Neural Network for Digit Classification

- Objective: To classify a handwritten digit in a given image.

- Machine Learning technology: Neural Network

- Dataset: MNIST dataset

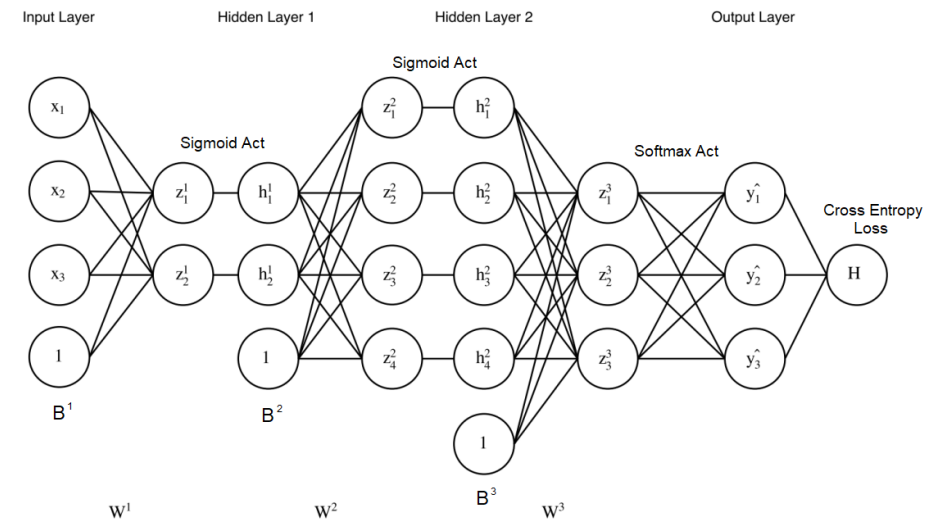