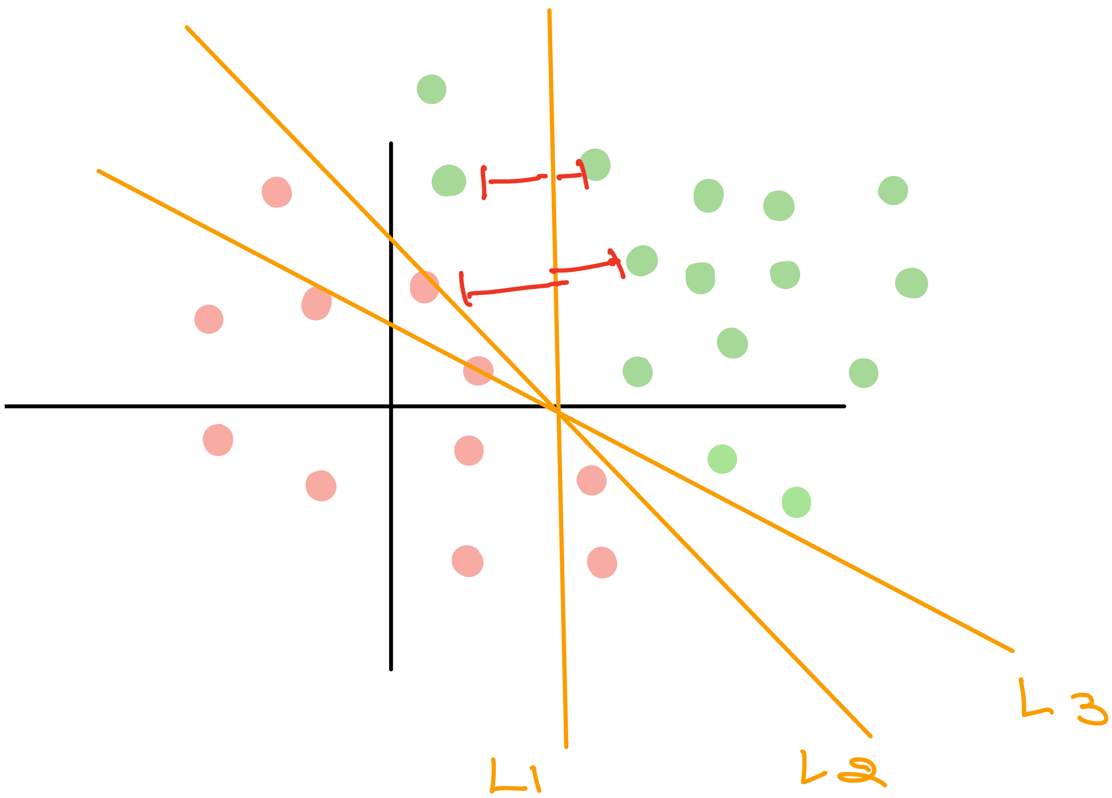
Agenda

1) Basic intuition of Classifier
2) Searching Algorithm: GridSearch
3) Optimization problem: Topics
4) Classification problem: Maths
5) Relationship between gain function and distance
6) Function: Domain and Range
7) Limits and Continuity
8) Homework: Some important F(x)'s

