Adam Gincel

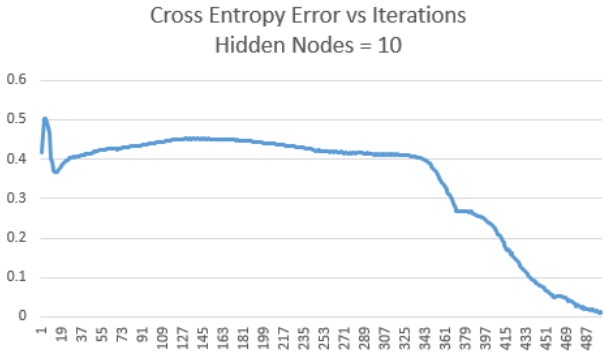
CS559

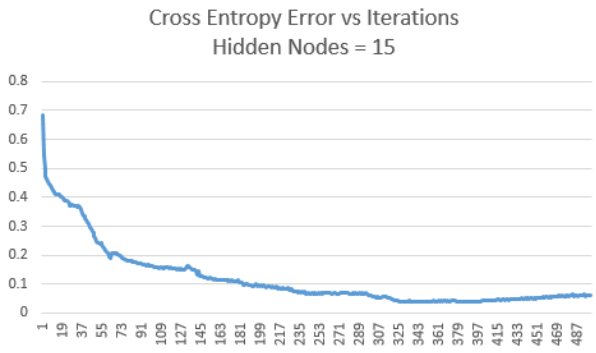
I pledge my honor that I have abided by the Stevens Honor System.

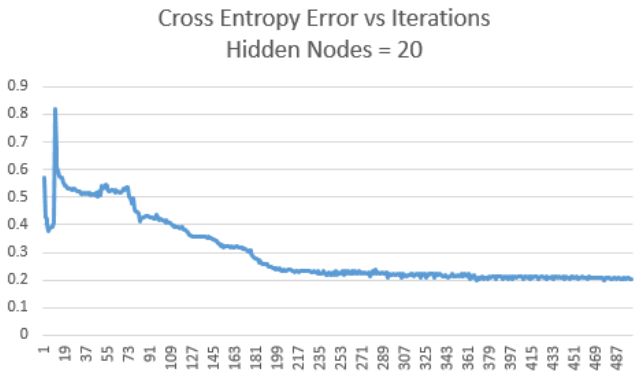
HW2 Data and Observations

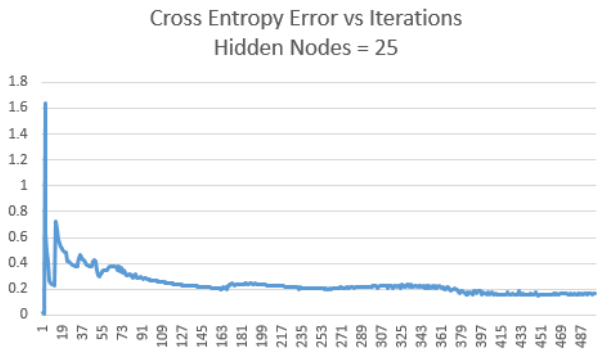
Our assignment in homework 2 was to program a neural network with back propagation to help predict two random datasets built from the same rules. Tuples ranging from 0 to x were created, and then an output dataset was created by adding up the floored values of the tuples, and modding by 2. Ie, [0.5, 1.2, 1.2] became 0 + 1 + 1 = 2 % 2 = 0. The neural network's goal is to learn how to predict the output from our input, and then apply its found weights onto a test set in the same form. Different quantities of hidden nodes, different learning rates, and different quantities of epochs yielded different levels of accuracy over time.

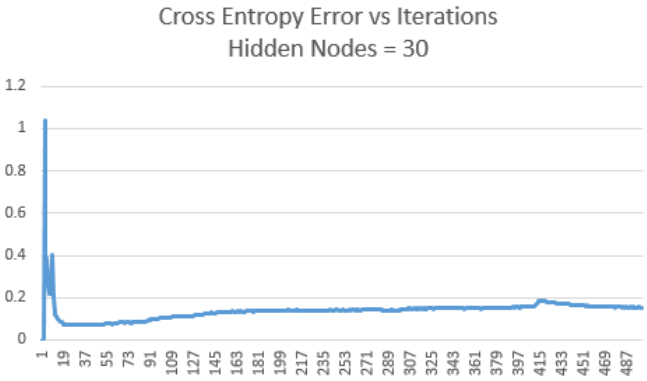
For n = 200 on the dataset from 0 to 2, we can observe cross entropy error descend over 500 iterations with learning rate 0.01. Here is how it starts to converge over different quantities of hidden nodes.

