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# Maths for ML

Fundamental →

⇒ Maths behind intuition in DS | ML

⇒ Linear Algebra

⇒ Coordinate geometry

⇒ Calculus

⇒ Optimization

⇒ How do you automate "Human Intelligence"

Concept → Visualisation → Basic Maths → Code Side.

⇒ 10 Lectures →

⇒ Complete your Assignments on time.

• Post Reads.



Say you will learn AI, nobody panics



But say you will learn linear algebra and optimisation, then everybody loses their minds

⇒ Making machine learn to make decision.

↳ To behave like a human.

→ Scale      → Automate

ML    → Automate      "Human Intelligence"

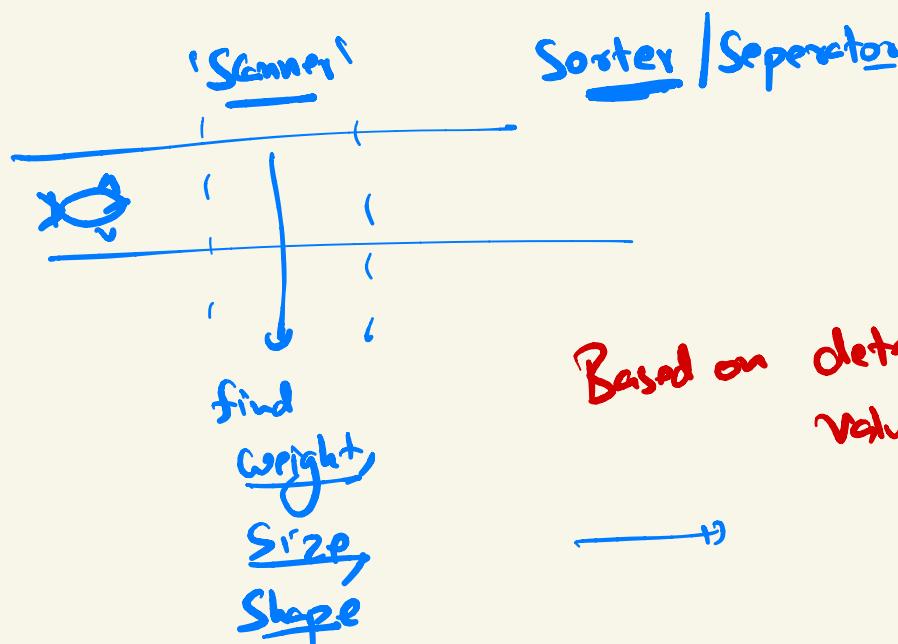
⇒ Fishes are getting Categorised.

The machine has learnt "how to sort fishes".

How will a human Sort them?.

- Weight
- Size
- Appearance
  - Color
  - Shape

Characteristics



⇒ Big fishes → Tuna, Catfish  
Small fishes → Pompom, - -

historical  
Labeled data to understand.

Labelled Dataset

Each Row Record or data pt.

Width	Length	Weight	Type	Target Labels
30	50	80	1	
11	20	25	2	
27	48	63	1	
16	31	29	2	

Features / attributes

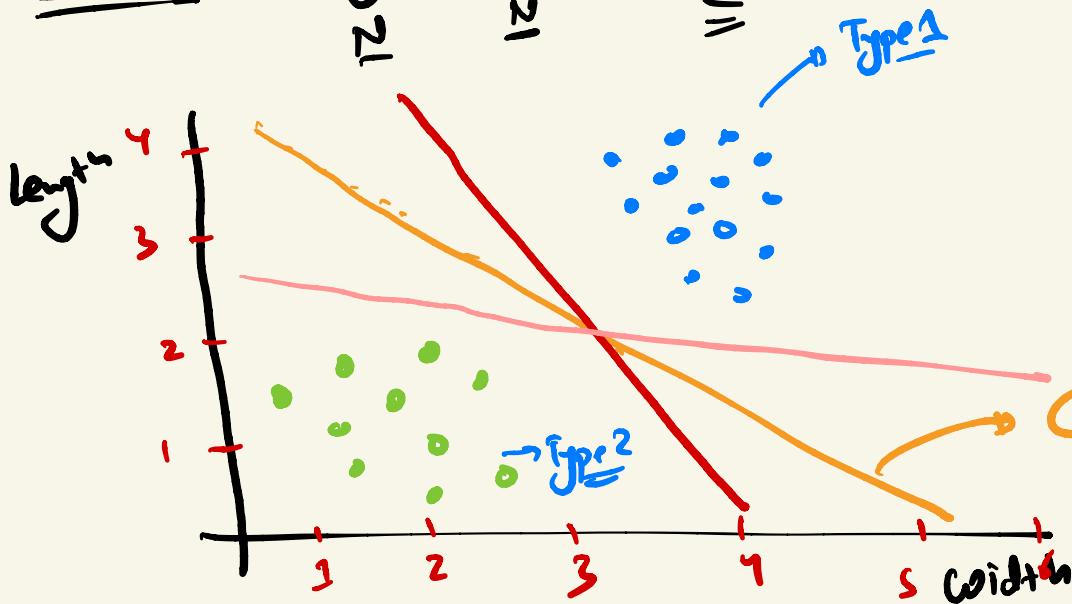
On the basis of weight, length, width

decide → Type

→ independent variable  
→ feature  
→ attribute

→ Target  
→ Label

Visualise Length, width, Type



from labelled data

Classification  
↳ tells us which class the data belongs to

⇒ Which line is the best way to classify →

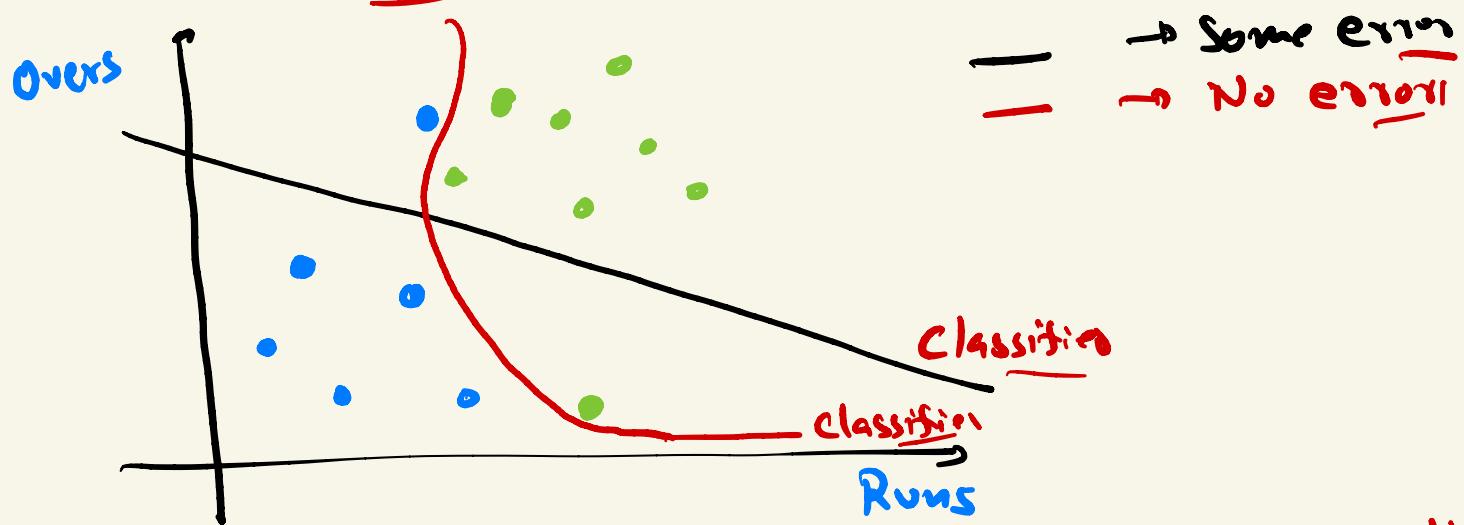
↳ ML is about identifying the best way to classify

