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MANIPAL INSTITUTE OF TECHNOLOGY
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SIXTH SEMESTER B.TECH. (E & C) DEGREE END SEMESTER EXAMINATION – April/May 2017
SUBJECT: SOFT COMPUTING TECHNIQUES (ECE - 4033)

TIME: 3 HOURS **MAX. MARKS: 50**

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

1A. It is required to approximate a nonlinear function $y = x^2$ by using a 2-layer perceptron network. Train the network for one step using back propagation algorithm. Use 2 linear neurons in the hidden layer and one linear neuron in the output layer. The input to the network is, $z = -1$.The bias input is -1 for each layer. Take η=λ=1.The initial weights of the hidden and output layers are respectively:

$$V^t = \begin{bmatrix} -1 & 0.2 \\ -0.6 & 0.8 \end{bmatrix}, W^t = [0.3 \quad 1 \quad 0].$$

1B. For the given data, perform 2 steps of delta learning rule perceptron learning with unipolar continuous neurons:

$W^{1t} = [1 \quad -1 \quad 0 \quad 0.5], (X_1^t = [1 \quad -2 \quad 1.5 \quad 0], d_1 = -1),$
$(X_2^t = [1 \quad -0.5 \quad -2 \quad -1.5], \quad d_2 = 1), c = 1. \lambda = 1$

1C. Implement the following Boolean expression using McCulloch-Pitt model of Neuron.

$f = x_1x_2x_3 + \overline{(x_1 + x_2)}$

(5+3+2)

2A. Draw the network architecture of a Probabilistic Neural Network (PNN) and explain briefly. Mention any 2 advantages and disadvantages of PNN classifier.

2B. A linear perceptron classifier is to be trained to assign $x_1 = -1$ to class 1 ($d_1 = 1$) , $x_2 = -3$ to class 2 ($d_2 = -1$) respectively. Display the movement of weight vectors on the weight space taking initial weight as $W^{1t} = [-1 \quad 1]$, c=0.5, bias input =+1 and sgn (0) =1.

2C. For the cost matrix and the classifier model shown in Fig.Q2C, Compute the cost of classification.

(5+3+2)

3A. Design an auto associative discrete Hopfield memory to store the images shown in Fig.Q3A (i & ii). Use bipolar neurons to perform async update by applying the initial pattern shown in Fig.Q3A (iii). Find energy at each iteration and comment on your result.

3B. Design a spatio temporal memory network using bipolar discrete neurons to store the following sequence:$S^0 = [1 \quad 1 \quad 1]^t \rightarrow S^1 = [1 \quad -1 \quad -1]^t \rightarrow S^2 = [-1 \quad 1 \quad -1]^t$. Test the memory performance for both forward and backward pass.

3C. Draw the network architecture for a BAM (Bidirectional Associative memory) and write the expression for storage of patterns.

(5+3+2)

4A. Design a simple fuzzy rule based system to simulate the nonlinear function given by: $y = x^2$, defined in the universe, x= [-1 1], y= [0 1].Use Mamadani minimum implication for interpreting fuzzy IF-THEN rules, min for t-norm and max for union. Test the output of the system for x=0, -1 using centre average defuzzification.

4B. Find the fuzzy composition for the following relations using max-product composition. Show each step.

$$R_1 = \begin{bmatrix} 0.1 & 0.2 \\ 0.01 & 0.4 \\ 1 & 0.6 \end{bmatrix}, \quad R_2 = \begin{bmatrix} 1 & 0.5 \\ 0.2 & 0.6 \end{bmatrix}$$

Is it commutative? Justify your answer with proof.

4C. Find whether min, algebraic sum and basic complement form an associated class or not.

(5+3+2)

5A. Consider a 2-input 1-output fuzzy system that is constructed from the following 3 rules:

If x1 is A1 and x2 is A2, Then y is A2

If x1 is A2 and x2 is A1, Then y is A1

Where A1, A2 are fuzzy sets with membership functions:

$\mu_{A1}(u) = 1 - |u|, if\ -1 \le u \le 1$ = 0 otherwise

$\mu_{A2}(u) = 1 - |u-1|, if\ 0 \le u \le 2$ = 0 otherwise

If the input to the fuzzy system is [x1*, x2*] = [0.5, 0.5], use singleton fuzzifier to determine the output of the fuzzy system y* in the following case:

i) Minimum inference engine and center average defuzzifier

ii) Product inference engine and center average defuzzifier

5B. Using Genetic algorithm, maximize the function $f(x) = x^2$. $0 \le x \le 3$. Take 1101, 1110, 1000 and 1010 as the initial population.

5C. Find the membership function for the fuzzy composite term, "*more or less small or not medium*", given that the fuzzy sets, $small = \left[\frac{1}{1} + \frac{0.5}{2} + \frac{0.1}{3}\right], medium = \left[\frac{0.2}{1} + \frac{1}{2} + \frac{0.2}{3}\right]$. Use basic fuzzy operations wherever required.

(5+3+2)

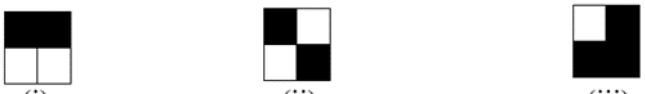
Cost

-1	1
1	-1

Classifier model

150	40
60	250

Fig.Q2C



(i) (ii) (iii)

Q3A