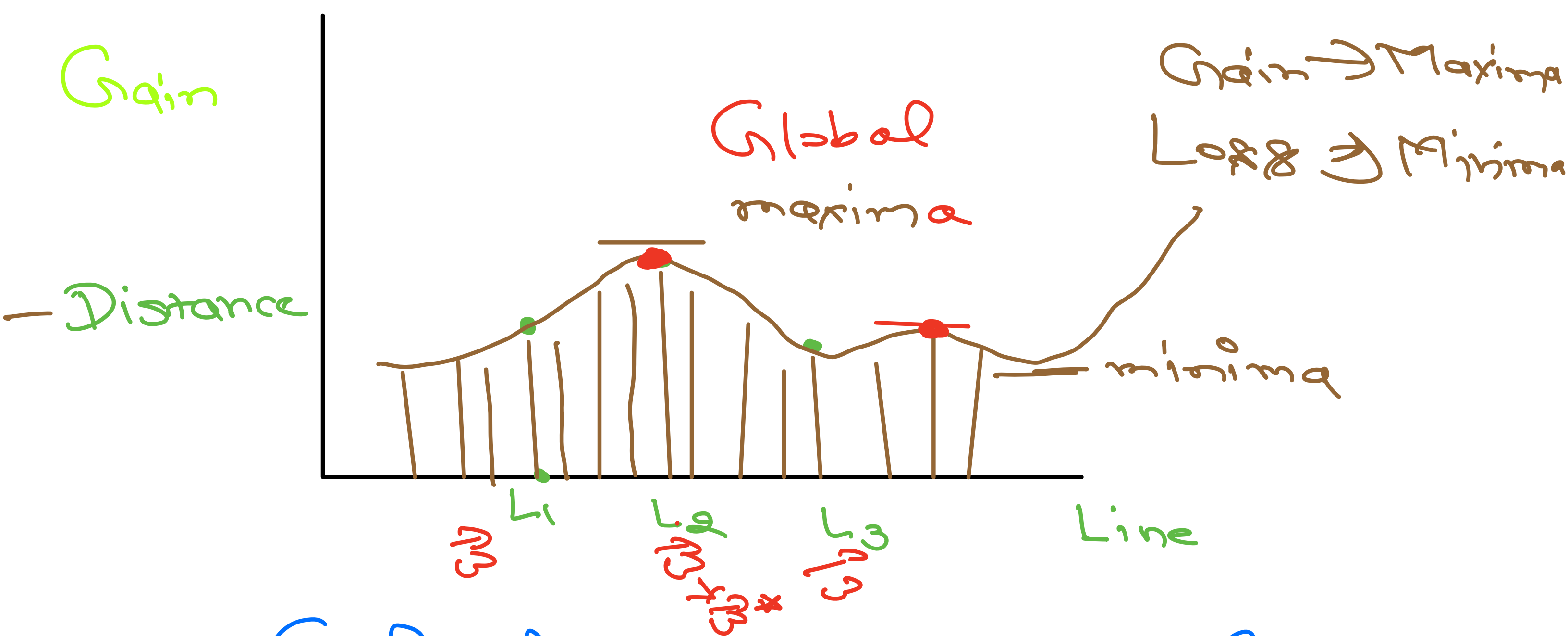
Basic intuition of a Classifier



Metric :

1. Accuracy
2. Distance

$L_1 = 100\%$
$L_2 \Rightarrow 100\%$
$L_3 \Rightarrow 91\%$



Calculus ⇒ Derivatives ?

$10^3 \times 10^3 \times 10^3 - - - - 10^{\omega 10}$ times
$\omega_1 \quad \omega_2 \quad \omega_3$

$\boxed{\text{Grid Search}}$

$\omega_1 \Rightarrow -10, 10 \Rightarrow 10^3$
$\omega_2 \Rightarrow -10, 10 \Rightarrow 10^3$
$\omega_0 \Rightarrow -10, 10 \Rightarrow 10^3$

$$G \Rightarrow \sum_{i=1}^{n} \left(\frac{\vec{\omega}^T \vec{x}_i + \omega_0}{\|\vec{\omega}\|} \right) \times y_i$$

maximum

$10^9 \times 10^{-6}$ seconds ⇒ 1000 secs

Optimize the values of $\omega_1, \omega_2, \omega_3$ to get the maximum G.

