

# Indian Institute of Science

E9-253: Neural Networks and Learning Systems-I

Instructor: Shayan Srinivasa Garani  
Home Work #2, Spring 2019

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

**Assigned date:** Feb. 18<sup>th</sup> 2019

**Due date:** Feb. 28<sup>th</sup> 2019 in class

PROBLEM 1: Solve problems 4.3 and 4.4 from the book Neural Networks and Learning Machines (third edition) by Simon Haykin. (20 pts.)

PROBLEM 2: Perform the experiment 4.19 from the book Neural Networks and Learning Machines (third edition) by Simon Haykin. (25 pts.)

PROBLEM 3:

- (a) Using multi-layer perceptron (MLP) with the sigmoid activation functions, classify the points marked as 'cross' and 'dot' into two classes as shown in Figure 1 and plot the decision boundary. You can experiment over a  $N \times N$  grid and vary  $N$  in your experiments.
- (b) Repeat (a) with activation functions: 1) ReLu, 2)  $\tanh(\cdot)$  3)  $\text{erf}(\cdot)$ , and 4) heavy-side function.
- (c) Repeat (a) with one hidden layer and by varying the value of  $D$  from 0.1 to 1 in steps of 0.1 and comment on the number of hidden neurons required for each  $D$ .
- (d) Repeat (a) by pruning the network for complexity by employing the following criteria: upon completion of training, remove those neurons from the network for which the  $L_2$  norm of the associated weight vector is less than an  $\epsilon = 10^{-3}$  and comment on the classification accuracy.

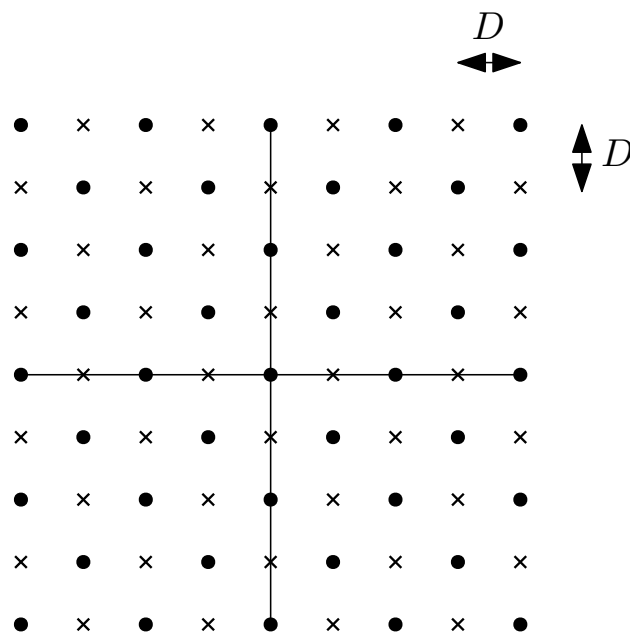


FIGURE 1. Points from two classes on a square grid array.

(55 pts.)