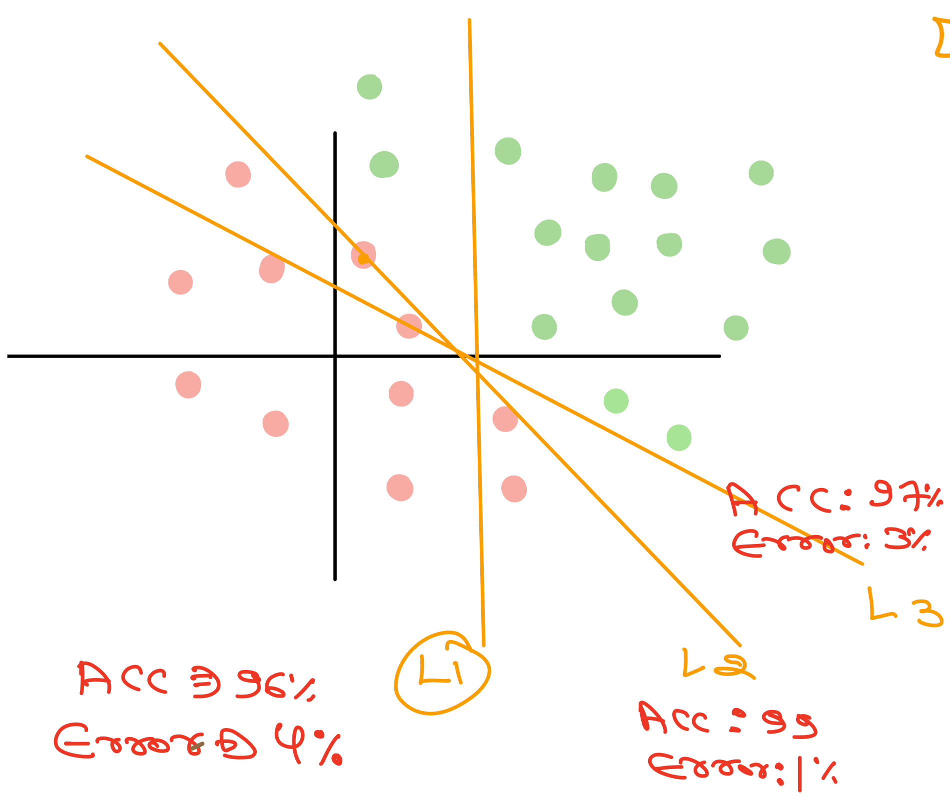
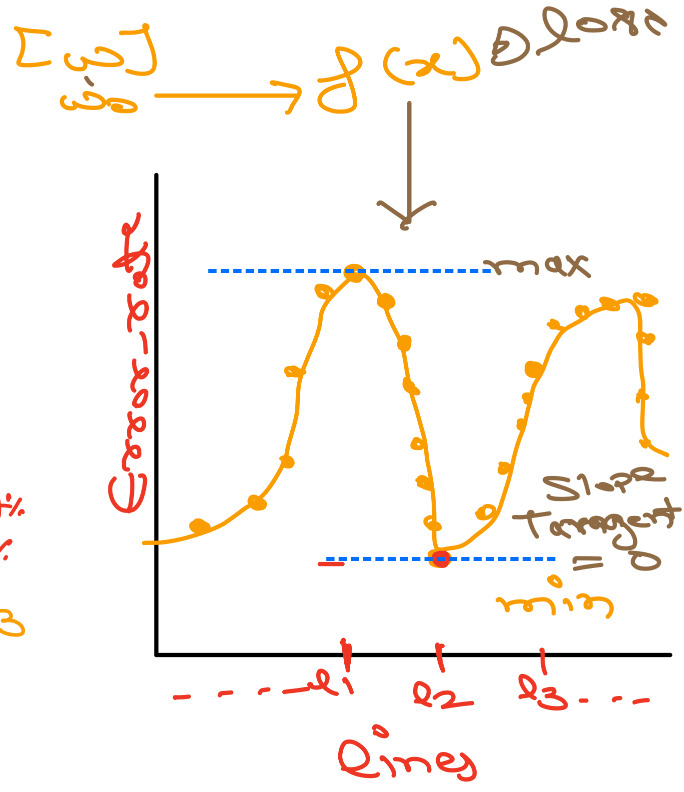
Agenda