Optimization

Gradient Descent ←

(It help us find the best (approximate) value of parameter for any function)

Minima and Maxima

Calculus (Multi Variate)

→ Single Variate

Slope, Tangents and Derivatives

→ Limit, Continuity and Differentiability

→ Functions

Defining Classification problem Mathematically

Given Dataset

feature Vector, labels

$$D : \{(x_i, y_i) : x_i \in \mathbb{R}^d, y_i \in \{-1, 1\}\}_{i=1}^{n}$$

Goal: Find a function $f(x)$ such that

$$f(\vec{x}) = y_i \qquad y_i' = y_i$$

where x is new vector and y_i is pred

$$G(D, \vec{\omega}, \omega_0)$$

$$G \Rightarrow \sum_{i=1}^{n} \left(\frac{\vec{\omega}^T \vec{x}_i + \omega_0}{\|\vec{\omega}\|} \right) \times y_i \qquad G \Rightarrow \sum_{i=1}^{n} g$$

$$G \Rightarrow \sum_{i=1}^{n} g(x_i, y_i, \vec{\omega}, \omega_0) / n$$

Distance Function

$$g(x_i, y_i, \vec{\omega}, \omega_0) \Rightarrow \left(\frac{\vec{\omega}^T \cdot x_i + \omega_0}{\|\vec{\omega}\|} \right) \times y_i$$

pred $\Rightarrow$ y_i or $\hat{y}_i$ $\leftarrow$ Not Unit Vector

$$\vec{\omega}^*, \omega_0^* = \underset{\vec{\omega}, \omega_0}{\operatorname{argmax}} \; G(D, \vec{\omega}, \omega_0)$$

$\vec{\omega}^*, \omega_0^* \rightarrow$ optimal value of $\vec{\omega}$ and ω_0

Question: Relationship between Gain function and Distance

① $G(D, \vec{w}, w_0) = \sum_{i=1}^{n} g(x_i, y_i, \vec{w}, w_0)$

② $G(D, \vec{w}, w_0) = \prod_{i=1}^{n} g(x_i, y_i, \vec{w}, w_0)$

Σ summation ✓

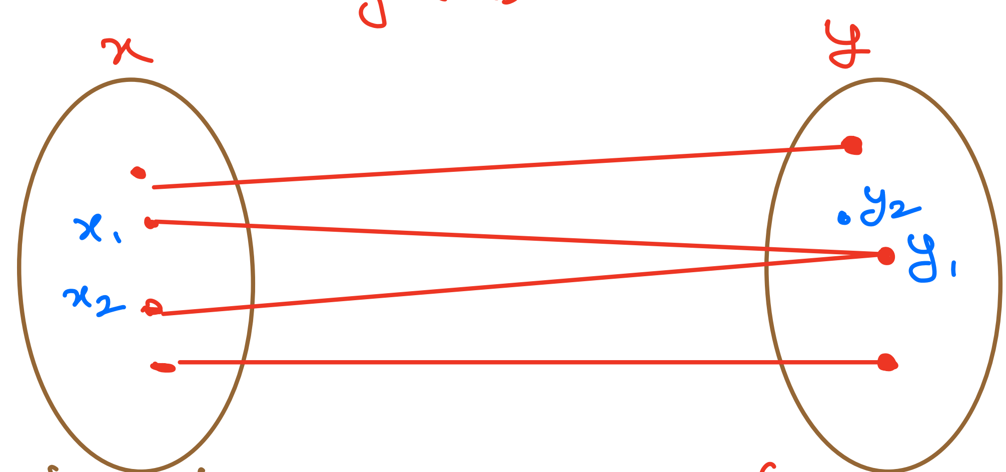
Π multiplication

Functions

$f(x) = y$

mapping between input and output

$f(x) = x^2$



This is a valid F(x)

