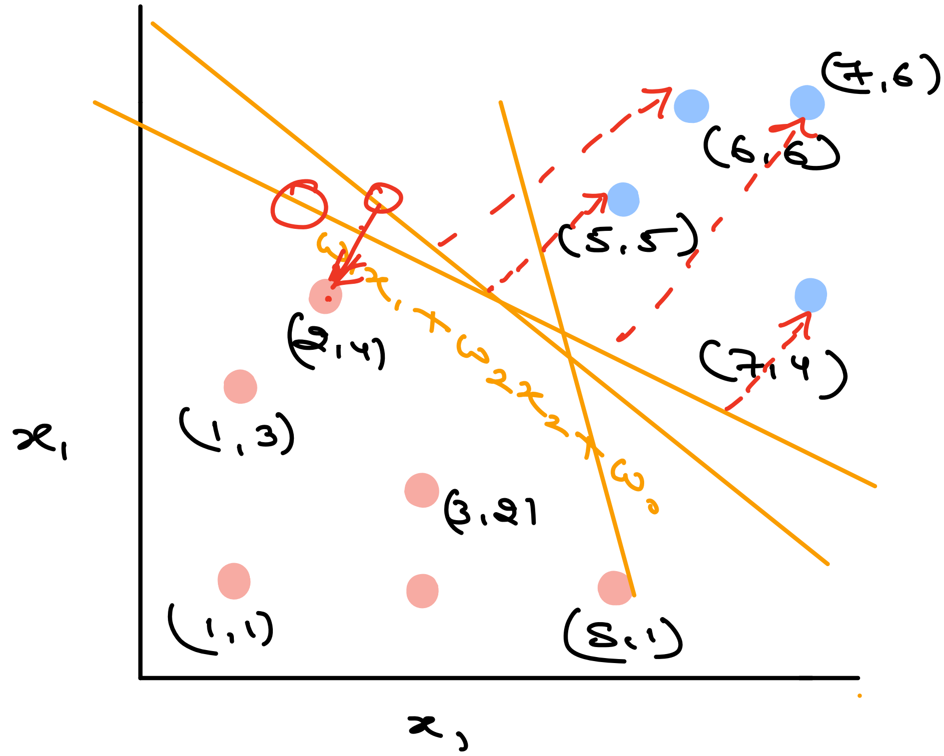
Agenda

- ⇒ Revision
- ⇒ End Goal
- ⇒ Vectors
  - ⇒ intro to Vectors
  - ⇒ Representation of Vectors
  - ⇒ Visualization of Vectors
  - ⇒ Magnitude of Vectors
    - ⇒ Norms : L1 and L2
  - ⇒ Dot product of Vectors
    - ⇒ Matrix Multiplication
  - ⇒ Angle b/w 2 vectors
  - ⇒ Connection b/w geometry and LA
  - ⇒ Unit Vector
  - ⇒ Vector projection

