

Machine Learning Context

[Math for ML]

- Last "foundations" module
- Build your 1st ML model in 4 weeks
- Here we learn things needed to understand how a machine learns

Module Overview

- Length: 10 lectures [1 month]
- Topics:-
 - Coordinate Geometry
 - Linear Algebra
 - Calculus
 - Optimization
- Focus: Applications in Machine learning
- Flow:
Concepts → Visualisations → Math → Code

Plan for next few classes

Class -1

- Slow , steady
- Examples of a simple ML appl.
- Visualisation / Geometry
- Some simple equations
 - ↳ Eqn of a Line

Class 2 onwards

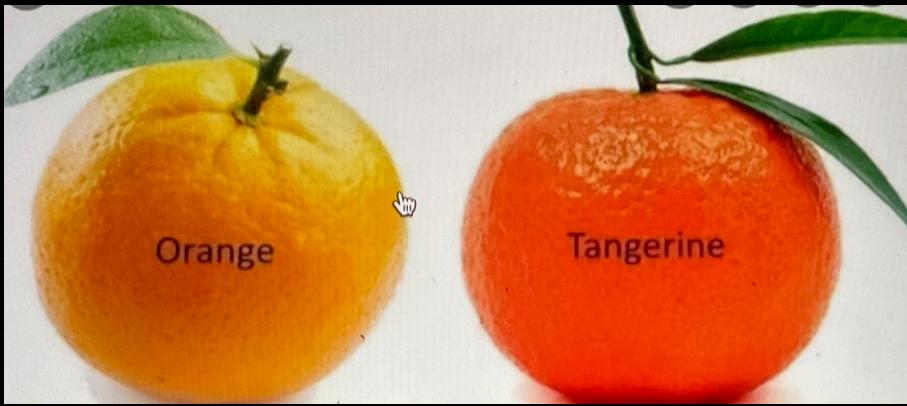
- ↳ more rigorous
- Math and geo heavy.

Machine Learning Applications

↳ Let's take a few examples for simple classification

Fruit Sorting

Assembly line for an orange juice company

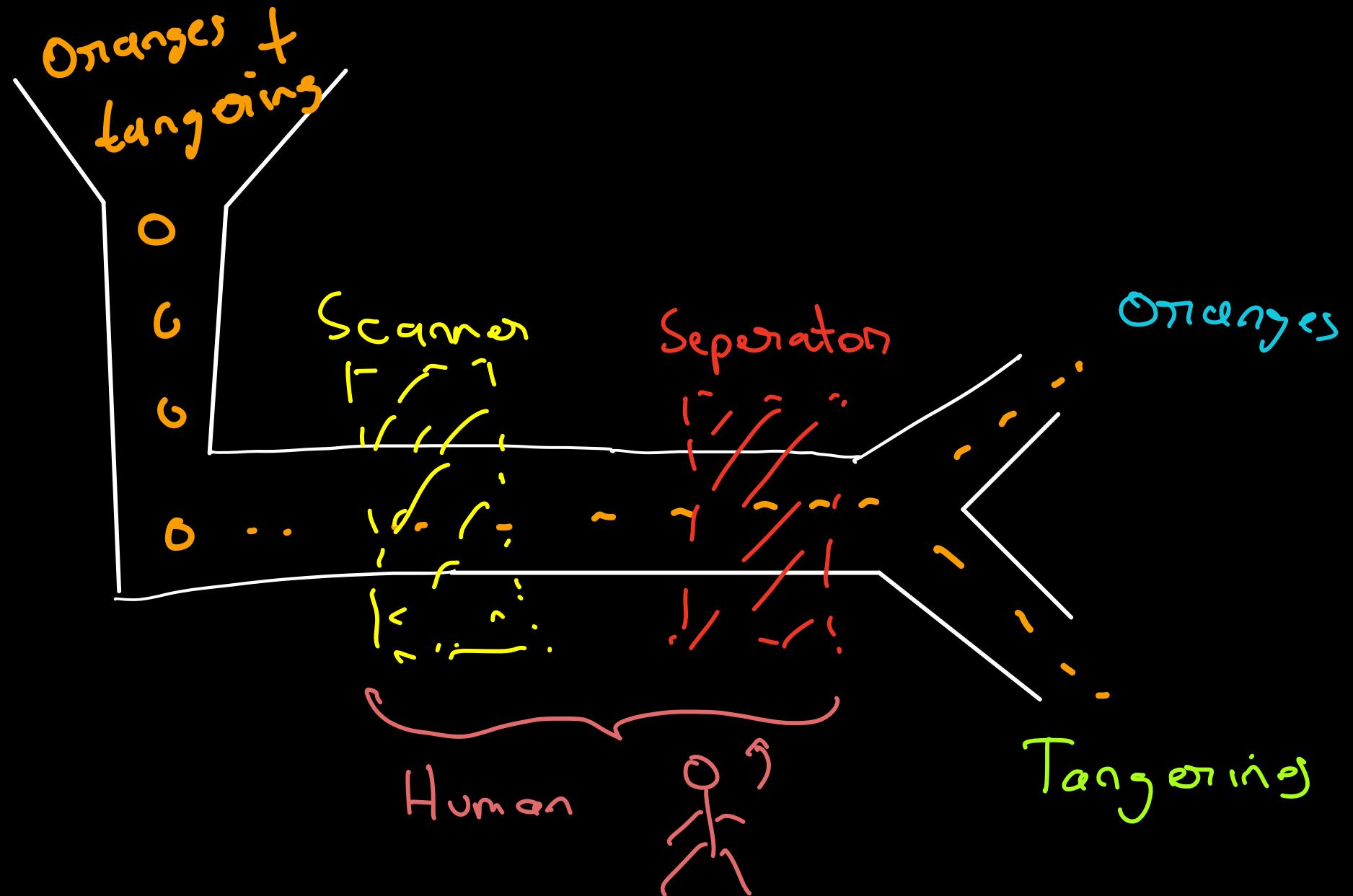


Q1:

Domain check →

→ Have u had both fruits?

