Artificial Intelligence

Fuzzy Logic

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Chapter Description

- Expected Outcomes
  - Student able to discuss the concepts of fuzzy logic system
  - Student able to anlyse and apply fuzzy logic system solution to a given problem

- References
  - Negnevitsky, M., Artificial intelligence: a guide to intelligent systems, 2005, Pearson Education

Content #1

- What is artificial intelligence?
- History of artificial intelligence
- Example of artificial intelligence application

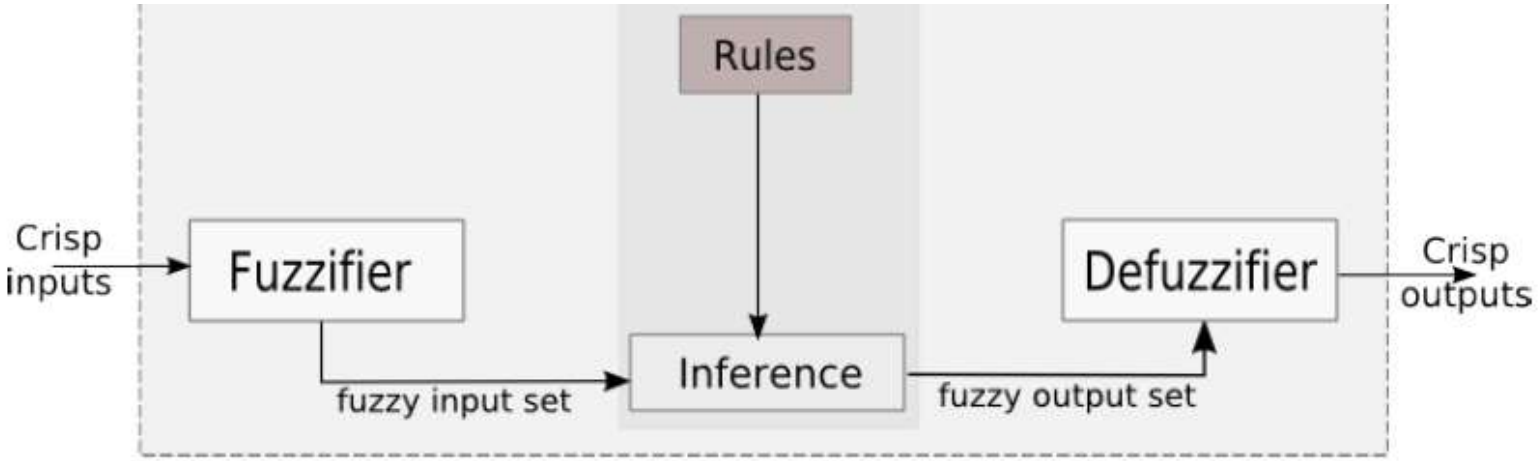
Fuzzy Logic System

- A fuzzy logic system (FLS) can be defined as the nonlinear mapping of an input data set to a scalar output data .
- FLS consists of four main parts:
  - Fuzzifier
  - Rules
  - Inference engine
  - Defuzzifier.

