Matrices

A matrix is a rectangular array of numbers, symbols or expressions arranged in rows and columns

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & & & \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{bmatrix}_{m \times n} \Rightarrow$$ has a_{ij} where i denotes the row and j denotes the columns

Example of Matrices in Data Science

① Data Representation

Dataset

	Math Score	Physic Score	Biology Score
→	55	65	75
→	65	60	55
→	70	45	80

	f1	f2	f3
→	55	65	75
→	65	60	55
→	70	45	80

3x3

② Images in Computer Vision

0 (black) ⟷ 255 (white)

3x3 grayscale Image

Image =

0	128	255
255	128	0
128	255	128

⇒

0	128	255
255	128	0
128	255	128

3x3

③ Confusion Matrix : Accuracy of the Model

f1 →
f2 → Model → o/p → $\hat{y}$ ⇒ predicted output.

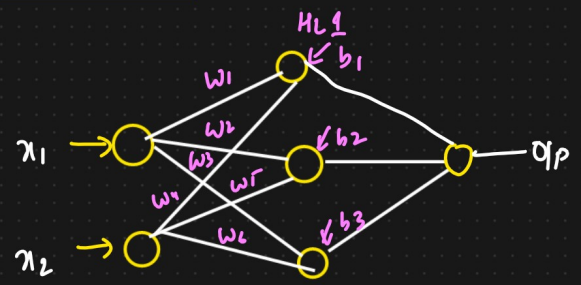
→ y ⇒ actual o/p

Confusion Matrix = $\begin{bmatrix} 50 & 10 \\ 5 & 35 \end{bmatrix}_{2\times2}$ ⇒

50 → True positive
10 → false negatives
5 → false positive
35 → True negative

$\frac{TP + TN}{TP + FN + FP + TN}$ = Accuracy.

④ Neural NW : Matrix Operation [linear Regression]



Forward propogation

$Z = W^T x + b$

$W = \begin{bmatrix} w_1 & w_2 & w_3 \\ w_4 & w_5 & w_6 \end{bmatrix}$

$x = [x_1, x_2]$

$[b_1, b_2, b_3]$

Matrix Multiplication

x_1 ↓ No. of study hours	x_2 ↓ IQ	⇑ o/p feature ↓ Score dependent feature
4	100	90
5	90	85
–	–	–

Regression

$y = mx + c$

$y = m_1x_1 + m_2x_2 + c$

m_1 → slope, m_2 → slope or coefficient

⇒ $m^T x + c$

$\{ m = [m_1, m_2] \quad x = [x_1, x_2] \}$

⑤ NLP :

Dataset

Review	Positive / Negative
→ The food is bad	0
→ The food is Good	1

$\begin{bmatrix} [0.1 & 0.2 & 0.3] \\ [0.4 & 0.5 & 0.6] \end{bmatrix} \begin{bmatrix} 0 \\ 1 \end{bmatrix}$

Matrics Operations

⇒ To manipulate and analyze multidimension data efficiently.

1) Matrix Addition And Substraction
2) Scalar Matrix Multiplication.
3) Matrix Multiplication

1) Matrix Addition And Substraction

Add or Substract corresponding elements of 2 matrices of the same dimension

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$$ ⇒ STORE A

3X3

$$B = \begin{bmatrix} 4 & 5 & 6 \\ 7 & 8 & 9 \\ 1 & 2 & 3 \end{bmatrix}$$ ⇒ STORE B

3X3

DATASET

	Prod A	Prod B	Prod C
Day 1	1	2	3
Day 2	4	5	6
Day 3	7	8	9

$$A+B = \begin{bmatrix} 1+4 & 2+5 & 3+6 \\ 4+7 & 5+8 & 6+9 \\ 7+1 & 8+2 & 9+3 \end{bmatrix}$$

$$= \begin{bmatrix} 5 & 7 & 9 \\ 11 & 13 & 15 \\ 8 & 10 & 12 \end{bmatrix}$$

② Scalar Multiplication

Scalar Multiplication involves multiplying every element of a matrix by a scalar value.

$$B = cA$$

Eg: Suppose we have a matrix representing product prices in dollars and we want to adjust these prices for inflation by a factor of 1.05.

Original :

$$P = \begin{bmatrix} 10 & 20 & 30 \\ 15 & 25 & 35 \\ 20 & 30 & 40 \end{bmatrix}$$

Scalar Multiplication

$$P_{adjusted} = 1.05 \cdot P = 1.05 \begin{bmatrix} 10 & 20 & 30 \\ 15 & 25 & 35 \\ 20 & 30 & 40 \end{bmatrix} = \begin{bmatrix} 10.5 & 21 & 31.5 \\ 15.75 & 26.25 & 36.75 \\ 21 & 31.5 & 42 \end{bmatrix}$$

Eg : DATASET : IT Firms

2024 $\Rightarrow$ 2025 $\Rightarrow$ Inflation 6%.

Base salary Sw Eng	Base Salary HR	Base Salary Accountant		1.06%
45K	30K	40K	×	
50K	35K	45K		
-	-	-		
-	-	-		

(3) Matrix Multiplication

Operation : It involves the dot product of rows of the first matrix with columns of the second matrix.

For 2 matrices A(mxn) and B(nxp), the result is a matrix C(mxp)

$$\begin{bmatrix} 1 & 2 & 3 \end{bmatrix} \begin{bmatrix} 2 \\ 3 \\ 4 \end{bmatrix} \Rightarrow 1\times2 + 2\times3 + 3\times4 = 2+6+12 = 20//.$$

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}_{2\times 3} \qquad B = \begin{bmatrix} 7 & 9 & 11 \\ 8 & 10 & 12 \end{bmatrix}_{2\times 3}$$

TRANSPUESTA

$m \times n$ $\qquad$ $n \times p$

$$B^T = \begin{bmatrix} 7 & 8 \\ 9 & 10 \\ 11 & 12 \end{bmatrix}_{3\times 2} \Rightarrow 2\times 2$$

$$C = A \cdot B = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix} \begin{bmatrix} 7 & 8 \\ 9 & 10 \\ 11 & 12 \end{bmatrix} = \begin{bmatrix} C_{11} & C_{12} \\ C_{21} & C_{22} \end{bmatrix}_{2\times 2} = \begin{bmatrix} 58 & 64 \\ 139 & 154 \end{bmatrix}$$

$C_{11} = (1\times 7) + (2\times 9) + (3\times 11) = 7 + 18 + 33 = 58$

$C_{12} = (1\times 8) + (2\times 10) + (3\times 12) = 8 + 20 + 36 = 64$

$C_{21} = (4\times 7) + (5\times 9) + (6\times 11) = 139$

$C_{22} = (4\times 8) + (5\times 10) + (6\times 12) = 154$