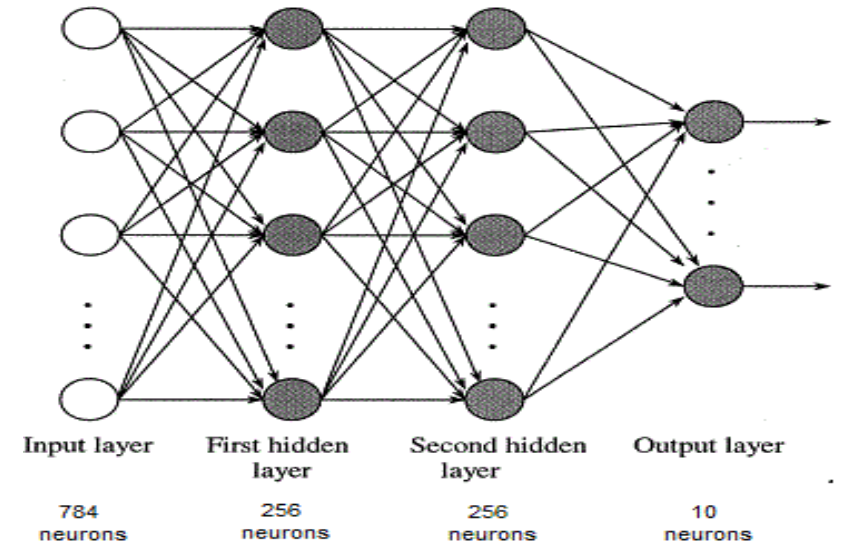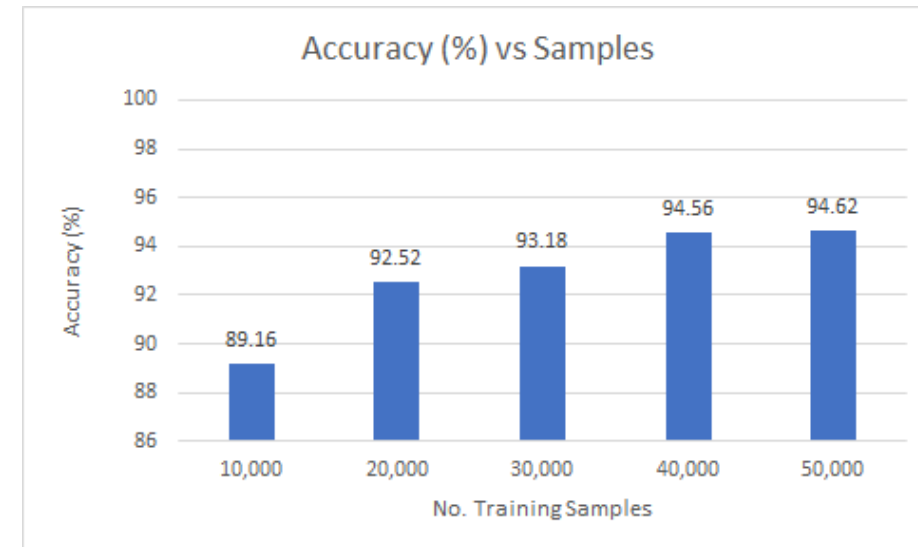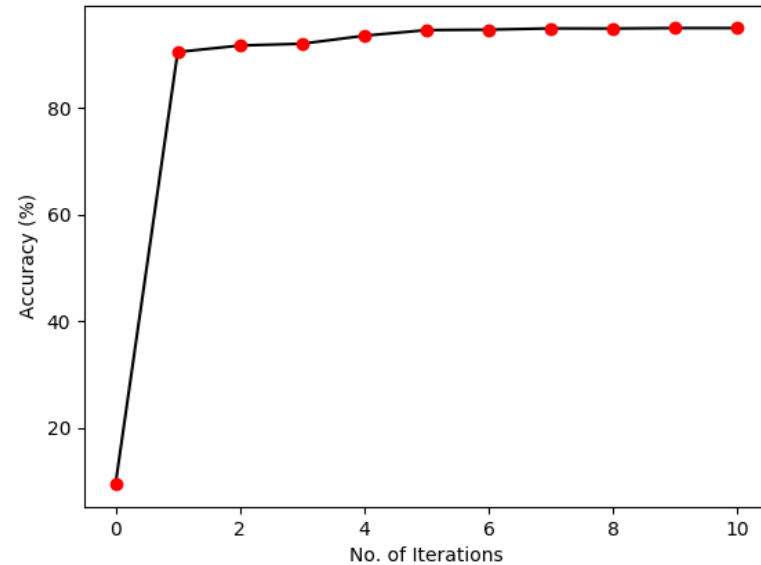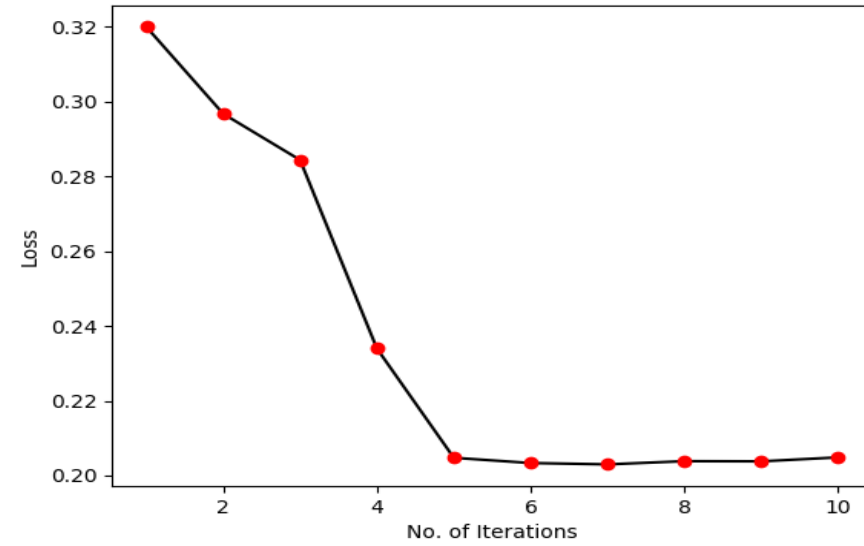- Potential Areas of Use: Self Driving Cars, Robotics

