NAG Toolbox for MATLAB

f08nt

1 Purpose

f08nt generates the complex unitary matrix Q which was determined by f08ns when reducing a complex general matrix A to Hessenberg form.

2 Syntax

```
[a, info] = f08nt(ilo, ihi, a, tau, 'n', n)
```

3 Description

f08nt is intended to be used following a call to f08ns, which reduces a complex general matrix A to upper Hessenberg form H by a unitary similarity transformation: $A = QHQ^{\mathrm{H}}$. f08ns represents the matrix Q as a product of $i_{\mathrm{hi}} - i_{\mathrm{lo}}$ elementary reflectors. Here i_{lo} and i_{hi} are values determined by f08nv when balancing the matrix; if the matrix has not been balanced, $i_{\mathrm{lo}} = 1$ and $i_{\mathrm{hi}} = n$.

This function may be used to generate Q explicitly as a square matrix. Q has the structure:

$$Q = \begin{pmatrix} I & 0 & 0 \\ 0 & Q_{22} & 0 \\ 0 & 0 & I \end{pmatrix}$$

where Q_{22} occupies rows and columns i_{lo} to i_{hi}.

4 References

Golub G H and Van Loan C F 1996 *Matrix Computations* (3rd Edition) Johns Hopkins University Press, Baltimore

5 Parameters

5.1 Compulsory Input Parameters

1: **ilo – int32 scalar**

2: **ihi – int32 scalar**

These **must** be the same parameters **ilo** and **ihi**, respectively, as supplied to f08ns.

Constraints:

if $\mathbf{n} > 0$, $1 \leq \mathbf{ilo} \leq \mathbf{ihi} \leq \mathbf{n}$;
if $\mathbf{n} = 0$, $\mathbf{ilo} = 1$ and $\mathbf{ihi} = 0$.

3: **a(lda,∗) – complex array**

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

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

Details of the vectors which define the elementary reflectors, as returned by f08ns.

4: **tau(∗) – complex array**

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

Further details of the elementary reflectors, as returned by f08ns.

5.2 Optional Input Parameters

1: **n – int32 scalar**

Default: The second dimension of the array **a**.

n, the order of the matrix Q.

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

5.3 Input Parameters Omitted from the MATLAB Interface

lda, work, lwork

5.4 Output Parameters

1: **a(lda,∗) – complex array**

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

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

The n by n unitary matrix Q.

2: **info – int32 scalar**

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

6 Error Indicators and Warnings

Errors or warnings detected by the function:

info $= -i$

If **info** $= -i$, parameter i had an illegal value on entry. The parameters are numbered as follows: 1: **n**, 2: **ilo**, 3: **ihi**, 4: **a**, 5: **lda**, 6: **tau**, 7: **work**, 8: **lwork**, 9: **info**.

It is possible that **info** refers to a parameter that is omitted from the MATLAB interface. This usually indicates that an error in one of the other input parameters has caused an incorrect value to be inferred.

7 Accuracy

The computed matrix Q differs from an exactly unitary matrix by a matrix E such that

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

where ϵ is the ***machine precision***.

8 Further Comments

The total number of real floating-point operations is approximately $\frac{16}{3}q^3$, where $q = i_{\mathrm{hi}} - i_{\mathrm{lo}}$.

The real analogue of this function is f08nf.

9 Example

```
ilo = int32(1);
ihi = int32(4);
a    =    [complex(-3.97,    -5.04),    complex(-1.131805187339771,    -
2.56930489882744), ...
           complex(-4.602742437533554,   -0.142631904083292),   complex(-
```

```
1.424912289366528, +1.732983703342187);
          complex(-5.479653273702635,  +0),  complex(1.858472820765587,  -
1.55018070644029), ...
           complex(4.414465526917012,   -0.7638237115550983),   complex(-
0.4805261336990153, -1.197599997332747);
                    complex(0.6932222118146283,    -0.4828752762602551),
complex(6.267276818064224, ...
      +0),  complex(-0.4503809403345012,  -0.02898183259817966),  complex(-
1.346684450078734, +1.65792489538873);
                   complex(-0.2112946907920694,    +0.0864412259893682),
complex(0.1242146188766495, ...
             -0.2289276049796828),    complex(-3.499985837393258,    +0),
complex(2.561908119568915, -3.370837460961531)];
tau = [complex(1.062047721455606, -0.2737399475982613);
     complex(1.805921371640585, +0.3479067029848286);
     complex(1.181823471041003, +0.9833311880432766)];
[aOut, info] = f08nt(ilo, ihi, a, tau)
```

```
aOut =
   1.0000                  0                  0                  0
         0              -0.0620 + 0.2737i   0.4995 + 0.6440i   0.4237 -
0.2783i
         0              -0.6041 + 0.7026i  -0.1487 - 0.1427i  -0.2634 -
0.1722i
         0               0.2007 - 0.1496i  -0.4652 + 0.2773i  -0.2482 -
0.7632i
info =
          0
```