ECE521 Assignment 1
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Task 1:

Training Size	Number of Validation Errors
5	107
50	40
100	27
200	17
400	9
800	12

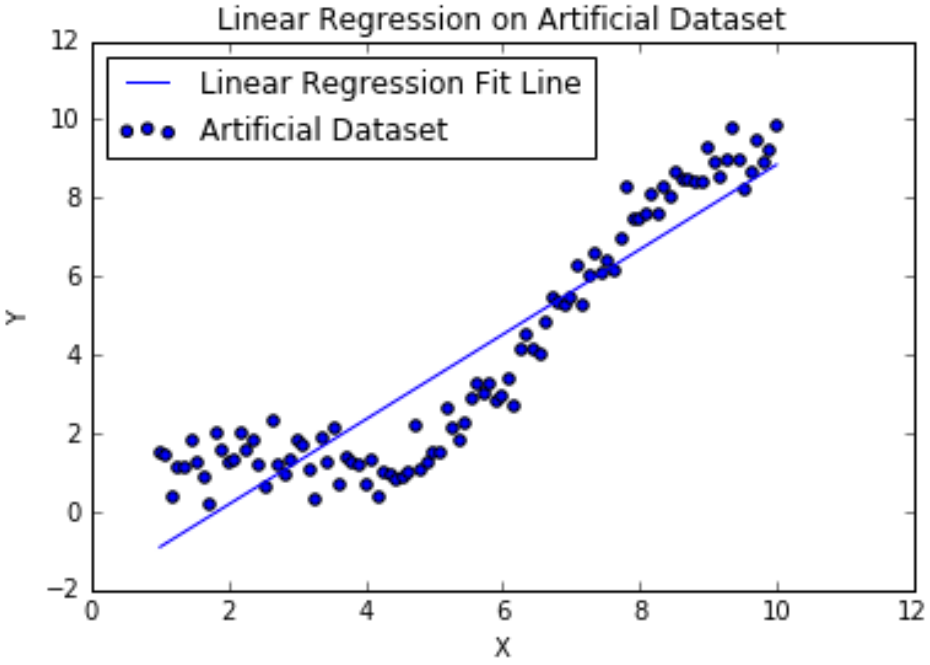
Increasing the training set size is best, and corresponds to a decreasing validation error, meaning that the model generalizes better and performs better on unseen data, as the training set gives a better representation of the underlying distribution of the data.

Task 2:

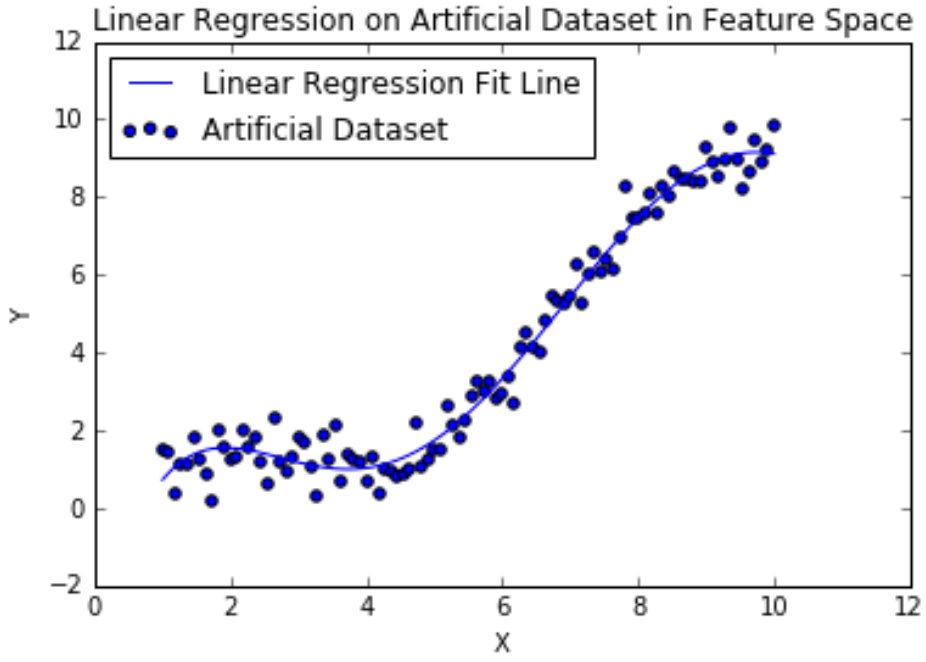
K Neighbors	Number of Validation Errors
1	12
3	8
5	10
7	9
21	11
101	24
401	51

