Department of Computer Science and Engineering
University at Buffalo The State University of New York

CSE 474: Introduction to Machine Learning

Programming Assignment - 2

Neural Networks

Group 17:

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Introduction

In this project we have implemented a multi-layer neural network for classifying handwritten digits and hand-drawn images. In the following report, we analyze the following aspects of our code:

1. Determining Hyperparameters for the neural network which more specifically relate to the optimal regularization constant lambda and number of hidden units.
2. Comparison Between the Accuracy and training time of deep neural network with different layers for the AI Quickdraw Dataset
3. Reported Accuracy of Classification method on Handwritten Digits Dataset
4. Reported Accuracy of Classification method on the AI Quickdraw Dataset

Determining Hyperparameters for the Neural Network

The hyperparameters for a neural network are dependent on the following parameters:

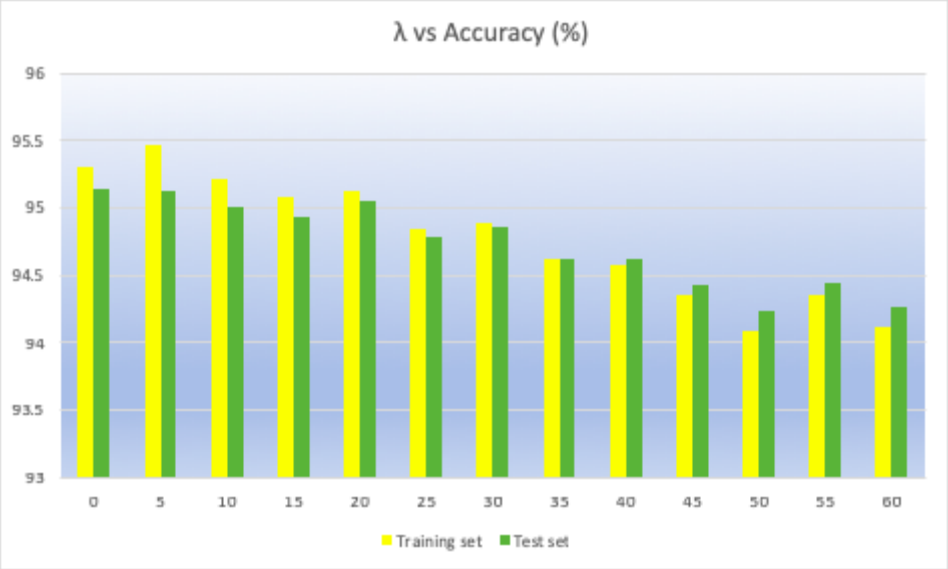
1) Regularization Constant (lambda)
2) Number of Hidden Units

Regularization Constant

The regularization constant is pivotal to prevent overfitting of data in a neural network. We can prevent the weights from becoming too large by introducing the regularization constant, which would serve the purpose of penalizing solutions. This would ensure that the neural network would prevent overfitting of the neural network and better results with regard to its performance against the test data set.

To find the optimal value of the regularization constant, we ran a loop from the lambda value ranging from 0 to 60 on both training and test data sets. We have observed a range of accuracies that were generated from each regularization constant that are depicted in the bar graph below:

λ	**Training set Accuracy**	**Test set Accuracy**
0	95.3	95.14
5	95.46	95.12
10	95.22	95.01
15	95.08	94.94
20	95.12	95.05
25	94.84	94.78
30	94.89	94.86
35	94.62	94.62
40	94.57	94.62
45	94.36	94.43
50	94.08	94.23
55	94.35	94.44
60	94.11	94.27



