCX.EQ.1 .AND. INCY.EQ.1 )
     $   GO TO 20
*
*     Code for unequal increments or equal increments not equal to 1
*
      IX = 1
      IY = 1
      IF( INCX.LT.0 )
     $   IX = ( -N+1 )*INCX + 1
      IF( INCY.LT.0 )
     $   IY = ( -N+1 )*INCY + 1
      DO 10 I = 1, N
         STEMP = C*CX( IX ) + S*CY( IY )
         CY( IY ) = C*CY( IY ) - DCONJG( S )*CX( IX )
         CX( IX ) = STEMP
         IX = IX + INCX
         IY = IY + INCY
   10 CONTINUE
      RETURN
*
*     Code for both increments equal to 1
*
   20 CONTINUE
      DO 30 I = 1, N
         STEMP = C*CX( I ) + S*CY( I )
```

```
        CY( I ) = C*CY( I ) - DCONJG( S )*CX( I )
        CX( I ) = STEMP
   30 CONTINUE
      RETURN
      END
```

———-

— LAPACK zrot —

```
(defun zrot (n cx incx cy incy c s)
 (declare (type (f2cl-lib:integer4) incy incx n)
  (type (array f2cl-lib:complex16 (*)) cy cx) (type (double-float) c)
  (type (f2cl-lib:complex16) s))
 (f2cl-lib:with-multi-array-data
     ((cx f2cl-lib:complex16 cx-%data% cx-%offset%)
      (cy f2cl-lib:complex16 cy-%data% cy-%offset%))
      (prog
       ((stemp #C(0.0d0 0.0d0)) (i 0) (ix 0) (iy 0))
       (declare (type (f2cl-lib:complex16) stemp)
                (type (f2cl-lib:integer4) iy ix i))
       (if (<= n 0) (go end_label))
       (if (and (= incx 1) (= incy 1)) (go label20))
       (setf ix 1) (setf iy 1)
       (if (< incx 0)
        (setf ix
         (f2cl-lib:int-add (f2cl-lib:int-mul (f2cl-lib:int-sub 1 n) incx) 1)))
       (if (< incy 0)
        (setf iy
         (f2cl-lib:int-add (f2cl-lib:int-mul (f2cl-lib:int-sub 1 n) incy) 1)))
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i n) nil)
               (tagbody
                 (setf stemp
                  (+ (* c (f2cl-lib:fref cx-%data% (ix) ((1 *)) cx-%offset%))
                   (* s (f2cl-lib:fref cy-%data% (iy) ((1 *)) cy-%offset%))))
                 (setf (f2cl-lib:fref cy-%data% (iy) ((1 *)) cy-%offset%)
                  (- (* c (f2cl-lib:fref cy-%data% (iy) ((1 *)) cy-%offset%))
                   (* (f2cl-lib:dconjg s)
                    (f2cl-lib:fref cx-%data% (ix) ((1 *)) cx-%offset%))))
                 (setf (f2cl-lib:fref cx-%data% (ix) ((1 *))
                             cx-%offset%) stemp)
                 (setf ix (f2cl-lib:int-add ix incx))
                 (setf iy (f2cl-lib:int-add iy incy))
                 label10))
       (go end_label) label20
       (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
              ((> i n) nil)
```

```
               (tagbody
                 (setf stemp
                  (+ (* c (f2cl-lib:fref cx-%data% (i) ((1 *)) cx-%offset%))
                   (* s (f2cl-lib:fref cy-%data% (i) ((1 *)) cy-%offset%))))
                 (setf (f2cl-lib:fref cy-%data% (i) ((1 *)) cy-%offset%)
                  (- (* c (f2cl-lib:fref cy-%data% (i) ((1 *)) cy-%offset%))
                   (* (f2cl-lib:dconjg s)
                      (f2cl-lib:fref cx-%data% (i) ((1 *)) cx-%offset%))))
                 (setf (f2cl-lib:fref cx-%data% (i) ((1 *)) cx-%offset%)
                         stemp) label30)
               )
       (go end_label) end_label (return (values nil nil nil nil nil nil nil)))
      ))
```

———-

6.128 ztrevc LAPACK

— **ztrevc.input** —

```
)set break resume
)sys rm -f ztrevc.output
)spool ztrevc.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **ztrevc.help** —

```
=======================================================================
ztrevc examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/

 Definition:
```

```
===========

      SUBROUTINE ZTREVC( SIDE, HOWMNY, SELECT, N, T, LDT, VL, LDVL, VR,
                         LDVR, MM, M, WORK, RWORK, INFO )

      .. Scalar Arguments ..
      CHARACTER          HOWMNY, SIDE
      INTEGER            INFO, LDT, LDVL, LDVR, M, MM, N
      ..
      .. Array Arguments ..
      LOGICAL            SELECT( * )
      DOUBLE PRECISION   RWORK( * )
      COMPLEX*16         T( LDT, * ), VL( LDVL, * ), VR( LDVR, * ),
     $                   WORK( * )
      ..


Purpose:
=============

ZTREVC computes some or all of the right and/or left eigenvectors of
a complex upper triangular matrix T.
Matrices of this type are produced by the Schur factorization of
a complex general matrix:  A = Q*T*Q**H, as computed by ZHSEQR.

The right eigenvector x and the left eigenvector y of T corresponding
to an eigenvalue w are defined by:

             T*x = w*x,     (y**H)*T = w*(y**H)

where y**H denotes the conjugate transpose of the vector y.
The eigenvalues are not input to this routine, but are read directly
from the diagonal of T.

This routine returns the matrices X and/or Y of right and left
eigenvectors of T, or the products Q*X and/or Q*Y, where Q is an
input matrix.  If Q is the unitary factor that reduces a matrix A to
Schur form T, then Q*X and Q*Y are the matrices of right and left
eigenvectors of A.

Arguments:
==========

 [in] SIDE

         SIDE is CHARACTER*1
         = 'R':  compute right eigenvectors only;
         = 'L':  compute left eigenvectors only;
         = 'B':  compute both right and left eigenvectors.
```

```
[in] HOWMNY

        HOWMNY is CHARACTER*1
        = 'A':  compute all right and/or left eigenvectors;
        = 'B':  compute all right and/or left eigenvectors,
                backtransformed using the matrices supplied in
                VR and/or VL;
        = 'S':  compute selected right and/or left eigenvectors,
                as indicated by the logical array SELECT.

[in] SELECT

        SELECT is LOGICAL array, dimension (N)
        If HOWMNY = 'S', SELECT specifies the eigenvectors to be
        computed.
        The eigenvector corresponding to the j-th eigenvalue is
        computed if SELECT(j) = .TRUE..
        Not referenced if HOWMNY = 'A' or 'B'.

[in] N

        N is INTEGER
        The order of the matrix T. N >= 0.

[in,out] T

        T is COMPLEX*16 array, dimension (LDT,N)
        The upper triangular matrix T.  T is modified, but restored
        on exit.

[in] LDT

        LDT is INTEGER
        The leading dimension of the array T. LDT >= max(1,N).

[in,out] VL

        VL is COMPLEX*16 array, dimension (LDVL,MM)
        On entry, if SIDE = 'L' or 'B' and HOWMNY = 'B', VL must
        contain an N-by-N matrix Q (usually the unitary matrix Q of
        Schur vectors returned by ZHSEQR).
        On exit, if SIDE = 'L' or 'B', VL contains:
        if HOWMNY = 'A', the matrix Y of left eigenvectors of T;
        if HOWMNY = 'B', the matrix Q*Y;
        if HOWMNY = 'S', the left eigenvectors of T specified by
                         SELECT, stored consecutively in the columns
                         of VL, in the same order as their
                         eigenvalues.
        Not referenced if SIDE = 'R'.
```

```
[in] LDVL

        LDVL is INTEGER
        The leading dimension of the array VL.  LDVL >= 1, and if
        SIDE = 'L' or 'B', LDVL >= N.

[in,out] VR

        VR is COMPLEX*16 array, dimension (LDVR,MM)
        On entry, if SIDE = 'R' or 'B' and HOWMNY = 'B', VR must
        contain an N-by-N matrix Q (usually the unitary matrix Q of
        Schur vectors returned by ZHSEQR).
        On exit, if SIDE = 'R' or 'B', VR contains:
        if HOWMNY = 'A', the matrix X of right eigenvectors of T;
        if HOWMNY = 'B', the matrix Q*X;
        if HOWMNY = 'S', the right eigenvectors of T specified by
                         SELECT, stored consecutively in the columns
                         of VR, in the same order as their
                         eigenvalues.
        Not referenced if SIDE = 'L'.

[in] LDVR

        LDVR is INTEGER
        The leading dimension of the array VR.  LDVR >= 1, and if
        SIDE = 'R' or 'B'; LDVR >= N.

[in] MM

        MM is INTEGER
        The number of columns in the arrays VL and/or VR. MM >= M.

[out] M

        M is INTEGER
        The number of columns in the arrays VL and/or VR actually
        used to store the eigenvectors.  If HOWMNY = 'A' or 'B', M
        is set to N.  Each selected eigenvector occupies one
        column.

[out] WORK

        WORK is COMPLEX*16 array, dimension (2*N)

[out] RWORK

        RWORK is DOUBLE PRECISION array, dimension (N)

[out] INFO
```

```
          INFO is INTEGER
          = 0:  successful exit
          < 0:  if INFO = -i, the i-th argument had an illegal value

 Authors:
 ========

  Univ. of Tennessee
  Univ. of California Berkeley
  Univ. of Colorado Denver
  NAG Ltd.

 November 2011

 Further Details:
 ====================

  The algorithm used in this program is basically backward (forward)
  substitution, with scaling to make the the code robust against
  possible overflow.

  Each eigenvector is normalized so that the element of largest
  magnitude has magnitude 1; here the magnitude of a complex number
  (x,y) is taken to be |x| + |y|.
```

— ztrevc.f —

```
*  =====================================================================
      SUBROUTINE ZTREVC( SIDE, HOWMNY, SELECT, N, T, LDT, VL, LDVL, VR,
     $                   LDVR, MM, M, WORK, RWORK, INFO )
*
*  -- LAPACK computational routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      CHARACTER          HOWMNY, SIDE
      INTEGER            INFO, LDT, LDVL, LDVR, M, MM, N
*     ..
*     .. Array Arguments ..
      LOGICAL            SELECT( * )
      DOUBLE PRECISION   RWORK( * )
      COMPLEX*16         T( LDT, * ), VL( LDVL, * ), VR( LDVR, * ),
     $                   WORK( * )
*     ..
```

```
*
*  =====================================================================
*
*     .. Parameters ..
      DOUBLE PRECISION   ZERO, ONE
      PARAMETER          ( ZERO = 0.0D+0, ONE = 1.0D+0 )
      COMPLEX*16         CMZERO, CMONE
      PARAMETER          ( CMZERO = ( 0.0D+0, 0.0D+0 ),
     $                   CMONE = ( 1.0D+0, 0.0D+0 ) )
*     ..
*     .. Local Scalars ..
      LOGICAL            ALLV, BOTHV, LEFTV, OVER, RIGHTV, SOMEV
      INTEGER            I, II, IS, J, K, KI
      DOUBLE PRECISION   OVFL, REMAX, SCALE, SMIN, SMLNUM, ULP, UNFL
      COMPLEX*16         CDUM
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      INTEGER            IZAMAX
      DOUBLE PRECISION   DLAMCH, DZASUM
      EXTERNAL           LSAME, IZAMAX, DLAMCH, DZASUM
*     ..
*     .. External Subroutines ..
      EXTERNAL           XERBLA, ZCOPY, ZDSCAL, ZGEMV, ZLATRS
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          ABS, DBLE, DCMPLX, DCONJG, DIMAG, MAX
*     ..
*     .. Statement Functions ..
      DOUBLE PRECISION   CABS1
*     ..
*     .. Statement Function definitions ..
      CABS1( CDUM ) = ABS( DBLE( CDUM ) ) + ABS( DIMAG( CDUM ) )
*     ..
*     .. Executable Statements ..
*
*     Decode and test the input parameters
*
      BOTHV = LSAME( SIDE, 'B' )
      RIGHTV = LSAME( SIDE, 'R' ) .OR. BOTHV
      LEFTV = LSAME( SIDE, 'L' ) .OR. BOTHV
*
      ALLV = LSAME( HOWMNY, 'A' )
      OVER = LSAME( HOWMNY, 'B' )
      SOMEV = LSAME( HOWMNY, 'S' )
*
*     Set M to the number of columns required to store the selected
*     eigenvectors.
*
      IF( SOMEV ) THEN
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```
         M = 0
         DO 10 J = 1, N
            IF( SELECT( J ) )
     $         M = M + 1
   10    CONTINUE
      ELSE
         M = N
      END IF
*
      INFO = 0
      IF( .NOT.RIGHTV .AND. .NOT.LEFTV ) THEN
         INFO = -1
      ELSE IF( .NOT.ALLV .AND. .NOT.OVER .AND. .NOT.SOMEV ) THEN
         INFO = -2
      ELSE IF( N.LT.0 ) THEN
         INFO = -4
      ELSE IF( LDT.LT.MAX( 1, N ) ) THEN
         INFO = -6
      ELSE IF( LDVL.LT.1 .OR. ( LEFTV .AND. LDVL.LT.N ) ) THEN
         INFO = -8
      ELSE IF( LDVR.LT.1 .OR. ( RIGHTV .AND. LDVR.LT.N ) ) THEN
         INFO = -10
      ELSE IF( MM.LT.M ) THEN
         INFO = -11
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'ZTREVC', -INFO )
         RETURN
      END IF
*
*     Quick return if possible.
*
      IF( N.EQ.0 )
     $   RETURN
*
*     Set the constants to control overflow.
*
      UNFL = DLAMCH( 'Safe minimum' )
      OVFL = ONE / UNFL
      CALL DLABAD( UNFL, OVFL )
      ULP = DLAMCH( 'Precision' )
      SMLNUM = UNFL*( N / ULP )
*
*     Store the diagonal elements of T in working array WORK.
*
      DO 20 I = 1, N
         WORK( I+N ) = T( I, I )
   20 CONTINUE
*
*     Compute 1-norm of each column of strictly upper triangular
```

```
*     part of T to control overflow in triangular solver.
*
      RWORK( 1 ) = ZERO
      DO 30 J = 2, N
         RWORK( J ) = DZASUM( J-1, T( 1, J ), 1 )
   30 CONTINUE
*
      IF( RIGHTV ) THEN
*
*        Compute right eigenvectors.
*
         IS = M
         DO 80 KI = N, 1, -1
*
            IF( SOMEV ) THEN
               IF( .NOT.SELECT( KI ) )
     $            GO TO 80
            END IF
            SMIN = MAX( ULP*( CABS1( T( KI, KI ) ) ), SMLNUM )
*
            WORK( 1 ) = CMONE
*
*           Form right-hand side.
*
            DO 40 K = 1, KI - 1
               WORK( K ) = -T( K, KI )
   40       CONTINUE
*
*           Solve the triangular system:
*              (T(1:KI-1,1:KI-1) - T(KI,KI))*X = SCALE*WORK.
*
            DO 50 K = 1, KI - 1
               T( K, K ) = T( K, K ) - T( KI, KI )
               IF( CABS1( T( K, K ) ).LT.SMIN )
     $            T( K, K ) = SMIN
   50       CONTINUE
*
            IF( KI.GT.1 ) THEN
               CALL ZLATRS( 'Upper', 'No transpose', 'Non-unit', 'Y',
     $                     KI-1, T, LDT, WORK( 1 ), SCALE, RWORK,
     $                     INFO )
               WORK( KI ) = SCALE
            END IF
*
*           Copy the vector x or Q*x to VR and normalize.
*
            IF( .NOT.OVER ) THEN
               CALL ZCOPY( KI, WORK( 1 ), 1, VR( 1, IS ), 1 )
*
               II = IZAMAX( KI, VR( 1, IS ), 1 )
```

```
               REMAX = ONE / CABS1( VR( II, IS ) )
               CALL ZDSCAL( KI, REMAX, VR( 1, IS ), 1 )
*
               DO 60 K = KI + 1, N
                  VR( K, IS ) = CMZERO
   60          CONTINUE
            ELSE
               IF( KI.GT.1 )
     $            CALL ZGEMV( 'N', N, KI-1, CMONE, VR, LDVR, WORK( 1 ),
     $                        1, DCMPLX( SCALE ), VR( 1, KI ), 1 )
*
               II = IZAMAX( N, VR( 1, KI ), 1 )
               REMAX = ONE / CABS1( VR( II, KI ) )
               CALL ZDSCAL( N, REMAX, VR( 1, KI ), 1 )
            END IF
*
*           Set back the original diagonal elements of T.
*
            DO 70 K = 1, KI - 1
               T( K, K ) = WORK( K+N )
   70       CONTINUE
*
            IS = IS - 1
   80    CONTINUE
      END IF
*
      IF( LEFTV ) THEN
*
*        Compute left eigenvectors.
*
         IS = 1
         DO 130 KI = 1, N
*
            IF( SOMEV ) THEN
               IF( .NOT.SELECT( KI ) )
     $            GO TO 130
            END IF
            SMIN = MAX( ULP*( CABS1( T( KI, KI ) ) ), SMLNUM )
*
            WORK( N ) = CMONE
*
*           Form right-hand side.
*
            DO 90 K = KI + 1, N
               WORK( K ) = -DCONJG( T( KI, K ) )
   90       CONTINUE
*
*           Solve the triangular system:
*              (T(KI+1:N,KI+1:N) - T(KI,KI))**H * X = SCALE*WORK.
*
```

```
            DO 100 K = KI + 1, N
               T( K, K ) = T( K, K ) - T( KI, KI )
               IF( CABS1( T( K, K ) ).LT.SMIN )
     $            T( K, K ) = SMIN
  100       CONTINUE
*
            IF( KI.LT.N ) THEN
               CALL ZLATRS( 'Upper', 'Conjugate transpose', 'Non-unit',
     $                      'Y', N-KI, T( KI+1, KI+1 ), LDT,
     $                      WORK( KI+1 ), SCALE, RWORK, INFO )
               WORK( KI ) = SCALE
            END IF
*
*           Copy the vector x or Q*x to VL and normalize.
*
            IF( .NOT.OVER ) THEN
               CALL ZCOPY( N-KI+1, WORK( KI ), 1, VL( KI, IS ), 1 )
*
               II = IZAMAX( N-KI+1, VL( KI, IS ), 1 ) + KI - 1
               REMAX = ONE / CABS1( VL( II, IS ) )
               CALL ZDSCAL( N-KI+1, REMAX, VL( KI, IS ), 1 )
*
               DO 110 K = 1, KI - 1
                  VL( K, IS ) = CMZERO
  110          CONTINUE
            ELSE
               IF( KI.LT.N )
     $            CALL ZGEMV( 'N', N, N-KI, CMONE, VL( 1, KI+1 ), LDVL,
     $                        WORK( KI+1 ), 1, DCMPLX( SCALE ),
     $                        VL( 1, KI ), 1 )
*
               II = IZAMAX( N, VL( 1, KI ), 1 )
               REMAX = ONE / CABS1( VL( II, KI ) )
               CALL ZDSCAL( N, REMAX, VL( 1, KI ), 1 )
            END IF
*
*           Set back the original diagonal elements of T.
*
            DO 120 K = KI + 1, N
               T( K, K ) = WORK( K+N )
  120       CONTINUE
*
            IS = IS + 1
  130    CONTINUE
      END IF
*
      RETURN
*
*     End of ZTREVC
*
```

```
      END
```

