

# Linear Algebra 1

## Overview

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- Length : 10 Lectures
- Topics :
  - Linear Algebra
  - Calculus
  - Co-ordinate Geometry
  - Optimisation

## Flow

Concept  $\rightarrow$  Visualization  $\rightarrow$  Maths  $\rightarrow$  Code

## Where to find Notes and Code?

- <https://github.com/SachinScaler/Feb24-Maths-for-ML/tree/main>
- Lecture Attachments

## Take Home

- Assessments (mandatory)
- Homework (optional)
- In class reads and Questions (optional)

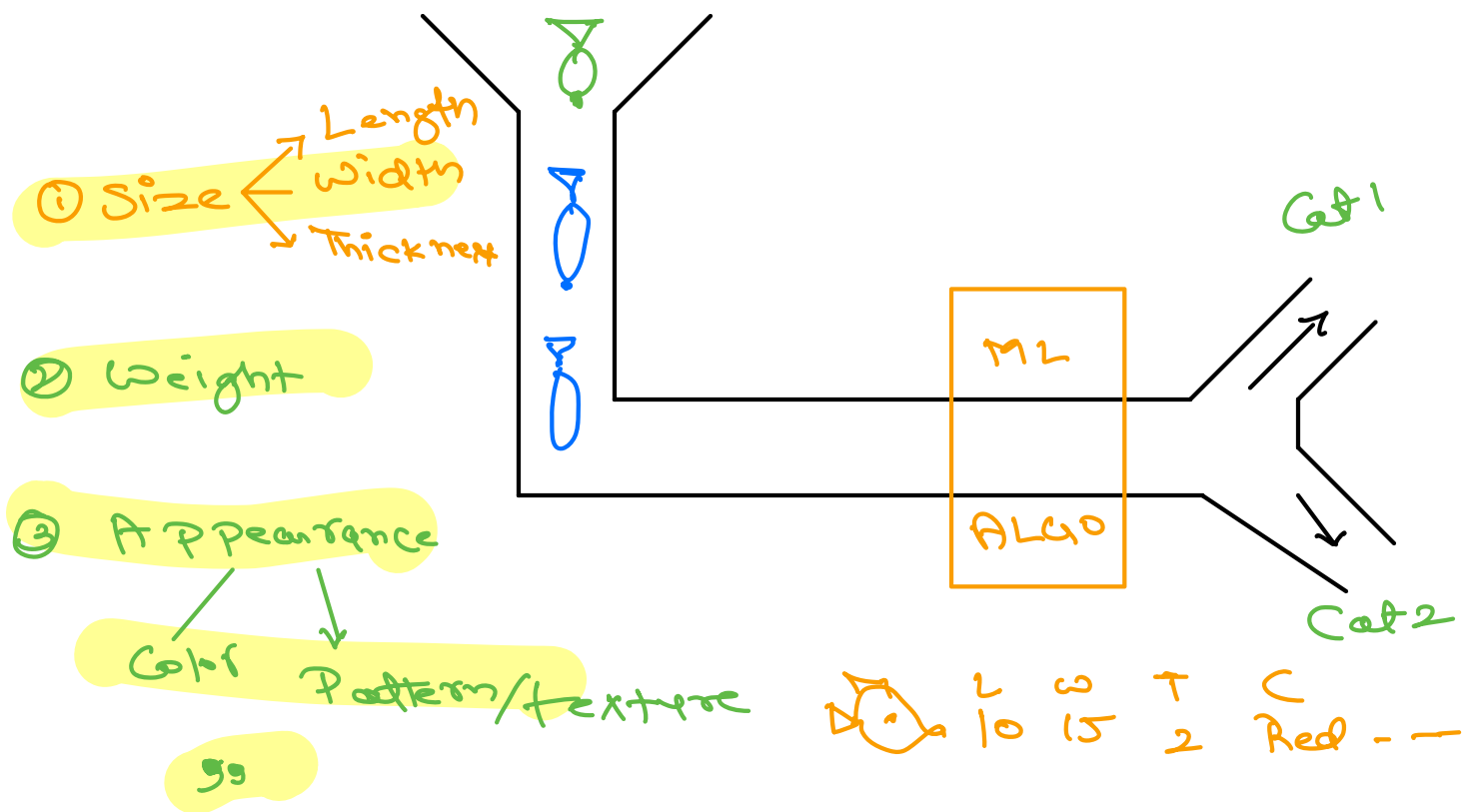
Say you will learn AI, nobody panics



But say you will learn linear algebra and optimisation, then everybody loses their minds

What is ML about?

