

ECE 477/595 Artificial Neural Networks
Department of Electrical and Computer Engineering
University of Dayton
Fall 2022

Assignment 1 (Due Date: 09/15/2022)

Perceptron Learning

Use the perceptron learning method to train a *Single Layer Perceptron* for the recognition of handwritten digits (0, 1, ..., 9).

The input to the single layer network architecture will be a set of binary pixels representing a 28×28 image of handwritten digits. The output should indicate which of the digits (0, ..., 9) is in the input image.

Use the MNIST database of handwritten digits available at: <http://yann.lecun.com/exdb/mnist/> for testing and training the system. These datasets are also provided in **Isidore Course Resources** -- Folder Name: *Hand Written Digits Data Set*.

Select a subset of the MNIST database consisting around **300 images** of handwritten digits (0, ..., 9) for training the system, and use another **100 images** for testing the system. Create **bipolar images** of handwritten digits from gray scale images available in MNIST by **simple thresholding** (*indicate the threshold value you used*).

Design a fully connected network structure of 784 input nodes and 10 output nodes. Use hard-limiter bipolar thresholding for computing the actual outputs. **Note:** Define the desired outputs for each training/test pattern as bipolar values (+1 and -1).

You may refer to the sample codes provided in the **Resources**.

Plot a learning curve that illustrates the mean square error versus iterations.

(One iteration: apply all the training inputs once to the network and compute the mean square error).

Plot the percentage True Positive rate and False Positive rate in testing your handwritten digit recognition system as a bar chart.

Task #1: Repeat this experiment **for different learning rate parameters** (*at least 3 experiments*).

Task #2: Repeat Tasks #1 with a large database.
(*1000 or more for training and 300 or more for testing*).

Task #3: **Repeat Task #2 with multilevel data** (*without thresholding the input data, normalize the input data, use sigmoid function for output thresholding*).
Note: Define the desired outputs as binary values (**1** and **0**) in this case.

Notes:

- The project should be implemented in MATLAB.
- A project report including the methodology, program outline with flow chart and/or illustrations, implementation results with sample data sets, comments/discussions on the obtained results, and appropriate technical references should be submitted on Isidore.
(*Report Format: single column, single space, 11-point Times New Roman font*).
- The program codes along with the dataset used for testing and validation should be submitted through **Isidore**.
- **Late submissions will not be accepted.**