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MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

SIXTH SEMESTER B.TECH (INFORMATION TECHNOLOGY / COMPUTER AND COMMUNICATION ENGINEERING) DEGREE MAKEUP EXAMINATION-JUNE 2019

SUBJECT:PROGRAM ELECTIVE-II NEURAL NETWORKS AND FUZZY LOGIC (ICT 4012)

(REVISED CREDIT SYSTEM)

TIME: 3 HOURS 18-/06/2019 **MAX. MARKS: 50**

Instructions to candidates

- Answer **ALL FIVE** full questions.
- Missing data, if any may be suitably assumed.

1A. For a neural networks describe the four rules of knowledge representation that are common sense in nature. [5]

1B. An auto-associative memory is trained on the following key vectors:

$$x_1 = \frac{1}{4}[-2, -3, \sqrt{3}]^T,\ x_2 = \frac{1}{4}[2, -2, -\sqrt{8}]^T,\ x_3 = \frac{1}{4}[3, -1, \sqrt{6}]^T$$

i) Using generalization of Hebb's rule, calculate the memory matrix of the network.

ii) A masked version of the key vector x_1, namely $x = [0, -3, \sqrt{3}]^T$ is applied to the memory. Calculate the response of the memory, and compare your result with the desired response x_1. [3]

1C. What do you understand by the term *credit assignment problem*? Briefly explain two types of credit-assignment problems. [2]

2A. Consider a Bayes classifier with classification condition

$$\Lambda(x) = \frac{f_x(x|\mathcal{C}_1)}{f_x(x|\mathcal{C}_2)} \text{ and } \xi = \frac{p_2(c_{12} - c_{22})}{p_1(c_{21} - c_{11})}$$

where

- p_i: a priori probability that the observation vector x is drawn from subspace $\mathcal{L}_i$ and $p_1 + p_2 = 1$
- c_{ij}: cost of deciding in favor of class $\mathcal{C}_i$ represented by subspace $\mathcal{L}_i$ when class $\mathcal{C}_j$ is true
- $f_x(x|\mathcal{C}_i)$: conditional probability density function of the random variable X, given that the observation vector x is drawn from subspace $\mathcal{L}_i$.

Show that a Bayes classifier for Gaussian environment, whose probability density function is defined by

$$f_x(x|\mathcal{C}_i) = \frac{1}{(2\pi)^{m/2}(det(C))^{1/2}} \exp\left(-\frac{1}{2}(x - \mu_i)^T C^{-1}(x - \mu_i)\right)$$

behaves like a perceptron. [5]

2B. With reference to SVM, briefly explain the following:

i) support vector

ii) margin of separation, and

iii) slack variable.

[3]

2C. With suitable mathematical formulation, show that "*for an ergodic process, the linear-least square filter asymptotically approaches the Weiner filter as the number of observation approaches infinity*".

[2]

3A. A railroad company intends to lay a new rail line on Konkan route. The whole area through which the new line is passing must be purchased for right-of-way consideration. It is surveyed in three stretches, and the data are collected for analysis. The surveyed data for the road are given by the sets, B_1, B_2, and B_3, where the sets are defined on the universe of right-of-way widths, in meters. For the railroad to purchase the land, it must have an assessment of the amount of land to be bought. The three surveys on right-of-way width are ambiguous, however, because some of the land along the proposed railway route is already in public domain and will not need to be purchased. Additionally, the original surveys are so old that some ambiguity exists on boundaries and public right-of-way for old utility lines and old roads. The three fuzzy sets, B_1, B_2, and B_3 are shown in Figure Q.3A, represent the uncertainty in each survey as to the membership of right-of-way width, in meters, in privately owned land. Calculate the single most nearly representative right-of-way width using centroid method. [5]

3B. Let x be a linguistic variable that measures a university's academic excellence, which takes values from the universe of discourse $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$. Suppose the term set of x includes Excellent, Good, Fair, and Bad. The fuzzy set representation of these linguistic variables are defined as:

$$\text{Excellent} = \left\{\frac{0.2}{8} + \frac{0.6}{9} + \frac{1}{10}\right\}$$
$$\text{Good} = \left\{\frac{0.1}{6} + \frac{0.5}{7} + \frac{0.9}{8} + \frac{1}{9} + \frac{1}{10} +\right\}$$
$$\text{Fair} = \left\{\frac{0.3}{2} + \frac{0.6}{3} + \frac{0.9}{4} + \frac{1}{5} + \frac{0.9}{6} + \frac{0.5}{7} + \frac{0.1}{8}\right\}$$
$$\text{Bad} = \left\{\frac{1}{1} + \frac{0.7}{2} + \frac{0.4}{3} + \frac{0.1}{4}\right\}$$

Construct the membership function for the following compound sets:

i) Not bad but not very good

ii) Good but not excellent.