— LAPACK ztrevc —

```
(let*
 ((zero 0.0d0) (one 1.0d0)
  (cmzero (coerce (f2cl-lib:cmplx 0.0d0 0.0d0) 'f2cl-lib:complex16))
  (cmone (coerce (f2cl-lib:cmplx 1.0d0 0.0d0) 'f2cl-lib:complex16)))
 (declare (type (double-float 0.0d0 0.0d0) zero)
  (type (double-float 1.0d0 1.0d0) one) (type (f2cl-lib:complex16) cmzero)
  (type (f2cl-lib:complex16) cmone) (ignorable zero one cmzero cmone))
 (defun ztrevc
  (side howmny select n t$ ldt vl ldvl vr ldvr mm m work rwork info)
  (declare (type (simple-array character (*)) howmny side)
   (type (array f2cl-lib:logical (*)) select)
   (type (f2cl-lib:integer4) info m mm ldvr ldvl ldt n)
   (type (array f2cl-lib:complex16 (*)) work vr vl t$)
   (type (array double-float (*)) rwork))
  (f2cl-lib:with-multi-array-data
      ((rwork double-float rwork-%data%
        rwork-%offset%)
       (t$ f2cl-lib:complex16 t$-%data% t$-%offset%)
       (vl f2cl-lib:complex16 vl-%data% vl-%offset%)
       (vr f2cl-lib:complex16 vr-%data% vr-%offset%)
       (work f2cl-lib:complex16 work-%data% work-%offset%)
       (select f2cl-lib:logical select-%data% select-%offset%)
       (side character side-%data% side-%offset%)
       (howmny character howmny-%data% howmny-%offset%))
       (labels
        ((cabs1 (cdum)
           (+ (abs (f2cl-lib:dble cdum)) (abs (f2cl-lib:dimag cdum)))))
        (declare
         (ftype (function (f2cl-lib:complex16)
                (values double-float &rest t)) cabs1))
        (prog
         ((cdum #C(0.0d0 0.0d0)) (ovfl 0.0d0) (remax 0.0d0)
          (scale 0.0d0) (smin 0.0d0)
          (smlnum 0.0d0) (ulp 0.0d0) (unfl 0.0d0)
          (i 0) (ii 0) (is 0) (j 0) (k 0)
          (ki 0) (allv nil) (bothv nil) (leftv nil) (over nil) (rightv nil)
          (somev nil) (dcmplx$ 0.0))
         (declare (type (f2cl-lib:complex16) cdum)
          (type (double-float) unfl ulp smlnum smin scale remax ovfl)
          (type (f2cl-lib:integer4) ki k j is ii i)
          (type f2cl-lib:logical somev rightv over leftv bothv allv)
          (type (single-float) dcmplx$))
```

```
(setf bothv
 (multiple-value-bind (ret-val var-0 var-1) (lsame side "B")
  (declare (ignore var-1)) (when var-0 (setf side var-0)) ret-val))
(setf rightv
 (or
  (multiple-value-bind (ret-val var-0 var-1) (lsame side "R")
   (declare (ignore var-1)) (when var-0 (setf side var-0)) ret-val)
  bothv))
(setf leftv
 (or
  (multiple-value-bind (ret-val var-0 var-1) (lsame side "L")
   (declare (ignore var-1)) (when var-0 (setf side var-0)) ret-val)
  bothv))
(setf allv
 (multiple-value-bind (ret-val var-0 var-1) (lsame howmny "A")
  (declare (ignore var-1)) (when var-0 (setf howmny var-0)) ret-val))
(setf over
 (multiple-value-bind (ret-val var-0 var-1) (lsame howmny "B")
  (declare (ignore var-1)) (when var-0 (setf howmny var-0)) ret-val))
(setf somev
 (multiple-value-bind (ret-val var-0 var-1) (lsame howmny "S")
  (declare (ignore var-1)) (when var-0 (setf howmny var-0)) ret-val))
(cond
 (somev (setf m 0)
  (f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
         ((> j n) nil)
          (tagbody
               (if (f2cl-lib:fref select-%data% (j)
                         ((1 *)) select-%offset%)
                (setf m (f2cl-lib:int-add m 1)))
               label10)))
 (t (setf m n)))
(setf info 0)
(cond ((and (not rightv) (not leftv)) (setf info -1))
 ((and (not allv) (not over) (not somev)) (setf info -2))
 ((< n 0) (setf info -4))
 ((< ldt (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 n)))
  (setf info -6))
 ((or (< ldvl 1) (and leftv (< ldvl n))) (setf info -8))
 ((or (< ldvr 1) (and rightv (< ldvr n))) (setf info -10))
 ((< mm m) (setf info -11)))
(cond ((/= info 0)
  (xerbla "ZTREVC" (f2cl-lib:int-sub info)) (go end_label)))
(if (= n 0) (go end_label)) (setf unfl (dlamch "Safe minimum"))
(setf ovfl (/ one unfl))
(multiple-value-bind (var-0 var-1)
 (dlabad unfl ovfl) (declare (ignore))
 (when var-0 (setf unfl var-0)) (when var-1 (setf ovfl var-1)))
(setf ulp (dlamch "Precision")) (setf smlnum (* unfl (/ n ulp)))
(f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
```

```
       ((> i n) nil)
        (tagbody
           (setf
            (f2cl-lib:fref work-%data%
              ((f2cl-lib:int-add i n)) ((1 *)) work-%offset%)
            (f2cl-lib:fref t$-%data% (i i)
              ((1 ldt) (1 *)) t$-%offset%))
           label20))
(setf (f2cl-lib:fref rwork-%data% (1) ((1 *)) rwork-%offset%) zero)
(f2cl-lib:fdo (j 2 (f2cl-lib:int-add j 1))
       ((> j n) nil)
        (tagbody
           (setf (f2cl-lib:fref rwork-%data% (j)
                    ((1 *)) rwork-%offset%)
            (dzasum (f2cl-lib:int-sub j 1)
             (f2cl-lib:array-slice t$-%data%
                 f2cl-lib:complex16 (1 j) ((1 ldt) (1 *))
              t$-%offset%)
             1))
           label30))
(cond
 (rightv (setf is m)
  (f2cl-lib:fdo (ki n (f2cl-lib:int-add ki (f2cl-lib:int-sub 1)))
         ((> ki 1)
             nil)
          (tagbody
               (cond
                (somev
                 (if (not (f2cl-lib:fref select-%data% (ki)
                             ((1 *)) select-%offset%))
                   (go label80))))
               (setf smin
                (max
                 (* ulp
                  (cabs1 (f2cl-lib:fref t$-%data% (ki ki)
                          ((1 ldt) (1 *)) t$-%offset%)))
                 smlnum))
               (setf (f2cl-lib:fref work-%data% (1)
                       ((1 *)) work-%offset%) cmone)
               (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
           ((> k
                 (f2cl-lib:int-add ki (f2cl-lib:int-sub 1)))
                nil)
            (tagbody
                  (setf (f2cl-lib:fref work-%data% (k)
                       ((1 *)) work-%offset%)
                   (- (f2cl-lib:fref t$-%data% (k ki)
                       ((1 ldt) (1 *)) t$-%offset%)))
                  label40))
               (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
```

```
((> k
       (f2cl-lib:int-add ki (f2cl-lib:int-sub 1)))
      nil)
 (tagbody
       (setf (f2cl-lib:fref t$-%data% (k k)
             ((1 ldt) (1 *)) t$-%offset%)
        (- (f2cl-lib:fref t$-%data% (k k)
            ((1 ldt) (1 *)) t$-%offset%)
         (f2cl-lib:fref t$-%data% (ki ki)
           ((1 ldt) (1 *)) t$-%offset%)))
       (if
        (< (cabs1 (f2cl-lib:fref t$-%data% (k k)
                    ((1 ldt) (1 *)) t$-%offset%))
         smin)
        (setf (f2cl-lib:fref t$-%data% (k k)
                ((1 ldt) (1 *)) t$-%offset%)
         (coerce smin 'f2cl-lib:complex16)))
        label50))
      (cond
       ((> ki 1)
        (multiple-value-bind
         (var-0 var-1 var-2 var-3 var-4 var-5
          var-6 var-7 var-8 var-9 var-10)
         (zlatrs "Upper" "No transpose" "Non-unit" "Y"
          (f2cl-lib:int-sub ki 1)
          t$ ldt
          (f2cl-lib:array-slice work-%data%
           f2cl-lib:complex16 (1) ((1 *))
           work-%offset%)
          scale rwork info)
         (declare (ignore var-0 var-1 var-2 var-3
                          var-4 var-5 var-7 var-9))
         (setf ldt var-6)
         (setf scale var-8)
         (setf info var-10))
        (setf (f2cl-lib:fref work-%data% (ki)
               ((1 *)) work-%offset%)
         (coerce scale 'f2cl-lib:complex16))))
      (cond
       ((not over)
        (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
         (zcopy ki
          (f2cl-lib:array-slice work-%data%
           f2cl-lib:complex16 (1) ((1 *))
           work-%offset%)
          1
          (f2cl-lib:array-slice vr-%data%
           f2cl-lib:complex16 (1 is)
           ((1 ldvr) (1 *)) vr-%offset%)
          1)
```

```
      (declare (ignore var-1 var-2 var-3 var-4))
      (when var-0 (setf ki var-0)))
     (setf ii
      (multiple-value-bind (ret-val var-0 var-1 var-2)
       (izamax ki
        (f2cl-lib:array-slice vr-%data%
         f2cl-lib:complex16 (1 is)
         ((1 ldvr) (1 *)) vr-%offset%)
        1)
       (declare (ignore var-1 var-2))
       (when var-0 (setf ki var-0)) ret-val))
     (setf remax
      (/ one
       (cabs1
        (f2cl-lib:fref vr-%data% (ii is)
          ((1 ldvr) (1 *)) vr-%offset%))))
     (multiple-value-bind (var-0 var-1 var-2 var-3)
      (zdscal ki remax
       (f2cl-lib:array-slice vr-%data%
        f2cl-lib:complex16 (1 is)
        ((1 ldvr) (1 *)) vr-%offset%)
       1)
      (declare (ignore var-2 var-3))
      (when var-0 (setf ki var-0))
      (when var-1 (setf remax var-1)))
     (f2cl-lib:fdo (k (f2cl-lib:int-add ki 1)
                      (f2cl-lib:int-add k 1))
((> k n)
       nil)
 (tagbody
        (setf (f2cl-lib:fref vr-%data% (k is)
               ((1 ldvr) (1 *)) vr-%offset%)
         cmzero)
        label60)))
    (t
     (if (> ki 1)
      (multiple-value-bind
       (var-0 var-1 var-2 var-3 var-4 var-5
        var-6 var-7 var-8 var-9 var-10)
       (zgemv "N" n (f2cl-lib:int-sub ki 1) cmone vr ldvr
        (f2cl-lib:array-slice work-%data%
         f2cl-lib:complex16 (1) ((1 *))
         work-%offset%)
        1 (f2cl-lib:dcmplx scale)
        (f2cl-lib:array-slice vr-%data%
         f2cl-lib:complex16 (1 ki)
         ((1 ldvr) (1 *)) vr-%offset%)
        1)
       (declare (ignore var-0 var-2 var-4 var-6
                        var-7 var-8 var-9 var-10))
```

```
                      (when var-1 (setf n var-1))
                      (when var-3 (setf cmone var-3))
                      (when var-5 (setf ldvr var-5))))
                    (setf ii
                     (multiple-value-bind (ret-val var-0 var-1 var-2)
                      (izamax n
                       (f2cl-lib:array-slice vr-%data%
                        f2cl-lib:complex16 (1 ki)
                        ((1 ldvr) (1 *)) vr-%offset%)
                       1)
                      (declare (ignore var-1 var-2))
                      (when var-0 (setf n var-0)) ret-val))
                    (setf remax
                     (/ one
                      (cabs1
                       (f2cl-lib:fref vr-%data% (ii ki)
                        ((1 ldvr) (1 *)) vr-%offset%))))
                    (multiple-value-bind (var-0 var-1 var-2 var-3)
                     (zdscal n remax
                      (f2cl-lib:array-slice vr-%data%
                       f2cl-lib:complex16 (1 ki)
                       ((1 ldvr) (1 *)) vr-%offset%)
                      1)
                     (declare (ignore var-2 var-3))
                     (when var-0 (setf n var-0))
                     (when var-1 (setf remax var-1)))))
                  (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
                   ((> k
                       (f2cl-lib:int-add ki (f2cl-lib:int-sub 1)))
                    nil)
                   (tagbody
                     (setf (f2cl-lib:fref t$-%data% (k k)
                            ((1 ldt) (1 *)) t$-%offset%)
                      (f2cl-lib:fref work-%data%
                       ((f2cl-lib:int-add k n)) ((1 *))
                       work-%offset%))
                     label70))
                  (setf is (f2cl-lib:int-sub is 1)) label80))))
(cond
 (leftv (setf is 1)
  (f2cl-lib:fdo (ki 1 (f2cl-lib:int-add ki 1))
         ((> ki n) nil)
          (tagbody
               (cond
                (somev
                 (if (not (f2cl-lib:fref select-%data% (ki)
                           ((1 *)) select-%offset%))
                  (go label130))))
               (setf smin
                (max
```

```
       (* ulp
        (cabs1 (f2cl-lib:fref t$-%data% (ki ki)
                 ((1 ldt) (1 *)) t$-%offset%)))
        smlnum))
     (setf (f2cl-lib:fref work-%data% (n) ((1 *))
                  work-%offset%) cmone)
     (f2cl-lib:fdo (k (f2cl-lib:int-add ki 1)
                      (f2cl-lib:int-add k 1))
((> k n)
      nil)
 (tagbody
       (setf (f2cl-lib:fref work-%data% (k)
                 ((1 *)) work-%offset%)
        (coerce
         (-
          (f2cl-lib:dconjg
           (f2cl-lib:fref t$-%data% (ki k)
              ((1 ldt) (1 *)) t$-%offset%)))
          'f2cl-lib:complex16))
        label90))
     (f2cl-lib:fdo (k
       (f2cl-lib:int-add ki 1) (f2cl-lib:int-add k 1))
((> k n)
      nil)
 (tagbody
       (setf (f2cl-lib:fref t$-%data% (k k)
               ((1 ldt) (1 *)) t$-%offset%)
        (- (f2cl-lib:fref t$-%data% (k k)
               ((1 ldt) (1 *)) t$-%offset%)
         (f2cl-lib:fref t$-%data% (ki ki)
              ((1 ldt) (1 *)) t$-%offset%)))
       (if
        (< (cabs1 (f2cl-lib:fref t$-%data% (k k)
                   ((1 ldt) (1 *)) t$-%offset%))
         smin)
        (setf (f2cl-lib:fref t$-%data% (k k)
                ((1 ldt) (1 *)) t$-%offset%)
         (coerce smin 'f2cl-lib:complex16)))
       label100))
     (cond
      ((< ki n)
       (multiple-value-bind
        (var-0 var-1 var-2 var-3 var-4 var-5
         var-6 var-7 var-8 var-9 var-10)
        (zlatrs "Upper" "Conjugate transpose" "Non-unit" "Y"
         (f2cl-lib:int-sub n ki)
         (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16
          ((+ ki 1) (f2cl-lib:int-add ki 1))
                      ((1 ldt) (1 *)) t$-%offset%)
         ldt
```

```
                (f2cl-lib:array-slice work-%data%
                 f2cl-lib:complex16 ((+ ki 1))
                 ((1 *)) work-%offset%)
                scale rwork info)
               (declare (ignore var-0 var-1 var-2 var-3
                                var-4 var-5 var-7 var-9))
               (setf ldt var-6)
               (setf scale var-8)
               (setf info var-10))
              (setf (f2cl-lib:fref work-%data% (ki)
                        ((1 *)) work-%offset%)
               (coerce scale 'f2cl-lib:complex16))))
            (cond
             ((not over)
              (zcopy (f2cl-lib:int-add (f2cl-lib:int-sub n ki) 1)
               (f2cl-lib:array-slice work-%data%
                f2cl-lib:complex16 (ki) ((1 *))
                work-%offset%)
               1
               (f2cl-lib:array-slice vl-%data%
                f2cl-lib:complex16 (ki is)
                ((1 ldvl) (1 *)) vl-%offset%)
               1)
              (setf ii
               (f2cl-lib:int-sub
                (f2cl-lib:int-add
                 (izamax (f2cl-lib:int-add
                          (f2cl-lib:int-sub n ki) 1)
                  (f2cl-lib:array-slice vl-%data%
                   f2cl-lib:complex16 (ki is)
                   ((1 ldvl) (1 *)) vl-%offset%)
                  1)
                 ki)
                1))
              (setf remax
               (/ one
                (cabs1
                 (f2cl-lib:fref vl-%data% (ii is)
                  ((1 ldvl) (1 *)) vl-%offset%))))
              (multiple-value-bind (var-0 var-1 var-2 var-3)
               (zdscal (f2cl-lib:int-add
                        (f2cl-lib:int-sub n ki) 1) remax
                (f2cl-lib:array-slice vl-%data%
                 f2cl-lib:complex16 (ki is)
                 ((1 ldvl) (1 *)) vl-%offset%)
                1)
               (declare (ignore var-0 var-2 var-3))
               (when var-1 (setf remax var-1)))
              (f2cl-lib:fdo (k 1 (f2cl-lib:int-add k 1))
((> k
```

```
        (f2cl-lib:int-add ki (f2cl-lib:int-sub 1)))
       nil)
(tagbody
        (setf (f2cl-lib:fref vl-%data% (k is)
                ((1 ldvl) (1 *)) vl-%offset%)
         cmzero)
        label110)))
   (t
    (if (< ki n)
     (multiple-value-bind
      (var-0 var-1 var-2 var-3 var-4 var-5 var-6
       var-7 var-8 var-9 var-10)
      (zgemv "N" n (f2cl-lib:int-sub n ki) cmone
       (f2cl-lib:array-slice vl-%data% f2cl-lib:complex16
        (1 (f2cl-lib:int-add ki 1))
             ((1 ldvl) (1 *)) vl-%offset%)
       ldvl
       (f2cl-lib:array-slice work-%data%
        f2cl-lib:complex16 ((+ ki 1))
        ((1 *)) work-%offset%)
       1 (f2cl-lib:dcmplx scale)
       (f2cl-lib:array-slice vl-%data%
        f2cl-lib:complex16 (1 ki)
        ((1 ldvl) (1 *)) vl-%offset%)
       1)
      (declare (ignore var-0 var-2 var-4 var-6
                       var-7 var-8 var-9 var-10))
      (when var-1 (setf n var-1))
      (when var-3 (setf cmone var-3))
      (when var-5 (setf ldvl var-5))))
    (setf ii
     (multiple-value-bind (ret-val var-0 var-1 var-2)
      (izamax n
       (f2cl-lib:array-slice vl-%data%
        f2cl-lib:complex16 (1 ki)
        ((1 ldvl) (1 *)) vl-%offset%)
       1)
      (declare (ignore var-1 var-2))
     (when var-0 (setf n var-0)) ret-val))
    (setf remax
     (/ one
      (cabs1
       (f2cl-lib:fref vl-%data% (ii ki)
         ((1 ldvl) (1 *)) vl-%offset%))))
    (multiple-value-bind (var-0 var-1 var-2 var-3)
     (zdscal n remax
      (f2cl-lib:array-slice vl-%data%
       f2cl-lib:complex16 (1 ki)
       ((1 ldvl) (1 *)) vl-%offset%)
      1)
```

```
                        (declare (ignore var-2 var-3))
                        (when var-0 (setf n var-0))
                        (when var-1 (setf remax var-1)))))
                    (f2cl-lib:fdo (k (f2cl-lib:int-add ki 1)
                                     (f2cl-lib:int-add k 1))
                ((> k n)
                      nil)
                 (tagbody
                       (setf (f2cl-lib:fref t$-%data% (k k)
                        ((1 ldt) (1 *)) t$-%offset%)
                        (f2cl-lib:fref work-%data%
                         ((f2cl-lib:int-add k n)) ((1 *))
                         work-%offset%))
                       label120))
                    (setf is (f2cl-lib:int-add is 1)) label130))))
  (go end_label) end_label
  (return
   (values side howmny nil n nil ldt nil ldvl nil
           ldvr nil m nil nil info))))
))))
```

———-

6.129 ztrexc LAPACK

— **ztrexc.input** —

```
)set break resume
)sys rm -f ztrexc.output
)spool ztrexc.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **ztrexc.help** —

```
==========================================================================
ztrexc examples
==========================================================================

==========================================================================
```

```
Man Page Details
=================================================================

 Online html documentation available at
           http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZTREXC( COMPQ, N, T, LDT, Q, LDQ, IFST, ILST, INFO )

       .. Scalar Arguments ..
       CHARACTER          COMPQ
       INTEGER            IFST, ILST, INFO, LDQ, LDT, N
       ..
       .. Array Arguments ..
       COMPLEX*16         Q( LDQ, * ), T( LDT, * )
       ..


 Purpose:
 =============

 ZTREXC reorders the Schur factorization of a complex matrix
 A = Q*T*Q**H, so that the diagonal element of T with row index IFST
 is moved to row ILST.

 The Schur form T is reordered by a unitary similarity transformation
 Z**H*T*Z, and optionally the matrix Q of Schur vectors is updated by
 postmultplying it with Z.