Fish Sorting Machine



# Terminologies

Independent Variables

Width	Length	Weight	Type
30	50	80	1
11	23	28	2
27	43	29	1
16	31	36	2

Features

Label

Target

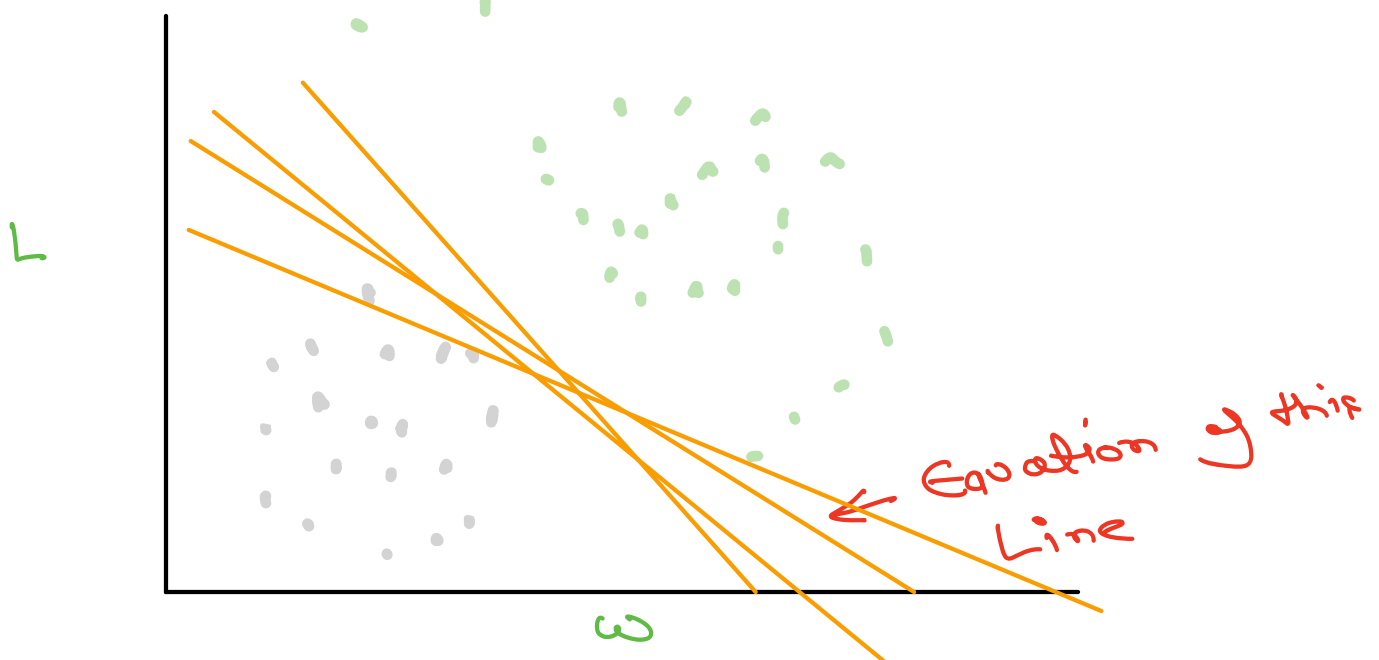
Dependent Variable

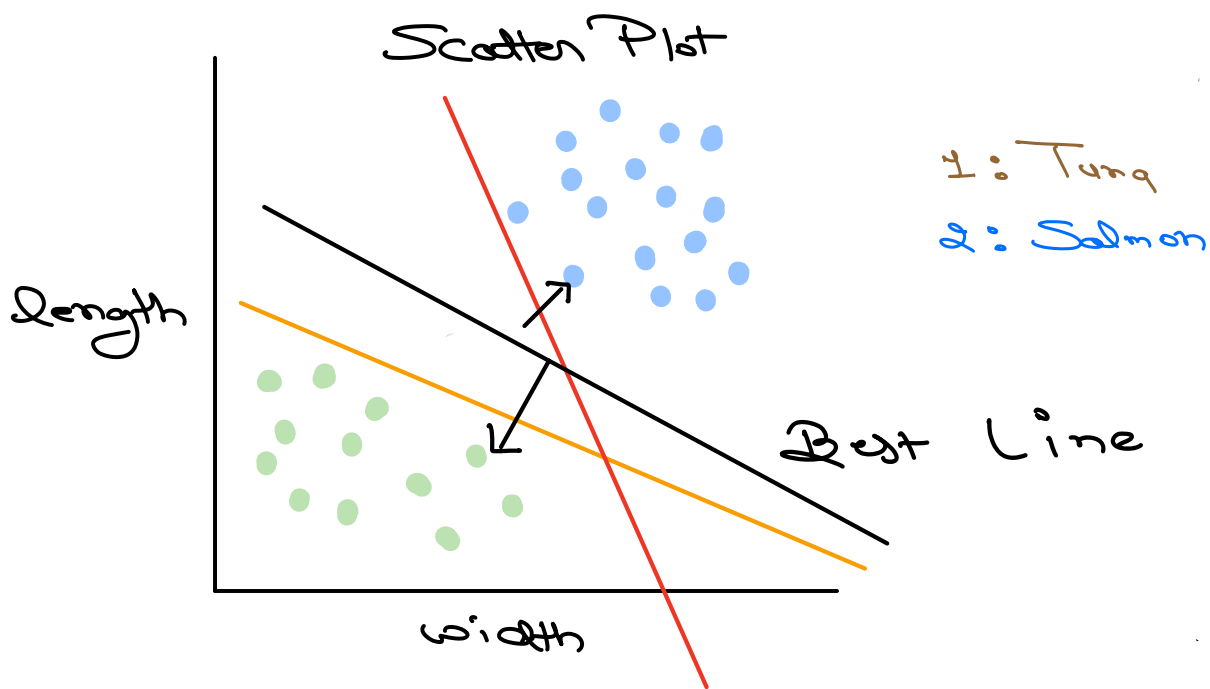
Record  
