Welcome Back

Agenda

1. Maths Complete
2. Linear Regression Intuition + Example

Determinant of a matrix

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$$

$$|A| = 4 - 2 \cdot 3 = -2$$

Matrices & Determinants

$$\begin{bmatrix} a & b \\ c & d \end{bmatrix} = ab - cd$$

$$\begin{bmatrix} \boxed{a_1} & \boxed{b_1} & \boxed{c_1} \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{bmatrix} = a_1 \begin{bmatrix} b_2 & c_2 \\ b_3 & c_3 \end{bmatrix} - b_1 \begin{bmatrix} a_2 & c_2 \\ a_3 & c_3 \end{bmatrix} + c_1 \begin{bmatrix} a_2 & b_2 \\ a_3 & b_3 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 2 & 3 \\ 4 & 6 & 8 \\ 5 & 7 & 9 \end{bmatrix} \Rightarrow 1[54-56] - 2[36-40] + 3[28-30]$$

$$= 1[-2] - 2(-4) + 3(-2)$$

$$= -2 + 8 - 6$$

$$= 0$$

Inverse of a matrix

$$A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

$$A^{-1} = \frac{1}{\det(A)} \begin{bmatrix} d & -b \\ -c & a \end{bmatrix} \quad \text{if } \det(A) \neq 0$$

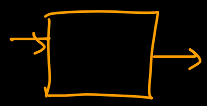
$$\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}^{-1} = \frac{1}{4-(6)} \begin{bmatrix} 4 & -2 \\ -\cancel{3} & 1 \end{bmatrix}$$

$$= \frac{1}{\cancel{-2}} \begin{bmatrix} 4 & -2 \\ -3 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} -2 & 1 \\ 1.5 & -0.5 \end{bmatrix}$$

Calculus

function $f(x)$



relationship b/w input & output

Limit on a function

Calculus

Diffrentiation   Integration

$$y = f(x) = \boxed{}$$

Diffrentiation

diffrentiation $\Rightarrow$ change in y wrt x

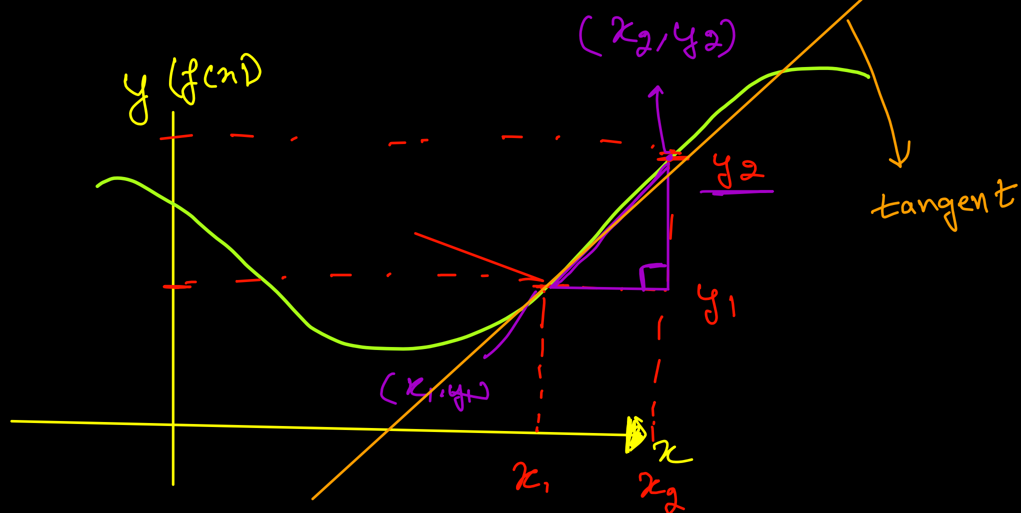
y = dependent variable
x = independent variable

$$\frac{dy}{dx} = y' = f'(x)$$

Student

Study hrs		Scores	Area		Price
	$\rightarrow$			$\rightarrow$	
	$\rightarrow$			$\rightarrow$	
	$\rightarrow$			$\rightarrow$	
	$\rightarrow$			$\rightarrow$	
	$\rightarrow$			$\rightarrow$	

$\frac{dy}{dx}$ = Change in x wrt y.



