

# NAG Toolbox for MATLAB

## f04ag

### 1 Purpose

f04ag calculates the approximate solution of a set of real symmetric positive-definite linear equations with multiple right-hand sides,  $AX = B$ , where  $A$  has been factorized by f03ae.

### 2 Syntax

```
[x] = f04ag(a, p, b, 'n', n, 'ir', ir)
```

### 3 Description

To solve a set of real linear equations  $AX = B$  where  $A$  is symmetric positive-definite, f04ag must be preceded by a call to f03ae which computes a Cholesky factorization of  $A$  as  $A = LL^T$ , where  $L$  is lower triangular. The columns  $x$  of the solution  $X$  are found by forward and backward substitution in  $Ly = b$  and  $L^T x = y$ , where  $b$  is a column of the right-hand sides.

### 4 References

Wilkinson J H and Reinsch C 1971 *Handbook for Automatic Computation II, Linear Algebra* Springer-Verlag

### 5 Parameters

#### 5.1 Compulsory Input Parameters

1: **a(lda,n)** – double array

**lda**, the first dimension of the array, must be at least **n**.

The upper triangle of the  $n$  by  $n$  positive-definite symmetric matrix  $A$ , and the subdiagonal elements of its Cholesky factor  $L$ , as returned by f03ae.

2: **p(n)** – double array

The reciprocals of the diagonal elements of  $L$ , as returned by f03ae.

3: **b(lb,ir)** – double array

**lb**, the first dimension of the array, must be at least **n**.

The  $n$  by  $r$  right-hand side matrix  $B$ . See also Section 8.

#### 5.2 Optional Input Parameters

1: **n** – int32 scalar

*Default:* The dimension of the arrays **a**, **p**. (An error is raised if these dimensions are not equal.)  
**n**, the order of the matrix  $A$ .

*Constraint:*  $n \geq 0$ .

2: **ir** – int32 scalar

*Default:* The dimension of the arrays **b**, **x**. (An error is raised if these dimensions are not equal.)  
**r**, the number of right-hand sides.

### 5.3 Input Parameters Omitted from the MATLAB Interface

lda, ldb, ldx

### 5.4 Output Parameters

1: **x(ldx,ir)** – double array

The  $n$  by  $r$  solution matrix  $X$ . See also Section 8.

## 6 Error Indicators and Warnings

ifail = 1

On entry, **n** < 1,  
or **ir** < 1,  
or **lda** < **n**,  
or **ldx** < **n**,  
or **ldb** < **n**.

## 7 Accuracy

The accuracy of the computed solutions depends on the conditioning of the original matrix. For a detailed error analysis see page 39 of Wilkinson and Reinsch 1971.

## 8 Further Comments

The time taken is approximately proportional to  $n^2r$ .

## 9 Example

```
a = [5, 7, 6, 5;
      3.130495168499706, 10, 8, 7;
      2.683281572999748, -0.89442719099999177, 10, 9;
      2.23606797749979, -6.332401570587782e-16, 2.121320343559644, 10];
p = [0.4472135954999579;
      2.236067977499794;
      0.7071067811865481;
      1.414213562373102];
b = [23;
      32;
      33;
      31];
[x] = f04ag(a, p, b)

x =
    1.0000
    1.0000
    1.0000
    1.0000
```