School of Information Technology
IIT Kharagpur

Course Id: IT60108 Soft Computing Applications   **Mid Sem Exam**

Date: February 25, 2009   **Total Time: 2 Hours**

Max. Marks: 75

Instructions: Answer all 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 a fuzzy set A defined by the trapezoidal membership function trapezoid(x; 20, 30, 60, 90).

   Determine de-fuzzification results using (a) Centroid of Area (b) Bisector of Area

   [5+5=10]

2. (a) Consider a Sugeno Fuzzy Model for inferencing with the following rules:

   i.   If x is Small and y is Small then $z = x + y - 1$

   ii.   If x is Small and y is Large then $z = y - 3$

   iii.   If x is Large and y is Small then $z = x + 3$

   iv.   If x is Large and y is Large then $z = x - y + 2$

   The antecedent fuzzy set memberships are defined as **Small X** = sig(x; -4, 1); **Large X** = sig(x; 3, 2);

   Small Y = sig(y; -4, 2) and **Large Y** = sig(y; 4, 1). What would be the Sugeno Model output for crisp

   inputs $x = 0.1$ and $y = 1.0$?   **[10]**

   (b) Justify truth or falsity of the following statement   **[5]**

   A zero-order Sugeno Fuzzy Model is a special case of the Tsukamoto fuzzy model

3. Consider a fuzzy information retrieval system with the relation R to denote relevance of documents (y1-y10) to keywords (x1-x6) and the relation T to denote a fuzzy thesaurus.

R	y1	y2	y3	y4	y5	y6	y7	y8	y9	y10
x1	.2	0	1	0	0	0	1	0	0	0
x2	1	0	0	.3	0	.4	0	0	1	0
x3	0	0	.8	0	.4	0	1	0	0	0
x4	0	1	0	0	0	0	0	.9	.7	.5
x5	1	0	.5	0	0	.6	0	0	0	0
x6	0	1	0	0	.2	0	1	0	0	.5

T	x1	x2	x3	x4	x5	x6
x1	1	.2	1	1	.5	1
x2	.2	1	.4	.7	.9	0
x3	1	.4	1	.9	.3	1
x4	1	.7	.9	1	0	0
x5	.5	.9	.3	0	1	.2
x6	1	0	1	0	.2	1

Let a fuzzy query Q consists of the keywords x1, x2 and x4 with membership values in fuzzy set **important** as 0.8, 0.4 and 0.7, respectively.

Determine the α-cut of the fuzzy set "**Documents relevant to the Query Q**" for $\alpha = 0.75$?   **[10]**

4. Consider Fuzzy C-means clustering of the following one-dimensional points: 4, 6, 10 and 11, with no. of clusters = 2. Let m = 2.0 and let the initial pseudo-partitions be:

A1 = 0.9/4 + 1.0/6 + 0.2/10 + 0.1/11

A2 = 0.1/4 + 0.0/6 + 0.8/10 + 0.9/11

    (a) Determine the initial cluster centers.

    (b) Determine the pseudo-partitions in the next iteration. What are the α-cuts of the fuzzy sets for α = 0.7 after the pseudo-partitions have been updated?

    (c) Define a suitable measure for quality of clustering and determine its value after the pseudo-partitions have been updated. **[4+[10+2]+4=20]**

5. Consider minimization of the objective function $f(x) = (x-2)^2$ for real values of x between 0 to 8. Consider population size to be 4 chromosomes and length of each chromosome to be 6.

    (a) Form the initial population

    (b) Show the new set of chromosomes obtained by using (you simply show the results of the selection process. No need to consider the effects of crossover and mutation)

        (i) deterministic selection (ii) stochastic sampling with replacement

    (c) If you ran the GA for sufficiently long time achieving the global optimum, what solution would you expect to get? **[3+[5+7]+5=20]**

Note: For (b), you need to show only one next generation. First, by starting from the initial population using (i); then once again starting from the initial population, but this time using (ii)

Use the following random nos. for answering your questions. Whenever you are using a random no., mention the corresponding Srl No. for ease of tracking the steps. If you need more random nos., restart from Srl. No. 1.

Srl No.	Random No.	Srl No.	Random No.	Srl No.	Random No.	Srl No.	Random No.
1	0.1	16	0.2	31	0.65	46	0.98
2	0.2	17	0.7	32	0.43	47	0.05
3	0.05	18	0.8	33	0.29	48	0.35
4	0.4	19	0.2	34	0.39	49	0.4
5	0.9	20	0.3	35	0.56	50	0.9
6	0.7	21	0.97	36	0.73	51	0.7
7	0.65	22	0.56	37	0.25	52	0.65
8	0.51	23	0.1	38	0.82	53	0.51
9	0.7	24	0.98	39	0.21	54	0.39
10	0.8	25	0.05	40	0.19	55	0.56
11	0.95	26	0.35	41	0.02	56	0.73
12	0.32	27	0.57	42	0.43	57	0.25
13	0.01	28	0.62	43	0.28	58	0.21
14	0.09	29	0.51	44	0.76	59	0.18
15	0.7	30	0.76	45	0.34	60	0.92