Convolutional Neural Network for MNIST Hand Written Digits Recognition:

OUTPUT ANALYSIS

Last run:

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Starting run for lr_1E-04,conv=2,fc=2,num_iter=200,batch_size=100
step 0, minibatch loss 2.30259, training accuracy 0.14
test accuracy 0.0892
step 10, minibatch loss 2.19029, training accuracy 0.49
step 20, minibatch loss 2.03895, training accuracy 0.56
step 30, minibatch loss 1.81736, training accuracy 0.57
step 40, minibatch loss 1.50182, training accuracy 0.74
step 50, minibatch loss 1.1708, training accuracy 0.78
step 60, minibatch loss 0.938296, training accuracy 0.85
step 70, minibatch loss 0.857225, training accuracy 0.74
step 80, minibatch loss 0.621109, training accuracy 0.84
step 90, minibatch loss 0.540518, training accuracy 0.87
step 100, minibatch loss 0.504224, training accuracy 0.88
test accuracy 0.8706
step 110, minibatch loss 0.664161, training accuracy 0.78
step 120, minibatch loss 0.450017, training accuracy 0.87
step 130, minibatch loss 0.344639, training accuracy 0.89
step 140, minibatch loss 0.337263, training accuracy 0.93
step 150, minibatch loss 0.328459, training accuracy 0.92
step 160, minibatch loss 0.387447, training accuracy 0.89
step 170, minibatch loss 0.258186, training accuracy 0.93
step 180, minibatch loss 0.35324, training accuracy 0.9
step 190, minibatch loss 0.259608, training accuracy 0.95
step 200, minibatch loss 0.389518, training accuracy 0.84
test accuracy 0.9124
Starting run for lr_1E-04,conv=1,fc=2,num_iter=200,batch_size=100
step 0, minibatch loss 2.30259, training accuracy 0.11
test accuracy 0.1068
step 10, minibatch loss 2.21911, training accuracy 0.14
step 20, minibatch loss 2.13751, training accuracy 0.37
step 30, minibatch loss 2.00173, training accuracy 0.58
step 40, minibatch loss 1.79769, training accuracy 0.77
step 50, minibatch loss 1.6435, training accuracy 0.78
step 60, minibatch loss 1.52041, training accuracy 0.74
step 70, minibatch loss 1.3433, training accuracy 0.75
step 80, minibatch loss 1.18608, training accuracy 0.78
step 90, minibatch loss 1.1278, training accuracy 0.78
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step 100, minibatch loss 0.964688, training accuracy 0.84
test accuracy 0.859
step 110, minibatch loss 0.901741, training accuracy 0.87
step 120, minibatch loss 0.988897, training accuracy 0.82
