School of Information Technology
IIT Kharagpur

Course Id: IT60108 Soft Computing Applications **End Sem Exam**
Date: April 25, 2007 **Total Time: 3 Hours**
Max. Marks: 100

Instructions: Answer any five questions. You may answer the questions in any order. However, all parts of the same question must be answered together. Clearly state any reasonable assumption you make.

1. Consider Fuzzy C-means clustering of the following one-dimensional points: 3, 4, 9 and 10, with no. of clusters = 2. Let the initial pseudo-partition be:
   A1 = 0.8/3 + 0.6/4 + 0.2/9 + 0.1/10
   A2 = 0.2/3 + 0.4/4 + 0.8/9 + 0.9/10
   Let m = 1.2
   (a) Determine the initial cluster centers
   (b) Determine the pseudo-partitions in the next iteration. **[8+12=20]**

2. Consider a multilayer perceptron (MLP) having 2 units in the input layer, 2 units in the hidden layer and one unit in the output layer. We want to train this MLP with the truth table of an XOR gate. Let us denote the units in the input layer by the subscript **k**, those in the hidden layer by the subscript **j** and that in the output layer by the subscript **i**. Consider that the input layer to hidden layer weights are initially set as follows: w_{11}=1, w_{12}=2, w_{21}=1 and w_{22}=1. Hidden layer to the output layer wights are initially set as follows w_{11}=1 and w_{21}=2. Consider that the transfer functions for the hidden layer units as well as the output layer units are as follows:

   $$\text{Output} = \frac{1}{1+e^{-Input}}$$

   Assume that the input layer units transfer their inputs without any change.

   (a) Determine the new weights after an input pattern (1 0) is given as the training data. The expected output is 1.
   (b) Consider that the transfer function for the hidden layer units is changed as follows, with the transfer function for the output layer remaining unchanged:

   $$\text{Output} = \frac{1-e^{-Input}}{1+e^{-Input}}$$

   Derive an expression for the input layer to hidden layer weight increments Δw_{kj}'s in terms of the MLP inputs, hidden layer outputs, desired outputs and weights.

   [12+8=20]

3. Consider an optimization problem in which the objective is to use GA to minimize the function
   $(x_1\text{-}1.5)^2 + (x_2\text{-}4)^2$ subject to
   $2x_1 – x_2 –1 >= 0$
   $0 <= x_1, x_2 <= 4$
   Let us assume that the string length for each variable is 4 and the population size in each generation is 6. Crossover probability = 0.3

   (a) Create an initial generation.
   (b) Create the second generation using deterministic sampling.
   (c) Create the third generation from the second generation using remainder stochastic sampling with replacement.

   For (a) – (c), use the random numbers at the end of the question paper if required. **[6+7+7=20]**

4. An optimization problem is to minimize the following function using SA:

   $f(x1, x2) = (x1^2 + x2 –1)^2 + (x1 + x2^2 - 7)^2$

   Range of both x1 and x2 is [0, 5]. Initial point is (2.5, 2.5) and initial temperature = 50. No. of iteration steps for each temperature = 2. Decrement temperature by a factor of 0.5. The neighboring points are to be chosen using a normal distribution of mean 0 and sigma = 0.833. Choose the numbers with normal distribution in the following sequence: 0.037, -0.086, -0.426, -1.810, 0.397, -0.312, 0.59, 0.21, -0.9, -0.3, 0.55, 0.45, -0.32, -0.98, 0.46, 0.12, -0.28, 0.97, -0.24, -.091, 0.28, -0.54, -0.21. If you need more numbers, keep repeating from the start of the list.

   Show the result of optimization if we stop after T =25. **[20]**

5. Consider an optimization problem with the following two objective functions for minimization:
   $f_1(x) = x^2$
   $f_2(x) = (x – 2)^2$

   in the interval $–3 <= x <= 3$

   Explain how you can solve it using

   (a) VEGA
   (b) MOGA

   You need to choose sample chromosomes of your own and show the results at least till the end of the second generation. Length of the chromosomes should be 4. **[10+10=20]**

6. Explain the following using one example each: **[5×4=20]**
   (a) Stochastic sampling without replacement as GA selection operator
   (b) Remainder stochastic sampling without replacement as GA selection operator
   (c) Mamdani Fuzzy Model
   (d) Competitive Learning Network

Use these Random Nos. for answering questions. If you need more, restart from Srl. No. 1.

Srl No.	Random No.	Srl No.	Random No.	Srl No.	Random No.	Srl No.	Random No.
1	0.2	16	0.4	31	0.9	46	0.2
2	0.4	17	0.8	32	0.1	47	0.3
3	0.7	18	0.8	33	0.2	48	0.2
4	0.2	19	0.6	34	0.2	49	0.7
5	0.1	20	0.5	35	0.3	50	0.8
6	0.3	21	0.1	36	0.7	51	0.5
7	0.8	22	0.9	37	0.8	52	0.5
8	0.9	23	0.2	38	0.7	53	0.6
9	0.1	24	0.3	39	0.5	54	0.7
10	0.2	25	0.4	40	0.4	55	0.3
11	0.5	26	0.5	41	0.5	56	0.4
12	0.7	27	0.4	42	0.3	57	0.8
13	0.8	28	0.6	43	0.8	58	0.4
14	0.9	29	0.7	44	0.2	59	0.5
15	0.4	30	0.2	45	0.1	60	0.6