School of Information Technology
Indian Institute of Technology, Kharagpur

IT 60108: Soft Computing Applications
Mid-Semester Examination
Spring, 2015-2016

Maximum Marks: 80 Time: 2 hours

Instructions:

1. Attempt **ALL** questions. There is **NO** negative marking.

2. The question paper consists of three pages and a total of **six** questions with some questions having sub-parts.

3. Marks allotted for each question have been clearly mentioned, students are advised to give brief, precise and to-the point answers to all questions, strictly keeping the marks allotted in consideration.

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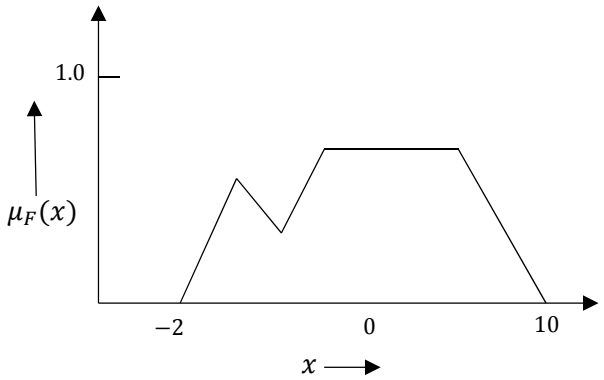
1. Which of the following is/ are fuzzy set(s). Justify your answer **[4 x 2=8]**

   (a) $A = \{(x_1, 0), (x_2, 0), (x_3, 0), (x_4, 0)\}$ defined over a universe of discourse $X = \{x_1, x_2, x_3, x_4, x_5, x_6\}$

   (b) $B = \left\{(x, \mu_B(x)) \middle| x \in Z, set\ of\ all\ integers\ and\ \mu_B(x) = \frac{1-x}{1+x}\right\}$

   (c) $C = D \times E$ where D and E are two fuzzy sets and $\times$ denotes the Cartesian product of two fuzzy sets.

   (d)



2. Find the results of the fuzzy operations as instructed in the following: **[2 x 4=8]**

   (a) $R = A \times B$ where

   $$A = \left\{\frac{0.1}{x_1}, \frac{0.2}{x_3}, \frac{0.5}{x_5}\right\}$$

   $$B = \left\{\frac{0.6}{x_2}, \frac{0.8}{x_3}, \frac{1.0}{x_6}\right\}$$

   (b) λ cut of the implication, $If\ x\ is\ A\ then\ y\ is\ B$, where

   $A = \{(x_1, 0.1), (x_2, 0.3), (x_3, 0.2)\}$

   $B = \{(x_1, 0.2), (x_2, 0.3), (x_3, 0.1)\}$

   and both are defined over $X = \{x_1, x_2, x_3, x_4\}$ and $\lambda = 0.7$

3. Any road is characterized with two fuzzy linguistics WIDE and NARROW whereas a journey is characterized with two fuzzy linguistics HIGH RISK and LOW RISK. The universe of discourses of road and journey are $\{Large, Medium, Small\}$ and $\{High, Moderate, Low\}$, respectively.
   A road and journey are associated with the following fuzzy implication:

   $$If\ road\ is\ WIDE\ then\ driving\ is\ RISKY.$$

   For the MG Road, it is given that

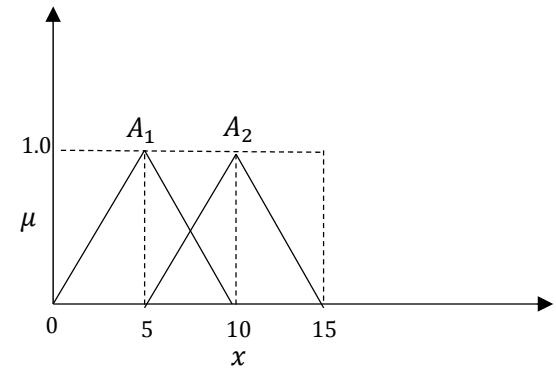
   $$Road\ is\ WIDE = \left\{\frac{0.3}{Large}, \frac{0.5}{Medium}, \frac{0.7}{Small}\right\}$$

