

Matrices

Standard notation: $M_{i,j}$ is the value in row i , column j of matrix M .

Number of elements: Mathcad numbers the rows and columns of matrices starting with zero. If $i := 0..imax$, then there are $imax+1$ rows in the array.

Origin: If $Origin:=1$ is written, then the counting starts at 1 rather than zero. This statement should be used carefully, if at all.

Typing in a matrix: To create a matrix type the variable name, then open the Matrix toolbar, select the matrix, then the number of rows and columns.

For example,

$$M := \begin{pmatrix} 1 & 2 \\ 3 & 4 \\ 4 & 6 \end{pmatrix} \quad \underline{N} := \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$$

then

$$M_{0,0} = 1 \quad M_{0,1} = 2 \quad \text{Note that the 1,1 element is NOT the upper left element.}$$

$$M_{1,0} = 3 \quad M_{1,1} = 4$$

To find the number of rows or columns: $rows(M) = 3 \quad cols(M) = 2$

The transpose is $M^T = \begin{pmatrix} 1 & 3 & 4 \\ 2 & 4 & 6 \end{pmatrix}$ **The reverse:** $reverse(M) = \begin{pmatrix} 4 & 6 \\ 3 & 4 \\ 1 & 2 \end{pmatrix}$
(by rows)

Column selector $M^{(1)} = \begin{pmatrix} 2 \\ 4 \\ 6 \end{pmatrix}$ **To create a vector from a row:** $(M^T)^{(0)} = \begin{pmatrix} 1 \\ 2 \end{pmatrix}$

Determinant: $|N| = -2 \quad |M| =$ This command does not work for a matrix that is not square

Vectorized equations in which the operation is performed term by term (select the vectorize operator from the taskbar):

$$\overrightarrow{(N \cdot N)} = \begin{pmatrix} 1 & 4 \\ 9 & 16 \end{pmatrix} \quad \frac{\overrightarrow{N}}{N} = \begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix}$$

Multiplication by a scalar $5 \cdot N = \begin{pmatrix} 5 & 10 \\ 15 & 20 \end{pmatrix} \quad N_{1,1} \cdot N = \begin{pmatrix} 4 & 8 \\ 12 & 16 \end{pmatrix}$

Matrix inverse: (to solve a set of linear equations) If $N \cdot \begin{pmatrix} 7 \\ 9 \end{pmatrix} = \begin{pmatrix} 25 \\ 57 \end{pmatrix}$ then $N^{-1} \cdot \begin{pmatrix} 25 \\ 57 \end{pmatrix} = \begin{pmatrix} 7 \\ 9 \end{pmatrix}$

Making matrices larger or smaller

On the previous page we defined: $M = \begin{pmatrix} 1 & 2 \\ 3 & 4 \\ 4 & 6 \end{pmatrix}$ $N = \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$

Stack is a command that adds the rows of the second argument to the rows of the first argument.

$\text{stack}(M, N) = \begin{pmatrix} 1 & 2 \\ 3 & 4 \\ 4 & 6 \\ 1 & 2 \\ 3 & 4 \end{pmatrix}$ The arguments must have the same number of columns.

Stack with programs: Stack can be used to return more than one value from a program.

$\underline{\underline{A}} := \begin{array}{l} a \leftarrow 1 \\ b \leftarrow e \\ c \leftarrow \pi \\ \text{stack}(a, b, c) \end{array}$ $A = \begin{pmatrix} 1 \\ 2.718 \\ 3.142 \end{pmatrix}$

Augment is a command that places the columns of the second argument after the columns of the first argument.

$\text{augment}(N, M^T, N) = \begin{pmatrix} 1 & 2 & 1 & 3 & 4 & 1 & 2 \\ 3 & 4 & 2 & 4 & 6 & 3 & 4 \end{pmatrix}$ There can be more than 2 arguments.
The arguments must have the same number of rows.

Submatrix is used to select part of a matrix:

The five arguments are the matrix, the start and end rows, and the start and end columns.

$M = \begin{pmatrix} 1 & 2 \\ 3 & 4 \\ 4 & 6 \end{pmatrix}$ $\text{submatrix}(M, 1, 2, 0, 1) = \begin{pmatrix} 3 & 4 \\ 4 & 6 \end{pmatrix}$ We have selected rows 1 and 2 and columns 0 and 1.

$\text{submatrix}(M, 1, 2, 0, 0) = \begin{pmatrix} 3 \\ 4 \end{pmatrix}$ We have selected rows 1 and 2 and column 0.