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MMTE-007

M.Sc. (MATHEMATICS WITH APPLICATIONS IN COMPUTER SCIENCE)
M.Sc. (MACS)

00795

Term-End Examination

June, 2014

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 Q. No.* ***1*** *to* ***6.***

(iii) *Use of calculator is* ***not*** *allowed.*

1. (a) In the field of computer networking there is an imprecise relationship between the level of use of a network communication band width and the latency experienced in peer-to-peer communication. Let $\underset{\sim}{X}$ be a fuzzy set of use levels (in terms of the percentage of full bandwidth used) and $\underset{\sim}{Y}$ be a fuzzy set of latencies (in milliseconds) with the following membership function : **6**

$$X = \left\{\frac{0.2}{10} + \frac{0.5}{20} + \frac{0.8}{40} + \frac{1.0}{60} + \frac{0.6}{80} + \frac{0.1}{100}\right\},$$

$$Y = \left\{\frac{0.3}{0.5} + \frac{0.6}{1} + \frac{0.9}{1.5} + \frac{1.0}{4} + \frac{0.6}{8} + \frac{0.3}{20}\right\},$$

(i) Find the Cartesian product represented by the relation $\underset{\sim}{R} = \underset{\sim}{X} \times \underset{\sim}{Y}$.

Now, suppose we have a second fuzzy set of bandwidth usage given by :

$$Z = \left\{ \frac{0.3}{10} + \frac{0.6}{20} + \frac{0.7}{40} + \frac{0.9}{60} + \frac{1}{80} + \frac{0.5}{100} \right\}.$$

(ii) Find $\underset{\sim}{S} = \underset{\sim 1 \times 6}{Z} \; o \; \underset{\sim 6 \times 6}{R}$ using Max-min composition and max-product composition.

(b) Consider the following travelling salesman problem involving 9 cities. **4**

Parent 1 :	B	C	D	E	F	G	H	I	J
Parent 2 :	D	E	F	B	C	J	I	H	G

Determine the children solution using :

(i) Order crossover #1, assuming 3rd and 7th as the crossover sites.

(ii) Order crossover #2, assuming 3rd, 5th and 7th as the crossover sites.

2. (a) Consider the following modification of the cost function defined in the following equation : **4**

$$J(\mu_j) = \sum_{j=1}^{K} \sum_{i=1}^{N} W_{ij} \|x_i - \mu_j\|^2$$

In this function, the weighting factor W_{ij} is defined as follows :

$$W_{ij} = \begin{cases} 1 \text{ if the data point } x_i \text{ lies inside cluster } J \\ 0 \text{ otherwise} \end{cases}$$

Show that the minimizing solution of this cost function is

$$\hat{\mu}_j = \frac{\sum_{i=1}^{N} W_{ij} x_i}{\sum_{i=1}^{N} W_{ij}}, \; j = 1, 2, \ldots K$$

How do you interpret the expressions in the numerator and denominator of this formula ?

(b) Improve the solution of the following problem : **6**

Max. $f(x) = x^2$

subject to $0 \leq x \leq 15$, by considering the length of the string as 4. Show only one iteraction for a population of size 4.

3. (a) Two fuzzy sets P and Q are defined on x as follows : **4**

$\mu(x_i)$	x_1	x_2	x_3	x_4	x_5
P	0.1	0.2	0.7	0.5	0.4
Q	0.9	0.6	0.3	0.2	0.8

Find the following λ cut sets

(i) $(\overline{P})_{0.2}$ and $(\overline{Q})_{0.3}$

(ii) $(Q \cup \overline{P})_{0.8}$

(iii) $(P \cap Q)_{0.4}$

(b) Compute the weight matrix for a 4-neuron Hopfield net with the single fundamental memory $\xi 1 = [1, -1, -1, 1]$ stored in it. 3

(c) Describe the relationship between the Self-Organising Map algorithm, and the Learning Vector Quantisation algorithm. 3

4. (a) The input to a single input neuron is 4.0, its weight is 2.3 and its bias is -6. 4

(i) What is the net input to the transfer function ?

