CMPE 597 Sp. Tp. Deep Learning
Spring 2022 Homework I
Due: April 10 by 11.59pm

1 Implementing a Network from Scratch

In this project, you will implement and train a convolutional neural network from scratch.

1. **Data:** Please use the MNIST dataset. You may use the data loaders of deep learning libraries.

2. **(25 points) Network:** Please implement the following network

Table 1: Network Architecture

Layer	**Parameters**
Conv1	kernel size: 5, stride: 1, channel: 4, activation: ReLU
Pooling	2×2 max pooling
Conv2	kernel size: 5, stride: 1, channel: 8, activation: ReLU
Pooling	2×2 max pooling
FC1	output dimensionality: 128, activation: ReLU
FC2	output dimensionality: 10, activation: linear

   Please use the softmax cross-entropy for the loss function. You may use the optimizer of your choice. You can determine the hyperparameters, such as learning rate, batch size, and the number of epochs. You are not allowed to use any deep learning library except the data loaders.

3. **(25 points) Equations for Forward and Backward Passes:** Please write the equations you will implement. You should indicate the dimensionalities. Please use a proper text editor to type the math equations. Notation should be clearly explained.

4. **(10 points) Sanity Check:** Please implement the same network using a deep learning library. Use the same set of hyperparameters and the optimizer. You may consider the same initial parameters in both of your implementations. Compare test classification accuracies after training for the same number of epochs. You should get at least 90% test accuracy with both of the implementations.

5. **(5 points) README:** Please provide a README file. I should be able to train and evaluate your models without any bugs. 20 points will be deducted if your code is buggy.

2 Decision Boundary of a Neural Network with ReLU

1. **Data:** Please download the dataset under the data folder. Plot the training data.

2. **(15 points)** Train a simple neural network with ReLU activation function to classify the data. Plot and comment on the decision boundary.

3. **(20 points)** Is it possible to obtain a non-linear decision boundary with ReLU activation function? Please investigate and explain mathematically. Do not forget to cite your references.

Submission

You need to submit a zip file with the name `NameSurname_Homework1.zip` containing the files below. If you cannot submit the model weights to Moodle due to submission size restrictions, you can provide a link to the model weights in README.

- A pdf report including your name, student number, answers to questions, and references.
- `README.txt`
- Training code for Section 1
- Evaluation code for Section 1
- Learned weights of the network implemented from scratch by you for Section 1
- Implementation for Section 2

IMPORTANT NOTE: You can use Python libraries and functions, such as `numpy`, `matplotlib`. Do not forget to cite your references and resources.