Final Project: Tensorflow and Neural Network Report
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Q4: Tensorflow

C:\Users\shraddha_m26\Desktop\Stats Programming\Assignments\Final_submit>python TF.py
Extracting /tmp/tensorflow/mnist/input_data\train-images-idx3-ubyte.gz
Extracting /tmp/tensorflow/mnist/input_data\train-labels-idx1-ubyte.gz
Extracting /tmp/tensorflow/mnist/input_data\t10k-images-idx3-ubyte.gz
Extracting /tmp/tensorflow/mnist/input_data\t10k-labels-idx1-ubyte.gz
2017-12-15 14:32:14.464112: I C:\tf_jenkins\home\workspace\rel-win\M\windows\PY\36\tensorflow\core\platform\cpu_feature_guard.cc:137] Your CPU supports instructions that this TensorF
low binary was not compiled to use: AVX AVX2
Epoch: 0
Accuracy: 0.6577
Epoch: 1
Accuracy: 0.8257
Epoch: 2
Accuracy: 0.8433
Epoch: 3
Accuracy: 0.8531
Epoch: 4
Accuracy: 0.8539
Epoch: 5
Accuracy: 0.8872
Epoch: 6
Accuracy: 0.942
Epoch: 7
Accuracy: 0.9473
Epoch: 8
Accuracy: 0.9499
Epoch: 9
Accuracy: 0.9543
Epoch: 10
Accuracy: 0.955
Epoch: 11
Accuracy: 0.9567
Epoch: 12
Accuracy: 0.9563
Epoch: 13
Accuracy: 0.9563
Epoch: 14
Accuracy: 0.9598
Epoch: 15

Accuracy: 0.9596
Epoch: 16
Accuracy: 0.9597
Epoch: 17
Accuracy: 0.9612
Epoch: 18
Accuracy: 0.9633
Epoch: 19
Accuracy: 0.9619
Epoch: 20
Accuracy: 0.9614
Epoch: 21
Accuracy: 0.9621
Epoch: 22
Accuracy: 0.9648
Epoch: 23
Accuracy: 0.9632
Epoch: 24
Accuracy: 0.9629
Epoch: 25
Accuracy: 0.9637
Epoch: 26
Accuracy: 0.9646
Epoch: 27
Accuracy: 0.9656
Epoch: 28
Accuracy: 0.9657
Epoch: 29
Accuracy: 0.9652
Epoch: 30
Accuracy: 0.9648
Epoch: 31
Accuracy: 0.9664
Epoch: 32
Accuracy: 0.9658
Epoch: 33
Accuracy: 0.9663
Epoch: 34
Accuracy: 0.9664
Epoch: 35
Accuracy: 0.9664
Epoch: 36
Accuracy: 0.9655
Epoch: 37
Accuracy: 0.9666
Epoch: 38
Accuracy: 0.9657

Epoch: 39
Accuracy: 0.9663
Epoch: 40
Accuracy: 0.9662
Epoch: 41
Accuracy: 0.9668
Epoch: 42
Accuracy: 0.9664
Epoch: 43
Accuracy: 0.9673
Epoch: 44
Accuracy: 0.9669
Epoch: 45
Accuracy: 0.9664
Epoch: 46
Accuracy: 0.967
Epoch: 47
Accuracy: 0.9662
Epoch: 48
Accuracy: 0.9668
Epoch: 49
Accuracy: 0.9666
Epoch: 50
Accuracy: 0.9669
Epoch: 51
Accuracy: 0.9668
Epoch: 52
Accuracy: 0.9665
Epoch: 53
Accuracy: 0.9667
Epoch: 54
Accuracy: 0.967
Epoch: 55
Accuracy: 0.9671
Epoch: 56
Accuracy: 0.9673
Epoch: 57
Accuracy: 0.9673
Epoch: 58
Accuracy: 0.9669
Epoch: 59
Accuracy: 0.9671
Epoch: 60
Accuracy: 0.9678
Epoch: 61
Accuracy: 0.9664
Epoch: 62

