

**July-November 2023 Semester**  
**CS5691: Pattern recognition and Machine Learning**  
**Programming Assignment III**

Date: **30<sup>th</sup> October, 2023**

Deadline for submission of PDF file of report: **Thursday, 30<sup>th</sup> November, 2023**

**Dataset 1:** 2-dimensional artificial data:

- (a) Linearly separable data set
- (b) Nonlinearly separable data set

**Dataset 2:** Image data set

**Classifiers to be built for Dataset 1(a):**

1. Perceptron
2. Multilayer feedforward neural network (MLFFNN) with a single hidden layer
3. SVM classifier using linear kernel

**Classifiers to be built for Dataset 1(b) :**

1. MLFFNN with two hidden layers
2. Nonlinear SVM using (a) Polynomial kernel and (b) Gaussian kernel

**Classifiers to be built for Dataset 2:**

1. MLFFNN with two hidden layers
2. Gaussian kernel based SVM using one-against-the-rest approach

**Input to Classifier for Dataset 2 :**

1. 81-dimensional feature vector
2. Reduced dimensional feature vector obtained using Principal Component Analysis (PCA)

**Use the cross-validation method to choose the best values of hyperparameters.**

**Report should include the following for each classifier and for each dataset:**

1. Table of classification accuracies of the model on training data and validation data for different values of hyperparameter
2. Classification accuracy of the best configuration of the model on test data
3. Confusion matrix for the best configuration of the model, on training data and test data
4. Decision region plots for Datasets 1(a) and 1(b). Superpose the training data on the decision region plot. For SVM model on Dataset 1(a), mark the support vectors. For SVM model on Dataset 1(b), mark the bounded and unbounded support vectors.
5. For the best configuration of MLFFNN classifier on Dataset 1(b), plot the surfaces of the outputs of hidden layer nodes and output layer nodes after the following epochs: 1, 5, 20, 100, and after convergence.

**Report should also include your observations about the performance for each classifier, and for each dataset.**