step 130, minibatch loss 0.894203, training accuracy 0.78
step 140, minibatch loss 0.853183, training accuracy 0.79
step 150, minibatch loss 0.883809, training accuracy 0.83
step 160, minibatch loss 0.74777, training accuracy 0.87
step 170, minibatch loss 0.747879, training accuracy 0.92
step 180, minibatch loss 0.698032, training accuracy 0.89
step 190, minibatch loss 0.721884, training accuracy 0.87
step 200, minibatch loss 0.701869, training accuracy 0.85
test accuracy 0.8977
Starting run for lr_1E-04,conv=2,fc=1,num_iter=200,batch_size=100
step 0, minibatch loss 2.30259, training accuracy 0.09
test accuracy 0.101
step 10, minibatch loss 2.22026, training accuracy 0.37
step 20, minibatch loss 2.1534, training accuracy 0.32
step 30, minibatch loss 1.9956, training accuracy 0.59
step 40, minibatch loss 1.79491, training accuracy 0.7
step 50, minibatch loss 1.63231, training accuracy 0.82
step 60, minibatch loss 1.44592, training accuracy 0.74
step 70, minibatch loss 1.34858, training accuracy 0.73
step 80, minibatch loss 1.17279, training accuracy 0.77
step 90, minibatch loss 1.15961, training accuracy 0.74
step 100, minibatch loss 1.0586, training accuracy 0.75
test accuracy 0.8146
step 110, minibatch loss 0.783738, training accuracy 0.86
step 120, minibatch loss 0.74791, training accuracy 0.82
step 130, minibatch loss 0.736321, training accuracy 0.81
step 140, minibatch loss 0.841733, training accuracy 0.73
step 150, minibatch loss 0.627398, training accuracy 0.83
step 160, minibatch loss 0.48956, training accuracy 0.9
step 170, minibatch loss 0.683313, training accuracy 0.77
step 180, minibatch loss 0.566281, training accuracy 0.9
step 190, minibatch loss 0.489215, training accuracy 0.87
step 200, minibatch loss 0.450917, training accuracy 0.91
test accuracy 0.8783
Starting run for lr_1E-04,conv=1,fc=1,num_iter=200,batch_size=100
step 0, minibatch loss 2.30259, training accuracy 0.06
test accuracy 0.101
step 10, minibatch loss 2.2629, training accuracy 0.11
step 20, minibatch loss 2.21184, training accuracy 0.67
step 30, minibatch loss 2.17604, training accuracy 0.55
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step 40, minibatch loss 2.1131, training accuracy 0.39
step 50, minibatch loss 2.06487, training accuracy 0.55
step 60, minibatch loss 2.01082, training accuracy 0.57
step 70, minibatch loss 1.98666, training accuracy 0.62
