CSCI 315: Artificial Intelligence

Assignment 3: Feed Forward Neural Network

Due Date: Monday March 1st @ 11:59PM

Information

For this assignment you will be implementing a feed-forward neural network with 2 hidden layers. You will be training your FFNN to analyze the MNIST dataset. MNIST is a dataset of hand-written digits, which you can predict using this neural network. The only libraries you need are NumPy. SciPy and Matplotlib. You should start with 200 hidden nodes in each hidden layer, a learning rate of 0.01 and 50 epochs. You should report your accuracy of the network, display a graph of the loss of the model per epoch, and display a graph of the performance of the model per epoch.

In the evaluation of your model, you need to demonstrate the effectiveness of the learning rate and of the number of hidden nodes. You should create a graph displaying the performance of the model based on the number of nodes per hidden layer [100, 200, 300, 400, 500, 600]. You should also display a graph of the performance of the model based on the learning rate [0.001, 0.01, 0.1, 0.2, 0.4, 0.6]. You should also display a graph of the performance of the model based on the number of epochs [5, 20, 50, 100, 200].

After determining the hyperparameters of the model, you are going to test your own data. To do this you need to install and use the program GIMP. With this program, you will draw each number 0-9. Then you will preprocess each file and use your network to test that data. You should provide the accuracy of your model on the 10 files.

The last part of your assignment is to look into the API call scipy.ndimage.interpolation.rotate(). This API call helps to rotate the images within your dataset. You are going to use this to create “new” data for training. In theory, this should boost the generalizability of your model and increase your overall accuracy. You will rotate each image by -10 degrees and +10 degrees. Please report your accuracy using this new method of data generation.

Source Code

There are three major parts to this assignment. The first is the ability to handle the MNIST data points. You will need to find this dataset (available via Keras and online), but you will need to process these images so that your FFNN can handle them. We want to avoid any signals being 0 or 1, therefore, we will adjust the pixels of our input to be between 0.01 and 0.99.

The second part is that you will need to create your network. I suggest you create a NN class, which will create a neural network objects using a variety of hyperparameters. You should initialize your weight matrix by taking values from a normal distribution, you should then set the standard deviation as a factor of the number of nodes to the power of -0.5. Your FFNN will be fully connected and should start with a single hidden layer. Once you get a single layer network working, you should add an additional layer to create a deep neural network. You should begin with a set of 200 hidden nodes and then determine if changing this affects accuracy. You are still using the sigmoid activation function and gradient descent as your learning algorithm. Your loss function for this project will be the mean squared error. Your neuralNetwork class should contain an \_\_init\_\_ function, a train function, and a query function.

The last part of your assignment is to use GIMP to classify all 10 of the digits your network has learned. Draw each of the 10 images, manipulate them so that your network can handle them and then run them through your NN for prediction. You will need to include these GIMP images in your submission. Please include the image already manipulated for input.

You should label each accuracy metric and every graph that you display. It is helpful to have headers printed out to let me know what part of the assignment you are displaying results for.

Turn In

As will be for every assignment, you need to submit an extensive readme that describes the functions you use and why you use them as well as citing all your sources. The README is about 30% of your grade so make sure you spend a good bit of time on it. If you have questions about my expectations, please refer to the “How to Write Analysis File” on canvas. Please zip up your code, the readme and your GIMP images then turn it in on Canvas.