HANDWRITTEN DIGIT RECOGNITION
USING NEURAL NETWORKS

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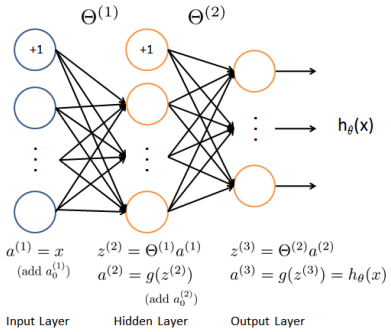


Figure 2: Neural network model.

Problem Statement

In this assignment we had to implement a neural network to recognize handwritten digits using the given data. The neural network will be able to represent more complex models that form non-linear hypotheses.

Dataset

Our dataset contained 5000 points, where each example had 784 features representing the pixels of a 28x28 image. The second file contained the labels that classified each training example according to its digit.

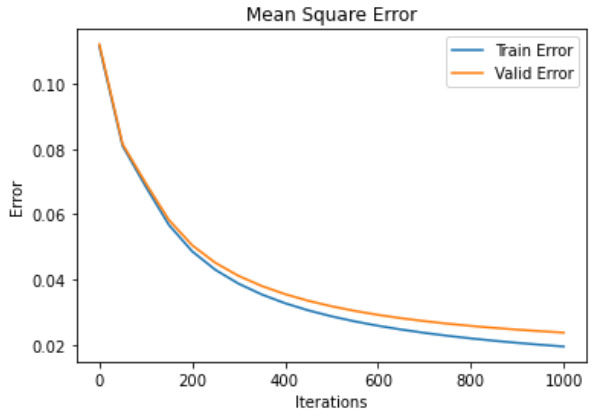
APPROACH AND RESULTS

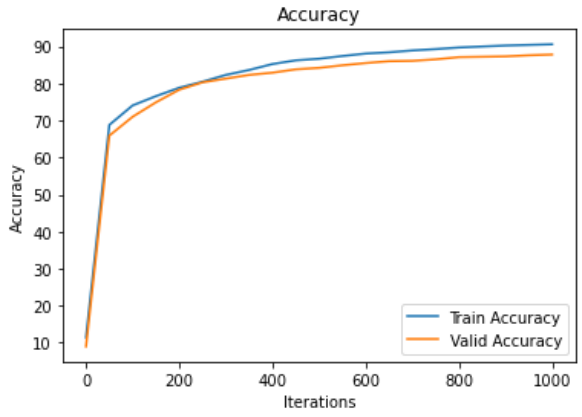
We create a neural network of 3 layers. The initial is the input layer with 784 nodes and one bias. The second layer has 100 nodes and the output layer has 10(because we are classifying in 10 digits). We have implemented forward and backward propagation,

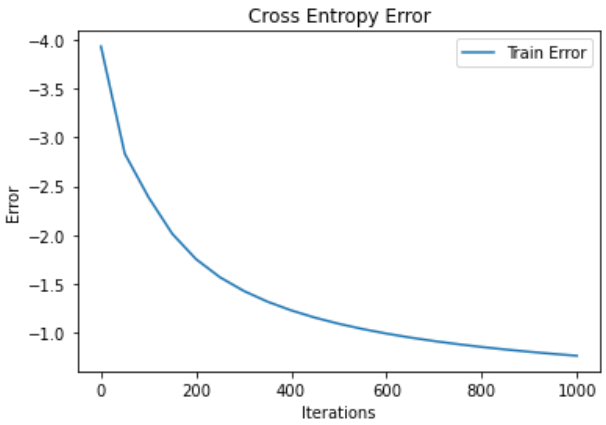
We implement both the error functions- Mean Square Error and Cross Entropy Error and have compared the results.

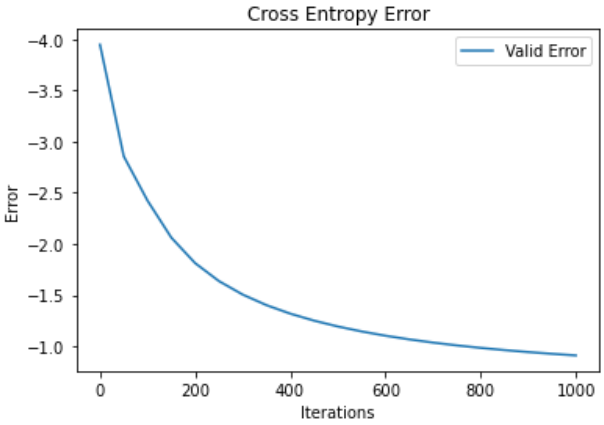
We randomly initialize weights and randomly split our dataset into train, validation and test sets.

Below show the findings without regularization(lambda = 0)







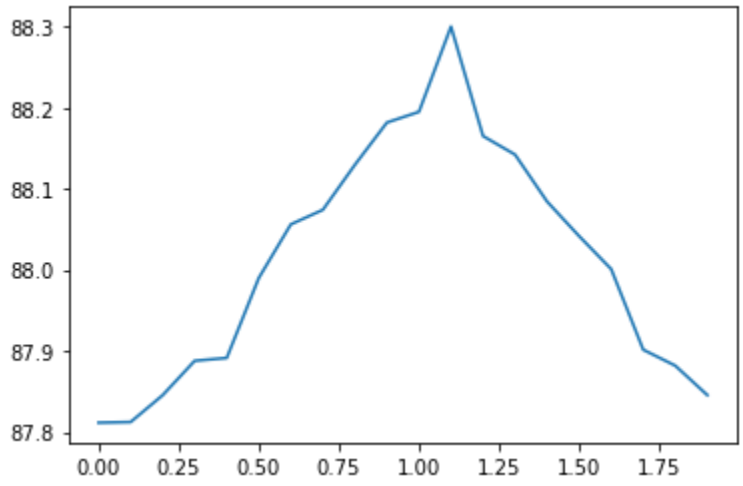


Accuracies:

- Training- 90.133%
- Validation- 87.8%
- Test = 88.3%

We then compare the range of regularization parameters with the accuracy, to obtain the optimal lambda.

The graph of lambda vs validation accuracy is given below:



From the above findings we obtain that the best regularization parameter would be 1.1

Changes in error and accuracy after implementing regularization:

```
------ Training 1000------
MSE: 0.01670034967317935
Cross Entropy: -0.6514720389541011
% Accuracy: 91.23333333333333
------ Validation 1000 ------
MSE: 0.021375787708619268
Cross Entropy: -0.8259266188865645
% Accuracy: 88.3
```

```
Test Accuracy:  89.0
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