step 80, minibatch loss 1.89238, training accuracy 0.78
step 90, minibatch loss 1.85856, training accuracy 0.69
step 100, minibatch loss 1.78932, training accuracy 0.73
test accuracy 0.7925
step 110, minibatch loss 1.74429, training accuracy 0.77
step 120, minibatch loss 1.70172, training accuracy 0.75
step 130, minibatch loss 1.62132, training accuracy 0.76
step 140, minibatch loss 1.52733, training accuracy 0.83
step 150, minibatch loss 1.50652, training accuracy 0.8
step 160, minibatch loss 1.5165, training accuracy 0.78
step 170, minibatch loss 1.45984, training accuracy 0.81
step 180, minibatch loss 1.39731, training accuracy 0.79
step 190, minibatch loss 1.29573, training accuracy 0.85
step 200, minibatch loss 1.30424, training accuracy 0.8
test accuracy 0.8298
Starting run for lr_1E-03,conv=2,fc=2,num_iter=200,batch_size=100
step 0, minibatch loss 2.30259, training accuracy 0.09
test accuracy 0.1879
step 10, minibatch loss 1.0798, training accuracy 0.66
step 20, minibatch loss 0.590124, training accuracy 0.85
step 30, minibatch loss 0.437273, training accuracy 0.86
step 40, minibatch loss 0.304915, training accuracy 0.9
step 50, minibatch loss 0.263408, training accuracy 0.91
step 60, minibatch loss 0.170059, training accuracy 0.97
step 70, minibatch loss 0.145406, training accuracy 0.95
step 80, minibatch loss 0.298874, training accuracy 0.93
step 90, minibatch loss 0.124884, training accuracy 0.98
step 100, minibatch loss 0.132376, training accuracy 0.94
test accuracy 0.9511
step 110, minibatch loss 0.226473, training accuracy 0.92
step 120, minibatch loss 0.0780128, training accuracy 0.98
step 130, minibatch loss 0.199494, training accuracy 0.94
step 140, minibatch loss 0.0450981, training accuracy 0.99
step 150, minibatch loss 0.111155, training accuracy 0.97
step 160, minibatch loss 0.0602609, training accuracy 1
step 170, minibatch loss 0.0376525, training accuracy 0.99
step 180, minibatch loss 0.0961556, training accuracy 0.95
step 190, minibatch loss 0.151187, training accuracy 0.95
step 200, minibatch loss 0.205455, training accuracy 0.96
test accuracy 0.972
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Starting run for lr_1E-03,conv=1,fc=2,num_iter=200,batch_size=100
step 0, minibatch loss 2.30259, training accuracy 0.05
test accuracy 0.2243
step 10, minibatch loss 2.09019, training accuracy 0.49
