July-November 2025 Semester
CS5691: Pattern recognition and Machine Learning
Programming Assignment III

Date:**10th October, 2025**

Deadline for submission of report: **11.59PM on Wednesday, 15th October, 2025**

Dataset 1: 2-d data for function approximation (Same as Dataset 2(a) of Assignment 1)
Dataset 2: Multivariate data for function approximation (Same as Dataset 3 of Assignment 1)
Dataset 3: 2-d data: Nonlinearly separable data (Same as Dataset 2 of Assignment 2)
Dataset 4: Image data (Dimension of feature vector: 36) for 5 classes (Same as Dataset 3 of Assignment 2)

Tasks:

1. Function Approximation for Dataset 1 using MLFFNN with one hidden layer having 8 nodes

2. Function Approximation for Dataset 2 using MLFFNN with two hidden layers having 15 nodes in the first hidden layer and 10 nodes in the second hidden layer

3. Classifier for Dataset 3 using MLFFNN with 12 nodes in the first hidden layer and 8 nodes in the second hidden layer

4. Classifier for Dataset 4 using MLFFNN with 25 nodes in the first hidden layer and 15 nodes in the second hidden layer

5. Classifier for Dataset 3 using Logistic regression classifier

6. Classifier for Dataset 4 using Logistic regression classifier

Configuration of MLFFNN :

1. For function approximation task, use the linear activation function in the output layer and the Tanh function in the hidden layers. Use the sum-of-squared errors as the error function.

2. For classification task, use the softmax activation function in the output layer and the Tanh function in the hidden layers. Use the cross-entropy as the error function.

3. Use the pattern mode of learning (Stochastic gradient descent).

4. Use learning rate (η) of 0.7 and momentum factor (α) of 0.9

5. Use the slope parameter (β) of 1.0 in the Tanh activation function.

6. Use a threshold of 0.001 on the change in the average error in the convergence criterion.

Configuration of Logistic Regression Classifier:

1. For Dataset 3, use polynomial basis functions. Degree of polynomial : 5, 7, 9

2. For Dataset 4, use Gaussian basis functions. The centers of Gaussian basis functions are to be identified by K-means clustering of the training examples of all classes. No. of basis functions (K) : 50, 75, 100. Width parameter σ is to be chosen such that the values of Gaussian basis functions are spread over the range of 0.0 to 1.0.

3. Use the pattern mode of learning (Stochastic gradient descent).

4. Use learning rate (η) of 0.7 and momentum factor (α) of 0.9

5. Use a threshold of 0.001 on the change in the average error in the convergence criterion.

Report should include the following for function approximation tasks:

1. Datasets 1 and 2: Training error (ξ_{av}) vs epoch plot
2. Datasets 1 and 2: Scatter plots for the training data and the test data
3. Dataset 1: Surface plots for outputs of any two nodes in the hidden layer and the node in the output layer, after Epochs 1, 10, 50, and convergence.

Report should include the following for classification tasks:

1. Datasets 3 and 4: Confusion matrices and classification accuracies for the training data and the test data, and for each of the classifiers.
2. Decision region plots of each of the classifiers (MLFFNN and Logistic regression model) for Dataset 3. Superpose the training data on the decision region plot.
3. MLFFNN based classifier for Dataset 3: Surface plots for outputs of any two nodes in the first hidden layer, any two nodes in the second hidden layer and all the nodes in the output layers, after Epochs 1, 10, 50, and convergence.
4. MLFFNN and Logistic regression model for Datasets 3 and 4: Training error(ξ_{av}) vs epoch plot.