**Exercise** *Computer Vision (CSCI 4220U)*

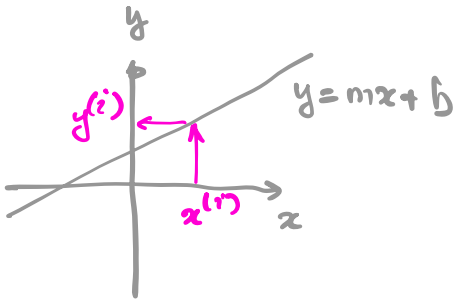
Please hand in this paper to the instructor before the end of the lecture.

Name: _____

Student number: _____ Date: _____

**Q.** You are given the following data:

| | Features | | | Labels |
|---|---|---|---|---|
| 1 | $x_1^{(1)}$ | $\cdots$ | $x_d^{(1)}$ | $y^{(1)}$ |
| 2 | $x_1^{(2)}$ | $\cdots$ | $x_d^{(2)}$ | $y^{(2)}$ |
| $\vdots$ | $\vdots$ | | $\vdots$ | $\vdots$ |
| N | $x_1^{(N)}$ | $\cdots$ | $x_d^{(N)}$ | $y^{(N)}$ |




You are asked to fit a linear model to it. Complete the following tasks.

1. Express the model mathematically.
2. How many paramters this model will have?
3. Write down the MSE loss expression for your setup.

1. $y = \theta_0 + \theta_1 x_1 + \cdots + \theta_d x_d$

2. $d+1$

3. $\mathcal{L}(\theta_0, \theta_1, \cdots, \theta_d) = \frac{1}{N} \sum_{i=1}^{N} (\hat{y}^{(i)} - y^{(i)})^2$,

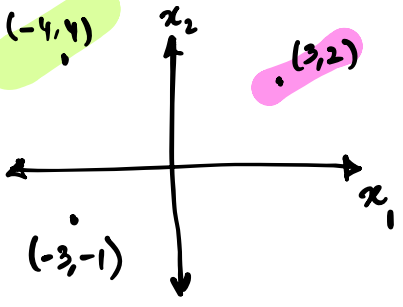
↑ prediction

where $\hat{y}^{(i)} = \theta_0 + \theta_1 x_1^{(i)} + \cdots + \theta_d x_d^{(i)}$, $i \in [1, N]$

4. Set up $Ax = b$ system for this model.

$$x = \begin{bmatrix} \theta_0 \\ \theta_1 \\ \vdots \\ \theta_d \end{bmatrix}$$

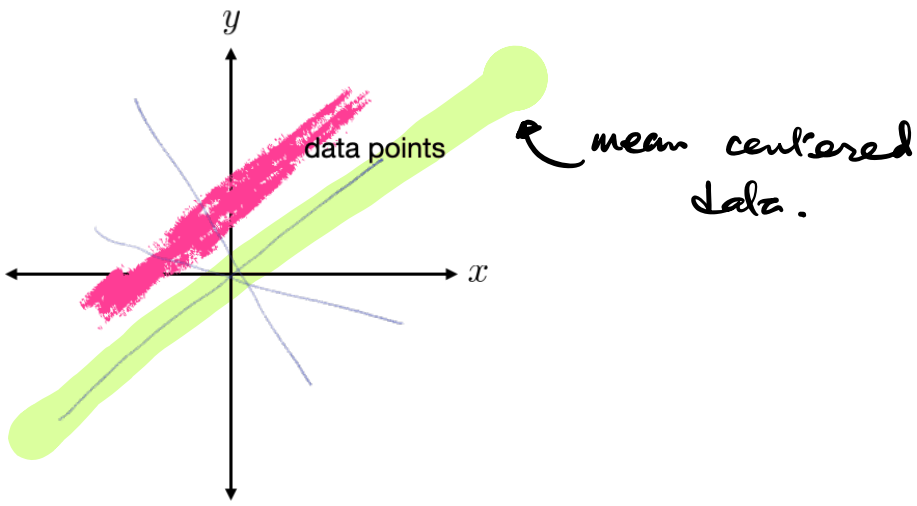
EXAMPLE:




$(x_1^{(1)}, x_2^{(1)}) = (3,2)$

$(x_1^{(2)}, x_2^{(2)}) = (-4,4)$

**Q.** Consider the following setup that shows a collection of data points. Here $x$-coordinate represents inputs and $y$-coordinates represents their respective output.




Since both $x$ and $y$ are continuous, we have a *regression* problem at our hand. We are asked to fit the following, single-parameter model to this data:

$$y = mx,$$

where $m$ is the lone model parameter.

Devise a scheme to fit this model to this data? Do you think this model has enough "model complexity" to fit this data well? Can you spot a problem? If there is a problem, can you suggest a fix.