

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

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

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

$$Q^T = Q_n \cdots Q_2 Q_1$$

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 Parameters

- 1: N – INTEGER *Input*
On entry: n , the order of the matrices U and R .
Constraint: $N \geq 0$.
- 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 $\max(1, 1 + (N - 1) \times \text{INCX})$.
On entry: the vector x . x_i must be stored in $X(1 + (i - 1) \times \text{INCX})$, for $i = 1, 2, \dots, N$.

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

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, N).

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

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

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

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

6 Error Indicators and Warnings

None.

7 Accuracy

Not applicable.

8 Further Comments

None.

9 Example

None.