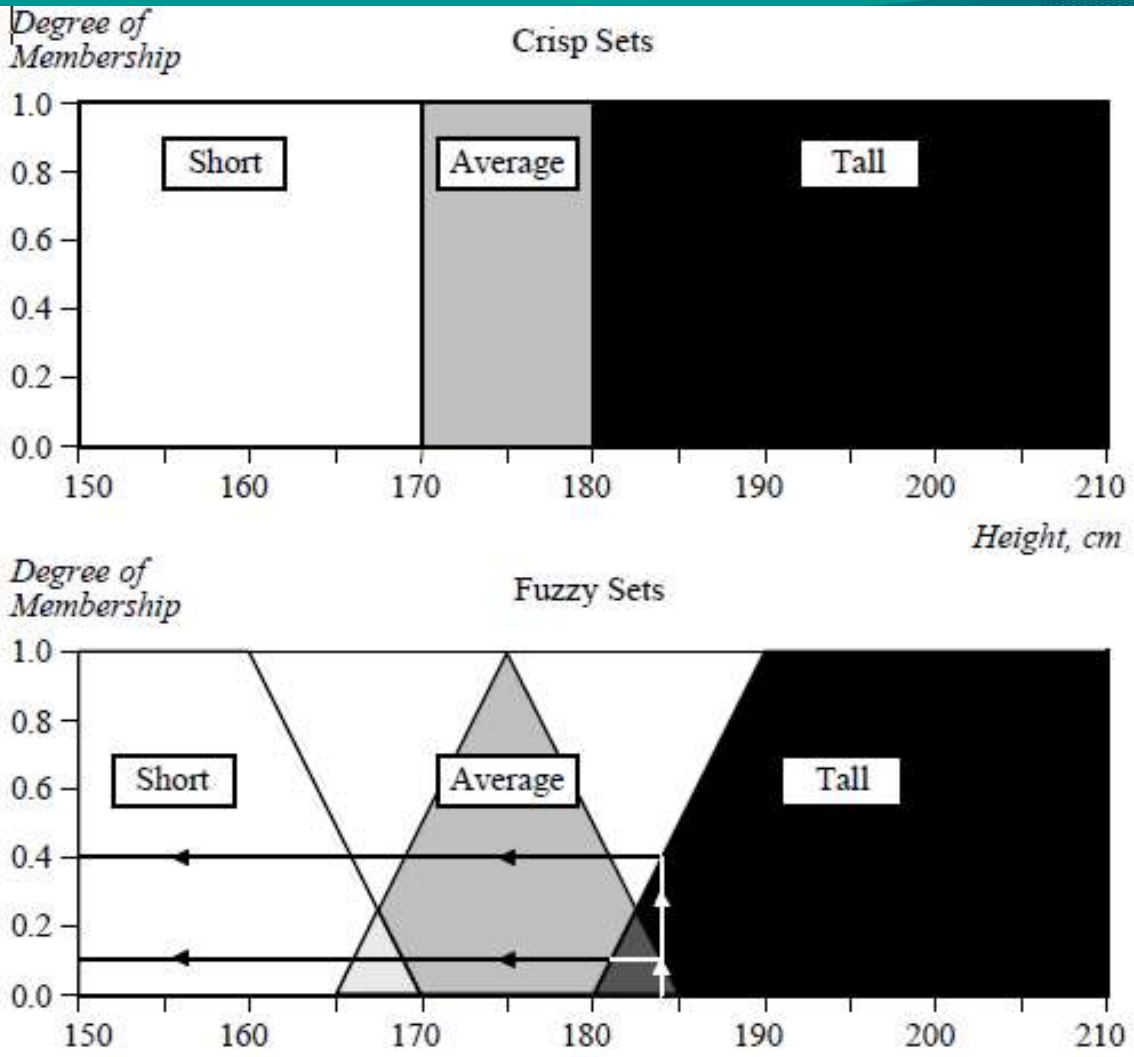
Fuzzy Logic System (FLS)

Algorithm Fuzzy logic algorithm

1. Define the linguistic variables and terms (initialization)
2. Construct the membership functions (initialization)
3. Construct the rule base (initialization)
4. Convert crisp input data to fuzzy values using the membership functions (fuzzification)
5. Evaluate the rules in the rule base (inference)
6. Combine the results of each rule (inference)
7. Convert the output data to non-fuzzy values (defuzzification)

