NAG Toolbox for MATLAB

f08bk

1 Purpose

f08bk multiplies a general real m by n matrix C by the real orthogonal matrix Z from an RZ factorization computed by f08bh.

2 Syntax

```
[c, info] = f08bk(side, trans, l, a, tau, c, 'm', m, 'n', n, 'k', k)
```

3 Description

f08bk is intended to be used following a call to f08bh, which performs an RZ factorization of a real upper trapezoidal matrix A and represents the orthogonal matrix Z as a product of elementary reflectors.

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

$$ZC, \quad Z^{\mathrm{T}}C, \quad CZ, \quad CZ^{\mathrm{T}},$$

overwriting the result on C, which may be any real rectangular m by n matrix.

4 References

Anderson E, Bai Z, Bischof C, Blackford S, Demmel J, Dongarra J J, Du Croz J J, Greenbaum A, Hammarling S, McKenney A and Sorensen D 1999 *LAPACK Users' Guide* (3rd Edition) SIAM, Philadelphia URL: http://www.netlib.org/lapack/lug

5 Parameters

5.1 Compulsory Input Parameters

1: **side – string**

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

side = 'L'

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

side = 'R'

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

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

2: **trans – string**

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

trans = 'N'

Z is applied to C.

trans = 'T'

Z^{T} is applied to C.

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

3: **l – int32 scalar**

The number of columns of the matrix A containing the meaningful part of the Householder reflectors.

Constraints:

if **side** = 'L', **m** $\geq$ **l** ≥ 0;
if **side** = 'R', **n** $\geq$ **l** ≥ 0.

4: **a**(**lda**,$*$) **– double array**

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

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

The ith row of **a** must contain the vector which defines the elementary reflector H_i, for $i = 1, 2, \ldots, k$, as returned by f08bh.

5: **tau**$(*)$ **– double array**

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

tau(i) must contain the scalar factor of the elementary reflector H_i, as returned by f08bh.

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.

Constraint: **m** ≥ 0.

2: **n – int32 scalar**

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

n, the number of columns of the matrix C.

Constraint: **n** ≥ 0.

3: **k – int32 scalar**

Default: The dimension of the array **tau**.

k, the number of elementary reflectors whose product defines the matrix Z.

Constraints:

if **side** = 'L', **m** $\geq$ **k** ≥ 0;
if **side** = 'R', **n** $\geq$ **k** ≥ 0.

5.3 Input Parameters Omitted from the MATLAB Interface

lda, ldc, work, lwork

5.4 Output Parameters

1: **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 ZC or $Z^{\mathrm{T}}C$ or CZ or $Z^{\mathrm{T}}C$ as specified by **side** and **trans**.

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: **side**, 2: **trans**, 3: **m**, 4: **n**, 5: **k**, 6: **l**, 7: **a**, 8: **lda**, 9: **tau**, 10: **c**, 11: **ldc**, 12: **work**, 13: **lwork**, 14: **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 $4nlk$ if **side** $=$ 'L' and $4mlk$ if **side** $=$ 'R'.

The complex analogue of this function is f08bx.

9 Example

```
side = 'Left';
trans = 'Transpose';
l = int32(1);
a   =   [-2.93656957316619,   -0.7272775614475427,   1.913421442570958,   -
1.031653513990358, -0.08896524689353416;
             0.523410930858115,   2.868142965065925,   0.172114756553487,
0.7328546114219521, -0.1692473628718724;
         0.4965693446602629,  -0.4778074470113847,  -2.302755370028275,  -
0.6895673528766084, 0.1052112039796441;
           0.3657166119457342,   -0.552004275578923,   -0.330617676999935,
1.234380700534615, -0.3172691368306203];
tau = [1.984294674439106;
     1.944305996659538;
     1.978103585231948;
     1.817092049956884];
c = [-0.6445180979632383, -3.683612831075249;
     -3.639300678781661, -0.5250341692736291;
     -3.165487836530267, -2.317704211202389;
     -1.622813603526484, -2.440412752457843;
```

```
     0, 0];
[cOut, info] = f08bk(side, trans, l, a, tau, c)
```

```
cOut =
    0.6344    3.6258
    3.3992    0.2818
    3.3678    2.4307
    0.9699    1.8284
   -1.4402   -1.6416
info =
           0
```