NAG Library Routine Document

F06QQF

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

F06QQF performs a QR factorization (as a sequence of plane rotations) of a real upper triangular matrix that has been augmented by a full row.

2 Specification

```
SUBROUTINE F06QQF (N, ALPHA, X, INCX, A, LDA, C, S)
INTEGER            N, INCX, LDA
REAL (KIND=nag_wp) ALPHA, X(*), A(LDA,*), C(N), S(N)
```

3 Description

F06QQF performs the factorization

$$\begin{pmatrix} U \\ \alpha x^{\mathrm{T}} \end{pmatrix} = Q \begin{pmatrix} R \\ 0 \end{pmatrix}$$

where U and R are n by n real upper triangular matrices, x is an n-element real vector, α is a real scalar, and Q is a real orthogonal matrix.

Q is formed as a sequence of plane rotations

$$Q^{\mathrm{T}} = Q_n \cdots Q_2 Q_1$$

where Q_k is a rotation in the $(k, n+1)$ plane, chosen to annihilate x_k.

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

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

4 References

None.

5 Arguments

1: N – INTEGER *Input*

On entry: n, the order of the matrices U and R.

Constraint: N ≥ 0.

2: ALPHA – REAL (KIND=nag_wp) *Input*

On entry: the scalar α.

3: X($*$) – REAL (KIND=nag_wp) array *Input/Output*

Note: the dimension of the array X must be at least $\max(1, 1 + (\mathrm{N} - 1) \times \mathrm{INCX})$.

On entry: the vector x. x_i must be stored in X$(1 + (i-1) \times$ INCX$)$, for $i = 1, 2, \ldots,$ N.

On exit: the referenced elements are overwritten by the tangents of the rotations Q_k, for $k = 1, 2, \ldots, n$.

4: INCX – INTEGER *Input*

On entry: the increment in the subscripts of X between successive elements of x.

Constraint: INCX > 0.

5: 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 n by n upper triangular matrix U.

On exit: the upper triangular matrix R.

6: LDA – INTEGER *Input*

On entry: the first dimension of the array A as declared in the (sub)program from which F06QQF is called.

Constraint: LDA $\geq \max(1, \text{N})$.

7: C(N) – REAL (KIND=nag_wp) array *Output*

On exit: the values c_k, the cosines of the rotations Q_k, for $k = 1, 2, \ldots, n$.

8: S(N) – REAL (KIND=nag_wp) array *Output*

On exit: the values s_k, the sines of the rotations Q_k, for $k = 1, 2, \ldots, n$.

6 Error Indicators and Warnings

None.

7 Accuracy

Not applicable.

8 Parallelism and Performance

F06QQF is not threaded in any implementation.

9 Further Comments

None.

10 Example

None.