CS671: Deep Learning and Applications
(JAN-JUNE 2025)
Programming Assignment-I

Date: 08-Feb-2025

Submission Deadline: 16-Feb-2025, Sunday, till 23:59 hrs

PART-I : Classification Tasks

Dataset 1: Linearly separable (LS) dataset: 3 classes, 2-dimensional linearly separable data is given. Each class has 500 data points.

Dataset 2: Nonlinearly separable (NLS) classes: 2-dimensional data of 3 classes that are non linearly separable is given. The number of examples in each class and their order is given at the beginning of each file. Divide the data from each class into training, and test data. From each class, train, and test split should be 70% and 30% respectively.

Model: Use Perceptron model with sigmoidal/step activation function for each given dataset.

Task:
1. Use the described Perceptron model with a one-against-one approach for the above given classification tasks.
2. Implement backpropagation algorithm from scratch for perceptron learning algorithm for the above given datasets.

Presentation of results:

Define the problem statement given and then give the following analysis on the task:
1. A visualization of train and test dataset for LS and NLS classes.
2. Plot of average error (y-axis) vs epochs (x-axis) on train data.
3. Choice of the activation function used.
4. Decision region plot superimposed by training data only for each of the datasets. Give the decision region plot between each pair of classes and also give the decision region plot after combining.
5. Confusion matrix and classification accuracy.
6. Inferences on the plots and inferences on the results observed.

Part-II : Classification Tasks using Multi-Layer Perceptron

Dataset: MNIST dataset: The dataset consists of 60,000 training images and 10,000 test images of handwritten digits (0-9). Each image is a 28x28 grayscale image, represented as a flattened vector of 784 pixels.

Model-1: You are required to build a simple MLP with one hidden layer to classify handwritten digits from the MNIST dataset. For MLP the network should be implemented from scratch using only basic Python libraries like NumPy. You are not allowed to use any deep learning frameworks like TensorFlow, PyTorch, or Keras.
Model-2: Build a Convolutional Neural Network (CNN) with n hidden layers (use the minimal value of n, empirically found) to classify the handwritten digits from the MNIST dataset. For CNN you may use the deep learning libraries and frameworks like TensorFlow, PyTorch, or Keras.

Task:
1. Implement a Multi-Layer Perceptron (MLP) with a single hidden layer from scratch to classify the MNIST dataset.
2. Implement the backpropagation algorithm from scratch for the above described model.

Presentation of results:
Define the problem statement given and then give the following analysis on the task:
1. A visualization of a few images of the dataset given.
2. Network Architecture used for MLP and CNN.
3. Choice of activation functions and loss functions used.
4. Plot of average error (y-axis) vs epochs (x-axis).
5. Confusion matrix and classification accuracy.
6. Inferences on the plots and the results observed for the two models.

DATASET LINK:
https://drive.google.com/file/d/1OXvwSKVd3k0BrYEEZDZJcw_3y9aZ_QyN/view?usp=sharing

Guidelines for the Submission:

1. Upload the Assignment Report in PDF format on LMS with the following name :
   \<Roll_number\>_Assignment1_Report.pdf

2. Upload the code files in a single zip file on LMS as with the following name:
   \<Roll_number\>_Assignment1_Code.zip

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