step 20, minibatch loss 1.40084, training accuracy 0.7
step 30, minibatch loss 0.882515, training accuracy 0.71
step 40, minibatch loss 0.624268, training accuracy 0.83
step 50, minibatch loss 0.46308, training accuracy 0.93
step 60, minibatch loss 0.47542, training accuracy 0.91
step 70, minibatch loss 0.480154, training accuracy 0.89
step 80, minibatch loss 0.448416, training accuracy 0.91
step 90, minibatch loss 0.241665, training accuracy 0.96
step 100, minibatch loss 0.209134, training accuracy 0.97
test accuracy 0.9444
step 110, minibatch loss 0.286776, training accuracy 0.94
step 120, minibatch loss 0.267685, training accuracy 0.96
step 130, minibatch loss 0.369162, training accuracy 0.91
step 140, minibatch loss 0.256007, training accuracy 0.92
step 150, minibatch loss 0.242118, training accuracy 0.94
step 160, minibatch loss 0.164412, training accuracy 0.96
step 170, minibatch loss 0.262166, training accuracy 0.9
step 180, minibatch loss 0.221107, training accuracy 0.95
step 190, minibatch loss 0.167048, training accuracy 0.97
step 200, minibatch loss 0.235654, training accuracy 0.94
test accuracy 0.9616
Starting run for lr_1E-03,conv=2,fc=1,num_iter=200,batch_size=100
step 0, minibatch loss 2.30259, training accuracy 0.09
test accuracy 0.1178
step 10, minibatch loss 1.4594, training accuracy 0.65
step 20, minibatch loss 0.698665, training accuracy 0.78
step 30, minibatch loss 0.437686, training accuracy 0.89
step 40, minibatch loss 0.42248, training accuracy 0.86
step 50, minibatch loss 0.506396, training accuracy 0.85
step 60, minibatch loss 0.241921, training accuracy 0.94
step 70, minibatch loss 0.240887, training accuracy 0.91
step 80, minibatch loss 0.309572, training accuracy 0.91
step 90, minibatch loss 0.306861, training accuracy 0.91
step 100, minibatch loss 0.33668, training accuracy 0.9
test accuracy 0.9346
step 110, minibatch loss 0.243276, training accuracy 0.93
step 120, minibatch loss 0.255682, training accuracy 0.89
step 130, minibatch loss 0.138106, training accuracy 0.94
step 140, minibatch loss 0.1484, training accuracy 0.96
step 150, minibatch loss 0.160928, training accuracy 0.94
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step 160, minibatch loss 0.122958, training accuracy 0.94
step 170, minibatch loss 0.275909, training accuracy 0.92
step 180, minibatch loss 0.222674, training accuracy 0.94