 Arguments:
 ==========

  [in] COMPQ

         COMPQ is CHARACTER*1
         = 'V':  update the matrix Q of Schur vectors;
         = 'N':  do not update Q.

  [in] N

         N is INTEGER
         The order of the matrix T. N >= 0.

  [in,out] T

         T is COMPLEX*16 array, dimension (LDT,N)
         On entry, the upper triangular matrix T.
         On exit, the reordered upper triangular matrix.
```

```
 [in] LDT

        LDT is INTEGER
        The leading dimension of the array T. LDT >= max(1,N).

 [in,out] Q

        Q is COMPLEX*16 array, dimension (LDQ,N)
        On entry, if COMPQ = 'V', the matrix Q of Schur vectors.
        On exit, if COMPQ = 'V', Q has been postmultiplied by the
        unitary transformation matrix Z which reorders T.
        If COMPQ = 'N', Q is not referenced.

 [in] LDQ

        LDQ is INTEGER
        The leading dimension of the array Q.  LDQ >= max(1,N).

 [in] IFST

        IFST is INTEGER

 [in] ILST

        ILST is INTEGER

        Specify the reordering of the diagonal elements of T:
        The element with row index IFST is moved to row ILST by a
        sequence of transpositions between adjacent elements.
        1 <= IFST <= N; 1 <= ILST <= N.

 [out] INFO

        INFO is INTEGER
        = 0:  successful exit
        < 0:  if INFO = -i, the i-th argument had an illegal value

Authors:
========

 Univ. of Tennessee
 Univ. of California Berkeley
 Univ. of Colorado Denver
 NAG Ltd.

November 2011
```

— ztrexc.f —

```
*  =====================================================================
      SUBROUTINE ZTREXC( COMPQ, N, T, LDT, Q, LDQ, IFST, ILST, INFO )
*
*  -- LAPACK computational routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      CHARACTER          COMPQ
      INTEGER            IFST, ILST, INFO, LDQ, LDT, N
*     ..
*     .. Array Arguments ..
      COMPLEX*16         Q( LDQ, * ), T( LDT, * )
*     ..
*
*  =====================================================================
*
*     .. Local Scalars ..
      LOGICAL            WANTQ
      INTEGER            K, M1, M2, M3
      DOUBLE PRECISION   CS
      COMPLEX*16         SN, T11, T22, TEMP
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. External Subroutines ..
      EXTERNAL           XERBLA, ZLARTG, ZROT
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG, MAX
*     ..
*     .. Executable Statements ..
*
*     Decode and test the input parameters.
*
      INFO = 0
      WANTQ = LSAME( COMPQ, 'V' )
      IF( .NOT.LSAME( COMPQ, 'N' ) .AND. .NOT.WANTQ ) THEN
         INFO = -1
      ELSE IF( N.LT.0 ) THEN
         INFO = -2
      ELSE IF( LDT.LT.MAX( 1, N ) ) THEN
         INFO = -4
      ELSE IF( LDQ.LT.1 .OR. ( WANTQ .AND. LDQ.LT.MAX( 1, N ) ) ) THEN
```

```
         INFO = -6
      ELSE IF( IFST.LT.1 .OR. IFST.GT.N ) THEN
         INFO = -7
      ELSE IF( ILST.LT.1 .OR. ILST.GT.N ) THEN
         INFO = -8
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'ZTREXC', -INFO )
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( N.EQ.1 .OR. IFST.EQ.ILST )
     $   RETURN
*
      IF( IFST.LT.ILST ) THEN
*
*        Move the IFST-th diagonal element forward down the diagonal.
*
         M1 = 0
         M2 = -1
         M3 = 1
      ELSE
*
*        Move the IFST-th diagonal element backward up the diagonal.
*
         M1 = -1
         M2 = 0
         M3 = -1
      END IF
*
      DO 10 K = IFST + M1, ILST + M2, M3
*
*        Interchange the k-th and (k+1)-th diagonal elements.
*
         T11 = T( K, K )
         T22 = T( K+1, K+1 )
*
*        Determine the transformation to perform the interchange.
*
         CALL ZLARTG( T( K, K+1 ), T22-T11, CS, SN, TEMP )
*
*        Apply transformation to the matrix T.
*
         IF( K+2.LE.N )
     $      CALL ZROT( N-K-1, T( K, K+2 ), LDT, T( K+1, K+2 ), LDT, CS,
     $                 SN )
         CALL ZROT( K-1, T( 1, K ), 1, T( 1, K+1 ), 1, CS,
     $              DCONJG( SN ) )
```

```
*
         T( K, K ) = T22
         T( K+1, K+1 ) = T11
*
         IF( WANTQ ) THEN
*
*           Accumulate transformation in the matrix Q.
*
            CALL ZROT( N, Q( 1, K ), 1, Q( 1, K+1 ), 1, CS,
     $                 DCONJG( SN ) )
         END IF
*
   10 CONTINUE
*
      RETURN
*
*     End of ZTREXC
*
      END
```

———-

— LAPACK ztrexc —

```
(defun ztrexc (compq n t$ ldt q ldq ifst ilst info)
 (declare (type (simple-array character (*)) compq)
  (type (f2cl-lib:integer4) info ilst ifst ldq ldt n)
  (type (array f2cl-lib:complex16 (*)) q t$))
 (f2cl-lib:with-multi-array-data
     ((t$ f2cl-lib:complex16 t$-%data% t$-%offset%)
      (q f2cl-lib:complex16 q-%data% q-%offset%)
      (compq character compq-%data% compq-%offset%))
      (prog
       ((sn #C(0.0d0 0.0d0)) (t11 #C(0.0d0 0.0d0)) (t22 #C(0.0d0 0.0d0))
        (temp #C(0.0d0 0.0d0)) (cs 0.0d0) (k 0) (m1 0) (m2 0)
                (m3 0) (wantq nil)
        (dconjg$ 0.0))
       (declare (type (f2cl-lib:complex16) temp t22 t11 sn)
                (type (double-float) cs)
        (type (f2cl-lib:integer4) m3 m2 m1 k) (type f2cl-lib:logical wantq)
        (type (single-float) dconjg$))
       (setf info 0)
       (setf wantq
        (multiple-value-bind (ret-val var-0 var-1) (lsame compq "V")
         (declare (ignore var-1)) (when var-0 (setf compq var-0)) ret-val))
       (cond
        ((and
          (not
```

```
    (multiple-value-bind (ret-val var-0 var-1) (lsame compq "N")
     (declare (ignore var-1)) (when var-0 (setf compq var-0)) ret-val))
   (not wantq))
  (setf info -1))
 ((< n 0) (setf info -2))
 ((< ldt (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 n)))
  (setf info -4))
 ((or (< ldq 1)
   (and wantq
    (< ldq (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 n)))))
  (setf info -6))
 ((or (< ifst 1) (> ifst n)) (setf info -7))
 ((or (< ilst 1) (> ilst n)) (setf info -8)))
(cond ((/= info 0)
   (xerbla "ZTREXC" (f2cl-lib:int-sub info)) (go end_label)))
(if (or (= n 1) (= ifst ilst)) (go end_label))
(cond ((< ifst ilst) (setf m1 0) (setf m2 -1) (setf m3 1))
 (t (setf m1 -1) (setf m2 0) (setf m3 -1)))
(f2cl-lib:fdo (k (f2cl-lib:int-add ifst m1) (f2cl-lib:int-add k m3))
        ((> k
           (f2cl-lib:int-add ilst m2))
         nil)
         (tagbody
           (setf t11 (f2cl-lib:fref t$-%data% (k k)
              ((1 ldt) (1 *)) t$-%offset%))
           (setf t22
            (f2cl-lib:fref t$-%data%
             ((f2cl-lib:int-add k 1) (f2cl-lib:int-add k 1))
             ((1 ldt) (1 *)) t$-%offset%))
           (multiple-value-bind (var-0 var-1 var-2 var-3 var-4)
            (zlartg
             (f2cl-lib:fref t$-%data% (k (f2cl-lib:int-add k 1))
              ((1 ldt) (1 *))
              t$-%offset%)
             (- t22 t11) cs sn temp)
            (declare (ignore var-0 var-1))
            (setf cs var-2)
            (setf sn var-3)
            (setf temp var-4))
           (if (<= (f2cl-lib:int-add k 2) n)
            (zrot (f2cl-lib:int-sub n k 1)
             (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16
              (k (f2cl-lib:int-add k 2)) ((1 ldt) (1 *)) t$-%offset%)
             ldt
             (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16
              ((+ k 1) (f2cl-lib:int-add k 2))
               ((1 ldt) (1 *)) t$-%offset%)
             ldt cs sn))
           (zrot (f2cl-lib:int-sub k 1)
            (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16 (1 k)
```

```
                  ((1 ldt) (1 *))
                  t$-%offset%)
                 1
                 (f2cl-lib:array-slice t$-%data% f2cl-lib:complex16
                  (1 (f2cl-lib:int-add k 1)) ((1 ldt) (1 *)) t$-%offset%)
                 1 cs (f2cl-lib:dconjg sn))
                (setf (f2cl-lib:fref t$-%data% (k k)
                        ((1 ldt) (1 *)) t$-%offset%) t22)
                (setf
                 (f2cl-lib:fref t$-%data% ((f2cl-lib:int-add k 1)
                                           (f2cl-lib:int-add k 1))
                  ((1 ldt) (1 *)) t$-%offset%)
                 t11)
                (cond
                 (wantq
                  (zrot n
                   (f2cl-lib:array-slice q-%data% f2cl-lib:complex16 (1 k)
                     ((1 ldq) (1 *))
                    q-%offset%)
                   1
                   (f2cl-lib:array-slice q-%data% f2cl-lib:complex16
                    (1 (f2cl-lib:int-add k 1)) ((1 ldq) (1 *)) q-%offset%)
                   1 cs (f2cl-lib:dconjg sn))))
                label10))
       (go end_label) end_label
       (return (values compq nil nil nil nil nil nil nil info)))))
```

———-

6.130 zung2r LAPACK

— **zung2r.input** —

```
)set break resume
)sys rm -f zung2r.output
)spool zung2r.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zung2r.help** —

```
=====================================================================
zung2r examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================

 Online html documentation available at
           http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZUNG2R( M, N, K, A, LDA, TAU, WORK, INFO )

       .. Scalar Arguments ..
       INTEGER            INFO, K, LDA, M, N
       ..
       .. Array Arguments ..
       COMPLEX*16         A( LDA, * ), TAU( * ), WORK( * )
       ..


 Purpose:
 =============

 ZUNG2R generates an m by n complex matrix Q with orthonormal columns,
 which is defined as the first n columns of a product of k elementary
 reflectors of order m

       Q  =  H(1) H(2) . . . H(k)

 as returned by ZGEQRF.

 Arguments:
 ==========

  [in] M

          M is INTEGER
          The number of rows of the matrix Q. M >= 0.

  [in] N

          N is INTEGER
          The number of columns of the matrix Q. M >= N >= 0.

  [in] K
```

```
          K is INTEGER
          The number of elementary reflectors whose product defines the
          matrix Q. N >= K >= 0.

  [in,out] A

          A is COMPLEX*16 array, dimension (LDA,N)
          On entry, the i-th column must contain the vector which
          defines the elementary reflector H(i), for i = 1,2,...,k, as
          returned by ZGEQRF in the first k columns of its array
          argument A.
          On exit, the m by n matrix Q.

  [in] LDA

          LDA is INTEGER
          The first dimension of the array A. LDA >= max(1,M).

  [in] TAU

          TAU is COMPLEX*16 array, dimension (K)
          TAU(i) must contain the scalar factor of the elementary
          reflector H(i), as returned by ZGEQRF.

  [out] WORK

          WORK is COMPLEX*16 array, dimension (N)

  [out] INFO

          INFO is INTEGER
          = 0: successful exit
          < 0: if INFO = -i, the i-th argument has an illegal value

Authors:
========

 Univ. of Tennessee
 Univ. of California Berkeley
 Univ. of Colorado Denver
 NAG Ltd.

November 2011
```

———-

— **zung2r.f** —

```
*  =====================================================================
      SUBROUTINE ZUNG2R( M, N, K, A, LDA, TAU, WORK, INFO )
*
*  -- LAPACK computational routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      INTEGER            INFO, K, LDA, M, N
*     ..
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      COMPLEX*16         ONE, ZERO
      PARAMETER          ( ONE = ( 1.0D+0, 0.0D+0 ),
     $                   ZERO = ( 0.0D+0, 0.0D+0 ) )
*     ..
*     .. Local Scalars ..
      INTEGER            I, J, L
*     ..
*     .. External Subroutines ..
      EXTERNAL           XERBLA, ZLARF, ZSCAL
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      IF( M.LT.0 ) THEN
         INFO = -1
      ELSE IF( N.LT.0 .OR. N.GT.M ) THEN
         INFO = -2
      ELSE IF( K.LT.0 .OR. K.GT.N ) THEN
         INFO = -3
      ELSE IF( LDA.LT.MAX( 1, M ) ) THEN
         INFO = -5
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'ZUNG2R', -INFO )
         RETURN
      END IF
*
```

```
*     Quick return if possible
*
      IF( N.LE.0 )
     $   RETURN
*
*     Initialise columns k+1:n to columns of the unit matrix
*
      DO 20 J = K + 1, N
         DO 10 L = 1, M
            A( L, J ) = ZERO
   10    CONTINUE
         A( J, J ) = ONE
   20 CONTINUE
*
      DO 40 I = K, 1, -1
*
*        Apply H(i) to A(i:m,i:n) from the left
*
         IF( I.LT.N ) THEN
            A( I, I ) = ONE
            CALL ZLARF( 'Left', M-I+1, N-I, A( I, I ), 1, TAU( I ),
     $                  A( I, I+1 ), LDA, WORK )
         END IF
         IF( I.LT.M )
     $      CALL ZSCAL( M-I, -TAU( I ), A( I+1, I ), 1 )
         A( I, I ) = ONE - TAU( I )
*
*        Set A(1:i-1,i) to zero
*
         DO 30 L = 1, I - 1
            A( L, I ) = ZERO
   30    CONTINUE
   40 CONTINUE
      RETURN
*
*     End of ZUNG2R
*
      END
```

———-

— LAPACK zung2r —

```
(let*
 ((one (coerce (f2cl-lib:cmplx 1.0d0 0.0d0) 'f2cl-lib:complex16))
  (zero (coerce (f2cl-lib:cmplx 0.0d0 0.0d0) 'f2cl-lib:complex16)))
 (declare (type (f2cl-lib:complex16) one) (type (f2cl-lib:complex16) zero)
  (ignorable one zero))
```

```
(defun zung2r (m n k a lda tau work info)
 (declare (type (f2cl-lib:integer4) info lda k n m)
  (type (array f2cl-lib:complex16 (*)) work tau a))
 (f2cl-lib:with-multi-array-data
     ((a f2cl-lib:complex16 a-%data% a-%offset%)
      (tau f2cl-lib:complex16 tau-%data% tau-%offset%)
      (work f2cl-lib:complex16 work-%data% work-%offset%))
      (prog ((i 0) (j 0) (l 0))
       (declare (type (f2cl-lib:integer4) l j i)) (setf info 0)
       (cond ((< m 0) (setf info -1)) ((or (< n 0) (> n m)) (setf info -2))
        ((or (< k 0) (> k n)) (setf info -3))
        ((< lda (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 m)))
         (setf info -5)))
       (cond ((/= info 0)
          (xerbla "ZUNG2R" (f2cl-lib:int-sub info)) (go end_label)))
       (if (<= n 0) (go end_label))
       (f2cl-lib:fdo (j (f2cl-lib:int-add k 1) (f2cl-lib:int-add j 1))
              ((> j n) nil)
               (tagbody
                 (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
               ((> l m) nil)
                (tagbody
                   (setf (f2cl-lib:fref a-%data% (l j)
                           ((1 lda) (1 *)) a-%offset%) zero)
                   label10))
                 (setf (f2cl-lib:fref a-%data% (j j)
                         ((1 lda) (1 *)) a-%offset%) one) label20)
               )
       (f2cl-lib:fdo (i k (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
              ((> i 1) nil)
               (tagbody
                 (cond
                  ((< i n)
                   (setf (f2cl-lib:fref a-%data% (i i)
                   ((1 lda) (1 *)) a-%offset%) one)
                   (multiple-value-bind
                    (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
                    (zlarf "Left" (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
                     (f2cl-lib:int-sub n i)
                     (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
                     (i i) ((1 lda) (1 *))
                      a-%offset%)
                     1 (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)
                     (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
                      (i (f2cl-lib:int-add i 1)) ((1 lda) (1 *)) a-%offset%)
                     lda work)
                    (declare (ignore var-0 var-1 var-2 var-3
                                     var-4 var-5 var-6 var-8))
                    (setf lda var-7))))
                 (if (< i m)
```

```
                 (zscal (f2cl-lib:int-sub m i)
                  (- (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%))
                  (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
                   ((+ i 1) i)
                   ((1 lda) (1 *)) a-%offset%)
                  1))
                (setf (f2cl-lib:fref a-%data% (i i)
                 ((1 lda) (1 *)) a-%offset%)
                 (- one (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)))
                (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
               ((> l
                   (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                  nil)
                (tagbody
                   (setf (f2cl-lib:fref a-%data% (l i)
                   ((1 lda) (1 *)) a-%offset%) zero)
                   label30))
                label40))
      (go end_label)
 end_label (return (values nil nil nil nil lda nil nil info)))
     )))
```

———-

6.131 zunghr LAPACK

— **zunghr.input** —

```
)set break resume
)sys rm -f zunghr.output
)spool zunghr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zunghr.help** —

```
====================================================================
zunghr examples
====================================================================
```

```
=====================================================================
Man Page Details
=====================================================================

 Online html documentation available at
           http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZUNGHR( N, ILO, IHI, A, LDA, TAU, WORK, LWORK, INFO )

       .. Scalar Arguments ..
       INTEGER            IHI, ILO, INFO, LDA, LWORK, N
       ..
       .. Array Arguments ..
       COMPLEX*16         A( LDA, * ), TAU( * ), WORK( * )
       ..


 Purpose:
 =============

 ZUNGHR generates a complex unitary matrix Q which is defined as the
 product of IHI-ILO elementary reflectors of order N, as returned by
 ZGEHRD:

 Q = H(ilo) H(ilo+1) . . . H(ihi-1).

 Arguments:
 ==========

  [in] N

          N is INTEGER
          The order of the matrix Q. N >= 0.

  [in] ILO

          ILO is INTEGER

  [in] IHI

          IHI is INTEGER

          ILO and IHI must have the same values as in the previous call
          of ZGEHRD. Q is equal to the unit matrix except in the
          submatrix Q(ilo+1:ihi,ilo+1:ihi).
          1 <= ILO <= IHI <= N, if N > 0; ILO=1 and IHI=0, if N=0.
```

```
 [in,out] A

         A is COMPLEX*16 array, dimension (LDA,N)
         On entry, the vectors which define the elementary reflectors,
         as returned by ZGEHRD.
         On exit, the N-by-N unitary matrix Q.

 [in] LDA

         LDA is INTEGER
         The leading dimension of the array A. LDA >= max(1,N).

 [in] TAU

         TAU is COMPLEX*16 array, dimension (N-1)
         TAU(i) must contain the scalar factor of the elementary
         reflector H(i), as returned by ZGEHRD.

 [out] WORK

         WORK is COMPLEX*16 array, dimension (MAX(1,LWORK))
         On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

 [in] LWORK

         LWORK is INTEGER
         The dimension of the array WORK. LWORK >= IHI-ILO.
         For optimum performance LWORK >= (IHI-ILO)*NB, where NB is
         the optimal blocksize.

         If LWORK = -1, then a workspace query is assumed; the routine
         only calculates the optimal size of the WORK array, returns
         this value as the first entry of the WORK array, and no error
         message related to LWORK is issued by XERBLA.

 [out] INFO

         INFO is INTEGER
         = 0:  successful exit
         < 0:  if INFO = -i, the i-th argument had an illegal value

Authors:
========

 Univ. of Tennessee
 Univ. of California Berkeley
 Univ. of Colorado Denver
 NAG Ltd.

