

NAG 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 performs a QR or RQ factorization (as a sequence of plane rotations) of a real upper Hessenberg matrix.

2 Specification

```
SUBROUTINE F06QRF (SIDE, N, K1, K2, C, S, A, LDA)
  INTEGER          N, K1, K2, LDA
  REAL (KIND=nag_wp) C(K2-1), S(K2-1), A(LDA,*)
  CHARACTER(1)    SIDE
```

3 Description

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 nonzero subdiagonal elements $h_{k+1,k}$, for $k = k_1, \dots, k_2 - 1$, only. P is formed as a sequence of plane rotations in planes k_1 to k_2 .

If $SIDE = 'L'$, the rotations are applied from the left:

$$PH = R,$$

where $P = P_{k_2-1} \cdots P_{k_1+1} P_{k_1}$.

If $SIDE = 'R'$, the rotations are applied from the right:

$$HP^T = R,$$

where $P = P_{k_1} P_{k_1+1} \cdots P_{k_2-1}$.

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

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

4 References

None.

5 Arguments

1: $SIDE$ – CHARACTER(1) *Input*

On entry: specifies whether H is operated on from the left or the right.

$SIDE = 'L'$

H is pre-multiplied from the left.

$SIDE = 'R'$

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 .
If $K1 < 1$ or $K2 \leq K1$ or $K2 > N$, an immediate return is effected.
- 5: C(K2 – 1) – REAL (KIND=nag_wp) 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(K2 – 1) – REAL (KIND=nag_wp) array *Input/Output*
On entry: the nonzero subdiagonal elements of H : $S(k)$ must hold $h_{k+1,k}$, for $k = k_1, \dots, k_2 - 1$.
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,*) – REAL (KIND=nag_wp) array *Input/Output*
Note: the second dimension of the array A must be at least 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.

7 Accuracy

Not applicable.

8 Parallelism and Performance

F06QRF is not threaded in any implementation.

9 Further Comments

None.

10 Example

None.