End Goal

x_1	x_2
5	5
2	4
6	6
3	2
7	4
5	1



w_1 and w_2 and w_0

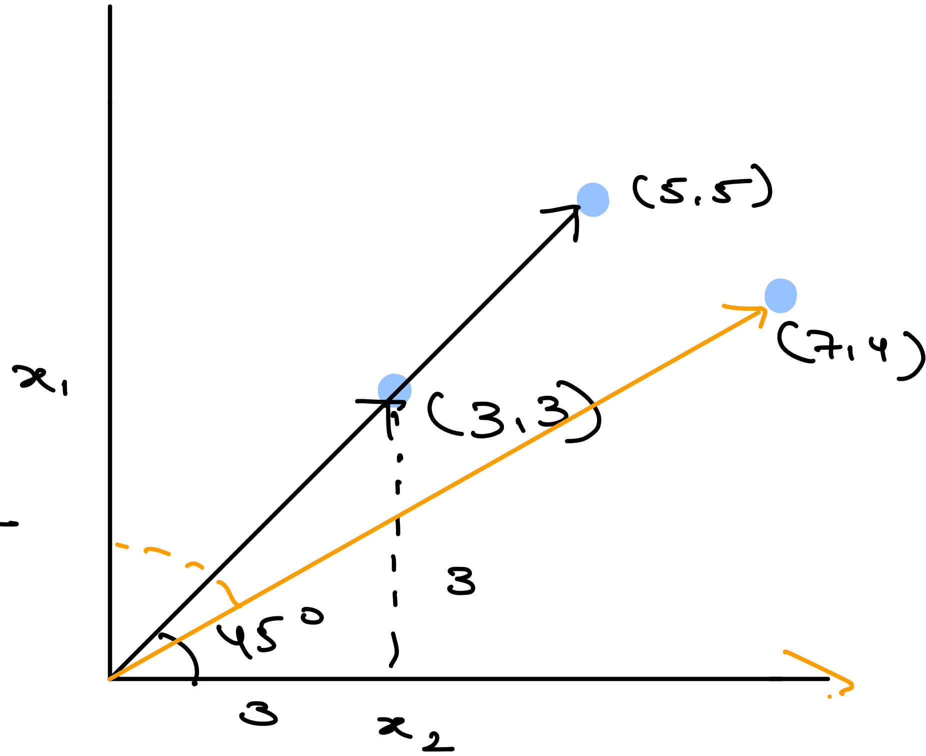
$$\boxed{w_1, w_2\ w_3 \in \mathbb{R}}$$

Vectors

$\Rightarrow$ Magnitude and direction

$x = [5, 5]$ 2d

$x \Rightarrow [4, 5, 6]$ 3d $\Rightarrow \sqrt{4^2 + 5^2 + 6^2}$



$\vec{x} = (3, 3)$

$||x|| \Rightarrow \sqrt{3^2 + 3^2}$

Norm of Vector

$||\vec{x}|| \longrightarrow$ magnitude

$x = [1, 2]$

$\bar{x}$

$\vec{x}$

Column Vectors

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

$x = [1, 2]$

$x^T \Rightarrow \begin{bmatrix} 1 \\ 2 \end{bmatrix}$

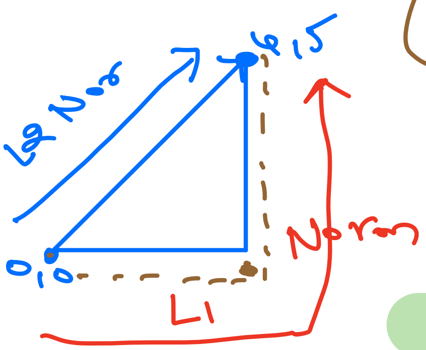
$$\bar{x} \Rightarrow \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_n \end{bmatrix}$$

Norm is just another for distance

L2 Norm $\Rightarrow \sqrt{x_1^2 + x_2^2 + x_3 - - x_n^2}$

or

Euclidean distance



L1 Norm $\Rightarrow |x_1| + |x_2| + |x_3| - - |x_n|$

(Manhattan distance)

Dot product Vector

⇒ Dot product

⇒ Cross product

$$\bar{x} \begin{bmatrix} 1 \\ 2 \end{bmatrix} \qquad \bar{y} \begin{bmatrix} 3 \\ 4 \end{bmatrix}$$

2×1 $\qquad$ 2×1

$\bar{x} \cdot \bar{y}$ ✗

$\bar{x}^T \bar{y}$ or $\bar{x} \bar{y}^T$

$a \times b \;\bullet\; m \times n$

$b = m$

output $a \times n$

$\bar{x}^T \Rightarrow \underset{1\times 2}{[1 \quad 2]}$ $\bar{y} = \underset{2\times 1}{\begin{bmatrix} 3 \\ 4 \end{bmatrix}}$

