

# EE 550

## Artificial Neural Networks

### Homework 4

Due: 29/04/2020

**Implementation of the Multilayer Perceptron Model** This project requires the simulation of the multilayer perceptron model (MLP) we have discussed in class. In your implementation, use the same syntax given in the class.

- 1) First, simulate the MLP model that can be used with arbitrary number of layers and neurons in each layer.
  - (i) Generate a data set for the binary XOR function. You will have a two input one output model. Your training pattern set will have 4 patterns. Choose a **3-layer network** with arbitrary number of nodes in the hidden layer.
  - (ii) **Plot** the total error (cost) function vs number of epochs (an epoch is defined as going over the training set once).
  - (iii) **Once convergence is achieved**, test the network with each sample pattern. **Show** the outputs for each input pattern.
- 2) Function approximation: Pick a nonlinear function like  $f(x) = \sin(x)$ , where  $x$  is given in radians. Generate a data set for  $x$  between 0 and  $2\pi$ . You should arbitrarily generate at least 60 data points.
  - (i) **Plot** the total cost function vs number of epochs.
  - (ii) **Once the cost function reaches a low threshold value**, **stop** learning and test your network arbitrary test inputs 0 and  $2\pi$ .
  - (iii) **Plot** the approximate graph on top the desired function  $\sin(x)$  with 25 test values.
- 3) From the data repository site <https://archive.ics.uci.edu>, download the Optical Recognition of Handwritten Digits data set (see Figure 1). This data set has 1797 samples and each sample has 64 attributes which generate an input matrix of 8x8 where each element is an integer in the range 0..16 (see Figure 2). Choose an MLP model. From each class, choose 40 samples as your training samples and 10 samples as your test data set (There should be 400 training and 100 test samples). Train the ANN with 400 training samples.
  - (i) **Plot** the total error vs number of epochs.
  - (ii) **Once convergence is achieved** (total error below a certain threshold), **stop** the learning algorithm and test your network with 100 test patterns.

- (iii) **Plot** the input and output for each case and determine if the network classifies the patterns correctly.

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Figure 1: Directory of the data set

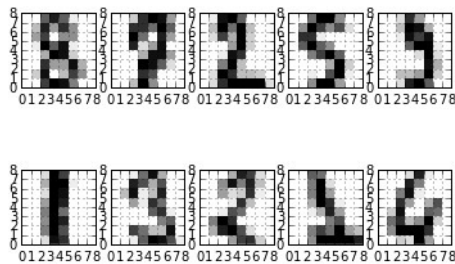


Figure 2: Handwritten Digits

### NOTES:

- 1) Please upload all your files (codes and report) to Moodle with the file convention
- 2) Plagiarism will not be tolerated.
- 3) Late submission will not be accepted.