Slope $= \frac{y_2 - y_1}{x_2 - x_1}$ $\Rightarrow$ its a change of y wrt x

$= \frac{\Delta y}{\Delta x}$

$\boxed{\Delta \text{price}} = 12 - 10$
$= 2$

Partial differentiation

$$\frac{\partial y}{\partial x}$$

price of house $= y = 3x_1 + 4x_2$

$x_1 \Downarrow$ climate

$x_2 \Downarrow$ area of house

Let us assume that climate & area are some how dependent on each other.

$$\frac{\partial y}{\partial x_1} = \frac{\partial 3x_1}{\partial x_1} + \cancel{\frac{\partial (4x_2)}{\partial x_1}} \rightarrow 0$$

$$\frac{dy}{dx_1} = \frac{d(3x_1)}{dx_1} + \frac{d(4x_2)}{dx_2} \times \frac{dx_2}{dx_1}$$

$y \rightarrow f(x) \rightarrow g(u)$

$$\boxed{\frac{dy}{dx} = \frac{d\,g(u)}{du} * \frac{du}{dx}}$$

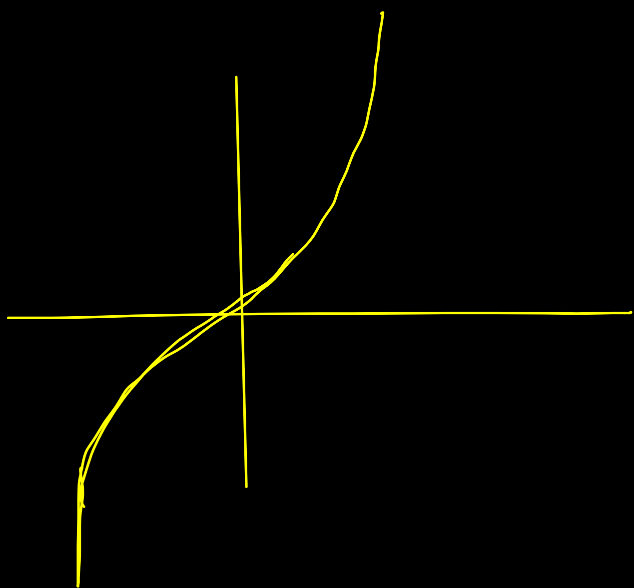
Rules of Differentiation

Sum rule $\frac{d(f_1(x)+f_2(x))}{dx} = \frac{df_1(x)}{dx} + \frac{df_2(x)}{dx}$

$\frac{d}{dz}(ax_1 + bx_2) \Rightarrow \frac{d(ax_1)}{dz} + \frac{d\, bx_2}{dz}$

Power Rule

$\frac{d\, x^{3}}{dx} = 3x^2$ $\quad \frac{dx^n}{dx} = nx^{n-1}$



Product rule

$$f(x) = u(x) * v(x)$$

$$\frac{d\,f(x)}{dx} = u(x)\left(\frac{d\,v(x)}{dx}\right) + v(x)\left(\frac{d\,u(x)}{dx}\right)$$

