⇒ Introduction to Machine Learning:

1. Artificial Intelligence:
   To create an application which can perform it's own task without any human intervention
   - e.g
   ① Netflix Recommendation System
   ② Self Driving car

2. Machine Learning
   Machine Learning is the subset of AI. It provides stats tools to analyze, visualize, prediction and forecasting of data

3. Deep Learning:
   Deep Learning is the subset of Machine Learning. The main aim of Deep Learning is to mimic the human brain means the machine learn like we human beings learn.
   ⇒ It use Multi-layered Neural Network.

4. **Data Science:**

Data Science is used in ML, DL and AI.

⇒ 3 Types of Machine Learning:

Machine Learning Techniques

- Supervised ML
- Unsupervised ML
- Reinforcement Learning

1- Supervised ML Technique:

e.g Predict House Price (Regression)

Dataset

Size of house	No. of Rooms	Price
	Independent Features/ Input Features	Dependent or Output Features
5000	5	450K
6000	6	500K

⇒ In supervised learning we get 2 types of problems to solve:

1. Regression (In Regression the values of output feature is continuous)
2. Classification

(In classification the output feature is categorical)

• e.g Classification

Independent feature → No. of study hours, No. of play hours

Dependent feature → Pass/Fail

No. of study hours	No. of play hours	Pass/Fail
7	3	Pass
2	6	Fail

⇒ If a classification problem has only two categories then it is **Binary classification**

⇒ If a classification problem has more than 2 categories then it is called **Multiclass Classification.**

⇒ In supervised Machine learning we must have a dependent or output feature.

⇒ In supervised ML, we have to predict the output

② **unsupervised ML:**
e.g Customer segmentation Dataset

Salary($)	Spending Score (1-10)
20000	9
45000	2
—	—
—	—

I am an Ecommerce Company

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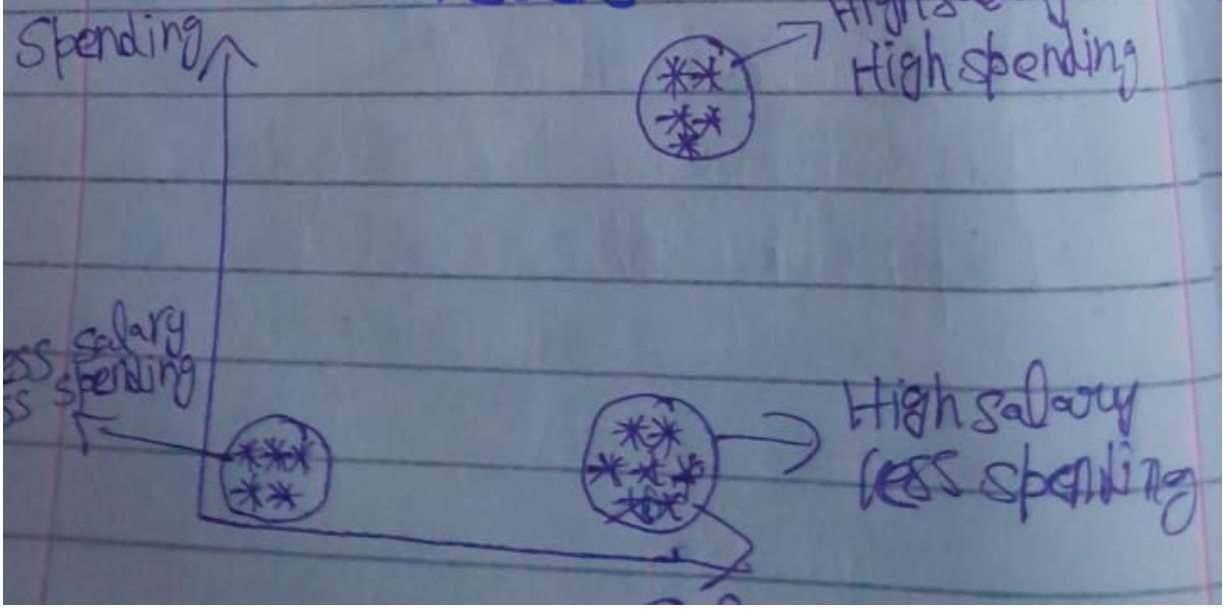
I have to send Email with some discount to customers

⇒ Using unsupervised ML we create **clusters**



⇛ In unsupervised ML we have no output feature and we don't predict anything.