(All possible input x can take

Domain

(All possible outputs

Range

Ex:- $f(x) = x^2$

Domain

$(-\infty, \infty)$

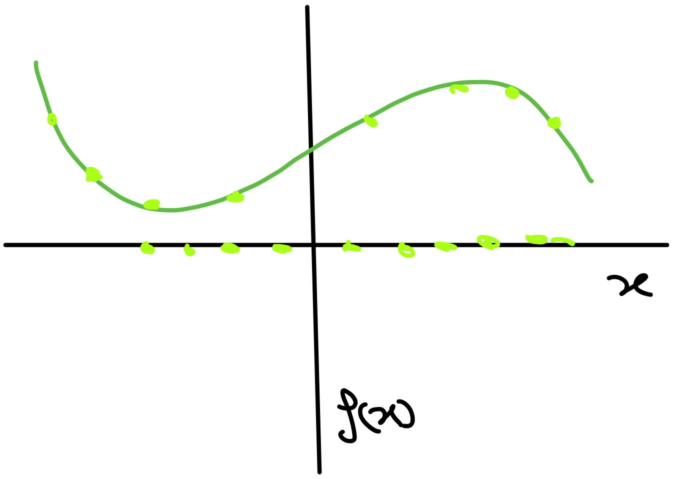
$D \in \mathbb{R}$

Range

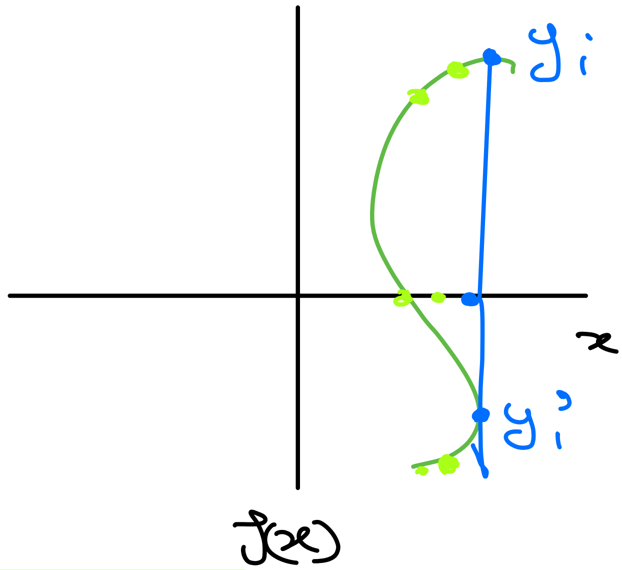
$[0, \infty)$

Q:-

①



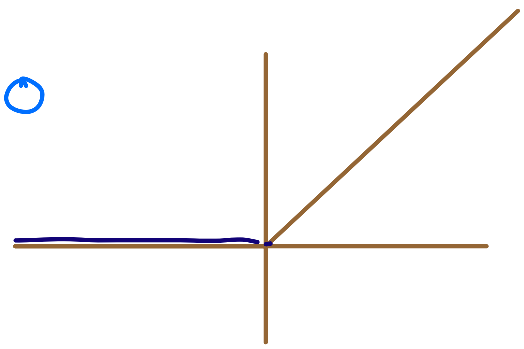
②



Valid Function

For one value of x you can get one and only one y

$$f(x) = x \begin{cases} x & > 0 \\ 0 & \end{cases}$$



(Relu)

Limits and Continuity

L.H.L

$$\lim_{x\to a^-} f(x)$$

Function

Continous   Discontinous

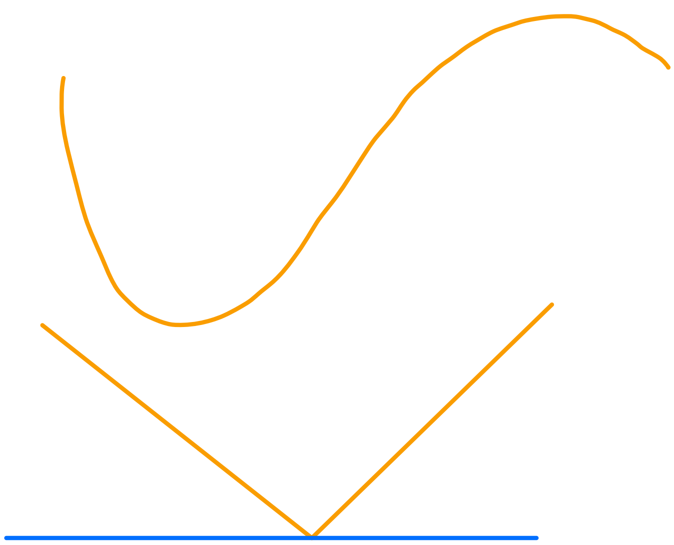
(x is approaching a from Left hand Side)

