ECE 477/595 Artificial Neural Networks

Department of Electrical and Computer Engineering

University of Dayton

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Assignment 3 (Due Date: 10/13/2022)

Radial Basis Function (RBF) Neural Network Learning

Train a Radial Basis Function (RBF) network architecture (*input layer, hidden layer, and output layer*) using the RBF learning method for the recognition of handwritten digits (0, 1,...., 9).

The input to the RBF network will be a set of **gray scale pixels** representing 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 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*). Use approximately the same number of data samples (*images*) for each digit in training/testing processes.

Design a fully connected network structure of 784 input layer nodes and 10 output layer nodes with ***sigmoid function*** output, and K hidden layer nodes (*K-Means Clustering*).

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

Task #1: Implement the K-Means Clustering algorithm to create pattern clusters. Estimate an optimum K value using the Elbow method for K-Means Clustering.

Task #2: Plot a learning curve (*convergence characteristics*) of the RBF network 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 chosen learning rate parameter (*example* $\eta = 0.1$).

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

Task #4: Repeat Task #2 and Task #3 for different values of the learning rate parameter. ($lower\ and\ higher\ than\ the\ initially\ chosen\ value\ of\ learning\ rate\ parameter$)

Task #5: Repeat the experiments and evaluate the performance (Task #2 and Task #3 with different number of hidden layer nodes (*lower than the estimated optimum K value, and higher than the estimated optimum K value*) using the best performing learning rate parameter obtained (*with the estimated optimum K value*).

Notes:

- The project should be implemented in MATLAB.
- The project report should include 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 and the report 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**.