

NAG Fortran Library Routine Document

F06QRF

Note: before using this routine, please read the Users' Note for your implementation to check the interpretation of ***bold italicised*** terms and other implementation-dependent details.

1 Purpose

F06QRF transforms an n by n real upper Hessenberg matrix H to upper triangular form R by applying an orthogonal matrix P from the left or the right. H is assumed to have non-zero sub-diagonal elements $h_{k+1,k}$ for $k = k_1, k_1 + 1, \dots, k_2 - 1$ only. P is formed as a sequence of plane rotations in planes k_1 to k_2 .

If $\text{SIDE} = \text{'L'}$, the rotations are applied from the left:

$$PH = R, \quad \text{where} \quad P = P_{k_2-1} \cdots P_{k_1+1} P_{k_1}.$$

If $\text{SIDE} = \text{'R'}$, the rotations are applied from the right:

$$HP^T = R, \quad \text{where} \quad P = P_{k_1} P_{k_1+1} \cdots P_{k_2-1}.$$

In either case, P_k is a rotation in the $(k, k+1)$ plane, chosen to annihilate $h_{k+1,k}$.

The 2 by 2 plane rotation part of P_k has the form

$$\begin{pmatrix} c_k & s_k \\ -s_k & c_k \end{pmatrix}.$$

2 Specification

```
SUBROUTINE F06QRF (SIDE, N, K1, K2, C, S, A, LDA)
  INTEGER          N, K1, K2, LDA
  double precision C(*), S(*), A(LDA,*)
  CHARACTER*1      SIDE
```

3 Description

None.

4 References

None.

5 Parameters

- 1: SIDE – CHARACTER*1 *Input*
On entry: specifies whether H is operated on from the left or the right, as follows:
 if $\text{SIDE} = \text{'L'}$, H is pre-multiplied from the left;
 if $\text{SIDE} = \text{'R'}$, H is post-multiplied from the right.
Constraint: SIDE = 'L' or 'R'.
- 2: N – INTEGER *Input*
On entry: n , the order of the matrix H .
Constraint: $N \geq 0$.

- 3: K1 – INTEGER *Input*
 4: K2 – INTEGER *Input*
On entry: the values k_1 and k_2 .
- 5: C(*) – **double precision** array *Output*
On exit: C(k) holds c_k , the cosine of the rotation P_k , for $k = k_1, \dots, k_2 - 1$.
- 6: S(*) – **double precision** array *Input/Output*
On entry: the non-zero sub-diagonal elements of H : S(k) must hold $h_{k+1,k}$, for $k = k_1, k_1 + 1, \dots, k_2 - 1$.
On exit: S(k) holds s_k , the sine of the rotation P_k , for $k = k_1, \dots, k_2 - 1$.
- 7: A(LDA,*) – **double precision** array *Input/Output*
Note: the second dimension of the array A must be at least $\max(1, N)$.
On entry: the upper triangular part of the n by n upper Hessenberg matrix H .
On exit: the upper triangular matrix R .
- 8: LDA – INTEGER *Input*
On entry: the first dimension of the array A as declared in the (sub)program from which F06QRF is called.
Constraint: $LDA \geq \max(1, N)$.

6 Error Indicators and Warnings

None.