Chain rule

$$y = f(x) = g(u)$$

$$\frac{dy}{dx} = \left(\frac{dy}{du}\right) * \left(\frac{du}{dx}\right)$$

$$y = (x^4 - 1)^{50}$$

$$x^4 - 1 = t$$

$$= t^{50}$$

$$y = \underbrace{(x^4 - 1)^{50}}_{= f(x)} = \underbrace{t^{50}}_{= g(t)}$$

$$y = f(x) = (x^4-1)^{50}$$

$$g(x) = (x^4-1)^{*}$$

$n = 50$

$$t = g(x) = x^4 - 1$$

$$\boxed{u(t) = t^{50}}$$

$$y = f(x) = u(g(x))$$

$u(t) = t^{50}$

$u(x^4-1) = (\cancel{x^4}-1)^{50}$

$u(g(x))$

$$t = x^4 - 1$$

$$\boxed{\frac{df}{dx} = \frac{du}{dt} * \frac{dt}{dx}}$$

$$= \frac{du}{dt} * \frac{dt}{dx}$$

$t = x^4 - 1$

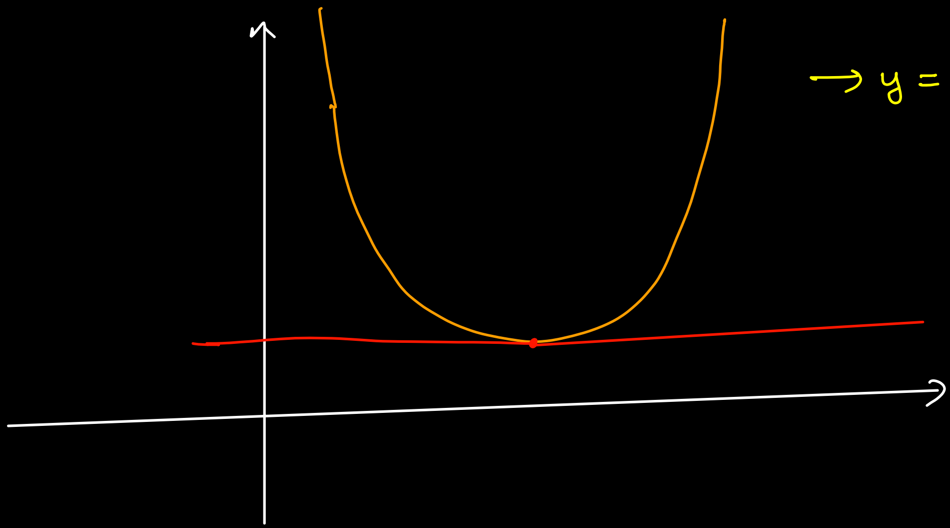
$\frac{dt}{dx} = 4x^3$

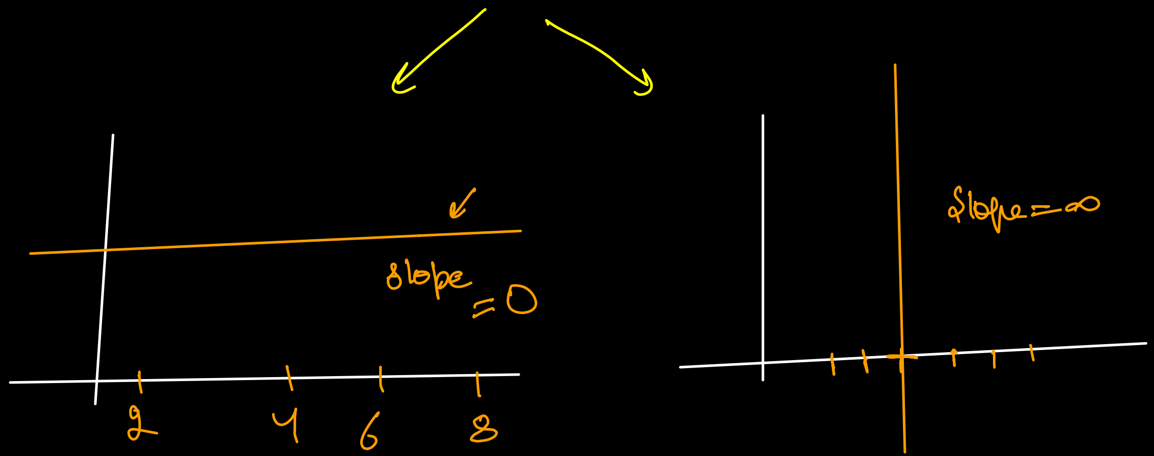
t^{50}

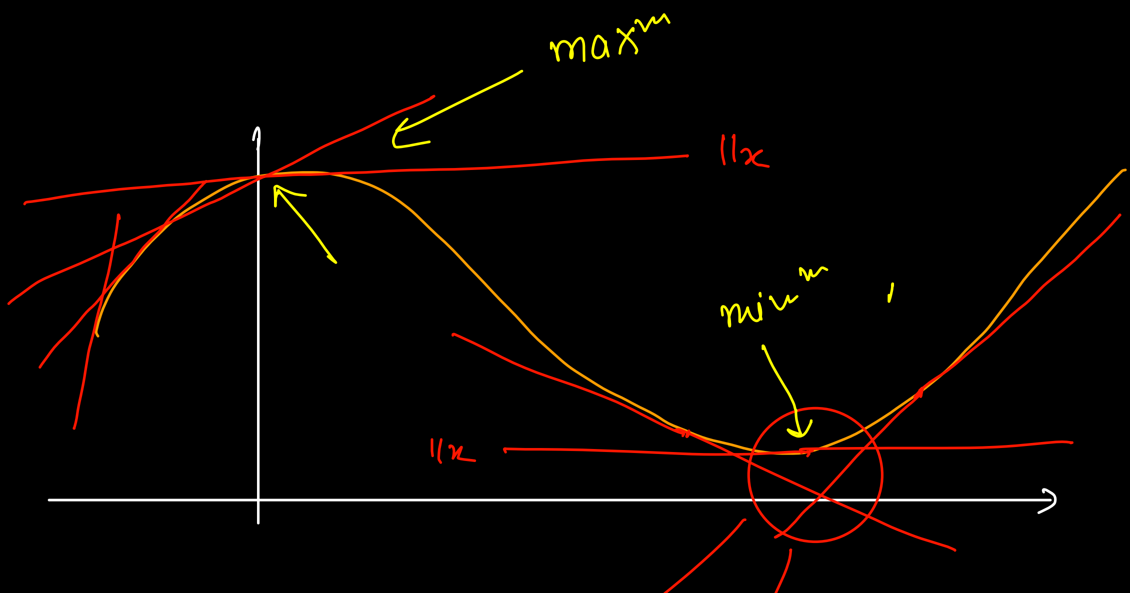
$$= 50t^{49} * 4x^3$$

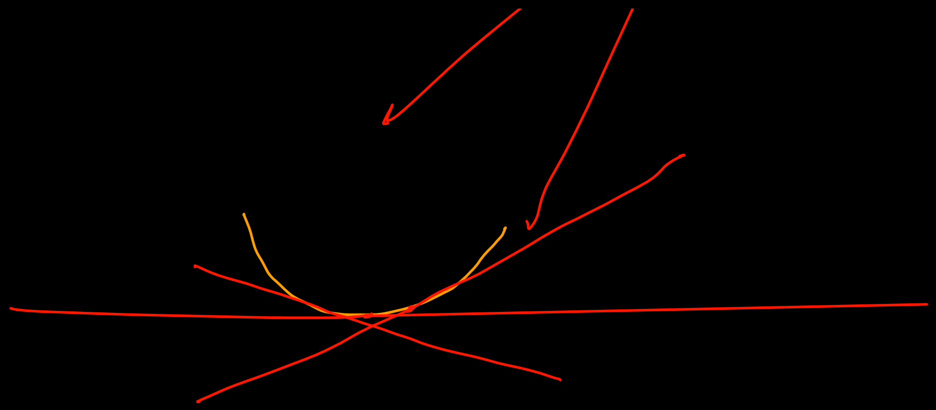
$$= 50(x^4-1) * 4x^3$$

Minima & maxima









When my slope is 0, we get the maxm / minm.

$$\frac{dy}{dx} = \text{slope} = 0$$

I am gonna get point of maxima / minima.

