

NAG Toolbox for MATLAB

f08bh

1 Purpose

f08bh reduces the m by n ($m \leq n$) real upper trapezoidal matrix A to upper triangular form by means of orthogonal transformations.

2 Syntax

```
[a, tau, info] = f08bh(a, 'm', m, 'n', n)
```

3 Description

The m by n ($m \leq n$) real upper trapezoidal matrix A given by

$$A = \begin{pmatrix} R_1 & R_2 \end{pmatrix},$$

where R_1 is an m by m upper triangular matrix and R_2 is an m by $(n - m)$ matrix, is factorized as

$$A = \begin{pmatrix} R & 0 \end{pmatrix} Z,$$

where R is also an m by m upper triangular matrix and Z is an n by n orthogonal 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: **a(lda,*)** – double array

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

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

The leading m by n upper trapezoidal part of the array **a** must contain the matrix to be factorized.

5.2 Optional Input Parameters

1: **m** – int32 scalar

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

m , the number of rows of the matrix A .

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

2: **n** – int32 scalar

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

n , the number of columns of the matrix A .

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

5.3 Input Parameters Omitted from the MATLAB Interface

lda, work, lwork

5.4 Output Parameters

1: **a(lda,*)** – double array

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

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

The leading m by m upper triangular part of **a** contains the upper triangular matrix R , and elements $\mathbf{m} + 1$ to $\mathbf{n}$ of the first m rows of **a**, with the array **tau**, represent the orthogonal matrix Z as a product of m elementary reflectors.

2: **tau(*)** – double array

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

The scalar factors of the elementary reflectors.

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: **m**, 2: **n**, 3: **a**, 4: **lda**, 5: **tau**, 6: **work**, 7: **lwork**, 8: **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 factorization is the exact factorization of a nearby matrix $A + E$, where

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

and ϵ is the *machine precision*.

8 Further Comments

The total number of floating point operations is approximately $4m^2(n - m)$.

The complex analogue of this function is f08bv.

9 Example

```
a = [2.890449791987399,    0.5161826384723808,    -1.719836135462501,
      0.202390645781731,   -1.502638105681696;
      0.523410930858115,   -2.70840460118862,    -0.3647717751290191,    -
      0.08725781308839184,  1.147525852147832;
      0.4965693446602629,   -0.4778074470113847,    2.252333283336778,
      0.8397289924690426,   -0.005952169991484053;
      0.3657166119457342,   -0.552004275578923,   -0.3306176769999935,    -
```

```
1.008602657027043, 0.711629393779034];  
[aOut, tau, info] = f08bh(a)  
  
aOut =  
    -2.9366    -0.7273     1.9134    -1.0317    -0.0890  
     0.5234     2.8681     0.1721     0.7329    -0.1692  
     0.4966    -0.4778    -2.3028    -0.6896     0.1052  
     0.3657    -0.5520    -0.3306     1.2344    -0.3173  
  
tau =  
     1.9843  
     1.9443  
     1.9781  
     1.8171  
  
info =  
      0
```