Factory Setup



We want to replace the human
and design an algorithm to classify
whether a fruit is orange or tangarine

6: Ang guesses which attributes might help
distinguish them ??

- Diameter } → collect from scanner
- Weight }
- Color X → almost same color

Terminology

of
Features
independent vars
attributes
predictions

D	W	F
10	100	T
8	70	O
10	80	O
7	100	T

Target
dependent var

Data point

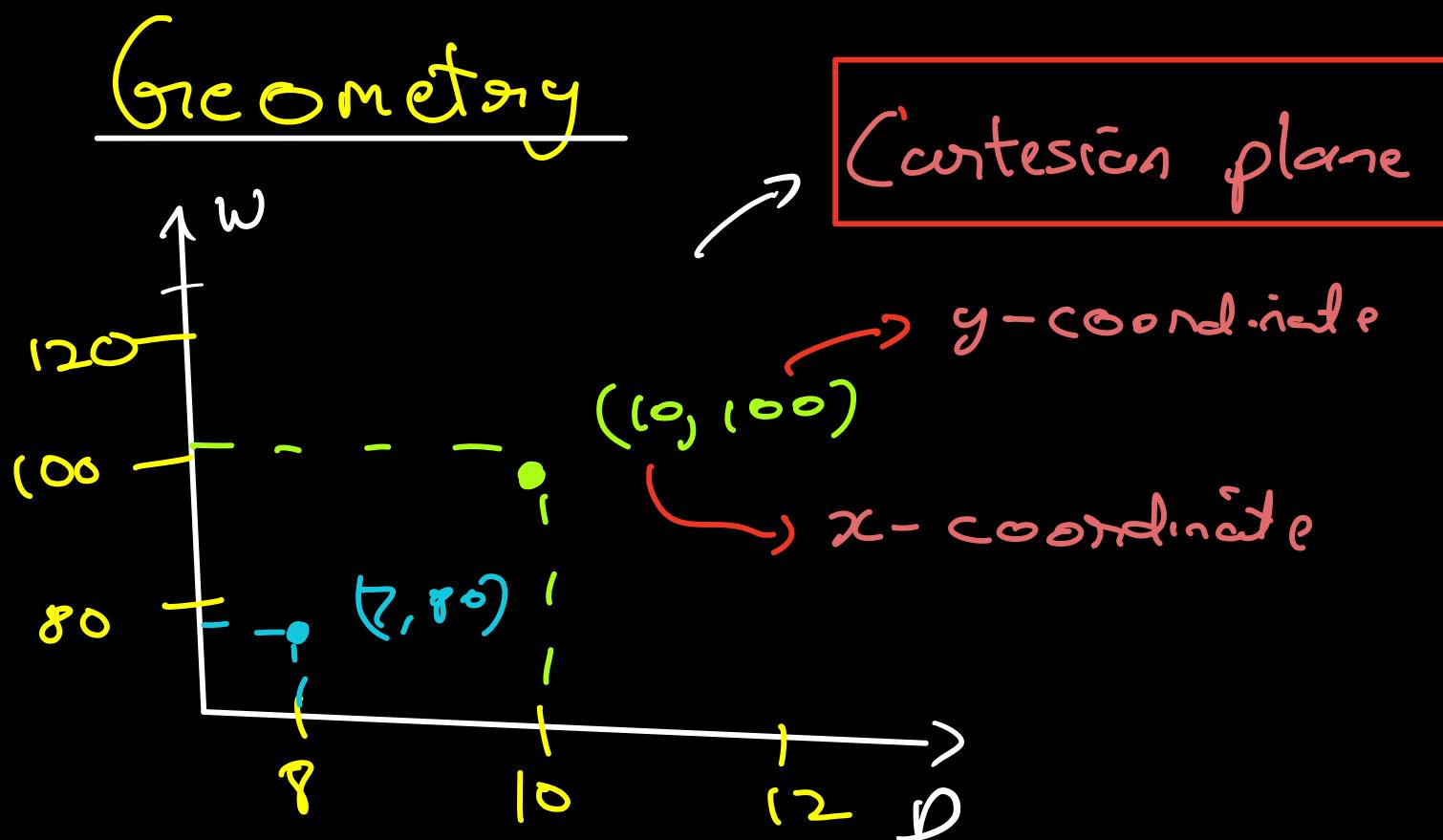
Many rows
Dataset

Q: Can you think of rules that
can determine fruit name?

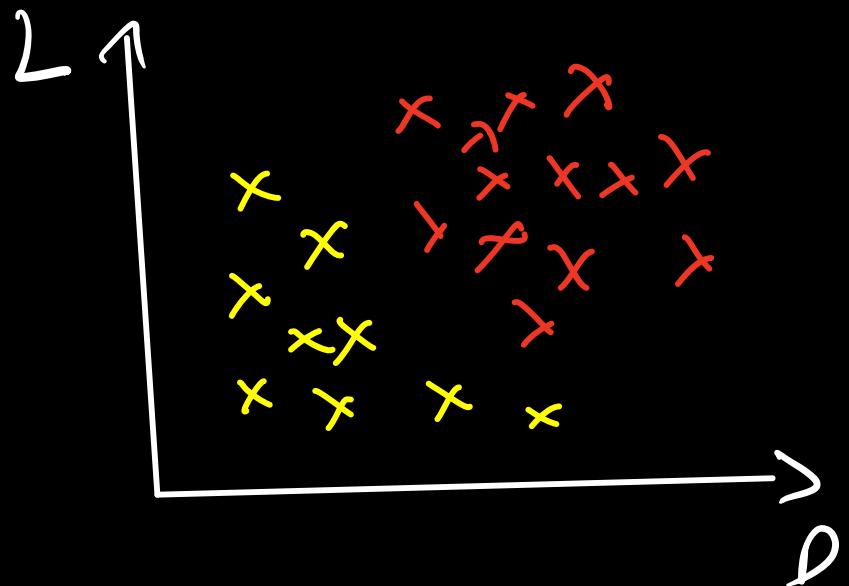
→ If $w > T$: Tangerine
 $D < R$: Orange

... etc.