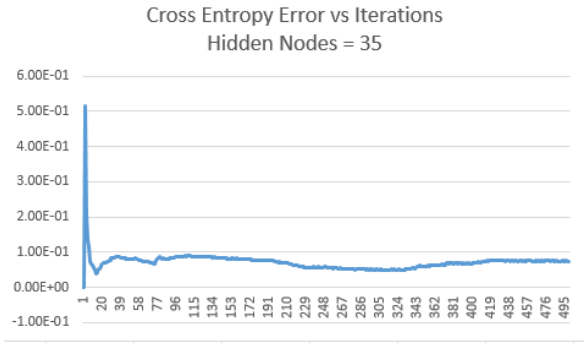




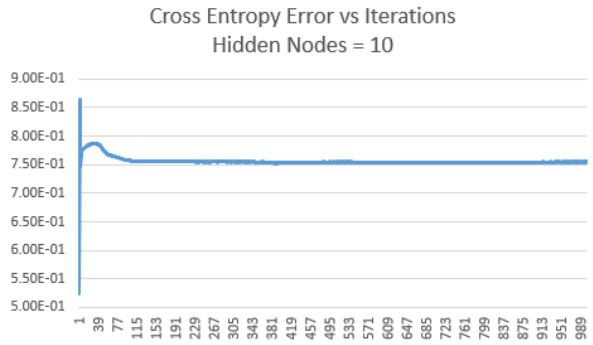


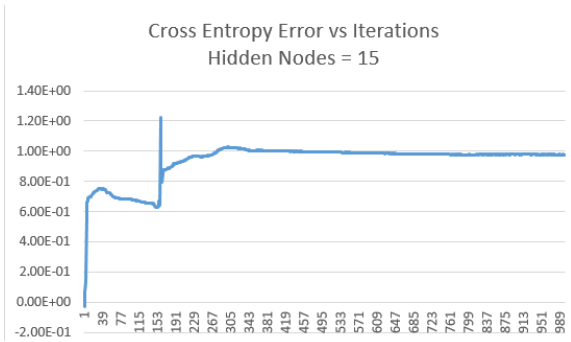


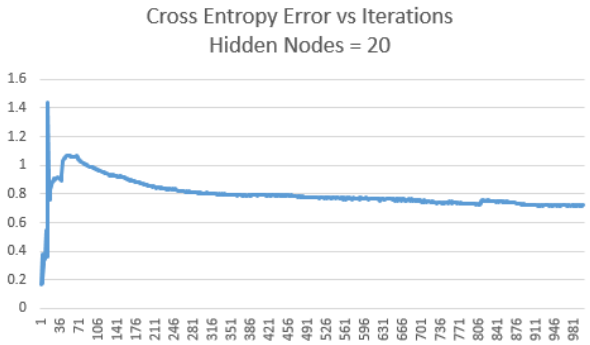


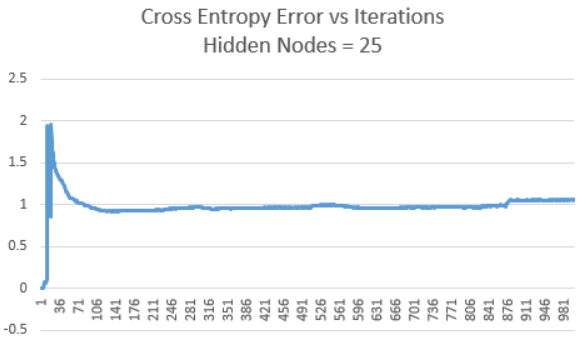


Here are similar measurements, using 600 samples on a dataset from 0 to 3, over 1000 iterations.