⇛ In unsupervised ML we make clusters.

- Algorithms to be discussed

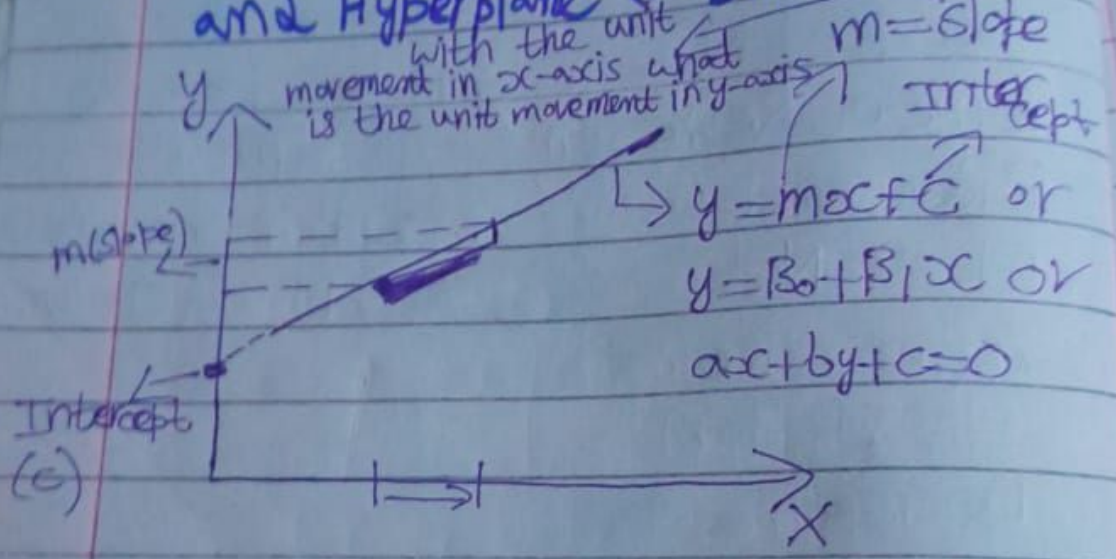
Supervised ML	Unsupervised ML
① Linear Regression	① KMeans
② Ridge and Lasso	② Heirarchical Mean
③ ElasticNet — Regression	③ DBScan Clusters
④ Logistic Regression (classification)	
⑤ DecisionTree	
⑥ Random Forest	
⑦ AdaBoost	
⑧ XgBoost	

For Both Classification and Regression

3. Reinforcement Learning:

e.g
Baby learn things on their own perform actions and get reward.

⇒ Equation of line, 3D plane and Hyperplane (n Dimension)



In equation of straight line,

$$y = mx + C$$

m ⇒ Slope ⇒ With the unit movement in x-axis what will be the unit movement in y-axis

C ⇒ Intercept ⇒ At x=0 where does the line meet y-axis

Now

$ax + by + c = 0$

$by = -ax - c$

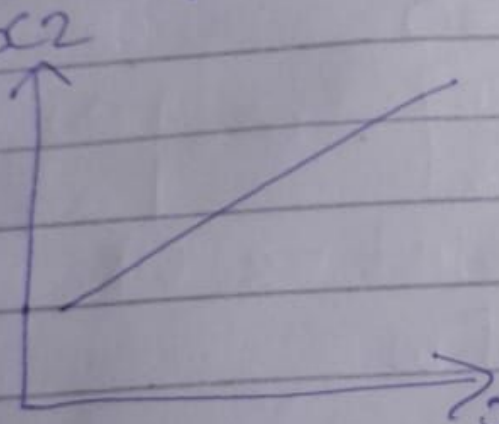
$y = \left[-\frac{a}{b}\right]x + \left[-\frac{c}{b}\right] \rightarrow c$

$\downarrow$

m

So both of these equations represent same

- Another way for equation of straight line:



$w_1 x_1 + w_2 x_2 + b = 0$ → Intercept

$$\boxed{w^T x + b = 0}$$

$\downarrow$

Equation of straight line

$\therefore$ w_1 and w_2 are coefficients

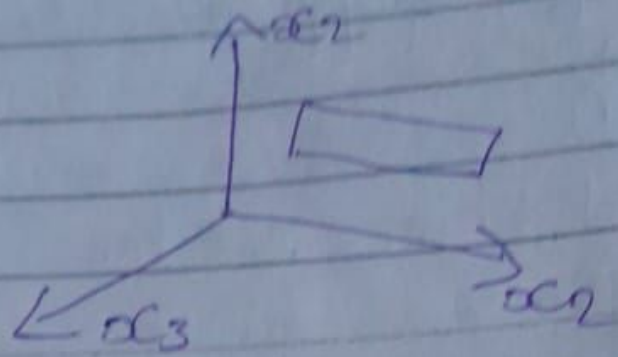
$w = \begin{bmatrix} w_1 \\ w_2 \end{bmatrix}$ $x = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$ For produ

we take transpose of w

$w^T = [w_1 \; w_2]$ $x = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$

• 3D plane

Now let's suppose we have 3 axis:



$$w_1x_1 + w_2x_2 + w_3x_3 + b = 0$$

$$w^Tx + b = 0$$

$$\therefore w = \begin{bmatrix} w_1 \\ w_2 \\ w_3 \end{bmatrix} \quad x = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

So for product we take transpose of w

$$w^T = \begin{bmatrix} w_1 & w_2 & w_3 \end{bmatrix} \quad x = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

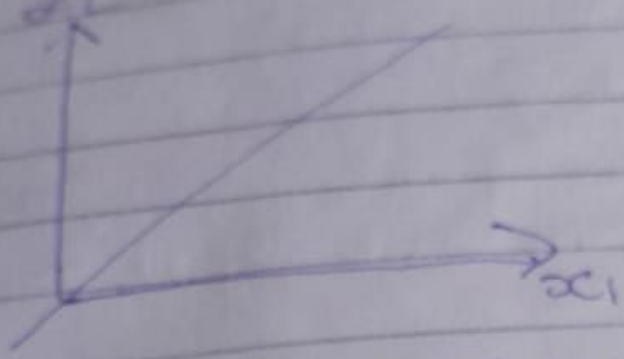
n-dimension Plane:

$$w_1x_1 + w_2x_2 + w_3x_3 + \cdots + w_nx_n + b =$$

$$\boxed{w^Tx + b = 0}$$

Case: Equation of straight line passing through origin

Wherever a straight line passing through origin



Equation is $w_1x_1 + w_2x_2 + b = 0$

$b \Rightarrow$ Intercept $\Rightarrow$ At $x=0$ where the line meet at y-axis

So as passing through origin $b=0$

So, Equation will be

$$w_1x_1 + w_2x_2 = 0$$

$$\boxed{w^T x = 0}$$

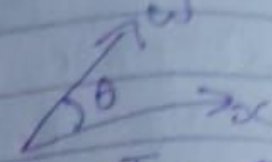
Equation of n-plane

$$\pi_n = w^T x = 0$$

$$w = \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ \vdots \\ w_n \end{bmatrix} \quad x = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ \vdots \\ x_n \end{bmatrix}$$

For Dot product we take w^T (transpose of of w)