Accuracy: 0.9682
Epoch: 63
Accuracy: 0.9683
Epoch: 64
Accuracy: 0.968
Epoch: 65
Accuracy: 0.9679
Epoch: 66
Accuracy: 0.9685
Epoch: 67
Accuracy: 0.968
Epoch: 68
Accuracy: 0.968
Epoch: 69
Accuracy: 0.9684
Epoch: 70
Accuracy: 0.9681
Epoch: 71
Accuracy: 0.9683
Epoch: 72
Accuracy: 0.9685
Epoch: 73
Accuracy: 0.9685
Epoch: 74
Accuracy: 0.9685
Epoch: 75
Accuracy: 0.9679
Epoch: 76
Accuracy: 0.9681
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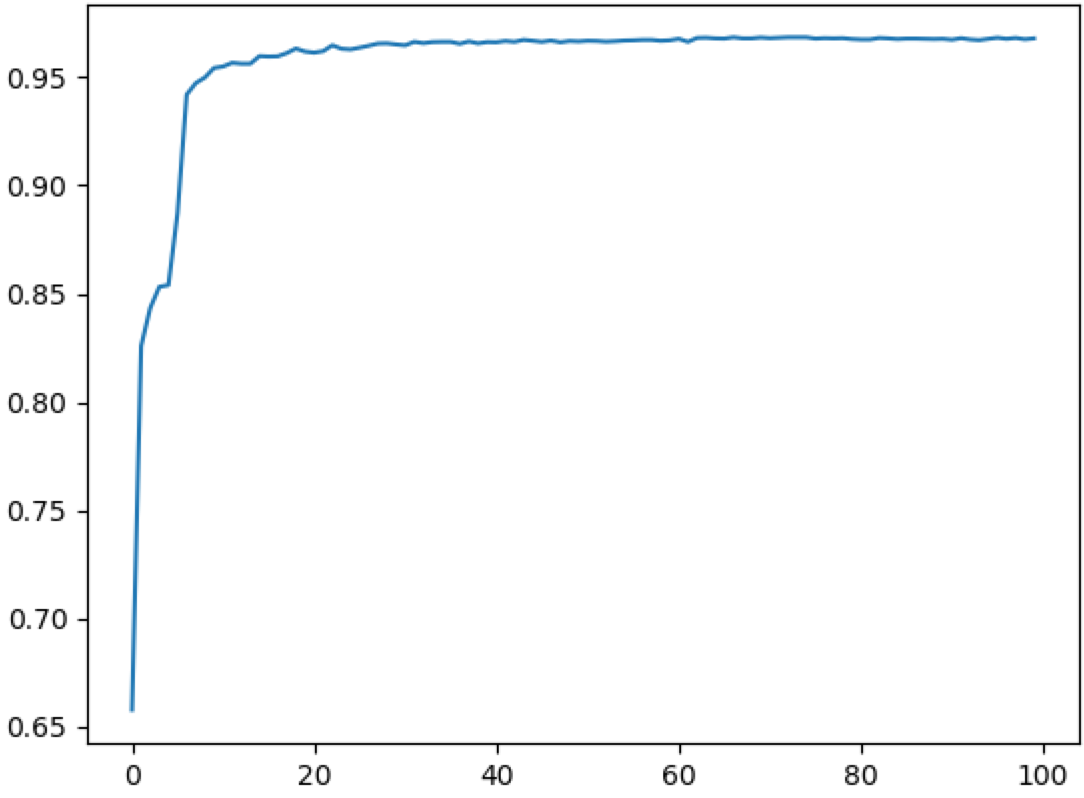
Accuracy: 0.968
Epoch: 78
Accuracy: 0.9681
Epoch: 79
Accuracy: 0.9677
Epoch: 80
Accuracy: 0.9675
Epoch: 81
Accuracy: 0.9675
Epoch: 82
Accuracy: 0.9682
Epoch: 83
Accuracy: 0.968
Epoch: 84
Accuracy: 0.9677
Epoch: 85
Accuracy: 0.9679

Epoch: 86
Accuracy: 0.9679
Epoch: 87
Accuracy: 0.9678
Epoch: 88
Accuracy: 0.9677
Epoch: 89
Accuracy: 0.9678
Epoch: 90
Accuracy: 0.9674
Epoch: 91
Accuracy: 0.9681
Epoch: 92
Accuracy: 0.9675
Epoch: 93
Accuracy: 0.9672
Epoch: 94
Accuracy: 0.9678
Epoch: 95
Accuracy: 0.9683
Epoch: 96
Accuracy: 0.9678
Epoch: 97
Accuracy: 0.9682
Epoch: 98
Accuracy: 0.9676
Epoch: 99
Accuracy: 0.968
0.968