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





Simple - Searching Algorithm

feature ⇒ x_1 and x_2

Parameters ⇒ $\underbrace{\overset{\text{weights}}{\underline{w_1, w_2}}, \overset{\text{bias}}{\underline{w_0}}}$

-10, 10, +0.1

w_1 ⇒ [-10, -9.9, -9.8 ... 0, 0.1 ... 9.9, 10] ⇒ 201

w_2 ⇒ [-10, -9.9, -9.8 ... 0, 0.1 ... 9.9, 10] ⇒ 201

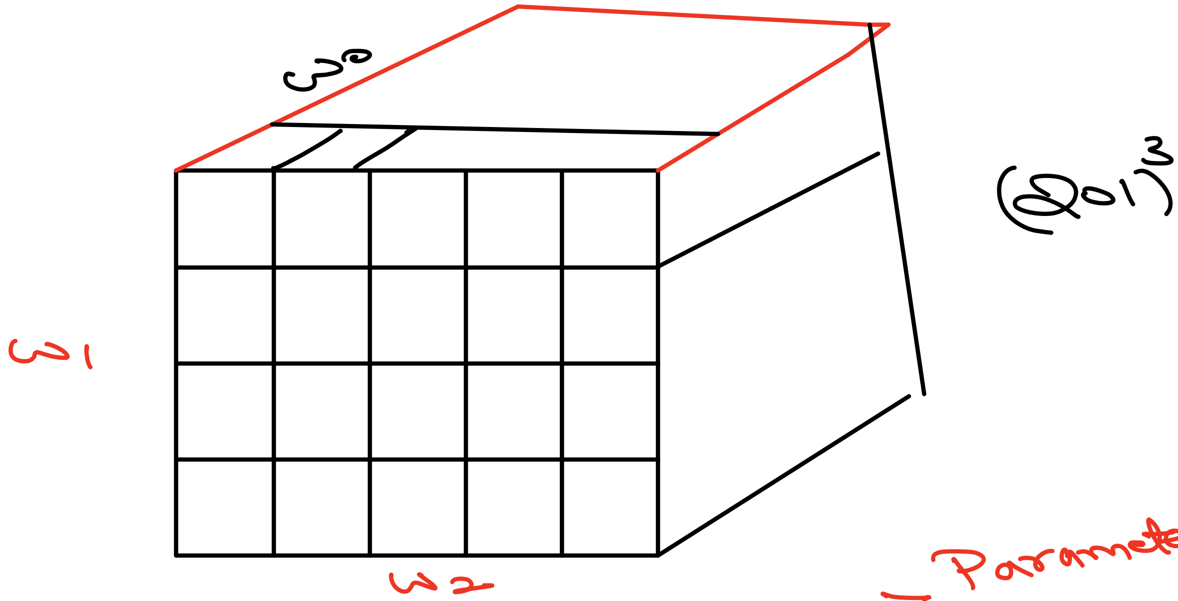
w_0 ⇒ [-10, -9.9, -9.8 ... 0, 0.1 ... 9.9, 10] ⇒ 201

```
for w1 in (-10, 10, 0.1):
    for w2 in (-10, 10, 0.1):
        for w0 in (-10, 10, 0.1):
            loss(w1 w2 w0, d)
```

8 million combinations

w_1^* w_2^* w_0^* ← min loss / max Gain

* best values / optimal value



Grid Search → Parameter ✗
→ Hyperparameter

x_1 x_2 x_3

$\underbrace{w_1 \quad w_2 \quad w_3}_{\text{Paramet}}$ $\quad \underset{\text{bias}}{w_0}$

Optimization with Calculus

Gradient Descent

(Calculus based optimization technique to find optimal values)

- Minima and Maxima
- Calculus (Multi Variate)
- → Single Variate
- Slope, Tangents and Derivatives
- Limit, Continuity and Differentiability
- Functions

