Welcome Back everyone

Agenda

1. ML understanding completion
2. Maths behind ML
3. Linear Regression
4. Logistic Regression.

Supervised ML

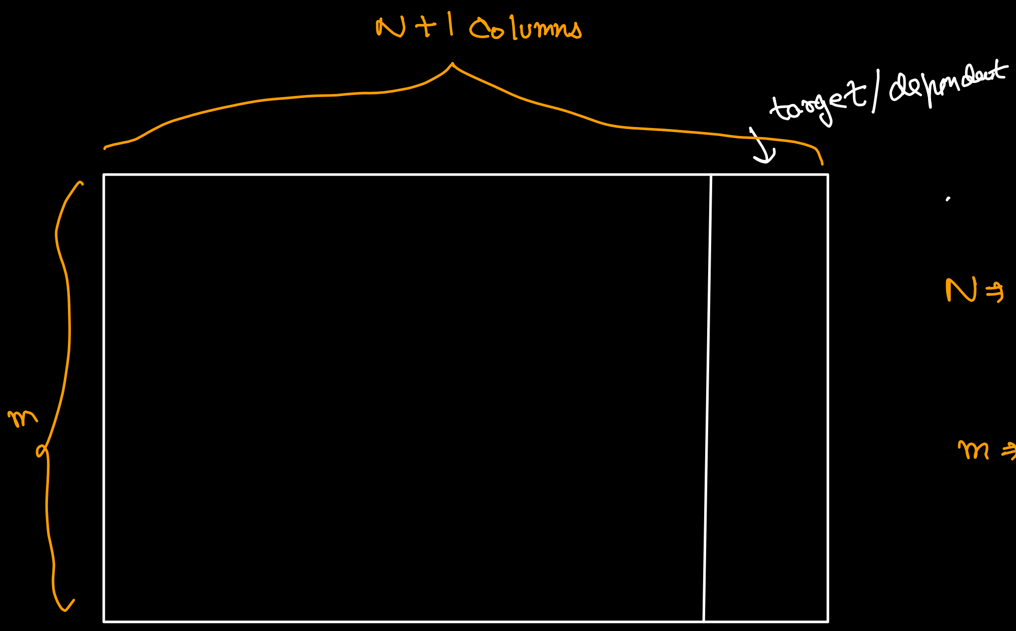
2/3 ML of course is gonna be supervised.