↓  
Best fit | Best way to separate the classes / types.

## $\Rightarrow$ IPL Experience $\rightarrow$

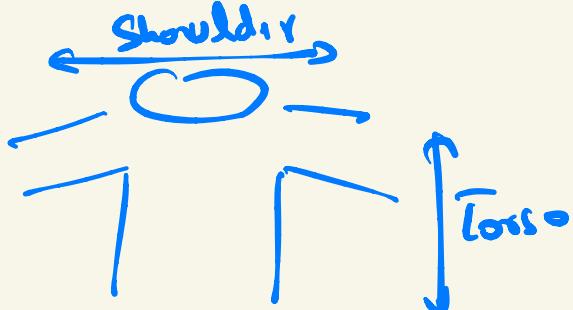
Runs	Overs	Outcomes $\rightarrow$ Target
90	6	LOSS
90	15	COIN
18	1	COIN
18	1	LOSS
30	7	WIN

feature,

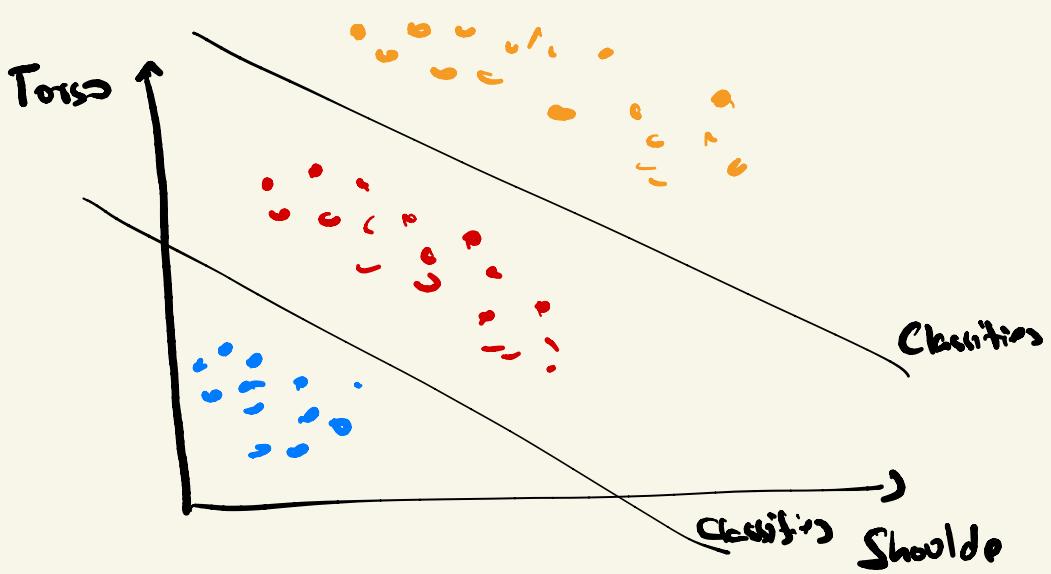


Straight lines might not be the best option every time.

$\Rightarrow$  Clothes / TShirt      S, M, L



T	S	Size
61	40	S
63	42	M
62	46	L



$\Rightarrow$  If more than 1 Class / Type in the Target  
 $\Rightarrow$  Use multiple classifier.

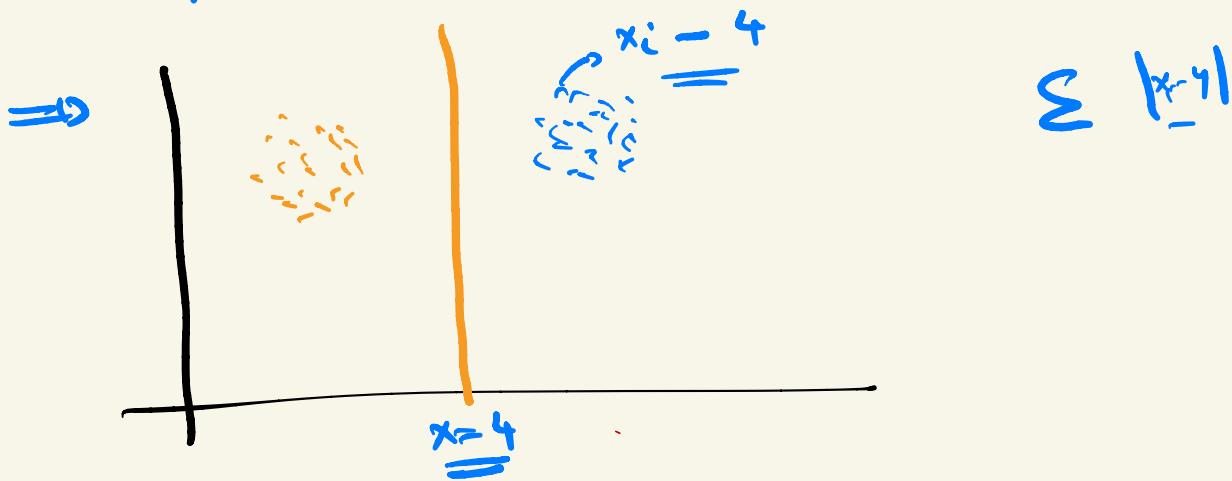
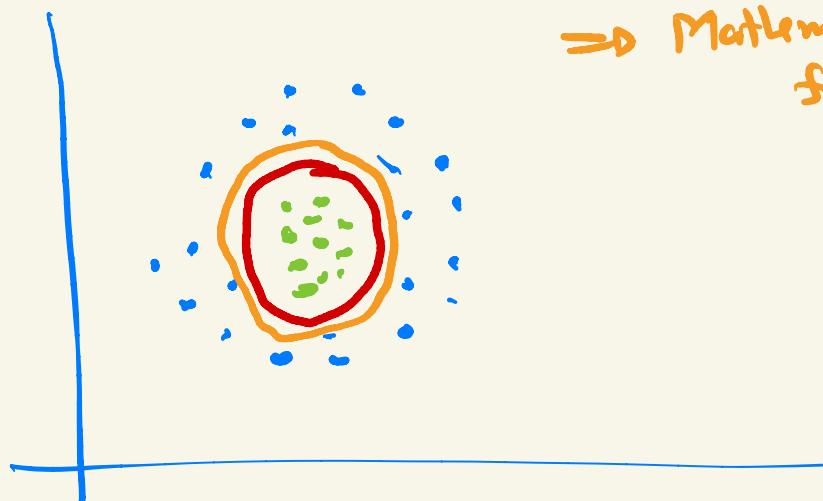
### Multi Class Classification