- ↳ Rules have to be decided manually and this threshold can be hard to calibrate.
- It's hard to think of rules that can combine multiple Features.



Quiz: Which color looks like it represents
Oranges?



Oranges ?

A → Red

B → Yellow ✓

Q: Can you think of a way to separate
these points? [Geometric way]

→ Line

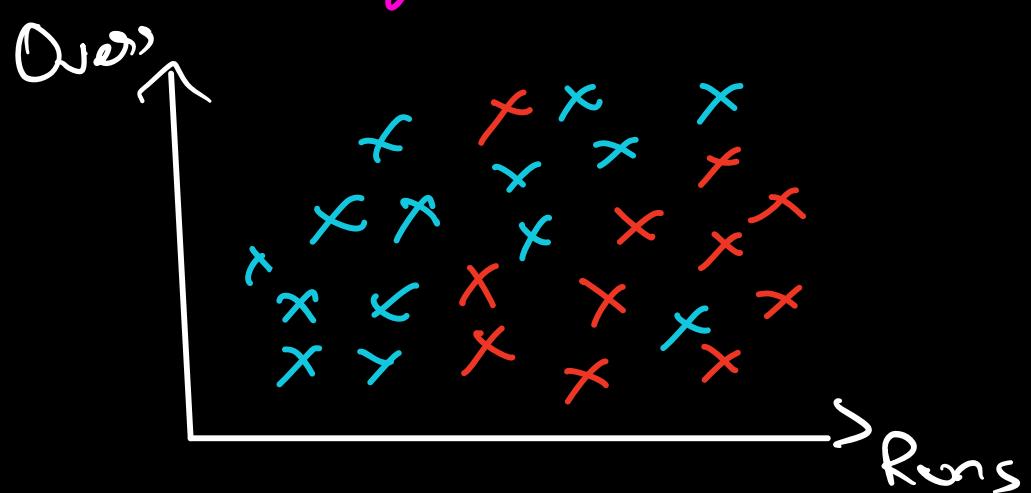
IPL Win prediction

Data →

Runs	Overs	Outcome
90	6	W
90	15	L
20	1	W
30	6	L

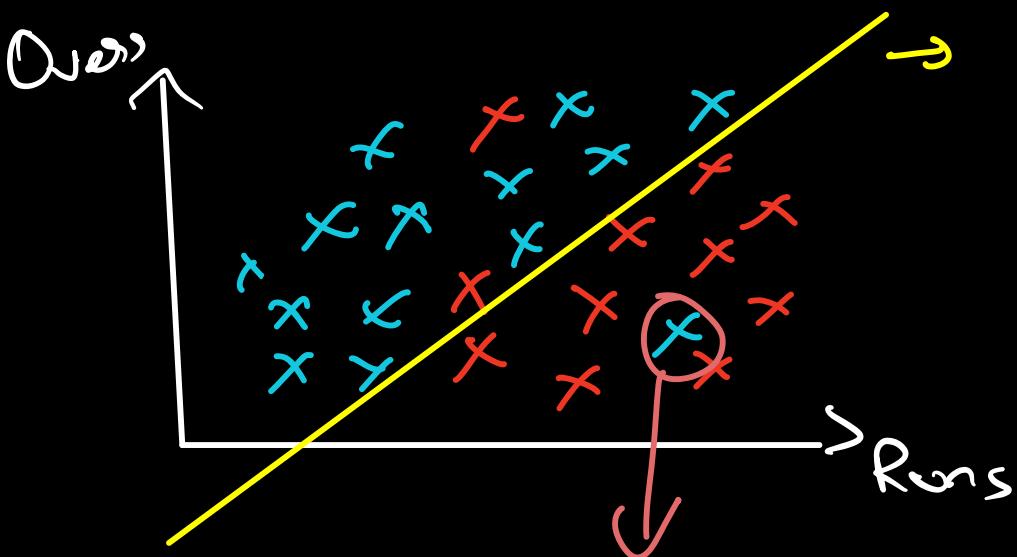
Marketing Company needs to decide to stop campaign.

Q: Can you imagine the scatter plot?



which side is Wins?