step 190, minibatch loss 0.146275, training accuracy 0.96
step 200, minibatch loss 0.155403, training accuracy 0.95
test accuracy 0.9578
Starting run for lr_1E-03,conv=1,fc=1,num_iter=200,batch_size=100
step 0, minibatch loss 2.30259, training accuracy 0.08
test accuracy 0.101
step 10, minibatch loss 1.91143, training accuracy 0.6
step 20, minibatch loss 1.61125, training accuracy 0.61
step 30, minibatch loss 1.1613, training accuracy 0.78
step 40, minibatch loss 0.881095, training accuracy 0.8
step 50, minibatch loss 0.77929, training accuracy 0.84
step 60, minibatch loss 0.766746, training accuracy 0.85
step 70, minibatch loss 0.610088, training accuracy 0.84
step 80, minibatch loss 0.554752, training accuracy 0.9
step 90, minibatch loss 0.503504, training accuracy 0.9
step 100, minibatch loss 0.414961, training accuracy 0.94
test accuracy 0.9202
step 110, minibatch loss 0.459797, training accuracy 0.95
step 120, minibatch loss 0.375952, training accuracy 0.95
step 130, minibatch loss 0.3908, training accuracy 0.91
step 140, minibatch loss 0.316007, training accuracy 0.96
step 150, minibatch loss 0.400319, training accuracy 0.92
step 160, minibatch loss 0.331074, training accuracy 0.95
step 170, minibatch loss 0.342095, training accuracy 0.96
step 180, minibatch loss 0.303314, training accuracy 0.95
step 190, minibatch loss 0.337001, training accuracy 0.92
step 200, minibatch loss 0.266489, training accuracy 0.94
test accuracy 0.9484
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Graph of the neural network layers:

Histogram distributions of first Convolutional layer:

It shows some high-level statistics on a distribution. Each line on the chart represents a percentile in the distribution over the data: for example, the bottom line shows how the minimum value has changed over time, and the line in the middle shows how the median has changed. Reading from top to bottom, the lines have the following meaning: [maximum, 93%, 84%, 69%, 50%, 31%, 16%, 7%, minimum]
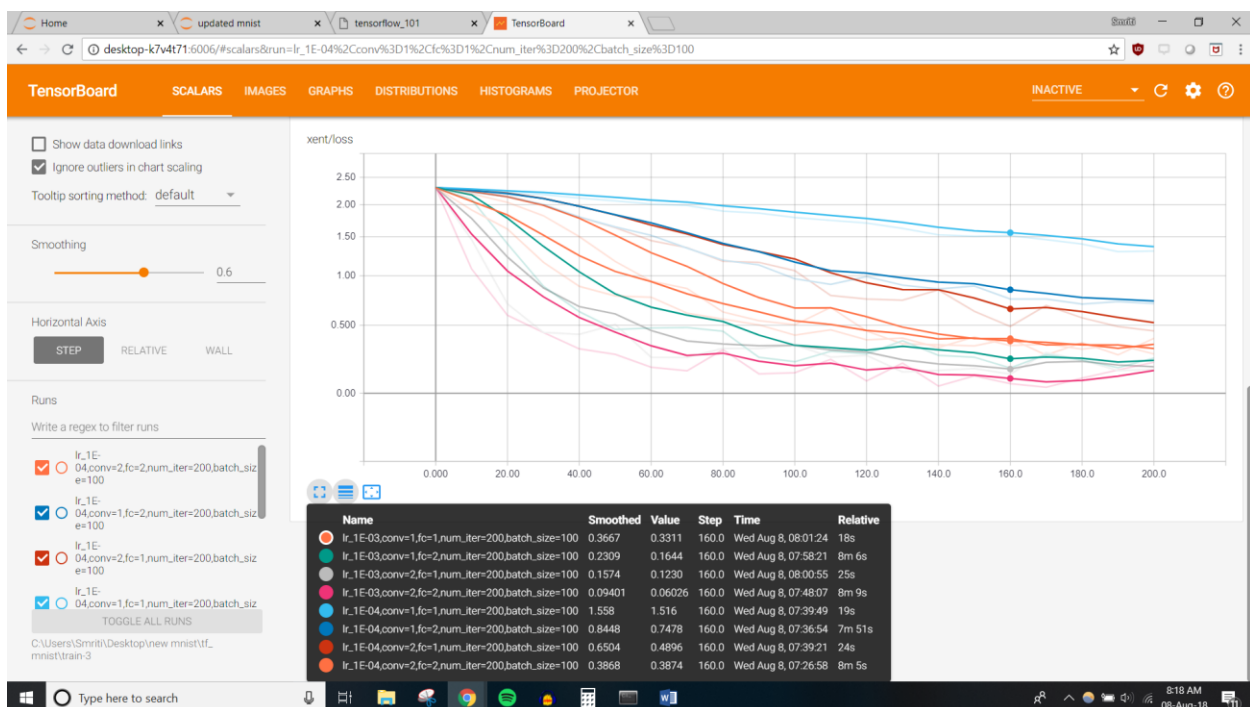
Visualization showing PCA distribution of all digits:
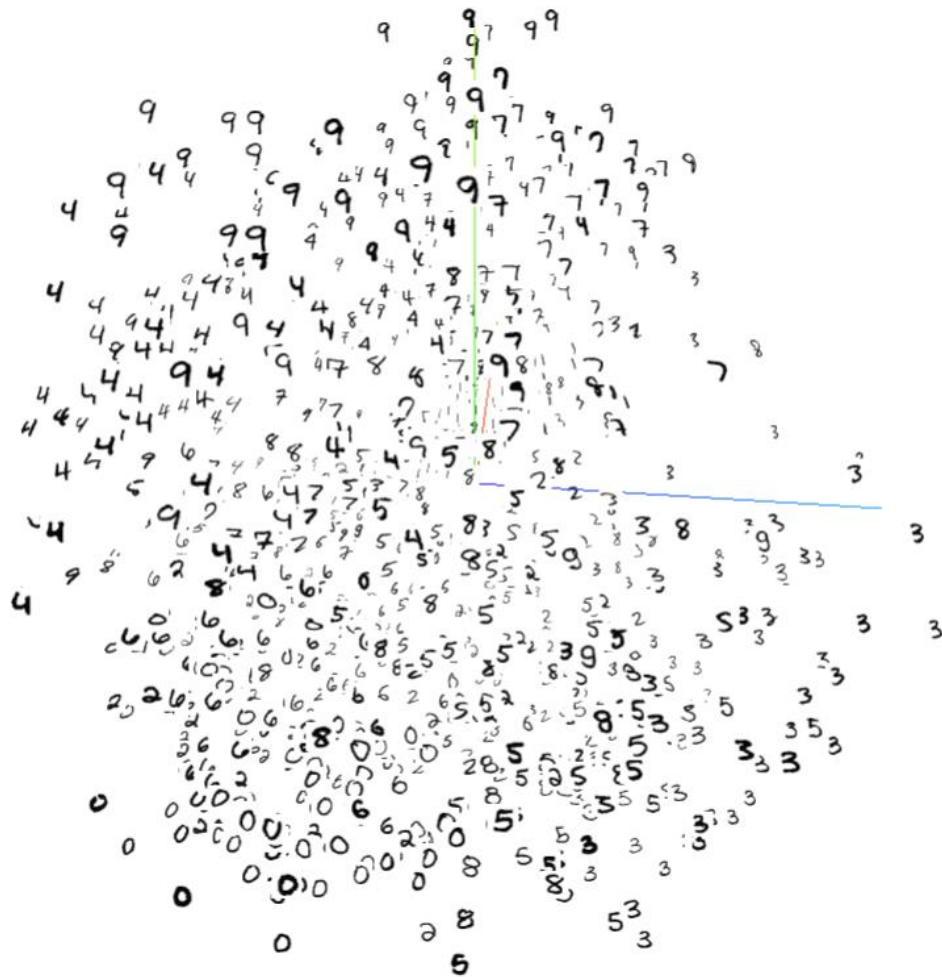
Accuracy changes on each step of hyperparameter tuning:
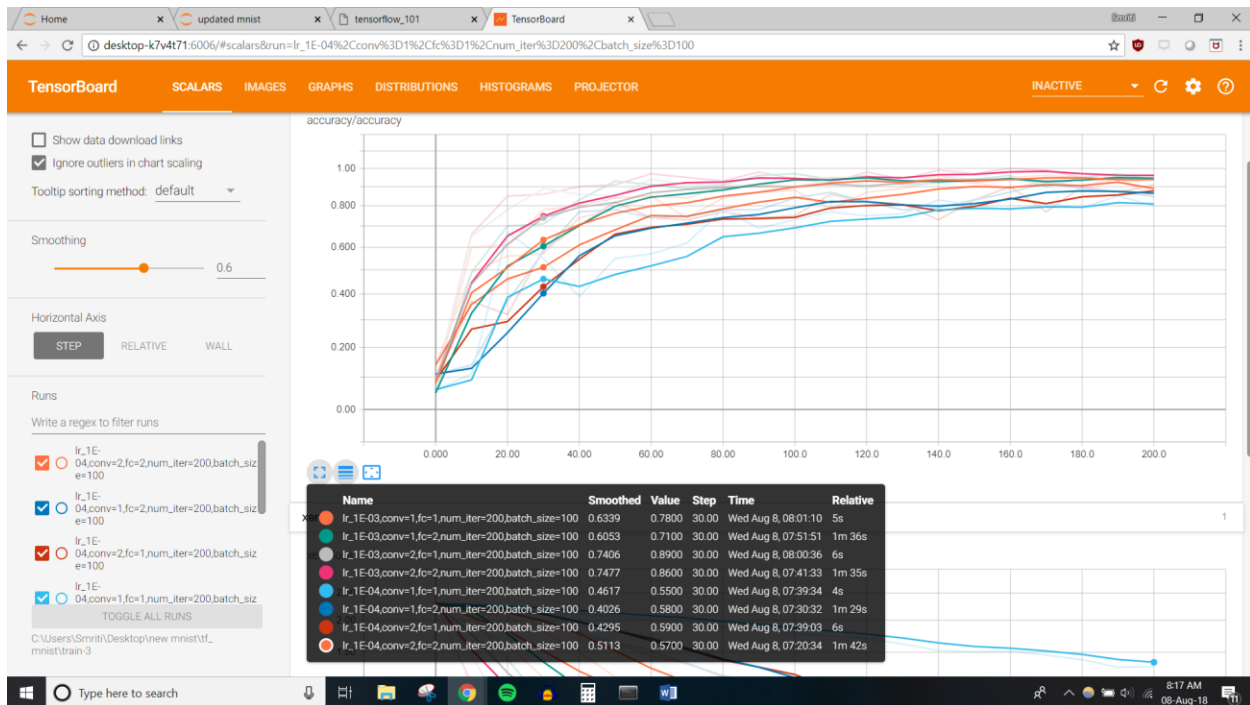
Loss changes on each step of hyperparameter tuning:

Many such visualizations are possible for Neural Networks (therefore all deep learning implementations) on Tensorboard