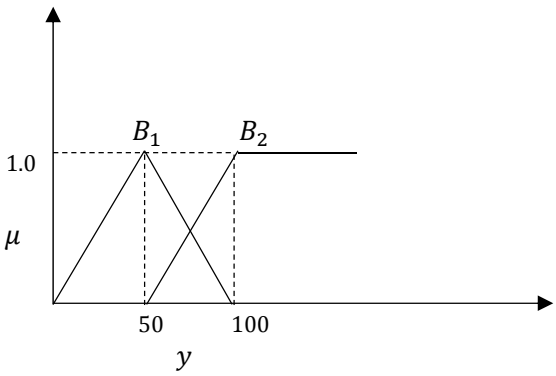
   $$driving\ is\ RISKY = \left\{\frac{0.9}{High}, \frac{0.7}{Moderate}, \frac{0.6}{Low}\right\}$$

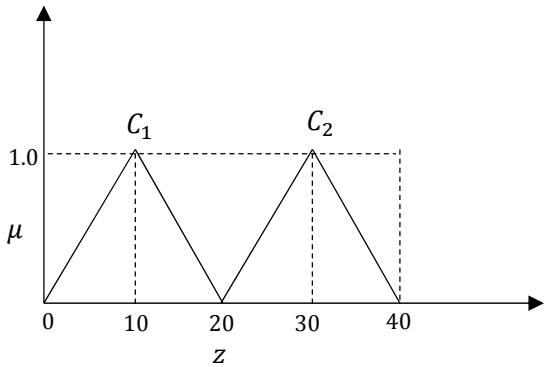
   $$Driving\ on\ M.G.\ road\ is\ RISKY = \left\{\frac{0.7}{High}, \frac{0.6}{Moderate}, \frac{0.5}{Low}\right\}$$

   What is the fuzzy set that, M . $G.\ road\ is\ NARROW$? **[10]**

4. In a fuzzy controller for two input $x = 6$ and $y = 25$, two fuzzy rules are fired as below:
   R_i: $IF\ x\ is\ A_1\ AND\ y\ is\ B_1\ THEN\ z\ is\ C_1$
   R_j: $IF\ x\ is\ A_2\ AND\ y\ is\ B_2\ THEN\ z\ is\ C_2$
   The fuzzy sets involved in R_i and R_j are known as given below:







(a) Graphically show the combined output due to R_i and R_j for $x = 6$ and $y = 25$.

(b) Apply COS (Center of Sum) defuzzification method to obtain the crisp value of the output when $x = 6$ and $y = 25$. **[2 x 7=14]**

5. Write brief answers to the following questions: **[4 x 4=16]**

(a) Draw an ANN with the minimum number of perceptron which would classify input pattern $00, 01, 10$ and 11 into two classes 0 and 1 following OR-logic.

(b) The $Tanh - sigmoid$ transfer function $\emptyset$ is defined as follows:

$$\emptyset(I) = \frac{e^{\theta i} - e^{-\theta i}}{e^{\theta i} + e^{-\theta i}}$$

where symbols bear usual meaning.

Prove that $\frac{\partial \emptyset}{\partial I} = \theta(1 + \emptyset(I))(1 - \emptyset(I))$

(c) State the Delta rule, which is usually followed in Back propagation algorithm. Is the rule applicable to any type of ANN?

(d) Draw a symbolic diagram (also called bubble diagarm) of a perceptron and clearly show the different unknown parameters in it.

6. Answer the following: **[8 x 3=24]**

(a) Draw a MLFFNN having $l - m - n$ configuration. Clearly show its network parameters.

(b) Suppose, $T =< T_o, T_I >$ is a training data for the supervised learning of a $l - m - n$ network. If $I_i \in T_I$ is the i^{th} input applied to the network, then express the error at the k^{th} perceptron in the output layer. Also, obtain the expression for total error *E* due to all $I_i \in T_I$.

(c) If w_{ij} and v_{jk} denote the weight of the link from an i^{th}neuron in the input layer to the j^{th} neuron in the hidden layer and from the j^{th} neuron in the hidden layer to the k^{th} neuron in the output layer, and e_K denotes the error of the k^{th} neuron in the output layer, then write down the chain rule of differentiation to calculate the following:

$$\frac{\partial e_K}{\partial w_{ij}} \text{ and } \frac{\partial e_K}{\partial v_{ij}} \ .$$

Clearly mention all the symbols used in the rule you have stated.