Solve with Instructors

Week - 1

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1.Density Estimation

$$L = -\sum \log P(x_i)$$

1. Arun goes for a walk on a daily basis and records the number of steps he has covered on each day using pedometer. The following table shows the recorded data for a week. He wants to know how many steps he can cover on the next day. Which ML model is more suitable here?

Day	Steps
05.09.2021	5800
06.09.2021	5945
07.09.2021	4880
08.09.2021	6120
09.09.2021	6430
10.09.2021	4640
11.09.2021	5980
12.09.2021	?

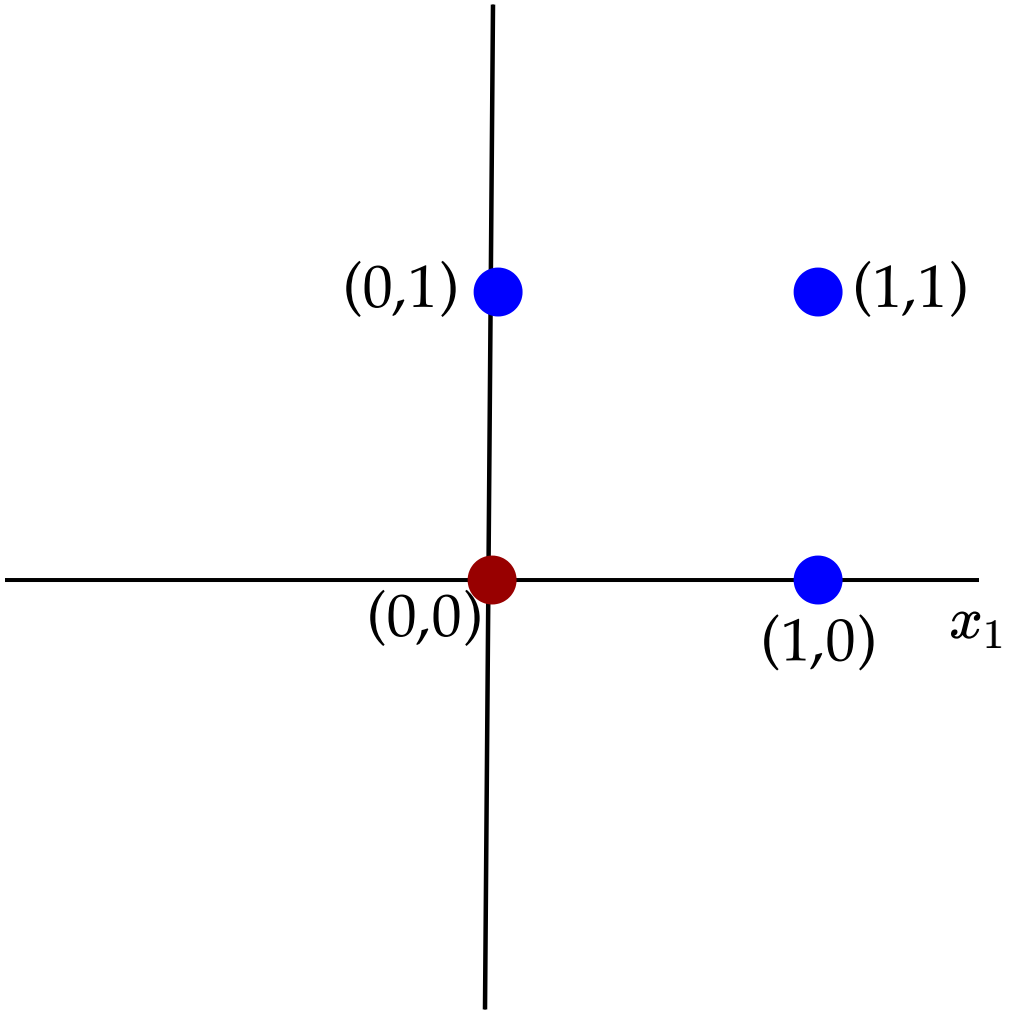
2. A behaviour analyst decided to study the emotional state of his spouse at the end of each day. He decided to observe and record various events **(Features)** that happen to her on a daily basis. The table below shows the data collected over a week. Which ML model would you suggest him?

