NAG Toolbox for MATLAB

f08jf

1 Purpose

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

2 Syntax

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

3 Description

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 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

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

5 Parameters

5.1 Compulsory Input Parameters

1: **d**$(*)$ – **double array**

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

The diagonal elements of the tridiagonal matrix T.

2: **e**$(*)$ – **double array**

Note: 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** – **int32 scalar**

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 Input Parameters Omitted from the MATLAB Interface

None.

5.4 Output Parameters

1: **d**$(*)$ **– double array**

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

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

2: **e**$(*)$ **– double array**

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

e is overwritten.

3: **info – int32 scalar**

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

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

```
d = [-6.99;
     7.92;
     2.34;
     0.32];
e = [-0.44;
     -2.63;
     -1.18];
[dOut, eOut, info] = f08jf(d, e)
```

```
dOut =
   -7.0037
   -0.4059
    2.0028
    8.9968
eOut =
     0
     0
     0
info =
           0
```