

Matrix Multiplication

To Multiply matrix A by matrix B :

- Multiply each Row in matrix A by each Column in matrix B
- Multiply corresponding entries and then add the resulting products

$$A = \begin{vmatrix} 1 & 2 \\ 3 & 4 \end{vmatrix} \qquad B = \begin{vmatrix} -1 & 1 & 2 \\ 3 & -2 & 3 \end{vmatrix}$$

$$2 \times \color{yellow}{\square}$$

$$\color{yellow}{\square} \times 3$$

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2 x ■

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■ x 3

$$A \cdot B = \begin{vmatrix} (1)(-1) + (2)(3) \\ \end{vmatrix} = \begin{vmatrix} 5 \\ \end{vmatrix}$$

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2×2 2×3

$$A \cdot B = \begin{vmatrix} (1)(-1) + (2)(3) & (1)(1) + (2)(-2) & (1)(2) + (2)(3) \\ & & \end{vmatrix} = \begin{vmatrix} 5 & -3 & 8 \\ & & \end{vmatrix}$$

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$$A \cdot B = \begin{vmatrix} (1)(-1) + (2)(3) & (1)(1) + (2)(-2) & (1)(2) + (2)(3) \\ (3)(-1) + (4)(3) \end{vmatrix} = \begin{vmatrix} 5 & -3 & 8 \\ 9 \end{vmatrix}$$

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- Multiply each Row in matrix A by each Column in matrix B
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$$A = \begin{vmatrix} 1 & 2 \\ 3 & 4 \end{vmatrix}$$

$2 \times \blacksquare$

$$B = \begin{vmatrix} -1 & 1 & 2 \\ 3 & -2 & 3 \end{vmatrix}$$

$\blacksquare \times 3$

$$A \cdot B = \begin{vmatrix} (1)(-1) + (2)(3) & (1)(1) + (2)(-2) & (1)(2) + (2)(3) \\ (3)(-1) + (4)(3) & (3)(1) + (4)(-2) & (3)(2) + (4)(3) \end{vmatrix} = \begin{vmatrix} 5 & -3 & 8 \\ 9 & -5 & 18 \end{vmatrix}$$

2×3

We had:

$$\begin{array}{c} \xrightarrow{\hspace{1cm}} \\ \xrightarrow{\hspace{1cm}} \end{array} A = \begin{vmatrix} 1 & 2 \\ 3 & 4 \end{vmatrix}, \quad \begin{array}{c} \text{3 columns} \\ \downarrow \quad \downarrow \quad \downarrow \\ B = \begin{vmatrix} -1 & 1 & 2 \\ 3 & -2 & 3 \end{vmatrix} \end{array} \quad \text{and} \quad \begin{array}{c} \text{Result:} \\ \text{2 rows by 3 columns} \\ A.B = \begin{vmatrix} 5 & -3 & 8 \\ 9 & -5 & 18 \end{vmatrix} \end{array}$$

$2 \times \blacksquare$ $\blacksquare \times 3$ 2×3

How about $B.A$:

$$B = \begin{vmatrix} -1 & 1 & 2 \\ 3 & -2 & 3 \end{vmatrix}, \quad A = \begin{vmatrix} 1 & 2 \\ 3 & 4 \end{vmatrix}$$

$2 \times \blacksquare$ $\blacksquare \times 2$

$B.A = \text{N.P.}$

For the following matrices, using the multiplication of Row by Column :

$$A = \begin{vmatrix} 1 & 1 & 5 \\ 2 & 1 & -1 \end{vmatrix}, \quad B = \begin{vmatrix} 2 \\ 1 \\ 0 \end{vmatrix}, \quad C = \begin{vmatrix} 2 & -1 \\ 1 & 2 \\ 0 & 4 \end{vmatrix}$$

- Which of the following multiplication is possible ?
- If it is possible, find the dimension of the resulting matrix

A.B

A.C

B.C

C.A

For the following matrices, using the multiplication of Row by Column :

$$A = \begin{vmatrix} 1 & 1 & 5 \\ 2 & 1 & -1 \end{vmatrix}, \quad B = \begin{vmatrix} 2 \\ 1 \\ 0 \end{vmatrix}, \quad C = \begin{vmatrix} 2 & -1 \\ 1 & 2 \\ 0 & 4 \end{vmatrix}$$