Day	**Gone for Shopping**	**Housemaid Present**	**Gone for walking**	**State of Emotion**
05.09.2021	Yes	Yes	Yes	Happy
06.09.2021	Yes	No	Yes	Neutral
07.09.2021	Yes	No	No	Anger
08.09.2021	No	Yes	Yes	Happy
09.09.2021	No	Yes	No	Neutral
10.09.2021	Yes	No	No	Happy
11.09.2021	No	No	No	Anger
12.09.2021	Yes	Yes	No	?

3.Consider the following table that contains data points and their corresponding labels.

S.No	x1	x2	y
1	0	0	0
2	0	1	1
3	1	0	1
4	1	1	1

- Plot these data points in a cartesian coordinate system.



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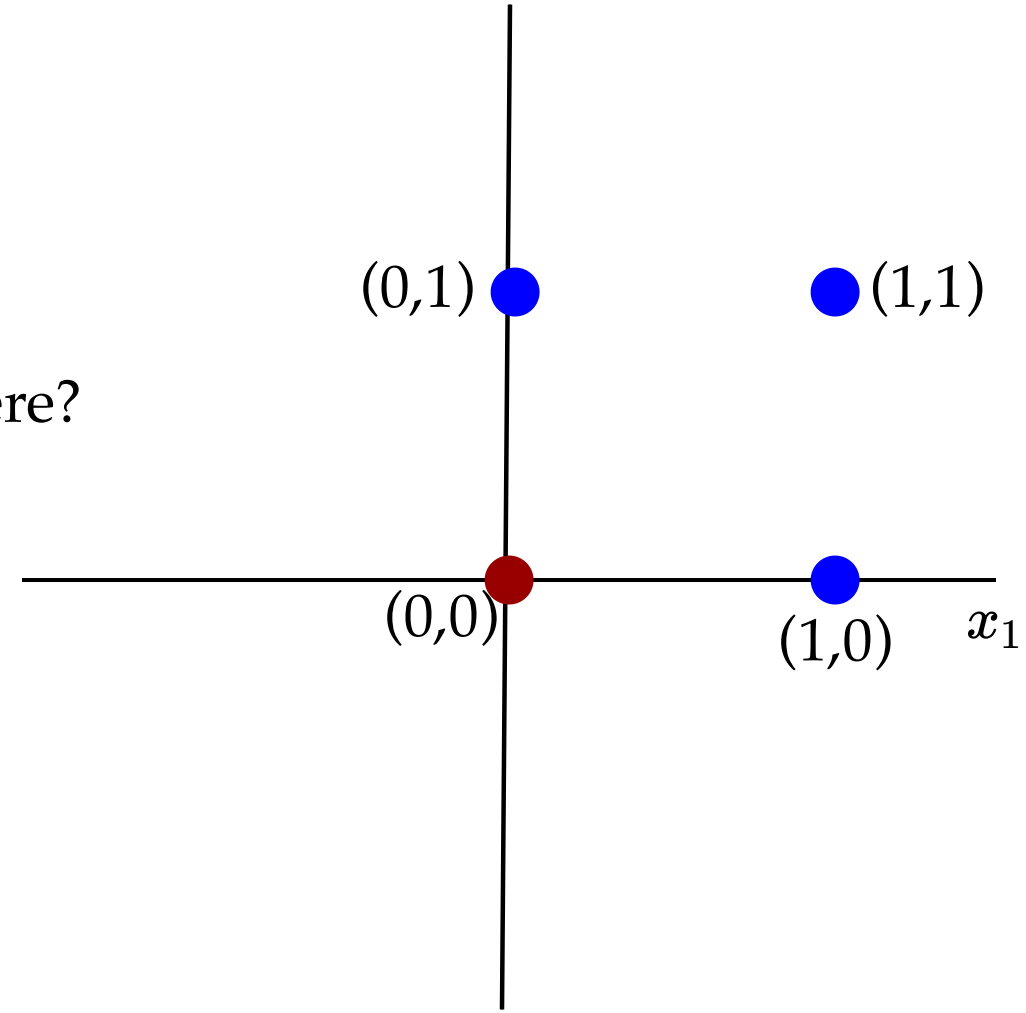
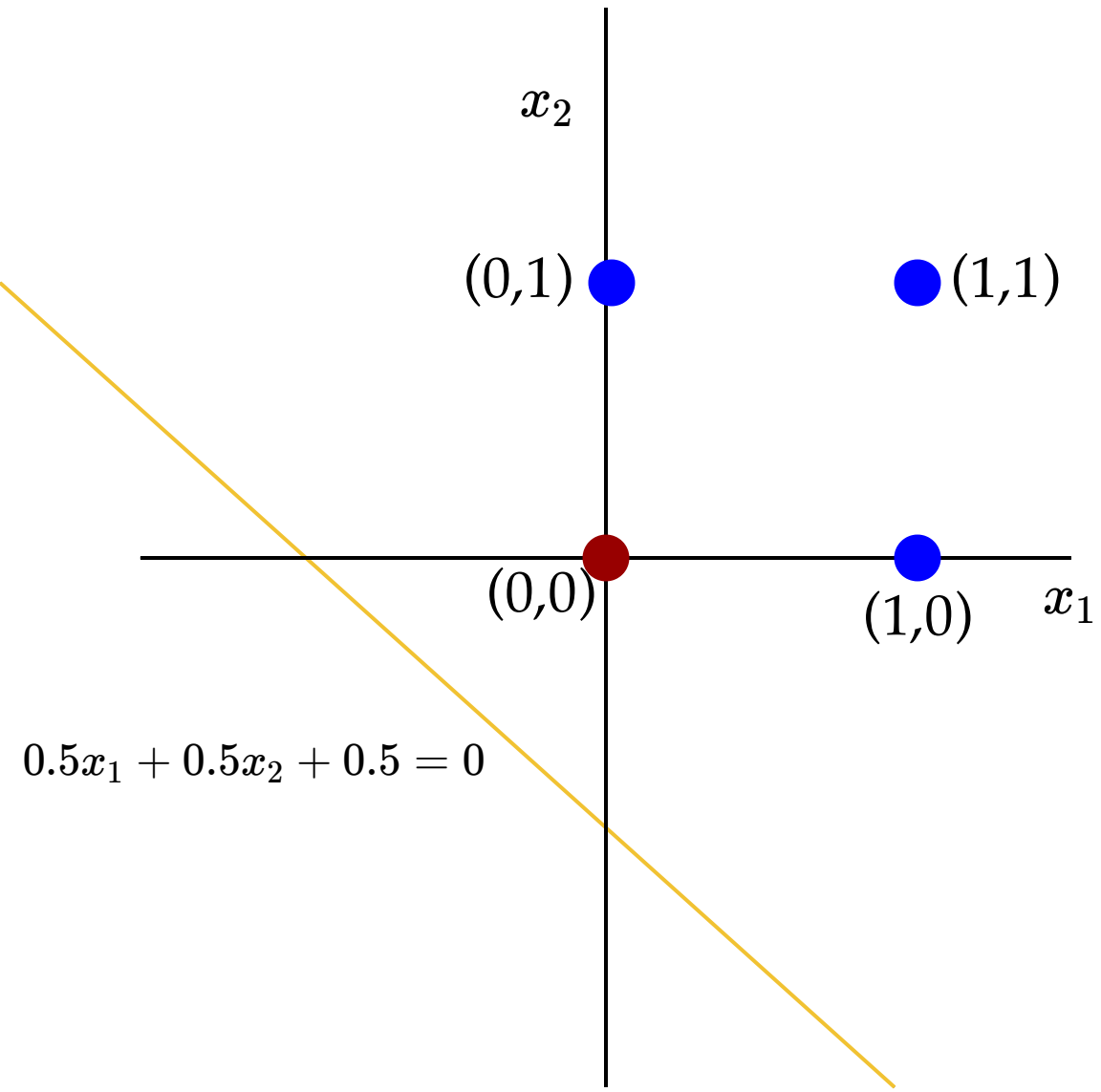