Datapoint

ML ALGO

use maths to  
learn how to  
separate fishes

Visualization

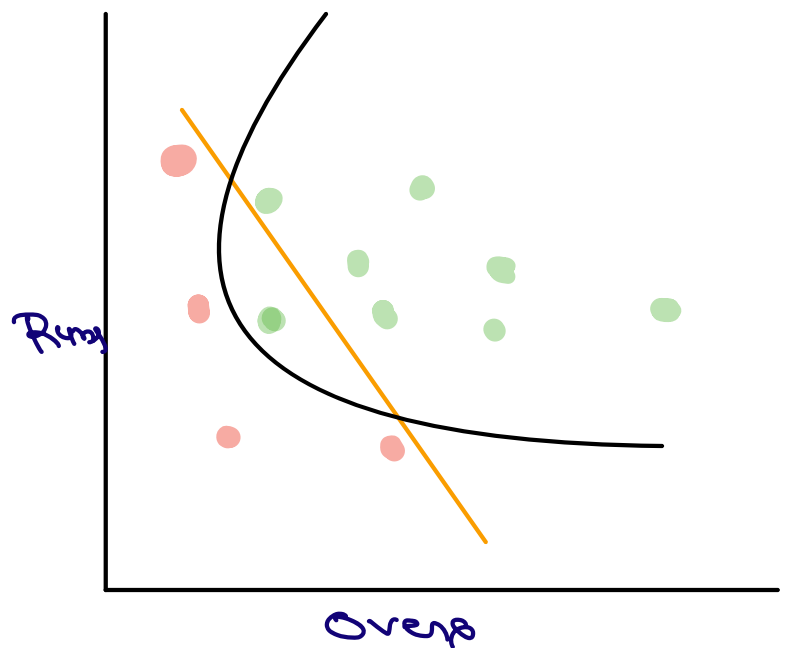




## Ex-2: Cricket win prediction



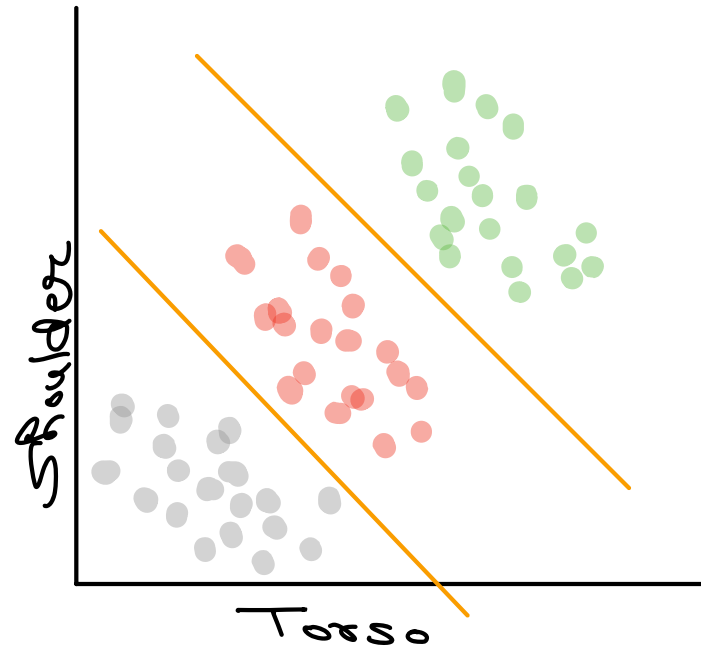
Runs	Over	Outcome
90	20	Lose
90	10	Win
30	8	Lose
88	12	Win



