22234747025

Department of Computer Science

MSc Computer Science - Semester II

MCSC 201: Machine Learning (UPC: 223411201)

16 Aug 2023

Max. marks: 70 Max. time: 3 Hours

Note1: Attempt all questions. All questions carry equal marks.

Note2: Use formal notation for all questions. Follow systematic approach towards the problem and show all intermediate steps neatly for full credit.

1. (a) Write the discriminant function based on the likelihood ratio for a two class problem and the corresponding decision rule. Transform it into linear form. (7)

   (b) Name one algorithm that performs (i) hard partitioning and (ii) soft partitioning. Write the optimization criterion for both algorithms using formal notation. (7)

2. (a) Consider a two class problem with the possible actions shown in the following loss matrix.

Action \ Actual Class	C1	C2
α_1: Choose C1	0	4
α_2: Choose C2	12	0

   Write the optimal decision rule for each action. How is the rule revised if Reject action (α_R) is added with equal cost (= 2) for both classes. (10)

   (b) Consider three class classification problem, where the classes are pairwise linearly separable. How many classifiers need to be trained? Justify with the help of a neat diagram. (4)

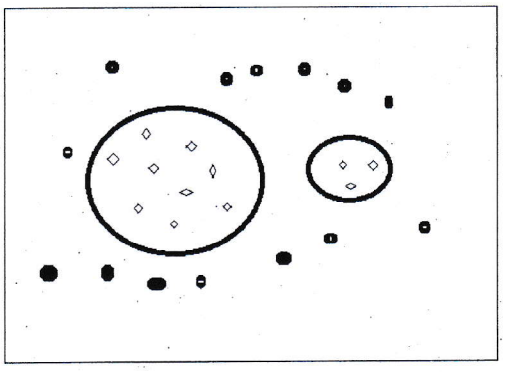
3. (a) Given a Normal variate $X \sim N(\mu, \sigma^2)$, find the MLE for the two parameters. (2+4)

   (b) Let X be a training data set in $\mathcal{R}^{10}$ with 1000 instances and Σ be its variance-covariance matrix. Further, w_1, w_2 are the first two principal components. Write down the constraints for maximizing the variance for the third principal component (w_3) with complete notation and reason. (8)

4. (a) Show that the total error of a classifier can be decomposed into two components (Bias and Variance). What do these components indicate about the classifier? (8)

   (b) Train a perceptron that implements OR function, and show its geometric interpretation. (6)

5. (a) Consider a two class problem with distribution of two classes and the decision boundaries shown as below. What is the hypothesis class? Justify your answer. (4)



(b) Derive cross-entropy loss for a 2-class classification problem. Given that $\mathcal{X}$ is the training set containing N instances. (10)

Good Luck