November 2011
```

———-

— **zunghr.f** —

```
*  =====================================================================
      SUBROUTINE ZUNGHR( N, ILO, IHI, A, LDA, TAU, WORK, LWORK, INFO )
*
*  -- LAPACK computational routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      INTEGER            IHI, ILO, INFO, LDA, LWORK, N
*     ..
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      COMPLEX*16         ZERO, ONE
      PARAMETER          ( ZERO = ( 0.0D+0, 0.0D+0 ),
     $                   ONE = ( 1.0D+0, 0.0D+0 ) )
*     ..
*     .. Local Scalars ..
      LOGICAL            LQUERY
      INTEGER            I, IINFO, J, LWKOPT, NB, NH
*     ..
*     .. External Subroutines ..
      EXTERNAL           XERBLA, ZUNGQR
*     ..
*     .. External Functions ..
      INTEGER            ILAENV
      EXTERNAL           ILAENV
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      NH = IHI - ILO
      LQUERY = ( LWORK.EQ.-1 )
```

```
      IF( N.LT.0 ) THEN
         INFO = -1
      ELSE IF( ILO.LT.1 .OR. ILO.GT.MAX( 1, N ) ) THEN
         INFO = -2
      ELSE IF( IHI.LT.MIN( ILO, N ) .OR. IHI.GT.N ) THEN
         INFO = -3
      ELSE IF( LDA.LT.MAX( 1, N ) ) THEN
         INFO = -5
      ELSE IF( LWORK.LT.MAX( 1, NH ) .AND. .NOT.LQUERY ) THEN
         INFO = -8
      END IF
*
      IF( INFO.EQ.0 ) THEN
         NB = ILAENV( 1, 'ZUNGQR', ' ', NH, NH, NH, -1 )
         LWKOPT = MAX( 1, NH )*NB
         WORK( 1 ) = LWKOPT
      END IF
*
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'ZUNGHR', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( N.EQ.0 ) THEN
         WORK( 1 ) = 1
         RETURN
      END IF
*
*     Shift the vectors which define the elementary reflectors one
*     column to the right, and set the first ilo and the last n-ihi
*     rows and columns to those of the unit matrix
*
      DO 40 J = IHI, ILO + 1, -1
         DO 10 I = 1, J - 1
            A( I, J ) = ZERO
   10    CONTINUE
         DO 20 I = J + 1, IHI
            A( I, J ) = A( I, J-1 )
   20    CONTINUE
         DO 30 I = IHI + 1, N
            A( I, J ) = ZERO
   30    CONTINUE
   40 CONTINUE
      DO 60 J = 1, ILO
         DO 50 I = 1, N
            A( I, J ) = ZERO
```

```
   50    CONTINUE
         A( J, J ) = ONE
   60 CONTINUE
      DO 80 J = IHI + 1, N
         DO 70 I = 1, N
            A( I, J ) = ZERO
   70    CONTINUE
         A( J, J ) = ONE
   80 CONTINUE
*
      IF( NH.GT.0 ) THEN
*
*        Generate Q(ilo+1:ihi,ilo+1:ihi)
*
         CALL ZUNGQR( NH, NH, NH, A( ILO+1, ILO+1 ), LDA, TAU( ILO ),
     $                WORK, LWORK, IINFO )
      END IF
      WORK( 1 ) = LWKOPT
      RETURN
*
*     End of ZUNGHR
*
      END
```

———-

— LAPACK zunghr —

```
(let*
 ((zero (coerce (f2cl-lib:cmplx 0.0d0 0.0d0) 'f2cl-lib:complex16))
  (one (coerce (f2cl-lib:cmplx 1.0d0 0.0d0) 'f2cl-lib:complex16)))
 (declare (type (f2cl-lib:complex16) zero) (type (f2cl-lib:complex16) one)
  (ignorable zero one))
 (defun zunghr (n ilo ihi a lda tau work lwork info)
  (declare (type (f2cl-lib:integer4) info lwork lda ihi ilo n)
   (type (array f2cl-lib:complex16 (*)) work tau a))
  (f2cl-lib:with-multi-array-data
      ((a f2cl-lib:complex16 a-%data% a-%offset%)
       (tau f2cl-lib:complex16 tau-%data% tau-%offset%)
       (work f2cl-lib:complex16 work-%data% work-%offset%))
       (prog
        ((i 0) (iinfo 0) (j 0) (lwkopt 0) (nb 0) (nh 0) (lquery nil))
        (declare (type (f2cl-lib:integer4) nh nb lwkopt j iinfo i)
         (type f2cl-lib:logical lquery))
        (setf info 0) (setf nh (f2cl-lib:int-sub ihi ilo))
        (setf lquery (coerce (= lwork -1) 'f2cl-lib:logical))
        (cond ((< n 0) (setf info -1))
         ((or (< ilo 1)
```

```
   (> ilo (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 n))))
  (setf info -2))
 ((or (< ihi (min (the f2cl-lib:integer4 ilo)
                  (the f2cl-lib:integer4 n)))
   (> ihi n))
  (setf info -3))
 ((< lda (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 n)))
  (setf info -5))
 ((and (< lwork (max (the f2cl-lib:integer4 1)
                     (the f2cl-lib:integer4 nh)))
   (not lquery))
  (setf info -8)))
(cond
 ((= info 0)
  (setf nb
   (multiple-value-bind (ret-val var-0 var-1 var-2 var-3
                         var-4 var-5 var-6)
    (ilaenv 1 "ZUNGQR" " " nh nh nh -1)
    (declare (ignore var-0 var-1 var-2 var-6))
    (when var-3 (setf nh var-3))
    (when var-4 (setf nh var-4))
    (when var-5 (setf nh var-5)) ret-val))
  (setf lwkopt
   (f2cl-lib:int-mul
    (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 nh)) nb))
  (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
   (coerce lwkopt 'f2cl-lib:complex16))))
(cond ((/= info 0)
      (xerbla "ZUNGHR" (f2cl-lib:int-sub info)) (go end_label))
 (lquery (go end_label)))
(cond
 ((= n 0)
  (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
   (coerce 1 'f2cl-lib:complex16))
  (go end_label)))
(f2cl-lib:fdo (j ihi (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
       ((> j
          (f2cl-lib:int-add ilo 1))
        nil)
       (tagbody
         (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
         ((> i
             (f2cl-lib:int-add j (f2cl-lib:int-sub 1)))
          nil)
          (tagbody
            (setf (f2cl-lib:fref a-%data% (i j)
                    ((1 lda) (1 *)) a-%offset%) zero)
            label10))
          (f2cl-lib:fdo (i (f2cl-lib:int-add j 1)
                           (f2cl-lib:int-add i 1))
```

```
          ((> i ihi)
             nil)
           (tagbody
              (setf (f2cl-lib:fref a-%data% (i j)
                   ((1 lda) (1 *)) a-%offset%)
               (f2cl-lib:fref a-%data% (i (f2cl-lib:int-sub j 1))
                ((1 lda) (1 *))
                a-%offset%))
              label20))
            (f2cl-lib:fdo (i (f2cl-lib:int-add ihi 1)
                             (f2cl-lib:int-add i 1))
          ((> i n)
             nil)
           (tagbody
              (setf (f2cl-lib:fref a-%data% (i j)
               ((1 lda) (1 *)) a-%offset%) zero)
              label30))
            label40))
(f2cl-lib:fdo (j 1 (f2cl-lib:int-add j 1))
       ((> j ilo) nil)
        (tagbody
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i n) nil)
         (tagbody
            (setf (f2cl-lib:fref a-%data% (i j)
            ((1 lda) (1 *)) a-%offset%) zero)
            label50))
          (setf (f2cl-lib:fref a-%data% (j j)
            ((1 lda) (1 *)) a-%offset%) one) label60)
        )
(f2cl-lib:fdo (j (f2cl-lib:int-add ihi 1) (f2cl-lib:int-add j 1))
       ((> j n) nil)
        (tagbody
          (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
        ((> i n) nil)
         (tagbody
            (setf (f2cl-lib:fref a-%data% (i j)
            ((1 lda) (1 *)) a-%offset%) zero)
            label70))
          (setf (f2cl-lib:fref a-%data% (j j)
            ((1 lda) (1 *)) a-%offset%) one) label80)
        )
(cond
 ((> nh 0)
  (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5
                        var-6 var-7 var-8)
   (zungqr nh nh nh
    (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
     ((+ ilo 1) (f2cl-lib:int-add ilo 1)) ((1 lda) (1 *)) a-%offset%)
    lda
```

```
            (f2cl-lib:array-slice tau-%data% f2cl-lib:complex16 (ilo) ((1 *))
             tau-%offset%)
            work lwork iinfo)
           (declare (ignore var-3 var-5 var-6)) (when var-0 (setf nh var-0))
           (when var-1 (setf nh var-1)) (when var-2 (setf nh var-2))
           (when var-4 (setf lda var-4)) (when var-7 (setf lwork var-7))
           (when var-8 (setf iinfo var-8)))))
        (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
         (coerce lwkopt 'f2cl-lib:complex16))
        (go end_label) end_label
        (return (values nil nil nil nil lda nil nil lwork info))))))
```

———-

6.132 zungqr LAPACK

— **zungqr.input** —

```
)set break resume
)sys rm -f zungqr.output
)spool zungqr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zungqr.help** —

```
=======================================================================
zungqr examples
=======================================================================

=======================================================================
Man Page Details
=======================================================================

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========
```

```
      SUBROUTINE ZUNGQR( M, N, K, A, LDA, TAU, WORK, LWORK, INFO )

      .. Scalar Arguments ..
      INTEGER            INFO, K, LDA, LWORK, M, N
      ..
      .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), TAU( * ), WORK( * )
      ..


Purpose:
=============

ZUNGQR generates an M-by-N complex matrix Q with orthonormal columns,
which is defined as the first N columns of a product of K elementary
reflectors of order M

      Q  =  H(1) H(2) . . . H(k)

as returned by ZGEQRF.

Arguments:
==========

 [in] M

         M is INTEGER
         The number of rows of the matrix Q. M >= 0.

 [in] N

         N is INTEGER
         The number of columns of the matrix Q. M >= N >= 0.

 [in] K

         K is INTEGER
         The number of elementary reflectors whose product defines the
         matrix Q. N >= K >= 0.

 [in,out] A

         A is COMPLEX*16 array, dimension (LDA,N)
         On entry, the i-th column must contain the vector which
         defines the elementary reflector H(i), for i = 1,2,...,k, as
         returned by ZGEQRF in the first k columns of its array
         argument A.
         On exit, the M-by-N matrix Q.

 [in] LDA
```

```
          LDA is INTEGER
          The first dimension of the array A. LDA >= max(1,M).

  [in] TAU

          TAU is COMPLEX*16 array, dimension (K)
          TAU(i) must contain the scalar factor of the elementary
          reflector H(i), as returned by ZGEQRF.

  [out] WORK

          WORK is COMPLEX*16 array, dimension (MAX(1,LWORK))
          On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

  [in] LWORK

          LWORK is INTEGER
          The dimension of the array WORK. LWORK >= max(1,N).
          For optimum performance LWORK >= N*NB, where NB is the
          optimal blocksize.

          If LWORK = -1, then a workspace query is assumed; the routine
          only calculates the optimal size of the WORK array, returns
          this value as the first entry of the WORK array, and no error
          message related to LWORK is issued by XERBLA.

  [out] INFO

          INFO is INTEGER
          = 0:  successful exit
          < 0:  if INFO = -i, the i-th argument has an illegal value

 Authors:
 ========

  Univ. of Tennessee
  Univ. of California Berkeley
  Univ. of Colorado Denver
  NAG Ltd.

 November 2011

          ---------

          -- zungqr.f --

*  =====================================================================
```

```
      SUBROUTINE ZUNGQR( M, N, K, A, LDA, TAU, WORK, LWORK, INFO )
*
*  -- LAPACK computational routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      INTEGER            INFO, K, LDA, LWORK, M, N
*     ..
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      COMPLEX*16         ZERO
      PARAMETER          ( ZERO = ( 0.0D+0, 0.0D+0 ) )
*     ..
*     .. Local Scalars ..
      LOGICAL            LQUERY
      INTEGER            I, IB, IINFO, IWS, J, KI, KK, L, LDWORK,
     $                   LWKOPT, NB, NBMIN, NX
*     ..
*     .. External Subroutines ..
      EXTERNAL           XERBLA, ZLARFB, ZLARFT, ZUNG2R
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. External Functions ..
      INTEGER            ILAENV
      EXTERNAL           ILAENV
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      NB = ILAENV( 1, 'ZUNGQR', ' ', M, N, K, -1 )
      LWKOPT = MAX( 1, N )*NB
      WORK( 1 ) = LWKOPT
      LQUERY = ( LWORK.EQ.-1 )
      IF( M.LT.0 ) THEN
         INFO = -1
      ELSE IF( N.LT.0 .OR. N.GT.M ) THEN
         INFO = -2
      ELSE IF( K.LT.0 .OR. K.GT.N ) THEN
         INFO = -3
```

```
      ELSE IF( LDA.LT.MAX( 1, M ) ) THEN
         INFO = -5
      ELSE IF( LWORK.LT.MAX( 1, N ) .AND. .NOT.LQUERY ) THEN
         INFO = -8
      END IF
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'ZUNGQR', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( N.LE.0 ) THEN
         WORK( 1 ) = 1
         RETURN
      END IF
*
      NBMIN = 2
      NX = 0
      IWS = N
      IF( NB.GT.1 .AND. NB.LT.K ) THEN
*
*        Determine when to cross over from blocked to unblocked code.
*
         NX = MAX( 0, ILAENV( 3, 'ZUNGQR', ' ', M, N, K, -1 ) )
         IF( NX.LT.K ) THEN
*
*           Determine if workspace is large enough for blocked code.
*
            LDWORK = N
            IWS = LDWORK*NB
            IF( LWORK.LT.IWS ) THEN
*
*              Not enough workspace to use optimal NB:  reduce NB and
*              determine the minimum value of NB.
*
               NB = LWORK / LDWORK
               NBMIN = MAX( 2, ILAENV( 2, 'ZUNGQR', ' ', M, N, K, -1 ) )
            END IF
         END IF
      END IF
*
      IF( NB.GE.NBMIN .AND. NB.LT.K .AND. NX.LT.K ) THEN
*
*        Use blocked code after the last block.
*        The first kk columns are handled by the block method.
*
         KI = ( ( K-NX-1 ) / NB )*NB
```

```
         KK = MIN( K, KI+NB )
*
*        Set A(1:kk,kk+1:n) to zero.
*
         DO 20 J = KK + 1, N
            DO 10 I = 1, KK
               A( I, J ) = ZERO
   10       CONTINUE
   20    CONTINUE
      ELSE
         KK = 0
      END IF
*
*     Use unblocked code for the last or only block.
*
      IF( KK.LT.N )
     $   CALL ZUNG2R( M-KK, N-KK, K-KK, A( KK+1, KK+1 ), LDA,
     $                TAU( KK+1 ), WORK, IINFO )
*
      IF( KK.GT.0 ) THEN
*
*        Use blocked code
*
         DO 50 I = KI + 1, 1, -NB
            IB = MIN( NB, K-I+1 )
            IF( I+IB.LE.N ) THEN
*
*              Form the triangular factor of the block reflector
*              H = H(i) H(i+1) . . . H(i+ib-1)
*
               CALL ZLARFT( 'Forward', 'Columnwise', M-I+1, IB,
     $                      A( I, I ), LDA, TAU( I ), WORK, LDWORK )
*
*              Apply H to A(i:m,i+ib:n) from the left
*
               CALL ZLARFB( 'Left', 'No transpose', 'Forward',
     $                      'Columnwise', M-I+1, N-I-IB+1, IB,
     $                      A( I, I ), LDA, WORK, LDWORK, A( I, I+IB ),
     $                      LDA, WORK( IB+1 ), LDWORK )
            END IF
*
*           Apply H to rows i:m of current block
*
            CALL ZUNG2R( M-I+1, IB, IB, A( I, I ), LDA, TAU( I ), WORK,
     $                   IINFO )
*
*           Set rows 1:i-1 of current block to zero
*
            DO 40 J = I, I + IB - 1
               DO 30 L = 1, I - 1
```

```
                A( L, J ) = ZERO
   30          CONTINUE
   40       CONTINUE
   50    CONTINUE
      END IF
*
      WORK( 1 ) = IWS
      RETURN
*
*     End of ZUNGQR
*
      END
```