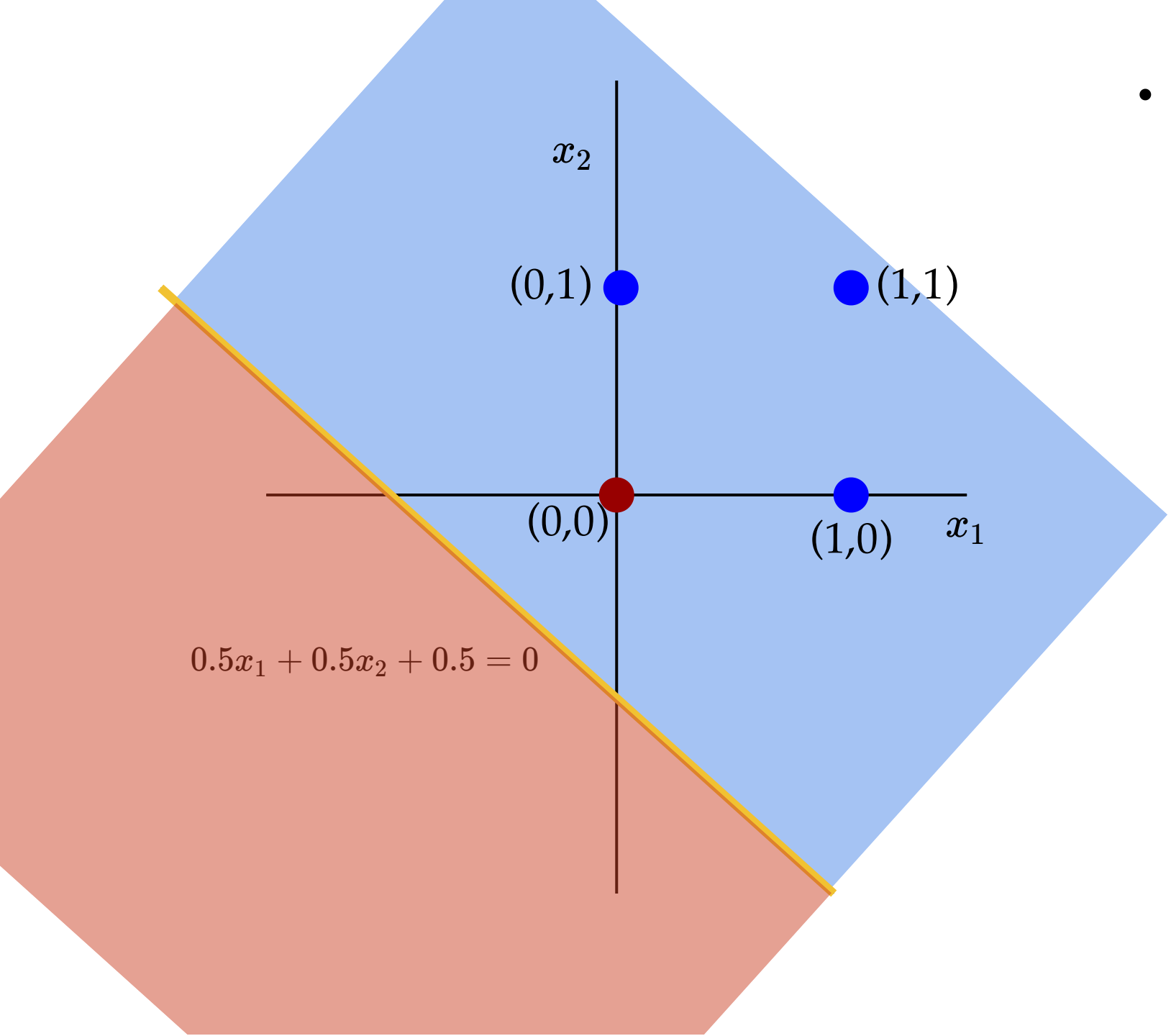
- Which ML model is more suitable here?

