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MMTE-007

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

Term-End Examination

June, 2012

MMTE-007 : SOFT COMPUTING AND ITS APPLICATIONS

Time : 2 hours *Maximum Marks : 50*

Note : *Attempt **any four** questions from Q. No. **1** to Q. No. **6**. Q. No. 7 is **compulsory**.*

1. Suppose a genetic algorithm uses chromosomes of the form $x = a\ b\ c\ d\ e\ f\ g\ h$ with a fixed length of eight genes. Each gene can be of any digit between 0 and 9. Let the fitness of individual x be calculated as $f(x) = (a+b)-(c+d)+(e+f)-(g+h)$ and let the initial population consist of four individual with the following chromosomes : **10**

$$x_1 = 6\ 5\ 4\ 1\ 3\ 5\ 3\ 2$$

$$x_2 = 8\ 7\ 1\ 2\ 6\ 6\ 0\ 1$$

$$x_3 = 2\ 3\ 9\ 2\ 1\ 2\ 8\ 5$$

$$x_4 = 4\ 1\ 8\ 5\ 2\ 0\ 9\ 4$$

(a) Evaluate the fitness of each individual, showing all your workings, and arrange them in order with the fittest first and the least fit last.

(b) Perform the following cross over operations :

(i) Cross the fittest two individuals using one point crossover at the middle point.

(ii) Cross the second and third fittest individuals using a two point crossover (points b and f).

(iii) Cross the first and third fittest individuals (ranked 1^{st} and 3^{rd}) using a uniform crossover.

(c) Suppose the new population consists of six offspring individuals received by the crossover operations in (i) above. Evaluate the fitness of the new population. Check whether the overall fitness improved.

(d) Find the chromosomes representing the optimal solution. Find the value of this fitness.

(e) By looking at the initial population of the algorithm check whether it will be able to reach the optimal solution without the mutation operator.

2. (a) The input vectors are $I_1 = [-1\ 0]^t$, $I_2 = [0\ 1]^t$ and $I_3 = \left[\sqrt{2}\ \ 1/\sqrt{2}\right]^t$ and initial values of three weight vectors are $[0\ -1]^t$, $\left[-2/\sqrt{5}, \frac{1}{\sqrt{5}}\right]^t$, $\left[-\frac{1}{\sqrt{5}}, \frac{2}{\sqrt{5}}\right]^t$, calculate the resulting weights found after training the competitive layer with Kohonen's rule and a learning rate α of 0.5 on the input - series in order I_1, I_2 and I_3. 6

(b) What are the important operators involved in genetic algorithm ? Discuss various schemes for selecting chromosomes from a pool of chromosomes. 4

3. (a) Consider the following training data set : 5

	Inputs		Output
	I_1	I_2	
1	0.4	-0.7	0.1

In a given Multilayer perception with two nodes at a hidden layer and weights between input layer and hidden layer given by $\begin{bmatrix} 0.1 & 0.4 \\ -0.2 & 0.2 \end{bmatrix}$ and weights between hidden and output node given by $\begin{bmatrix} 0.2 \\ -0.4 \end{bmatrix}$.

(i) Find the output at each node of MLP.

(ii) Find the updated weights after one iteration.

(b) Using max-min composition, find relation between R and S 5

$$R = \begin{array}{c} \\ x_1 \\ x_2 \\ x_3 \end{array} \begin{array}{c} \begin{array}{ccc} y_1 & y_2 & y_3 \end{array} \\ \begin{bmatrix} 1 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix} \end{array} \quad \text{and} \quad S = \begin{array}{c} \\ y_1 \\ y_2 \\ y_3 \end{array} \begin{array}{c} \begin{array}{cc} z_1 & z_2 \end{array} \\ \begin{bmatrix} 0 & 1 \\ 1 & 0 \\ 1 & 1 \end{bmatrix} \end{array}.$$

4. (a) Let X be the universe of commercial aircraft of interest. 6

$X = \{ a_{10}, b_{52}, b_{117}, c_5, c_{130}, f_4, f_{14}, f_{15}, f_{16}, f_{111}, kc_{130} \}$. Let A be the fuzzy set for passenger class aircraft

$$A = \left\{ \frac{0.3}{f_{16}} + \frac{0.5}{f_4} + \frac{0.4}{a_{10}} + \frac{0.6}{f_{14}} + \frac{0.7}{f_{111}} + \frac{1.0}{b_{117}} + \frac{1.0}{b_{52}} \right\}.$$

Let B be the fuzzy set of cargo

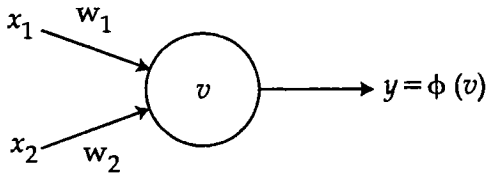
$$B = \left\{ \frac{0.4}{b_{117}} + \frac{0.4}{f_{111}} + \frac{0.6}{f_4} + \frac{0.8}{f_{15}} + \frac{0.9}{f_{14}} + \frac{1.0}{f_{16}} \right\}.$$

Find the values of the following operations.

$A \cup B$, $A \cap B$, A^c, B^c, $A - B$ and $B - A$.

(b) Draw the architecture of a multilayer perception (MLP) and explain its operations. Mention its advantages and disadvantages. 4

5. (a) The AND function can be implemented by a single unit with two nodes. 6



If the weights are $w_1 = w_2 = 1$ and the activation function is $\phi(v) = \begin{cases} 1 \text{ ; if } v \geq 2 \\ 0 \text{ ; otherwise} \end{cases}$.

(i) Test, how the neural AND function works.

(ii) Suggest how to change either the weights or the threshold level of this single unit in order to implement the logical OR function. Initial weights are given by $w_1 = w_2 = 2$.

(iii) Check whether OR function can be implemented using a single unit.

(b) What is an epoch and a training set and how it is used to train neural networks ? 4

6. (a) Suppose we want to compare two sensors based upon their detection levels and gain settings. The following table of gain settings and sensor detection levels with a standard item being monitored provides typical membership values to represent the detection levels for each of the sensors. 6

Gain setting	Sensor 1 detection levels	Sensor 2 detection levels
0	0	0
20	0.5	0.35
40	0.65	0.5
60	0.85	0.75
80	1	0.90
100	1	1

The universe of discourse is $x = \{0, 20, 40, 60, 80, 100\}$. Find the membership function for the two sensors.

Also, find the following membership functions using standard set operations.

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

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

(iii) $\mu_{S_1 C}(x)$

(iv) $\mu_{S_2 C}(x)$

(v) $\mu_{S_1 C \cup S_2 C}(x)$

(vi) $\mu_{(S_1 \cup S_2)^C}(x)$

(b) Find the length and order of the following schema. 4

(i) $S_1 = (1 * * 0 0 * 1 * *)$

(ii) $S_2 = (* 0 0 * 1 * *)$

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

(a) A fuzzy membership can take true and false values simultaneously.

(b) Mutation defines how chromosomes of parents are mixed to obtain genetic codes of their off-springs.

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

(d) A non-linear separable data can be classified by a single perception.

(e) 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 an equivalence relation.