Next session: Calculus (Multi Variate), Single Variate, Slope, Tangents and Derivatives

today: Limit, Continuity and Differentiability; Functions

Learning Path

Defining Classification problem Mathematically

Given Dataset

$D : \{ (x_i , y_i) : x_i \in \mathbb{R}^{d \to 2}, y_i \in \{-1, 1\} \}_{i=1}^{n}$

inputs output

x_1	x_2	y	$\hat{y}$
		-1	-1
		+1	+1

inputs Output

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

$f(\bar{x}) = \hat{y}_i$

$\bar{w}, w_0$

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

$\downarrow$ distance

label

Metric $\Rightarrow G(D, \vec{w}, w_0) \Rightarrow$ SOD / Accuracy

Datbase Parameters

$$\boxed{\bar{w}^*, w_0^* \Rightarrow \underset{\bar{w}, w_0}{\operatorname{argmax}}\, G(D, \vec{w}, w_0)}$$

Distance Function

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

x_i, y_i → Point

$\vec{\omega}, \omega_0$ → Parameters of line

Definition:

Optimal value of $\vec{\omega}$ and ω_0: $\vec{\omega}^*, \omega_0^*$

$$\vec{\omega}^*\ \vec{\omega}_0 = \underset{\vec{\omega}, \omega_0}{\operatorname{argmax}}\, G(D, \vec{\omega}, \omega_0)$$

argmax = The best possible value of arguments $\vec{\omega}$ and ω_0 so that Gain function is maximized