Binary Classification

## Ex-3: T-shirt Size Prediction

Torso	Shoulder	Size
45	32	S
52	45	M
60	52	L
65	48	L
48	36	S
55	43	M



## Multi-Class Classification

- ① Supervised Algorithms: Labels are available
- ② Unsupervised Algorithms: Labels are not available

News Classification → Sport  
→ Politics  
,,



→ Crypto  
→ Grief

# Process of building a ML Solution

- a) Data Collection and Cleaning
- b) EDA and Visualization
- c) Choosing an appropriate Geometric Structure to Separate Classes
- d) Choosing a LOSS function which helps in finding the Best Fit Structure
- e) Training and Optimization

## Co-ordinate Geometry

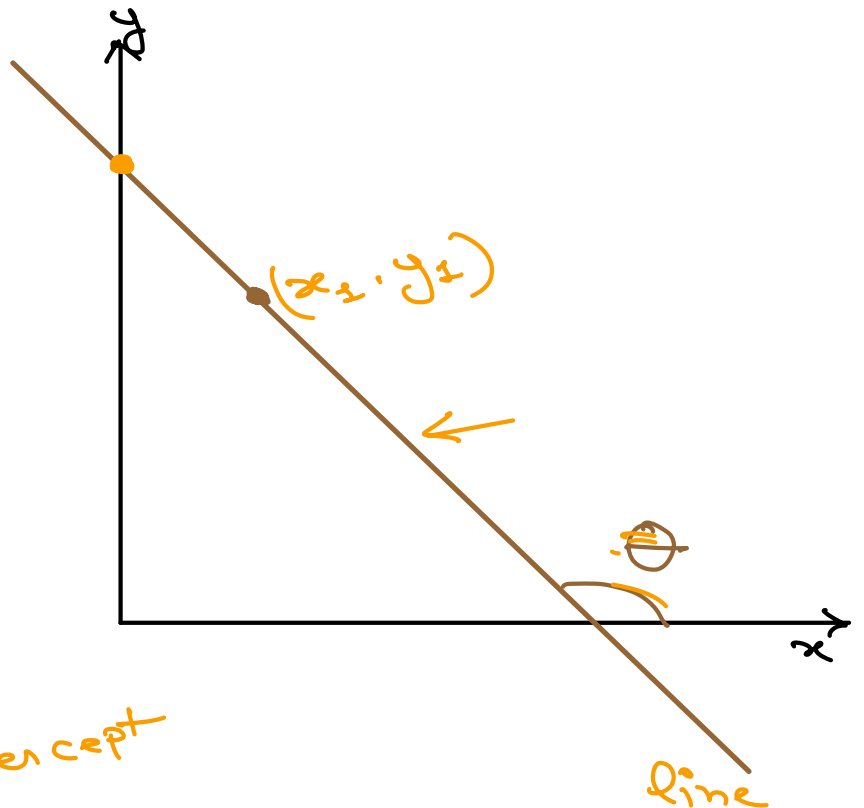
Eq<sup>n</sup> of line

Slope - Intercept  
Equation

$$y = mx + c$$

Slope

Intercept

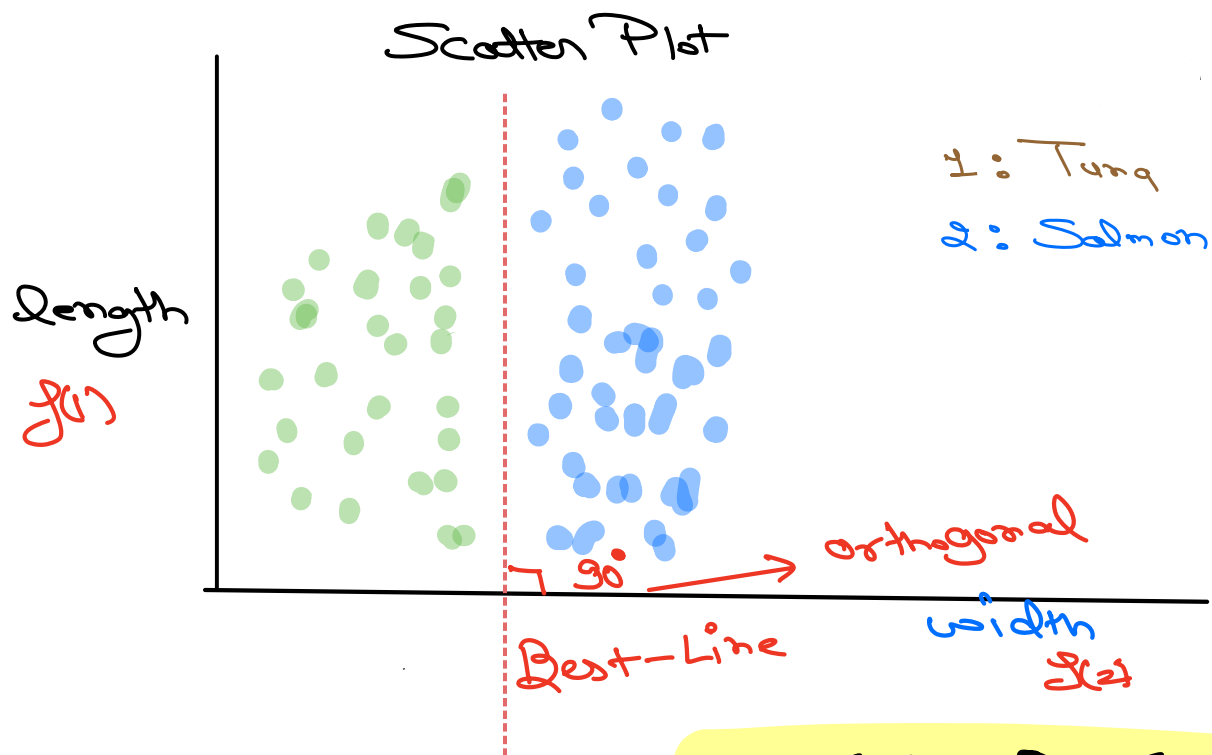
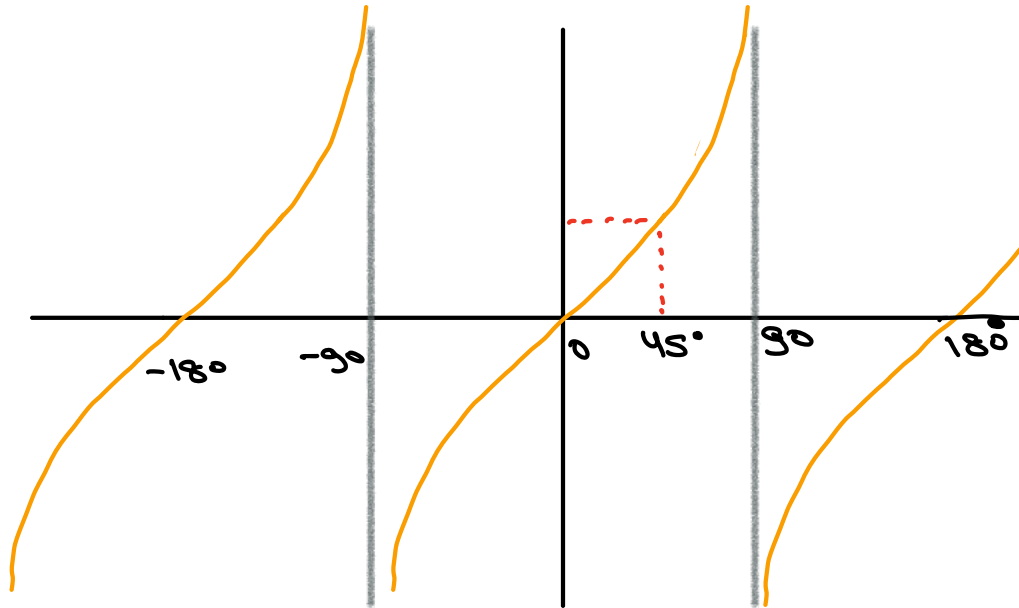