R.H.L

$$\lim_{x\to a^+} f(x)$$

$$\lim_{x\to a^+} f(x) = \lim_{x\to a^-} f(x) = f(x)_{x=a}$$

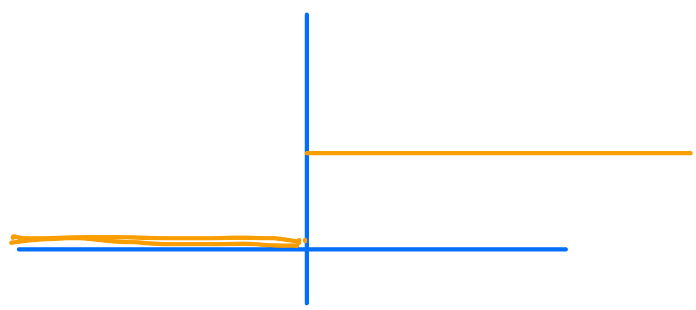
(f(x) is Continous at x = a)



|x|

Step Function

$$f(x) \Rightarrow \begin{cases} 1; & x \geq 0 \\ 0; & x < 0 \end{cases}$$



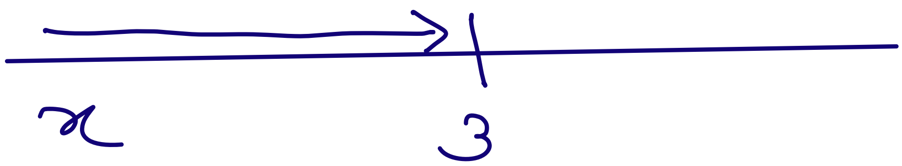
$y = x^2 \Rightarrow$ L.H.L == R.H.L

$\Rightarrow f(x)_3$

$a \to 3$

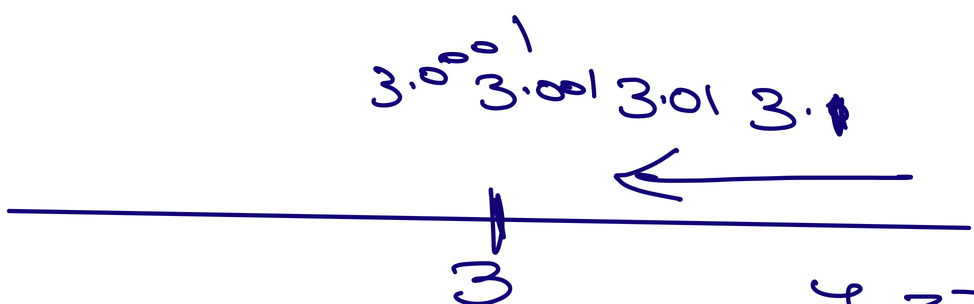
$$\lim_{x \to 3^-} f(x) = 9$$

2.9, 2.99, 2.999, 2.9999



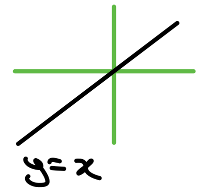
$y \to 9$

$$\lim_{x \to 3^+} f(x) = 9$$



$y = x^2$

H.W

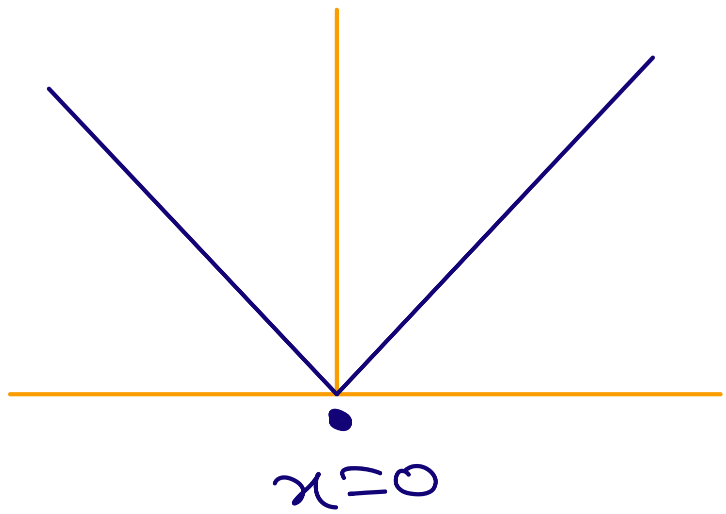
$f(x)$	Domain	Range	Continous	Plot
① $y = x$	$(-\infty, \infty)$	$(-\infty, \infty)$	✓	