$\bar{x}^T \cdot y \Rightarrow 1\times 3 + 2\times 4 \Rightarrow$

Bank loan approval system

$\Rightarrow$ income $\Rightarrow$ 3500

$\Rightarrow$ Cibil score $\Rightarrow$ 800

$\Rightarrow$ Current_loans $\Rightarrow$ 3

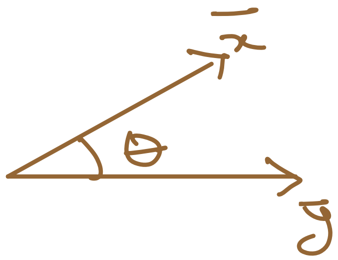
$$\boxed{w_1 \times \text{income} + w_2\, \text{Cbscore} + w_3 \times \text{Cull}}$$

$\geq$ Target ✓

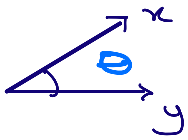
$<$ Target ✗

$$\begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \end{bmatrix}^T \cdot \begin{bmatrix} \text{income} \\ \text{cibil\_Score} \\ \text{Current\_loans} \\ \text{no\_dep} \end{bmatrix} \Rightarrow 100$$

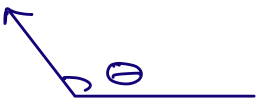
Angle b/w two Vectors



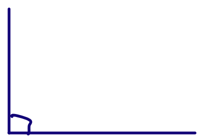
$$\boxed{\cos\theta = \frac{\bar{x}^T \cdot \bar{y}}{\|x\| \, \|y\|}}$$

① 

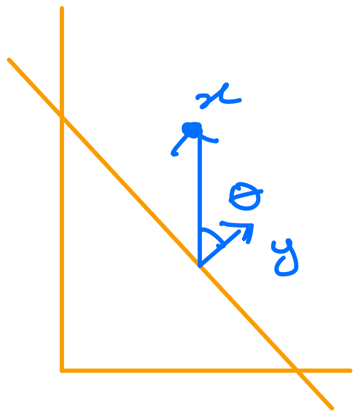
$\theta < 90$ then $x^T \cdot y \Rightarrow +ve$

