NAG Toolbox for MATLAB

f08gg

1 Purpose

f08gg multiplies an arbitrary real matrix C by the real orthogonal matrix Q which was determined by f08ge when reducing a real symmetric matrix to tridiagonal form.

2 Syntax

```
[ap, c, info] = f08gg(side, uplo, trans, ap, tau, c, 'm', m, 'n', n)
```

3 Description

f08gg is intended to be used after a call to f08ge, which reduces a real symmetric matrix A to symmetric tridiagonal form T by an orthogonal similarity transformation: $A = QTQ^{\mathrm{T}}$. f08ge represents the orthogonal matrix Q as a product of elementary reflectors.

This function may be used to form one of the matrix products

$$QC, Q^{\mathrm{T}}C, CQ \text{ or } CQ^{\mathrm{T}},$$

overwriting the result on C (which may be any real rectangular matrix).

A common application of this function is to transform a matrix Z of eigenvectors of T to the matrix QZ of eigenvectors of A.

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: **side – string**

Indicates how Q or Q^{T} is to be applied to C.

side = 'L'

Q or Q^{T} is applied to C from the left.

side = 'R'

Q or Q^{T} is applied to C from the right.

Constraint: **side** = 'L' or 'R'.

2: **uplo – string**

This **must** be the same parameter **uplo** as supplied to f08ge.

Constraint: **uplo** = 'U' or 'L'.

3: **trans – string**

Indicates whether Q or Q^{T} is to be applied to C.

trans = 'N'

Q is applied to C.

trans = 'T'

Q^{T} is applied to C.

Constraint: **trans** = 'N' or 'T'.

4: **ap**$(*)$ **– double array**

Note: the dimension of the array **ap** must be at least $\max(1, \mathbf{m} \times (\mathbf{m}+1)/2)$ if **side** = 'L' and at least $\max(1, \mathbf{n} \times (\mathbf{n}+1)/2)$ if **side** = 'R'.

Details of the vectors which define the elementary reflectors, as returned by f08ge.

5: **tau**$(*)$ **– double array**

Note: the dimension of the array **tau** must be at least $\max(1, \mathbf{m}-1)$ if **side** = 'L' and at least $\max(1, \mathbf{n}-1)$ if **side** = 'R'.

Further details of the elementary reflectors, as returned by f08ge.

6: **c**(**ldc**,$*$) **– double array**

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

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

The m by n matrix C.

5.2 Optional Input Parameters

1: **m – int32 scalar**

Default: The first dimension of the array **c**.

m, the number of rows of the matrix C; m is also the order of Q if **side** = 'L'.

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

2: **n – int32 scalar**

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

n, the number of columns of the matrix C; n is also the order of Q if **side** = 'R'.

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

5.3 Input Parameters Omitted from the MATLAB Interface

ldc, work

5.4 Output Parameters

1: **ap**$(*)$ **– double array**

Note: the dimension of the array **ap** must be at least $\max(1, \mathbf{m} \times (\mathbf{m}+1)/2)$ if **side** = 'L' and at least $\max(1, \mathbf{n} \times (\mathbf{n}+1)/2)$ if **side** = 'R'.

Is used as internal workspace prior to being restored and hence is unchanged.

2: **c**(**ldc**,$*$) **– double array**

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

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

c contains QC or $Q^{\mathrm{T}}C$ or CQ or CQ^{T} as specified by **side** and **trans**.

3: **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: **side**, 2: **uplo**, 3: **trans**, 4: **m**, 5: **n**, 6: **ap**, 7: **tau**, 8: **c**, 9: **ldc**, 10: **work**, 11: **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 result differs from the exact result by a matrix E such that

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

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

8 Further Comments

The total number of floating-point operations is approximately $2m^2n$ if **side** = 'L' and $2mn^2$ if **side** = 'R'.

The complex analogue of this function is f08gu.

9 Example

```
side = 'Left';
uplo = 'L';
trans = 'No transpose';
ap = [2.07;
     -5.825753170191817;
     0.4331793442217867;
     -0.1186086299654892;
     1.474093708197552;
     2.624045178795586;
     0.8062881532775791;
     -0.6491595075457843;
     0.9162727563219193;
     -1.694934200651768];
tau = [1.664291789738249;
     1.212047324162142;
     0];
c = [0.5657591788223874, -0.2328424308031574;
     0.6869179572505918, -0.1626170961491636;
     -0.4395889372131648, -0.3017273343882724;
     0.1217449705930083, 0.9101102670229791];
[apOut, cOut, info] = f08gg(side, uplo, trans, ap, tau, c)
```

```
apOut =
    2.0700
   -5.8258
    0.4332
   -0.1186
```

```
    1.4741
    2.6240
    0.8063
   -0.6492
    0.9163
   -1.6949
cOut =
    0.5658   -0.2328
   -0.3478    0.7994
   -0.4740   -0.4087
    0.5781    0.3737
info =
           0
```