Machine Learning 2007
(Home work 3)

July 1, 2009

- Due on Wednesday, July 20, before 10 a.m.
- Late submissions will not be accepted.
- Submit hard copy of the results, plots and your workings
- Submit a printed copy of the codes also.
- You may save time if you use MATLAB for the computations and plots.
- Please do not hesitate to contact me if you do not understand the problems.

1. **[15 + 10 + 15 points] Multilayer Perceptrons**

   (a) In this example we shall train an MLP to classify the satellite image that we used in our previous example. We shall also learn to use the functions in MATLAB for training an MLP.

      i. Study the functions *newff*, *train* and *sim*. These functions are enough to train and test a multilayer perceptron. A sample code to train and test an MLP (sampleMlp.m)is given in the course web page. The program sampleMlp.m trains an MLP with the data in trgSine.dat and test the network using the data in testSine.dat. Both these files can also be found in the class web page. You need to train an MLP on the same data using the same program by varying the number of nodes in the hidden layer. Provide results for 2,3,5,10,15 and 20 hidden nodes in a single hidden layer. Show plots showing how good your networks perform on the test data, also report the mean sum of square error for all the networks. Also briefly explain why the performance changes with the change in the number of hidden nodes.

      ii. Train an MLP with 10 hidden nodes using the data rsTrain.dat (which we used in the previous homework). Classify the whole image into land and water using the trained network.

iii. Now, train an MLP network with trgIris.txt (given in the webpage). Do a 10 fold cross validation on the data. Repeat the experiment 10 times with different initializations and report the mean and standard deviation of the error.

2. **[10 +15 points] K-Means Algorithm**

   (a) In the course website of homework 2 you will find four files named, band1.irs, band2.irs, band3.irs and band4.irs. Download these files. These files contain a satellite image of Kolkata in 4 different bands. Use the k-means algorithm to cluster this data into 2, 4 and 6 clusters. Display the clusters suitably.

   (b) Download the file lena.pgm from the course website. This file contains a gray level picture of size 256×256. Our objective here is to compress this image using the k-means algorithm. Break this image into 4×4 blocks and consider these blocks as your data. Cluster this data into k clusters. Now, for each block b_i, replace the block b_i by the mean of the cluster in which b_i belong. Do this for $k = 100, 50$ and 10. Display the corresponding images. Comment on the amount of compression achieved in each case.

3. **[10 + 15 points] Radial Basis Function Networks**

   (a) Derive the update equation of the weights from the hidden to output layer of a radial basis function network considering the mean and spread of the hidden nodes fixed.

   (b) Implement a radial basis function network. Use the k-means algorithm to fix the centers of the hidden nodes. Apply the method discussed in class to find the spreads. Train the network with trgIris.dat. Do a 10 fold cross validation on the data. Repeat the experiment 10 times with different initializations and report the mean and standard deviation of the error.