$$\text{Slope} = \tan \theta = m$$

Intercept  $\Rightarrow$  y value  $\rightarrow x=0$

$$m \rightarrow (-\infty, \infty)$$

$$\theta = 90 \rightarrow \infty$$



$$-\infty < \tan \theta < \infty$$

$$\text{length} = m * \text{width} + c$$

$$\downarrow$$

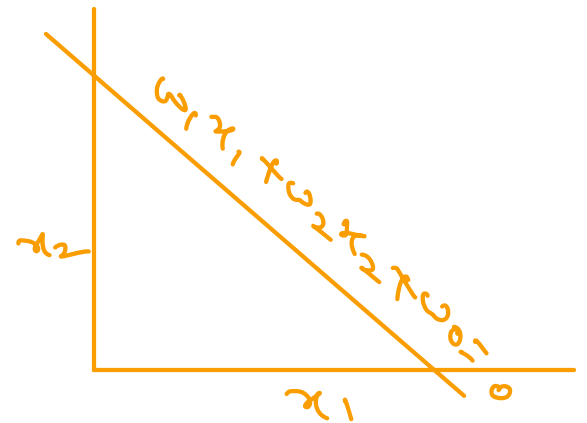
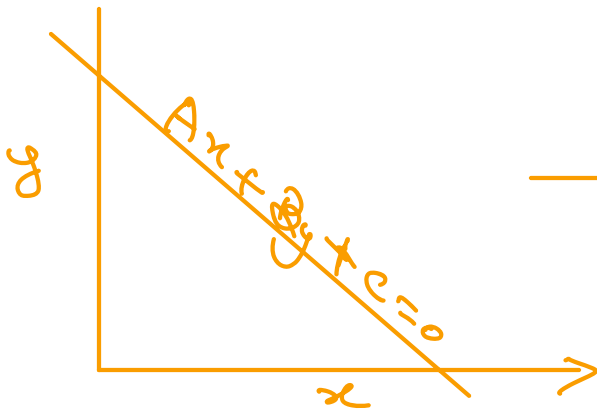
$$w_1 x_1 + w_0 = 0 \rightarrow 90^\circ$$

$$y_1 = m * x_2 + c$$

$$\tan \theta \Rightarrow \tan 90 = \infty$$

# General Form of Line

$$\underbrace{Ax}_{\omega_1 x_1} + \underbrace{By}_{\omega_2 x_2} + \underbrace{C}_{\omega_0} = 0$$



Relationship b/w m

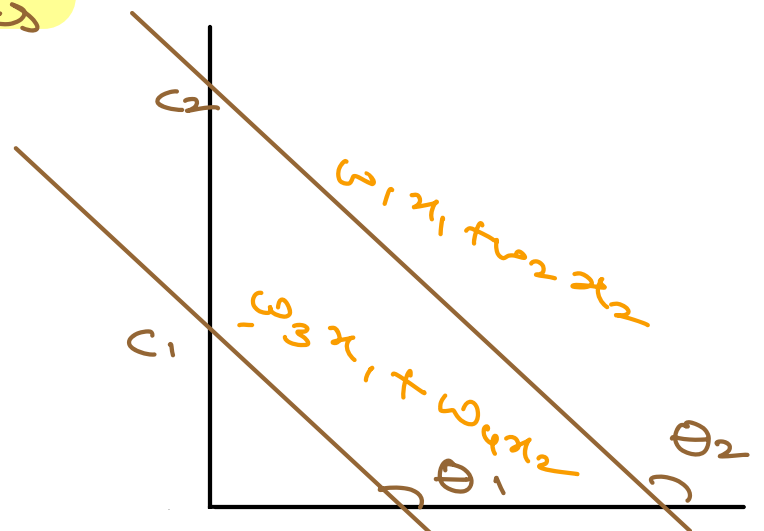
## \* Parallel lines

$$y = m_1 x + C_1$$

$$y = m_2 x + C_2$$

$$m_1 = m_2$$

$$-\frac{\omega_2}{\omega_1} = -\frac{\omega_4}{\omega_3}$$



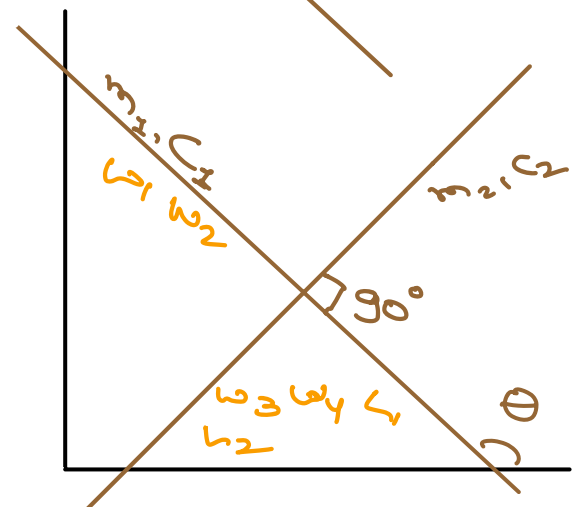
## \* Perpendicular lines

$$y = m_1 x + C_1$$

$$y = m_2 x + C_2$$

$$m_2 \times m_1 = -1$$

$$-\frac{\omega_2}{\omega_1} \times \left( -\frac{\omega_4}{\omega_3} \right) = -1$$





