FUZZY EXPERT SYSTEM: IMPORTANCE AND APPLICATION

BY-

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OVERVIEW

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- Fuzzy Logic
- Definition
- Development process
- Linguistic variables and hedges
- Operations on Fuzzy System
- Pros And Cons
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INTRODUCTION

- Experts rely on common sense when they solve problems.
- How can we represent expert knowledge that uses vague and ambiguous terms in a computer?
- Fuzzy logic is not logic that is fuzzy, but logic that is used to describe fuzziness.
- Fuzzy logic is the theory of fuzzy sets, sets that calibrate vagueness.
- Fuzzy logic is based on the idea that all things admit of degrees.

FUZZY LOGIC

- What is fuzzy logic?

- Boolean logic uses sharp distinctions.
- Fuzzy logic reflects how people think. It attempts to model our sense of words, our decision making and our common sense. As a result, it is leading to new, more human, intelligent systems .

WHY ??

Why fuzzy?

- As Zadeh said, the term is concrete, immediate and descriptive.

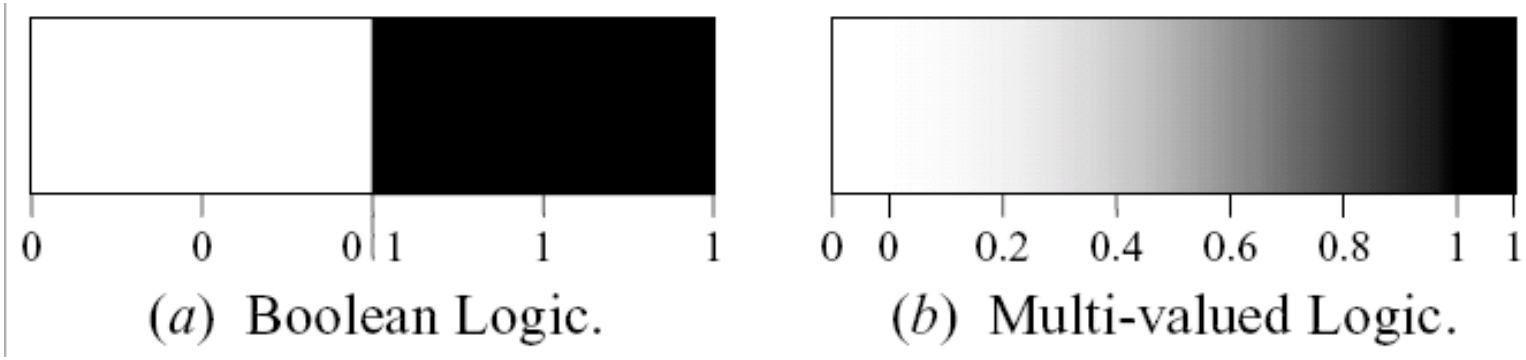
Why logic?

- Fuzziness rests on fuzzy set theory, and fuzzy logic is just a small part of that theory.

- Fuzzy logic is useful for commercial and practical purposes.
- It can control machines and consumer products. It may not give accurate reasoning, but acceptable reasoning.
- Fuzzy logic helps to deal with the uncertainty in engineering.

DEFINITION

- Fuzzy logic is a set of mathematical principles for knowledge representation based on degrees of membership.
- Unlike two-valued Boolean logic, fuzzy logic is multi-valued.
- It deals with degrees of membership and degrees of truth.
- Fuzzy logic uses the continuum of logical values between 0 (completely false) and 1 (completely true).



(*a*) Boolean Logic. (*b*) Multi-valued Logic.

DEVELOPMENT PROCESS

- Specify the problem;define linguistic variables.
- Determine fuzzy sets.
- Elicit and construct fuzzy rules.
- Encode the fuzzy sets,fuzzy rules and procedures required to perform fuzzy inference into expert system.
- Evaluate and tune the system.

LINGUISTIC VARIABLES AND HEDGES

- At the root of fuzzy set theory lies the idea of linguistic variables.
- A linguistic variable is a fuzzy variable. For example, the statement “John is tall” implies that the linguistic variable John takes the linguistic value tall.
- Example

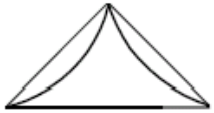
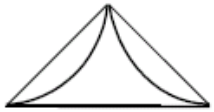
IF wind is strong
THEN sailing is good

IF project_duration is long
THEN completion_risk is high

IF speed is slow
THEN stopping_distance is short

HEDGE

- A linguistic variable carries with it the concept of fuzzy set qualifiers, called hedges.
- Hedges are terms that modify the shape of fuzzy sets. They include adverbs such as very, somewhat, quite, more or less and slightly.

Hedge	*Mathematical Expression*	*Graphical Representation*
A little	$[\mu_A(x)]^{1.3}$	
Slightly	$[\mu_A(x)]^{1.7}$	
Very	$[\mu_A(x)]^{2}$	
Extremely	$[\mu_A(x)]^{3}$	

OPERATIONS

- **Fuzzification**

Definition of fuzzy sets determination of the degree of membership of crisp inputs in appropriate fuzzy sets.