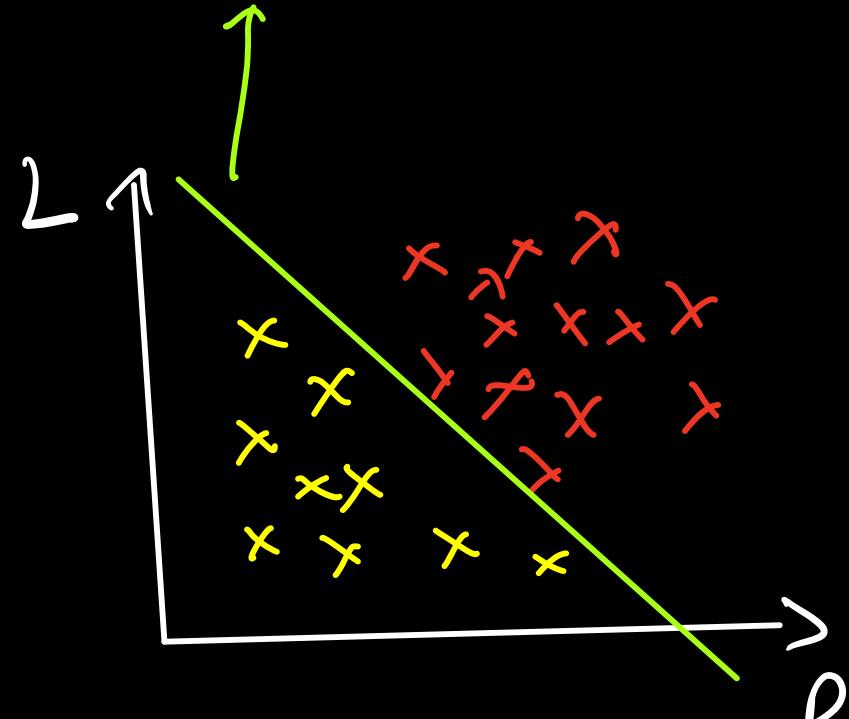
A → Red ✓
B → Blue



Decision boundary

Miss Classified

Classification

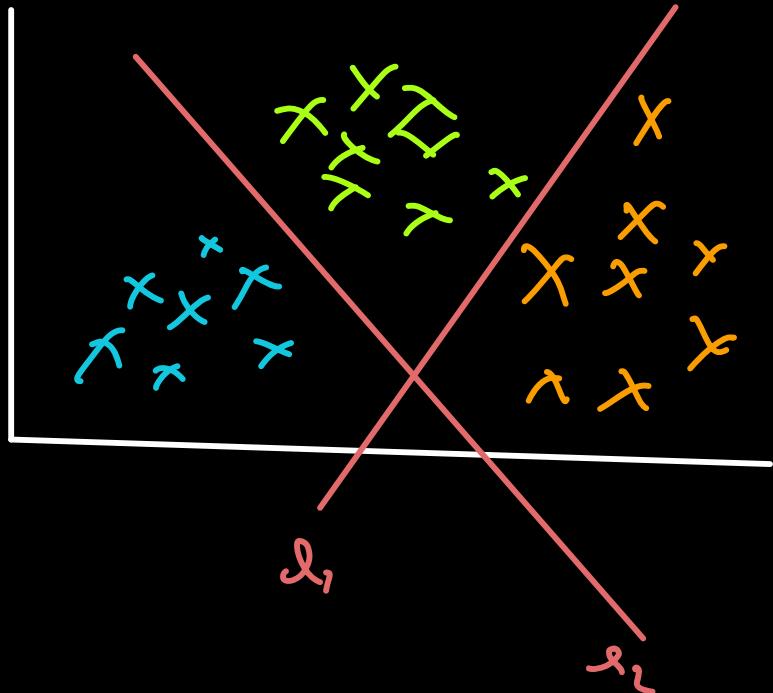


Machine Learning

A machine is able to find this line by "learning" from given data

Multiple Classes

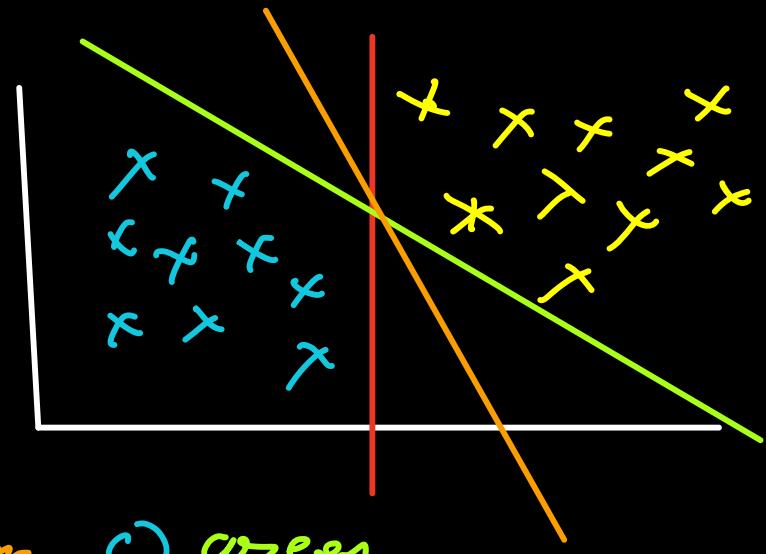
The number of classes or labels can be more than 2 also



Q: Why is this a hard problem?

There can be multiple lines and some complex shapes also.

→ Later

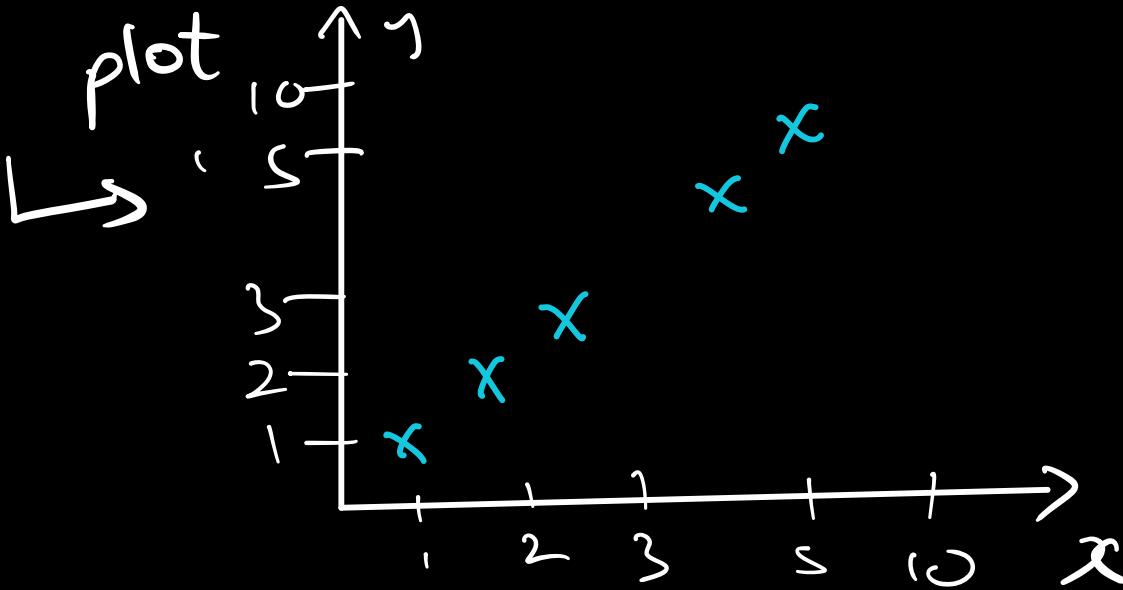


Best line? → a) Red b) Orange c) green

Line

Mathematically, what is a line?