Classification



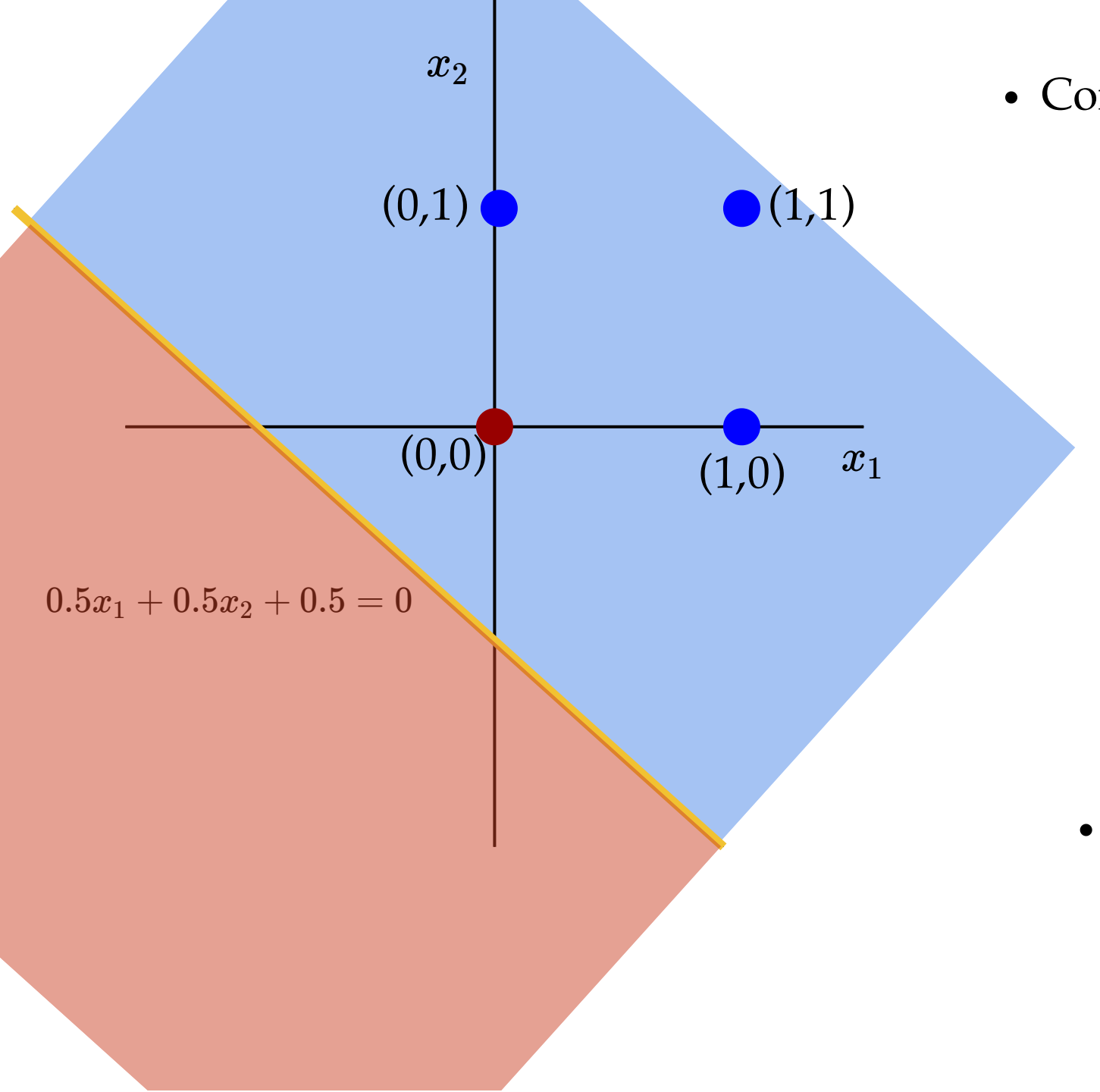
- Plot those data points in a cartesian coordinate system.
  - Which ML model is more suitable here?
  - Come up with a **linear separator** and **initialize** the parameter values to (0.5,0.5,0.5).