Question: Relationship between Gain function and Distance

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

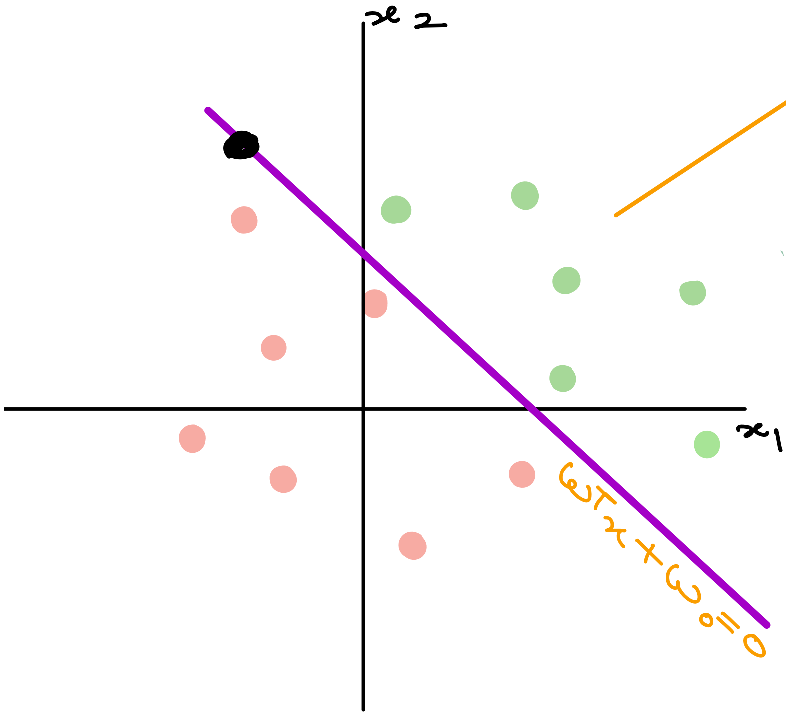
✓

!=0

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

✗

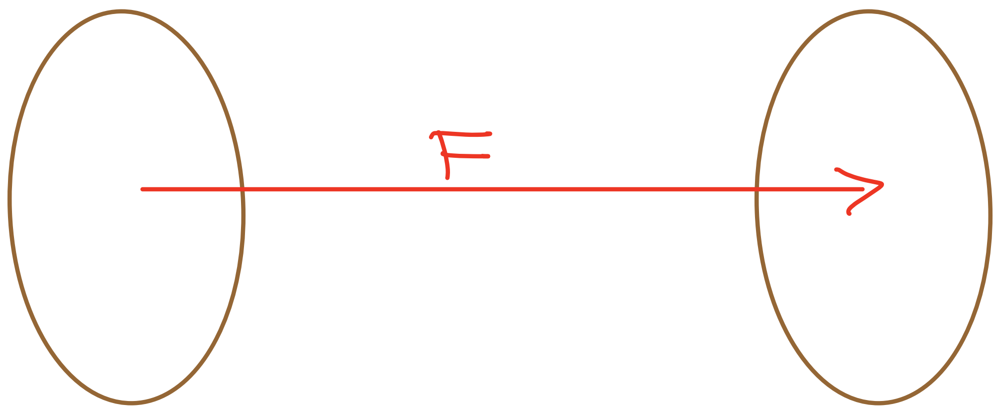
0



Functions

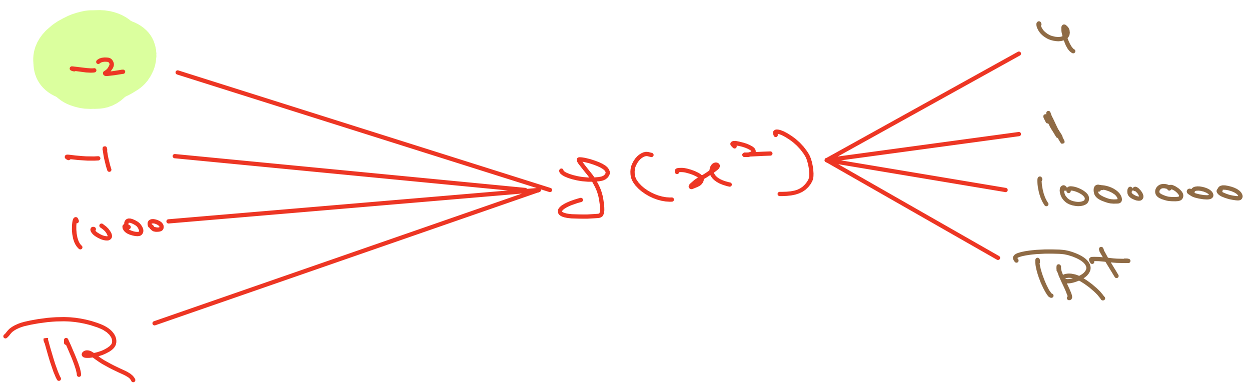
$f(x) = y \longrightarrow f(\text{input}) = \text{output}$

A mapping between input and output



Domain (All the possible input)

Range (All the possible outputs)



