Sc. Engg. CSE 8th Semester (23)

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

MID SEMESTER EXAMINATION

SUMMER SEMESTER, 2013-2014

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.

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1. a) A discriminant function is a linear combination of the components of x and can be written as: $g(x) = w^t x + w_0$. Find the weight coefficients of vector w for a 'minimum distance to class member' classifier. 10

   b) Write down the differences between Supervised, Unsupervised and Reinforcement Learning. 6

   c) Draw a diagram illustrating the design cycle of a pattern recognition system and explain how feedback information from classifier evaluation may change each component of the design cycle. 4+5

2. a) Consider a minimum error rate classification achieved by the use of the following discriminant functions: $g_i(x) = \ln P(\mathrm{x} \mid \omega_i) + \ln P(\omega_i)$, where each class has its own covariance matrix. For the multivariate normal case, convert this discriminant function to its general form $g(x) = w^t x + w_0$. 10

   b) For which special case, the discriminant function will change the classifier in question 2.(a) to a 'minimum distance' classifier? 5

   c) 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 $(c+1)^{\text{th}}$ 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 $P(\omega_i|\mathrm{x}) \geq P(\omega_j|\mathrm{x})$ for all j and if $P(\omega_i|\mathrm{x}) \geq 1 - \lambda_r/\lambda_s$, and reject otherwise.

3. a) 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 classifier for the same set of samples and find the decision boundary? [Note: Mention the choice of your criterion function.] 10

   b) Briefly discuss why and when Mahalanobis distance is preferred over Euclidean distance. 5

   c) How do nonparametric density estimation techniques estimate the unknown probability density functions? Step by step derive the final estimation function, and list the conditions for convergence. 10

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4. a) Let random variable x have an exponential density: 15

$$p(x\,|\,\theta) = \begin{cases} \theta e^{\theta x} & x \geq 0 \\ 0 & \text{otherwise} \end{cases} \quad \text{and } \theta > 0.$$

Suppose that n samples x_1, x_2, ..., x_n are drawn independently according to $p(x\,|\,\theta)$. Show that the maximum likelihood estimate of θ is given by

$$\hat{\theta} = -\frac{1}{\frac{1}{n}\sum_{k=1}^{n} x_k}$$

b) For the univariate Gaussian case, estimate $p(\mu\,|\,D)$ using Bayesian Parameter estimation. 10