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SIXTH SEMESTER **B. Tech. [CO]**

MID SEMESTER EXAMINATION ***March-2020***

CO324 PATTERN RECOGNITION

Time: 1:30 Hours *Max. Marks: 25*

Note: Answer ***ALL*** questions.
Assume suitable missing data, if any.
Use of scientific calculator is permitted.
USE ONLY OPTIMAL NUMBER OF WORDS FOR YOUR ANSWERS

1. A former incidentally mixed kiwi (Chinese gooseberry) fruits with Chiku (sapodilla) fruits. Let us design an automatic pattern recognition system for classification of above two types of fruits. Show the major steps in designing using block diagram, with **one sentence** (at the max two sentences if it is really required) description of each block. Also state which features you will like involve (answer pointwise). [3]

2. In the design of a classifier, ~~where each~~ object is represented by a one dimensional feature vector x. It is given that there are two classes ω_1 and ω_2. Ten samples of each classes are given. For class ω_1: {1, 2, 3, 3, 4, 4, 4, 5, 5, 6}, and for class ω_2:{4, 6, 7, 7, 8, 8, 8, 9, 9, 10}. Find and plot the probability distributions: $p(x|\omega_1)$, and $p(x|\omega_2)$. ~~Also, find a decision boundary that minimizes the total number of~~ misclassifications. [3]

3. Consider the two class classification problem, where classification errors for two classes have different loss. Let $\lambda(\alpha_i|\omega_j)$ represents the loss if the actual class is j and classifier assigns class i. Derive a classification rule for minimizing the risk, where conditional risk is defined as $R(\alpha_i|\mathrm{X}) = \sum_{j=1}^{2} \lambda(\alpha_i|\omega_j)p(\omega_j|\mathrm{X})$, where X is a feature vector. [5]

4. Let the marks obtained by students in data structures (DS), Algorithm Design and Analysis (ADA), and Pattern Recognition (PR) in the

Table-I. Find the variance-covariance matrix (Σ). Also, transform the given data into the vector space form by principle components: [**Hint:** Eigenvalues and eigenvectors of Σ: $\lambda_1 = 14.82$, $\lambda_2 = 629.11$, and $\lambda_3 = 910.07$; $e_1 = [-3.75, 4.28, 1]^T, e_2 = [-0.50, -0.68, 1]^T, e_3 = [1.06, 0.69, 1]^T$] [7]

Table-I

Student	DS	ADA	PR
1	90	60	90
2	90	90	30
3	60	60	60
4	60	60	90
5	30	30	30

5. The grade points (out of 10) of the students are given in Table-II. Assume the grade points follow Gaussian distribution $N(\mu, \sigma^2)$. Explain the concept likelihood with a diagram (and if required, **maximum two sentences**). Find mean μ of the distribution using Maximum Likelihood Estimation (MLE). Assume the value of $\sigma^2 = 2$. [7]
[**Hint:** Overall likelihood is given by product of likelihood at each data point. You can use symmetry property of normal distribution to reduce the number of points to check. Also, *Log*likehood can be used to further simplify the calculation, since *Log* is monotonically increasing function.]

Table-II

Student	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Grade Point	7	10	7	8	7	4	9	5	5	6	9	6	8	7	6	8

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