### Process of Building ML Algorithm

- ① Collect data → Labelled data  
 ↓  
 features      Target      for multiple records.
- ② Data Visualization. → plots  
 $\rightarrow$  t-SNE, PCA ] ← More than 2-3 features
- ③ Choose appropriate geometrical structure to separate Classes → .
- ④ Choose a Loss function which decides the best structure. [Maths].

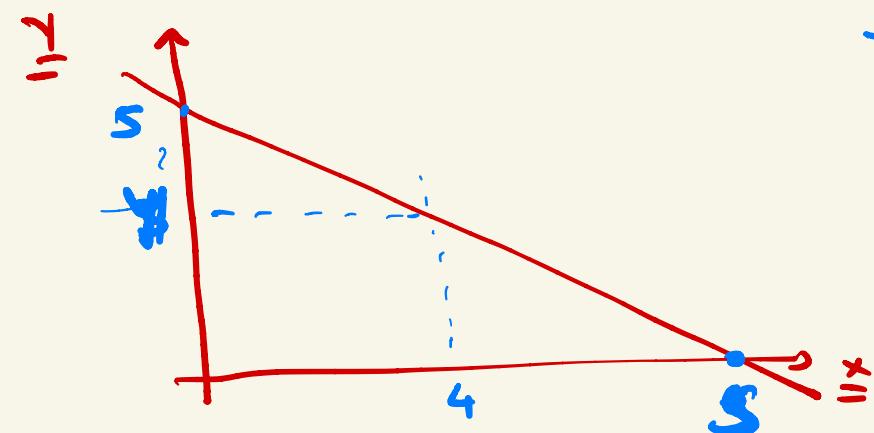
## ⑤ Training | Optimization - $\rightarrow$ putting more data

$\Rightarrow$  Mathematical function  $\Rightarrow$  Loss function



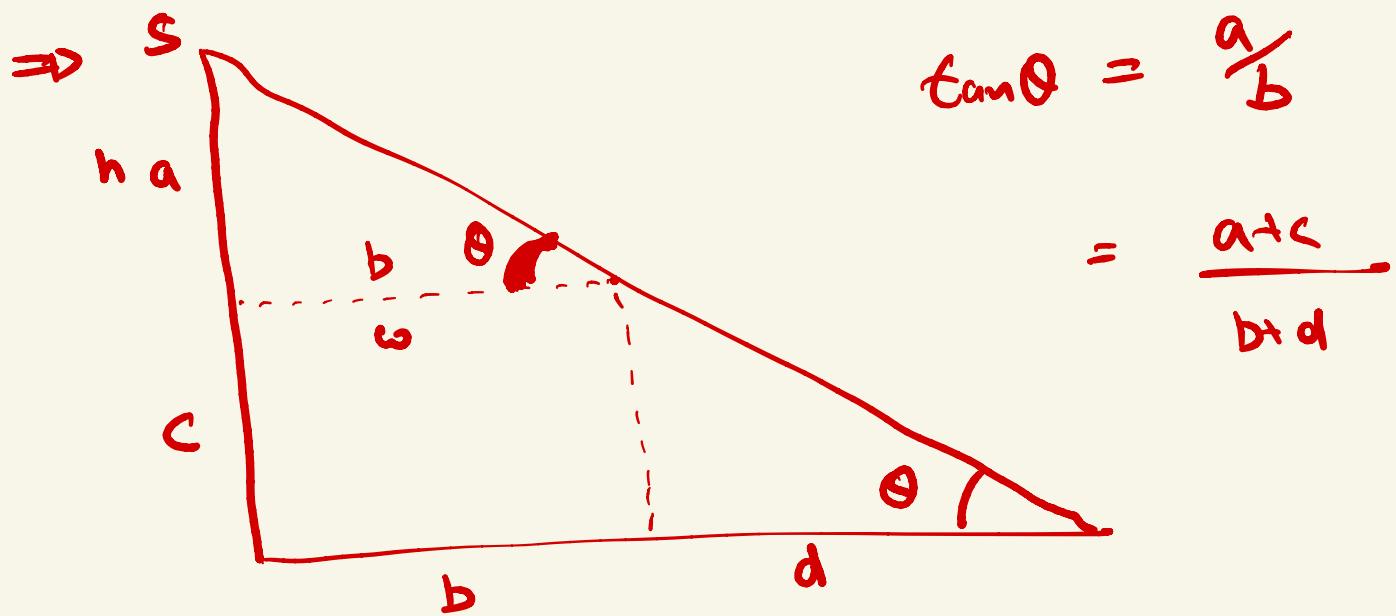
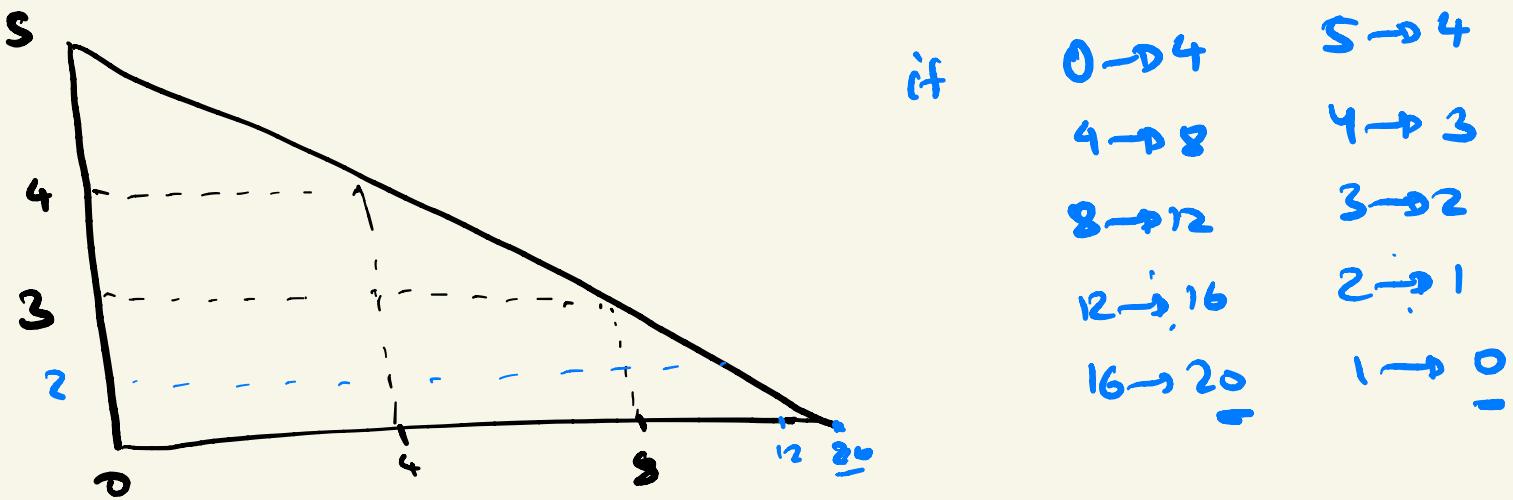
After training  $\rightarrow$  Colickever Curve has the lowest loss function value  $\rightarrow$  Best Classification

