Matrix

Part 1:
Syllabus:

Matrix - Basics

1. Scalars; Vectors; Matrix
2. Shape of a Matrix
3. Different Types of Matrix
4. Transpose of a Matrix
5. Role of Matrix in Machine Learning

$$\begin{bmatrix} 1 & 4 & 5 \\ 2 & 7 & 3 \\ 8 & -3 & 1 \end{bmatrix}$$

Shape of a Matrix

$$\begin{bmatrix} 2 & 5 \\ 4 & 8 \end{bmatrix}$$

2 x 2 Matrix

$$\begin{bmatrix} 8 & 6 & 1 \\ 2 & 9 & 2 \\ 3 & 4 & 3 \end{bmatrix}$$

3 x 3 Matrix

$$\begin{bmatrix} 2 & 3 \\ 6 & 4 \\ 7 & 8 \end{bmatrix}$$

3 x 2 Matrix

General Matrix Notation :

$$\begin{bmatrix} a_{1,1} & a_{1,2} & a_{1,3} & \cdots \\ a_{2,1} & a_{2,2} & a_{2,3} & \cdots \\ a_{3,1} & a_{3,2} & a_{3,3} & \cdots \\ \vdots & \vdots & \vdots & \ddots \end{bmatrix}$$

m x n Matrix

$a_{ij} \rightarrow$ Matrix element

$i \rightarrow$ Row number

$j \rightarrow$ Column number

Different Types of Matrices

Null Matrix or Zero Matrix :

$$\begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

2 x 2

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

3 x 3

$$\begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

4 x 4

Identity Matrix :

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

2 x 2

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

3 x 3

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

4 x 4

Transpose of a Matrix

Transpose of a matrix is formed by turning all the rows of a given matrix into columns and vice-versa

$$A = \begin{bmatrix} 2 & 5 \\ 4 & 8 \end{bmatrix} \qquad A^T = \begin{bmatrix} 2 & 4 \\ 5 & 8 \end{bmatrix}$$

$$B = \begin{bmatrix} 8 & 6 & 1 \\ 2 & 9 & 2 \\ 3 & 4 & 3 \end{bmatrix} \qquad B^T = \begin{bmatrix} 8 & 2 & 3 \\ 6 & 9 & 4 \\ 1 & 2 & 3 \end{bmatrix}$$

Matrix in Machine Learning

House Price Dataset

crim	zn	indus	chas	nox	rm	age	dis	rad	tax	ptratio	b	lstat	price
0.00632	18	2.31	0	0.538	6.575	65.2	4.09	1	296	15.3	396.9	4.98	24
0.02731	0	7.07	0	0.469	6.421	78.9	4.9671	2	242	17.8	396.9	9.14	21.6
0.02729	0	7.07	0	0.469	7.185	61.1	4.9671	2	242	17.8	392.83	4.03	34.7
0.03237	0	2.18	0	0.458	6.998	45.8	6.0622	3	222	18.7	394.63	2.94	33.4

4 x 14 Matrix

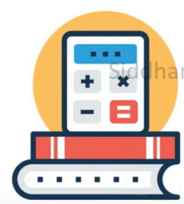
all the elements are represented as an matrix. Therefore, all the operations uses matrix. Thus, matrix is very important for machine learning.

Part 2:

syllabus:

1. Matrix Addition
2. Matrix Subtraction
3. Multiplying a Matrix by a Scalar
4. Multiplying 2 Matrices

$$\begin{bmatrix} 1 & 4 & 5 \\ 2 & 7 & 3 \\ 8 & -3 & 1 \end{bmatrix}$$



Scalars; Vectors; Matrix

Scalar

24

Vector

$\begin{bmatrix} 2 & -8 & 7 \end{bmatrix}$

row

or column $\begin{bmatrix} -6 \\ -4 \\ 27 \end{bmatrix}$

Matrix

$$\begin{bmatrix} 1 & 4 & 5 \\ 2 & 7 & 3 \\ 8 & -3 & 1 \end{bmatrix}$$

Matrix Addition

Rule : Two Matrices can be added only if the have the same shape, that is, both the matrix should have the same number of rows and columns