1] Classification

O/P is category

2] Regression

O/P is continous value



N ⇒ predictors/ independent features

m ⇒ rows

① Problem Understanding

Amazon ⇒ Recommendation system

Gmail ⇒ spam / ham

② Find Data

Amazon ⇒ history of orders

Gmail ⇒ Email data / Previous data

Can be collected from company / client data or outside

1 source

multiple source

March

July

October

December

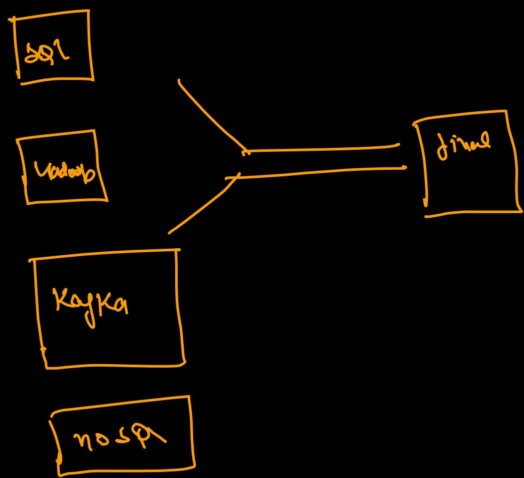
} Sales

3) Data Understanding

4) Data Loding & cleaning

if multiple sources,

make it clean



1) feature selection

2) Overfiting, missing, Outlier,

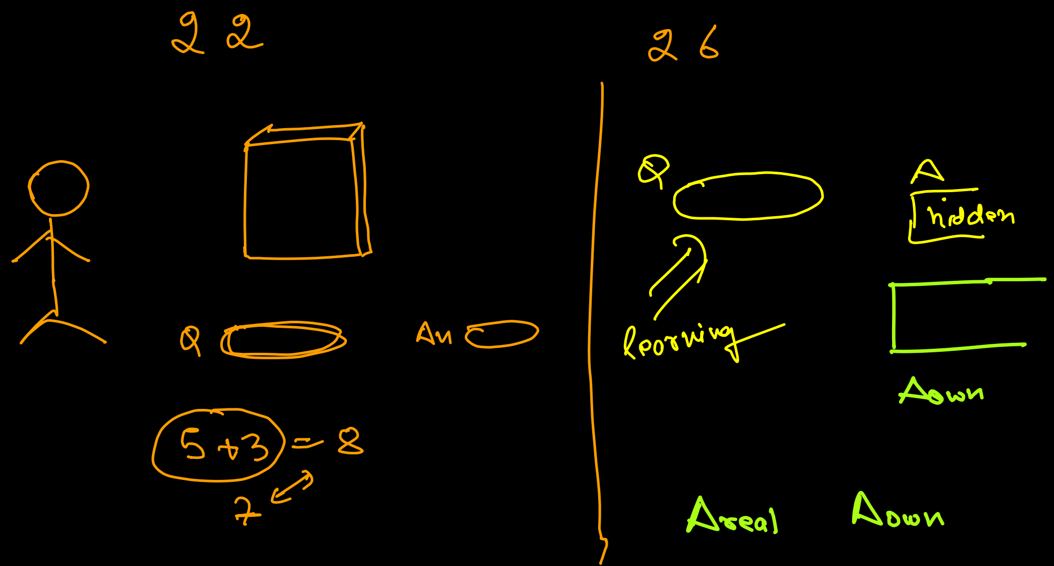
String → int

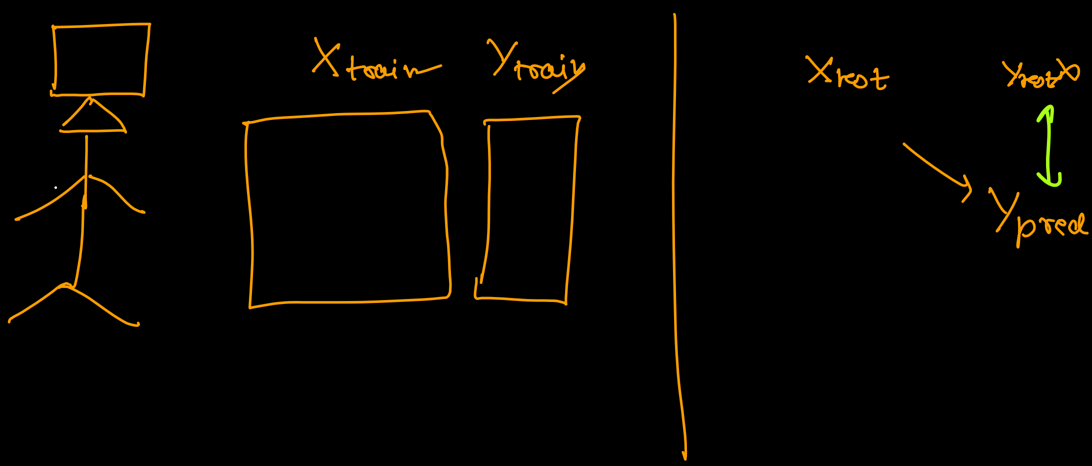
3) Variable +/- , feature engineering.

5. Train our algo

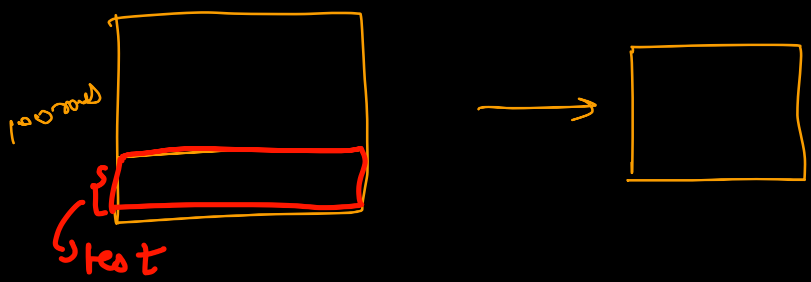
X_{train} Y_{train}

X_{test} Y_{test}





$X_{test} \Rightarrow$ new data



★ Our aim is always to perform well on future data / experiences. not on past data / experience