$\Rightarrow$  Basics of Lines  $\rightarrow$



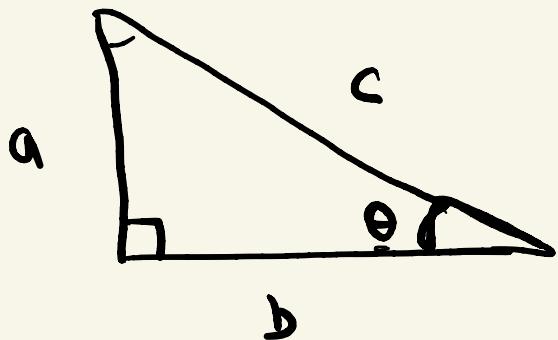
$$y = f(x)$$

$$\begin{aligned} y &\rightarrow x=4 \rightarrow 1 \\ &\rightarrow x=0 \rightarrow 5 \\ &\rightarrow x=5 \rightarrow 0 \end{aligned}$$



$$\frac{x \text{ distance}}{y \text{ distance}} \rightarrow \frac{x-0}{y-0}$$

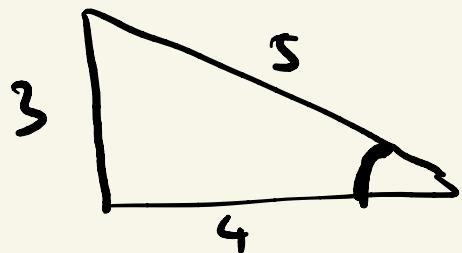
$$\Rightarrow \left( \frac{y-x}{x-0} \right) = \tan \theta = k$$



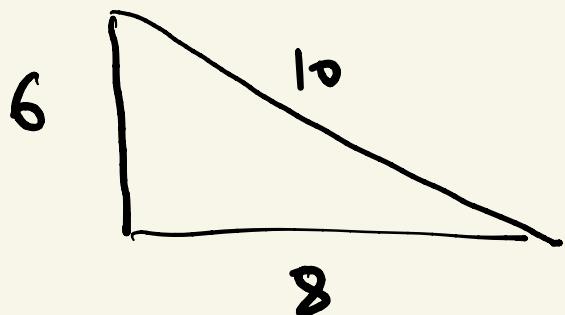
$$\Rightarrow \tan \theta = \frac{a}{b} = \frac{\text{height}}{\text{width}}$$

$$\Rightarrow \sin \theta = \frac{a}{c}$$

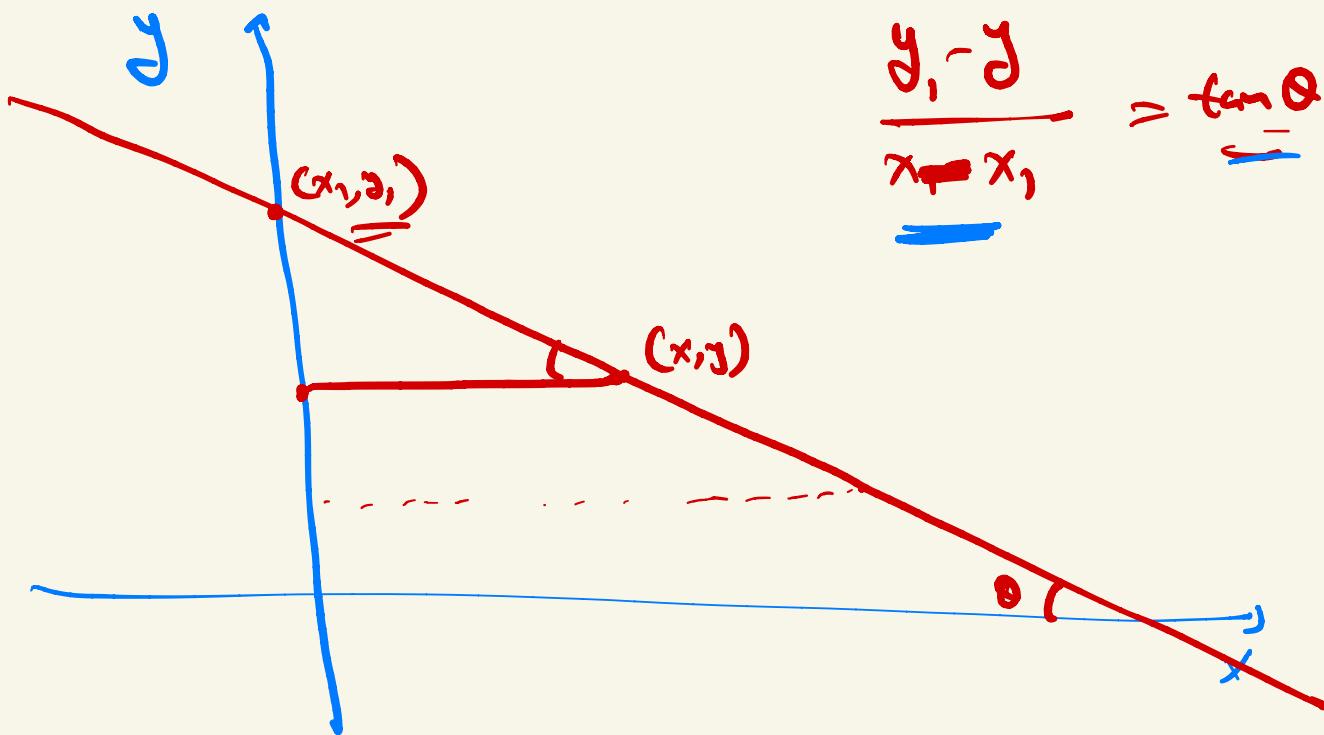
$$\Rightarrow \cos \theta = \frac{b}{c}$$



