MATRICES

What is a Matrix?

A matrix is a two-dimensional arrangement of numbers in rows and columns enclosed bya pair of square brackets ([ ]), in the form shown below.

Application of Matrices in Real Life:

Matrices are nothing but the rectangular arrangement of numbers, expressions, symbols which are arranged in columns and rows.
The numbers present in the matrix are called as entities or entries.
A matrix is said to be having 'm' number of rows and 'n' number of columns.
Matrices find many applications in scientific fields and apply to practical real life problems as well, thus making an indispensable concept for solving many practical problems.

Some of the main applications of matrices are briefed below:

- In physics related applications, matrices are applied in the study of electrical circuits, quantum mechanics and optics.

In the calculation of battery power outputs, resistor conversion of electrical energy into another useful energy, these matrices play a major role in calculations.
Especially in solving the problems using Kirchoff's laws of voltage and current, the matrices are essential.

- In computer based applications, matrices play a vital role in the projection of three dimensional image into a two dimensional screen, creating the realistic seeming motions.

Stochastic matrices and Eigen vector solvers are used in the page rank algorithms which are used in the ranking of web pages in Google search.
The matrix calculus is used in the generalization of analytical notions like exponentials and derivatives to their higher dimensions.
One of the most important usages of matrices in computer side applications are encryption of message codes.
Matrices and their inverse matrices are used for a programmer for coding or encrypting a message.
A message is made as a sequence of numbers in a binary format for communication and it follows code theory for solving.
Hence with the help of matrices, those equations are solved.
With these encryptions only, internet functions are working and even banks could work with transmission of sensitive and private data's.

- In geology, matrices are used for taking seismic surveys.

They are used for plotting graphs, statistics and also to do scientific studies in almost different fields.

- Matrices are used in representing the real world data's like the traits of people's population, habits, etc.

They are best representation methods for plotting the common survey things.

- Matrices are used in calculating the gross domestic products in economics which eventually helps in calculating the goods production efficiently.
- Matrices are used in many organizations such as for scientists for recording the data for their experiments.

- In robotics and automation, matrices are the base elements for the robot movements.

The movements of the robots are programmed with the calculation of matrices' rows and columns. The inputs for controlling robots are given based on the calculations from matrices.

History & Uses Of Matrices:

The history of matrices goes back to ancient times! But the term "matrix" was not applied to the concept until 1850.

"Matrix" is the Latin word for womb, and it retains that sense in English. It can also mean more generally any place in which something is formed or produced.

The orgins of mathematical matrices lie with the study of systems of simultaneous linear equations. An important Chinese text from between 300 BC and AD 200, *Nine Chapters of the Mathematical Art*(*Chiu Chang Suan Shu*), gives the first known example of the use of matrix methods to solve simultaneous equations.

Since their first appearance in ancient China, matrices have remained important mathematical tools. Today, they are used not simply for solving systems of simultaneous linear equations, but also for describing the quantum mechanics of atomic structure, designing computer game graphics, analyzing relationships, and even plotting complicateddance steps!

Method To Solve The Matrices:

A Matrix is an array of numbers:

$$\begin{bmatrix} 6 & 4 & 24 \\ 1 & -9 & 8 \end{bmatrix}$$

There are many things you can do with them ...

Adding

To add two matrices, just add the numbers in the matching positions:

3+4=7

$$\begin{bmatrix} 3 & 8 \\ 4 & 6 \end{bmatrix} + \begin{bmatrix} 4 & 0 \\ 1 & -9 \end{bmatrix} = \begin{bmatrix} 7 & 8 \\ 5 & -3 \end{bmatrix}$$

These are the calculations:

3+4=7	8+0=8
4+1=5	6-9=-3

The two matrices must be the same size, i.e. the rows must match in size, and the columns must match in size.