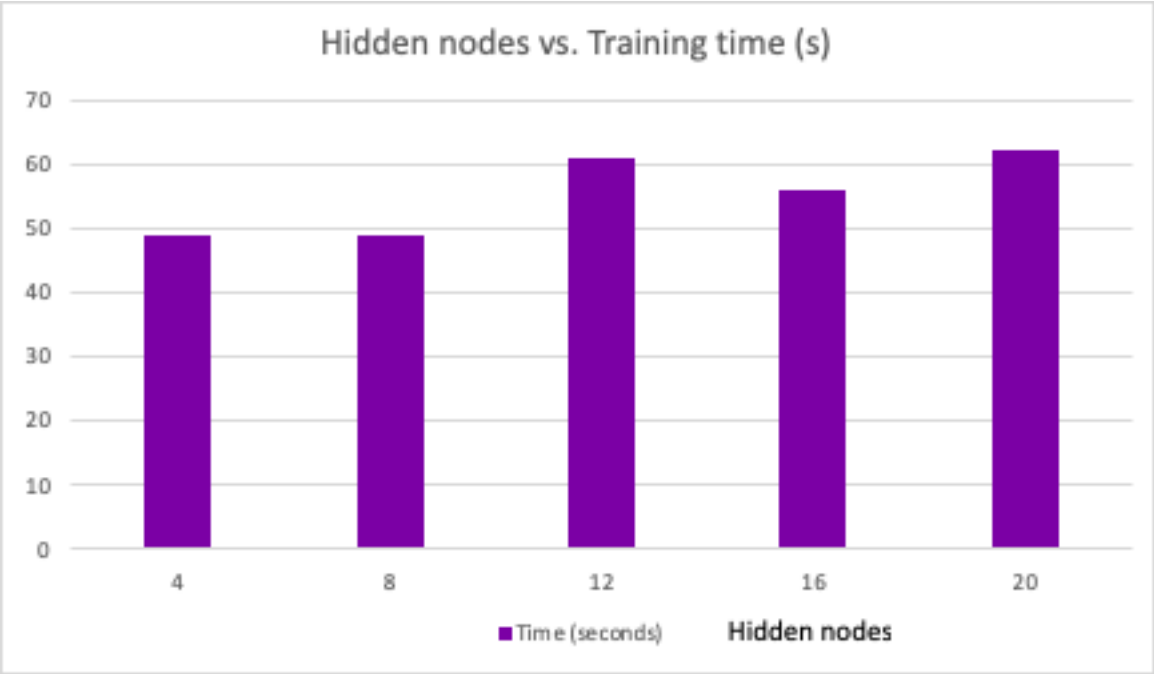
As we observe from the bar graph, the testing and training accuracies vary, with an overall decrease in accuracy as the regularization constant increases towards 60. Similar accuracies are due to similarities between the training data set and testing data set.

Number of Hidden Units

The number of hidden units in a neural network can make a significant difference when considering time to train the neural network. As we increase the number of hidden nodes, the training time increases as well. The results can be observed in the graph and table that are that is depicted below:

Number of Nodes	Training Time
4	49
8	49
12	61
16	56
20	62

Since hidden units can be considered as learned features extracted from the original dataset, the number of hidden nodes represent the learned features of the neural network. The more hidden nodes, we have a better representation of the features of the network itself. Therefore, the optimal number of hidden nodes would imply accuracy and efficient training time.



Comparison Between the Accuracy and training time of deep neural network with different layers for the AI Quickdraw Dataset

The training time of the deep neural network is

Layers	Train Accuracy	Test Accuracy	Time
2	67%	61.54%	2090s

3	62%	62.348%	2290s
5	66.5%	60.80%	2520s
7	58.0%	59.28%	2845s

Reported Accuracy of Classification method on Handwritten Digits Dataset

The Handwritten Digits Dataset(Mnist_all.pickle) was used in the nnScript.py python script to report the training and test accuracies. The values that were obtained are in the table below:

Training Set	Test Set
95.32% Accurate	94.89% Accurate

Reported Accuracy of Classification method on the AI Quickdraw Dataset

The AI Quickdraw dataset was used in the nnScript.py python script to report the training and test accuracies. The values that were obtained in the table below:

Training Set	Test Set
74.477% Accurate	74.028% Accurate