$$\tan \theta = \frac{3}{4}$$



$$\tan \theta = \frac{6}{8}$$



$$\frac{y - y_1}{x - x_1} = \tan \theta = k$$

$$\frac{y_1 - y}{x - 0} = \tan \theta = k$$

$$y_1 - y = kx$$

$$y = -kx + y_1$$

$$y = mx + c$$

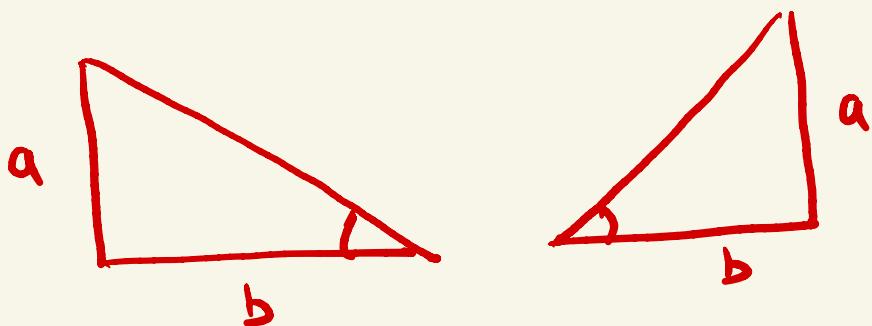
Slope

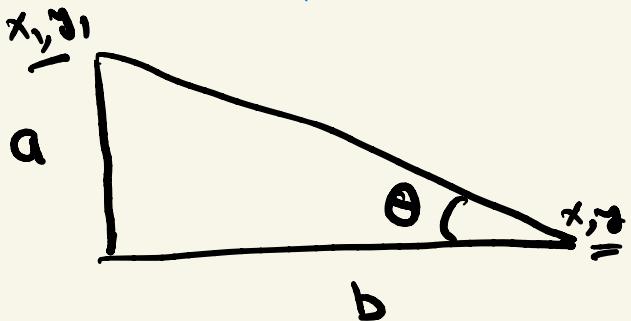
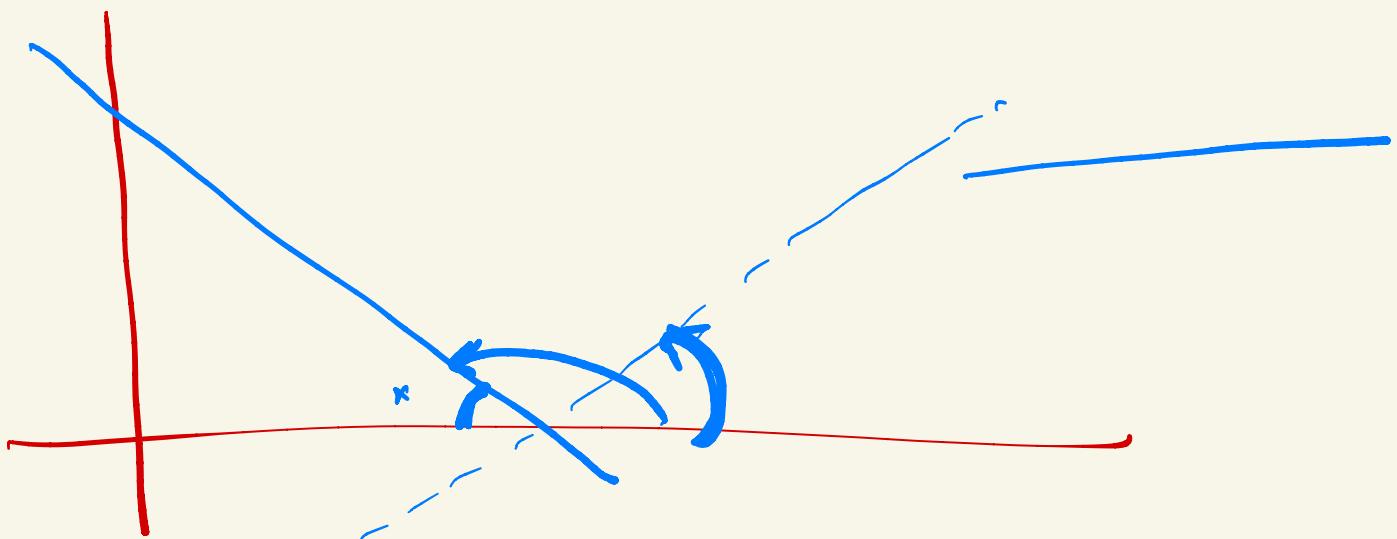
y intercept

equation of  
straight line

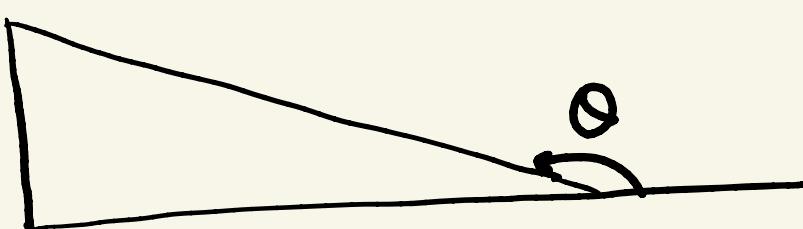
↳ value of  $y$  if  $x = 0$ .

$$\frac{y_1 - y}{x - x_1} = \frac{y - y_1}{x - x_1}$$





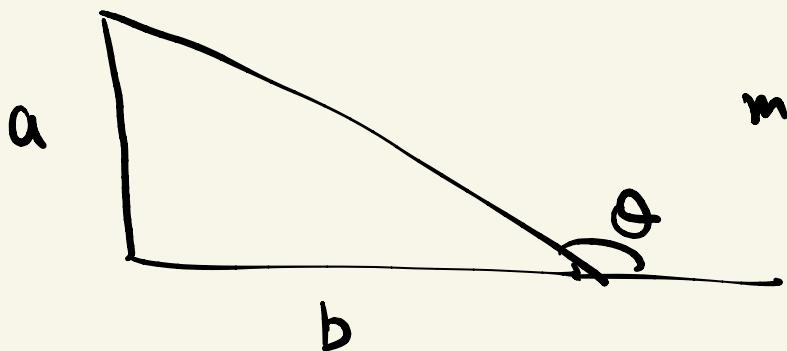
$$\tan \theta = \frac{a}{b} = \frac{y_1 - y}{x - x_1}$$