Ex:- $f(x) = x$

Domain $\Rightarrow (-\infty, \infty)$

Range $\Rightarrow (-\infty, \infty)$

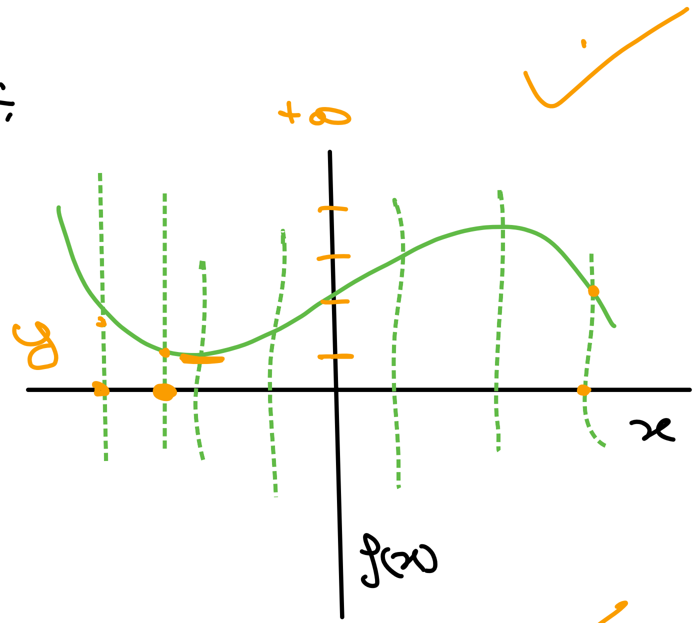
$f(x) = x^2$

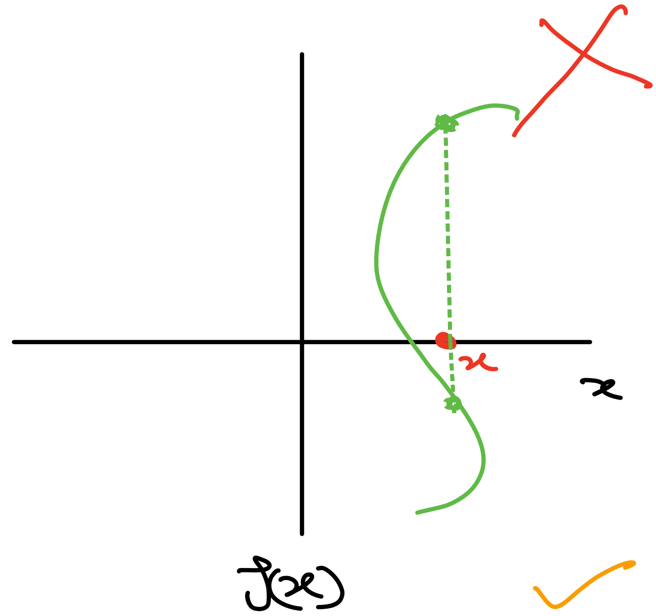
Domain $\Rightarrow (-\infty, \infty)$

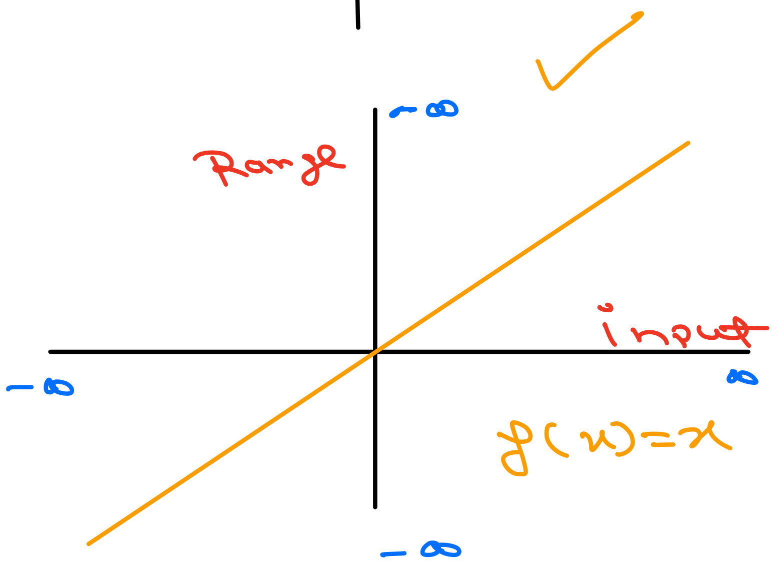
Range $\Rightarrow (0, \infty)$

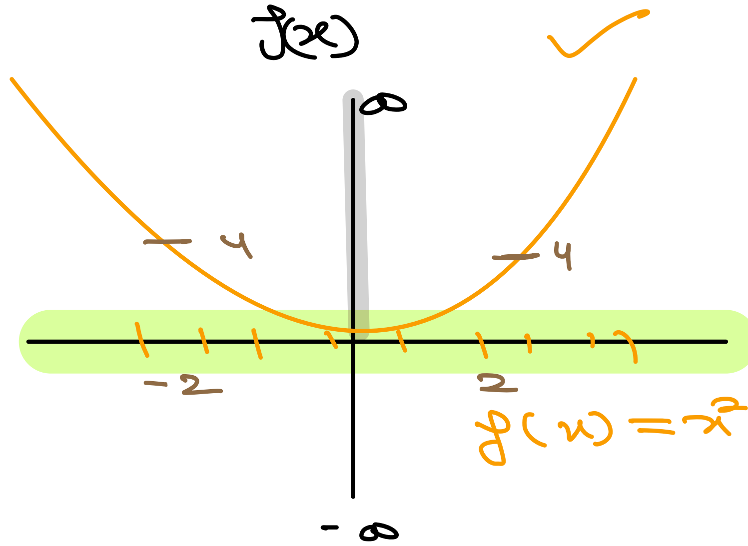
For a value of x, function can return only one y

Q:









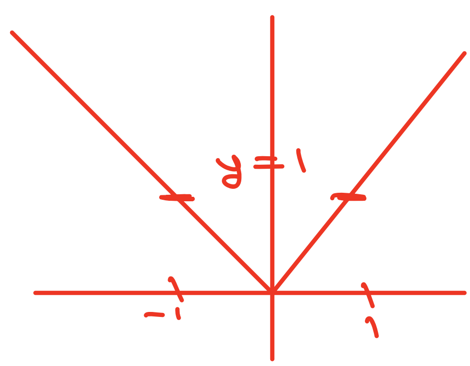
$f(x) = \text{Sqrt}(x)$

Domain = $\mathbb{R}^+$

Range = $\mathbb{R}^+$

Valid f(x)

$y = |x|$



Quiz time!

Quiz Ended!

Which condition must a relation satisfy to be considered a function?