Now let's suppose two vectors w and x



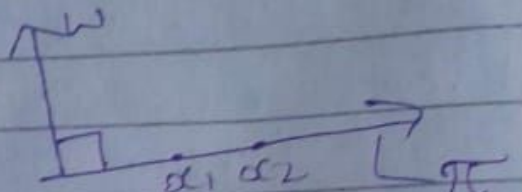
As we know
$w^T x = 0$

$w \cdot x = (\|w\| \cdot \|x\|) \cos\theta = w^T x = 0$

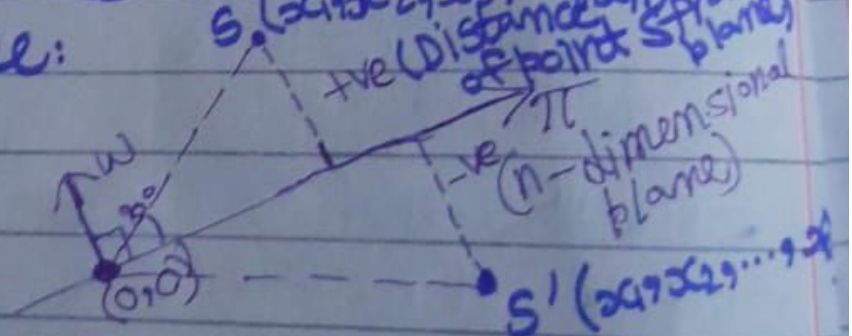
If $\theta = 90°$ $\cos\theta = 0$

Me $w \perp \pi$

w is always going to be perpendicular to all points in plane



⇒ Distance of a point from Plane:



AS this plane passing through origin the equation is:

$w^T x = 0$

AS

$w^T x = 0$

$wx = \|w\| \|x\| \cos\theta = 0$

For this case must be 0
and $\cos\theta = 0$ if $\theta = 90°$
Means w should be perpendicular
to plane π.
Distance of point S from plane is

$$d = \frac{w^T S}{\|w\|}$$ ⇒ Magnitude of w

where $w^T = \|w\| \|S\| \cos\theta$
As $0 < \theta < 90$ so distance above plane
is always +ve

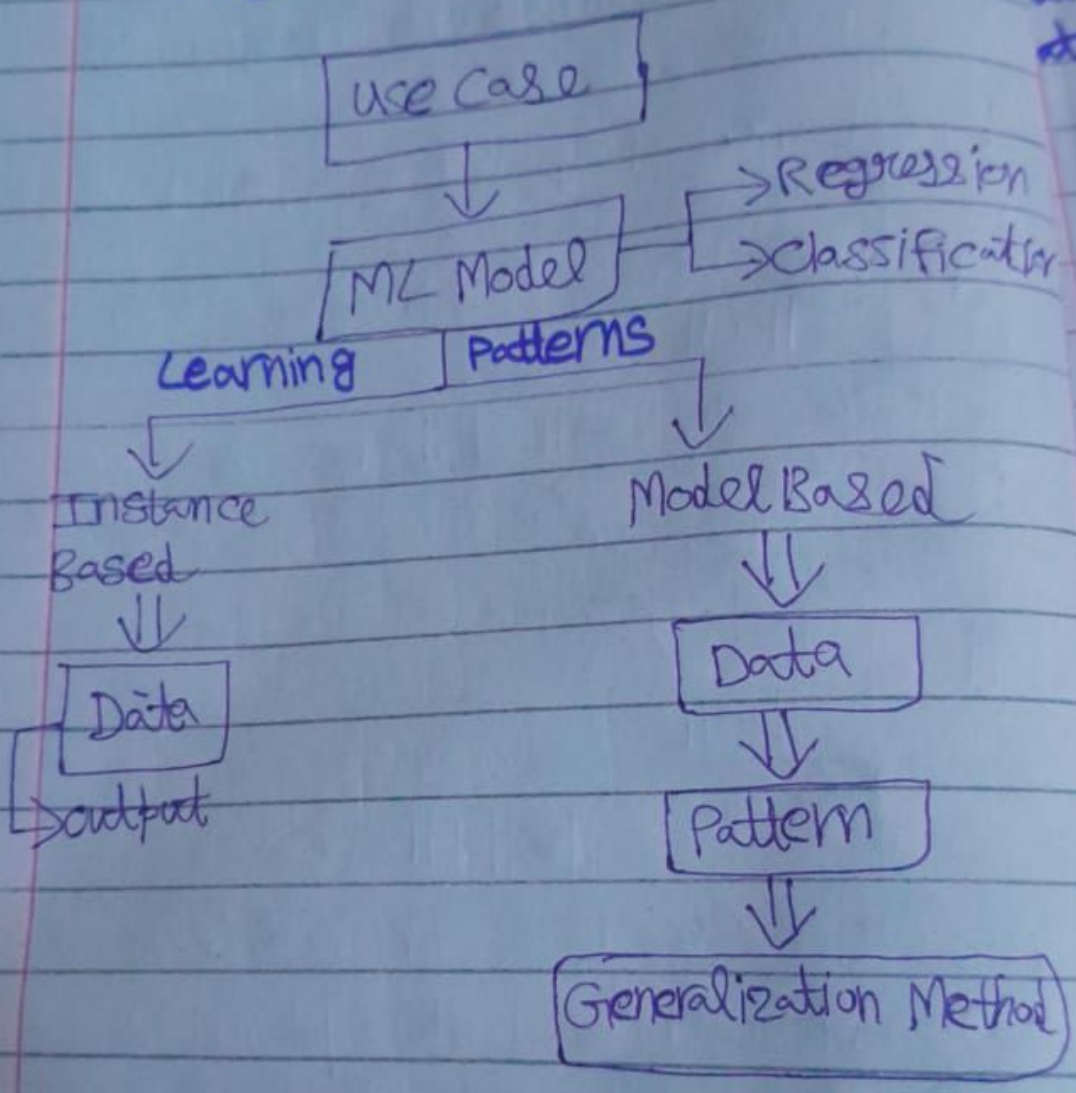
For point S'