$$\tan \theta = \frac{y - y_1}{x - x_1}$$

$y = mx + c$

Slope intercept equation



$$m = \frac{a}{b}$$

$$y = \frac{a}{b}x + c = \frac{ax+bc}{b} = y \Rightarrow ax+bc = by$$

$$\underline{ax} - \underline{by} + \underline{bc} = 0$$

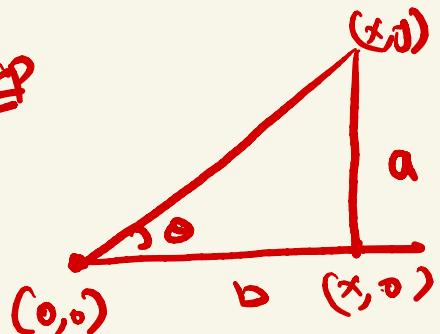
$$a_1x + a_2y + a_3 = 0$$

↓      ↓      ↓

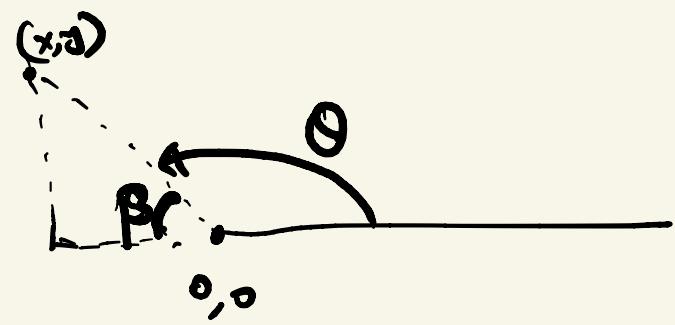
$a$      $-b$      $bc$

general equation of  
line

Recap



$$\tan \theta = \frac{a}{b} = \frac{y-0}{x-0}$$



$$\tan \theta = \frac{y-0}{x-0}$$

anticlockwise angle from  $+x$  axis

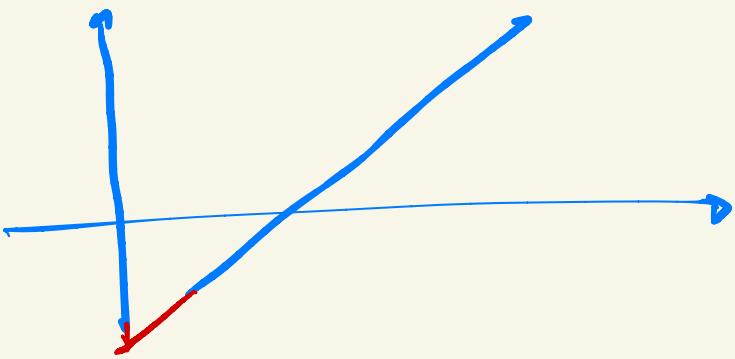
$$\underline{\tan \theta} = \frac{y-0}{x-0}$$

Slope

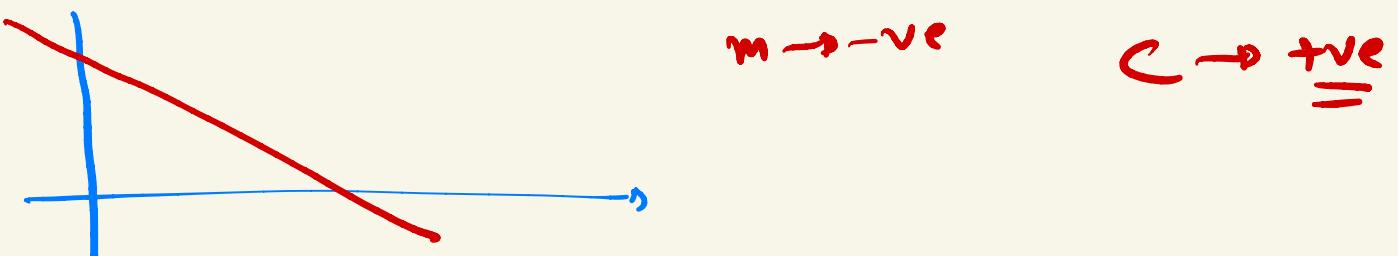
$$\downarrow \\ m$$

$\Rightarrow$  anticlockwise from  $+x$  axis.