② $y = \frac{1}{x}$				
③ $y = e^{x}$				
④ $y = \lvert x \rvert$				
⑤ $y = \log(x)$				
⑥ $y = \frac{1}{1+e^{-x}}$				
⑦ $\sin\theta$				

(8) $y = \cos\theta$

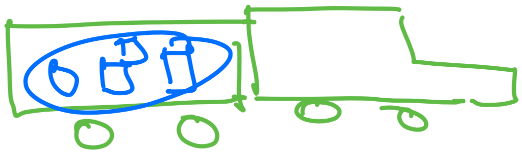
(9) $y = \tan\theta$

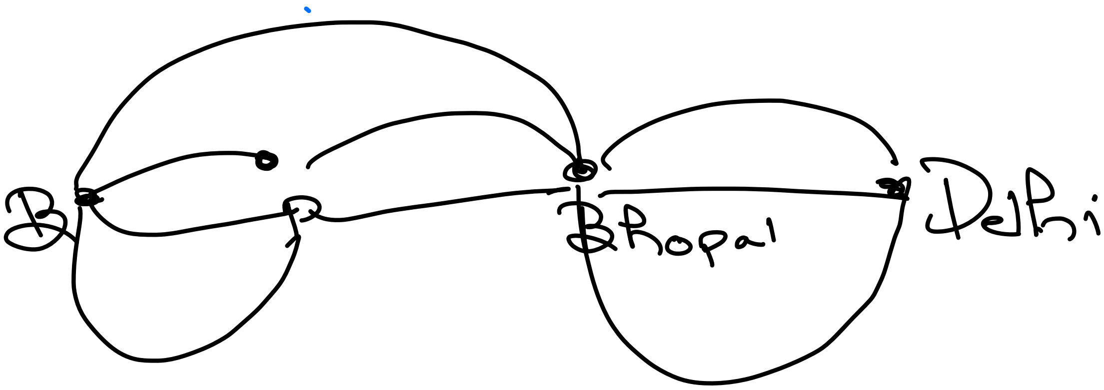
Check Continuity at $x=0$

H.W



Delhivery Intro





OSRM ⇒ Source Destination

↳ suggest most optimal path

↳ Time

Actual Time

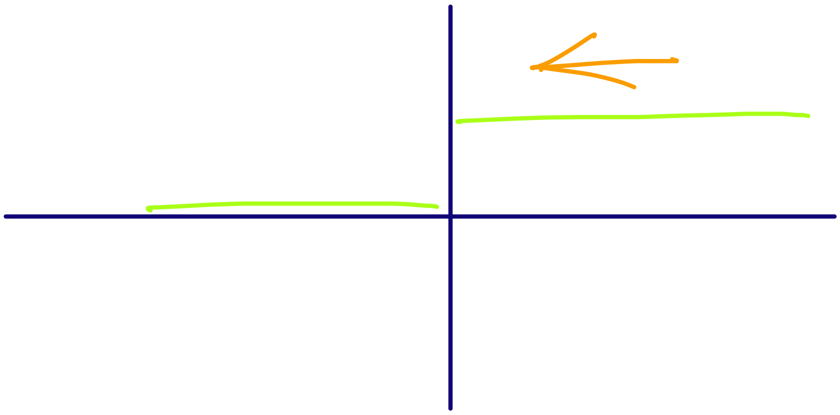
Actual Distance

Actual Time vs OSRM Time

D

$$
\begin{tikzcd}
B \arrow[r, bend left] \arrow[rrr, bend right] & \underset{wh_1}{\bullet} \arrow[r, bend left] & \underset{wh_2}{\bullet} \arrow[r, bend left] & D
\end{tikzcd}
$$