6) Test / Evaluate the Algorithm

7> Model deployment → sagem
flask

Maths for ML

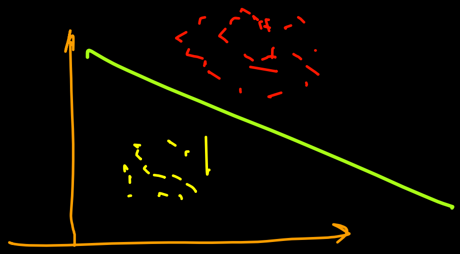
1] Linear Algebra

2] Differential calculus

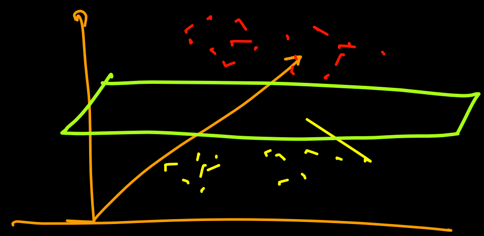
3] Probability

4] Statistics

Linear Algebra



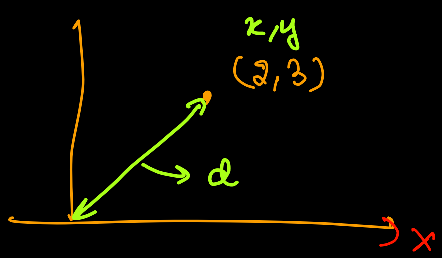
2-D



~~3-D~~

Above 3-D, we face issues in thinking.

Point ⇒ A ~~loca~~ position in a space

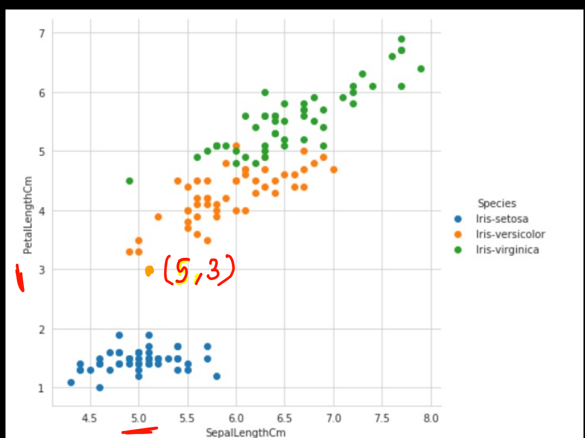


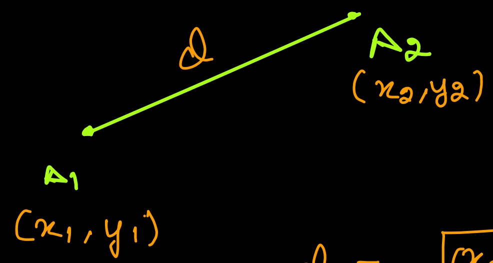
$$d = \sqrt{x^2 + y^2}$$

$$= \sqrt{x^2 + y^2 + z^2}$$

$$= \sqrt{x^2 + y^2 + z^2 + w^2}$$

(5, 3, 4)

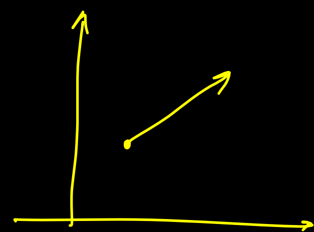




$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

Vector / Matrices (numpy)

Vector $\Rightarrow$ [ ]