Scatter plot ↳



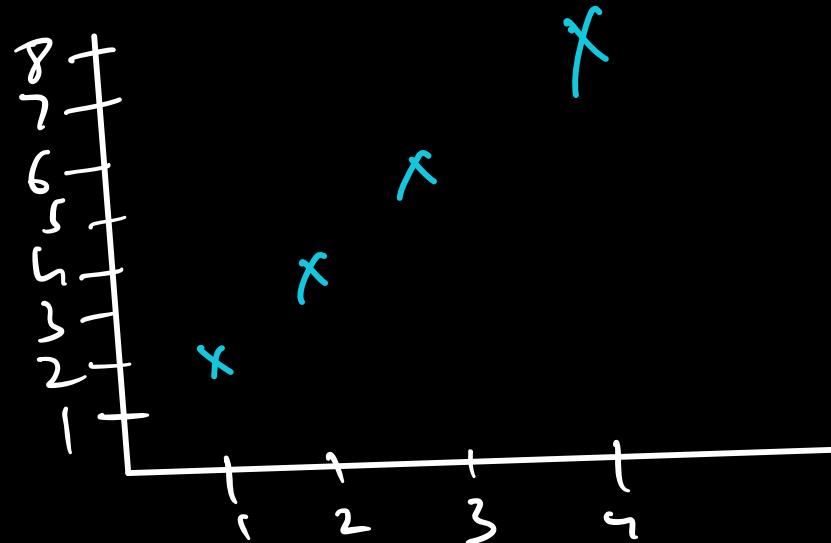
How can we represent all these points?

$$\rightarrow y = x$$

Look carefully at the coordinates:

$$(1, 1) \quad (2, 2) \quad (3, 3) \quad (5, 5) \quad (10, 10)$$

Quiz:



$$(1, 2) \quad (2, 4) \quad \dots \quad (4, 8)$$

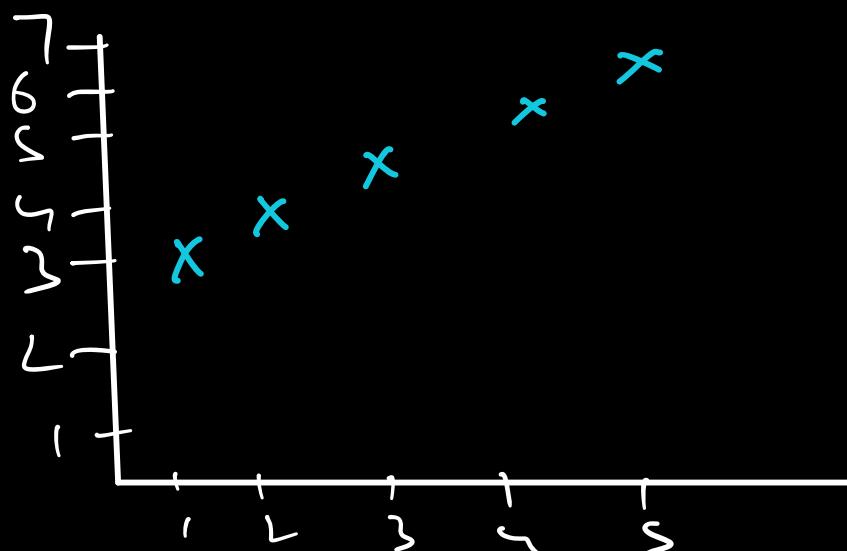
a) $y = x$

b) $y = 2x$ ✓

c) $2y = x$

d) $y = x + 2$

Quiz:



a) $y = 2x$

b) $y = 2x$

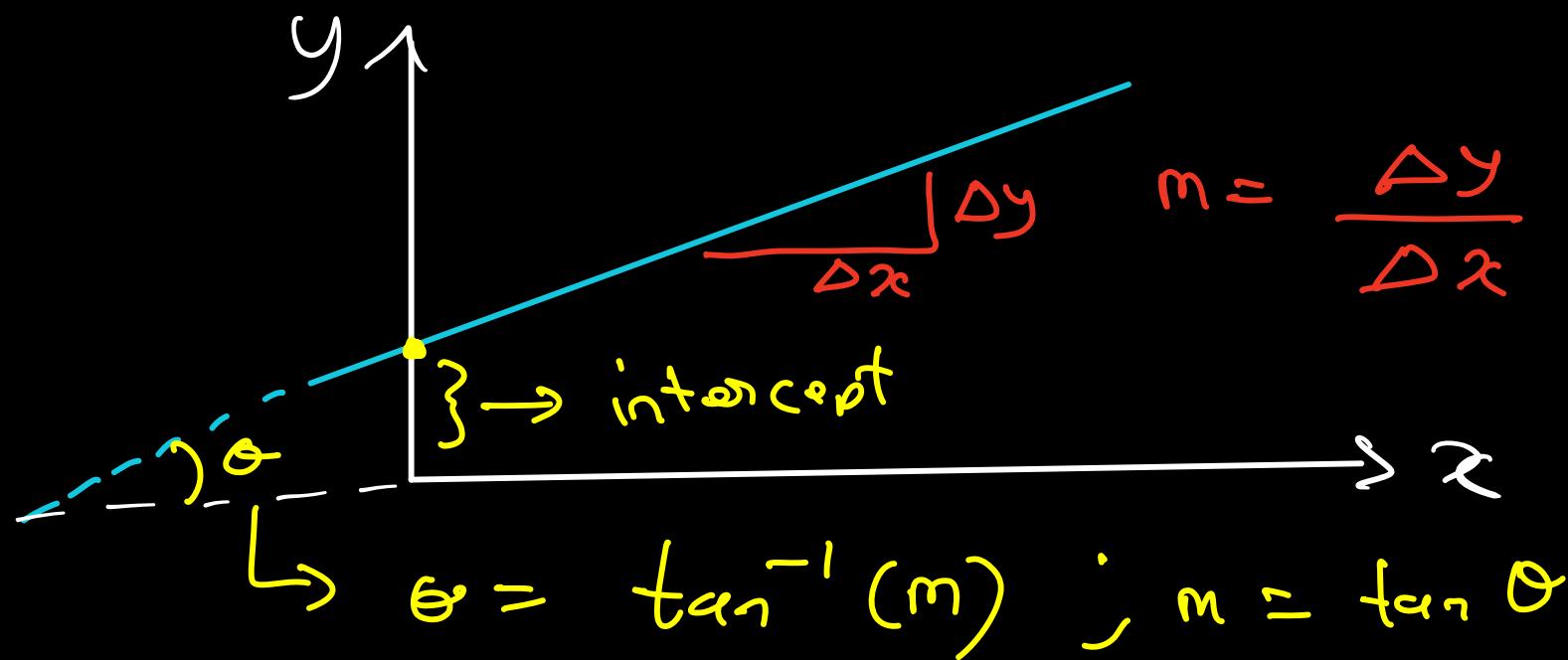
c) $y = 2x + 2$ ✓

d) $y = 2x - 2$

Equation of a Line

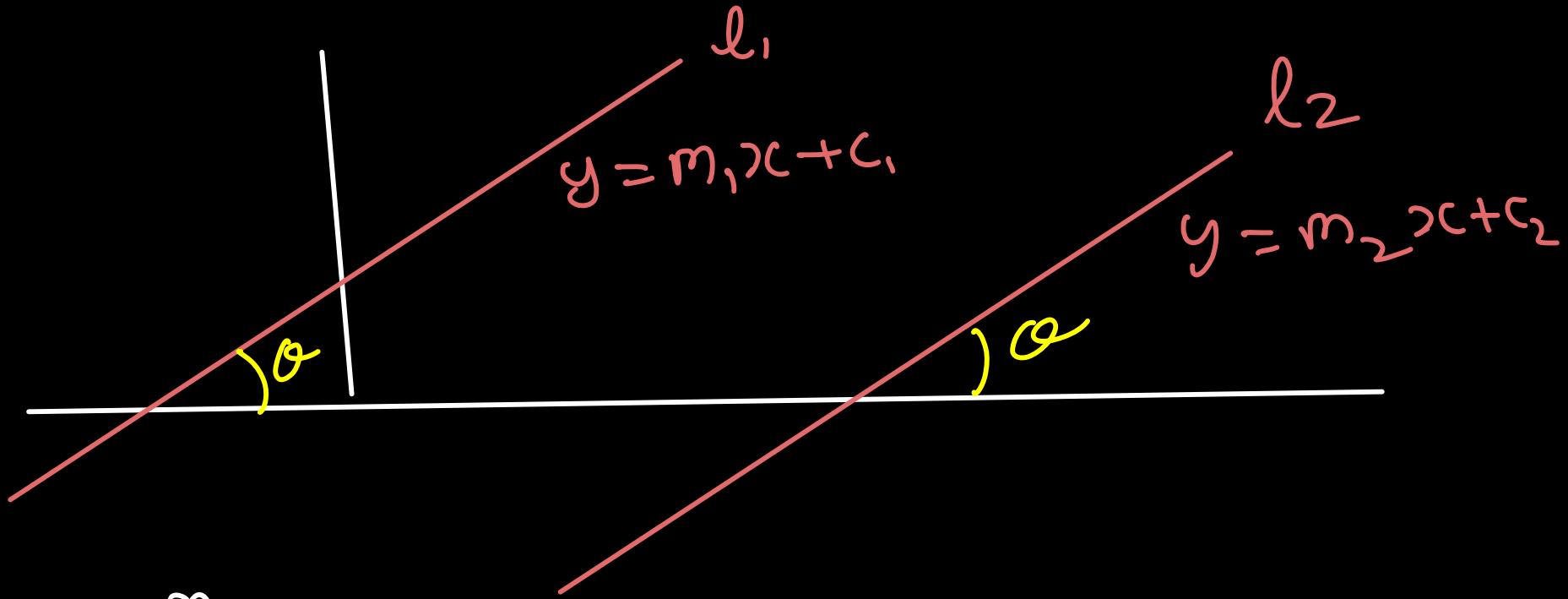
$$y = mx + c$$

↓ ↓
slope intercept



