School of Information Technology
Indian Institute of Technology Kharagpur
IT60108: Soft Computing Applications
Class Test - I

F.M. 20 | Session 2014 – 2015 | Time: 20 mins

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1. **Read the following statements carefully and mark them as true (T) or false (F).**

   (a) A fuzzy set is a crisp set but the reverse is not true. (F)
   Hint: A crisp set is a fuzzy set but the reverse is not true

   (b) If A, B and C are three fuzzy sets defined over the same universe of discourse say X, such that $A \subseteq B$ and $B \subseteq C$, then $A \subseteq C$. (T) Hint: Satisfies transitive property

   (c) If A'_α denotes the strong $\alpha-$cut of a fuzzy set A, then $Support(A)=A'_0$. (T)
   Hint: $A_0 = \{x \mid \mu(x) > 0 \; \forall x \in A\}$ = support(A).

   (d) Given a fuzzy set A, $|Core(A)| = |A^*|$, where A^* is the crisp version of fuzzy set A and $|X|$ denotes the cardinality of the set X. (T)
   Hint: $A^* = \{x \mid \mu(x) = 1, \forall x \in A\}$ = Core(A), Hence, the result

   (e) The truth values of an n-values logic are

   $$\frac{0}{n-1}, \frac{1}{n-1}, \frac{2}{n-1}, \cdots, \frac{n-2}{n-1}, \frac{n-1}{n-1}$$ (T)

   (f) If x *is* A then y *is* B and given that y *is* C. If so, we can conclude x *is* D. (F)
   Hint: It is true of y is B'. Then $D = B' \circ R(x,y)$, where $R: A \Rightarrow B$

   (g) If $A = \{(x_1, 0.8), (x_2, 0.6), (x_3, 0.4)\,(x_4, 0.2)\}$, $B = \{(y_1, 0.8), (y_2, 0.6), (y_3, 0.4)\,(y_4, 0.2)\}$
   A relation $R = A * B$ where $*$ denotes a T-norm operator, and is given below.

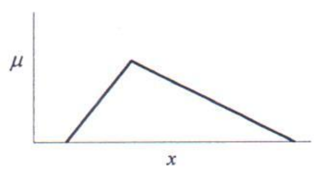
   $$\begin{array}{c c} & \begin{array}{cccc} y_1 & y_2 & y_3 & y_4 \end{array} \\ \begin{array}{c} x_1 \\ x_2 \\ x_3 \\ x_4 \end{array} & \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \end{array}$$

   Hint: It is drastic product

   Here, the T-norm operator $*$ is bounded product. (F)

   (h) If A'_α and $\bar{A}$ denotes $\alpha-$cut and complement of a fuzzy set A, then $\bar{A}_\alpha = A_\alpha$ (F)
   Hint: $\bar{A}_\alpha \neq A_\alpha$

   (i) A fuzzy set is plotted in the graph as shown below.

   Hint: CoS and CoG give the same result for symmetric geometric objects only.

   The crisp value according to both CoS and CoG will be the same. (F)

   (j) If P and Q are two fuzzy propositions with $T(P)$ and $T(Q)$ are their truth values, then the truth value of the fuzzy proposition $P \Rightarrow Q$ is $min(T(P), T(Q))$. (F)

   Hint: $P \Rightarrow Q \equiv min\{1 - T(P), T(Q)\}$

2. **With reference to each question, one or more option(s) is/are correct. Choose the correct option(s) only.**

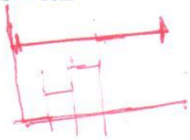
(a) Which of the following cannot be stated using fuzzy logic?

i. Color of an apple
ii. Height of a person
iii. Date of birth of a student Hint: This is certain for a person
iv. Speed of a car

$0 \le x \le 1$

(b) A membership function $\mu(x)$ is defined as $\mu(x) = \lceil x \rceil$. The membership function is with

i. discrete values over a discrete domain of universe of discourse
ii. discrete values of a continuous domain of universe of discourse Hint:
iii. Continuous values of a discrete domain of universe of discourse
iv. Continuous values of a continuous domain of universe of discourse



(c) If A and B are two fuzzy sets and $x \in A$, $y \in B$. Let $C = A \oplus B$. Then

i. $\mu_c(x,y) = min\{\mu_A(x), \mu_B(y)\}$
ii. $\mu_c(x,y) = min\{1, \mu_A(x) + \mu_B(y)\}$
iii. $\mu_c(x,y) = max\{0, \mu_A(x) + \mu_B(y) - 1\}$
iv. $\mu_c(x,y) = max\{\mu_A(x), \mu_B(y)\}$

Hint: $A \oplus B$, $\oplus$ is the bounded sum operator

(d) A fuzzy set may have

i. at least one crossover point
ii. at most two crossover points
iii. an infinite number of crossover points
iv. Only one crossover point

Hint: All other options are incorrect

(e) The truth value of
R: "If *mango is sweet* then *cost is high*" given P: mango is sweet with $\mu(P) = 0.3$ and Q: cost is high with $\mu(Q) = 0.7$. Then

i. $\mu(R) = 0.3$
ii. $\mu(R) = 0.5$
iii. $\mu(R) = 0.7$
iv. $\mu(R) = 0.0$

Hint: $P \Rightarrow Q$

$$\mu_R = \min\{1 - T(P), T(Q)\} = \min(0.7, 0.7) = 0.7$$

(f) A fuzzy set A is given as follow.

$A = (10, 0.1), (15, 0.2), \underline{(20, 0.4), (25, 0.4), (30, 0.4)}, (35, 0.3), (40, 0.2), (45, 0.1)$

The crisp value of A according to *Mean of Maxima* (MoM) method is

i. 27.5
ii. 25
iii. 20
iv. 30

$$x^* = \frac{a+b}{2} = \frac{20+30}{2} = 25$$

(g) If x *is* A then y *is* B else y *is* C. The output of the above fuzzy rule is

i. a fuzzy set

ii. a crisp set

iii. a fuzzy relation

iv. a membership function

$R = (A \times B) \cup (\bar{A} \times C)$, so, it is a relation

(h) Takugi-Sugeno approach to FLC design is computationally more expensive comapred to Mamdani approach because

i. Mamdani approach considers a less number of rules in fuzzy rule base

ii. Searching a rule in Mamdani approach is simple and hence less time consuming

iii. Takagi-Sugeno approach consider a large number of rules in fuzzy rule base

iv. Computation of each rule in Takagi-Sugeno approach is more time consuming

(i) An equivalence between *Fuzzy* vs. *Probability* to that of *Prediction* vs. *Forecasting* is

i. Fuzzy $\approx$ *Prediction*

ii. Fuzzy $\approx$ *Forecasting*

iii. Probability $\approx$ *Prediction*

iv. Probability $\approx$ *Forecasting*

(j) One difference between Mamdani approach and Takagi-Sugeno appraoch to FLC design is that

i. Mamdani approach needs defuzzification module whereas Takagi-Sugeno approach does not

ii. Mamdani appraoch is easy to interpret but less accurate

iii. Takagi-Sugeno approach is less interpretable but more accurate

iv. Takagi-Sugeno approach does not require any fuzzification module whereas Mamdani approach needs.