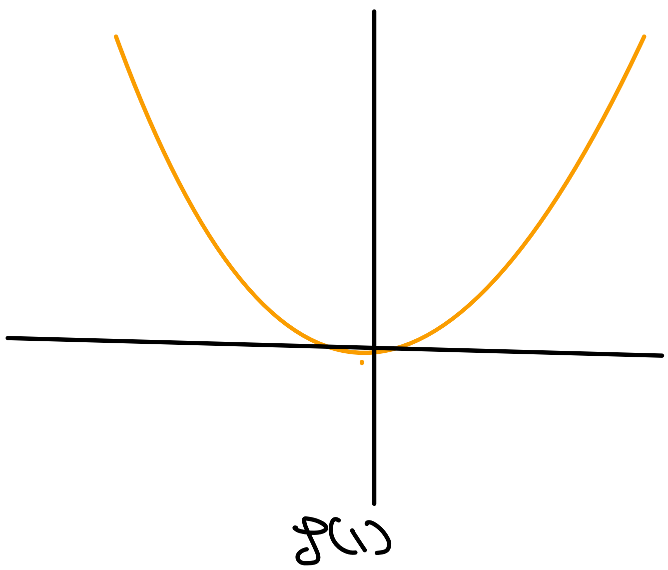
23 users have participated

A	For every y, there must exist multiple x values.	9%
B	For every x, there must exist multiple y values.	13%
C	For every x, there must exist only one y value.	70%
D	For every y, there must exist only one x value.	9%

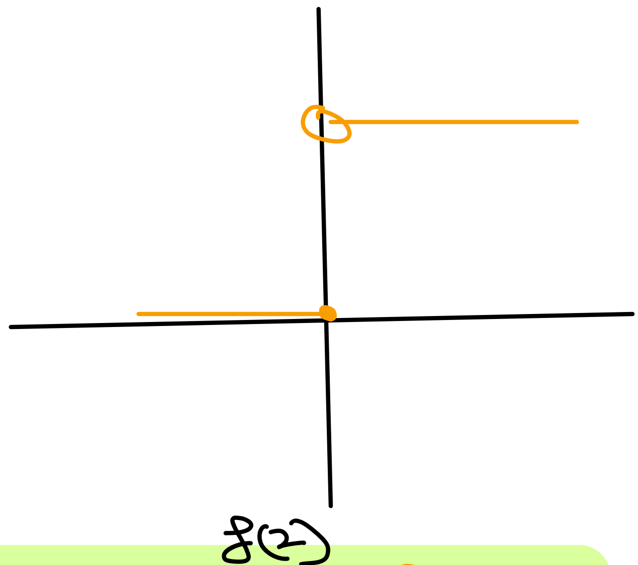
Limits and Continuity

function

Continous function



discontinous function



Not Continous @ $x=0$

If you can draw graph of f(x) without lifting your pen it's considered continous.