- Which of the following multiplication is possible ?
- If it is possible, find the dimension of the resulting matrix

$$A \cdot B = \begin{vmatrix} 1 & 1 & 5 \\ 2 & 1 & -1 \end{vmatrix} \cdot \begin{vmatrix} 2 \\ 1 \\ 0 \end{vmatrix} = \begin{bmatrix} 3 \\ 5 \end{bmatrix}$$

$2 \times 3 \quad 3 \times 1 \quad 2 \times 1$

For the following matrices, using the multiplication of Row by Column :

$$A = \begin{vmatrix} 1 & 1 & 5 \\ 2 & 1 & -1 \end{vmatrix}, \quad B = \begin{vmatrix} 2 \\ 1 \\ 0 \end{vmatrix}, \quad C = \begin{vmatrix} 2 & -1 \\ 1 & 2 \\ 0 & 4 \end{vmatrix}$$

- a) Which of the following multiplication is possible ?
b) If it is possible, find the dimension of the resulting matrix

$$A.C = \begin{vmatrix} 1 & 1 & 5 \\ 2 & 1 & -1 \end{vmatrix} \cdot \begin{vmatrix} 2 & -1 \\ 1 & 2 \\ 0 & 4 \end{vmatrix} = \begin{bmatrix} 3 & 21 \\ 5 & -4 \end{bmatrix}$$

2×3 3×2 2×2

For the following matrices, using the multiplication of Row by Column :

$$A = \begin{vmatrix} 1 & 1 & 5 \\ 2 & 1 & -1 \end{vmatrix}, \quad B = \begin{vmatrix} 2 \\ 1 \\ 0 \end{vmatrix}, \quad C = \begin{vmatrix} 2 & -1 \\ 1 & 2 \\ 0 & 4 \end{vmatrix}$$

- Which of the following multiplication is possible ?
- If it is possible, find the dimension of the resulting matrix

$$B.C = \begin{vmatrix} 2 \\ 1 \\ 0 \end{vmatrix} \cdot \begin{vmatrix} 2 & -1 \\ 1 & 2 \\ 0 & 4 \end{vmatrix}$$

N. P.

$$3 \times \text{ } \quad \text{ } \times 2$$

For the following matrices, using the multiplication of Row by Column :

$$A = \begin{vmatrix} 1 & 1 & 5 \\ 2 & 1 & -1 \end{vmatrix}, \quad B = \begin{vmatrix} 2 \\ 1 \\ 0 \end{vmatrix}, \quad C = \begin{vmatrix} 2 & -1 \\ 1 & 2 \\ 0 & 4 \end{vmatrix}$$

- Which of the following multiplication is possible ?
- If it is possible, find the dimension of the resulting matrix

$$C \cdot A = \begin{vmatrix} 2 & -1 \\ 1 & 2 \\ 0 & 4 \end{vmatrix} \begin{vmatrix} 1 & 1 & 5 \\ 2 & 1 & -1 \end{vmatrix} = \begin{bmatrix} 0 & 1 & 11 \\ 5 & 3 & 3 \\ 8 & 4 & -4 \end{bmatrix}$$

$\underline{3} \times \underline{2} \quad \underline{2} \times \underline{3}$
 3×3

For the following matrices, Find $A.B$ and $B.A$ if possible:

$$A = \begin{vmatrix} 1 & 1 & 5 \end{vmatrix}, \quad B = \begin{vmatrix} 2 \\ 1 \\ 0 \end{vmatrix}$$

$$A.B = \begin{vmatrix} 1 & 1 & 5 \end{vmatrix} \cdot \begin{vmatrix} 2 \\ 1 \\ 0 \end{vmatrix} = \begin{bmatrix} 3 \end{bmatrix}$$

1×3 3×1 1×1

$$B.A = \begin{vmatrix} 2 \\ 1 \\ 0 \end{vmatrix} \cdot \begin{vmatrix} 1 & 1 & 5 \end{vmatrix} = \begin{bmatrix} 2 & 2 & 10 \\ 1 & 1 & 5 \\ 0 & 0 & 0 \end{bmatrix}$$

3×3 3×3 3×3