$$y = 3x^2 + 2$$

$$\frac{dy}{dx} = \frac{d(3x^2)}{dx} + \cancel{\frac{d(2)}{dx}} \to 0$$

$$= 6x$$

$$3\boxed{\frac{dx^2}{dx}}$$

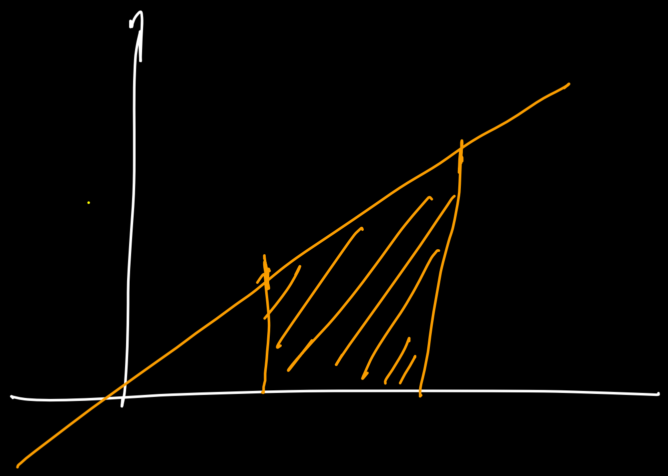
$$\Downarrow$$

$$2x^{2-1} = 2x^1$$

$$\frac{dy}{dx} = 0 \Rightarrow 6x = 0$$

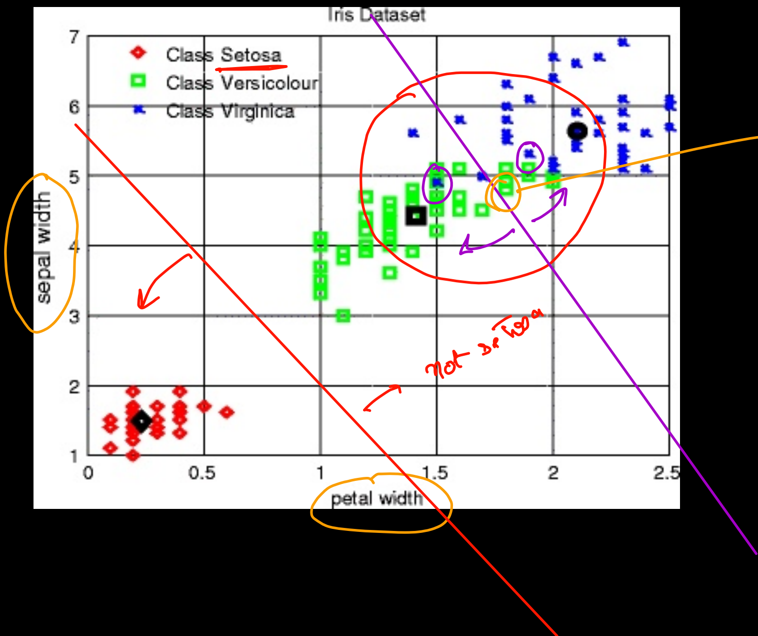
$$\underline{x = 0}$$

Integration ⇒



Probability

iris dataset



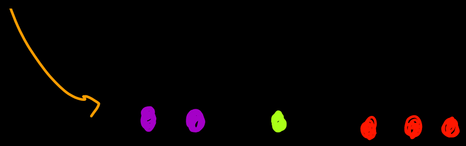
what is your Probability of being versicolor or Virginica

$$\text{Probability} = \frac{\text{Favourable Outcomes}}{\text{Total Outcomes.}}$$

$P(\text{green}) = \frac{2}{7}$

$P($ violet $)$ given that green bowl is already removed/got out.

