Indian Institute of Science

CCE: Neural Networks for Signal Processing-1

Instructor: Shayan Srinivasa Garani
TA: Prayag Gowgi
Home Work #2, Spring 2017

Late submission policy: Points scored = Correct points scored $\times e^{-d}$, d = # days late

Assigned date: Feb. 3rd 2017 **Due date:** Feb. 17th 2017 in class

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PROBLEM 1:

(a) The perceptron may be used to perform numerous logic functions. Demonstrate the implementation of the binary logic functions **AND**, **OR** and **COMPLEMENT**.

(b) A basic limitation of the perceptron is that it cannot implement the **EXCLUSIVE OR** function. Explain the reason for this limitation.

(10 pts.)

PROBLEM 2: Consider one-dimensional data points that are Gaussian-distributed with means $+1$ and -1 and with a variance of 1. Design a classifier that separates these two classes. How would the classifier change if they have the same mean (say, 1) but different variances (say, 1 and 5)? Generate the data points according to these probability distributions and comment upon the classification error.
(10 pts.)

PROBLEM 3: It is required to classify the set of data points as shown in Figure 1 into two classes.

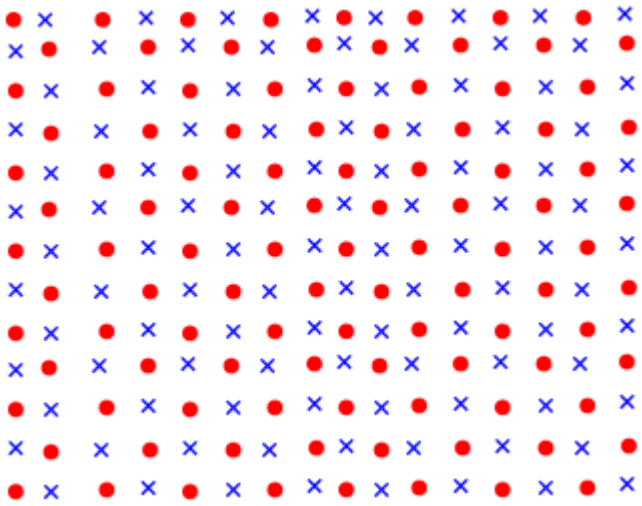

FIGURE 1. Set of data points.

(a) Implement the multilayer perceptron (MLP) neural network architecture configured in online mode to classify the set of data points shown in blue and red in Figure 1. We expect you to show the decision boundary as well. Experiment and report the number of hidden layers and neurons minimally required for this classification task.

(b) Repeat part (a) using the MLP architecture configured in batch mode. Show the decision boundary as well.

Note: Choose an appropriate activation function, such as the $\tanh(.)$ function.

(20 pts.)

PROBLEM 4: Generate the set of data points as shown in Figure 2.

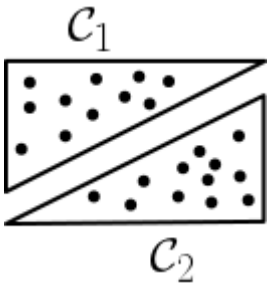

FIGURE 2. Set of data points uniformly distributed within two right angled triangles forming classes $\mathcal{C}_1$ and $\mathcal{C}_2$.

(a) Classify the set of data points into classes $\mathcal{C}_1$ and $\mathcal{C}_2$ using the perceptron algorithm configured in online and batch modes.
(b) Start with different initial conditions for the weight vector and the bias. Check whether you get the same decision boundary and comment upon this.
(c) Add Gaussian noise with 0 mean and variance ranging from 0 to 5 to the set of data points shown in Figure 2. What is your stopping criterion for learning? What can you comment upon the classification accuracy experimentally?

(20 pts.)