Row

Column

$[\quad]_{1\times 3}$ $r \times c$

$[\quad]_{3\times 1}$ $r \times c$

list ≈ vector

Matrices

$$\begin{bmatrix} 1 & 2 & 3 \\ 5 & 0 & 9 \\ 8 & 10 & 3 \end{bmatrix}_{3\times 3}$$

list of list

$$\Downarrow$$

$$\begin{bmatrix} A_{11} & A_{12} & A_{13} \\ & & A_{33} \end{bmatrix}$$

Transpose of a matrix

$$\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix} \xRightarrow{T} \begin{bmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{bmatrix}$$

used a lot in machine

addition

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

Multiplication

Dot Product

Dot Product

$$\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} \bullet \begin{bmatrix} 5 & 6 \\ 7 & 8 \end{bmatrix} = \begin{bmatrix} (1\cdot 5)+(2\cdot 7) & (1\cdot 6)+(2\cdot 8) \\ (3\cdot 5)+(4\cdot 7) & (3\cdot 6)+(4\cdot 8) \end{bmatrix}$$

$$= \begin{bmatrix} 5+14 & 6+16 \\ 15+28 & 18+32 \end{bmatrix} = \begin{bmatrix} 19 & 22 \\ 43 & 50 \end{bmatrix}$$

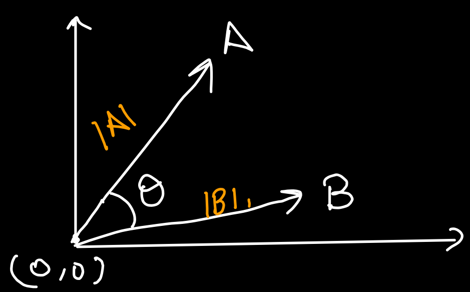
$A_{r_1 \times c_1}$ $B_{r_2 \times c_2}$

then $c_1 = r_2$ else error

resulting matrix will have shape as $\underline{r_1 \times c_2}$

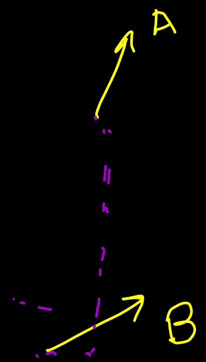
Unit matrix $[I]=\begin{bmatrix}1&0&0\\0&1&0\\0&0&1\end{bmatrix}$ $a_{ij}=1 \quad for\ i=j$ $a_{ij}=0 \quad for\ i\neq j$	*Upper triangular matrix* $\begin{bmatrix}a_{11}&a_{12}&a_{13}\\0&a_{22}&a_{23}\\0&0&a_{33}\end{bmatrix}$ $a_{ij}=0 \quad for\ \ i<j$	*Lower triangular matrix* $\begin{bmatrix}a_{11}&0&0\\a_{21}&a_{22}&0\\a_{31}&a_{32}&a_{33}\end{bmatrix}$ $a_{ij}=0 \quad for\ \ i>j$
Diagonal matrix $\begin{bmatrix}a_{11}&0&0\\0&a_{22}&0\\0&0&a_{33}\end{bmatrix}$ $a_{ij}=0 \quad for\ \ i\neq j$	*Symetric matrix* $\begin{bmatrix}a_{11}&b&c\\b&a_{22}&d\\c&d&a_{33}\end{bmatrix}$ $a_{ij}=a_{ji}$	*Anti symetric matrix* $\begin{bmatrix}0&-b&-c\\b&0&d\\c&-d&0\end{bmatrix}$ $a_{ii}=0$ $a_{ij}=-a_{ji}$
Square matrix $A=\begin{bmatrix}a_{11}&a_{12}\\a_{21}&a_{22}\end{bmatrix}$ *number of rows equal to the number of culomns* $A(n\times n)$.	*General size matrix* $\begin{bmatrix}a_{11}&a_{12}&a_{13}&a_{14}\\a_{21}&a_{22}&a_{23}&a_{24}\end{bmatrix}$ *A is a* (2×4) *matrix*	