[3]

3C. Consider a fuzzy set, $A = \left\{\frac{0.3}{2} + \frac{0.6}{3} + \frac{0.9}{4} + \frac{1}{5} + \frac{0.9}{6} + \frac{0.5}{7} + \frac{0.1}{8}\right\}$. Find the following

i) Core element of the set

ii) Boundary elements of the set

[2]

4A. You want to compare two sensors based upon their detection levels and gain settings. Table Q.4A lists gain settings and sensor detection levels with a standard item being monitored with typical membership values to represent the detection levels for each of the sensors.

The universe of discourse is $X = \{0, 20, 40, 60, 80, 100\}$. Consider S_1 and S_2 as the membership functions for the two sensors. Find the following membership functions using standard set operations:

(i) $\mu_{S_1 \cup S_2}(x)$ (iii) $\mu_{S_1 \cup \overline{S_2}}(x)$ (v) $\mu_{\overline{S_1 \cup S_2}}(x)$

(ii) $\mu_{S_1 \cap S_2}(x)$ (iv) $\mu_{\overline{S_1 \cap S_2}}(x)$ (vi) $\mu_{\overline{S_1}}(x)$

[5]

4B. Using Zadeh's notation, determine the λ-cut sets for the six sets operations in Q.4A using $\lambda = 0.2$, and 0.8. [3]

4C. Using the inference approach, find the membership values for each of the triangular shapes (I,R,IR,E,T) for the triangle, $45^0, 75^0, 60^0$.

[2]

5A. For the data shown in Table Q.5A, 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 $3 \times 3 \times 1$ neural network. Assume a random set of weights for your neural network.

Table: Q.5A

x_1	x_2	x_3	R_1	R_2
3.5	0.5	2.5	0.0	1.0

[5]

5B. We want to set up a database of documents that cover a certain broad scientific subject to various degrees of depth. We are interested in the relationship, for each individual document, between a researcher's amount of expertise in this subject and relevance of that document to the teacher's scientific endeavors. A "relevant" document is defined as

$$\text{“Relevant”} = V = \left\{ \frac{0.0}{irrelevant} + \frac{0.2}{tangential} + \frac{1.0}{relevant} + \frac{1.0}{crucial} \right\}.$$

A "knowledgeable" researcher is defined as

$$\text{“Knowledgeable”} = K = \left\{ \frac{0.0}{novice} + \frac{0.3}{student} + \frac{0.8}{graduate} + \frac{1.0}{expert} \right\}.$$

Consider a certain very in-depth document. A knowledgeable researcher will find this document relevant to the research at hand. There is a relationship between K and V

i) Find the relation IF K, THEN V for this in-depth document using classical implication.

ii) A "freshman" researcher would have different view of the same document. A freshman could be described by another fuzzy set on the universe of researchers as

$$\text{“freshman”} = F = \left\{ \frac{0.5}{novice} + \frac{0.7}{student} + \frac{0.0}{graduate} + \frac{0.0}{expert} \right\}.$$

Find the relevancy of the in-depth document to this freshman using max-min composition on the relation found in (i).

[3]

5C. A factory process control involves two linguistic (atomic) parameters consisting of pressure and temperature in a fluid delivery system. Nominal pressure limits range from 400 psi to 1000 psi. Nominal temperature limits are 130 to 140^0 F. We characterize each parameter in fuzzy linguistic terms as follows:

$$\text{"Low temperature"} = \left\{ \frac{1}{131} + \frac{0.8}{132} + \frac{0.6}{133} + \frac{0.4}{134} + \frac{0.2}{135} + \frac{0}{136} \right\}$$

$$\text{"High temperature"} = \left\{ \frac{0}{134} + \frac{0.2}{135} + \frac{0.4}{136} + \frac{0.6}{137} + \frac{0.8}{138} + \frac{1}{139} \right\}.$$

Find the membership function for the statement "Temperature not very low and not very high".

[2]

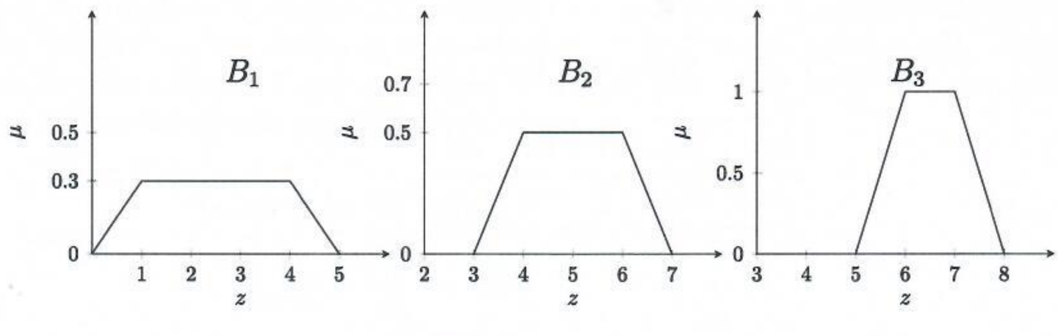

Figure: Q.3A

Table: Q.4A

Gain setting	Sensor 1 detection level S_1	Sensor 2 detection level S_2
0	0	0
20	0.5	0.45
40	0.65	0.6
60	0.85	0.8
80	1	0.95
100	1	1