(ii) What is the neuron output for the following transfer functions :

(A) Hard limit,

(B) Linear

(C) Log-sigmoid ?

(b) Consider a Hopfield network whose weight matrix is given by : 6

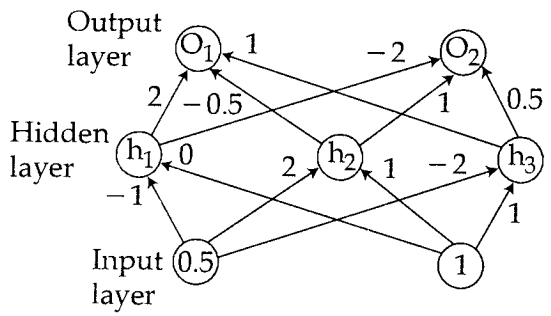
$$W = \frac{1}{3}\begin{pmatrix} 0 & -2 & 2 \\ -2 & 0 & -2 \\ 2 & -2 & 0 \end{pmatrix}$$

Run the Hopfield network for the test input vectors $pt_1 = (1 \quad 1 \quad -1)$ and $pt_2 = (-1 \quad -1 \quad 1)$.

5. (a) The following is a network of linear neurons, that is, neurons whose output is identical to their net input, $o_i = net_i$. 6

(i) Compute the output of the hidden-layer and the output-layer neurons for the given inputs (0.5, 1) and enter those values into the corresponding circles.

(ii) What is the output of the network for the input (1, 2), i.e. the left input neuron having the value 1 and the right one having the value 2 ? Do you have to do all the network computations once again in order to answer this question ? Explain.



(b) List all the schemas of the chromosome "101" and find their corresponding orders and lengths. **4**

6. (a) If the input vectors are $I_1 = [1 \ -1]^T$, $I_2 = [1 \ 1]^T$ and $I_3 = [-1 \ 1]^T$, use the Kohonen learning with $\alpha = 0.5$ and train for one pass through the input vector. Assume an initial weight matrix. **6**

$$W = \begin{pmatrix} 0 & -1 \\ \frac{-2}{\sqrt{5}} & \frac{-1}{\sqrt{5}} \\ \frac{-1}{\sqrt{5}} & \frac{2}{\sqrt{5}} \end{pmatrix}$$

(b) Show that XOR can be solved using multilayer perceptron. **4**

7. Which of the following statements are true or false ? Give reasons for your answer. **10**

(a) The Fuzzy relation

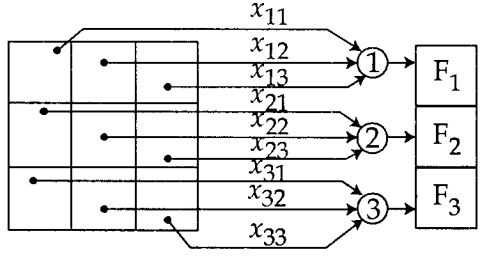
$$R = \begin{bmatrix} 1 & 0.6 & 0 & 0.2 & 0.3 \\ 0.6 & 1 & 0.4 & 0 & 0.8 \\ 0 & 0.4 & 1 & 0 & 0 \\ 0.2 & 0 & 0 & 1 & 0.5 \\ 0.3 & 0.8 & 0 & 0.5 & 1 \end{bmatrix}$$ is

always reflexive, symmetric and transitive.

(b) For a genetic algorithm to be used to evolve a binary string of length n containing only 1s, the offspring of parents with a high fitness value have a high fitness value.

(c) Hopfield networks are most often used for auto-association.

(d) The network shown in the figure below is a single layer feed-forward neural network as well as an auto - associative neural network.



where F_1, F_2 and F_3 are neurons of output layer.

(e) If a 3-input neuron is trained to output a zero when the input is 110 and a one when the input is 111, then after generalization, the output will be zero for the following inputs : 000, 010, 110, 100.