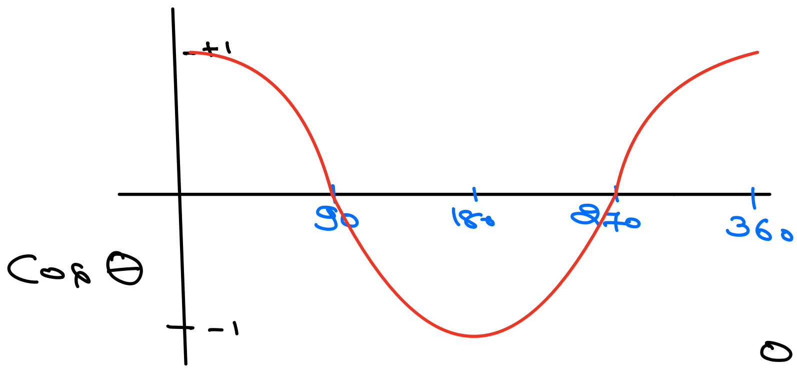
② 

$180 > \theta > 90$ then $x^T \cdot y \Rightarrow -ve$

③ 

$\theta = 90$ then $x^T \cdot y$? $\Rightarrow 0$





0 - 90
270 → ⇒ +ve

90 - 270 ⇒ -ve

$$-1 \le \cos\theta \le 1$$

H.W: Find angle b/w $\bar{x}$ and $\bar{y}$

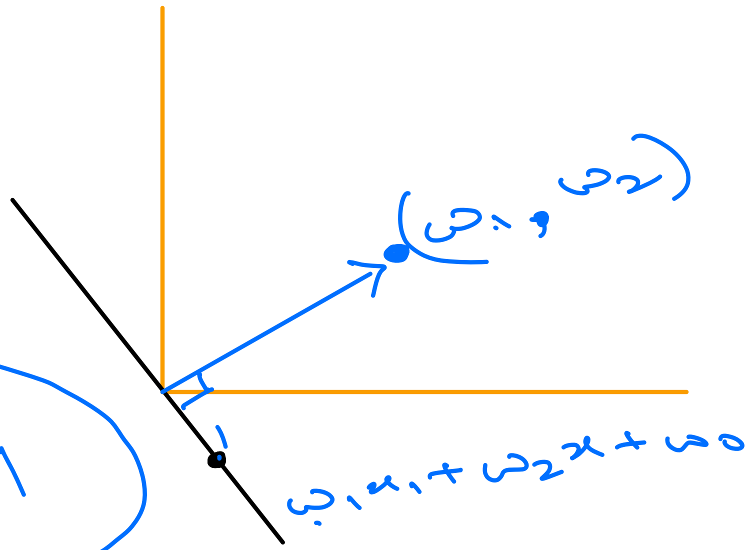
1) $\bar{x}$ [1, 2, 3] $\bar{y} \Rightarrow$ [10, -2, 3]

Proof

$\vec{w}$ will be $\perp$ to line $w_1x_1 + w_2x_2 = 0$

$$w_1x_1 + w_2x_2 = 0$$

$$\begin{bmatrix} w_1 \\ w_2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$



$$\cos\theta = \frac{w^T x}{\|x\| \, \|w\|}$$

$$\cos\theta \Rightarrow 0$$

90°

★ Unit Vector

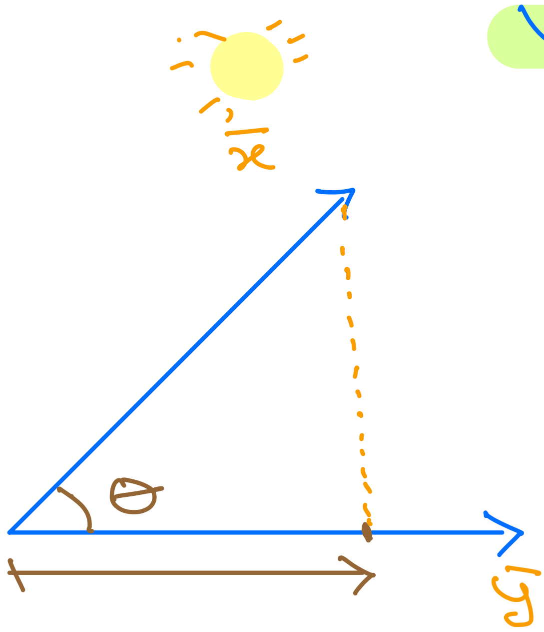
⇒ It's a vector with magnitude of 1

$$w \Rightarrow [1, 2, 3]$$

$$\boxed{\hat{w} \Rightarrow \frac{\bar{w}}{\|w\|}} \Rightarrow \frac{1}{\|w\|}, \frac{2}{\|w\|}, \frac{3}{\|w\|}$$

$$\hat{w} \Rightarrow \frac{1}{\sqrt{14}}, \frac{2}{\sqrt{14}}, \frac{3}{\sqrt{14}}$$