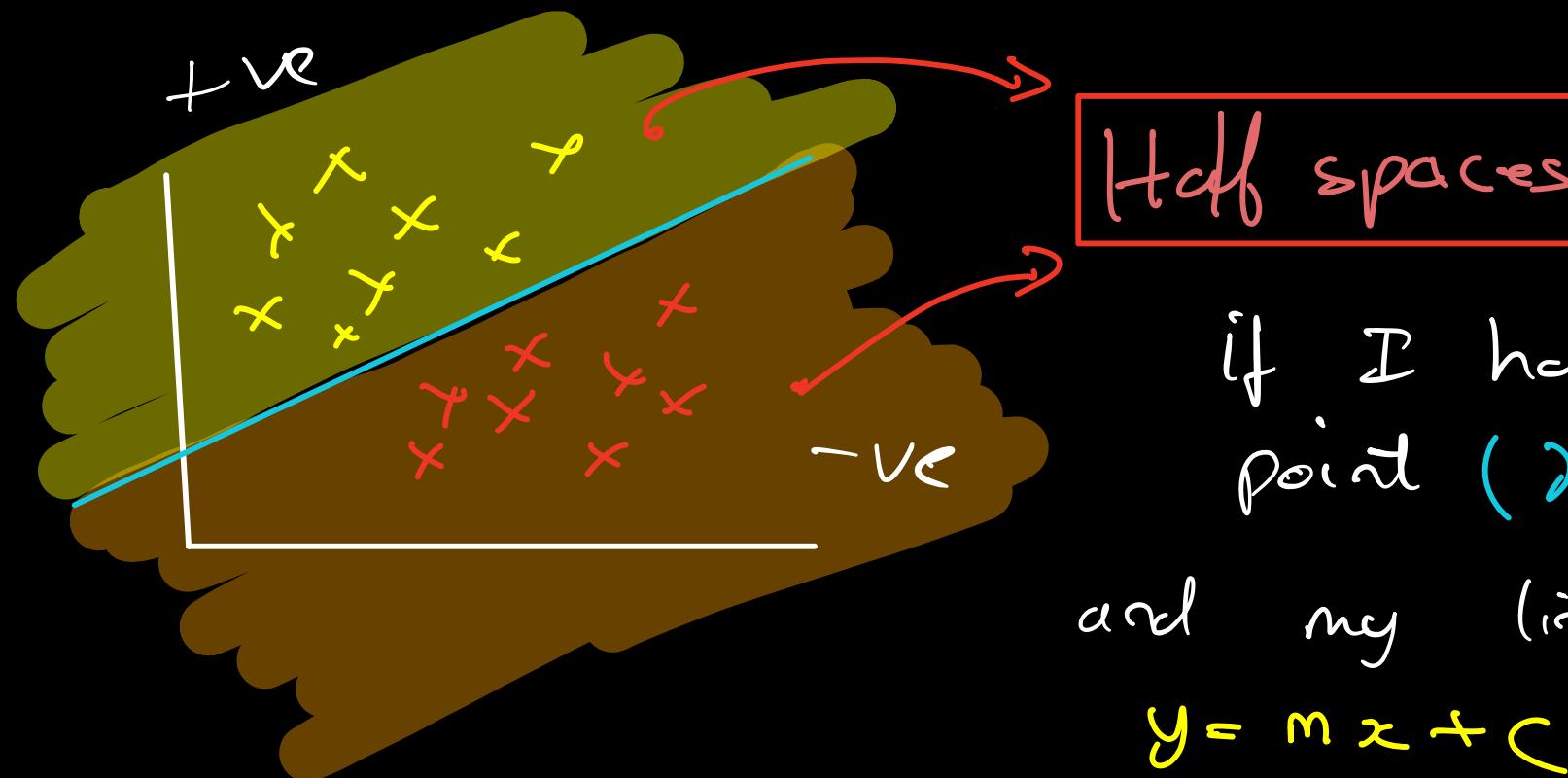
→ Demos

Quiz : For 2 parallel lines , choose
the correct answer.



- a) $m_1 = m_2$
- b) $c_1 = c_2$
- c) $m_1 = c_2$
- d) $m_1 - m_2 = c_1 - c_2$

Half Spaces



if I have a new
point (x_1, y_1)