———-

— LAPACK zungqr —

```
(let* ((zero (coerce (f2cl-lib:cmplx 0.0d0 0.0d0) 'f2cl-lib:complex16)))
 (declare (type (f2cl-lib:complex16) zero) (ignorable zero))
 (defun zungqr (m n k a lda tau work lwork info)
  (declare (type (f2cl-lib:integer4) info lwork lda k n m)
   (type (array f2cl-lib:complex16 (*)) work tau a))
  (f2cl-lib:with-multi-array-data
      ((a f2cl-lib:complex16 a-%data% a-%offset%)
       (tau f2cl-lib:complex16 tau-%data% tau-%offset%)
       (work f2cl-lib:complex16 work-%data% work-%offset%))
       (prog
        ((i 0) (ib 0) (iinfo 0) (iws 0) (j 0) (ki 0) (kk 0) (l 0) (ldwork 0)
         (lwkopt 0) (nb 0) (nbmin 0) (nx 0) (lquery nil))
        (declare
         (type (f2cl-lib:integer4) nx nbmin nb lwkopt ldwork
             l kk ki j iws iinfo ib i)
         (type f2cl-lib:logical lquery))
        (setf info 0)
        (setf nb
         (multiple-value-bind (ret-val var-0 var-1 var-2 var-3
                               var-4 var-5 var-6)
          (ilaenv 1 "ZUNGQR" " " m n k -1)
          (declare (ignore var-0 var-1 var-2 var-6))
          (when var-3 (setf m var-3)) (when var-4 (setf n var-4))
          (when var-5 (setf k var-5)) ret-val))
        (setf lwkopt
         (f2cl-lib:int-mul (max (the f2cl-lib:integer4 1)
                                (the f2cl-lib:integer4 n))
          nb))
        (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
         (coerce lwkopt 'f2cl-lib:complex16))
        (setf lquery (coerce (= lwork -1) 'f2cl-lib:logical))
```

```
(cond ((< m 0) (setf info -1)) ((or (< n 0) (> n m)) (setf info -2))
 ((or (< k 0) (> k n)) (setf info -3))
 ((< lda (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 m)))
  (setf info -5))
 ((and (< lwork (max (the f2cl-lib:integer4 1)
                     (the f2cl-lib:integer4 n)))
   (not lquery))
  (setf info -8)))
(cond ((/= info 0)
    (xerbla "ZUNGQR" (f2cl-lib:int-sub info)) (go end_label))
 (lquery (go end_label)))
(cond
 ((<= n 0)
  (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
   (coerce 1 'f2cl-lib:complex16))
  (go end_label)))
(setf nbmin 2) (setf nx 0) (setf iws n)
(cond
 ((and (> nb 1) (< nb k))
  (setf nx
   (max (the f2cl-lib:integer4 0)
    (the f2cl-lib:integer4
     (multiple-value-bind (ret-val var-0 var-1 var-2
                           var-3 var-4 var-5 var-6)
      (ilaenv 3 "ZUNGQR" " " m n k -1)
      (declare (ignore var-0 var-1 var-2 var-6))
      (when var-3 (setf m var-3))
      (when var-4 (setf n var-4))
      (when var-5 (setf k var-5)) ret-val))))
  (cond
   ((< nx k) (setf ldwork n) (setf iws (f2cl-lib:int-mul ldwork nb))
    (cond
     ((< lwork iws)
      (setf nb (the f2cl-lib:integer4 (truncate lwork ldwork)))
      (setf nbmin
       (max (the f2cl-lib:integer4 2)
        (the f2cl-lib:integer4
         (multiple-value-bind
          (ret-val var-0 var-1 var-2 var-3 var-4 var-5 var-6)
          (ilaenv 2 "ZUNGQR" " " m n k -1)
          (declare (ignore var-0 var-1 var-2 var-6))
          (when var-3 (setf m var-3)) (when var-4 (setf n var-4))
          (when var-5 (setf k var-5)) ret-val)))))))))
(cond
 ((and (>= nb nbmin) (< nb k) (< nx k))
  (setf ki (* (the f2cl-lib:integer4 (truncate (- k nx 1) nb)) nb))
  (setf kk
   (min (the f2cl-lib:integer4 k)
    (the f2cl-lib:integer4 (f2cl-lib:int-add ki nb))))
  (f2cl-lib:fdo (j (f2cl-lib:int-add kk 1) (f2cl-lib:int-add j 1))
```

```
          ((> j n)
              nil)
           (tagbody
               (f2cl-lib:fdo (i 1 (f2cl-lib:int-add i 1))
           ((> i kk) nil)
            (tagbody
                 (setf (f2cl-lib:fref a-%data% (i j)
                    ((1 lda) (1 *)) a-%offset%) zero)
                label10))
               label20)))
 (t (setf kk 0)))
(if (< kk n)
 (multiple-value-bind (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7)
  (zung2r (f2cl-lib:int-sub m kk) (f2cl-lib:int-sub n kk)
   (f2cl-lib:int-sub k kk)
   (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
    ((+ kk 1) (f2cl-lib:int-add kk 1)) ((1 lda) (1 *)) a-%offset%)
   lda
   (f2cl-lib:array-slice tau-%data% f2cl-lib:complex16
    ((+ kk 1)) ((1 *))
    tau-%offset%)
   work iinfo)
  (declare (ignore var-0 var-1 var-2 var-3 var-5 var-6))
  (setf lda var-4)
  (setf iinfo var-7)))
(cond
 ((> kk 0)
  (f2cl-lib:fdo (i (f2cl-lib:int-add ki 1)
              (f2cl-lib:int-add i (f2cl-lib:int-sub nb)))
          ((> i 1) nil)
           (tagbody
               (setf ib
                (min (the f2cl-lib:integer4 nb)
                 (the f2cl-lib:integer4
                   (f2cl-lib:int-add (f2cl-lib:int-sub k i) 1))))
               (cond
                ((<= (f2cl-lib:int-add i ib) n)
                 (multiple-value-bind
                  (var-0 var-1 var-2 var-3 var-4 var-5
                   var-6 var-7 var-8)
                  (zlarft "Forward" "Columnwise"
                   (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1) ib
                   (f2cl-lib:array-slice a-%data%
                      f2cl-lib:complex16 (i i) ((1 lda) (1 *))
                    a-%offset%)
                   lda
                   (f2cl-lib:array-slice tau-%data%
                      f2cl-lib:complex16 (i) ((1 *))
                    tau-%offset%)
                   work ldwork)
```

```
          (declare (ignore var-0 var-1 var-2 var-3
                           var-4 var-6 var-7))
          (setf lda var-5) (setf ldwork var-8))
         (multiple-value-bind
          (var-0 var-1 var-2 var-3 var-4
           var-5 var-6 var-7 var-8 var-9 var-10
           var-11 var-12 var-13 var-14)
          (zlarfb "Left" "No transpose" "Forward" "Columnwise"
           (f2cl-lib:int-add (f2cl-lib:int-sub m i) 1)
           (f2cl-lib:int-add (f2cl-lib:int-sub n i ib) 1) ib
           (f2cl-lib:array-slice a-%data%
              f2cl-lib:complex16 (i i) ((1 lda) (1 *))
            a-%offset%)
           lda work ldwork
           (f2cl-lib:array-slice a-%data% f2cl-lib:complex16
            (i (f2cl-lib:int-add i ib))
              ((1 lda) (1 *)) a-%offset%)
           lda
           (f2cl-lib:array-slice work-%data%
              f2cl-lib:complex16 ((+ ib 1)) ((1 *))
            work-%offset%)
           ldwork)
          (declare
           (ignore var-0 var-1 var-2 var-3 var-4
                   var-5 var-7 var-9 var-11 var-13))
          (setf ib var-6)
          (setf lda var-8)
          (setf ldwork var-10)
          (setf lda var-12)
          (setf ldwork var-14))))
       (multiple-value-bind (var-0 var-1 var-2 var-3
                             var-4 var-5 var-6 var-7)
        (zung2r (f2cl-lib:int-add
                 (f2cl-lib:int-sub m i) 1) ib ib
         (f2cl-lib:array-slice a-%data%
           f2cl-lib:complex16 (i i) ((1 lda) (1 *))
          a-%offset%)
         lda
         (f2cl-lib:array-slice tau-%data%
            f2cl-lib:complex16 (i) ((1 *))
          tau-%offset%)
         work iinfo)
        (declare (ignore var-0 var-1 var-2
                  var-3 var-5 var-6))
        (setf lda var-4)
        (setf iinfo var-7))
       (f2cl-lib:fdo (j i (f2cl-lib:int-add j 1))
    ((> j
        (f2cl-lib:int-add i ib (f2cl-lib:int-sub 1)))
     nil)
```

```
                  (tagbody
                       (f2cl-lib:fdo (l 1 (f2cl-lib:int-add l 1))
                  ((> l
                         (f2cl-lib:int-add i (f2cl-lib:int-sub 1)))
                        nil)
                   (tagbody
                         (setf (f2cl-lib:fref a-%data% (l j)
                            ((1 lda) (1 *)) a-%offset%) zero)
                         label30))
                        label40))
                     label50))))
        (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
         (coerce iws 'f2cl-lib:complex16))
        (go end_label)
  end_label
        (return (values m n k nil lda nil nil nil info)))
       )))
```

———-

6.133 zunm2r LAPACK

— **zunm2r.input** —

```
)set break resume
)sys rm -f zunm2r.output
)spool zunm2r.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zunm2r.help** —

```
=====================================================================
zunm2r examples
=====================================================================

=====================================================================
Man Page Details
=====================================================================
```

```
Online html documentation available at
           http://www.netlib.org/lapack/explore-html/

Definition:
===========

      SUBROUTINE ZUNM2R( SIDE, TRANS, M, N, K, A, LDA, TAU, C, LDC,
                         WORK, INFO )

      .. Scalar Arguments ..
      CHARACTER          SIDE, TRANS
      INTEGER            INFO, K, LDA, LDC, M, N
      ..
      .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), C( LDC, * ), TAU( * ), WORK( * )
      ..


Purpose:
=============

ZUNM2R overwrites the general complex m-by-n matrix C with

      Q * C  if SIDE = 'L' and TRANS = 'N', or

      Q**H* C  if SIDE = 'L' and TRANS = 'C', or

      C * Q  if SIDE = 'R' and TRANS = 'N', or

      C * Q**H if SIDE = 'R' and TRANS = 'C',

where Q is a complex unitary matrix defined as the product of k
elementary reflectors

      Q = H(1) H(2) . . . H(k)

as returned by ZGEQRF. Q is of order m if SIDE = 'L' and of order n
if SIDE = 'R'.

Arguments:
==========

 [in] SIDE

         SIDE is CHARACTER*1
         = 'L': apply Q or Q**H from the Left
         = 'R': apply Q or Q**H from the Right

 [in] TRANS
```

```
          TRANS is CHARACTER*1
          = 'N': apply Q  (No transpose)
          = 'C': apply Q**H (Conjugate transpose)

  [in] M

          M is INTEGER
          The number of rows of the matrix C. M >= 0.

  [in] N

          N is INTEGER
          The number of columns of the matrix C. N >= 0.

  [in] K

          K is INTEGER
          The number of elementary reflectors whose product defines
          the matrix Q.
          If SIDE = 'L', M >= K >= 0;
          if SIDE = 'R', N >= K >= 0.

  [in] A

          A is COMPLEX*16 array, dimension (LDA,K)
          The i-th column must contain the vector which defines the
          elementary reflector H(i), for i = 1,2,...,k, as returned by
          ZGEQRF in the first k columns of its array argument A.
          A is modified by the routine but restored on exit.

  [in] LDA

          LDA is INTEGER
          The leading dimension of the array A.
          If SIDE = 'L', LDA >= max(1,M);
          if SIDE = 'R', LDA >= max(1,N).

  [in] TAU

          TAU is COMPLEX*16 array, dimension (K)
          TAU(i) must contain the scalar factor of the elementary
          reflector H(i), as returned by ZGEQRF.

  [in,out] C

          C is COMPLEX*16 array, dimension (LDC,N)
          On entry, the m-by-n matrix C.
          On exit, C is overwritten by Q*C or Q**H*C or C*Q**H or C*Q.

  [in] LDC
```

```
          LDC is INTEGER
          The leading dimension of the array C. LDC >= max(1,M).

  [out] WORK

          WORK is COMPLEX*16 array, dimension
                                 (N) if SIDE = 'L',
                                 (M) if SIDE = 'R'

  [out] INFO

          INFO is INTEGER
          = 0: successful exit
          < 0: if INFO = -i, the i-th argument had an illegal value

 Authors:
 ========

  Univ. of Tennessee
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  NAG Ltd.

 November 2011
```

———-

— zunm2r.f —

```
*  =====================================================================
      SUBROUTINE ZUNM2R( SIDE, TRANS, M, N, K, A, LDA, TAU, C, LDC,
     $                   WORK, INFO )
*
*  -- LAPACK computational routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      CHARACTER          SIDE, TRANS
      INTEGER            INFO, K, LDA, LDC, M, N
*     ..
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), C( LDC, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
```

```
*
*     .. Parameters ..
      COMPLEX*16         ONE
      PARAMETER          ( ONE = ( 1.0D+0, 0.0D+0 ) )
*     ..
*     .. Local Scalars ..
      LOGICAL            LEFT, NOTRAN
      INTEGER            I, I1, I2, I3, IC, JC, MI, NI, NQ
      COMPLEX*16         AII, TAUI
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      EXTERNAL           LSAME
*     ..
*     .. External Subroutines ..
      EXTERNAL           XERBLA, ZLARF
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          DCONJG, MAX
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      LEFT = LSAME( SIDE, 'L' )
      NOTRAN = LSAME( TRANS, 'N' )
*
*     NQ is the order of Q
*
      IF( LEFT ) THEN
         NQ = M
      ELSE
         NQ = N
      END IF
      IF( .NOT.LEFT .AND. .NOT.LSAME( SIDE, 'R' ) ) THEN
         INFO = -1
      ELSE IF( .NOT.NOTRAN .AND. .NOT.LSAME( TRANS, 'C' ) ) THEN
         INFO = -2
      ELSE IF( M.LT.0 ) THEN
         INFO = -3
      ELSE IF( N.LT.0 ) THEN
         INFO = -4
      ELSE IF( K.LT.0 .OR. K.GT.NQ ) THEN
         INFO = -5
      ELSE IF( LDA.LT.MAX( 1, NQ ) ) THEN
         INFO = -7
      ELSE IF( LDC.LT.MAX( 1, M ) ) THEN
         INFO = -10
      END IF
```

```
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'ZUNM2R', -INFO )
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( M.EQ.0 .OR. N.EQ.0 .OR. K.EQ.0 )
     $   RETURN
*
      IF( ( LEFT .AND. .NOT.NOTRAN .OR. .NOT.LEFT .AND. NOTRAN ) ) THEN
         I1 = 1
         I2 = K
         I3 = 1
      ELSE
         I1 = K
         I2 = 1
         I3 = -1
      END IF
*
      IF( LEFT ) THEN
         NI = N
         JC = 1
      ELSE
         MI = M
         IC = 1
      END IF
*
      DO 10 I = I1, I2, I3
         IF( LEFT ) THEN
*
*           H(i) or H(i)**H is applied to C(i:m,1:n)
*
            MI = M - I + 1
            IC = I
         ELSE
*
*           H(i) or H(i)**H is applied to C(1:m,i:n)
*
            NI = N - I + 1
            JC = I
         END IF
*
*        Apply H(i) or H(i)**H
*
         IF( NOTRAN ) THEN
            TAUI = TAU( I )
         ELSE
            TAUI = DCONJG( TAU( I ) )
         END IF
```

```
         AII = A( I, I )
         A( I, I ) = ONE
         CALL ZLARF( SIDE, MI, NI, A( I, I ), 1, TAUI, C( IC, JC ), LDC,
     $               WORK )
         A( I, I ) = AII
   10 CONTINUE
      RETURN
*
*     End of ZUNM2R
*
      END
```

— LAPACK zunm2r —

```
(let* ((one (coerce (f2cl-lib:cmplx 1.0d0 0.0d0) 'f2cl-lib:complex16)))
 (declare (type (f2cl-lib:complex16) one) (ignorable one))
 (defun zunm2r (side trans m n k a lda tau c ldc work info)
  (declare (type (simple-array character (*)) trans side)
   (type (f2cl-lib:integer4) info ldc lda k n m)
   (type (array f2cl-lib:complex16 (*)) work c tau a))
  (f2cl-lib:with-multi-array-data
      ((a f2cl-lib:complex16 a-%data% a-%offset%)
       (tau f2cl-lib:complex16 tau-%data% tau-%offset%)
       (c f2cl-lib:complex16 c-%data% c-%offset%)
       (work f2cl-lib:complex16 work-%data% work-%offset%)
       (side character side-%data% side-%offset%)
       (trans character trans-%data% trans-%offset%))
       (prog
        ((aii #C(0.0d0 0.0d0))
         (taui #C(0.0d0 0.0d0)) (i 0) (i1 0) (i2 0) (i3 0)
         (ic 0) (jc 0) (mi 0) (ni 0) (nq 0) (left nil) (notran nil))
        (declare (type (f2cl-lib:complex16) taui aii)
         (type (f2cl-lib:integer4) nq ni mi jc ic i3 i2 i1 i)
         (type f2cl-lib:logical notran left))
        (setf info 0)
        (setf left
         (multiple-value-bind (ret-val var-0 var-1) (lsame side "L")
          (declare (ignore var-1)) (when var-0 (setf side var-0)) ret-val))
        (setf notran
         (multiple-value-bind (ret-val var-0 var-1) (lsame trans "N")
          (declare (ignore var-1)) (when var-0 (setf trans var-0)) ret-val))
        (cond (left (setf nq m)) (t (setf nq n)))
        (cond
         ((and (not left)
           (not
            (multiple-value-bind (ret-val var-0 var-1) (lsame side "R")
```

```
     (declare (ignore var-1)) (when var-0 (setf side var-0)) ret-val)))
  (setf info -1))
 ((and (not notran)
   (not
    (multiple-value-bind (ret-val var-0 var-1) (lsame trans "C")
     (declare (ignore var-1))
     (when var-0 (setf trans var-0)) ret-val)))
  (setf info -2))
 ((< m 0) (setf info -3)) ((< n 0) (setf info -4))
 ((or (< k 0) (> k nq)) (setf info -5))
 ((< lda (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 nq)))
  (setf info -7))
 ((< ldc (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 m)))
  (setf info -10)))
(cond ((/= info 0)
   (xerbla "ZUNM2R" (f2cl-lib:int-sub info)) (go end_label)))
(if (or (= m 0) (= n 0) (= k 0)) (go end_label))
(cond
 ((or (and left (not notran)) (and (not left) notran))
  (setf i1 1)
  (setf i2 k)
  (setf i3 1))
 (t (setf i1 k) (setf i2 1) (setf i3 -1)))
(cond (left (setf ni n) (setf jc 1)) (t (setf mi m) (setf ic 1)))
(f2cl-lib:fdo (i i1 (f2cl-lib:int-add i i3))
       ((> i i2) nil)
        (tagbody
          (cond
           (left (setf mi (f2cl-lib:int-add
                           (f2cl-lib:int-sub m i) 1)) (setf ic i))
           (t (setf ni (f2cl-lib:int-add
                        (f2cl-lib:int-sub n i) 1)) (setf jc i)))
          (cond
           (notran
             (setf taui
               (f2cl-lib:fref tau-%data% (i) ((1 *)) tau-%offset%)))
           (t
            (setf taui
             (coerce
              (f2cl-lib:dconjg (f2cl-lib:fref tau-%data% (i)
                ((1 *)) tau-%offset%))
              'f2cl-lib:complex16))))
          (setf aii (f2cl-lib:fref a-%data% (i i)
             ((1 lda) (1 *)) a-%offset%))
          (setf (f2cl-lib:fref a-%data% (i i)
             ((1 lda) (1 *)) a-%offset%) one)
          (multiple-value-bind (var-0 var-1 var-2 var-3
                                var-4 var-5 var-6 var-7 var-8)
           (zlarf side mi ni
            (f2cl-lib:array-slice a-%data%
```

```
                    f2cl-lib:complex16 (i i) ((1 lda) (1 *))
                   a-%offset%)
                  1 taui
                  (f2cl-lib:array-slice c-%data%
                     f2cl-lib:complex16 (ic jc) ((1 ldc) (1 *))
                   c-%offset%)
                  ldc work)
                 (declare (ignore var-1 var-2 var-3 var-4 var-5 var-6 var-8))
                 (setf side var-0) (setf ldc var-7))
                (setf (f2cl-lib:fref a-%data% (i i)
                    ((1 lda) (1 *)) a-%offset%) aii) label10)
              )
       (go end_label) end_label
       (return (values side trans nil nil nil nil nil nil nil ldc nil info)))
      )))
```

———-

6.134 zunmhr LAPACK

— **zunmhr.input** —

```
)set break resume
)sys rm -f zunmhr.output
)spool zunmhr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zunmhr.help** —

```
======================================================================
zunmhr examples
======================================================================

======================================================================
Man Page Details
======================================================================

 Online html documentation available at
            http://www.netlib.org/lapack/explore-html/
```

```
Definition:
===========

      SUBROUTINE ZUNMHR( SIDE, TRANS, M, N, ILO, IHI, A, LDA, TAU, C,
                         LDC, WORK, LWORK, INFO )

      .. Scalar Arguments ..
      CHARACTER          SIDE, TRANS
      INTEGER            IHI, ILO, INFO, LDA, LDC, LWORK, M, N
      ..
      .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), C( LDC, * ), TAU( * ), WORK( * )
      ..


Purpose:
=============

ZUNMHR overwrites the general complex M-by-N matrix C with

                SIDE = 'L'     SIDE = 'R'
TRANS = 'N':      Q * C          C * Q
TRANS = 'C':      Q**H * C       C * Q**H

where Q is a complex unitary matrix of order nq, with nq = m if
SIDE = 'L' and nq = n if SIDE = 'R'. Q is defined as the product of
IHI-ILO elementary reflectors, as returned by ZGEHRD:

Q = H(ilo) H(ilo+1) . . . H(ihi-1).

Arguments:
==========

 [in] SIDE

         SIDE is CHARACTER*1
         = 'L': apply Q or Q**H from the Left;
         = 'R': apply Q or Q**H from the Right.

 [in] TRANS

         TRANS is CHARACTER*1
         = 'N': apply Q  (No transpose)
         = 'C': apply Q**H (Conjugate transpose)

 [in] M

         M is INTEGER
         The number of rows of the matrix C. M >= 0.
```

```
[in] N

        N is INTEGER
        The number of columns of the matrix C. N >= 0.

[in] ILO

        ILO is INTEGER

[in] IHI

        IHI is INTEGER

        ILO and IHI must have the same values as in the previous call
        of ZGEHRD. Q is equal to the unit matrix except in the
        submatrix Q(ilo+1:ihi,ilo+1:ihi).
        If SIDE = 'L', then 1 <= ILO <= IHI <= M, if M > 0, and
        ILO = 1 and IHI = 0, if M = 0;
        if SIDE = 'R', then 1 <= ILO <= IHI <= N, if N > 0, and
        ILO = 1 and IHI = 0, if N = 0.

[in] A

        A is COMPLEX*16 array, dimension
                             (LDA,M) if SIDE = 'L'
                             (LDA,N) if SIDE = 'R'
        The vectors which define the elementary reflectors, as
        returned by ZGEHRD.

[in] LDA

        LDA is INTEGER
        The leading dimension of the array A.
        LDA >= max(1,M) if SIDE = 'L'; LDA >= max(1,N) if SIDE = 'R'.

[in] TAU

        TAU is COMPLEX*16 array, dimension
                             (M-1) if SIDE = 'L'
                             (N-1) if SIDE = 'R'
        TAU(i) must contain the scalar factor of the elementary
        reflector H(i), as returned by ZGEHRD.

[in,out] C

        C is COMPLEX*16 array, dimension (LDC,N)
        On entry, the M-by-N matrix C.
        On exit, C is overwritten by Q*C or Q**H*C or C*Q**H or C*Q.
```

```
  [in] LDC

          LDC is INTEGER
          The leading dimension of the array C. LDC >= max(1,M).

  [out] WORK

          WORK is COMPLEX*16 array, dimension (MAX(1,LWORK))
          On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

  [in] LWORK

          LWORK is INTEGER
          The dimension of the array WORK.
          If SIDE = 'L', LWORK >= max(1,N);
          if SIDE = 'R', LWORK >= max(1,M).
          For optimum performance LWORK >= N*NB if SIDE = 'L', and
          LWORK >= M*NB if SIDE = 'R', where NB is the optimal
          blocksize.

          If LWORK = -1, then a workspace query is assumed; the routine
          only calculates the optimal size of the WORK array, returns
          this value as the first entry of the WORK array, and no error
          message related to LWORK is issued by XERBLA.

  [out] INFO

          INFO is INTEGER
          = 0:  successful exit
          < 0:  if INFO = -i, the i-th argument had an illegal value

 Authors:
 ========

  Univ. of Tennessee
  Univ. of California Berkeley
  Univ. of Colorado Denver
  NAG Ltd.

 November 2011
```