L.H.L @ point ⇒ 3

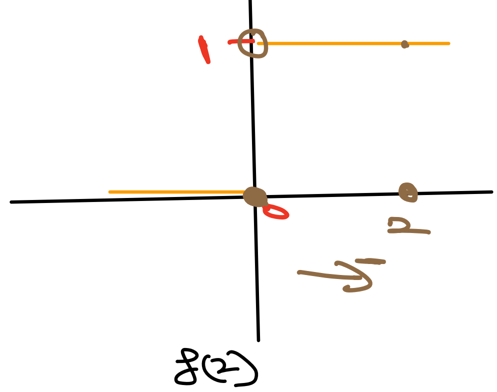
$$\lim_{x \to 3^-} f(x) \Rightarrow 9$$

2.9, 2.99, 2.999, 2.999

⇒ As we approach x from Left hand side, the value of y is L.H.L of x

$\lim_{x \to 2^-} f(x) = 1$

$\lim_{x \to 0^-} f(x) = 0$



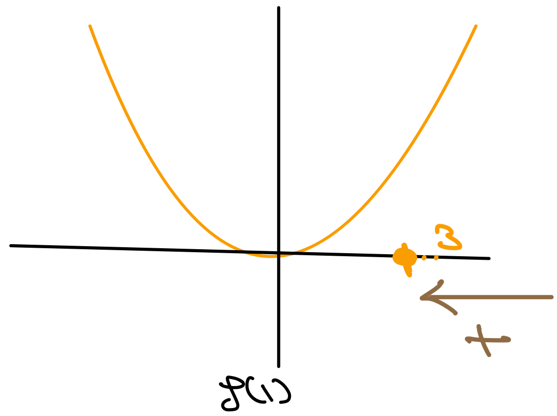
$-0.1, -0.01, -.001$

R.H.L

$f(x) = x^2$

① $\lim_{x \to 3^+} f(x) = 9$

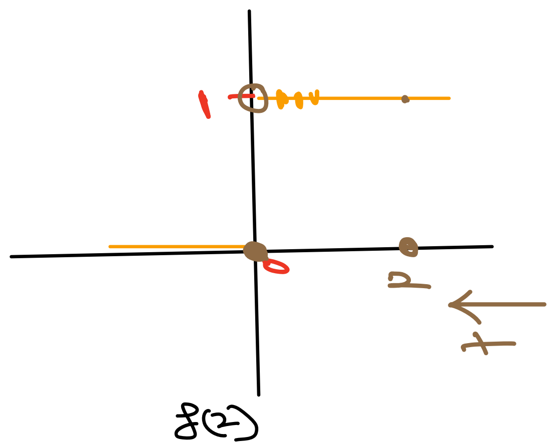
$3.1, 3.01, 3.0001$



② $\lim_{x \to 2^+} f(x) = 1$

③ $\lim_{x \to 0^+} f(x) = 1$

$0.1, 0.01, 0.001, 0.0001$



$-0.1, -0.01, -.001$

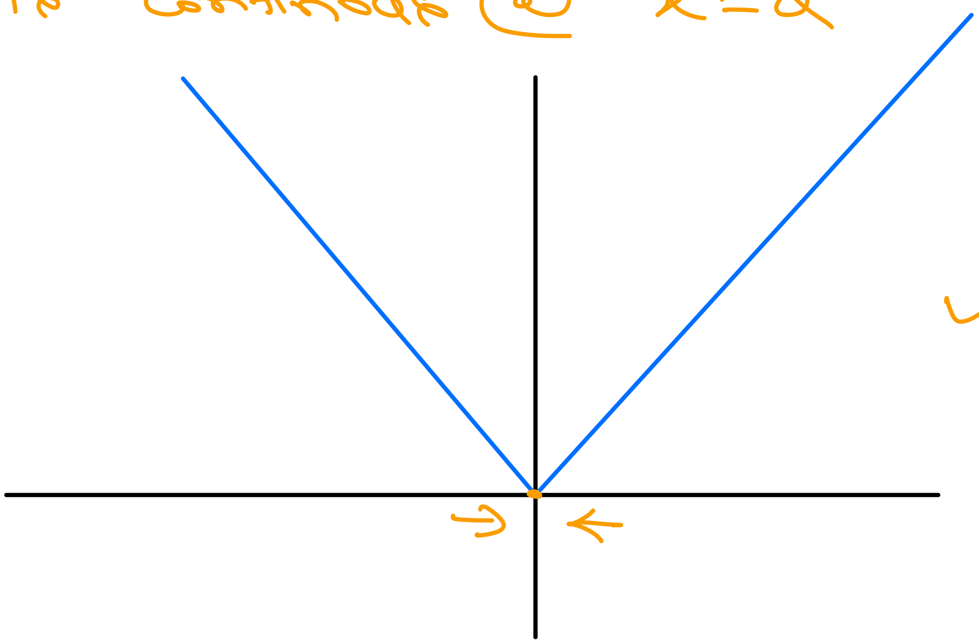
If L.H.L == R.H.L = f(P) at some point P, the f(x) is continous at P

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

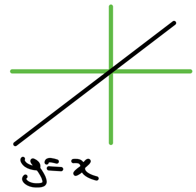
R.H.L = L.H.L = f(x)

f(x) is continous @ x = a

$f(x) = |x|$



H.W

f(x)	Domain	Range	Continous	Plot
① $y = f(x)$	$(-\infty, \infty)$	$(-\infty, \infty)$	✓	

② $y = \frac{1}{x}$

③ $y = e^{x}$

④ $y = |x|$

⑤ $y = \log(x)$

⑥ $y = \frac{1}{1+e^{-x}}$

⑦ $\sin\theta$

⑧ $y = \cos\theta$

⑨ $y = \tan\theta$