Vector projection



P and $\bar{y}$ will be zero

P lies on $\bar{y}$

projection of x on y

Revision and Doubts

$y = mx + c$

$$\underbrace{w_1 x_1}_{x_1 \to x} + \underbrace{w_2 x_2}_{x_2 \to y} + w_0$$

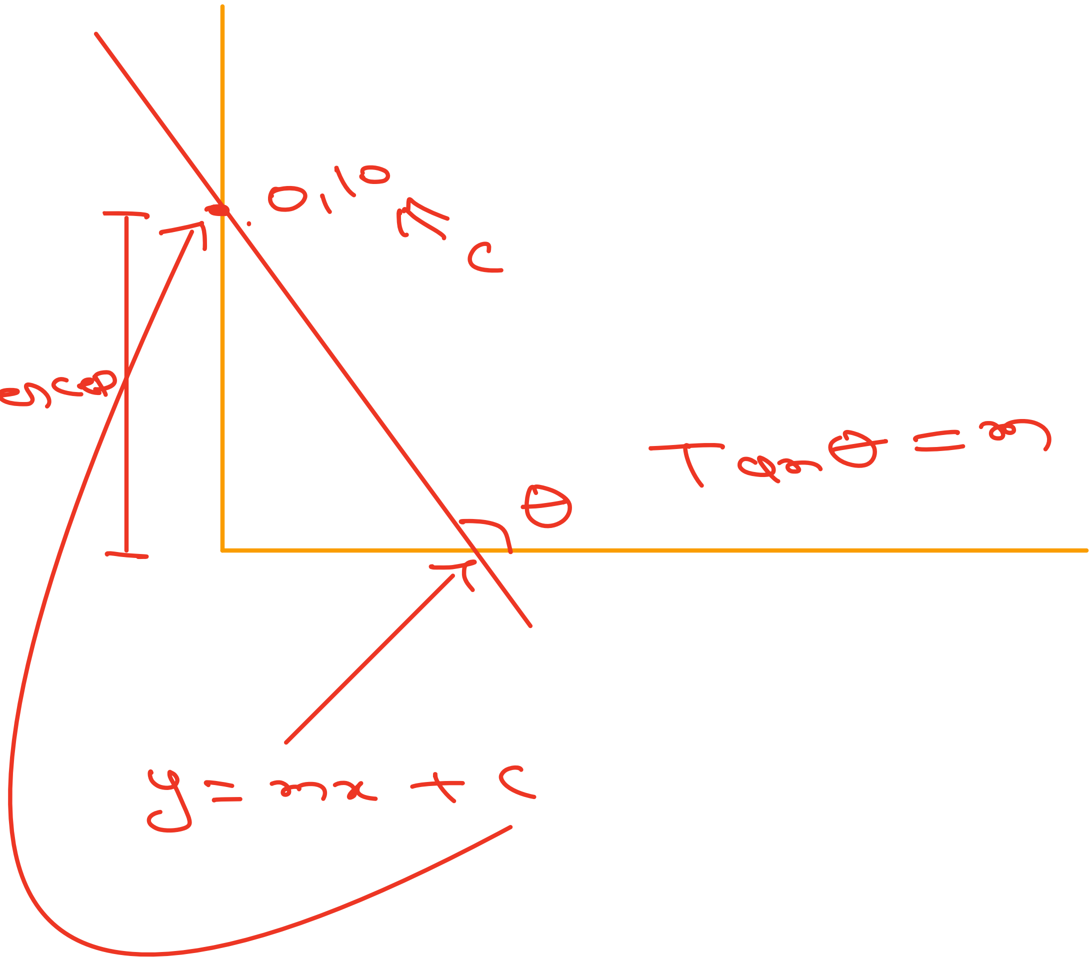
$$w_2 x_2 \Rightarrow -w_1 x_0 - w_0$$

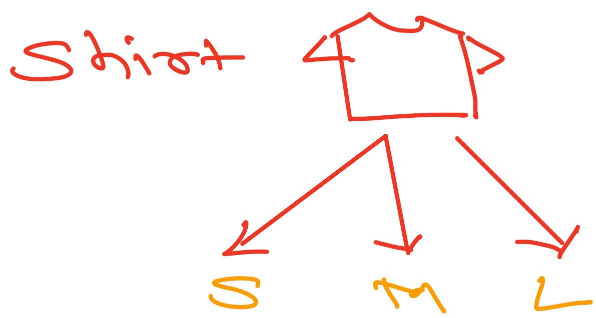
$m \to \infty$

Tango

$$x_2 \Rightarrow -\frac{w_1 x_1}{w_2} - \frac{w_0}{w_2}$$