$$\omega_1 x_1 + \omega_2 x_2 + \omega_0 = 0$$

$$x_2 = m x_1 + c$$

$$\omega_1 x_1 + \omega_2 x_2 = -\omega_0$$

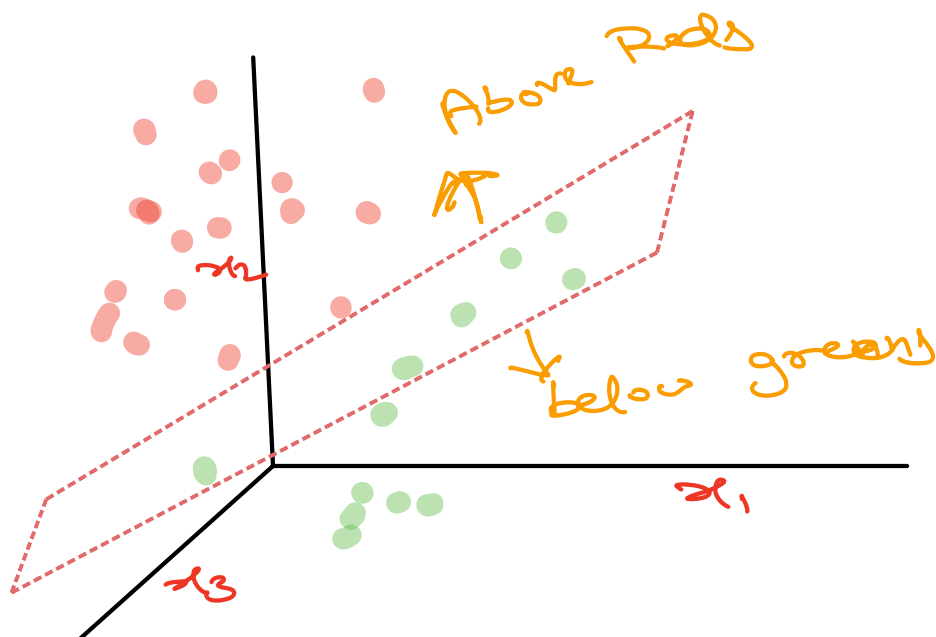
$$\frac{\omega_2 x_2}{\omega_2} = -\frac{\omega_0}{\omega_2} - \frac{\omega_1 x_1}{\omega_2}$$

$$x_2 = \left( -\frac{\omega_0}{\omega_2} \right) - \left( \frac{\omega_1}{\omega_2} \right) x_1$$

$$m = -\frac{\omega_1}{\omega_2}$$

$$c = -\frac{\omega_0}{\omega_2}$$

What happens with more than 2 Dims



$$\omega_1 x_1 + \omega_2 x_2 + \omega_3 x_3 + \omega_0 = 0$$

4 features

$$w_1 x_1 + w_2 x_2 + w_3 x_3 + w_4 x_4 + w_0 = 0$$

↓  
3d Hyperplane

n features  $\longrightarrow$  n-1 d Hyperplane

$$w_1 x_1 + w_2 x_2 + \dots + w_n x_n + w_0 = 0$$

\* ML Terminologies

$$w_1 x_1 + w_2 x_2 + w_0$$

$w_1 \ w_2 \ w_3 \ \dots \ \Rightarrow$  **Weights**

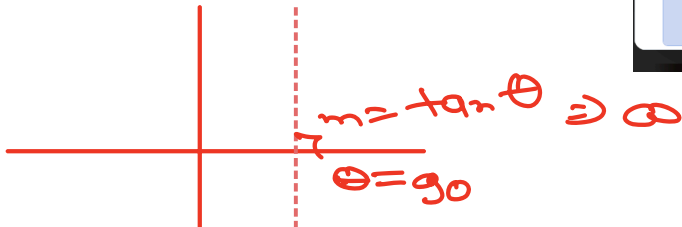
$$Ax + By + C$$

Coefficients

$w_0 \longrightarrow$  **Bias**

In the slope-intercept form of a linear equation,  $y = mx + b$ , which of the following statements is true regarding lines being perpendicular to the x-axis?

$$y = mx + b$$



A

Lines described by this form can be perpendicular to the x-axis for any value of 'm.'