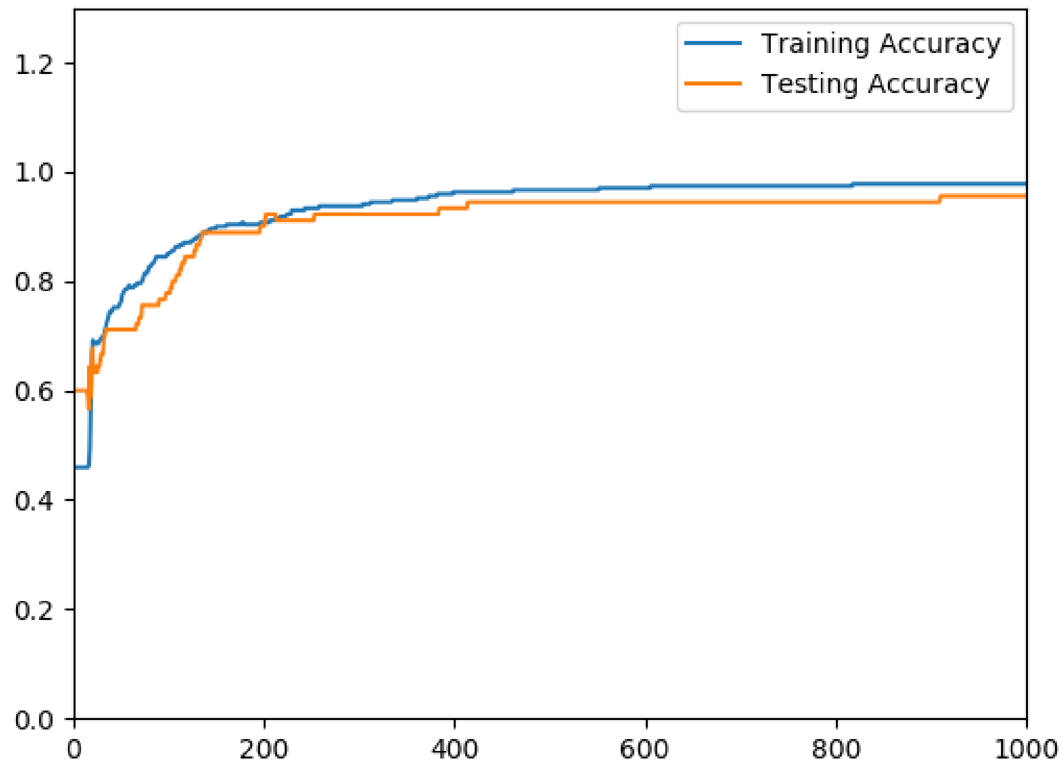


Q3:

2-layer Neural Network using relu and sigmoid activation function:

C:\Users\shraddha_m26\Desktop\Stats Programming\Assignments\Final>python 2_layer_nn.py
Training Accuracy at Iteration 0 : 0.459259259259
Testing Accuracy at Iteration 0 : 0.6
Training Accuracy at Iteration 50 : 0.762962962963
Testing Accuracy at Iteration 50 : 0.711111111111
Training Accuracy at Iteration 100 : 0.851851851852
Testing Accuracy at Iteration 100 : 0.777777777778
Training Accuracy at Iteration 150 : 0.9
Testing Accuracy at Iteration 150 : 0.888888888889
Training Accuracy at Iteration 200 : 0.907407407407
Testing Accuracy at Iteration 200 : 0.9
Training Accuracy at Iteration 250 : 0.933333333333
Testing Accuracy at Iteration 250 : 0.911111111111
Training Accuracy at Iteration 300 : 0.937037037037
Testing Accuracy at Iteration 300 : 0.922222222222
Training Accuracy at Iteration 350 : 0.948148148148
Testing Accuracy at Iteration 350 : 0.922222222222
Training Accuracy at Iteration 400 : 0.962962962963
Testing Accuracy at Iteration 400 : 0.933333333333
Training Accuracy at Iteration 450 : 0.962962962963

Testing Accuracy at Iteration 450 : 0.944444444444
Training Accuracy at Iteration 500 : 0.966666666667
Testing Accuracy at Iteration 500 : 0.944444444444
Training Accuracy at Iteration 550 : 0.966666666667
Testing Accuracy at Iteration 550 : 0.944444444444
Training Accuracy at Iteration 600 : 0.97037037037
Testing Accuracy at Iteration 600 : 0.944444444444
Training Accuracy at Iteration 650 : 0.974074074074
Testing Accuracy at Iteration 650 : 0.944444444444
Training Accuracy at Iteration 700 : 0.974074074074
Testing Accuracy at Iteration 700 : 0.944444444444
Training Accuracy at Iteration 750 : 0.974074074074
Testing Accuracy at Iteration 750 : 0.944444444444
Training Accuracy at Iteration 800 : 0.974074074074
Testing Accuracy at Iteration 800 : 0.944444444444
Training Accuracy at Iteration 850 : 0.977777777778
Testing Accuracy at Iteration 850 : 0.944444444444
Training Accuracy at Iteration 900 : 0.977777777778
Testing Accuracy at Iteration 900 : 0.944444444444
Training Accuracy at Iteration 950 : 0.977777777778
Testing Accuracy at Iteration 950 : 0.955555555556



Observation: Neural network is a non-linear classifier, as the hidden layers introduce complexity. Neural networks are also heavily parametric. As seen from the graph, neural networks converge last, but reliably reach the correct beta values, often local minimas. However, neural networks are prone to overfitting. The algorithm is complex, hence, it takes the most amount of time to converge.