→ condⁿ



$P(\text{violet}) = 2/6$

Conditional Probability

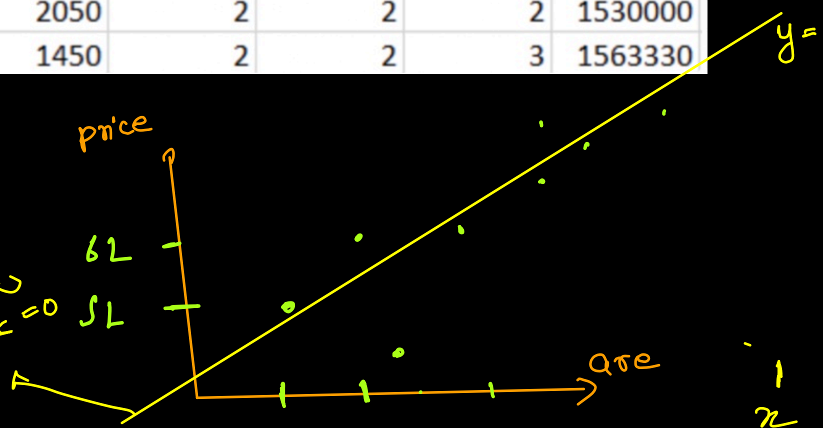
Statistics

Linear Regression

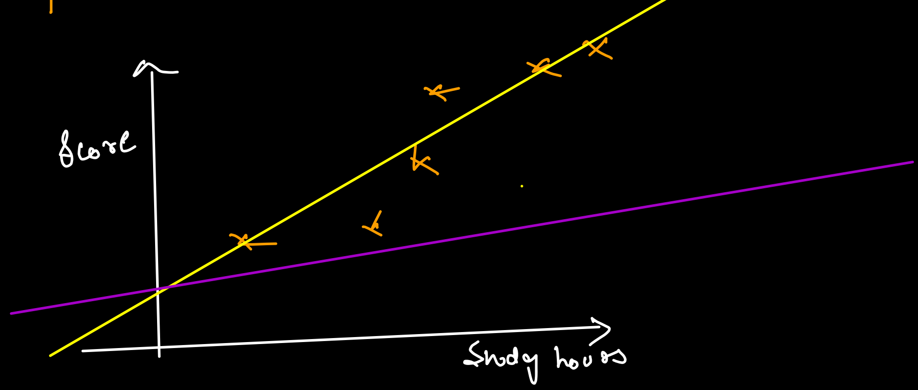
	A	B	C	D	E
1	area	bedrooms	balcony	age	price
2	1200	2	0	2	500000
3	2300	3	2	5	620000
4	2500	4	2	1	122500
5	3650	5	3	3	6000000
6	1800	3	1	5	2122000
7	3000	3	1	4	120000
8	1222	1	0	2	450000
9	4600	5	3	1	6500000
10	2050	2	2	2	1530000
11	1450	2	2	3	1563330

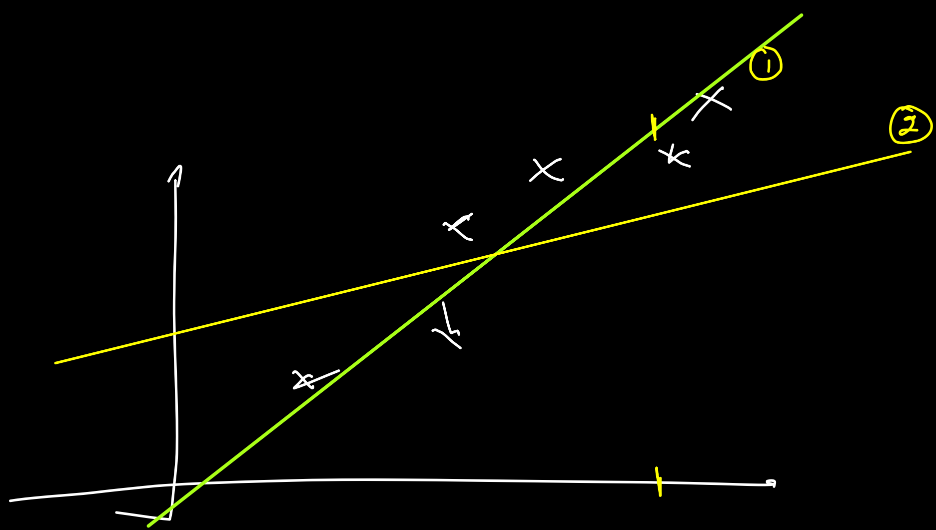
$mx + c \approx w$

$Ax + y \cancel{+c} = 0$



Study Hours	Test Prep Hours	Score
3	2	75
5	1	82
2	3	69
7	2	88
4	4	78
6	1	85
1	2	62
3	3	72
5	4	80
4	2	76





$\Rightarrow$ It is a prediction algorithm

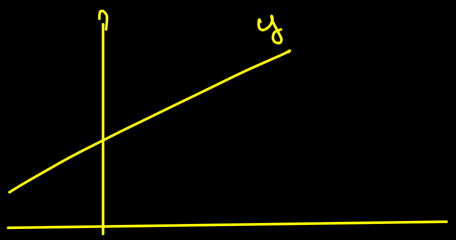
$\Rightarrow$ It is used for regression problem