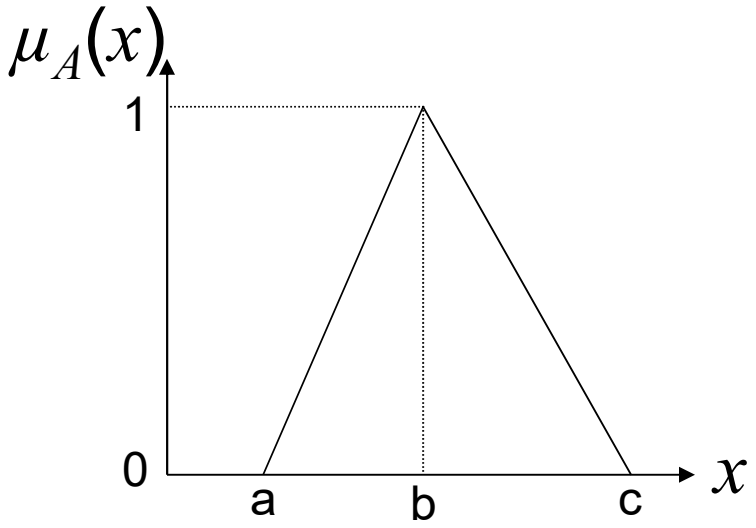


Crip Sets vs. Fuzzy Sets



Triangular Membership Functions

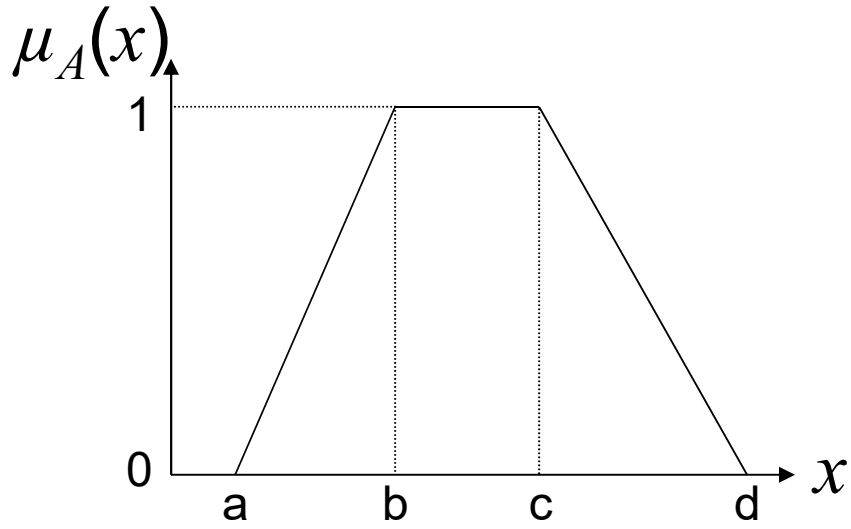
$$\mu_A(x) = \begin{cases} 0 & if\ x \le a \\ \dfrac{x-a}{b-a} & if\ a \le x \le b \\ \dfrac{c-x}{c-b} & if\ b \le x \le c \\ 0 & if\ x \ge c \end{cases}$$



- a, b and c represent the x coordinates of the three vertices of μ_A(x) in a fuzzy set A (a: lower boundary and c: upper boundary where membership degree is zero, b: the center where membership degree is 1)

Trapezoid Membership Functions

$$\mu_A(x) = \begin{cases} 0 & if\ x \le a \\ \dfrac{x-a}{b-a} & if\ a \le x \le b \\ 1 & if\ b \le x \le c \\ \dfrac{d-x}{d-c} & if\ c \le x \le d \\ 0 & if\ x \ge d \end{cases}$$



- a, b, c and d represent the x coordinates of the four vertices of μ_A(x) in a fuzzy set A (a: lower boundary and d: upper boundary where membership degree is zero, b and c: the center line where membership degree is 1)

Problem

- You have to developed a fuzzy logic system for intelligence car speed. The inputs of your system is the ambience temperature which taken form the car sensors, and cloud cover data taken weather data server. Your system should suggest the driver what is the appropriate speed base on the inputs.

Linguistic Variables

- Temp: {Freezing, Cool, Warm, Hot}
- Cover:{Sunny, Partly Cloudy, Overcast}
- Speed:{Slow, Fast}

Rules

- If it's Sunny and Cool, drive Fast
- If it's Sunny and Hot, drive Fast
- If it's Cloudy and Warm, drive Slow
- If it's Cloudy and Cool, drive Slow

Conclusion of The Chapter

- Conclusion #1
  - ….
  - ….
- Conclusion #2
  - ….
  - …..
  - ….
- Conclusio #x
  - ……..
  - ……..
  - ……..