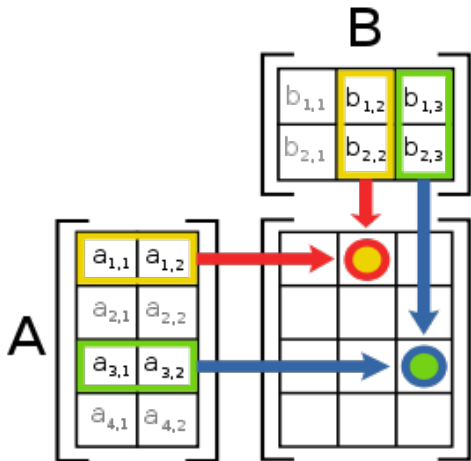


MULTIPLICATION OF MATRICES

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Multiplication of a Matrix by a Scalar



When a [matrix](#) is multiplied by a scalar then each element of that matrix is multiplied by the [scalar](#). In general, we can say, if $A = [a_{ij}]_{m \times n}$ is a matrix and 'k' is a scalar, then kA is another matrix which is obtained by multiplying each element of A by 'k'.

$$A = \begin{pmatrix} 2 & 3 & 4 \\ 0 & -7 & 1 \end{pmatrix}$$

For example: If

then, $5A$ is obtained by multiplying each element by 5

$$5A = \begin{pmatrix} 10 & 15 & 20 \\ 0 & -35 & 5 \end{pmatrix}$$

Properties of Scalar Multiplication

- i) If A and B are matrices and k is a scalar then $k(A + B) = kA + kB$
- ii) If A is a matrix and k and l are scalars then $(k + l)A = kA + lA$

Multiplication of Matrices

The product of two matrices A and B is defined if the number of [columns](#) of A is equal to the number of [rows](#) of B. Let $A = [a_{ij}]$ be $m \times n$ matrix and $B = [b_{jk}]$ be an $n \times p$ matrix. Then, the product of A and B is a matrix C of order $m \times p$.

$$A = \begin{pmatrix} 3 & -2 \\ 4 & 7 \end{pmatrix} \text{ and } B = \begin{pmatrix} 1 & -3 & 4 \\ 0 & 2 & 5 \end{pmatrix}$$

For example: Find AB, if

Solution: Matrix A has 2 columns and B has 2 rows, so number of columns of 1st matrix is same as number of rows of 2nd matrix, hence it is conformable for multiplication.

$$\begin{aligned}
 AB &= \begin{bmatrix} 3 \times 1 + (-2) \times 0 & 3 \times (-3) + (-2) \times 2 & 3 \times 4 + (-2) \times 5 \\ 4 \times 1 + 7 \times 0 & 4 \times (-3) + 7 \times 2 & 4 \times 4 + 7 \times 5 \end{bmatrix} \\
 &= \begin{bmatrix} 3 - 0 & -9 - 4 & 12 - 10 \\ 4 + 0 & -12 + 14 & 16 + 35 \end{bmatrix} \\
 &= \begin{bmatrix} 3 & -13 & 2 \\ 4 & 2 & 51 \end{bmatrix}
 \end{aligned}$$

Order of A = 2 x 2 and order of B = 2 x 3, so order of AB = 2 x 3

Properties of Multiplication of Matrices

i) **Associative** Law: For any three matrices A, B and C, we have
 $(AB)C = A(BC)$, whenever both sides of equality are defined.

ii) **Distributive** law: For three matrices A, B and C

a) $A(B + C) = AB + AC$

b) $(A + B)C = AC + BC$

iii) Existence of **multiplicative identity**: For every square matrix A, there exists an identity matrix of same order such that $IA = AI = A$

For example: Find $A^2 - 5A + 6I$, if $A = \begin{pmatrix} 2 & 0 & 1 \\ 2 & 1 & 3 \\ 1 & -1 & 0 \end{pmatrix}$

$$A^2 = \begin{pmatrix} 2 & 0 & 1 \\ 2 & 1 & 3 \\ 1 & -1 & 0 \end{pmatrix} \times \begin{pmatrix} 2 & 0 & 1 \\ 2 & 1 & 3 \\ 1 & -1 & 0 \end{pmatrix}$$

$$= \begin{pmatrix} 4 + 0 + 1 & 0 + 0 - 1 & 2 + 0 + 0 \\ 4 + 2 + 3 & 0 + 1 - 3 & 2 + 3 + 0 \\ 2 - 2 + 0 & 0 - 1 - 0 & 1 - 3 + 0 \end{pmatrix}$$

$$= \begin{pmatrix} 5 & -1 & 2 \\ 9 & -2 & 5 \\ 0 & -1 & -2 \end{pmatrix}$$

$$5A = \begin{pmatrix} 10 & 0 & 5 \\ 10 & 5 & 15 \\ 5 & -5 & 0 \end{pmatrix}$$

$$6I = \begin{pmatrix} 6 & 0 & 0 \\ 0 & 6 & 0 \\ 0 & 0 & 6 \end{pmatrix}$$

$$A^2 - 5A + 6I = \begin{pmatrix} 5 & -1 & 2 \\ 9 & -2 & 5 \\ 0 & -1 & -2 \end{pmatrix} - \begin{pmatrix} 10 & 0 & 5 \\ 10 & 5 & 15 \\ 5 & -5 & 0 \end{pmatrix} + \begin{pmatrix} 6 & 0 & 0 \\ 0 & 6 & 0 \\ 0 & 0 & 6 \end{pmatrix}$$

$$= \begin{pmatrix} 1 & -1 & -3 \\ -1 & -1 & -10 \\ -5 & 4 & 4 \end{pmatrix}$$

iv) Matrix multiplication is not commutative. If A and B are any two matrices then $AB \neq BA$

Now try it yourself! Should you still need any help, [click here](#) to schedule live online session with e Tutor!

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Reference Links:

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- http://www.mathwords.com/r/row_of_a_matrix.htm
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