Ex :- Discontin



$fx \Rightarrow \begin{cases} 1 & x \geq 0 \\ 0 & x < 0 \end{cases}$

$\underset{x \to 0^-}{\text{LHL}} \; f(x) \Rightarrow 0$

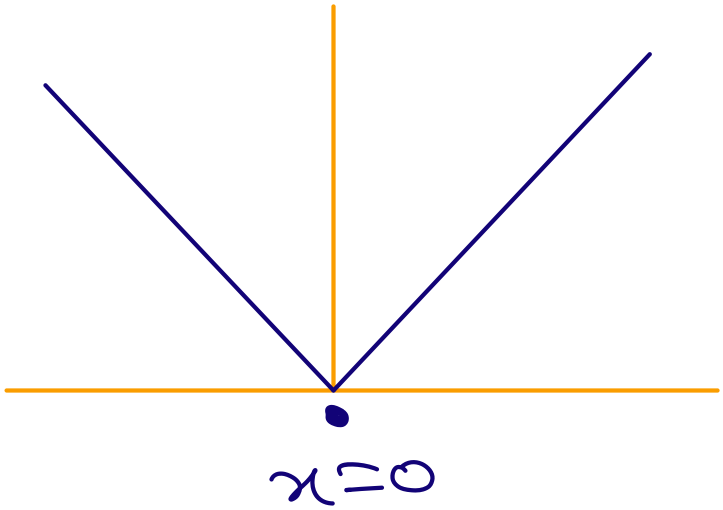
$\underset{x \to 0^+}{\text{RHL}} \; f(x) \Rightarrow 1$

0.1, 0.01
0.001
0.0001

$\underset{x = 0}{f(x)} \Rightarrow 1$

$\text{LHL} \neq \text{RHL} = fx$

H.W



Dataset

70	15	15
Train Set	Val set	Test set
Training AI	Tune Hyperparameter	Evaluating perform