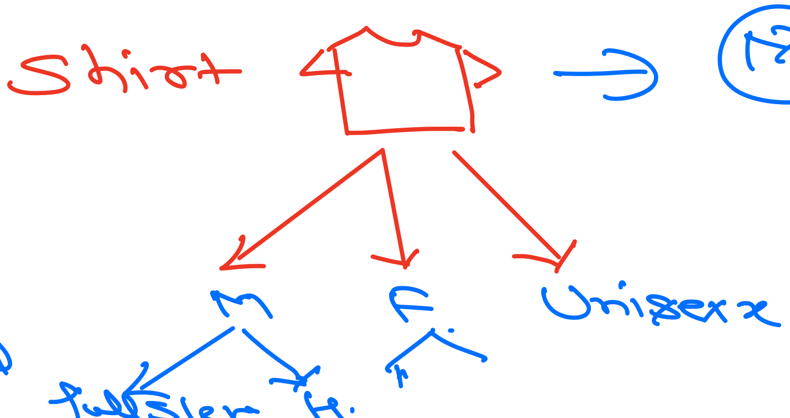
$$y \Rightarrow \underbrace{m}_{-\frac{w_1}{w_2}} x + \underbrace{c}_{-\frac{w_0}{w_2}}$$





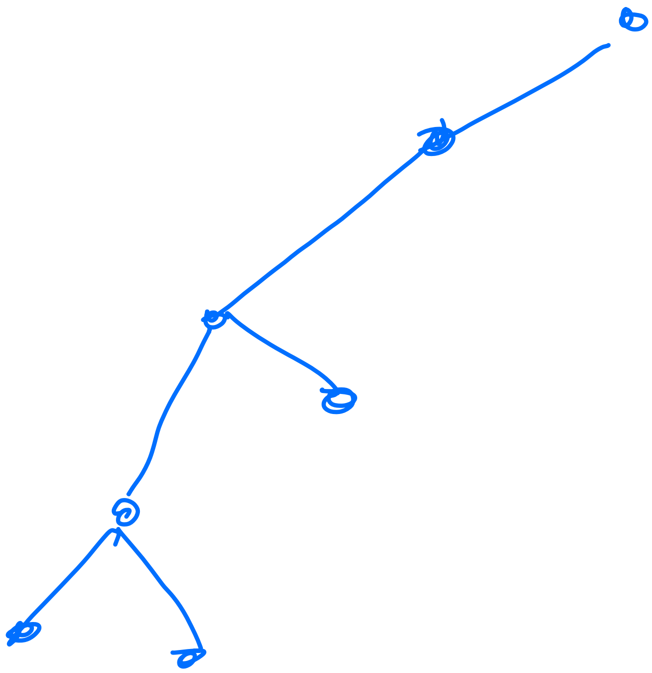
Size prediction

Multi-Class



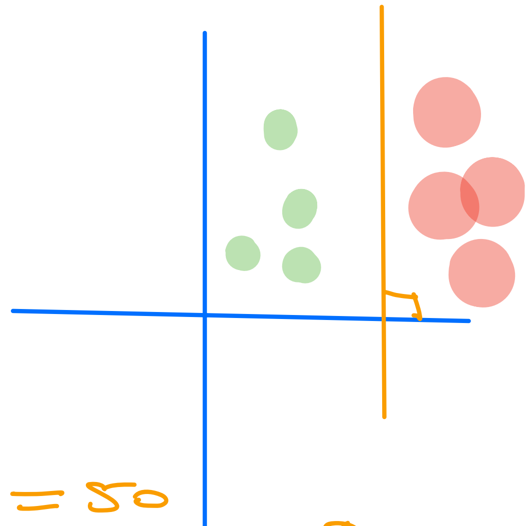
M Sleeve Type

variation pred



$m\theta$ Tan θ

$\theta \leftarrow$ Tango



$w_1x_1 + w_2x_2 + w_3x_3 = 50$

≥ 20

$\vec{w}^T \cdot \vec{x}$

x_1	x_2	x_3	yes
10	20	30	✓
20	30	10	✗
40	50	60	✓