S.No	**x1**	**x2**	**y**
1	0	0	0
2	0	1	1
3	1	0	1
4	1	1	1



- Make predictions with the $sign(\cdot)$ function

S.No	x1	x2	y	y~
1	0	0	0	1
2	0	1	1	1
3	1	0	1	1
4	1	1	1	1



- Compute the squared error loss

S.No	x1	x2	y	$\tilde{y}$	SE
1	0	0	0	1	1
2	0	1	1	1	0
3	1	0	1	1	0
4	1	1	1	1	0

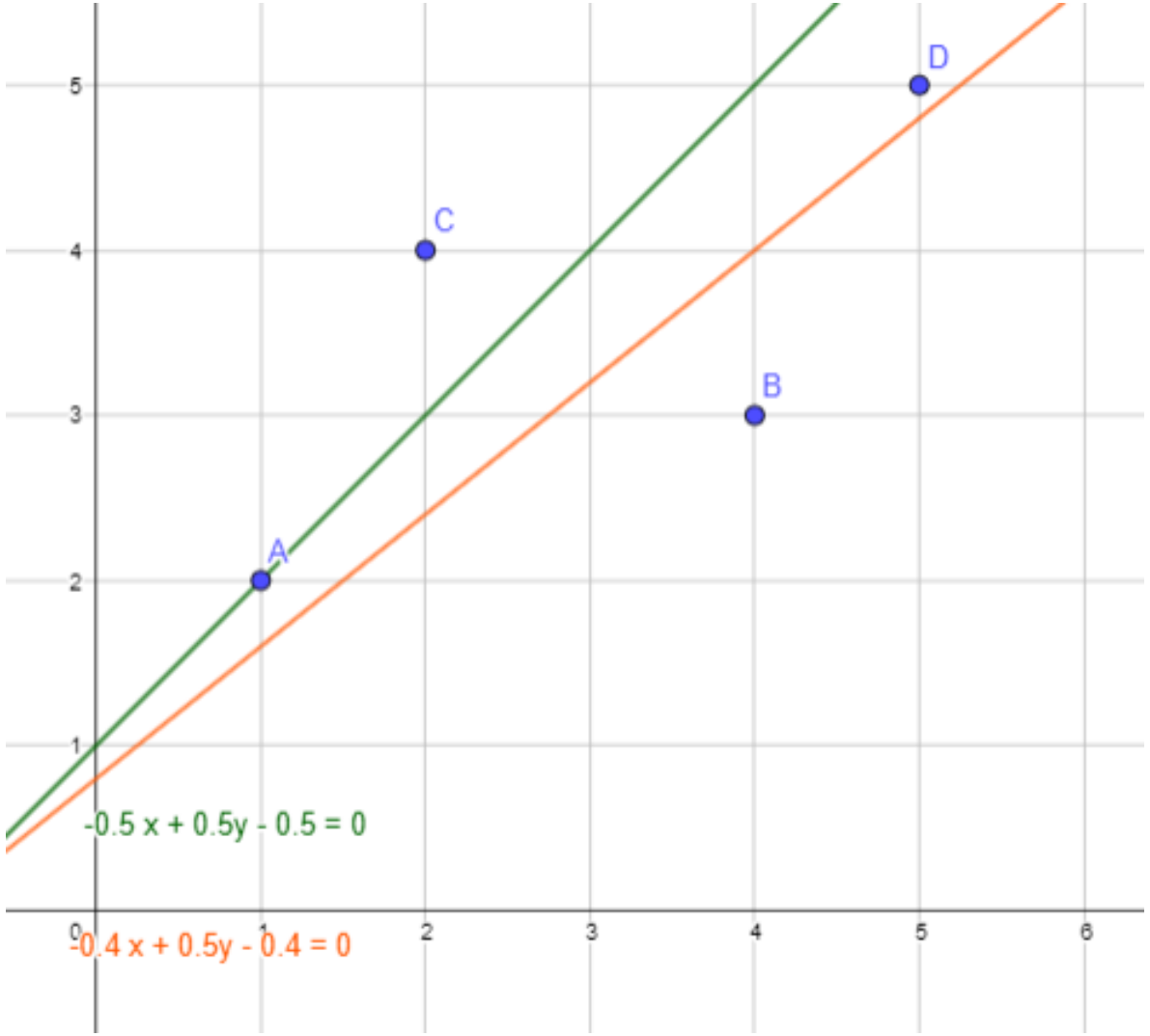
$\text{Loss} = \frac{1}{4} \cdot 1 = 0.25$