SVM:

```
C:\Users\shraddha_m26\Desktop\Stats Programming\Assignments\Final>python svm.py
Training Accuracy:
[ 0.         0.97794118  0.97794118  0.97794118  0.97794118  0.97794118
  0.97794118  0.97794118  0.99264706  0.99264706  0.99264706  0.99264706
  0.99264706  0.99264706  0.99264706  0.99264706  0.99264706  0.99264706
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  0.99264706  0.99264706  0.99264706  1.          0.99264706  1.          1.
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Testing Accuracy:

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[ 0.93406593  0.93406593  0.93406593  0.93406593  0.93406593  0.95604396
  1.          1.          1.          1.          1.          1.          1.
  1.          1.          1.          1.          1.          1.          1.
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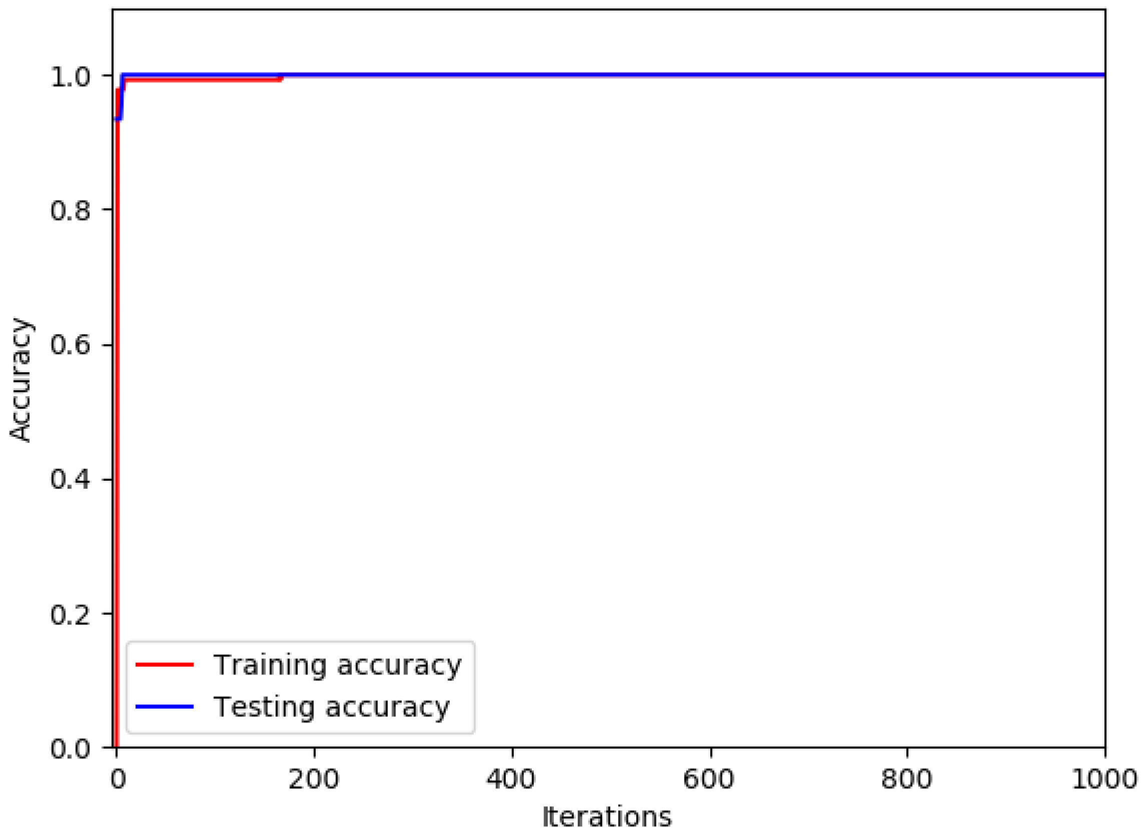

Observation: SVM (support vector machine) constructs a hyperplane or set of hyperplanes in a high- or infinite-dimensional space, which can be used for classification, regression, or other tasks like outlier detection. SVM uses the closest points in different classes as “support vectors” to estimate a convex, yet optimal hyperplane separating the classes. SVM has a regularization parameter that avoids over fitting. As seen from the graph, SVM avoids over fitting and provides excellent results for the test accuracy. SVMs are resilient to noise and take the least time to train.

Adaboost:

```
C:\Users\shraddha_m26\Desktop\Stats Programming\Assignments\Final>python svm.py
Training Accuracy:
[ 0.90441176  0.90441176  0.92279412  0.93382353  0.91911765  0.93382353
  0.91911765  0.94485294  0.92647059  0.94117647  0.92647059  0.94485294
  0.94117647  0.93014706  0.93014706  0.93014706  0.93014706  0.93014706
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Testing Accuracy:
[ 0.89010989  0.89010989  0.84615385  0.9010989   0.86813187  0.9010989
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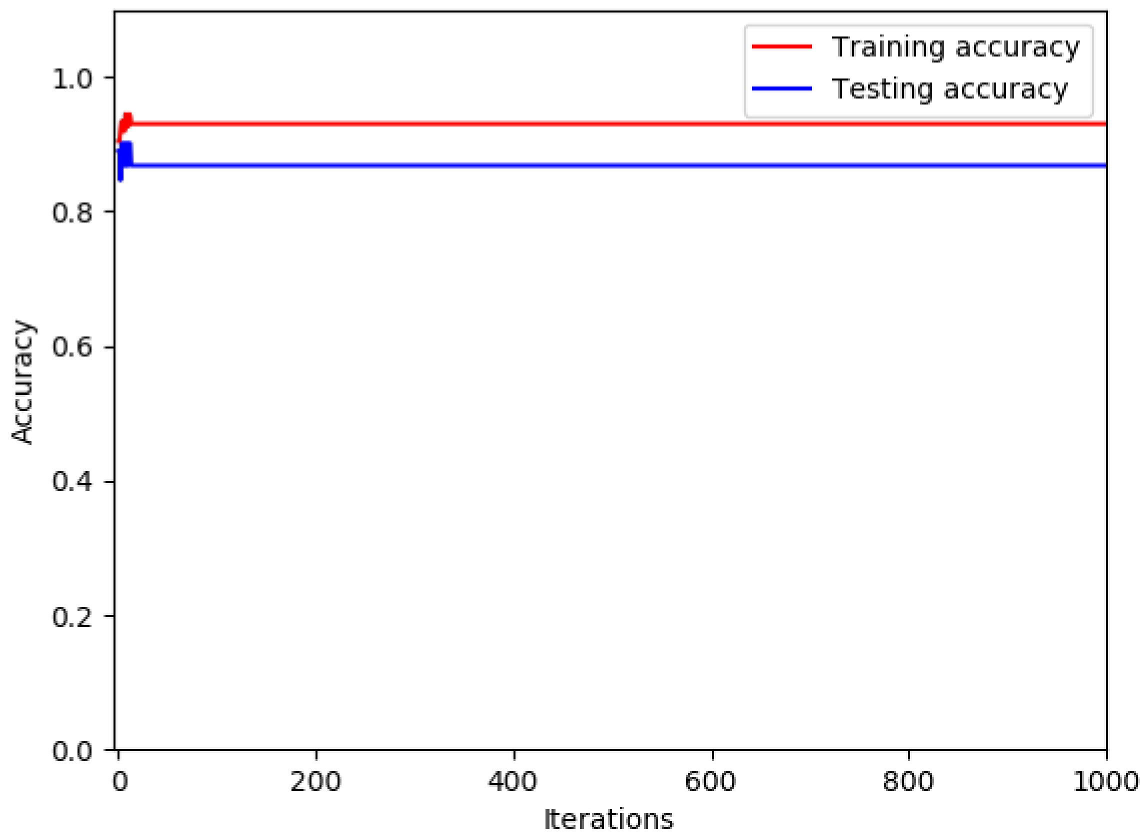

Observation: Adaboost combines the output of the other learning algorithms ('weak learners') into a weighted sum that represents the final output of the boosted classifier. Adaboost can handle sparse dataset and hence, can work with weak classifiers. But, it shows some variations after it reaches peak classification correctness. AdaBoost can be sensitive to noisy data and outliers. As seen from the graph, Adaboost reaches an effective solution quickly, but in subsequent iterations, it becomes sensitive to noise. Adaboost is the least accurate for the given dataset. It should be used when there is a class imbalance in the dataset.