1. **Simple Neural Network:**
2. **Sum of Square Error vs Cross - Entropy Error (ReLU)**

Best Result for Cross Entropy with Early Stopping

1. Activation: ReLU
2. Loss Function: categorical\_crossentropy
3. Accuracy: 96.38
4. Training Time: 2.63sec
5. No. of hidden layers: 2
6. No. of neurons per layer: 37
7. Learning rate: 0.05
8. Momentum rate: 0.9

Class Accuracies:

Class 0 : 0.9888

Class 1 : 1.0

Class 2 : 0.9774

Class 3 : 0.9454

Class 4 : 0.9724

Class 5 : 0.9725

Class 6 : 0.989

Class 7 : 0.905

Class 8 : 0.9138

Class 9 : 0.9722

Confusion Matrix:

[[176 0 0 0 0 2 0 0 0 0]

[ 0 182 0 0 0 0 0 0 0 0]

[ 0 3 173 0 0 0 0 0 1 0]

[ 1 0 3 173 0 4 0 0 0 2]

[ 0 1 0 0 176 0 0 1 2 1]

[ 0 1 0 1 0 177 0 0 1 2]

[ 0 0 0 0 2 0 179 0 0 0]

[ 0 0 0 0 1 10 0 162 1 5]

[ 0 7 0 0 0 3 1 0 159 4]

[ 0 0 0 1 1 2 0 0 1 175]]

Best Results for Sum of Square Errors with Early Stopping

1. Activation: ReLU
2. Loss Function: mean\_squared\_error
3. Accuracy: 95.44
4. Training Time: 10.04sec
5. No. of hidden layers: 2
6. No. of neurons per layer: 36
7. Learning rate: 0.05
8. Momentum rate: 0.9

Class Accuracies:

Class 0 : 0.9719

Class 1 : 0.956

Class 2 : 0.9435

Class 3 : 0.9071

Class 4 : 0.9724

Class 5 : 0.9835

Class 6 : 0.9834

Class 7 : 0.905

Class 8 : 0.8851

Class 9 : 0.9167

Confusion Matrix:

[[173 0 0 0 1 4 0 0 0 0]

[ 0 174 0 0 0 1 0 0 0 7]

[ 0 6 167 4 0 0 0 0 0 0]

[ 0 0 6 166 0 6 0 1 1 3]

[ 0 2 0 0 176 0 2 0 1 0]

[ 0 0 0 0 0 179 1 0 0 2]

[ 0 2 0 0 0 0 178 0 1 0]

[ 0 0 0 0 1 6 0 162 2 8]

[ 1 10 0 0 0 5 0 0 154 4]

[ 0 1 0 1 8 4 0 0 1 165]]

1. **Sum of Square Error vs Cross - Entropy Error (Tanh)**

Best Results for Sum of Square Errors with Early Stopping

1. Activation: Tanh
2. Loss Function: categorical\_crossentropy
3. Accuracy: 96.1
4. Training Time: 1.10sec
5. No. of hidden layers: 2
6. No. of neurons per layer: 36
7. Learning rate: 0.05
8. Momentum rate: 0.9

Class Accuracies:

Class 0 : 1.0

Class 1 : 0.989

Class 2 : 0.9661

Class 3 : 0.9399

Class 4 : 0.9724

Class 5 : 0.9615

Class 6 : 0.9779

Class 7 : 0.8939

Class 8 : 0.9253

Class 9 : 0.9833

Confusion Matrix:

[[178 0 0 0 0 0 0 0 0 0]

[ 0 180 0 0 0 0 0 0 1 1]

[ 0 5 171 0 0 0 0 0 1 0]

[ 1 0 2 172 0 3 0 0 2 3]

[ 0 1 0 0 176 0 0 1 3 0]

[ 0 0 0 0 0 175 2 0 0 5]

[ 0 1 0 0 2 0 177 0 1 0]

[ 0 0 0 0 2 4 0 160 1 12]

[ 0 5 0 0 0 3 0 1 161 4]

[ 0 0 0 0 1 2 0 0 0 177]]

Experimental Results:

* Accuracy increased by increasing learning rate from 0.001 to 0.005, beyond that the accuracy degraded
* Accuracy for filters at 1024 was highest compared to 512, 128, 100, 50, 2048
* Accuracy for number of neurons per layer was highest for 37 compared to 200, 100, 40, 30, 20, 35, 36, 38
* There was no considerable effect for 3 hidden layers
* Momentum rates was max at 0.9 for learning rate at 0.09. Other values used were 0.2, 0.5, 0.8, 0.7

1. **Convoluted Neural Network:**

All Experiments are performed by changing only one parameter at a time.

Best Result for Cross Entropy with Early Stopping (ReLU)

1. Activation: ReLU
2. Loss Function: categorical\_crossentropy
3. Accuracy: 96.27
4. Training Time: 2.29 sec
5. Filter Size: 1024
6. No. of hidden layers: 2
7. No. of neurons per layer: 37
8. Learning rate: 0.05
9. Momentum rate: 0.9

Class Accuracies:

Class 0 : 0.9775

Class 1 : 0.989

Class 2 : 0.9944

Class 3 : 0.9508

Class 4 : 0.9724

Class 5 : 0.978

Class 6 : 0.9834

Class 7 : 0.905

Class 8 : 0.931

Class 9 : 0.9444

Confusion Matrix:

[[174 0 0 0 0 4 0 0 0 0]

[ 0 180 0 0 0 0 1 0 1 0]

[ 0 1 176 0 0 0 0 0 0 0]

[ 0 0 4 174 0 4 0 0 0 1]

[ 0 1 0 0 176 0 0 1 3 0]

[ 0 0 1 0 0 178 0 0 1 2]

[ 0 0 0 0 2 0 178 0 1 0]

[ 0 0 0 0 1 10 0 162 2 4]

[ 0 6 0 0 0 3 0 0 162 3]

[ 0 0 0 2 1 4 0 0 3 170]]

Experimental Results:

* Accuracy increased by increasing learning rate from 0.001 to 0.005, beyond that the accuracy degraded
* Accuracy for filters at 1024 was highest compared to 512, 128, 100, 50, 2048
* Accuracy for number of neurons per layer was highest for 37 compared to 200, 100, 40, 30, 20, 35, 36, 38