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Structure of Our Neural Network

- 784 (input) – 256(H1) – 256(H2) – 10 (Output)
- Normalized input (Divided by 255)
- Sigmoid Activation at each hidden layer
- Softmax Activation at output layer
- Cross entropy loss

- Network Parameters
  - Weights: W1, W2, W3
  - Biases: B1, B2, B3

- Data size: Training 10k, Validation 5k, Test 5k

Input layer	First hidden layer	Second hidden layer	Output layer
784 neurons	256 neurons	256 neurons	10 neurons

Results
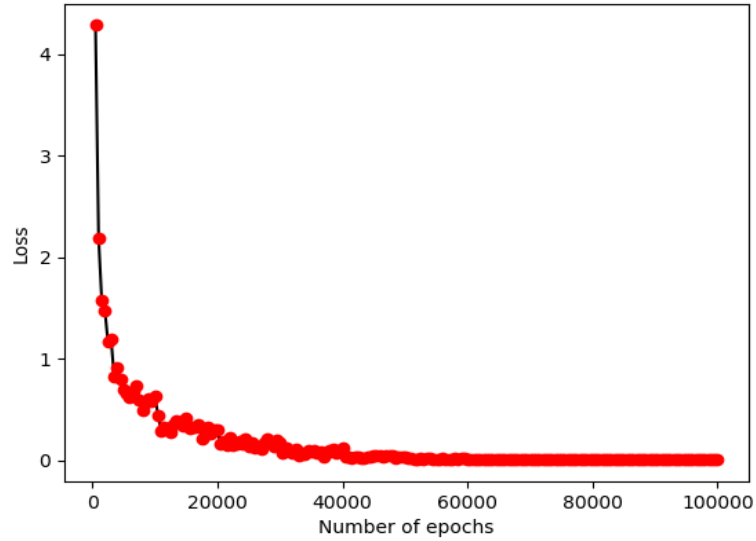
Dropout Regularization to avoid Overfitting
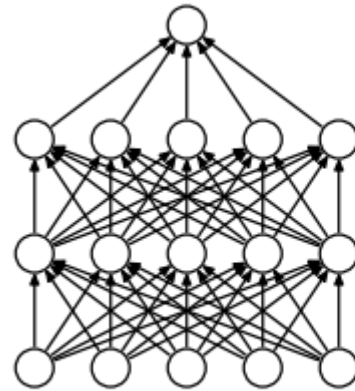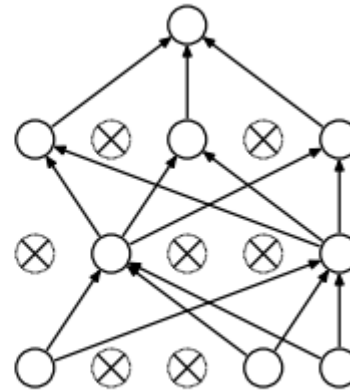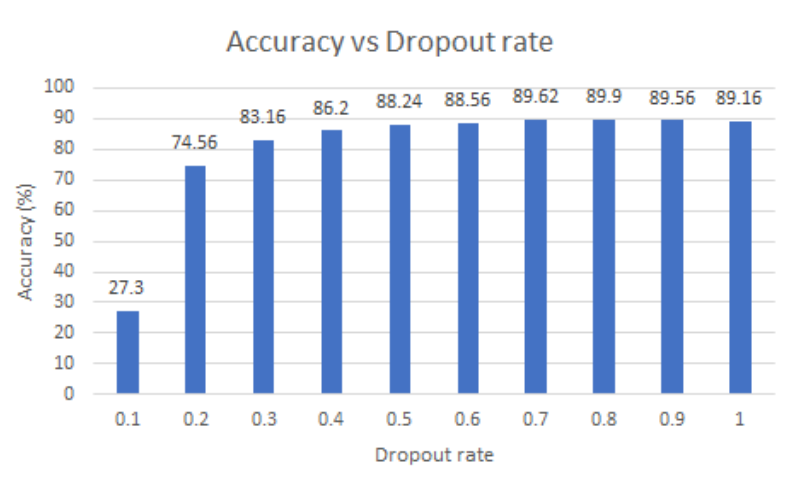

(a) Standard Neural Net

(b) After applying dropout.

