Machine Learning Mid Sem Spring 2021 Set-4

Instructions

1. This is a **closed book online proctored** exam.
   a. You should not refer to books, notes or online resources.
   b. You should not discuss questions or answers with anyone (including outsiders)
   c. You should have your camera and microphone **ON** at all times and no headphones.
2. Write the solutions clearly and legibly in A4 sheets, using pen (NOT pencil) and at the end of the exam you should submit the scanned copy of your solutions as explained by the faculty
3. **Write your name, roll no. and question set (e.g. Set-4) on each page.**
4. Follow all other instructions given by the faculty during the exam.

Descriptive Questions (10 Marks each)

1. State conditional risk of the Bayes theorem for two-category classification. A customer wants to buy an Apple Macbook and assume the two classes of Macbook with different processors as $\omega_1 \rightarrow M1\ Processor\ based\ Macbook$ and $\omega_2 \rightarrow Intel\ Processor\ based\ Macbook$. Let the two actions the customer can be taken in this problem are $\alpha_1 \rightarrow$ *buying M1 Processor Mac*, α_2 -> *buying Intel Processor Mac*. However, each processor configuration has certain speed and cost trade-offs, so let loss for deciding two actions $\lambda(\alpha_1 \mid \omega_1) = 2$; $\lambda(\alpha_1 \mid \omega_2) = 12$; $\lambda(\alpha_2 \mid \omega_1) = 5$; $\lambda(\alpha_2 \mid \omega_2) = 15$; Assume equal priors, and let likelihood of people buying M1 processor Macbook as $p(x \mid \omega_1) = 0.9$, and people buying intel processor Macbook $p(x \mid \omega_2) =$

0.75. Can you please help the customer by finding the best choice using conditional risk of the Bayes theorem and the plain Bayes theorem? (3+7)

2. (a) Define maximum likelihood estimation for linear regression with an example. (2)
   (b) What is the difference between MLE and MAP? (2)
   (c) Explain an overfitting and underfitting problem with an example. (2)
   (d) Suppose $x_1, x_2, ..., x_n$ are iid samples from a distribution with density

$$f_X(x \mid \theta) = \begin{cases} \dfrac{\theta x^{\theta-1}}{3^\theta}, & 0 \le x \le 3 \\ 0, & \text{otherwise} \end{cases}$$

   Find the maximum likelihood estimation for θ. (4)