Angle between 2 vectors

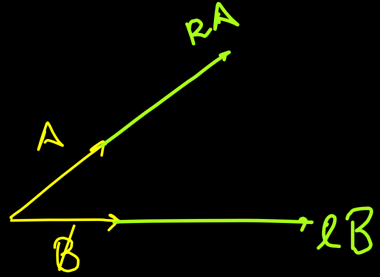


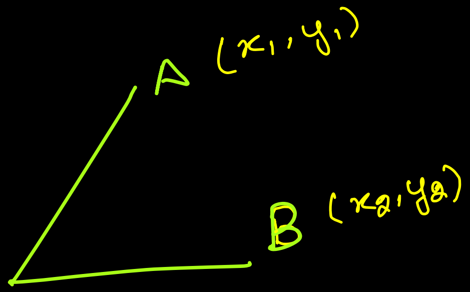
$$\cos\theta = \frac{A\cdot B}{|A|\,|B|}$$

$$\theta = \cos^{-1}\frac{A\cdot B}{|A|\,|B|}$$



Vector can be moved without changing its dirn





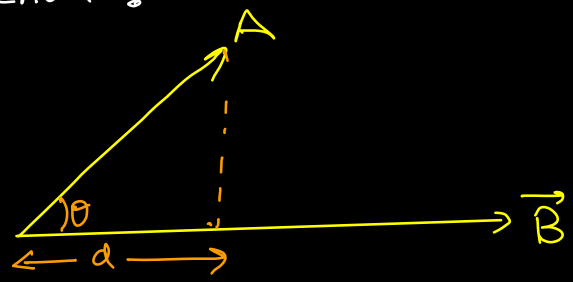
$$|A| = \sqrt{x_1^2 + y_1^2}$$

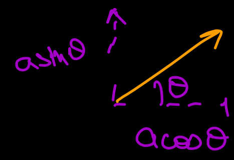
$$|B| =$$

$$\cos\theta = \frac{x_1 x_2 + y_1 y_2}{|A| \; |B|}$$

$$= \frac{\sum_{i=1}^{n} x_i * y_i}{|A| \; |B|}$$

Projection :





$$d = |A| \cos\theta$$

$$\frac{a \cdot b}{|a|\,|b|} = \cos\theta \leftarrow$$

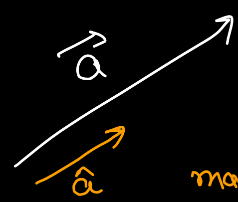
$$\boxed{\frac{a \cdot b}{|b|}} = |a| \cos\theta = d = \cancel{\text{projection}}$$

