Solve a real general system of linear equations with iterative refinement.

Usage

CALL LSARG (N, A, LDA, B, IPATH, X)

Arguments

N — Number of equations. (Input)

A — N by N matrix containing the coefficients of the linear system. (Input)

LDA — Leading dimension of A exactly as specified in the dimension statement of the calling program. (Input)

B — Vector of length N containing the right-hand side of the linear system. (Input)

IPATH — Path indicator. (Input)
IPATH = 1 means the system $AX = B$ is solved.
IPATH = 2 means the system $A^TX = B$ is solved.

X — Vector of length N containing the solution to the linear system. (Output)

Comments

1. Automatic workspace usage is

LSARG	N2 + 2N units, or
DLSARG	2N2 + 3N units.

Workspace may be explicitly provided, if desired, by use of L2ARG/DL2ARG. The reference is

```
CALL L2ARG (N, A, LDA, B, IPATH, X, FAC, IPVT, WK)
```

The additional arguments are as follows:

FAC — Work vector of length N2 containing the *LU* factorization of A on output.

IPVT — Integer work vector of length N containing the pivoting information for the *LU* factorization of A on output.

WK — Work vector of length N.

2. Informational errors

Type	Code	
3	1	The input matrix is too ill-conditioned. The solution might not be accurate.
4	2	The input matrix is singular.

Algorithm

Routine LSARG solves a system of linear algebraic equations having a real general coefficient matrix. It first uses the routine LFCRG to compute an *LU* factorization of the coefficient matrix and to estimate the condition number of the matrix. The solution of the linear system is then found using the iterative refinement routine LFIRG.

LSARG fails if *U*, the upper triangular part of the factorization, has a zero diagonal element or if the iterative refinement algorithm fails to converge. These errors occur only if *A* is singular or very close to a singular matrix.

If the estimated condition number is greater than $1/\varepsilon$ (where ε is machine precision), a warning error is issued. This indicates that very small changes in *A* can cause very large changes in the solution *x*. Iterative refinement can sometimes find the solution to such a

system. LSARG solves the problem that is represented in the computer; however, this problem may differ from the problem whose solution is desired.

Example

A system of three linear equations is solved. The coefficient matrix has real general form and the right-hand-side vector *b* has three elements.

```
C                                  Declare variables
      PARAMETER  (IPATH=1, LDA=3, N=3)
      REAL       A(LDA,LDA), B(N), X(N)
C
C                                  Set values for A and B
C
C                                  A = ( 33.0  16.0  72.0)
C                                      (-24.0 -10.0 -57.0)
C                                      ( 18.0 -11.0   7.0)
C
C                                  B = (129.0 -96.0   8.5)
C
      DATA A/33.0, -24.0, 18.0, 16.0, -10.0, -11.0, 72.0, -57.0,
7.0/
      DATA B/129.0, -96.0, 8.5/
C
      CALL LSARG (N, A, LDA, B, IPATH, X)
C                                  Print results
      CALL WRRRN ('X', 1, N, X, 1, 0)
      END
```

Output

```
           X
    1       2       3
1.000   1.500   1.000
```