The optimal performance is when K equals three, and decreases as K grows large, because the set of K neighbors starts to include a significant fraction of the entire training set, and therefore many points from both classes.

Task 3:



Task 4:



Non-linearity in the model gives it the capacity to better fit a training set that is not from a linear distribution, reducing the training squared error.

Task 5:

The algorithm labels predictions that are >= 0.5 as 1, and predictions that are < 0.5 as 0.

Hyper-parameters:

- Epochs: 100
- Learning Rate: 0.001
- Initial weights: 0
- Mini-batch size: 1

Training Size	Number of Validation Errors
100	35
200	24
400	24
800	23

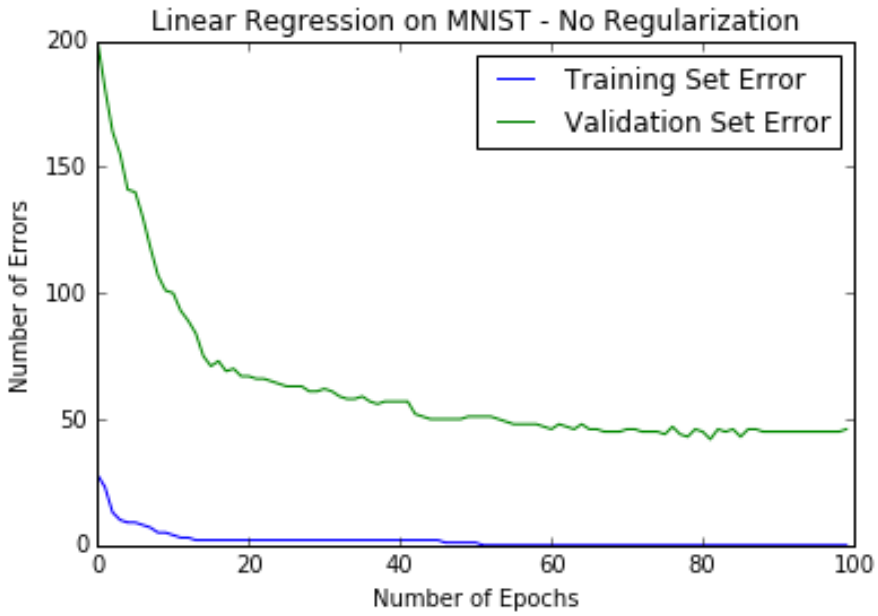
A large training size is best, as it decreases the variance, and improves the generalization of the model, as a larger training set better represents the underlying distribution of the data.

Task 6:

The algorithm labels predictions that are >= 0.5 as 1, and predictions that are < 0.5 as 0.

Hyper-parameters:

- Epochs: 100
- Learning Rate: 0.002
- Initial weights: 0
- Mini-batch size: 1



Task 7:

The same binary thresholding and hyper-parameters from Task 6 apply.

L2 Regularization	Number of Validation Errors
0	45
0.0001	45
0.001	45
0.01	45
0.1	52
0.5	82

In this case a higher weight decay hurts performance, and the best regularization is none at all, but this is because the weights are already initialized to zero, and forcing them towards zero actually underfits the data because the weights aren't allowed to grow large enough to model the training distribution.