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Soft Computing

Assignment 2 [Fuzzy set]

Q1) List the elements of the following sets:

i) $A = \{n \in N : n \text{ is an odd prime} < 150\}$

$A = \{3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97, 101, 103, 107, 109, 113, 127, 131, 137, 139, 149\}$

ii) $B = \{x \in R : x^2 - 8x + 15 = 0\}$

$x^2 - 8x + 15 = 0$ ∵ can only have 2 values

$x^2 - 3x - 5x + 15 = 0$

$x(x-3) - 5(x-3) = 0$

$(x-3)(x-5) = 0$

$x = 3, 5$

$B = \{3, 5\}$

iii) $C = \{\max(a,b) : a, b \text{ are twin Prime} \leq 150\}$

$C = \{5, 7, 13, 19, 31, 43, 61, 73, 103, 109, 139\}$

* these pair of prime nums, whose difference is 2

Q2) Describe the concept of a fuzzy set in your own words.

Fuzzy means something that is not clear or is noisy. Let us take an example, as of current scenario of UP elections, it is not clear that who will win in upcoming legislative election. We only can predict their chances of winning (or degree of win), as various new agencies are doing. Like BJP with 0.8, SP with 0.7, BSP with 0.3 and Cong. with 0.1 of degree of winning. Therefore, when we represent it in the form of set of ordered pair then that is called Fuzzy set.

$$W = \{(BJP, 0.8), (SP, 0.7), (BSP, 0.3), (Cong, 0.1)\}$$

In Mathematics, fuzzy sets are sets whose elements have degrees of membership. Fuzzy set was introduced by Lotfi A. Zadeh (LAZ). in 1965. If X is universe of discourse, and $x \in X$, then fuzzy set A in X is

defined as set of ordered pairs

$$A = \{(x, \mu_A(x)) : x \in X\}$$

$\mu_A(x)$ is membership function which determines degree of membership. And the range is $[0,1]$.

Q3 Order the fuzzy sets defined by the following membership grade functions (assuming $x \geq 0$) by inclusion relation:

$$A(x) = \frac{1}{1+10x}, \quad B(x) = \left(\frac{1}{1+10x}\right)^{1/2}, \quad C(x) = \left(\frac{1}{1+10x}\right)^{2}$$

Ans Order of Fuzzy Set would be:

$$C(x) = \left(\frac{1}{1+10x}\right)^{2}$$

$$A(x) = \frac{1}{1+10x}$$

$$B(x) = \left(\frac{1}{1+10x}\right)^{1/2}$$

Q4) Let A and B are two fuzzy sets and $x \in U$, If $\mu_A(x) = 0.3$ and $\mu_B(x) = 0.9$, then find out the following membership values:

i) $\mu_{A \cup B}(x) = 0.9$ $\because \max[\mu_A(x), \mu_B(x)]$

ii) $\mu_{A \cap B}(x) = 0.3$ $\because \min[\mu_A(x), \mu_B(x)]$

iii) $\mu_{\bar{A} \cup \bar{B}}(x) = \mu_{\overline{A \cap B}}(x)$

$= \mu_{1 - A \cap B}(x)$ or $1 - \mu_{A \cap B}(x)$

$= 1 - 0.3$

$= 0.7$

iv) $\mu_{\bar{A} \cap \bar{B}}(x) = \mu_{\overline{A \cup B}}(x)$

$= 1 - \mu_{A \cup B}(x)$

$= 1 - 0.9$

$= 0.1$

v) $\mu_{\overline{A \cup B}}(x) = 1 - \mu_{A \cup B}(x)$

$= 1 - 0.9$

$= 0.1$

vi) $\mu_{\overline{A \cap B}}(x) = 1 - \mu_{A \cap B}(x)$

$= 1 - 0.3$

$= 0.7$

Q5) Determine the Union and Intersention of the fuzzy sets

$A = \{(1, 0.1), (2, 0.5), (3, 0.8), (4, 1), (5, 0.7), (6, 0.2)\}$

$B = \{(1, 1), (2, 0.8), (3, 0.4), (4, 0.1)\}$

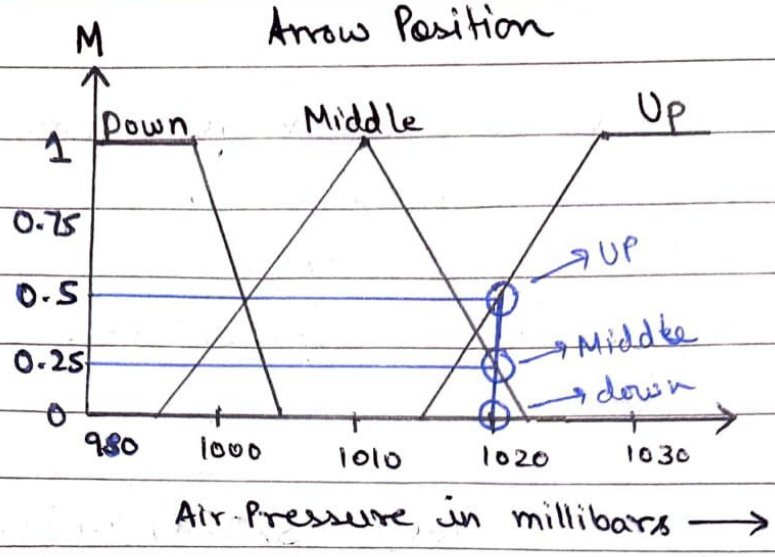
$A \cup B = \{(1, 1.0), (2, 0.8), (3, 0.8), (4, 1.0), (5, 0.7), (6, 0.2)\}$

* For rest of the element in B, we assure their degree equal to 0.