$$\underset{2 \times 2}{\begin{bmatrix} 2 & 3 \\ 10 & 5 \end{bmatrix}} + \underset{2 \times 2}{\begin{bmatrix} 10 & 5 \\ 20 & 4 \end{bmatrix}} = \underset{2 \times 2}{\begin{bmatrix} 12 & 8 \\ 30 & 9 \end{bmatrix}}$$

$$\underset{3 \times 2}{\begin{bmatrix} 2 & 1 \\ 4 & 2 \\ 6 & 3 \end{bmatrix}} + \underset{3 \times 2}{\begin{bmatrix} 5 & 2 \\ 3 & 6 \\ 2 & 5 \end{bmatrix}} = \begin{bmatrix} 7 & 3 \\ 7 & 8 \\ 8 & 8 \end{bmatrix}$$

Matrix Subtraction

Rule : Two Matrices can be subtracted only if they have the same shape, that is, both the matrix should have the same number of rows and columns

$$\begin{bmatrix} 2 & 3 \\ 10 & 5 \end{bmatrix} - \begin{bmatrix} 10 & 5 \\ 20 & 4 \end{bmatrix} = \begin{bmatrix} -8 & -2 \\ -10 & 1 \end{bmatrix}$$

2 x 2 2 x 2 2 x 2

$$\begin{bmatrix} 2 & 1 \\ 4 & 2 \\ 6 & 3 \end{bmatrix} - \begin{bmatrix} 5 & 2 \\ 3 & 6 \\ 2 & 5 \end{bmatrix} = \begin{bmatrix} -3 & -1 \\ 1 & -4 \\ 4 & -2 \end{bmatrix}$$

3 x 2 3 x 2 3 x 2

Multiplying a Matrix by a Scalar

$$5 \quad \times \underset{3 \times 1}{\begin{bmatrix} 2 \\ 4 \\ 6 \end{bmatrix}} = \begin{bmatrix} 5 \times 2 \\ 5 \times 4 \\ 5 \times 6 \end{bmatrix} = \underset{3 \times 1}{\begin{bmatrix} 10 \\ 20 \\ 30 \end{bmatrix}}$$

$$5 \quad \times \underset{3 \times 2}{\begin{bmatrix} 2 & 1 \\ 4 & 2 \\ 6 & 3 \end{bmatrix}} = \underset{3 \times 2}{\begin{bmatrix} 10 & 5 \\ 20 & 10 \\ 30 & 15 \end{bmatrix}}$$

Note : Vectors are a type of Matrix with either one row or one column

vectors are also a type of matrix with one row or one column.

Multiplying 2 Matrices

Rule : The number of columns in the First matrix should be equal to the number of rows in the Second Matrix

The resultant matrix will have the same number of rows as the first matrix & the same number of columns as the Second Matrix

$$\begin{bmatrix} 2 & 3 \\ 10 & 5 \end{bmatrix} \times \begin{bmatrix} 10 & 5 \\ 20 & 4 \end{bmatrix}$$

2 x 2 2 x 2

Can be multiplied.
Resultant matrix will have the shape 2 x 2

$$\begin{bmatrix} 2 & 1 \\ 4 & 2 \\ 6 & 3 \end{bmatrix} \times \begin{bmatrix} 5 & 2 \\ 3 & 6 \\ 2 & 5 \end{bmatrix}$$

3 x 2 3 x 2

Cannot be multiplied.

Multiplying 2 Matrices

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix}\begin{pmatrix} e & f \\ g & h \end{pmatrix} = \begin{pmatrix} ae + bg & af + bh \\ ce + dg & cf + dh \end{pmatrix}$$

$$\begin{bmatrix} 2 & 4 \\ 3 & 6 \end{bmatrix} \times \begin{bmatrix} 5 & 6 \\ 3 & 4 \end{bmatrix} = \begin{bmatrix} 2x5 + 4x3 & 2x6 + 4x4 \\ 3x5 + 6x3 & 3x6 + 6x4 \end{bmatrix} = \begin{bmatrix} 22 & 28 \\ 33 & 42 \end{bmatrix}$$

2 x 2 2 x 2 2 x 2