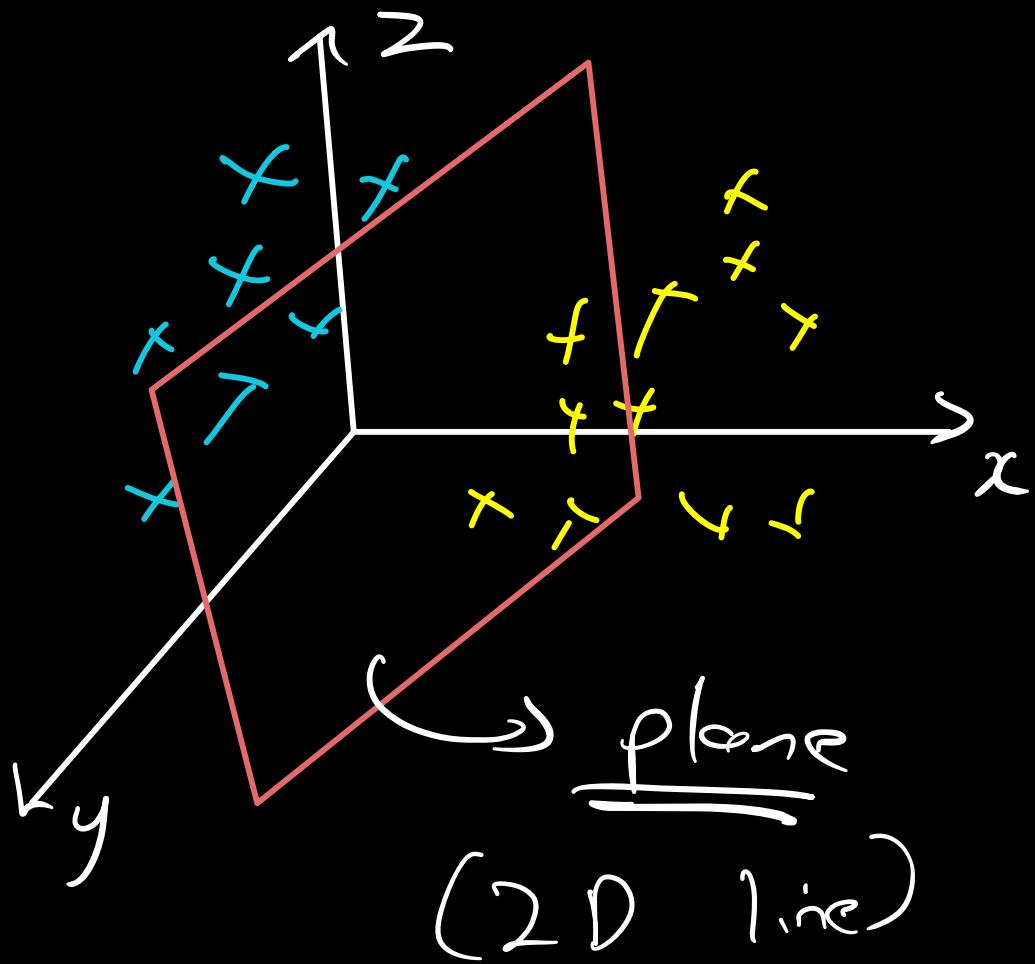
and my line is

$$y = mx + c$$

→ if $y_1 > m(x_1) + c \rightarrow +ve$ half space

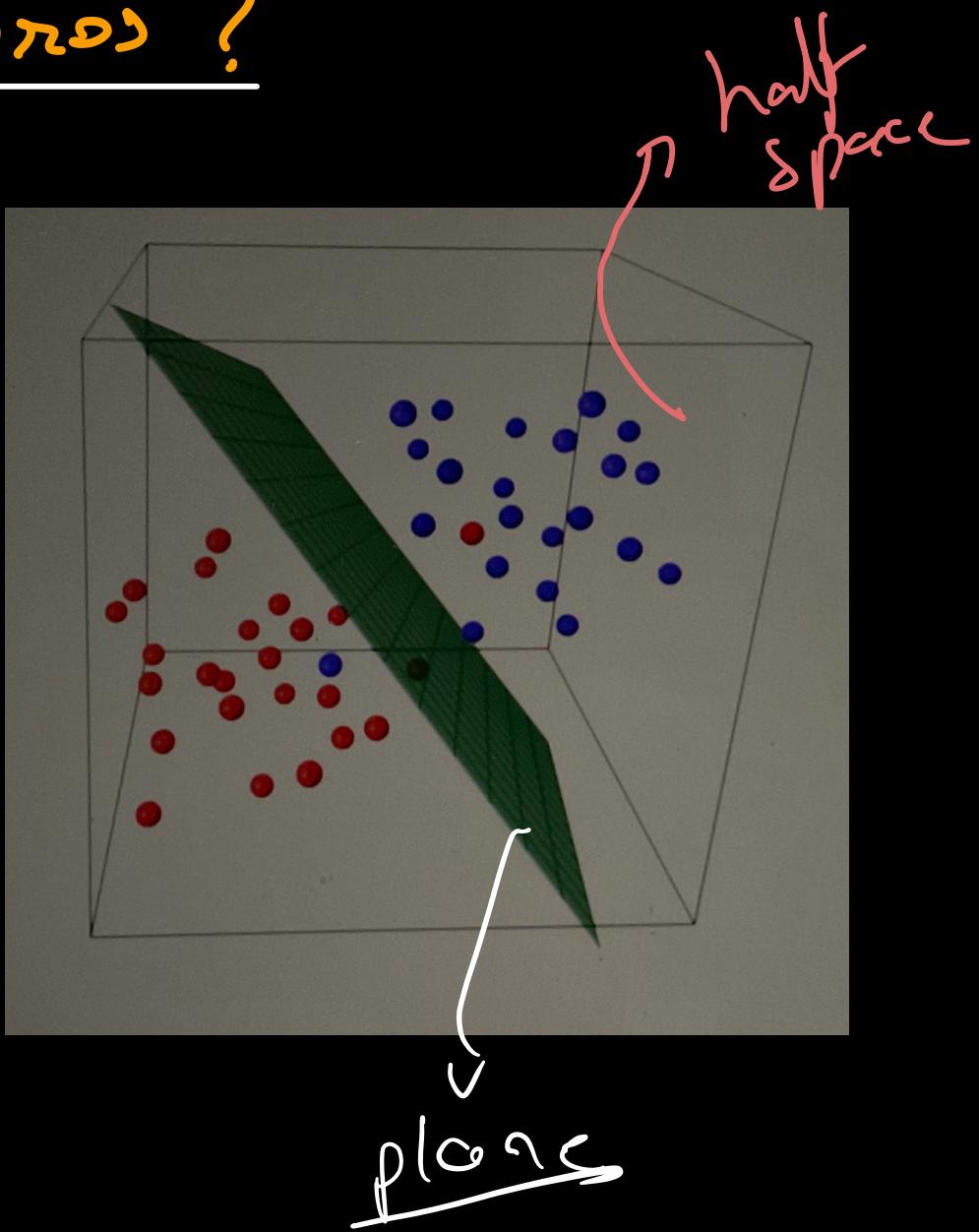
→ if $y_1 < m(x_1) + c \rightarrow -ve$ half space

More than 2 features ?



Hyperplane

→ A linear surface in n-d



Other forms of Line Eqⁿ

$$\rightarrow y = mx + c \quad [\text{slope - intercept}]$$

$$\rightarrow (y - y_1) = m(x - x_1) \quad [\text{one point}]$$

$$\rightarrow (y - y_1) = \left(\frac{y_2 - y_1}{x_2 - x_1} \right) (x - x_1) \quad [2 \text{ point}]$$

$$\rightarrow \frac{x}{a} + \frac{y}{b} = 1 \quad [\text{intercept form}]$$

$$\rightarrow ax + by + c = 0 \quad [\text{general form}]$$

$$\omega_1 x + \omega_2 y + \omega_0 = 0$$



$$\omega_1 x + \omega_2 y + \omega_3 z + \omega_0 = 0$$



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

↳ General Eqn of a hyperplane

→ Used in many ML models

→ Backbone of Neural Networks

Eqⁿ of a
plane