



Uva Wellassa University of Sri Lanka
Faculty of Science & Technology
Department of Computer Science & Technology
CST Degree Programme
Year IV Semester I
End Semester Examination – February/March 2012



CST453-2 Fuzzy Logic and Fuzzy Controllers

Instructions

Answer all questions. Each question carries equal mark.

No. of questions: Four (04)

No. of pages: Three (03)

Time: Two hours (2 hr)

Total marks allocated: 40%

Index No:

1. For each of the following defuzzification methods

- (i) Max membership principle
- (ii) Centroid method
- (iii) Weighted average method
- (iv) Mean max membership

give an example of a fuzzy set for which the method fails to work or yields an inadequate result.

2. For fuzzy sets A and B , prove the following properties of λ -cut sets:

- (i) $(A \cup B)_\lambda = A_\lambda \cup B_\lambda$
- (ii) $(A \cap B)_\lambda = A_\lambda \cap B_\lambda$
- (iii) $(U \setminus A)_\lambda \neq U \setminus (A_\lambda)$, except for $\lambda = 0.5$. U is the universal set.
- (iv) If $\lambda \leq \alpha$ where $0 \leq \alpha \leq 1$ then $A_\alpha \subseteq A_\lambda$

3. Given the fuzzy sets:

$$\text{Tall}(X) = \left\{ \begin{array}{l} 0 \text{ if } X < 1.6\text{m} \\ (X - 1.6\text{m}) / 0.2, \text{ if } 1.6\text{m} \leq X < 1.8\text{m} \\ 1, \text{ if } X \geq 1.8\text{m} \end{array} \right\}$$

$$\text{Short}(X) = \left\{ \begin{array}{l} 1 \text{ if } X < 1.6\text{m} \\ (1.8\text{m} - X) / 0.2, \text{ if } 1.6\text{m} \leq X < 1.8\text{m} \end{array} \right\}$$

0, if $X \geq 1.8\text{m}$ }

- (i) Sketch the graphs of Tall(X) and Short(X).
- (ii) Calculate the Union of the fuzzy sets Tall(X) and Short(X).
- (iii) Calculate the Intersection of the fuzzy sets Tall(X) and Short(X).
- (iv) Show that the complement of Tall(X) is Short(X).
- (v) Given additional fuzzy sets:

$$\text{Strong}(Y) = \left\{ \begin{array}{l} 0 \text{ if } Y < 30\text{kg} \\ (Y - 30\text{kg}) / 20, \text{ if } 30\text{kg} \leq Y < 50\text{kg} \\ 1, \text{ if } Y \geq 50\text{kg} \end{array} \right\}$$

$$\text{Weak}(Y) = \left\{ \begin{array}{l} 1 \text{ if } Y < 30\text{kg} \\ (50\text{kg} - Y) / 20, \text{ if } 30\text{kg} \leq Y < 50\text{kg} \\ 0, \text{ if } Y \geq 50\text{kg} \end{array} \right\}$$

and the fuzzy rules:

If Tall(X) OR Strong(Y) then Heavy(Z)
If Short(X) AND Weak(Y) then Light(Z)

Calculate the membership values of Heavy(Z) and Light(Z) where

- (i) $X = 1.65\text{m}$, $Y = 30\text{kg}$
- (ii) $X = 1.70\text{m}$, $Y = 45\text{kg}$

4. You are designing a fuzzy controller for an "intelligent" air-conditioner. You need to maintain a temperature that feels comfortable. The problem is that the actual room temperature does not always correspond to the subjective temperature feeling of the people in the room. A certain comfort level is reached with different room temperatures, depending on a number of conditions. You need to take the following factors into account:
- The same room temperature is perceived warmer if the sun shines.
 - Someone who turns down the set temperature wants a large cooling effect. Due to this, most people tend to put the temperature dial lower than necessary. Usually, people forget to turn the temperature dial up again. Before this is corrected, the increased cooling wastes energy.
 - Someone who turns down the AC just a little bit is not interested in a quick response but rather in an accurate temperature. Reacting too much to this can cause an overshoot in the room temperature.
 - If someone changes the room temperature very often, the control should be sensible.
 - If room temperature varies strongly, the room is often used. Hence, control should be sensible.

The sensors in your AC measure the following input parameters: room temperature, set temperature, brightness in the room, and the number of dial changes in a certain time interval.

Design linguistic variables and a fuzzy rule block for your controller.