CSE471: Statistical Methods in AI -- Spring 2016

Assignment 3: Multilayer Neural Networks

DUE: Before 12midnight on 24 Feb 2016

INSTRUCTIONS:

i. You may do the assignment in Matlab/Octave, R, Python, C/C++ or Java.
ii. You need to upload pdf files in the Course Portal. One file should contain your answers, results and analysis. A separate file should contain code you have written and its sample output.
iii. At the top-right of the first page of your submission, include the assignment number, your name and roll number.
iv. *IMPORTANT:* Make sure that the assignment that you submit is your own work. *Do not copy any part from any source* including your friends, seniors or the internet. Any breach of this rule could result in serious actions including an **F grade** in the course.
v. Your grade will depend on the correctness of answers and output. In addition, due consideration will be given to the clarity and details of your answers and the legibility and structure of your code.

Preamble:

The aim of this assignment is to experiment with Multilayer Feedforward Neural Network (MLFNN) with Backpropagation (BP) learning we learned as part of Chapter 6 on real world problems. Due credit will be given for choosing non-trivial feature extraction and insightful presentation of results. *Please write your own code for BP algorithm and MLFNN training and testing. Do not use any libraries or copy directly any code from any resource – coding BP gives you greater insight into the practical issues.*

1. The aim is to code a complete handwritten digit recognizer and test it on the MNIST digit dataset. (Download the dataset and its description from: http://yann.lecun.com/exdb/mnist/). The MNIST database of handwritten digits, available from this page, has a training set of 60,000 examples, and a test set of 10,000 examples. It is a subset of a larger set available from NIST. The digits have been size-normalized and centered in a fixed-size image.

   Your recognizer needs to read the image data, extract features from it and use a multilayer feedforward neural network classifier to recognize any test image. Use 5-fold cross validation for your experiments.

   Write a detailed report on the different features that you used and the corresponding error rates (reported as percentages). Also give a *confusion matrix* that shows the kind of errors that your classifier makes. In this problem, your confusion matrix is a 10 x 10 matrix, where the rows represent the true label of a test sample and the columns

represent the predicted labels of the NN classifier. Also give a plot of the error rate as the number of features increases. Report the average error rate as well as standard deviation of the error rate for each fold along with other metrics such as Precision, Recall/Sensitivity, Specificity and Accuracy.

2. Compare the results with classification using Euclidean distance based 1-Nearest Neighbor (1NN) Classifier. Present an analysis and discussion of your results.

3. Now, try one variation of preprocessing using *deskewing, adding noise, etc.* and also try one variation with other objective functions / regularization terms such as *cross entropy, weight decay, tangentprop, etc.* and compare your results from (1) above. Present an analysis and discussion of your results. [See results table on http://yann.lecun.com/exdb/mnist/ to see various combinations and their best results. There are links to papers describing some of these variations. If you refer to and use any of these, please cite the reference and state in your report what you have implemented from these papers as part of your exploration].