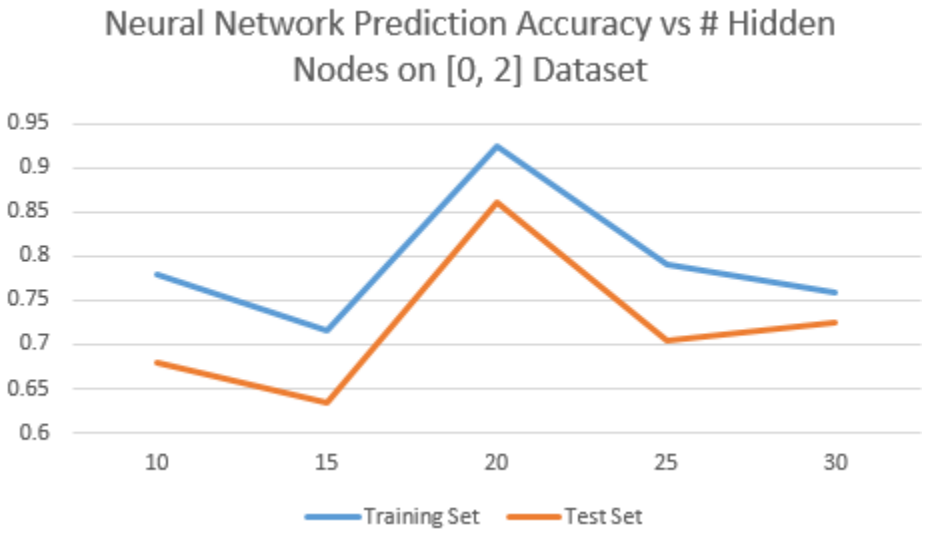




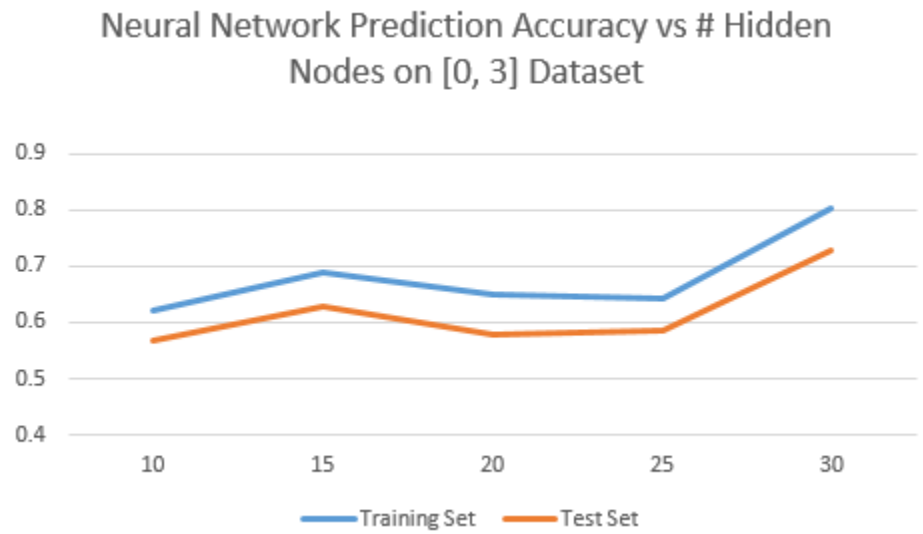




Using the Neural Network to predict over randomly generated datasets yielded different results, depending on the parameters. This graph shows the relative accuracy shown on a training and test set (both of length 200), using a learning rate of 0.01 over 500 iterations on the [0, 2] dataset.



Similarly, here is a graph of the accuracy shown in predicting a training and test set of length 600 using a learning rate of 0.01 over 1000 iterations on the [0, 3] dataset.



Conclusions

As each input in the beginning dataset is equally important to the output, it didn't surprise me to see generally similar weights throughout the resulting network, changing in each iteration in response to new random datasets and in response to how many hidden nodes they went through. In spite of this, I am very certain my implementation of this is flawed – there are many times on seemingly random datasets that the network will perform shockingly poorly on predicting datasets that it should have no trouble with, sometimes dipping below 48% on a dataset that, with different values, it had successfully predicted over 90% correctly. I am of the hope that, because my program is capable of converging and of, with the right parameters and the right dataset, predicting very well, it is not entirely broken.

In general, I have seen more consistent results on the [0, 2] dataset with between 25 and 30 hidden nodes. Different learning rates and epochs also change these numbers, though I kept them consistent for the sake of demonstrating the effect changing a single variable (ie, quantity of hidden nodes) had on the results of the program. I am not certain why the program does not perform nearly as well in predicting on the [0, 3] dataset as the [0, 2] dataset, through it is possible that with enough iterations and the right parameters, I could find better results. Intuitively, I tend to see very similar results in predicting over a corresponding training and test set, even when the test set is much larger than the training set. An example test on a [0, 2] dataset with 30 hidden nodes, learning rate 0.01, 1000 iterations, on a training set of 2000 and a test set of 5000 yields 1768/2000 (88.4%) on the training set and 4410/5000 (88.2%) on the test set.

Differences in my cross entropy graphs from those seen in class, occasionally inconsistent or weird results, and other issues lead me to believe that my program is not 100% on the mark, but largely better than random guesses, consistent predictions between training and test

sets, and differences seen when changing learning rate and iterations lead me to believe it isn't entirely off the mark as well.

Operation

This program, hw2.py, is a Python 3 script that uses the numpy library. If you do not have it installed, you will need to use PIP to install numpy. After that, in any command window navigated to the right folder, running "python hw2.py" will execute the program.

During runtime, the program will first ask you what dataset you are looking to run this on, from 0 to x. Examples include entering 2, which will generate random values in the [0, 2] range in the tuples, 3, which will generate from [0, 3], etc. The program will then ask how large the training and test sets should be, and will generate accordingly. Next, you will be prompted to enter how many hidden nodes you'd like to use, followed by a learning rate, and a number of iterations to train over. After that, the program will run, predicting over both the training and test sets, will show you the number of guesses it got right, and will output the network to weights.txt. It also outputs the sum_error over time to outputs.txt, which was used to graph cross entropy earlier in this report.