Neural Networks for Image Classification

Johannes Omberg Lier Per-Christian Berg

November 24, 2015

Five different Neural Networks

ANN Nr:	Layers:	Activation:
1	[784, 100, 50, 10]	Sinh
2	[784, 1024, 720, 10]	Sinh
3	[784, 1024, 720, 10]	Rectify
4	[784, 20, 50, 30, 10]	Rectify
5	[784, 625, 10]	Sigmoid

Table 1: Five different neural networks

We have implemented three different activation functions for comparison in this task. The first function we implemented was the `sigmoid` function, which returns a matrix with the sigmoid of each element in the input matrix.

$$sigmoid(x_i) = \frac{1}{1 + e^{-x_i}}$$

The second activation function, `sinh` or the hyperbolic sine, returns a matrix with the hyperbolic sine value of each element of the input matrix.

$$sinh(x_i) = \frac{e^{x_i} - e^{-x_i}}{2}$$

Lastly, we implemented the `rectify` function. The rectifier function simply returns a matrix where each element is the same as in the input matrix if the value is more than zero, or zero otherwise.

$$rectify(x_i) = maximum(x_i, 0)$$

In order to train the neural network, we ran through all the 60,000 training features several times to find a good balance between result and runtime. In the five tests displayed in table 1 we have trained the neural net 20 times with the training set, which gives a good enough result for comparison.

Statistics

Results

We have deliberately run networks with both `sinh` and `rectify` twice and one network with the `sigmoid` function because of its lacking performance with three layers. After some testing we have experienced that a network with three hidden layers using the `sigmoid` function will not exceed 20 % correct classifications during the first ten rounds of training. The five networks shown in this report are selected from a larger list of networks assembled by us. From this larger list, ANN number three was the best we found in terms of accuracy after finished training, and the worst was an ANN using sigmoid with three hidden layers. Also, from the tests, we found that in general two hidden layers gave better results than one and three hidden layers and that one hidden layer gave better results than three hidden layers.

Each network was trained, and tested with the testing set 20 times.

Discussion

As previously mentioned, ANN number three is the best neural network we have found from using different combinations of activation functions, number of hidden layers and number of nodes in each hidden layer in terms of final accuracy after finished training. This network's accuracy during training is represented in the third graph (middle row, to the left) in figure 1. In addition to achieving the highest number of correct classifications, ANN number three is the network that has the steadiest accuracy, which can be seen by looking final accuracy and max accuracy at figure 2. Also, network three takes the least iterations (runs of training) before it stagnates. The two networks using the `sinh` activation function has the least steady accuracies, especially the second (top row, to the right). From this we have concluded that we should avoid using these networks because of the high fluctuation in accuracy, which seems unpredictable.

It is worth mentioning that the networks with the highest amount of total nodes takes some time to train, and the ones with fewer takes less time. In any case, none of them spends unreasonably long time, and the networks with the most nodes will reach it's maximum around half way through training.

[1] Top left: ANN 1, Top right: ANN 2, Middle left: ANN 3, Middle right: ANN 4, Bottom: ANN 5

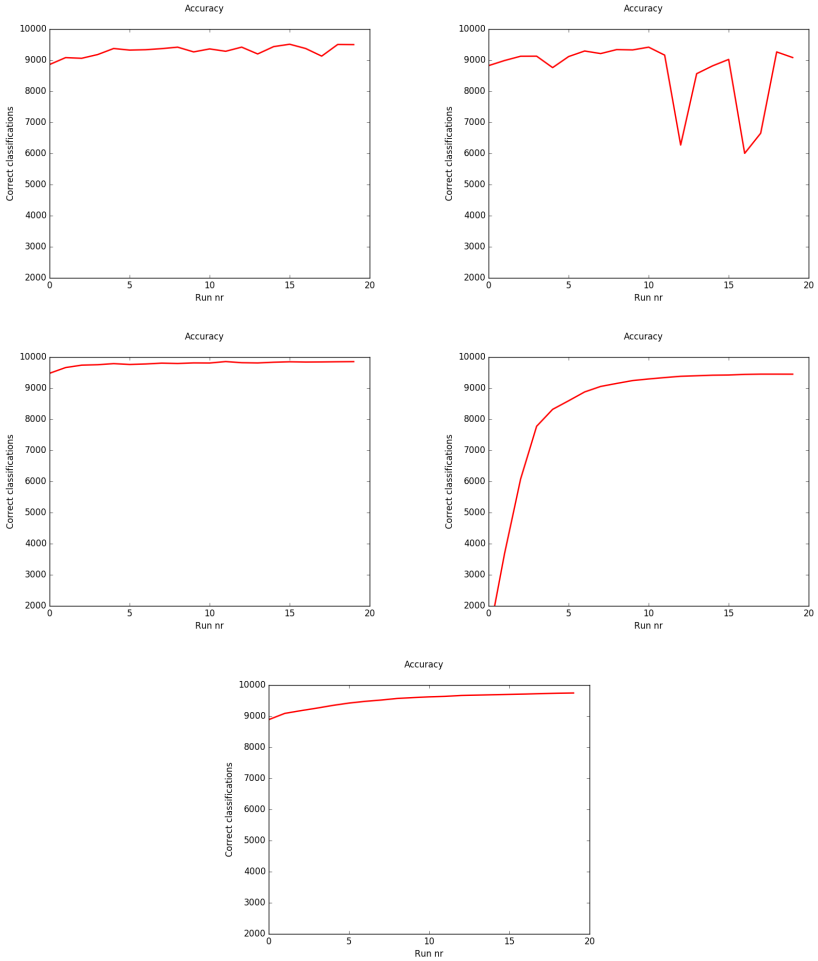

Figure 1: Accuracy during training[1]

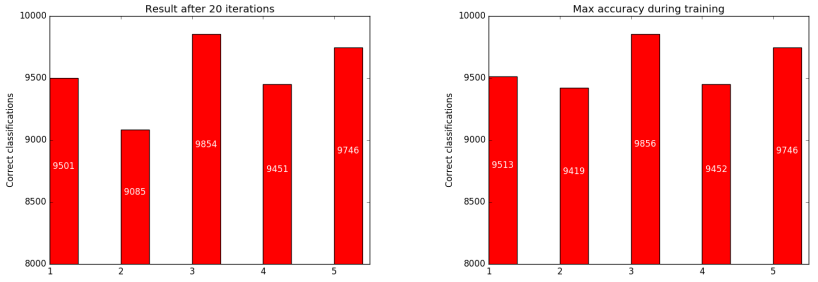

Figure 2: Final result (left) and max accuracy (right)