———-

— zunmhr.f —

```
*  =====================================================================
      SUBROUTINE ZUNMHR( SIDE, TRANS, M, N, ILO, IHI, A, LDA, TAU, C,
     $                   LDC, WORK, LWORK, INFO )
```

```
*
*  -- LAPACK computational routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      CHARACTER          SIDE, TRANS
      INTEGER            IHI, ILO, INFO, LDA, LDC, LWORK, M, N
*     ..
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), C( LDC, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Local Scalars ..
      LOGICAL            LEFT, LQUERY
      INTEGER            I1, I2, IINFO, LWKOPT, MI, NB, NH, NI, NQ, NW
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
      INTEGER            ILAENV
      EXTERNAL           LSAME, ILAENV
*     ..
*     .. External Subroutines ..
      EXTERNAL           XERBLA, ZUNMQR
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      NH = IHI - ILO
      LEFT = LSAME( SIDE, 'L' )
      LQUERY = ( LWORK.EQ.-1 )
*
*     NQ is the order of Q and NW is the minimum dimension of WORK
*
      IF( LEFT ) THEN
         NQ = M
         NW = N
      ELSE
         NQ = N
         NW = M
      END IF
      IF( .NOT.LEFT .AND. .NOT.LSAME( SIDE, 'R' ) ) THEN
```

```
         INFO = -1
      ELSE IF( .NOT.LSAME( TRANS, 'N' ) .AND. .NOT.LSAME( TRANS, 'C' ) )
     $          THEN
         INFO = -2
      ELSE IF( M.LT.0 ) THEN
         INFO = -3
      ELSE IF( N.LT.0 ) THEN
         INFO = -4
      ELSE IF( ILO.LT.1 .OR. ILO.GT.MAX( 1, NQ ) ) THEN
         INFO = -5
      ELSE IF( IHI.LT.MIN( ILO, NQ ) .OR. IHI.GT.NQ ) THEN
         INFO = -6
      ELSE IF( LDA.LT.MAX( 1, NQ ) ) THEN
         INFO = -8
      ELSE IF( LDC.LT.MAX( 1, M ) ) THEN
         INFO = -11
      ELSE IF( LWORK.LT.MAX( 1, NW ) .AND. .NOT.LQUERY ) THEN
         INFO = -13
      END IF
*
      IF( INFO.EQ.0 ) THEN
         IF( LEFT ) THEN
            NB = ILAENV( 1, 'ZUNMQR', SIDE // TRANS, NH, N, NH, -1 )
         ELSE
            NB = ILAENV( 1, 'ZUNMQR', SIDE // TRANS, M, NH, NH, -1 )
         END IF
         LWKOPT = MAX( 1, NW )*NB
         WORK( 1 ) = LWKOPT
      END IF
*
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'ZUNMHR', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( M.EQ.0 .OR. N.EQ.0 .OR. NH.EQ.0 ) THEN
         WORK( 1 ) = 1
         RETURN
      END IF
*
      IF( LEFT ) THEN
         MI = NH
         NI = N
         I1 = ILO + 1
         I2 = 1
      ELSE
```

```
         MI = M
         NI = NH
         I1 = 1
         I2 = ILO + 1
      END IF
*
      CALL ZUNMQR( SIDE, TRANS, MI, NI, NH, A( ILO+1, ILO ), LDA,
     $             TAU( ILO ), C( I1, I2 ), LDC, WORK, LWORK, IINFO )
*
      WORK( 1 ) = LWKOPT
      RETURN
*
*     End of ZUNMHR
*
      END
```

———-

— LAPACK zunmhr —

```
(defun zunmhr (side trans m n ilo ihi a lda tau c ldc work lwork info)
 (declare (type (simple-array character (*)) trans side)
  (type (f2cl-lib:integer4) info lwork ldc lda ihi ilo n m)
  (type (array f2cl-lib:complex16 (*)) work c tau a))
 (f2cl-lib:with-multi-array-data
     ((a f2cl-lib:complex16 a-%data% a-%offset%)
      (tau f2cl-lib:complex16 tau-%data% tau-%offset%)
      (c f2cl-lib:complex16 c-%data% c-%offset%)
      (work f2cl-lib:complex16 work-%data% work-%offset%)
      (side character side-%data% side-%offset%)
      (trans character trans-%data% trans-%offset%))
      (prog
       ((i1 0) (i2 0) (iinfo 0) (lwkopt 0) (mi 0)
        (nb 0) (nh 0) (ni 0) (nq 0) (nw 0)
        (left nil) (lquery nil))
       (declare (type (f2cl-lib:integer4) nw nq ni nh nb mi lwkopt iinfo i2 i1)
        (type f2cl-lib:logical lquery left))
       (setf info 0) (setf nh (f2cl-lib:int-sub ihi ilo))
       (setf left
        (multiple-value-bind (ret-val var-0 var-1) (lsame side "L")
         (declare (ignore var-1)) (when var-0 (setf side var-0)) ret-val))
       (setf lquery (coerce (= lwork -1) 'f2cl-lib:logical))
       (cond (left (setf nq m) (setf nw n)) (t (setf nq n) (setf nw m)))
       (cond
        ((and (not left)
          (not
           (multiple-value-bind (ret-val var-0 var-1) (lsame side "R")
            (declare (ignore var-1)) (when var-0 (setf side var-0)) ret-val)))
```

```
  (setf info -1))
 ((and
   (not
    (multiple-value-bind (ret-val var-0 var-1) (lsame trans "N")
     (declare (ignore var-1)) (when var-0 (setf trans var-0)) ret-val))
   (not
    (multiple-value-bind (ret-val var-0 var-1) (lsame trans "C")
     (declare (ignore var-1)) (when var-0 (setf trans var-0)) ret-val)))
  (setf info -2))
 ((< m 0) (setf info -3)) ((< n 0) (setf info -4))
 ((or (< ilo 1)
   (> ilo (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 nq))))
  (setf info -5))
 ((or (< ihi (min (the f2cl-lib:integer4 ilo)
                  (the f2cl-lib:integer4 nq)))
   (> ihi nq))
  (setf info -6))
 ((< lda (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 nq)))
  (setf info -8))
 ((< ldc (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 m)))
  (setf info -11))
 ((and (< lwork (max (the f2cl-lib:integer4 1)
                     (the f2cl-lib:integer4 nw)))
   (not lquery))
  (setf info -13)))
(cond
 ((= info 0)
  (cond
   (left
    (setf nb
     (multiple-value-bind (ret-val var-0 var-1 var-2
                           var-3 var-4 var-5 var-6)
      (ilaenv 1 "ZUNMQR" (f2cl-lib:f2cl-// side trans) nh n nh -1)
      (declare (ignore var-0 var-1 var-2 var-6))
      (when var-3 (setf nh var-3))
      (when var-4 (setf n var-4))
      (when var-5 (setf nh var-5)) ret-val)))
   (t
    (setf nb
     (multiple-value-bind (ret-val var-0 var-1 var-2 var-3
                           var-4 var-5 var-6)
      (ilaenv 1 "ZUNMQR" (f2cl-lib:f2cl-// side trans) m nh nh -1)
      (declare (ignore var-0 var-1 var-2 var-6))
      (when var-3 (setf m var-3))
      (when var-4 (setf nh var-4))
      (when var-5 (setf nh var-5)) ret-val))))
  (setf lwkopt
   (f2cl-lib:int-mul
    (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 nw)) nb))
  (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
```

```
   (coerce lwkopt 'f2cl-lib:complex16))))
 (cond ((/= info 0)
    (xerbla "ZUNMHR" (f2cl-lib:int-sub info)) (go end_label))
  (lquery (go end_label)))
 (cond
  ((or (= m 0) (= n 0) (= nh 0))
   (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
    (coerce 1 'f2cl-lib:complex16))
   (go end_label)))
 (cond
  (left (setf mi nh) (setf ni n) (setf i1 (f2cl-lib:int-add ilo 1))
   (setf i2 1))
  (t (setf mi m)
     (setf ni nh)
     (setf i1 1)
     (setf i2 (f2cl-lib:int-add ilo 1))))
 (multiple-value-bind
  (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7
   var-8 var-9 var-10 var-11
   var-12)
  (zunmqr side trans mi ni nh
   (f2cl-lib:array-slice a-%data% f2cl-lib:complex16 ((+ ilo 1) ilo)
    ((1 lda) (1 *)) a-%offset%)
   lda
   (f2cl-lib:array-slice tau-%data% f2cl-lib:complex16 (ilo) ((1 *))
    tau-%offset%)
   (f2cl-lib:array-slice c-%data%
      f2cl-lib:complex16 (i1 i2) ((1 ldc) (1 *))
    c-%offset%)
   ldc work lwork iinfo)
  (declare (ignore var-5 var-7 var-8 var-10))
  (when var-0 (setf side var-0))
  (when var-1 (setf trans var-1)) (when var-2 (setf mi var-2))
  (when var-3 (setf ni var-3)) (when var-4 (setf nh var-4))
  (when var-6 (setf lda var-6)) (when var-9 (setf ldc var-9))
  (when var-11 (setf lwork var-11)) (when var-12 (setf iinfo var-12)))
 (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
  (coerce lwkopt 'f2cl-lib:complex16))
 (go end_label) end_label
 (return
  (values side trans m n nil nil nil lda nil nil ldc nil lwork info)))
))
```

6.135 zunmqr LAPACK

— **zunmqr.input** —

```
)set break resume
)sys rm -f zunmqr.output
)spool zunmqr.output
)set message test on
)set message auto off
)clear all

)spool
)lisp (bye)
```

———-

— **zunmqr.help** —

```
=========================================================================
zunmqr examples
=========================================================================

=========================================================================
Man Page Details
=========================================================================

 Online html documentation available at
           http://www.netlib.org/lapack/explore-html/

 Definition:
 ===========

       SUBROUTINE ZUNMQR( SIDE, TRANS, M, N, K, A, LDA, TAU, C, LDC,
                          WORK, LWORK, INFO )

       .. Scalar Arguments ..
       CHARACTER          SIDE, TRANS
       INTEGER            INFO, K, LDA, LDC, LWORK, M, N
       ..
       .. Array Arguments ..
       COMPLEX*16         A( LDA, * ), C( LDC, * ), TAU( * ), WORK( * )
       ..


 Purpose:
 =============

 ZUNMQR overwrites the general complex M-by-N matrix C with

                 SIDE = 'L'     SIDE = 'R'
 TRANS = 'N':      Q * C          C * Q
```

```
TRANS = 'C':      Q**H * C       C * Q**H

where Q is a complex unitary matrix defined as the product of k
elementary reflectors

      Q = H(1) H(2) . . . H(k)

as returned by ZGEQRF. Q is of order M if SIDE = 'L' and of order N
if SIDE = 'R'.

Arguments:
==========

 [in] SIDE

        SIDE is CHARACTER*1
        = 'L': apply Q or Q**H from the Left;
        = 'R': apply Q or Q**H from the Right.

 [in] TRANS

        TRANS is CHARACTER*1
        = 'N':  No transpose, apply Q;
        = 'C':  Conjugate transpose, apply Q**H.

 [in] M

        M is INTEGER
        The number of rows of the matrix C. M >= 0.

 [in] N

        N is INTEGER
        The number of columns of the matrix C. N >= 0.

 [in] K

        K is INTEGER
        The number of elementary reflectors whose product defines
        the matrix Q.
        If SIDE = 'L', M >= K >= 0;
        if SIDE = 'R', N >= K >= 0.

 [in] A

        A is COMPLEX*16 array, dimension (LDA,K)
        The i-th column must contain the vector which defines the
        elementary reflector H(i), for i = 1,2,...,k, as returned by
        ZGEQRF in the first k columns of its array argument A.
        A is modified by the routine but restored on exit.
```

```
[in] LDA

        LDA is INTEGER
        The leading dimension of the array A.
        If SIDE = 'L', LDA >= max(1,M);
        if SIDE = 'R', LDA >= max(1,N).

[in] TAU

        TAU is COMPLEX*16 array, dimension (K)
        TAU(i) must contain the scalar factor of the elementary
        reflector H(i), as returned by ZGEQRF.

[in,out] C

        C is COMPLEX*16 array, dimension (LDC,N)
        On entry, the M-by-N matrix C.
        On exit, C is overwritten by Q*C or Q**H*C or C*Q**H or C*Q.

[in] LDC

        LDC is INTEGER
        The leading dimension of the array C. LDC >= max(1,M).

[out] WORK

        WORK is COMPLEX*16 array, dimension (MAX(1,LWORK))
        On exit, if INFO = 0, WORK(1) returns the optimal LWORK.

[in] LWORK

        LWORK is INTEGER
        The dimension of the array WORK.
        If SIDE = 'L', LWORK >= max(1,N);
        if SIDE = 'R', LWORK >= max(1,M).
        For optimum performance LWORK >= N*NB if SIDE = 'L', and
        LWORK >= M*NB if SIDE = 'R', where NB is the optimal
        blocksize.

        If LWORK = -1, then a workspace query is assumed; the routine
        only calculates the optimal size of the WORK array, returns
        this value as the first entry of the WORK array, and no error
        message related to LWORK is issued by XERBLA.

[out] INFO

        INFO is INTEGER
        = 0:  successful exit
        < 0:  if INFO = -i, the i-th argument had an illegal value
```

```
 Authors:
 ========

  Univ. of Tennessee
  Univ. of California Berkeley
  Univ. of Colorado Denver
  NAG Ltd.

 November 2011
```

———-

— zunmqr.f —

```
*  =====================================================================
      SUBROUTINE ZUNMQR( SIDE, TRANS, M, N, K, A, LDA, TAU, C, LDC,
     $                   WORK, LWORK, INFO )
*
*  -- LAPACK computational routine (version 3.4.0) --
*  -- LAPACK is a software package provided by Univ. of Tennessee,    --
*  -- Univ. of California Berkeley, Univ. of Colorado Denver and NAG Ltd..--
*     November 2011
*
*     .. Scalar Arguments ..
      CHARACTER          SIDE, TRANS
      INTEGER            INFO, K, LDA, LDC, LWORK, M, N
*     ..
*     .. Array Arguments ..
      COMPLEX*16         A( LDA, * ), C( LDC, * ), TAU( * ), WORK( * )
*     ..
*
*  =====================================================================
*
*     .. Parameters ..
      INTEGER            NBMAX, LDT
      PARAMETER          ( NBMAX = 64, LDT = NBMAX+1 )
*     ..
*     .. Local Scalars ..
      LOGICAL            LEFT, LQUERY, NOTRAN
      INTEGER            I, I1, I2, I3, IB, IC, IINFO, IWS, JC, LDWORK,
     $                   LWKOPT, MI, NB, NBMIN, NI, NQ, NW
*     ..
*     .. Local Arrays ..
      COMPLEX*16         T( LDT, NBMAX )
*     ..
*     .. External Functions ..
      LOGICAL            LSAME
```

```
      INTEGER            ILAENV
      EXTERNAL           LSAME, ILAENV
*     ..
*     .. External Subroutines ..
      EXTERNAL           XERBLA, ZLARFB, ZLARFT, ZUNM2R
*     ..
*     .. Intrinsic Functions ..
      INTRINSIC          MAX, MIN
*     ..
*     .. Executable Statements ..
*
*     Test the input arguments
*
      INFO = 0
      LEFT = LSAME( SIDE, 'L' )
      NOTRAN = LSAME( TRANS, 'N' )
      LQUERY = ( LWORK.EQ.-1 )
*
*     NQ is the order of Q and NW is the minimum dimension of WORK
*
      IF( LEFT ) THEN
         NQ = M
         NW = N
      ELSE
         NQ = N
         NW = M
      END IF
      IF( .NOT.LEFT .AND. .NOT.LSAME( SIDE, 'R' ) ) THEN
         INFO = -1
      ELSE IF( .NOT.NOTRAN .AND. .NOT.LSAME( TRANS, 'C' ) ) THEN
         INFO = -2
      ELSE IF( M.LT.0 ) THEN
         INFO = -3
      ELSE IF( N.LT.0 ) THEN
         INFO = -4
      ELSE IF( K.LT.0 .OR. K.GT.NQ ) THEN
         INFO = -5
      ELSE IF( LDA.LT.MAX( 1, NQ ) ) THEN
         INFO = -7
      ELSE IF( LDC.LT.MAX( 1, M ) ) THEN
         INFO = -10
      ELSE IF( LWORK.LT.MAX( 1, NW ) .AND. .NOT.LQUERY ) THEN
         INFO = -12
      END IF
*
      IF( INFO.EQ.0 ) THEN
*
*        Determine the block size.  NB may be at most NBMAX, where NBMAX
*        is used to define the local array T.
*
```

```
         NB = MIN( NBMAX, ILAENV( 1, 'ZUNMQR', SIDE // TRANS, M, N, K,
     $        -1 ) )
         LWKOPT = MAX( 1, NW )*NB
         WORK( 1 ) = LWKOPT
      END IF
*
      IF( INFO.NE.0 ) THEN
         CALL XERBLA( 'ZUNMQR', -INFO )
         RETURN
      ELSE IF( LQUERY ) THEN
         RETURN
      END IF
*
*     Quick return if possible
*
      IF( M.EQ.0 .OR. N.EQ.0 .OR. K.EQ.0 ) THEN
         WORK( 1 ) = 1
         RETURN
      END IF
*
      NBMIN = 2
      LDWORK = NW
      IF( NB.GT.1 .AND. NB.LT.K ) THEN
         IWS = NW*NB
         IF( LWORK.LT.IWS ) THEN
            NB = LWORK / LDWORK
            NBMIN = MAX( 2, ILAENV( 2, 'ZUNMQR', SIDE // TRANS, M, N, K,
     $              -1 ) )
         END IF
      ELSE
         IWS = NW
      END IF
*
      IF( NB.LT.NBMIN .OR. NB.GE.K ) THEN
*
*        Use unblocked code
*
         CALL ZUNM2R( SIDE, TRANS, M, N, K, A, LDA, TAU, C, LDC, WORK,
     $                IINFO )
      ELSE
*
*        Use blocked code
*
         IF( ( LEFT .AND. .NOT.NOTRAN ) .OR.
     $       ( .NOT.LEFT .AND. NOTRAN ) ) THEN
            I1 = 1
            I2 = K
            I3 = NB
         ELSE
            I1 = ( ( K-1 ) / NB )*NB + 1
```

```
            I2 = 1
            I3 = -NB
         END IF
*
         IF( LEFT ) THEN
            NI = N
            JC = 1
         ELSE
            MI = M
            IC = 1
         END IF
*
         DO 10 I = I1, I2, I3
            IB = MIN( NB, K-I+1 )
*
*           Form the triangular factor of the block reflector
*           H = H(i) H(i+1) . . . H(i+ib-1)
*
            CALL ZLARFT( 'Forward', 'Columnwise', NQ-I+1, IB, A( I, I ),
     $                   LDA, TAU( I ), T, LDT )
            IF( LEFT ) THEN
*
*              H or H**H is applied to C(i:m,1:n)
*
               MI = M - I + 1
               IC = I
            ELSE
*
*              H or H**H is applied to C(1:m,i:n)
*
               NI = N - I + 1
               JC = I
            END IF
*
*           Apply H or H**H
*
            CALL ZLARFB( SIDE, TRANS, 'Forward', 'Columnwise', MI, NI,
     $                   IB, A( I, I ), LDA, T, LDT, C( IC, JC ), LDC,
     $                   WORK, LDWORK )
   10    CONTINUE
      END IF
      WORK( 1 ) = LWKOPT
      RETURN
*
*     End of ZUNMQR
*
      END
```

```
Warning:  Types of argument 0 in call to ZUNM2R do not match.
  Declared type: (SIMPLE-ARRAY CHARACTER (*))
  Argument type: (STRING 1)
Warning:  Types of argument 1 in call to ZUNM2R do not match.
  Declared type: (SIMPLE-ARRAY CHARACTER (*))
  Argument type: (STRING 1)
Warning:  Types of argument 0 in call to ZLARFB do not match.
  Declared type: (SIMPLE-ARRAY CHARACTER (*))
  Argument type: (STRING 1)
Warning:  Types of argument 1 in call to ZLARFB do not match.
  Declared type: (SIMPLE-ARRAY CHARACTER (*))
  Argument type: (STRING 1)
```

