CSCI 4100 Assignment 4

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1. Exercise 2.4 in LFD
2. We can construct a nonsingular matrix whose rows represent

the points, that is, put input vectors to be whose rows represent , then we define the target vector . Suppose , where since there’s hypothesis . To show that points in X that the perceptron can shatter we can show that has solution for w, that is, we show has solution for w where . Since there exists a such that is nonsingular, and , we can then construct a linearly independent matrix: . Thus we show points in that the perceptron can shatter and therefore, .

1. Suppose input space is dimension, are linearly

independent and form a basis for . Now there is a , by the fact that any vectors of length have to be linearly dependent. Then there exists such that . Then . Now we assign to +1 if and to -1 if . Then when , and ; when , and . Now we have , . When we choose the class of other vectors carefully like this way, then the classification of is dictated: here and cannot be . Thus, points cannot be shattered, and .

1. Problem 2.3 in LFD
2. Positive or negative rays:

For N points, there are N+1 regions and the rays have two endpoints which can be

put into N+1 regions. To compute , we consider to add both ends are in same point, then . Since , then by Theorem 2.4, .

1. Positive or negative interval:

To compute , we have choices with two sets of values (+1, -1).

Thus, . Since , then by Theorem 2.4, .

1. Two concentric spheres in :

This problem is same as positive intervals, because we can rewrite the problem

as . Then, . Since , then by Theorem 2.4, .

1. Problem 2.8 in LFD

We can verify if the function is possible growth function by Theorem 2.4.

Possible, .

: Possible, .

: Possible, if no break point exists, then .

: Impossible, break point is 2 since . Then by Theorem 2.4 we have , but . Thus, there is a contradiction.

: Impossible, break point is 2 since . Then by Theorem 2.4 we have , but . Thus, there is a contradiction.

: Impossible, break point is 2 since . Then by Theorem 2.4 we have , but . Thus, there is a contradiction.

1. Problem 2.10 in LFD

Suppose where k is the maximum number of dichotomies that

can implement on N points. Then for any 2N points, it can be first N points plus a second N points, each of which have at most k dichotomies. Thus, for 2N points we at most can implement combinations, then .

Then from generalization bound, we have.

1. Problem 2.12 in LFD

From generalization bound, we have , where . Then .

For , .

For .

For .

For .

For .

For .

For .

Sample size converges to . Thus, .