⇓

projection without θ

Unit vector $(\hat{a})$

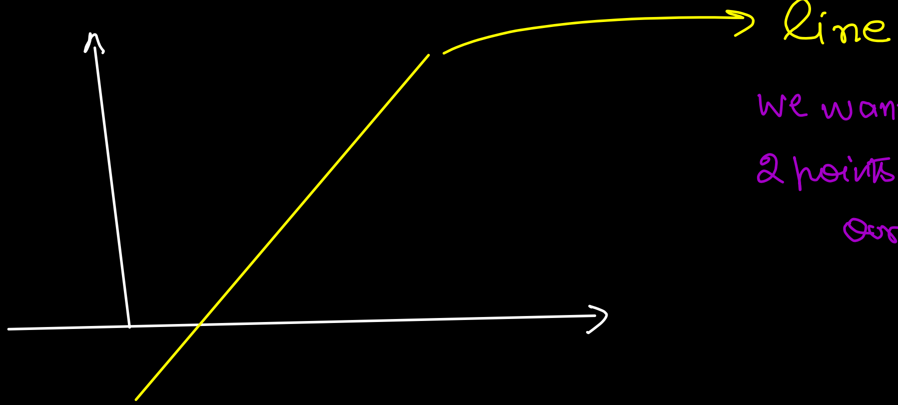
$$\hat{a} = \frac{\vec{a}}{||a||}$$



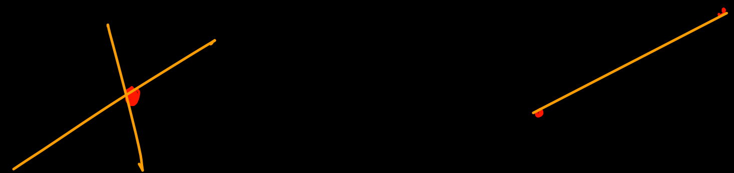
magnitude = 1

dir^n = same

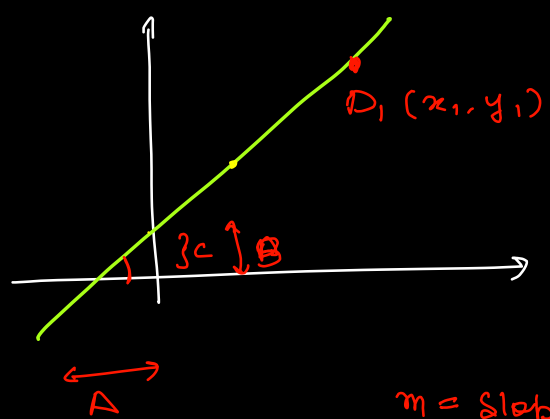
Line

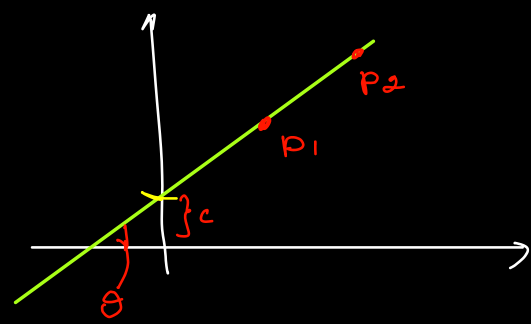


We want atleast 2 points to define our line,



Line equation





m = slope = $\tan\theta$

C = intercept

$$y = \underbrace{m}_{\text{slope}} x + \underbrace{c}_{\text{y-intercept}}$$

$$Ax + By + C = 0$$

$$Ax_1 + Bx_2 + c = 0$$

$$\omega_1 x_1 + \omega_2 x_2 + \omega_0 = 0$$

extend to multiple dimⁿ

$$w_1x_1 + w_2x_2 + w_3x_3 \dots w_nx_n + \omega_0 = 0$$

$\omega = [\quad]$ $\qquad$ $x = [\quad]$

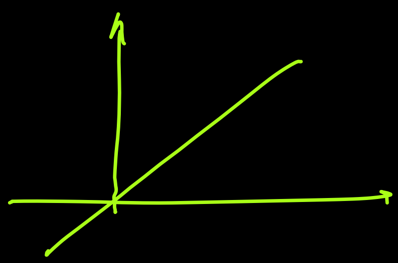
$$\omega_0 + \underbrace{[\omega_1 \quad \omega_2 \quad \cdots \quad \omega_n]}_{\omega^T} \underbrace{\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ \vdots \\ x_n \end{bmatrix}}_{x} = 0$$

$$W_0 + \omega^T x = 0$$

$$w_0 + w^T x = 0$$

$$w_0 = 0$$

will pass through origin



$$w^T x = 0$$

Why transpose?

$$w = \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ \vdots \\ w_n \end{bmatrix}_{n \times 1} \qquad X = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ \vdots \\ x_n \end{bmatrix}_{n \times 1}$$

$$\begin{bmatrix} w^T \end{bmatrix}_{1 \times n} \begin{bmatrix} X \end{bmatrix}_{n \times 1} =$$

$$\boxed{a \cdot b = b \cdot a}$$

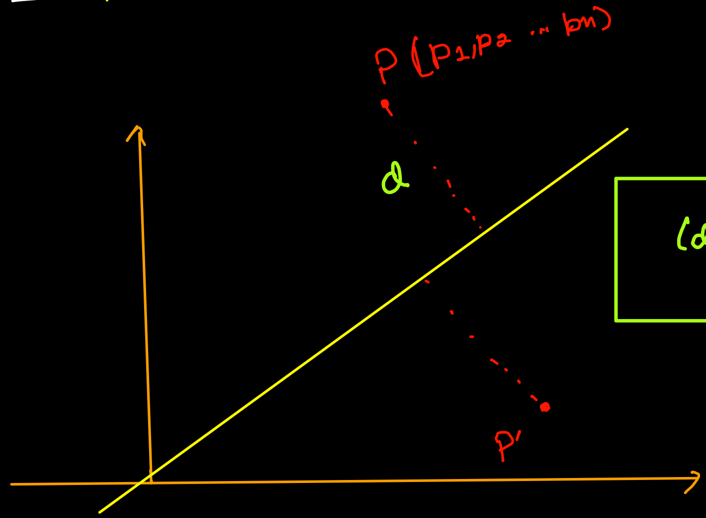
Commutative

$$\mathbf{a}\cdot\mathbf{b}=\mathbf{b}\cdot\mathbf{a},$$

which follows from the definition (θ is the angle between $\mathbf{a}$ and $\mathbf{b}$):[6]

