

ECE 477/595 Artificial Neural Networks
Department of Electrical and Computer Engineering
University of Dayton
Fall 2022
Assignment 2 (Due Date: 09/27/2022)

Multilayer Perceptron Learning

Train a three-layer feed-forward neural network architecture (*input layer, hidden layer, and output layer*) using the multilayer perceptron learning method (*error back-propagation algorithm*) for the recognition of handwritten digits (0, 1, ..., 9).

The input to the multilayer network will be a set of **grayscale 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 a subset of the MNIST database consisting of around **1000 images** of handwritten digits (0, ..., 9) for training the system, and use another **300 images** for testing the system (*without thresholding the data*). Design a fully connected network structure of **784 input nodes and 10 output nodes and 10 hidden nodes**.

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

Task #1: Plot a learning curve (*convergence characteristics*) 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*) for a learning rate parameter $0 < \eta < 1$.

Task #2: Plot the learning curves for different values of the learning rate parameter.

Task #3: Plot the percentage True Positive rate and False Positive rate in testing your handwritten digit recognition system as a **bar chart**.

Task #4: Repeat the experiment and evaluate the performance with a different number of hidden nodes (*example: 5, 15, 20, 30 etc.*).

Notes:

- The project should be implemented in MATLAB.
- **The methodology, program outline with flowchart 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** for evaluation.
- **Late submissions will not be accepted.**