— LAPACK zunmqr —

```
(let* ((nbmax 64) (ldt (+ nbmax 1)))
 (declare (type (f2cl-lib:integer4 64 64) nbmax) (type (f2cl-lib:integer4) ldt)
  (ignorable nbmax ldt))
 (defun zunmqr (side trans m n k a lda tau c ldc work lwork info)
  (declare (type (simple-array character (*)) trans side)
   (type (f2cl-lib:integer4) info lwork ldc lda k n m)
   (type (array f2cl-lib:complex16 (*)) work c tau a))
  (f2cl-lib:with-multi-array-data
      ((a f2cl-lib:complex16 a-%data% a-%offset%)
       (tau f2cl-lib:complex16 tau-%data% tau-%offset%)
       (c f2cl-lib:complex16 c-%data% c-%offset%)
       (work f2cl-lib:complex16 work-%data% work-%offset%)
       (side character side-%data% side-%offset%)
       (trans character trans-%data% trans-%offset%))
       (prog
        ((i 0) (i1 0) (i2 0) (i3 0) (ib 0) (ic 0)
         (iinfo 0) (iws 0) (jc 0) (ldwork 0)
         (lwkopt 0) (mi 0) (nb 0) (nbmin 0) (ni 0) (nq 0) (nw 0) (left nil)
         (lquery nil) (notran nil)
         (t$
          (make-array (the fixnum (reduce #'* (list ldt nbmax))) :element-type
           'f2cl-lib:complex16)))
        (declare
         (type (f2cl-lib:integer4) nw nq ni nbmin nb mi
          lwkopt ldwork jc iws iinfo ic
          ib i3 i2 i1 i)
         (type f2cl-lib:logical notran lquery left)
         (type (array f2cl-lib:complex16 (*)) t$))
        (setf info 0)
        (setf left
         (multiple-value-bind (ret-val var-0 var-1) (lsame side "L")
          (declare (ignore var-1)) (when var-0 (setf side var-0)) ret-val))
        (setf notran
         (multiple-value-bind (ret-val var-0 var-1) (lsame trans "N")
```

```
  (declare (ignore var-1)) (when var-0 (setf trans var-0)) ret-val))
(setf lquery (coerce (= lwork -1) 'f2cl-lib:logical))
(cond (left (setf nq m) (setf nw n)) (t (setf nq n) (setf nw m)))
(cond
 ((and (not left)
   (not
    (multiple-value-bind (ret-val var-0 var-1) (lsame side "R")
     (declare (ignore var-1)) (when var-0 (setf side var-0)) ret-val)))
  (setf info -1))
 ((and (not notran)
   (not
    (multiple-value-bind (ret-val var-0 var-1) (lsame trans "C")
     (declare (ignore var-1))
     (when var-0 (setf trans var-0)) ret-val)))
  (setf info -2))
 ((< m 0) (setf info -3)) ((< n 0) (setf info -4))
 ((or (< k 0) (> k nq)) (setf info -5))
 ((< lda (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 nq)))
  (setf info -7))
 ((< ldc (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 m)))
  (setf info -10))
 ((and (< lwork (max (the f2cl-lib:integer4 1)
                     (the f2cl-lib:integer4 nw)))
   (not lquery))
  (setf info -12)))
(cond
 ((= info 0)
  (setf nb
   (min (the f2cl-lib:integer4 nbmax)
    (the f2cl-lib:integer4
     (multiple-value-bind (ret-val var-0 var-1 var-2
                           var-3 var-4 var-5 var-6)
      (ilaenv 1 "ZUNMQR" (f2cl-lib:f2cl-// side trans) m n k -1)
      (declare (ignore var-0 var-1 var-2 var-6))
      (when var-3 (setf m var-3))
      (when var-4 (setf n var-4))
      (when var-5 (setf k var-5)) ret-val))))
  (setf lwkopt
   (f2cl-lib:int-mul
    (max (the f2cl-lib:integer4 1) (the f2cl-lib:integer4 nw)) nb))
  (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
   (coerce lwkopt 'f2cl-lib:complex16))))
(cond ((/= info 0)
   (xerbla "ZUNMQR" (f2cl-lib:int-sub info)) (go end_label))
 (lquery (go end_label)))
(cond
 ((or (= m 0) (= n 0) (= k 0))
  (setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
   (coerce 1 'f2cl-lib:complex16))
  (go end_label)))
```

```
(setf nbmin 2) (setf ldwork nw)
(cond
 ((and (> nb 1) (< nb k)) (setf iws (f2cl-lib:int-mul nw nb))
  (cond
   ((< lwork iws)
    (setf nb (the f2cl-lib:integer4 (truncate lwork ldwork)))
    (setf nbmin
     (max (the f2cl-lib:integer4 2)
      (the f2cl-lib:integer4
       (multiple-value-bind
        (ret-val var-0 var-1 var-2 var-3 var-4 var-5 var-6)
        (ilaenv 2 "ZUNMQR" (f2cl-lib:f2cl-// side trans) m n k -1)
        (declare (ignore var-0 var-1 var-2 var-6))
        (when var-3 (setf m var-3))
        (when var-4 (setf n var-4))
        (when var-5 (setf k var-5)) ret-val)))))))
 (t (setf iws nw)))
(cond
 ((or (< nb nbmin) (>= nb k))
  (multiple-value-bind
   (var-0 var-1 var-2 var-3 var-4 var-5
    var-6 var-7 var-8 var-9 var-10 var-11)
   (zunm2r side trans m n k a lda tau c ldc work iinfo)
   (declare (ignore var-2 var-3 var-4 var-5 var-6 var-7 var-8 var-10))
   (setf side var-0)
   (setf trans var-1)
   (setf ldc var-9)
   (setf iinfo var-11)))
 (t
  (cond
   ((or (and left (not notran)) (and (not left) notran)) (setf i1 1)
    (setf i2 k) (setf i3 nb))
   (t (setf i1
        (+ (* (the f2cl-lib:integer4 (truncate (- k 1) nb)) nb) 1))
    (setf i2 1) (setf i3 (f2cl-lib:int-sub nb))))
  (cond (left (setf ni n) (setf jc 1)) (t (setf mi m) (setf ic 1)))
  (f2cl-lib:fdo (i i1 (f2cl-lib:int-add i i3))
         ((> i i2) nil)
          (tagbody
              (setf ib
               (min (the f2cl-lib:integer4 nb)
                (the f2cl-lib:integer4 (f2cl-lib:int-add
                                        (f2cl-lib:int-sub k i) 1))))
              (multiple-value-bind
               (var-0 var-1 var-2 var-3 var-4 var-5 var-6 var-7 var-8)
               (zlarft "Forward" "Columnwise"
                (f2cl-lib:int-add (f2cl-lib:int-sub nq i) 1) ib
                (f2cl-lib:array-slice a-%data%
                   f2cl-lib:complex16 (i i) ((1 lda) (1 *))
                 a-%offset%)
```

```
                 lda
                 (f2cl-lib:array-slice tau-%data%
                    f2cl-lib:complex16 (i) ((1 *))
                  tau-%offset%)
                 t$ ldt)
                (declare (ignore var-0 var-1 var-2 var-3
                          var-4 var-6 var-7))
                (setf lda var-5) (setf ldt var-8))
               (cond
                (left (setf mi (f2cl-lib:int-add
                                (f2cl-lib:int-sub m i) 1)) (setf ic i))
                (t (setf ni (f2cl-lib:int-add
                             (f2cl-lib:int-sub n i) 1)) (setf jc i)))
               (multiple-value-bind
                (var-0 var-1 var-2 var-3 var-4 var-5
                 var-6 var-7 var-8 var-9 var-10 var-11
                 var-12 var-13 var-14)
                (zlarfb side trans "Forward" "Columnwise" mi ni ib
                 (f2cl-lib:array-slice a-%data%
                    f2cl-lib:complex16 (i i) ((1 lda) (1 *))
                  a-%offset%)
                 lda t$ ldt
                 (f2cl-lib:array-slice c-%data%
                    f2cl-lib:complex16 (ic jc) ((1 ldc) (1 *))
                  c-%offset%)
                 ldc work ldwork)
                (declare (ignore var-2 var-3 var-4 var-5
                          var-7 var-9 var-11 var-13))
                (setf side var-0)
                (setf trans var-1)
                (setf ib var-6)
                (setf lda var-8)
                (setf ldt var-10)
                (setf ldc var-12)
                (setf ldwork var-14))
               label10))))
(setf (f2cl-lib:fref work-%data% (1) ((1 *)) work-%offset%)
 (coerce lwkopt 'f2cl-lib:complex16))
(go end_label) end_label
(return
  (values side trans m n k nil lda nil nil ldc nil nil info))))))
```

