

# Multiplication, addition and subtraction of matrices

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September 2024

Notes on basic arithmetical operations on matrices including addition, subtraction and multiplication of different sized matrices.

## 1 Multiplication

Two matrices can only be multiplied together if the number of the columns in the first is the same as the number of rows in the second. The result of two is a matrix that has the same number of rows as the first matrix, and same number of columns as the second.

### 1.1 Example 1

Find  $ab$  where  $a = \begin{pmatrix} 1 & 4 \\ 6 & 3 \end{pmatrix}$  and  $b = \begin{pmatrix} 2 \\ 5 \end{pmatrix}$

$$c = \begin{pmatrix} 1 & 4 \\ 6 & 3 \end{pmatrix} \cdot \begin{pmatrix} 2 \\ 5 \end{pmatrix} = \begin{pmatrix} 1 * 2 + 4 * 5 \\ 6 * 2 + 3 * 5 \end{pmatrix} = \begin{pmatrix} 22 \\ 27 \end{pmatrix}$$

The first row of  $a$  multiplies the first column of  $b$  to give:

$$(1 * 2) + (4 * 5) = 2 + 20 = 22$$

The second row of  $a$  then multiplies by the first column of  $b$  to give:

$$(6 * 2) + (3 * 5) = 12 + 15 = 27$$

## 1.2 Example 2

Find, if possible:  $\begin{pmatrix} 1 & 4 & 9 \\ 2 & 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} 1 & 9 \\ 8 & 7 \\ -7 & 3 \end{pmatrix}$

$$\begin{pmatrix} 1 \times 1 + 4 \times 8 + 9 \times -7 & 1 \times 9 + 4 \times 7 + 9 \times 3 \\ 2 \times 1 + 0 \times 8 + 1 \times -7 & 2 \times 9 + 0 \times 7 + 1 \times 3 \end{pmatrix}$$

The first row multiplies by both columns, and then the second row multiplies by both columns.

$$= \begin{pmatrix} -30 & 64 \\ -5 & 21 \end{pmatrix}$$