Accuracy vs Dropout rate

Max Accuracy for 0.8

Accuracy (%) w.r.t. Dropout
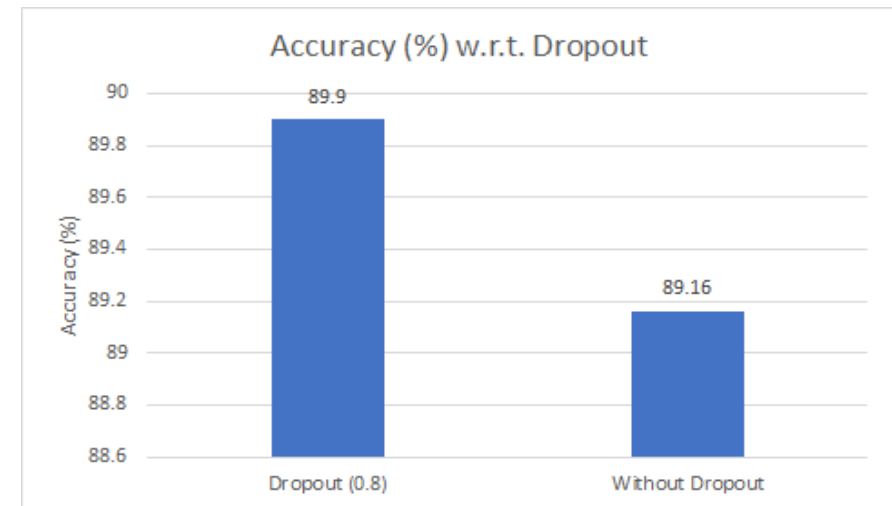
Dropout improved the accuracy in Testing

Confusion Matrix

```
      0    1    2    3    4    5    6    7    8    9
0  [521    2    1    0    0    0    2    0    1    0]
1  [  0  523    4    1    0    4    1    1    0    1]
2  [ 27    5  411    6    8    0   17    7   13    2]
3  [ 14    3    9  395    1   20    3    4   31   10]
4  [  2    0    0    0  439    0    6    2    1   16]
5  [ 54    2    1    5    3  408   11    0    5    3]
6  [ 15    3    0    0    2    3  484    0    4    0]
7  [ 11    5    7    0    7    1    0  436    7   18]
8  [ 40    2    8    7    2    5   13    2  408    4]
9  [ 10    4    0    1   20    0    1   18   13  433]]
```

Normalized Confusion Matrix

```
       0     1     2     3     4     5     6     7     8     9
[  98.9   0.4   0.2   0.    0.    0.    0.4   0.    0.2   0.  ]
[   0.   97.8   0.7   0.2   0.    0.7   0.2   0.2   0.    0.2]
[   5.4   1.   82.9   1.2   1.6   0.    3.4   1.4   2.6   0.4]
[   2.9   0.6   1.8  80.6   0.2   4.1   0.6   0.8   6.3   2. ]
[   0.4   0.    0.    0.   94.2   0.    1.3   0.4   0.2   3.4]
[  11.    0.4   0.2   1.    0.6  82.9   2.2   0.    1.    0.6]
[   2.9   0.6   0.    0.    0.4   0.6  94.7   0.    0.8   0. ]
[   2.2   1.    1.4   0.    1.4   0.2   0.   88.6   1.4   3.7]
[   8.1   0.4   1.6   1.4   0.4   1.    2.6   0.4  83.1   0.8]
[   2.    0.8   0.    0.2   4.    0.    0.2   3.6   2.6  86.6]]
```

As we can see from the confusion matrix
- 3 is confused with 8
- 5 is confused with 0
- 8 is confused with 0