CBCS SCHEME

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15EC753

Seventh Semester B.E. Degree Examination, Dec.2019/Jan.2020
Pattern Recognition

Time: 3 hrs. Max. Marks: 80

Note: ***Answer FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Discuss the following terms (i) Pattern recognition (ii) Supervised learning (iii) Unsupervised learning (iv) Features (v) Feature vectors (vi) Classifier. **(06 Marks)**

b. Write the formula for Bayes rule and explain each term. **(04 Marks)**

c. In a two-class problem with a single feature x the pdfs arc Gaussians with variance $\sigma^2 = \frac{1}{2}$ for both classes and mean values 0 and 1, respectively, that is $p(x/w_1) = \frac{1}{\sqrt{\pi}} e^{-x^2}$; $p(x/w_2) = \frac{1}{\sqrt{\pi}} e^{-(x-1)^2}$. If $P(w_1) = P(w_2) = 0.5$ then comute the threshold x_0

(i) For minimum error probability

(ii) For minimum risk if the loss matrix is,

$$L = \begin{bmatrix} 0 & 0.5 \\ 1 & 0 \end{bmatrix}$$

(06 Marks)

OR

2 a. Discuss the applications of pattern recognition. **(06 Marks)**

b. Write the equation for one-dimensional Gaussian pdf and explain each term. **(04 Marks)**

c. In a two–class two dimensional classification task, the feature vectors are generated by two normal distributions sharing the same covariance matrix, $\Sigma = \begin{bmatrix} 1.1 & 0.3 \\ 0.3 & 1.9 \end{bmatrix}$; $P(\omega_1) = P(\omega_2)$; and the mean vectors are $\underline{\mu_1} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$; $\underline{\mu_2} = \begin{bmatrix} 3 \\ 3 \end{bmatrix}$. Classify the vector $\underline{x} = \begin{bmatrix} 1.0 \\ 2.2 \end{bmatrix}$, using Bayesian classifier. **(06 Marks)**

Module-2

3 Given the image $\underline{X} = \begin{bmatrix} 1 & 2 \\ 2 & 3 \end{bmatrix}$ and the orthogonal transform matrix $\underline{U} = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$

(i) Find the transformed image $\underline{Y}$ from $\underline{X}$ and $\underline{U}$ (ii) Reconstruct the image $\underline{X}$ from $\underline{Y}$ and $\underline{U}$. (iii) Obtain basis images (iv) Find the transformed image using the basis images. (v) Reconstruct the original image from basis images. **(16 Marks)**

OR

4 Given a 2 bit 2×3 image $\underline{X}=\begin{bmatrix}1 & 1 & 0\\ 0 & 0 & 1\end{bmatrix}$ determine its singular value decomposition. If only the first Eigen value and the Eigen vector is used to reconstruct the image then verify that the square error of the reconstructed image is equal to the sum of the omitted eigen values. **(16 Marks)**

Module-3

5 a. Assume that N data points $\underline{x}_1, \underline{x}_2, \ldots\ldots\ldots \underline{x}_N$ have been generated by a one-dimensional Gaussian pdf of known mean, μ, but of unknown variance. Derive the maximum likelihood estimate of the variance. **(08 Marks)**

b. Let $\underline{x}_1, \underline{x}_2, \ldots\ldots\ldots \underline{x}_N$ be vectors stemmed from a normal distribution with known covariance matrix and unknown mean, that is,

$$P(\underline{x}_K;\mu)=\frac{1}{(2\pi)^{\frac{\ell}{2}}\left|\sum\right|^{\frac{1}{2}}}\exp\left(-\frac{1}{2}(\underline{x}_K-\mu)^T\sum{}^{-1}(\underline{x}_K-\mu)\right)$$

Obtain the maximum likelihood estimate of the unknown mean vector. **(08 Marks)**

OR

6 a. Let $P(x/\mu)$ be a univariate Gaussian $N(\mu,\sigma^2)$ with unknown parameter the mean, which is also assumed to follow a Gaussian $N(\mu_0,\sigma_0^2)$. Use Bayesian estimation techniques to calculate the posteriori density $P(\mu/x)$ and obtain the mean and the variance. **(08 Marks)**

b. Let $\underline{x}_1, \underline{x}_2, \ldots\ldots\ldots \underline{x}_N$ be vectors stemmed from a normal distribution with known covariance matrix and the unknown mean vector $\underline{\mu}$ is known to be normally distributed as,

$$P(\underline{\mu})=\frac{1}{(2\pi)^{\ell/2}\sigma_\mu^\ell}\exp\left(-\frac{1}{2}\frac{\|\underline{\mu}-\underline{\mu}_0\|^2}{\sigma_\mu^2}\right)$$

Obtain the maximum a posteriori probability estimate of the unknown mean vector. **(08 Marks)**

Module-4

7 a. Discuss the perceptron algorithm. **(08 Marks)**

b. Fig. Q7 (b) shows four points in the two-dimensional space-points $(-1,0)$, $(0,1)$ belong to class ω_1 and points $(0,-1)$, $(1,0)$ belong to class ω_2. Design a linear classifer using the perceptron algorithm in its reward and punishment form. Assume $\rho=1$ and the initial weight vector $\underline{\omega}(0)=\begin{bmatrix}0\\0\\0\end{bmatrix}$ in the extended three dimensional space. **(08 Marks)**

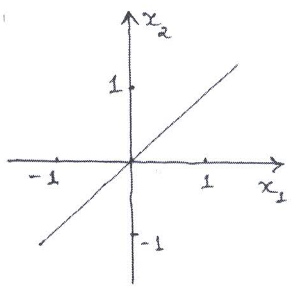

Fig. Q7 (b)

OR

8 a. Discuss the basic perceptron model. **(08 Marks)**

b. Consider a linear classifer $x_1 + x_2 - 0.5 = 0$ corresponding to the weight vector $[1 \quad 1 \quad -0.5]^T$, which has been computed from the latest iteration step of the perceptron algorithm with $\rho_t = \rho = 0.7$. The line classifies correctly all the vectors except $[0.4 \quad 0.05]^T \in \omega_1$ and $[-0.20 \quad 0.75]^T \in \omega_2$. Use perceptron algorithm to update the weight vector and hence obtain the classifier. **(08 Marks)**

Module-5

9 a. Discuss the AND and OR problem. **(08 Marks)**

b. Discuss how the XOR problem is solved by using a two layer perceptron model. **(08 Marks)**

OR

10 a. Define clustering. Explain the basic steps of clustering. **(08 Marks)**

b. Given $\underline{x} = \begin{bmatrix} 0 \\ 1 \\ 2 \end{bmatrix}$ and $\underline{y} = \begin{bmatrix} 4 \\ 3 \\ 2 \end{bmatrix}$. Determine $d_1(x,y)$, $d_2(x,y)$, $d_\infty(x,y)$ and $d_\theta(x,y)$. Assume all weights are equal to 1. **(08 Marks)**

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