$$d = \frac{w^T S'}{\|w\|}$$

$\Rightarrow w^T S' = \|w\| \|S\| \cos\theta$

As $90 < \theta < 180$ or $\theta > 90$
So distance below plane is
always negative -(ve)
⇒ -ve means it is on opposite
side of plane

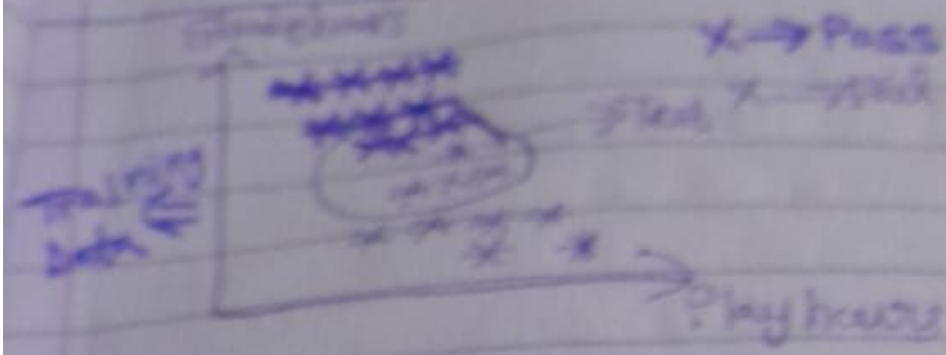
⇒ Instance Based Learning vs Model Based Learning



e.g

Let we have features

No. of play hours	No. of Study hours	Pass/Fail



Instance Based Learning

⇓

Domain expert

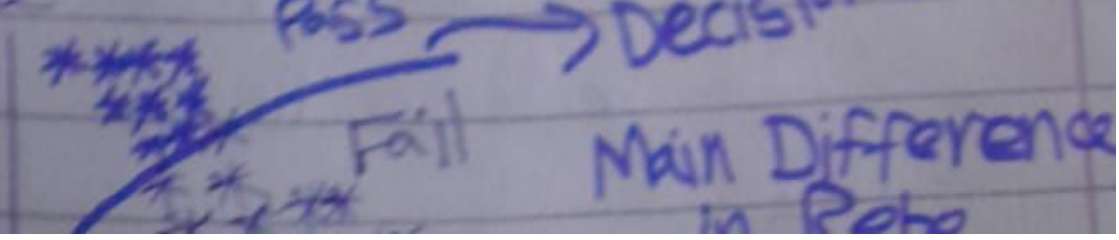
Let's suppose the new point comes. The model have training data It is not going to see the pattern It will see the neighbouring data points

⇒ Means it focus more on training data.

eg KNN (Kth Nearest Neighbour)

Model Based Learning

It tries to understand the pattern and creates a generalized method and behaves according to it like



Main Difference