*SE = Squared Error

- Is the linear model good enough?

Compared to what?

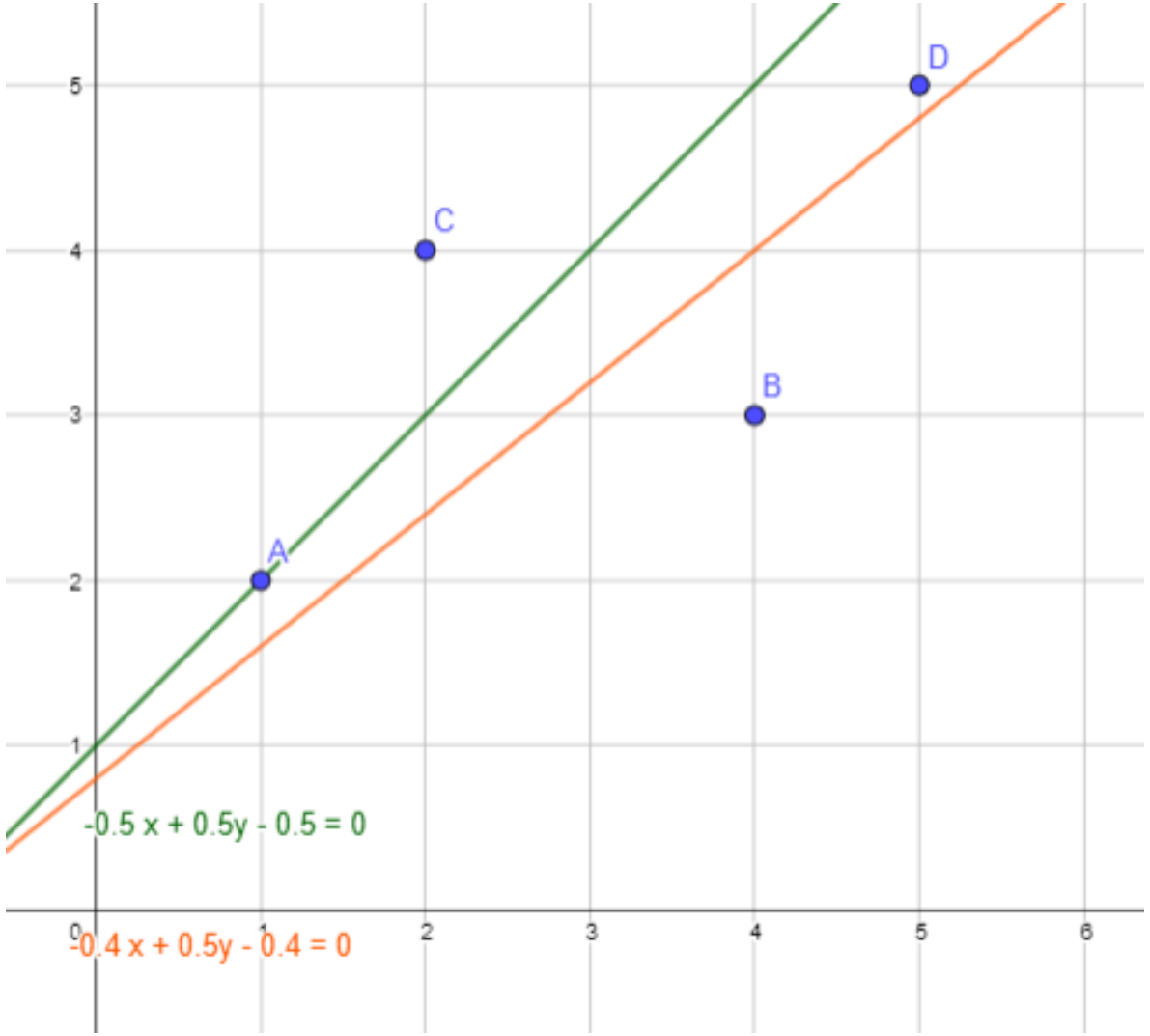
4. Look at the graph below and answer the following questions