$A \cap B = \{(1, 0.1), (2, 0.5), (3, 0.4), (4, 0.1), (5, 0), (6, 0)\}$

Q6) Consider the given fuzzy expert system for given weather forecast. And Answer:

a) How much is the arrow Down, Up or in Middle if it Indicates that the pressure is 1020 millibars ? Use membership functions on the graph.

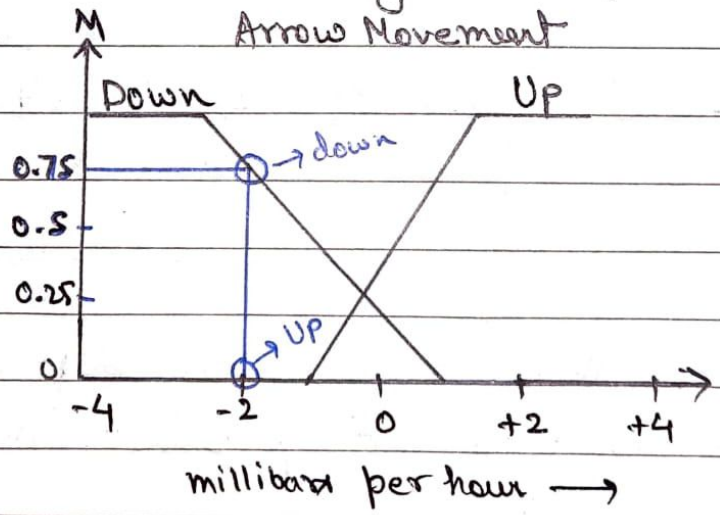


$\mu_{up}(x) = 0.5$

$\mu_{middle}(x) = 0.25$

$\mu_{down}(x) = 0.0$

b) How much is the arrow moving down or Up if the pressure changes -2 millibars every hour?



$\mu_{up}(y) = 0.0$

$\mu_{down}(y) = 0.75$

c) Using the membership values found above and confidences of the rules in the table calculate the degree of confidence in that the sky is clear or cloudy?

We have found following data from prev sections:

μ(x = arrow pos is down) = 0
μ(x = arrow pos is middle) = 0.25
μ(x = arrow pos is Up) = 0.5

μ(y = arrow is moving down) = 0.75
μ(y = arrow is moving up) = 0

Now, evaluate given rule

Rule 1: If arrow is down

$\mu_{down}(x) = 0$

Rule 2: If arrow is in middle and moving down

μ(x = pos is middle $\wedge$ y = moving down)
= min [0.25, 0.75] = 0.25

Rule 3: If arrow is in middle and Moving up.

$\mu(x = \text{arrow pos middle} \cap y = \text{moving up})$

$= \min[0.25, 0] = 0$

Rule 4: If arrow is up

$\mu_{up}(x) = 0.5$

Now,

Degree of confidence:

= (membership values of given condition) x (degrees of confidence of rules)

Rule 1: $\mu_1(w = \text{clouds}) = 0 \times 0.8 = 0$

Rule 2: $\mu_2(w = \text{clouds}) = 0.25 \times 0.6 = 0.15$

Rule 3: $\mu_1(w = \text{sunny}) = 0 \times 0.6 = 0$

Rule 4: $\mu_2(w = \text{sunny}) = 0.5 \times 0.8 = 0.40$

Let us combine two conclusions into one

$\mu(x) = \mu_1(x) + \mu_2(x) - \mu_1(x) \times \mu_2(x)$

$\mu(\text{cloud}) = 0 + 0.15 - 0 \times 0.15 = 0.15$
$\mu(\text{sunny}) = 0 + 0.40 - 0 \times 0.40 = 0.40$

Therefore Results of forecast are :

$\mu(w = \text{cloudy}) = 0.15$
$\mu(w = \text{sunny}) = 0.4.$

Q7) What is the purpose of defuzzyfication? Name atleast one method used for defuzzification.

Ans Defuzzification is the process of representing a fuzzy set with a crisp number. Internal representations of data in a fuzzy system are usually fuzzy sets. But the output frequently needs to be crisp number that can be used to perform a function.

The most commonly used defuzzification method is the center of area method (COA), also commonly referred to as the centroid method. This method determines the center of area of fuzzy set and returns the corresponding crisp value.