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Matrix Algebra

A matrix is a collection of numbers ordered in rows and columns.

A matrix is a rectangular or square array of numbers or variables. We use uppercase bold letters to represent matrices.

Ex:- $A = \begin{bmatrix} 8 & 4 & 3 \\ 2 & 1 & 6 \end{bmatrix}$ — row

↓ col

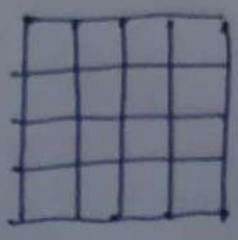
2×3

Matrices are called multi-dimensional. we have data being stored in different directions in a grid.

The dimensions of this matrix are "2×3" or "2 by 3", 2 rows and 3 columns

8, 4, 3, 2, 1, 6 → Each of these values Elements of the matrix. So our matrix is total of 6 Elements.

Matrices seem similar to tables and Spreadsheets

Ex:-  $\begin{bmatrix} 8 & 4 & 3 \\ 2 & 1 & 6 \end{bmatrix}$

However, the purpose of matrices not simply the store values but matrices are main characters in mathematical operations such as.
Addition, subtraction and multiplication 2 matrix.

A matrix can only contain numbers, symbols, or expressions.

$$A_{2\times 3} = \begin{bmatrix} 5 & 4 & 3 \\ 1 & -3 & 6 \end{bmatrix} \quad B = \begin{bmatrix} a & b & c \\ d & e & b \end{bmatrix}_{2\times 3}$$

$$C = \begin{bmatrix} x-a & 5+b \\ f-e & 2 \end{bmatrix}_{2\times 2}.$$

Matrices can be of any size $m \times n$

$$A = \Big[\quad\Big]\Big\}\ m \text{ rows}$$

n columns.

All numbers we know from algebra are refferd to as scalars in linear algebra.

$[8] \rightarrow$ is a scalar.

Note: Scalars have 0 dimensions

A single real number is called a Scalar. Thus,

[3]; [5]; [7] so on.

A Vector is a matrix with a single row or Column.

Ex:- $X = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$ $Z = \begin{bmatrix} 4 \\ 3 \\ 2 \end{bmatrix}_{3\times 1}$

Elements in a vector are often identified by a single subscript.

Types of Vectors

1. Row Vector 2. Column Vector.

$\begin{bmatrix} 6 & 3 & 2 & 1 \end{bmatrix}$ $\begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$

What is the length of the Vector?

Row vector length is = 4

Column Vector length is = 3

Scalar – [x] one of Zero dimension

Vector – $\begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix}_{m\times 1}$ one dimension

Matrix – $\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ b_{11} & b_{12} & b_{13} \end{bmatrix}_{m\times n}$ – 2D dimension.

Two matrices or two vectors are Equal if they are of the same size and if the elements in corresponding positions are Equal:

For Ex:- $\begin{bmatrix} 1 & 6 & 7 \\ 4 & 2 & 9 \end{bmatrix} = \begin{bmatrix} 1 & 6 & 7 \\ 4 & 2 & 9 \end{bmatrix}$

Matrix Equality

$\begin{bmatrix} 5 & 2 & -9 \\ 6 & 3 & 1 \end{bmatrix} \neq \begin{bmatrix} 4 & 2 & -9 \\ 6 & 3 & 1 \end{bmatrix}$ → value changed

Transpose Matrix

If we change the rows and columns of a matrix A, the resulting matrix is known as Transpose of A and is denoted by A'

Ex:- $A = \begin{bmatrix} 8 & 7 \\ 9 & 1 \\ 6 & -2 \end{bmatrix}$ $A' = \begin{bmatrix} 8 & 9 & 6 \\ 7 & 1 & -2 \end{bmatrix}$

3 by 2 turned into 2 by 3 matrix after initiative of transpose.

Ex:- Addition of Matrix

$$A = \begin{bmatrix} 7 & 1 & 4 \\ 8 & 2 & 3 \end{bmatrix} \quad B = \begin{bmatrix} 6 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix} \quad C = ?$$

$C = A + B \qquad C = c_{ij} = a_{ij} + b_{ij}$

$$C = \begin{bmatrix} 7+6 & 1+2 & 4+3 \\ 8+4 & 2+5 & 3+6 \end{bmatrix} = \begin{bmatrix} 13 & 3 & 7 \\ 12 & 7 & 9 \end{bmatrix}$$

Python Code

```
import numpy as np
```
→ Imoport necessary libraries.

```
m = np.array([[3,4,6],[7,8,9]])
m1 = np.array([[1,2,3],[4,5,6]])
```

Output :

```
m+m1
```

O/p :- array([[4,6,9],[11,13,15]])

Ex :- Subtraction of matrix

$$A = \begin{bmatrix} 5 & 3 \\ -2 & 4 \end{bmatrix} \quad B = \begin{bmatrix} 7 & -5 \\ 3 & 8 \end{bmatrix}$$

$$C = A - B = \begin{bmatrix} 5-7 & 3+5 \\ -2-3 & 4-8 \end{bmatrix} = \begin{bmatrix} -2 & 8 \\ -5 & -4 \end{bmatrix}$$

Code Snippet

```
m3 = np.array([[5,3],[-2,4]])
m4 = np.array([[7,-5],[3,8]])
```

O/p : array([[-2, 8], [-5, -4]])