NAG Toolbox

nag_lapack_dsterf (f08jf)

1 Purpose

nag_lapack_dsterf (f08jf) computes all the eigenvalues of a real symmetric tridiagonal matrix.

2 Syntax

```
[d, e, info] = nag_lapack_dsterf(d, e, 'n', n)
[d, e, info] = f08jf(d, e, 'n', n)
```

3 Description

nag_lapack_dsterf (f08jf) computes all the eigenvalues of a real symmetric tridiagonal matrix, using a square-root-free variant of the QR algorithm.

The function uses an explicit shift, and, like nag_lapack_dsteqr (f08je), switches between the QR and QL variants in order to handle graded matrices effectively (see Greenbaum and Dongarra (1980)).

4 References

Greenbaum A and Dongarra J J (1980) Experiments with QR/QL methods for the symmetric triangular eigenproblem *LAPACK Working Note No. 17 (Technical Report CS-89-92)* University of Tennessee, Knoxville http://www.netlib.org/lapack/lawnspdf/lawn17.pdf

Parlett B N (1998) *The Symmetric Eigenvalue Problem* SIAM, Philadelphia

5 Parameters

5.1 Compulsory Input Parameters

1: **d**(:) – REAL (KIND=nag_wp) array

The dimension of the array **d** must be at least $\max(1, \mathbf{n})$

The diagonal elements of the tridiagonal matrix T.

2: **e**(:) – REAL (KIND=nag_wp) array

The dimension of the array **e** must be at least $\max(1, \mathbf{n} - 1)$

The off-diagonal elements of the tridiagonal matrix T.

5.2 Optional Input Parameters

1: **n** – INTEGER

Default: the first dimension of the array **d** and the second dimension of the array **d**. (An error is raised if these dimensions are not equal.)

n, the order of the matrix T.

Constraint: $\mathbf{n} \geq 0$.

5.3 Output Parameters

1: **d**(:) – REAL (KIND=nag_wp) array

The dimension of the array **d** will be $\max(1, \mathbf{n})$

The n eigenvalues in ascending order, unless **info** > 0 (in which case see Section 6).

2: **e**(:) – REAL (KIND=nag_wp) array

The dimension of the array **e** will be $\max(1, \mathbf{n} - 1)$

3: **info** – INTEGER

info $= 0$ unless the function detects an error (see Section 6).

6 Error Indicators and Warnings

info $= -i$

If **info** $= -i$, parameter i had an illegal value on entry. The parameters are numbered as follows:

1: **n**, 2: **d**, 3: **e**, 4: **info**.

info > 0 (*warning*)

The algorithm has failed to find all the eigenvalues after a total of $30 \times \mathbf{n}$ iterations. If **info** $= i$, then on exit i elements of **e** have not converged to zero.

7 Accuracy

The computed eigenvalues are exact for a nearby matrix $(T + E)$, where

$$\|E\|_2 = O(\epsilon)\|T\|_2,$$

and ϵ is the ***machine precision***.

If λ_i is an exact eigenvalue and $\tilde{\lambda}_i$ is the corresponding computed value, then

$$\left|\tilde{\lambda}_i - \lambda_i\right| \leq c(n)\epsilon\|T\|_2,$$

where $c(n)$ is a modestly increasing function of n.

8 Further Comments

The total number of floating-point operations is typically about $14n^2$, but depends on how rapidly the algorithm converges. The operations are all performed in scalar mode.

There is no complex analogue of this function.

9 Example

This example computes all the eigenvalues of the symmetric tridiagonal matrix T, where

$$T = \begin{pmatrix} -6.99 & -0.44 & 0.00 & 0.00 \\ -0.44 & 7.92 & -2.63 & 0.00 \\ 0.00 & -2.63 & 2.34 & -1.18 \\ 0.00 & 0.00 & -1.18 & 0.32 \end{pmatrix}.$$

9.1 Program Text

```
function f08jf_example

fprintf('f08jf example results\n\n');

% Symmetric tridiagonal A stored as diagonal and off-diagonal
n = 4;
d = [-6.99;     7.92;     2.34;     0.32];
e = [-0.44;    -2.63;    -1.18];

% Eigenvalues only of A
[w, ~, info] = f08jf( ...
                      d, e);

disp('Eigenvalues');
disp(w');
```

9.2 Program Results

```
f08jf example results

Eigenvalues
   -7.0037   -0.4059    2.0028    8.9968
```