Machine Learning and Adaptive Systems
(ECE656)

Computer Assignment 2 (Pattern Recognition Using Neural Networks- (Due in Three Weeks)

The purpose of this computer assignment is to design two neural networks, one using BPNN and one using CNN, for pattern recognition. A subset (10-15%) of the main MNIST database of handwritten digits, which contains 60,000 training samples and 10,000 testing samples, should be used for this computer assignment. The digits have been size-normalized and centered in a fixed-size image. Data standardization (covered in class) may be needed to ensure invariance to scaling for those classifiers that are NOT scale invariant.

The MNIST data set may be downloaded from http://yann.lecun.com/exdb/mnist/. Please note the file format for this data on the same website.

1. Randomly divide this subset of MNIST database into training (equal number of samples for each class), validation, and testing data sets to be used to properly train each network. The optimum performing network is selected based upon its performance on the validation data set. Network generalization ability is determined on the testing data set.
2. Using either the standard generalized delta rule with variable learning rate and a momentum factor or a fast learning algorithm e.g., Levenberg Marquet, train an appropriate three-layer BPNN on the training data and monitor its learning curve during the training after certain number of epochs to determine if the network is properly training. At least 10 random weight initializations should be tried and the best performing (on the validation set) should be chosen. Determine the generalization ability of the best trained network on the testing data set using performance measures such as the overall correct classification rate and the confusion matrix of the classifier.
3. Repeat part 2 using an appropriate CNN structure trained and tested using the same training, validation, and testing sets. Try both 4- and 6-layer CNNs with a softmax final layer for performing classification. MATLAB CNN function can be found at https://www.mathworks.com/matlabcentral/fileexchange/24291-cnn-convolutional-neural-network-class or other websites.
4. Provide a comprehensive benchmarking of the two networks based upon their overall correct classification rates, the associated confusion matrices, and complexity.
5. Provide a discussion on your results and point out the advantages/disadvantages in a brief report.