B.Sc. Engg. CSE 8th Semester (15) 187 10 August 2015 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

MID SEMESTER EXAMINATION SUMMER SEMESTER, 2014-2015

DURATION: 1 Hour 30 Minutes FULL MARKS: 75

CSE 4835: Pattern Recognition

Programmable calculators are not allowed. Do not write anything on the question paper.

There are 4 (four) questions. Answer any 3 (three) of them.

Figures in the right margin indicate marks.

1\. a) In many pattern classification problems one has the option either to assign the pattern to one of c classes, or to *reject* it as being unrecognizable. If the cost for rejects is not too high, rejection may be a desirable action. 10

$$\text{Let } \lambda(\alpha_i \mid \omega_j) = \begin{cases} 0 & i = j \quad i,j = 1,2,\ldots,c \\ \lambda_r & i = c+1 \\ \lambda_s & \text{otherwise} \end{cases}$$

where, λ_r is the loss incurred for choosing the $(c+1)^{th}$ action, rejection, and λ_s is the loss incurred for making a substitution error. Show that the minimum risk is obtained if we decide ω_i if $P(\omega_i|x) \geq P(\omega_j|x)$ for all j and if $P(\omega_i|x) \geq 1 - \lambda_r/\lambda_s$, and reject otherwise.

b) Write the differences between Bayes Minimum Error classifier and Bayes Minimum Risk classifier. 5

c) Briefly describe the components of a typical pattern recognition system. 10

2\. a) Write notes on the following terms: 3×3

i. Generalization
ii. Reinforcement Learning
iii. Deformation invariance of features

b) Why and when is Mahalanobis distance preferred over Euclidean distance? 5

c) Let the likelihood density function $P(x \mid \omega_i) \doteq N(\mu_i, \sigma^2 \mathrm{I})$ for a two-category d-dimensional problem with $P(\omega_1) = P(\omega_1) = 0.5$. Prove that the minimum probability of error is given by 11

$$P_e = \frac{1}{2\pi}\int_a^{\infty} e^{-u^2/2}\,du \text{ where } a = \|\mu_2 - \mu_1\|/(2\sigma).$$

3\. a) Suppose x have a uniform density 10

$$p(x \mid \theta) \doteq \mathrm{U}(0,\theta) = \begin{cases} 1/\theta & 0 \leq x \leq \theta \\ 0 & \text{otherwise} \end{cases}.$$

If n samples $D=\{x_1, x_2, \ldots, x_n\}$ are drawn independently according to $p(x|\theta)$, then show that the maximum likelihood estimate for θ is max[D], i.e., the value of the maximum element in D.

b) How is the estimate from Maximul Likelihood Estimation different from or similar to the estimate of Bayes Parameter Estimation? 5

c) Describe the general principal of Bayes Parameter Estimation technique for approximating the unknown parameters. 10

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4. a) Derive the equation for finding the distance r from a sample point x to the decision boundary plane H. How can you find the position of the origin by simply seeing the equation of a decision boundary? 3+2

b) How many ways can you devise multicategory classifiers employing linear discriminant functions? For each of the designs, state the limitations with appropriate illustrations. 3×3

c) Suppose a set of samples is given for a 2-class problem and they are not linearly separable in the original feature space. How can you design a linear machine for the same set of samples and find a decision boundary? [Note: Choose a criterion function with a margin b] 11