$$\mathbf{a}\cdot\mathbf{b}=\|\mathbf{a}\|\,\|\mathbf{b}\|\cos\theta=\|\mathbf{b}\|\,\|\mathbf{a}\|\cos\theta=\mathbf{b}\cdot\mathbf{a}.$$

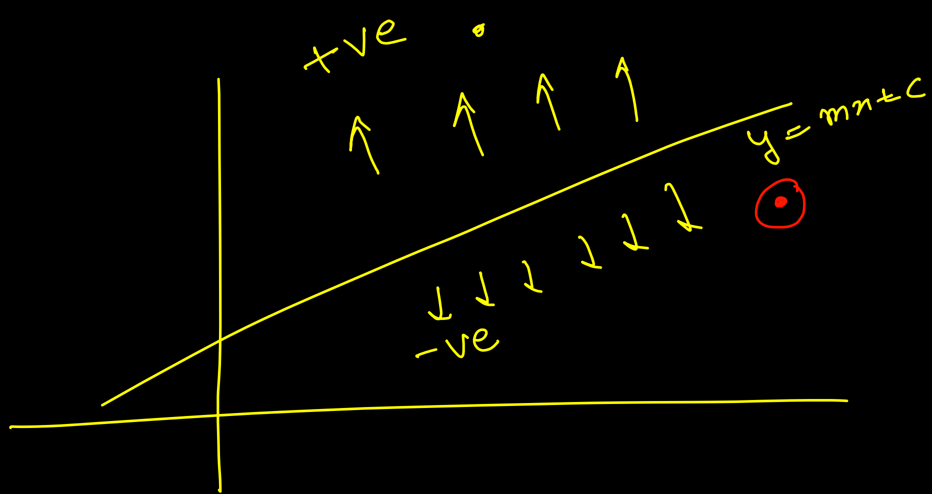
Dist of a point from a Plane



$w_0 = 0$

$$\boxed{(d)\ \text{distance} = \frac{w^T P}{\|w\|}}$$

$$\boxed{(d)\ \text{distance} = \frac{w^T P}{\|w\|}}$$



Dataset

x_1 x_2 x_3 x_4 x_5 Y

Id	SepalLengthCm	SepalWidthCm	PetalLengthCm	PetalWidthCm	Species
1	5.1	3.5	1.4	0.2	Iris-setosa
2	4.9	3	1.4	0.2	Iris-setosa
3	4.7	3.2	1.3	0.2	Iris-setosa
4	4.6	3.1	1.5	0.2	Iris-setosa
5	5	3.6	1.4	0.2	Iris-setosa
6	5.4	3.9	1.7	0.4	Iris-setosa
7	4.6	3.4	1.4	0.3	Iris-setosa
8	5	3.4	1.5	0.2	Iris-setosa
9	4.4	2.9	1.4	0.2	Iris-setosa
10	4.9	3.1	1.5	0.1	Iris-setosa
11	5.4	3.7	1.5	0.2	Iris-setosa
12	4.8	3.4	1.6	0.2	Iris-setosa
13	4.8	3	1.4	0.1	Iris-setosa
14	4.3	3	1.1	0.1	Iris-setosa
15	5.8	4	1.2	0.2	Iris-setosa
16	5.7	4.4	1.5	0.4	Iris-setosa
17	5.4	3.9	1.3	0.4	Iris-setosa
18	5.1	3.5	1.4	0.3	Iris-setosa
19	5.7	3.8	1.7	0.3	Iris-setosa

sample

features.

Class labels

Y_i = { setosa
versicolor
verginica }

$\mathcal{D} = \{ X_i , Y_i \}$

X_1 = vector in a N dim^n space