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MMTE-007

M. SC. (MATHEMATICS WITH APPLICATIONS IN COMPUTER SCIENCE)
M. Sc. (MACS)
Term-End Examination
December, 2021

MMTE-007 : SOFT COMPUTING AND ITS APPLICATIONS

Time : 2 Hours *Maximum Marks : 50*

(Weightage 50%)

Note : (*i*) *Question No.* ***7*** *is compulsory.*

(*ii*) *Attempt any* ***four*** *questions from Question Nos.* ***1*** *to* ***6.***

(*iii*) *Use of non-programmable, scientific calculator is allowed.*

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1. (a) Two fuzzy sets A and B are given below :

$$A = \left\{\frac{0.2}{1}, \frac{0.5}{2}, \frac{0.8}{3}\right\}$$

and $$B = \left\{\frac{1}{1}, \frac{0.6}{2}, \frac{0.2}{3}\right\}$$

Determine the fuzzy relation C as a composition between fuzzy sets A and B, by using max-product. 4

(b) Consider the Hopfield network whose weight matrix is given by :

$$W = \frac{1}{3}\begin{bmatrix} 0 & -2 & 2 \\ -2 & 0 & -2 \\ 2 & -2 & 0 \end{bmatrix}$$

Consider two test input vectors :

$$P_1 = [1 \; -1 \; 1] \text{ and } P_2 = [-1 \; 1 \; -1]$$

Check whether the output state vectors satisfy alignment conditions. 4

(c) Write four chromosome sets, which are identified by schema S = (1 0 * 0 *). 2

2. (a) If $\alpha_1 < \alpha_2$, then prove that $A_{\alpha_1} \geq A_{\alpha_2}$, where $\supseteq$ denotes a crisp superset relation. 3

(b) If $4x + 2y = 8$ and $3x + 4y = 12$ for $-2 \leq x \leq 2$ and $-1 \leq y \leq 3$, find the value of x and y at the end of the first iteration using genetic algorithm. 7

3. (a) What is the role of transfer function in neural network ? Briefly discuss the following transfer functions, your discussion should include respective mathematical expressions : 4

(i) Threshold function

(ii) Linear function

(iii) Sigmoid function

(b) Compare and contrast ADALINE network with MADALINE network. Draw the decision boundaries of MADALINE to solve XOR problem. 6

4. (a) Consider the following parent strings :

Parent A	Parent B
1	2
2	3
4	6
9	8
8	5
6	1
7	4
3	7
5	9

Find the offsprings using (i) order crossover and (ii) position crossover. 4

(b) Consider a four-input two-cluster Kohonen neural network with weights [0.1. 0.5 ; 0.7, 0.3; 0.2, 0.9]. The input patterns are

$$I = \begin{bmatrix} 1 & -1 & 1 & 1 \\ 1 & -1 & -1 & -1 \end{bmatrix}.$$ 6

(i) Find the Euclidean distances to each cluster for each input pattern.

(ii) Modify and find the updated weight after the first input pattern. Use a learning rate of 0.6.

5. (a) Let R and S be two fuzzy relations defined as :

$$R = \begin{bmatrix} 0 & 0.2 & 0.8 \\ 0.3 & 0.6 & 1.0 \end{bmatrix} \text{ and } S = \begin{bmatrix} 0.3 & 0.7 & 1.0 \\ 0.5 & 1.0 & 0.6 \\ 1.0 & 0.2 & 0 \end{bmatrix}$$

Compute R o S using max-min composition. 4

(b) A 2-input, 1-output, 2-layer feed-forward neural network has the weights of the hidden layer as [0.3, 0.4; 0.2, 0.8; 0.1, 0.6] and output layer weights are [0.2, 0.5, 0.4]. The bias values are 0.5 and 0.4. Find the output of the neural network for the input I = [0.5 0.2]′, where the activation function is sigmoidal function with parameter 0.2. 6

6. (a) State Schema theorem. Write any *two* applications of Schema theorem. 4

(b) Determine the connectivity matrix for the pattern P as given below : 4

$$P = \begin{bmatrix} 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 \end{bmatrix}$$

(c) Give an example of the network which can solve the XOR problem by constructing the decision boundaries. 2

7. State whether the following statements are true *or* false. Give a short proof or a counter-example in support of your answer : 10

(a) Perceptron can find weights for classification type of problems that are not linearly separable.

(b) Every original pattern of a discrete Hopfield network with a synchronous update provides a global minimum.

(c) The back propagation algorithm is used for both classification and clustering.

(d) Parents with high fitness value, reproduce the offsprings with high fitness value, for any fitness function.

(e) For two fuzzy sets A and B, if $\mu_A(X) = 0.3$ and $\mu_B(X) = 0.9$, then $\mu_{\overline{A} \cup \overline{B}} = 0.6$.