1 SUMMARY

To **solve a system** of *n* **linear algebraic equations** in *n* unknowns

$$\sum_{j=1}^{n} a_{ij} x_j = b_i \qquad i=1,2,...,n$$

when the coefficient matrix $\mathbf{A}=\{a_{ij}\}_{n\times n}$ is **upper Hessenberg** ($a_{ij}=0$ when $i>j+1$), or upper Hessenberg squared ($a_{ij}=0$ when $i>j+2$).

The subroutine may be re-entered to provide additional right-hand sides for the economic solution of systems with the same coefficient matrix **A**.

Gaussian elimination with partial pivoting is used accumulating inner products double length.

ATTRIBUTES — **Version:** 1.0.0. **Types:** `MA12A; MA12AD.` **Calls:** `FD05`. **Original date:** July 1966. **Origin:** M.Reynolds*, Harwell.

2 HOW TO USE THE PACKAGE

2.1 The argument list and calling sequence

The single precision version:

```
CALL MA12A(A,N,IA,NOPT,MTYPE,B,IPR)
```

The double precision version:

```
CALL MA12AD(A,N,IA,NOPT,MTYPE,B,IPR)
```

`A` is a two-dimensional `REAL` (`DOUBLE PRECISION` in the D version) array of dimensions at least *n* by *n* (first dimension specified in `IA`), set by the user to the elements a_{ij} i=1,2,...,n, j=1,2,...,n of the matrix **A**. The lower triangular zero-part of the matrix need not be set. The array is overwritten by the subroutine.

`N` is an `INTEGER` variable which must be set by the user to *n* the number of equations. **Restriction:** $n\geq 2$ for Hessenberg case, $n\geq 3$ for Hessenberg squared case.

`IA` is an `INTEGER` variable which must be set by the user to the first dimension of the array `A`.

`NOPT` is an `INTEGER` variable which must be set by the user to select the re-entry option. If `NOPT=1` the equation matrix **A** is factorized and the equations solved. If `NOPT=2` the factorization is assumed to have been done on a previous entry and the array `A` and the second row of the array `B` remain unchanged and the first row of the array `B` contains a new right-hand side.

`MTYPE` is an `INTEGER` variable which must be set by the user to indicate the type of matrix structure given in `A`. If `MTYPE=1` the matrix is upper Hessenberg and if `MTYPE=2` it is upper Hessenberg squared.

`B` is a two-dimensional `REAL` (`DOUBLE PRECISION` in the D version) array of dimension at least 2 by *n* consisting of two rows. `B(1,I) I=1,N` is set by the user to the right-hand side of the equations b_i i=1,2,...,n and will contain on return the solution x_j j=1,2,...,n. `B(2,I) I=1,N` is used by the subroutine to hold the row interchanges and if the re-entry option is used these must not be altered.

`IPR` is an `INTEGER` variable which is used to turn off diagnostic printing. Normally it should be set to a nonzero value, then in the event of a near singular matrix being detected a diagnostic is printed. Set it to zero to suppress diagnostic printing.

3 GENERAL INFORMATION

Use of Common: none.

Workspace: the array A and the second row of B are used by the subroutine.

Other subroutines: calls FD05.

Input/Output: diagnostic message, see IPR.

Restrictions:

$n \geq 2$ (Hessenberg form).

$n \geq 3$ (Hessenberg squared form).