$$\Rightarrow y = mx + c$$

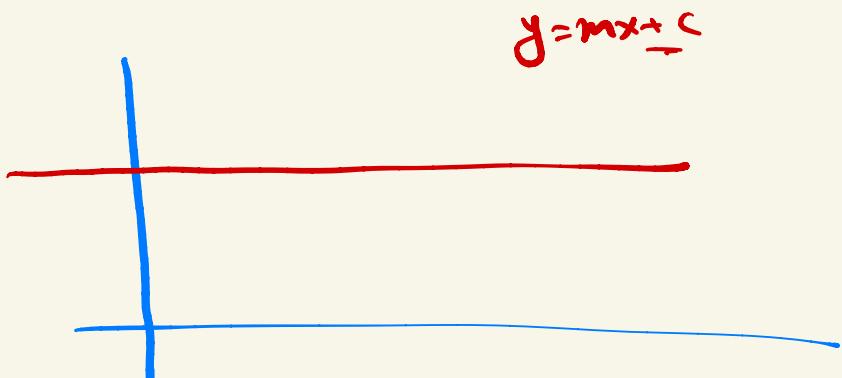


$$m \rightarrow +ve \quad c \rightarrow +ve$$



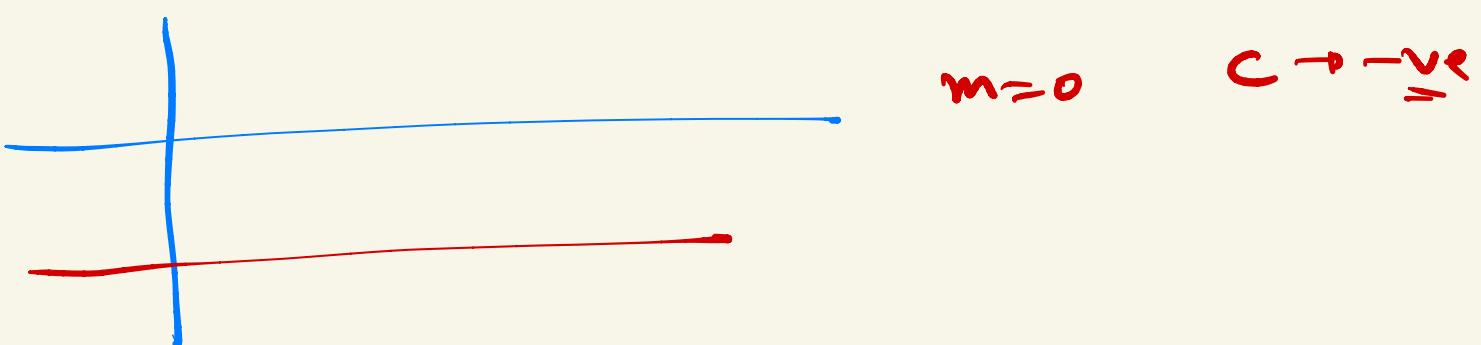
$$m \rightarrow -ve$$

$$c \rightarrow +ve$$



$$m = 0$$

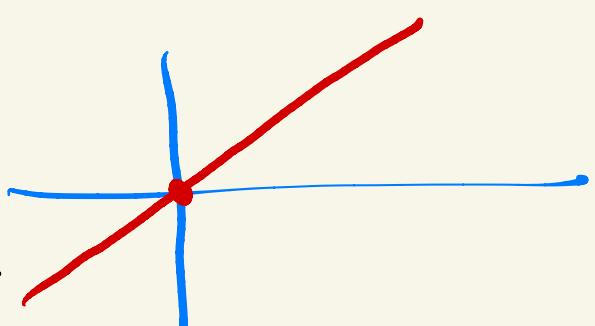
$$c \rightarrow +ve$$



$$m = 0$$

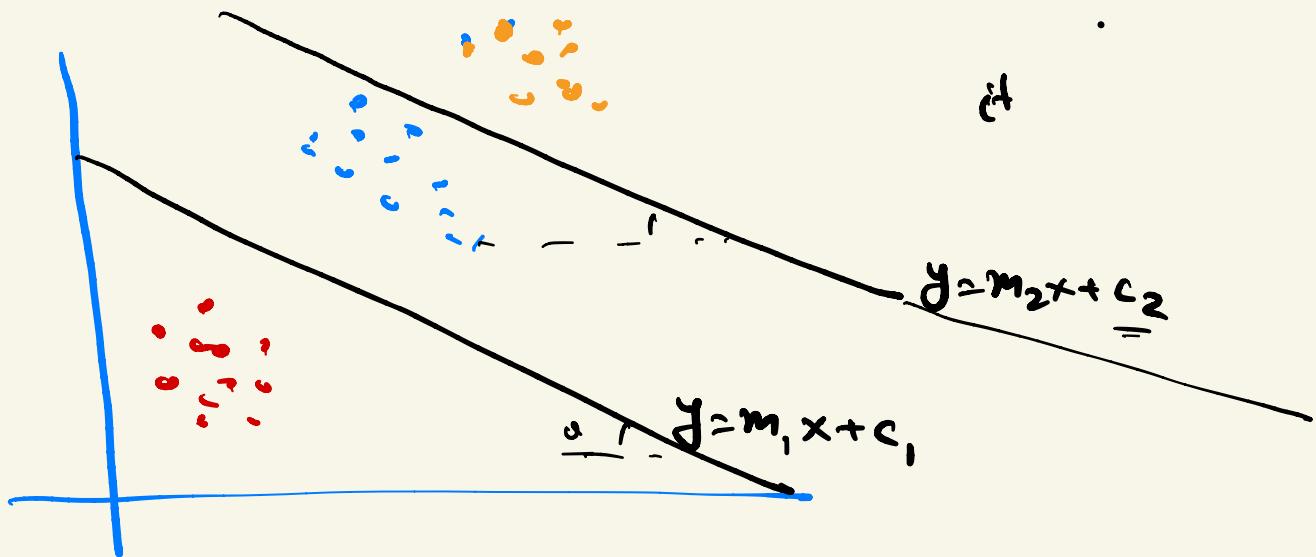
$$c \rightarrow -ve$$

$$\text{if } c = 0 \Rightarrow y = mx$$



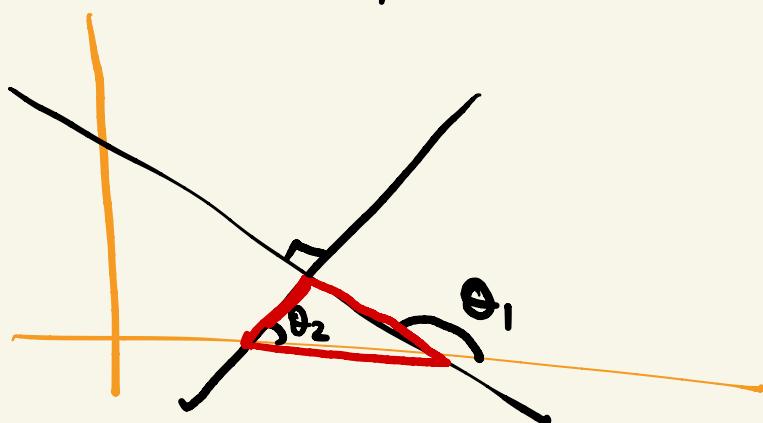
$$c = 0$$

$$m \rightarrow +ve$$

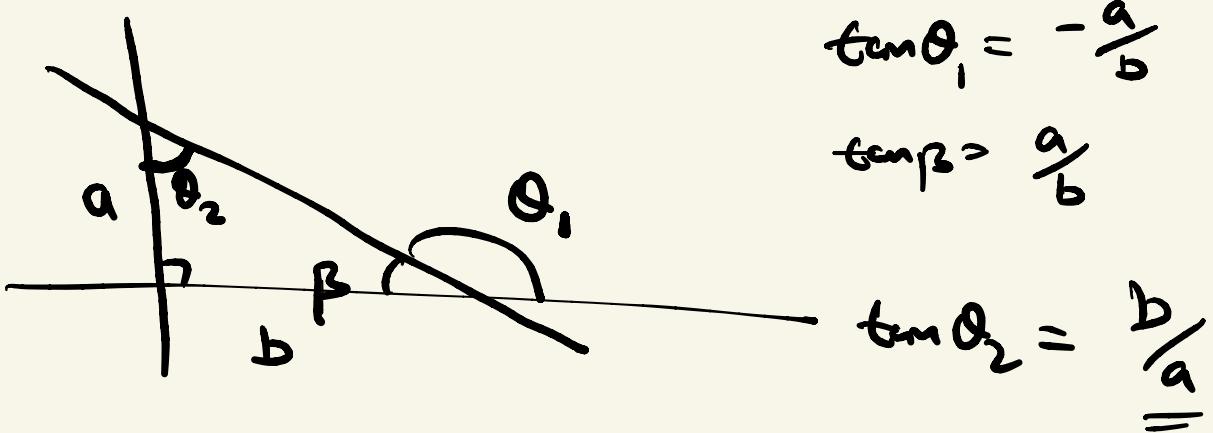


if lines are parallel  $m_1 = m_2$

⇒ # lines are perpendicular →



$$90 + \theta_2 + 180 - \theta_1 = 180$$



$$\tan \theta_1 = -\frac{a}{b}$$

$$\tan \beta = \frac{a}{b}$$

$$\tan \theta_2 = \frac{b}{a}$$

a  $m_1 = \tan \theta_1 = -\frac{a}{b}$

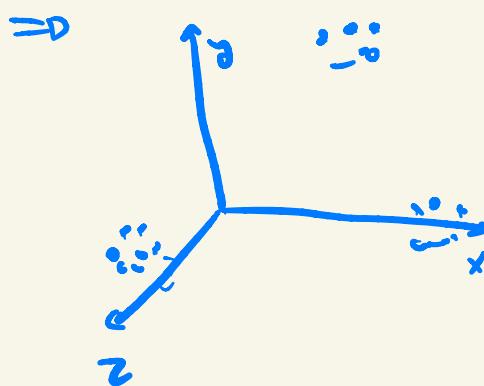
$$m_2 = \tan \theta_2 = \frac{b}{a}$$

$$m_1 \times m_2 = -1$$

-ve inverse

$$\Rightarrow y = mx + c$$

$$\Rightarrow \underline{\omega_1 x + \omega_2 y + \omega_3 = 0} \quad ] \text{this is more useful.}$$



2D  $\rightarrow$  Line

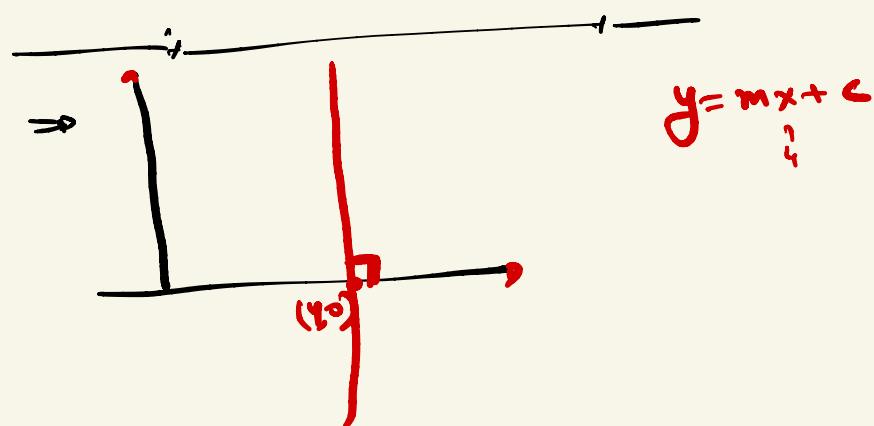
3D  $\rightarrow$  plane

4D  $\rightarrow$  hyperplane

nD  $\rightarrow$  nD hyperplane

$\Rightarrow$  Try to visualize things in 2D  $\rightarrow$  general equation.

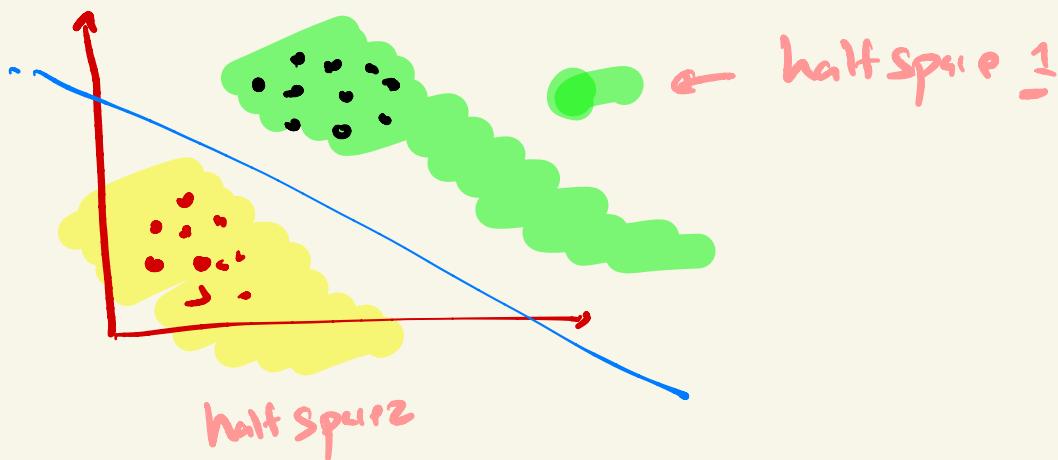