Recognise the type of ML problem from the graph.

Regression. (How?)

4. Look at the graph below and answer the following questions



Which of these regression lines is the best one (in the MSE sense)

Can't answer just by looking at the graphs.

$$y = x + 1$$

$$y = 0.8x + 0.8$$

Compute squared error loss for both these functions.

5.The table below shows the original labels and predicted labels (classes) of some **Multiclass** classification problem. Compute the squared error loss and 0-1 loss. Which loss function seems to be a good one?

Labels/Ground Truth	**Predicted**
1	1
2	4
3	1
4	4
1	4
2	2
3	3
4	1
1	1
1	1
1	1

5.The table below shows the original labels and predicted labels (classes) of some **Multiclass** classification problem. Compute the squared error loss and 0-1 loss. Which loss function seems to be a good one?

Labels/Ground Truth	**Predicted**	**Squared Difference**	**0-1**
1	1	0	0
2	4	4	1
3	1	4	1
4	4	0	0
1	4	9	1
2	2	0	0
3	3	0	0
4	1	9	1`
1	1	0	0
1	1	0	0
1	1	0	0

$$\text{SE} : \frac{1}{11} \cdot 22 = 2$$

$$\text{0-1} : \frac{1}{11} \cdot 4 = 0.363 \ (36\ \% \text{ misclassified})$$

6. Consider an encoder $\mathbf{W}$ and decoder $\mathbf{W^T}$ functions given below

$$\mathbf{W} = \begin{bmatrix} 1, 0, 0, 0 \\ 0, 1, 0, 0 \end{bmatrix} \qquad \mathbf{W^T} = \begin{bmatrix} 1, 0 \\ 0, 1 \\ 0, 0 \\ 0, 0 \end{bmatrix}$$

Compress the data point $\mathbf{x} = [1, 2, 3, 4]^T$ to obtain $\mathbf{u}$ and reconstruct $\mathbf{x'}$ from $\mathbf{u}$

How close the reconstruction is to the original?

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$$\mathbf{W} = \begin{bmatrix} 1,0,0,0 \\ 0,1,0,0 \end{bmatrix} \qquad \mathbf{W^T} = \begin{bmatrix} 1,0 \\ 0,1 \\ 0,0 \\ 0,0 \end{bmatrix}$$

Compress a data point $\mathbf{x} = [1,2,3,4]^T$ to obtain $\mathbf{u}$ and reconstruct $\mathbf{x'}$ from $\mathbf{u}$

$$u = Wx = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$$

$$x' = W^T u = \begin{bmatrix} 1 \\ 2 \\ 0 \\ 0 \end{bmatrix}$$

How close the reconstruction is to the original?

$$L = \left\| \begin{bmatrix} 1 \\ 2 \\ 0 \\ 0 \end{bmatrix} - \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \end{bmatrix} \right\|^2 = 25$$

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1.https://www.flaticon.com/free-icon/edit_1160515?term=pen%20and%20paper&related_id=1160515