Example: a matrix with **3 rows** and **5 columns** can be added to another matrix of **3 rows** and **5 columns**.
But it could not be added to a matrix with **3 rows** and **4 columns** (the columns don't match in size)

Negative

The negative of a matrix is also simple:

$$-(2)=-2$$

$$-\begin{bmatrix} 2 & -4 \\ 7 & 10 \end{bmatrix} = \begin{bmatrix} -2 & 4 \\ -7 & -10 \end{bmatrix}$$

These are the calculations:

-(2)=-2	-(-4)=+4
-(7)=-7	-(10)=-10

Subtracting

To subtract two matrices, just subtract the numbers in the matching positions:

$$3-4=-1$$

$$\begin{bmatrix} 3 & 8 \\ 4 & 6 \end{bmatrix} - \begin{bmatrix} 4 & 0 \\ 1 & -9 \end{bmatrix} = \begin{bmatrix} -1 & 8 \\ 3 & 15 \end{bmatrix}$$

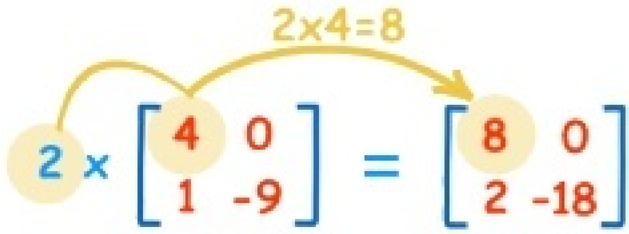
These are the calculations:

3-4=-1	8-0=8
4-1=3	6-(-9)=15

*Note: subtracting is actually defined as the **addition** of a negative matrix: A + (-B)*

Multiply by a Constant

You can multiply a matrix by some value:



These are the calculations:

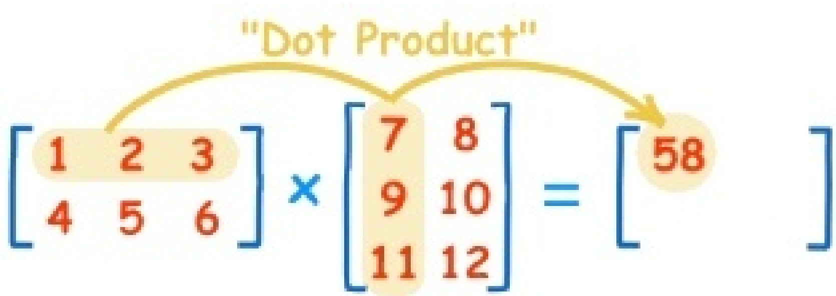
2×4=8	2×0=0
2×1=2	2×-9=-18

We call the constant a **scalar**, so officially this is called "scalar multiplication".

Multiplying a Matrix by Another Matrix

But to multiply a matrix **by another matrix** you need to do the "dot product" of rows and columns ... what does that mean? Let me show you with an example:

To work out the answer for the **1st row** and **1st column**:



The "Dot Product" is where you **multiply matching members**, then sum up:

$$(1, 2, 3) \bullet (7, 9, 11) = 1\times7 + 2\times9 + 3\times11 = 58$$

We match the 1st members (1 and 7), multiply them, likewise for the 2nd members (2 and 9) and the 3rd members (3 and 11), and finally sum them up.

Dividing

And what about division? Well you **don't** actually divide matrices, you do it this way:

$$A/B = A \times (1/B) = A \times B^{-1}$$

where $\mathbf{B}^{-1}$ means the "inverse" of B.

Transposing

To "transpose" a matrix, just swap the rows and columns. We put a "T" in the top right-hand corner to mean transpose:

$$\begin{bmatrix} 6 & 4 & 24 \\ 1 & -9 & 8 \end{bmatrix}^{T} = \begin{bmatrix} 6 & 1 \\ 4 & -9 \\ 24 & 8 \end{bmatrix}$$

Notation

A matrix is usually shown by a **capital letter** (such as A, or B)

Each entry (or "element") is shown by a **lower case letter** with a "subscript" of **row,column**:

$$A = \begin{bmatrix} a_{1,1} & a_{1,2} & a_{1,3} \\ a_{2,1} & a_{2,2} & a_{2,3} \end{bmatrix}$$

Order of Multiplication

In arithmetic we are used to:

$$3 \times 5 = 5 \times 3$$

(The Commutative Law of Multiplication)

But this is **not** generally true for matrices (matrix multiplication is **not commutative**):

$$AB \neq BA$$

When you change the order of multiplication, the answer is (usually) **different**.

Identity Matrix

The "Identity Matrix" is the matrix equivalent of the number "1":

$$I = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

It is a **special matrix**, because when you multiply by it, the original is unchanged:

$$A \times I = A$$

$$I \times A = A$$