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MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

SEVENTH SEMESTER B.TECH (INFORMATION TECHNOLOGY / COMPUTER AND COMMUNICATION ENGINEERING) DEGREE MAKEUP EXAMINATION-FEB 2022
SUBJECT:PROGRAM ELECTIVE-V NEURAL NETWORKS AND FUZZY LOGIC (ICT 4052)
(REVISED CREDIT SYSTEM)

TIME: 1.15 HOURS **17/02/2022** **MAX. MARKS: 20**

Instructions to candidates
- Answer **ALL** questions.
- Missing data, if any may be suitably assumed.

PART-B

1A. For ℓ_2 norm soft margin SVM, the algorithm is given by the following optimization problem:

$$\begin{aligned} \min_{w,b,\xi} \quad & \frac{1}{2}||w||^2 + \frac{C}{2}\sum_{i=1}^{m}\xi_i^2 \\ \text{s.t.} \quad & y^{(i)}(w^T x^{(i)} + b) \geq 1 - \xi_i \quad i = 1, \ldots, m \end{aligned}$$

i) Write the Lagrangian for the given optimization problem.

ii) Derive the dual optimization problem.

[5]

1B. Consider the cost function

$$\mathcal{E}(\mathbf{w}) = \frac{1}{2}\sigma^2 - \mathbf{r}_{\mathbf{xd}}^T\mathbf{w} + \frac{1}{2}\mathbf{w}^T\mathbf{R}_{\mathbf{x}}\mathbf{w}$$

where σ^2 is some constant and

$$\mathbf{r}_{\mathbf{xd}} = \begin{bmatrix} 0.8182 \\ 0.354 \end{bmatrix}, \mathbf{R}_{\mathbf{x}} = \begin{bmatrix} 1 & 0.8182 \\ 0.8182 & 1 \end{bmatrix}$$

Find the optimum value of $\mathbf{w}^*$ for which $\mathcal{E}(\mathbf{w})$ reaches its minimum value. [3]

1C. The opeartion of the Bayes classifier for the Gaussian environment is analogous to that of the perceptron in that they are both linear classifiers. However, there are some subtle and important difference between them. Briefly discuss those differences. [2]

2A. For the data shown in Table Q.2A, show the first iteration of back propagation algorithm in trying to compute the membership values for the input variables x_1, x_2 and x_3 in the output region R_1 and R_2. Use a $3 \times 3 \times 2$ neural network architecture. Assume a random set of weights for your neural network.

Table: Q.2A

x_1	x_2	x_3	R_1	R_2
1.5	1.0	0.8	1.0	0.0

[5]

2B. In photography, it is important to relate reagent thickness to color balance on the film medium. Let Y be a universe of color balance, $Y = [0, 1, 2, 3, 4]$, where 0=yellow, 4=blue, and 2=neutral. Let X be a universe of the reagent thickness, $X = [0, 1, 2, 3, 4]$, where 0=thin, 4=thick, and 2=semi-thick. Now, suppose that a relation is obtained from a Cartesian product as follows:

$$R = X \times Y = \begin{array}{c} \\ 0 \\ 1 \\ 2 \\ 3 \\ 4 \end{array} \begin{array}{c} \begin{array}{ccccc} 0 & 1 & 2 & 3 & 4 \end{array} \\ \begin{bmatrix} 1 & 0.8 & 0.6 & 0.2 & 0 \\ 0.8 & 1 & 0.8 & 0.6 & 0 \\ 0.6 & 0.8 & 1 & 0.8 & 0.6 \\ 0.2 & 0.6 & 0.8 & 1 & 0.8 \\ 0 & 0.2 & 0.6 & 0.8 & 1 \end{bmatrix} \end{array}$$

It is required to relate color balance on the film medium to the perceived quality of the picture. For this we need an additional universe of perceived picture quality, $Z = [0, 1, 2, 3, 4]$, where 0=bad, 4=excellent, and 2=fair. Suppose a relation is obtained from a Cartesian product

$$S = Y \times Z = \begin{array}{c} \\ 0 \\ 1 \\ 2 \\ 3 \\ 4 \end{array} \begin{array}{c} \begin{array}{ccccc} 0 & 1 & 2 & 3 & 4 \end{array} \\ \begin{bmatrix} 1 & 0.6 & 0.4 & 0.2 & 0 \\ 0.6 & 1 & 0.6 & 0.4 & 0 \\ 0.4 & 0.6 & 1 & 0.6 & 0.4 \\ 0.2 & 0.4 & 0.6 & 1 & 0.6 \\ 0 & 0.2 & 0.4 & 0.6 & 1 \end{bmatrix} \end{array}$$

i) Find $T = R \circ S$ using max-min composition

ii) Find $T = R \circ S$ using max-product composition.

[3]

2C. Draw the structure of an RBF network from interpolation theory perspective and briefly write about the various components of this network. [2]