$$\omega_1 x + \omega_2 y + \omega_3 z + \omega_4 = 0 \quad \square$$



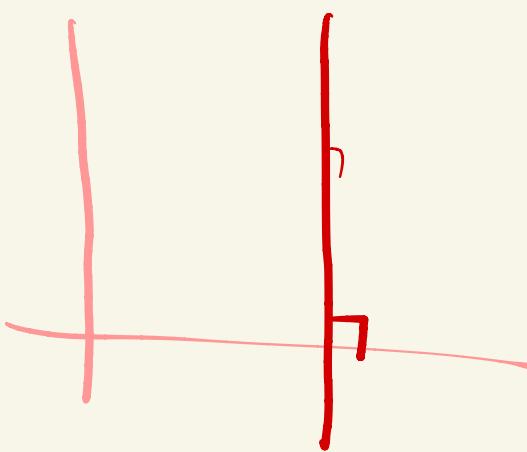
$$\Rightarrow Ax + By + C = 0 \rightarrow$$

$x, y \rightarrow$  feature

$A, B \rightarrow$  weights  $\rightarrow$  relationship b/w  $x$  &  $y$  for the best fit Conv.



In the slope-intercept form of a linear equation,  $y = mx + b$ , which of the following statements is true regarding lines being perpendicular to the x-axis?



Lines described by this form can be perpendicular to the x-axis for any value of 'm.'

Lines described by this form are never perfectly perpendicular to the x-axis, regardless of the value of 'm.'

Lines described by this form are always perfectly perpendicular to the x-axis, regardless of the value of 'm.'

Lines described by this form are only perpendicular to the x-axis when 'm' is negative.

$$m = \left( \frac{y - y_1}{x - x_1} \right) = \underline{\underline{0}}$$

$$\Rightarrow \boxed{x - 0 \cdot y - 4 = 0}$$

$y_0$   
 $y_1$   
 $y_2$   
⋮

- => ① Intuition  
 => ② Visualization  
 => Ask Question. → attempt the question.

Suppose you are given an equation of a line. What is the angle of the line w.r.t -axis?

$$y = \frac{1}{\sqrt{3}}x + 2$$

$$= m = \frac{1}{\sqrt{3}} = \tan \theta$$

$$\boxed{\tan \theta = \frac{1}{\sqrt{3}}}$$

$$\underline{\theta ?} \text{ given } \tan \theta = \frac{1}{\sqrt{3}}$$