Chapter 7

LAPACK tests

```
;;;
;;; Simple tests for selected LAPACK routines.
;;;
;;; $Id$
;;;

(in-package "LAPACK")

;; Convert the eigenvalues returned by DGEEV into an array
(defun make-eigval (wr wi)
  (let ((e-val (make-array (length wr))))
    (map-into e-val #'(lambda (r i)
       ;; Do we really want to do this?  Should we
       ;; just make all of the eigenvalues complex?
       (if (zerop i)
   r
   (complex r i)))
      wr wi)
    e-val))

;; Convert the eigenvalues returned by DGEEV into a more typical
;; matrix form.
(defun make-eigvec (n vr wi)
  (let ((evec (make-array (list n n))))
    (do ((col 0 (incf col))
 (posn 0))
((>= col n))
      (cond ((zerop (aref wi col))
     (dotimes (row n)
       (setf (aref evec row col) (aref vr posn))
       (incf posn)))
    (t
```

```
     (dotimes (row n)
       (let* ((next-posn (+ posn n))
      (val+ (complex (aref vr posn) (aref vr next-posn)))
      (val- (conjugate val+)))
 (setf (aref evec row col) val+)
 (setf (aref evec row (1+ col)) val-)
 (incf posn)))
     ;; Skip over the next column, which we've already used
     (incf col)
     (incf posn n))))
    evec))

;; Expected results from
;;   http://www.nag.co.uk/lapack-ex/examples/results/dgeev-ex.r
;;
;; DGEEV Example Program Results
;;
;;  Eigenvalue( 1) =  7.9948E-01
;;
;;  Eigenvector( 1)
;;  -6.5509E-01
;;  -5.2363E-01
;;   5.3622E-01
;;  -9.5607E-02
;;
;;  Eigenvalue( 2) = (-9.9412E-02, 4.0079E-01)
;;
;;  Eigenvector( 2)
;;  (-1.9330E-01, 2.5463E-01)
;;  ( 2.5186E-01,-5.2240E-01)
;;  ( 9.7182E-02,-3.0838E-01)
;;  ( 6.7595E-01, 0.0000E+00)
;;
;;  Eigenvalue( 3) = (-9.9412E-02,-4.0079E-01)
;;
;;  Eigenvector( 3)
;;  (-1.9330E-01,-2.5463E-01)
;;  ( 2.5186E-01, 5.2240E-01)
;;  ( 9.7182E-02, 3.0838E-01)
;;  ( 6.7595E-01,-0.0000E+00)
;;
;;  Eigenvalue( 4) = -1.0066E-01
;;
;;  Eigenvector( 4)
;;   1.2533E-01
;;   3.3202E-01
;;   5.9384E-01
;;   7.2209E-01
;;
(defun print-dgeev-results (e-val e-vec)
```

```
  (format t "~2%DGEEV Example Program Results~%")
  (let ((n (length e-val)))
    (dotimes (k n)
      (format t "Eigenvalue(~D) = ~A~%" k (aref e-val k))
      (format t "~%Eigenvector(~D)~%" k)
      (dotimes (row n)
(format t "~A~%" (aref e-vec row k)))
      (terpri))))

(defun check-eigen-val-vec (n e-val e-vec true-val true-vec &key (tol 1d-14))
  (flet ((relerr-ok (est true)
   (let* ((re (/ (abs (- est true))
 (abs true)))
  (ok (<= re tol)))
     ;; Return NIL if it's ok.  Otherwise return a list to
     ;; indicate what failed.
     (unless ok
       (format t "est  = ~S~%true = ~S~%  rel  = ~S~%"
       est true re)
       (list est true re)))))
    (or (relerr-ok (aref e-val n) true-val)
(dotimes (k n t)
  (let ((res (relerr-ok (aref e-vec k n) (aref true-vec k))))
    (when res
      (return res)))))))

;; DGEEV example based on the example from
;; http://www.nag.co.uk/lapack-ex/node87.html
(defun test-dgeev ()
  ;; The matrix is
  ;;
  ;;  0.35  0.45 -0.14 -0.17
  ;;  0.09  0.07 -0.54  0.35
  ;; -0.44 -0.33 -0.03  0.17
  ;;  0.25 -0.32 -0.13  0.11
  ;;
  ;; Recall that Fortran arrays are column-major order!
  (let* ((n 4)
 (a-mat (make-array (* n n) :element-type 'double-float
    :initial-contents '(0.35d0 0.09d0 -0.44d0 0.25d0
0.45d0 0.07d0 -0.33d0 -0.32d0
-0.14d0 -0.54d0 -0.03d0 -0.13d0
-0.17d0 0.35d0 0.17d0 0.11d0)))
 (wr (make-array n :element-type 'double-float))
 (wi (make-array n :element-type 'double-float))
 (vl (make-array 0 :element-type 'double-float))
 (vr (make-array (* n n) :element-type 'double-float))
 (lwork 660)
 (work (make-array lwork :element-type 'double-float)))
    (multiple-value-bind (z-jobvl z-jobvr z-n z-a z-lda z-wr z-wi z-vl z-ldvl
```

```
                        z-vr z-ldvr z-work z-lwork info)
(dgeev "N" "V" n a-mat n wr wi vl n vr n work lwork 0)
      (declare (ignore z-jobvl z-jobvr z-n z-a z-lda z-wr z-wi z-vl z-ldvl z-vr
       z-ldvr z-work z-lwork))
      (let ((e-val (make-eigval wr wi))
    (e-vec (make-eigvec n vr wi)))
;; Display solution
(cond ((zerop info)
       (print-dgeev-results e-val
    e-vec))
      (t
       (format t "Failure in DGEEV.  INFO = ~D~%" info)))
;; Display workspace info
(format t "Optimum workspace required = ~D~%" (truncate (aref work 0)))
(format t "Workspace provided = ~D~%" lwork)

(values e-val e-vec)))))

(rt:deftest dgeev.1
    (multiple-value-bind (e-val e-vec)
(test-dgeev)
      (list (check-eigen-val-vec 0 e-val e-vec
 0.799482122586210d0
 #(-0.6550887675124076d0
   -0.5236294609021240d0
   0.5362184613722345d0
   -0.0956067782012298d0))
    (check-eigen-val-vec 1 e-val e-vec
 #c(-0.0994124532950747d0 0.4007924719897546d0)
 #(#c(-0.193301548264222d0 0.254631571927584d0)
   #c(0.251856531726740d0 -0.522404734711629d0)
   #c(0.097182458443282d0 -0.308383755897228d0)
   #c(0.675954054254748 0d0)))
    (check-eigen-val-vec 2 e-val e-vec
 #c(-0.0994124532950747d0 -0.4007924719897546d0)
 #(#c(-0.193301548264222d0 -0.254631571927584d0)
   #c(0.251856531726740d0 0.522404734711629d0)
   #c(0.097182458443282d0 0.308383755897228d0)
   #c(0.675954054254748 0d0)))
    (check-eigen-val-vec 3 e-val e-vec
 -0.100657215996059d0
 #(0.125332697230903d0
   0.332022215571751d0
   0.593837759557331d0
   0.722087029862455d0
   -0.6550887675124076d0))))
  (t t t t))

;; Expected results http://www.nag.co.uk/lapack-ex/examples/results/dgeevx-ex.r
;;
```

```
;; DGEEVX Example Program Results
;;
;;  Eigenvalue( 1) =  7.9948E-01
;;
;;  Reciprocal condition number =  9.9E-01
;;  Error bound                 =  1.3E-16
;;
;;  Eigenvector( 1)
;;  -6.5509E-01
;;  -5.2363E-01
;;   5.3622E-01
;;  -9.5607E-02
;;
;;  Reciprocal condition number =  8.2E-01
;;  Error bound                 =  1.6E-16
;;
;;  Eigenvalue( 2) = (-9.9412E-02, 4.0079E-01)
;;
;;  Reciprocal condition number =  7.0E-01
;;  Error bound                 =  1.8E-16
;;
;;  Eigenvector( 2)
;;  (-1.9330E-01, 2.5463E-01)
;;  ( 2.5186E-01,-5.2240E-01)
;;  ( 9.7182E-02,-3.0838E-01)
;;  ( 6.7595E-01, 0.0000E+00)
;;
;;  Reciprocal condition number =  4.0E-01
;;  Error bound                 =  3.3E-16
;;
;;  Eigenvalue( 3) = (-9.9412E-02,-4.0079E-01)
;;
;;  Reciprocal condition number =  7.0E-01
;;  Error bound                 =  1.8E-16
;;
;;  Eigenvector( 3)
;;  (-1.9330E-01,-2.5463E-01)
;;  ( 2.5186E-01, 5.2240E-01)
;;  ( 9.7182E-02, 3.0838E-01)
;;  ( 6.7595E-01,-0.0000E+00)
;;
;;  Reciprocal condition number =  4.0E-01
;;  Error bound                 =  3.3E-16
;;
;;  Eigenvalue( 4) = -1.0066E-01
;;
;;  Reciprocal condition number =  5.7E-01
;;  Error bound                 =  2.3E-16
;;
;;  Eigenvector( 4)
```

```
;;   1.2533E-01
;;   3.3202E-01
;;   5.9384E-01
;;   7.2209E-01
;;
;;  Reciprocal condition number =  3.1E-01
;;  Error bound                 =  4.2E-16
;;
(defun print-dgeevx-results (tol e-val e-vec rconde rcondv)
  (format t "~2%DGEEVX Example Program Results~%")
  (let ((n (length e-val)))
    (dotimes (k n)
      (format t "Eigenvalue(~D) = ~A~%" k (aref e-val k))
      (let ((rcnd (aref rconde k)))
(format t "Reciprocal condition number = ~A~%" rcnd)
(if (plusp rcnd)
    (format t "Error bound = ~A~%" (/ tol rcnd))
    (format t "Error bound is infinite~%")))

      (format t "~%Eigenvector(~D)~%" k)
      (dotimes (row n)
(format t "~A~%" (aref e-vec row k)))
      (let ((rcnd (aref rcondv k)))
(format t "Reciprocal condition number = ~A~%" rcnd)
(if (plusp rcnd)
    (format t "Error bound = ~A~%" (/ tol rcnd))
    (format t "Error bound is infinity~%")))
      (terpri))))

(defun test-dgeevx ()
  (let* ((n 4)
 (a-mat (make-array (* n n) :element-type 'double-float
    :initial-contents '(0.35d0 0.09d0 -0.44d0 0.25d0
0.45d0 0.07d0 -0.33d0 -0.32d0
-0.14d0 -0.54d0 -0.03d0 -0.13d0
-0.17d0 0.35d0 0.17d0 0.11d0)))
 (wr (make-array n :element-type 'double-float))
 (wi (make-array n :element-type 'double-float))
 (vl (make-array (* n n) :element-type 'double-float))
 (vr (make-array (* n n) :element-type 'double-float))
 (scale (make-array n :element-type 'double-float))
 (rconde (make-array n :element-type 'double-float))
 (rcondv (make-array n :element-type 'double-float))
 (lwork 660)
 (work (make-array lwork :element-type 'double-float))
 (iwork (make-array (- (* n 2) 2) :element-type 'f2cl-lib::integer4)))
    (multiple-value-bind (z-balanc z-jobvl z-jobvr z-sense z-n z-a z-lda z-wr
                          z-wi z-vl z-ldvl z-vr z-ldvr ilo ihi z-scale abnrm
                          z-rconde z-rcondv z-work z-lwork z-iwork info)
(dgeevx "Balance" "Vectors (left)" "Vectors (right)"
```

```
"Both reciprocal condition numbers"
n a-mat n wr wi vl n vr n 0 0 scale 0d0 rconde rcondv
work lwork iwork 0)
      (declare (ignore z-balanc z-jobvl z-jobvr z-sense z-n z-a z-lda z-wr
                       z-wi z-vl z-ldvl z-vr z-ldvr z-scale z-rconde z-rcondv
                       z-work z-lwork z-iwork))
      ;; Display solution
      (cond ((zerop info)
     (let* ((eps (dlamch "Eps"))
    (tol (* eps abnrm)))
       (print-dgeevx-results tol
     (make-eigval wr wi)
     (make-eigvec n vr wi)
     rconde rcondv)))
    (t
     (format t "Failure in DGEEV.  INFO = ~D~%" info)))
      ;; Display workspace info
      (format t "Optimum workspace required = ~D~%" (truncate (aref work 0)))
      (format t "Workspace provided = ~D~%" lwork))))

;; Expected results (from
;;    http://www.nag.co.uk/lapack-ex/examples/results/dgesv-ex.r)
;; Solution
;;         1.0000    -1.0000     3.0000    -5.0000
;;
;;  Details of factorization
;;              1          2          3          4
;;  1      5.2500    -2.9500    -0.9500    -3.8000
;;  2      0.3429     3.8914     2.3757     0.4129
;;  3      0.3010    -0.4631    -1.5139     0.2948
;;  4     -0.2114    -0.3299     0.0047     0.1314
;;
;;  Pivot indices
;;              2          2          3          4
;;
(defun print-dgesv-results (n a b ipiv)
  (format t "~2%DGESV Example Program Results~%")
  (format t "Solution~%")
  (dotimes (k n)
    (format t "~21,14e " (aref b k)))
  (format t "~&Details of factorization~%")
  (dotimes (r n)
    (dotimes (c n)
      (format t "~21,14e" (aref a (+ r (* c n)))))
    (terpri))
  (format t "Pivot indices~%")
  (dotimes (k n)
    (format t " ~d" (aref ipiv k)))
  (terpri))
```

```
(defun test-dgesv ()
  ;;
  ;; Matrix A:
  ;;  1.80   2.88   2.05  -0.89
  ;;  5.25  -2.95  -0.95  -3.80
  ;;  1.58  -2.69  -2.90  -1.04
  ;; -1.11  -0.66  -0.59   0.80
  ;;
  ;; RHS:
  ;; 9.52  24.35   0.77  -6.22
  (let* ((n 4)
 (a-mat (make-array (* n n) :element-type 'double-float
    :initial-contents '(1.80d0 5.25d0 1.58d0 -1.11d0
2.88d0 -2.95d0 -2.69d0 -0.66d0
2.05d0 -0.95d0 -2.90d0 -0.59d0
-0.89d0 -3.80d0 -1.04d0 0.8d0)))
 (b (make-array n :element-type 'double-float
:initial-contents '(9.52d0 24.35d0 0.77d0 -6.22d0)))
 (ipiv (make-array n :element-type 'f2cl-lib:integer4)))
    (multiple-value-bind (z-n z-nrhs z-a z-lda z-ipiv z-b z-ldb info)
(dgesv n 1 a-mat n ipiv b n 0)
      (declare (ignore z-n z-nrhs z-a z-lda z-ipiv z-b z-ldb))
      ;; Display solution
      (cond ((zerop info)
     (print-dgesv-results n a-mat b ipiv))
    (t
     (format t "The (~D, ~D) element of the factor U is zero~%"
                      info info))))))

;; Expected results (from )
;;
;; It seems, however, that the result from that page are wrong.  At
;; least they seem wrong when I run the actual test program.  The main
;; difference is that the singular vectors have the signs of some
;; entries wrong.
;;
;; The result below is what the test program actually produces.

;; DGESDD Example Program Results
;;
;;  Singular values
;;      9.9966  3.6831  1.3569  0.5000
;;  Left singular vectors
;;           1       2       3       4
;;  1  -0.1921  0.8030 -0.0041  0.5642
;;  2   0.8794  0.3926  0.0752 -0.2587
;;  3  -0.2140  0.2980 -0.7827 -0.5027
;;  4   0.3795 -0.3351 -0.6178  0.6017
;;
;;  Right singular vectors by row (first m rows of V**T)
```

```
;;           1       2       3       4       5       6
;;  1  -0.2774 -0.2020 -0.2918  0.0938  0.4213 -0.7816
;;  2   0.6003  0.0301 -0.3348  0.3699 -0.5266 -0.3353
;;  3   0.1277 -0.2805 -0.6453 -0.6781 -0.0413  0.1645
;;  4  -0.1323 -0.7034 -0.1906  0.5399  0.0575  0.3957
;;
;;  Error estimate for the singular values
;;         1.1E-15
;;
;;  Error estimates for the left singular vectors
;;         1.8E-16    4.8E-16    1.3E-15    1.3E-15
;;
;;  Error estimates for the right singular vectors
;;         1.8E-16    4.8E-16    1.3E-15    2.2E-15
;;
(defun print-dgesdd-results (m n s u a)
  (format t "~2%DGESDD Example Program Results~%")
  (format t "Singular values~%")
  (dotimes (k m)
    (format t "~20,14e" (aref s k)))
  (format t "~2%Left singular vectors~%")
  (dotimes (r m)
    (dotimes (c m)
      (format t "~16,7e" (aref u (+ r (* c m)))))
    (terpri))
  (format t "~%Right singular vectors (first m rows of V**T)~%")
  (dotimes (r m)
    (dotimes (c n)
      (format t "~16,7e" (aref a (+ r (* c m)))))
    (terpri))
  ;; Compute error estimates for the singular vectors
  (let ((serrbd (* (aref s 0) (dlamch "Eps")))
(rcondu (make-array m :element-type 'double-float))
(rcondv (make-array m :element-type 'double-float))
(uerrbd (make-array m :element-type 'double-float))
(verrbd (make-array m :element-type 'double-float)))
    (ddisna "Left" m n s rcondu 0)
    (ddisna "Right" m n s rcondv 0)
    (dotimes (k m)
      (setf (aref uerrbd k) (/ serrbd (aref rcondu k)))
      (setf (aref verrbd k) (/ serrbd (aref rcondv k))))
    (format t "Error estimate for the singular values~%")
    (format t "~20,15g~%" serrbd)
    (format t "~%~%Error estimates for the left singular values~%")
    (format t "~{~15,4e~^ ~}~%" (coerce uerrbd 'list))
    (format t "~%~%Error estimates for the right singular values~%")
    (format t "~{~15,4e~^ ~}~%" (coerce verrbd 'list))))

(defun test-dgesdd ()
  ;;
```

```
  ;; Matrix A:
  ;;  2.27   0.28  -0.48   1.07  -2.35   0.62
  ;; -1.54  -1.67  -3.09   1.22   2.93  -7.39
  ;;  1.15   0.94   0.99   0.79  -1.45   1.03
  ;; -1.94  -0.78  -0.21   0.63   2.30  -2.57
  (let* ((m 4) ; rows
 (n 6) ; cols
 (a-mat (make-array (* m n) :element-type 'double-float
    :initial-contents '(2.27d0 -1.54d0 1.15d0 -1.94d0
0.28d0 -1.67d0 0.94d0 -0.78d0
-0.48d0 -3.09d0 0.99d0 -0.21d0
1.07d0 1.22d0 0.79d0 0.63d0
-2.35d0 2.93d0 -1.45d0 2.30d0
0.62d0 -7.39d0 1.03d0 -2.57d0)))
 (s (make-array (min m n) :element-type 'double-float))
 (u (make-array (* m (min m n)):element-type 'double-float))
 (vt (make-array (* n n) :element-type 'double-float))
 (lwork 1000)
 (work (make-array lwork :element-type 'double-float))
 (iwork (make-array (* 8 (min m n)) :element-type 'f2cl-lib:integer4)))
    (multiple-value-bind (z-jobz z-m z-n z-a z-lda z-s z-u z-ldu z-vt z-ldvt
                          z-work z-lwork z-iwork info)
(dgesdd "Overwrite A by transpose(V)"
                m n a-mat m s u m vt n work lwork iwork 0)
      (declare (ignore z-jobz z-m z-n z-a z-lda z-s z-u z-ldu z-vt z-ldvt
                       z-work z-lwork z-iwork ))
      ;; Display solution
      (cond ((zerop info)
     (print-dgesdd-results m n s u a-mat))
    (t
     (format t "Failure in DGESDD.  Info = ~D~%" info)))
      (format t "Optimum workspace required = ~D~%" (truncate (aref work 0)))
      (format t "Workspace provided = ~D~%" lwork))))

;; Expected results (from
;;     http://www.nag.co.uk/lapack-ex/examples/results/dgesvd-ex.r)
;; DGESVD Example Program Results
;;
;;  Singular values
;;      9.9966  3.6831  1.3569  0.5000
;;  Left singular vectors (first n columns of U)
;;           1       2       3       4
;;  1  -0.2774 -0.6003 -0.1277  0.1323
;;  2  -0.2020 -0.0301  0.2805  0.7034
;;  3  -0.2918  0.3348  0.6453  0.1906
;;  4   0.0938 -0.3699  0.6781 -0.5399
;;  5   0.4213  0.5266  0.0413 -0.0575
;;  6  -0.7816  0.3353 -0.1645 -0.3957
;;
;;  Right singular vectors by row (V**T)
```

```
;;           1       2       3       4
;;  1  -0.1921  0.8794 -0.2140  0.3795
;;  2  -0.8030 -0.3926 -0.2980  0.3351
;;  3   0.0041 -0.0752  0.7827  0.6178
;;  4  -0.5642  0.2587  0.5027 -0.6017
;;
;;  Error estimate for the singular values
;;         1.1E-15
;;
;;  Error estimates for the left singular vectors
;;         1.8E-16    4.8E-16    1.3E-15    2.2E-15
;;
;;  Error estimates for the right singular vectors
;;         1.8E-16    4.8E-16    1.3E-15    1.3E-15
;;
(defun print-dgesvd-results (m n s vt a)
  (format t "~2%DGESVD Example Program Results~%")
  (format t "Singular values~%")
  (dotimes (k n)
    (format t "~20,14e" (aref s k)))
  (format t "~2%Left singular vectors~%")
  (dotimes (r m)
    (dotimes (c n)
      (format t "~16,7e" (aref a (+ r (* c m)))))
    (terpri))
  (format t "~%Right singular vectors (first m rows of V**T)~%")
  (dotimes (r n)
    (dotimes (c n)
      (format t "~16,7e" (aref vt (+ r (* c n)))))
    (terpri))
  ;; Compute error estimates for the singular vectors
  (let ((serrbd (* (aref s 0) (dlamch "Eps")))
(rcondu (make-array n :element-type 'double-float))
(rcondv (make-array n :element-type 'double-float))
(uerrbd (make-array n :element-type 'double-float))
(verrbd (make-array n :element-type 'double-float)))
    (ddisna "Left" m n s rcondu 0)
    (ddisna "Right" m n s rcondv 0)
    (dotimes (k n)
      (setf (aref uerrbd k) (/ serrbd (aref rcondu k)))
      (setf (aref verrbd k) (/ serrbd (aref rcondv k))))
    (format t "Error estimate for the singular values~%")
    (format t "~20,15g~%" serrbd)
    (format t "~%~%Error estimates for the left singular values~%")
    (format t "~{~15,4e~^ ~}~%" (coerce uerrbd 'list))
    (format t "~%~%Error estimates for the right singular values~%")
    (format t "~{~15,4e~^ ~}~%" (coerce verrbd 'list))))

(defun test-dgesvd ()
  ;;
```

```
  ;; Matrix A:
  ;;     2.27  -1.54   1.15  -1.94
  ;;     0.28  -1.67   0.94  -0.78
  ;;    -0.48  -3.09   0.99  -0.21
  ;;     1.07   1.22   0.79   0.63
  ;;    -2.35   2.93  -1.45   2.30
  ;;     0.62  -7.39   1.03  -2.57
  (let* ((m 6) ; rows
 (n 4) ; cols
 (a-mat (make-array (* m n) :element-type 'double-float
    :initial-contents '(2.27d0 0.28d0 -0.48d0 1.07d0 -2.35d0 0.62d0
-1.54d0 -1.67d0 -3.09d0 1.22d0 2.93d0 -7.39d0
1.15d0 0.94d0 0.99d0 0.79d0 -1.45d0 1.03d0
    -1.94d0 -0.78d0 -0.21d0 0.63d0 2.30d0 -2.57d0)))
 (s (make-array (min m n) :element-type 'double-float))
 (u (make-array (* m (min m n)):element-type 'double-float))
 (vt (make-array (* n n) :element-type 'double-float))
 (lwork (+ 10 (* 4 8)
   (* 64 (+ 10 8))))
 (work (make-array lwork :element-type 'double-float)))
    (multiple-value-bind (z-jobz z-jobvt z-m z-n z-a z-lda z-s z-u z-ldu z-vt
                          z-ldvt z-work z-lwork info)
(dgesvd "Overwrite A by U" "Singular vectors (V)"
m n a-mat m s u m vt n work lwork 0)
      (declare (ignore z-jobz z-jobvt z-m z-n z-a z-lda z-s z-u z-ldu z-vt
                       z-ldvt z-work z-lwork))
      ;; Display solution
      (cond ((zerop info)
     (print-dgesvd-results m n s vt a-mat))
    (t
     (format t "Failure in DGESDD.  Info = ~D~%" info)))
      (format t "Optimum workspace required = ~D~%" (truncate (aref work 0)))
      (format t "Workspace provided = ~D~%" lwork))))

(defun make-complex-eigvec (n vr)
  (make-array (list n n)
      :displaced-to vr
      :element-type (array-element-type vr)))

(defun print-zgeev-results (e-val e-vec)
  (format t "~2%ZGEEV Example Program Results~%")
  (let ((n (length e-val)))
    (dotimes (k n)
      (format t "Eigenvalue(~D) = ~A~%" k (aref e-val k))
      (format t "~%Eigenvector(~D)~%" k)
      (dotimes (row n)
(format t "~A~%" (aref e-vec row k)))
      (terpri))))

(defun test-zgeev ()
```

```
  ;; The matrix is
  ;;
  ;; #c(-3.97, -5.04)  #c(-4.11,  3.70)  #c(-0.34,  1.01)  #c( 1.29, -0.86)
  ;; #c( 0.34, -1.50)  #c( 1.52, -0.43)  #c( 1.88, -5.38)  #c( 3.36,  0.65)
  ;; #c( 3.31, -3.85)  #c( 2.50,  3.45)  #c( 0.88, -1.08)  #c( 0.64, -1.48)
  ;; #c(-1.10,  0.82)  #c( 1.81, -1.59)  #c( 3.25,  1.33)  #c( 1.57, -3.44)
  ;;
  ;; Recall that Fortran arrays are column-major order!
  (let* ((n 4)
 (a-mat (make-array (* n n)
    :element-type '(complex double-float)
    :initial-contents '(#c(-3.97d0 -5.04d0)
#c( 0.34d0 -1.50d0)
#c( 3.31d0 -3.85d0)
#c(-1.10d0  0.82d0)
#c(-4.11d0  3.70d0)
#c( 1.52d0 -0.43d0)
#c( 2.50d0  3.45d0)
#c( 1.81d0 -1.59d0)
#c(-0.34d0  1.01d0)
#c( 1.88d0 -5.38d0)
#c( 0.88d0 -1.08d0)
#c( 3.25d0  1.33d0)
#c( 1.29d0 -0.86d0)
#c( 3.36d0  0.65d0)
#c( 0.64d0 -1.48d0)
#c( 1.57d0 -3.44d0))))
 (lwork 660)
 (w (make-array n :element-type '(complex double-float)))
 (rw (make-array lwork :element-type 'double-float))
 (vl (make-array 0 :element-type '(complex double-float)))
 (vr (make-array (* n n) :element-type '(complex double-float)))
 (work (make-array lwork :element-type '(complex double-float))))
    (multiple-value-bind (z-jobvl z-jobvr z-n z-a z-lda z-w z-vl z-ldvl z-vr
z-ldvr z-work z-lwork z-rwork info)
(zgeev "N" "V" n a-mat n w vl n vr n work lwork rw 0)
      (declare (ignore z-jobvl z-jobvr z-n z-a z-lda z-w z-vl z-ldvl z-vr
       z-ldvr z-work z-lwork z-rwork))
      ;; Display solution
      (cond ((zerop info)
     (print-zgeev-results w
  (make-complex-eigvec n vr)))
    (t
     (format t "Failure in DGEEV.  INFO = ~D~%" info)))
      ;; Display workspace info
      (format t "Optimum workspace required = ~D~%"
                (truncate (realpart (aref work 0))))
      (format t "Workspace provided = ~D~%" lwork))))

(defun do-all-lapack-tests ()
```

```
  (test-dgeev)
  (test-dgeevx)
  (test-dgesv)
  (test-dgesdd)
  (test-dgesvd)
  (test-zgeev))

;;; $Log$
;;; Revision 1.11  2006/12/01 04:29:29  rtoy
;;; Create packages for BLAS and LAPACK routines.
;;;
;;; blas.system:
;;; o Converted files are in the BLAS package.
;;; o Add blas-package defsystem to load the package definition.
;;;
;;; lapack.system:
;;; o Converted files are in the LAPACK package.
;;; o Add lapack-package defsystem to load the package definition.
;;;
;;; lapack/lapack-tests.lisp:
;;; o Tests are in the LAPACK package
;;;
;;; Revision 1.10  2006/11/28 15:49:01  rtoy
;;; Print out short title for each test.
;;;
;;; Revision 1.9  2006/11/27 22:22:23  rtoy
;;; Add expected results.
;;;
;;; Revision 1.8  2006/11/27 20:04:33  rtoy
;;; Add DGESVD and update files and tests appropriately.
;;;
;;; Revision 1.7  2006/11/27 15:23:29  rtoy
;;; Add function to run all the tests.
;;;
;;; Revision 1.6  2006/11/26 23:26:47  rtoy
;;; packages/lapack.system:
;;; o Add DGESDD and dependencies
;;; o Add DDISNA to compute condition number of singular vectors
;;;
;;; packages/lapack/.cvsignore:
;;; o Ignore new generated Lisp files.
;;;
;;; packages/lapack/lapack-tests.lisp:
;;; o Add test for DGESDD
;;;
;;; Revision 1.5  2006/11/26 14:26:42  rtoy
;;; Add expected results for DGESV.
;;;
;;; Revision 1.4  2006/11/26 14:24:46  rtoy
;;; packages/lapack.system:
```

```
;;; o DGESV and dependencies
;;;
;;; packages/.cvsignore:
;;; o Ignore generated dgesv.lisp and dependencies
;;;
;;; packages/lapack/lapack-tests.lisp:
;;; o Test routine for DGESV
;;;
;;; Revision 1.3  2006/11/26 05:31:16  rtoy
;;; packages/lapack.system:
;;; o Add DGEEVX and dependencies
;;;
;;; packages/lapack/lapack-tests.lisp:
;;; o Add test for DGEEVX
;;; o Add comments
;;;
;;; packages/lapack/dgeevx.f:
;;; packages/lapack/dlacon.f:
;;; packages/lapack/dlaexc.f:
;;; packages/lapack/dlaqtr.f:
;;; packages/lapack/dlasy2.f:
;;; packages/lapack/dtrexc.f:
;;; packages/lapack/dtrsna.f:
;;; o New files for DGEEVX and dependencies.
;;;
;;; Revision 1.2  2006/11/26 04:53:22  rtoy
;;; Add comments
;;;
;;; Revision 1.1  2006/11/26 04:51:05  rtoy
;;; packages/lapack.system:
;;; o Add defsystem for LAPACK tests
;;;
;;; packages/lapack/lapack-tests.lisp:
;;; o Add simple tests for LAPACK.  (Currently only DGEEV).
;;;
```

Chapter 8

Chunk collections

— **BLAS FORTRAN** —

```
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\begin{chunk}{ddot.f}
\begin{chunk}{dnrm2.f}
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\begin{chunk}{dgemv.f}
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———-

— LAPACK FORTRAN —

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— Numerics —

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(in-package "BOOT")

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\getchunk{BLAS 1 daxpy}
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\getchunk{BLAS 1 drotg}
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\getchunk{BLAS 1 dscal}
\getchunk{BLAS 1 dswap}
\getchunk{BLAS 1 dzasum}
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\getchunk{BLAS 1 icamax}
\getchunk{BLAS 1 idamax}
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— untested —

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\getchunk{BLAS xerbla}

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———-

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