B

Lines described by this form are never perfectly perpendicular to the x-axis, regardless of the value of 'm.'

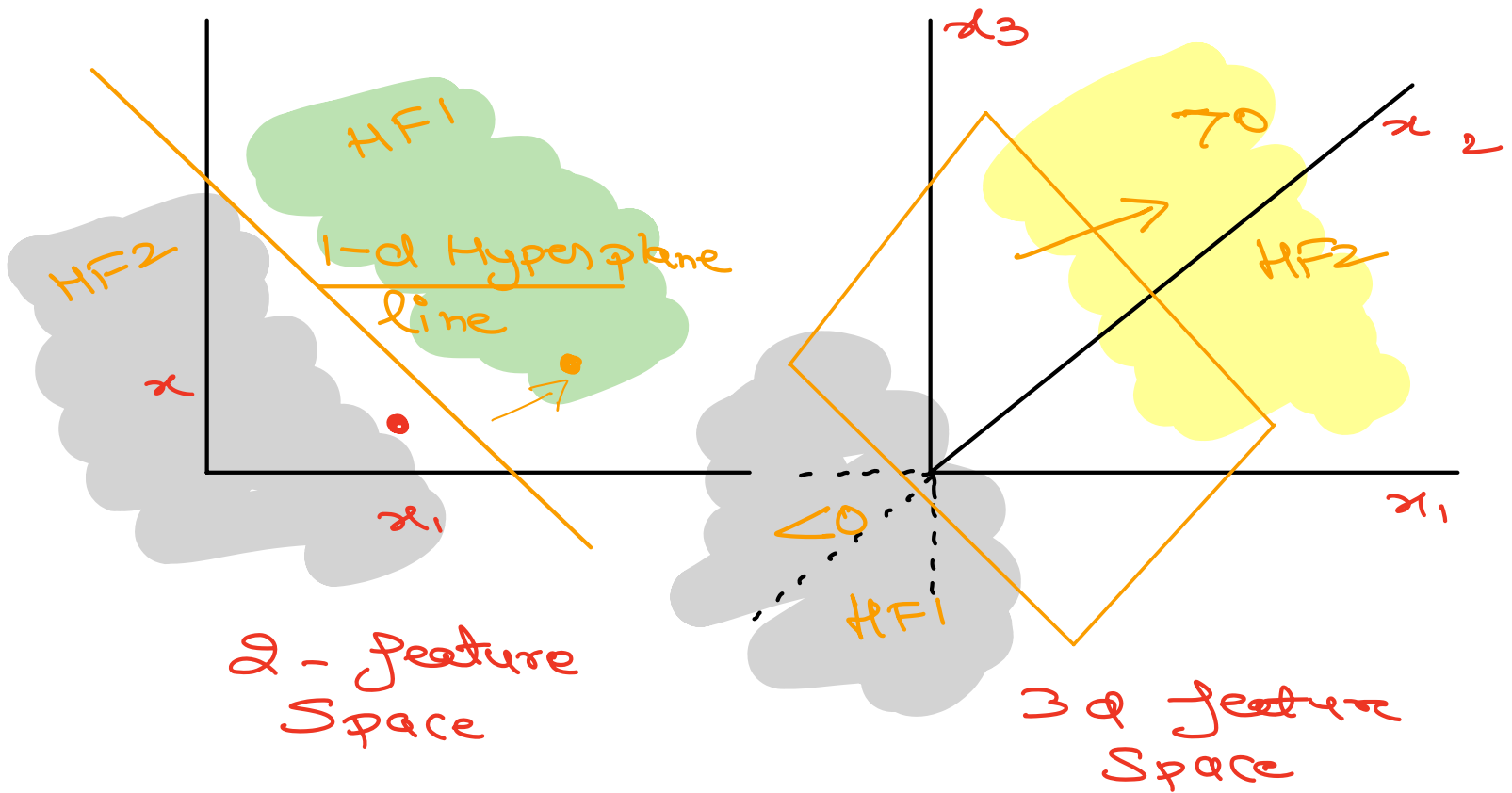
C

Lines described by this form are always perfectly perpendicular to the x-axis, regardless of the value of 'm.'

D

Lines described by this form are only perpendicular to the x-axis when 'm' is negative.

# Half-Spaces



1) 2 feature space can be divided into two halfspace using a Line

2) 3d feature Space can be divided into two Half Space using a 2D plane

$$\hookrightarrow w_1 x_1 + w_2 x_2 + w_3 x_3 + w_0 = 0$$

Qd.-Hyperplane

$\downarrow$   
10

$\downarrow$   
20

$\downarrow$   
30