$\Downarrow$

we have
continous value as O/P

Give training data $\longrightarrow$ learn some f^n

$$Score = \underline{3} * \text{study hrs} + \underline{5}$$



$$y = \underline{3x} + 5$$

$$X \longrightarrow \boxed{\quad\quad} \longrightarrow Y$$

want our algo
start giving us
some output based
on training.

new values → **predicted fn** → predicted O/P

$\Downarrow$

hypothesis fn

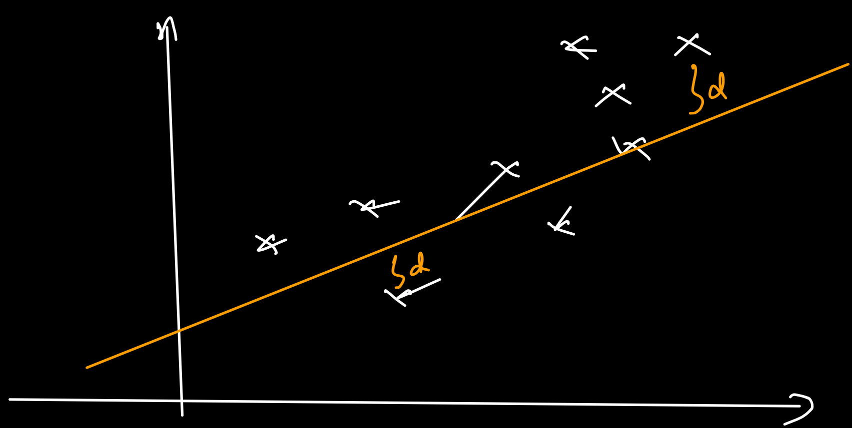
3 features

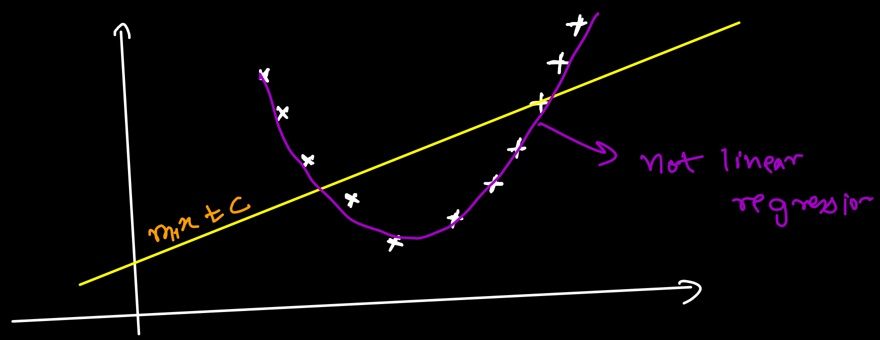
$$\underset{\substack{\Downarrow \\ \text{score}}}{y} = m_1 \underset{\substack{\Downarrow \\ \text{study hrs}}}{x_1} + m_2 \underset{\substack{\Downarrow \\ \text{play hrs}}}{x_2} + m_3 \underset{\substack{\Downarrow \\ \text{sleep hrs}}}{x_3} + c$$

$+ m_4 (\underset{\substack{\Downarrow \\ \text{phone model}}}{x_4})$

⇒ Our fn is dependent on each feature linearly.

⇒ more dependency ⇒ more m





We are still gonna predict a line.

$$y = \underline{m_1} x + \underline{c} \longrightarrow 1 \text{ var}$$

$$y = m_1 x_1 + m_2 x_2 + c \longrightarrow 2 \text{ var}$$

$$y = m_1 x_1 + m_2 x_2 + m_3 x_3 + c \longrightarrow 3 \text{ var}$$

$\Rightarrow$ no. of variables $= (n+1)$

n → dim^n

Simple
(1 indep & 1 dep var)

Multiple
(>1 indep. & 1 dep variable)

Simple Linear Regression

1 independent

1 dependent

$$y = \underline{m}\,x + \underline{c}$$

$$h_\theta(x) = \underline{\theta_1}\,x + \theta_0$$