$x = 4, 3, 5$

$a \Rightarrow (1, 2, -1)$

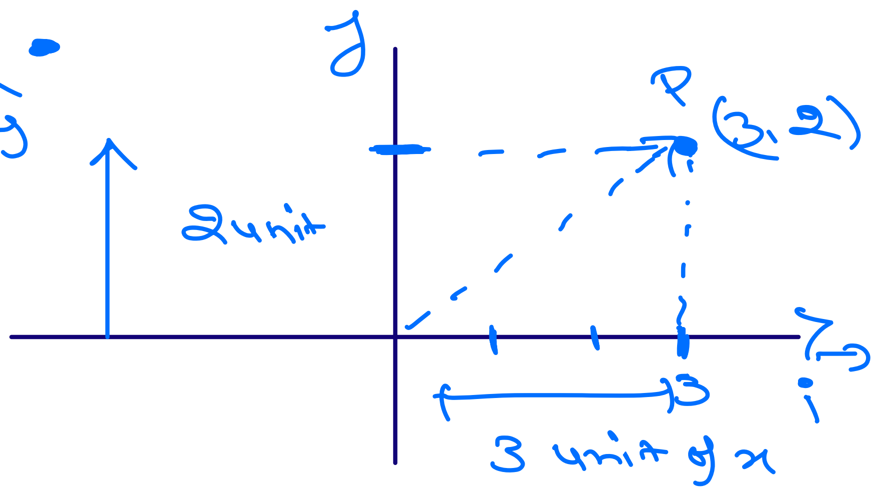
$b \Rightarrow (3, 1, 5)$

$\vec{x}\cdot\hat{a} \Rightarrow \vec{x}\cdot\frac{\vec{a}}{||a||}$

$\vec{x}\cdot\hat{b} \Rightarrow \vec{x}\cdot\frac{b}{||b||}$

$a\hat{i} - b\hat{j}$

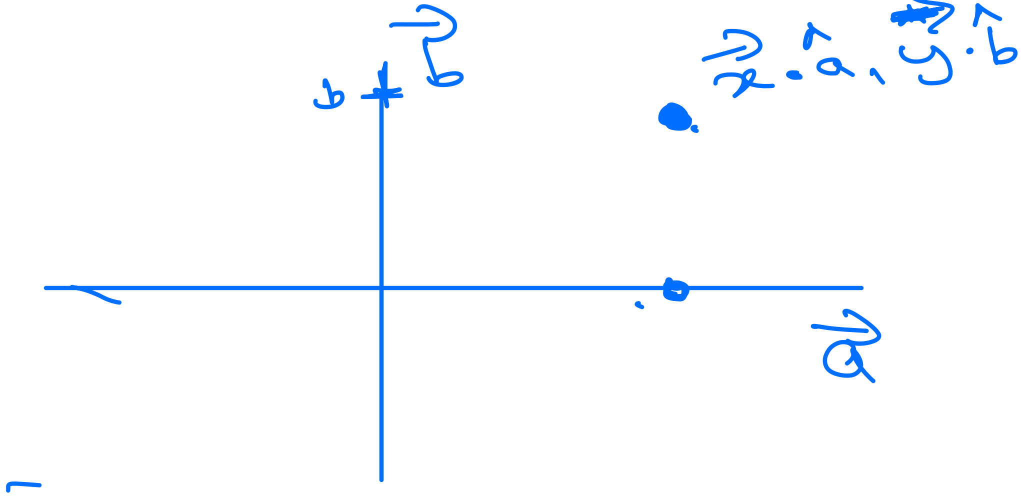
$a\hat{x} - b\hat{y}$

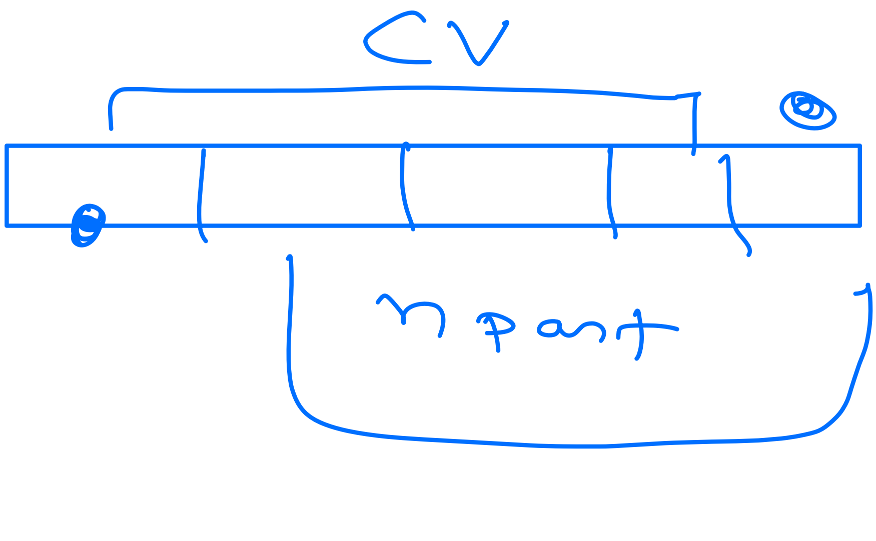


$(3, 2) \Rightarrow 3\hat{i} + 2\hat{j}$

$3\hat{x} + 2\hat{y}$

$\vec{p}$ 3, 2


$\vec{b}$
$\hat{b}$
$\vec{x} \cdot \hat{a}$, $\vec{y} \cdot \hat{b}$
$\vec{a}$


CV
n part