- **Inference**

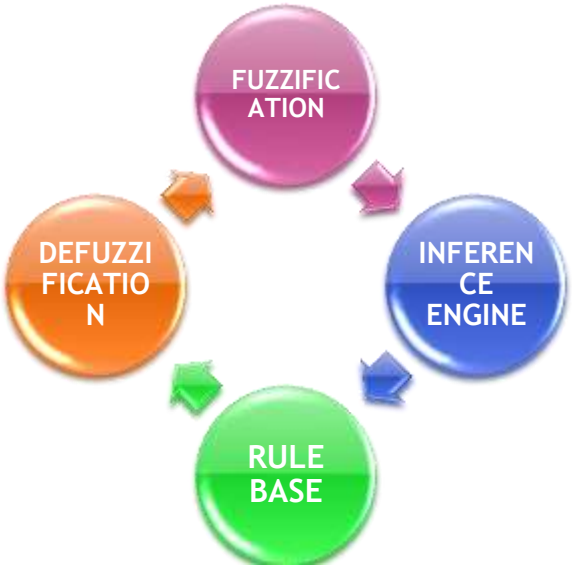
Evaluation of fuzzy rules to produce an output for each rule.

- **Compostion**

Aggregation or combination of the outputs of all rules.

- **Defuzzification**

Computation of crisp output.

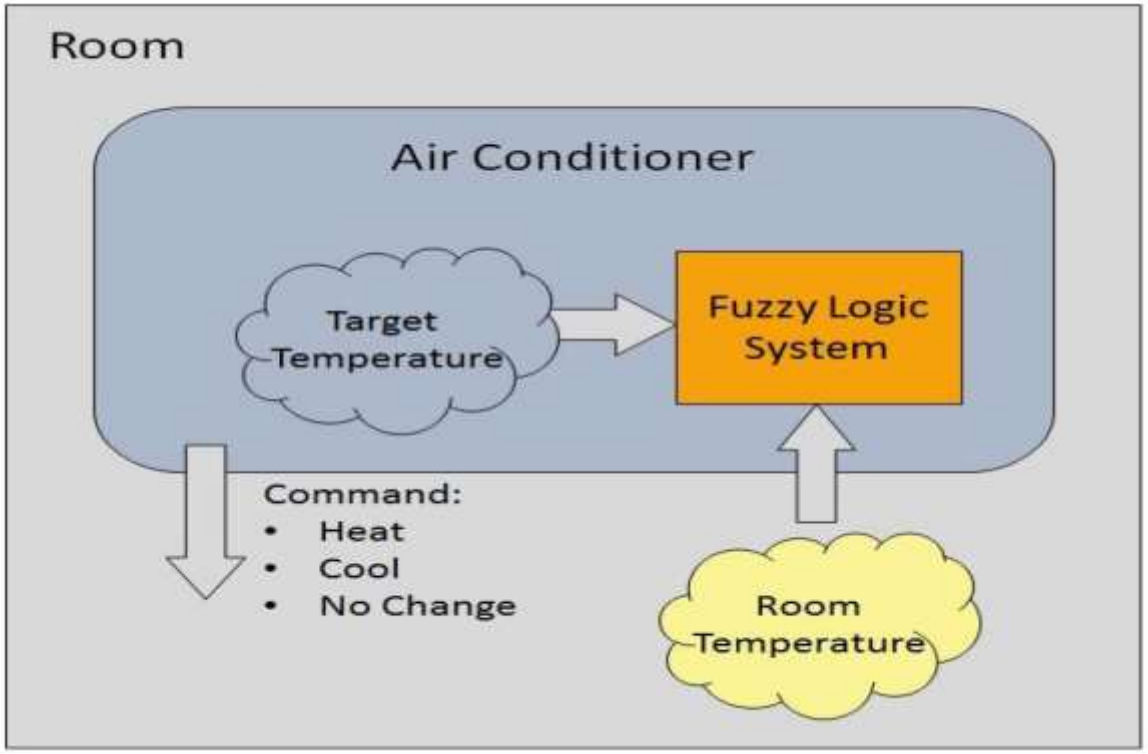


PROS AND CONS

- ***PROS***
- Mathematical concepts within fuzzy reasoning are very simple.
- You can modify a FLS by just adding or deleting rules due to flexibility of fuzzy logic.
- Fuzzy logic Systems can take imprecise, distorted, noisy input information.
- FLSs are easy to construct and understand.
- Fuzzy logic is a solution to complex problems in all fields of life, including medicine, as it resembles human reasoning and decision making.
- ***CONS***
- There is no systematic approach to fuzzy system designing.
- They are understandable only when simple. They are suitable for the problems which do not need high accuracy.

EXAMPLE:AIR CONDITIONER

- Let us consider an air conditioning system with 5-lvel fuzzy logic system. This system adjusts the temperature of air conditioner by comparing the room temperature and the target temperature value.



ALGORITHM

- Define linguistic variables and terms.
- Construct membership functions for them.
- Construct knowledge base of rules.
- Convert crisp data into fuzzy data sets using membership functions. *Fuzzification*‘
- Evaluate rules in the rule base. *Interfaceengine* Combine results from each rule. Composition
- Convert output data into non-fuzzy values. *Defuzzification*

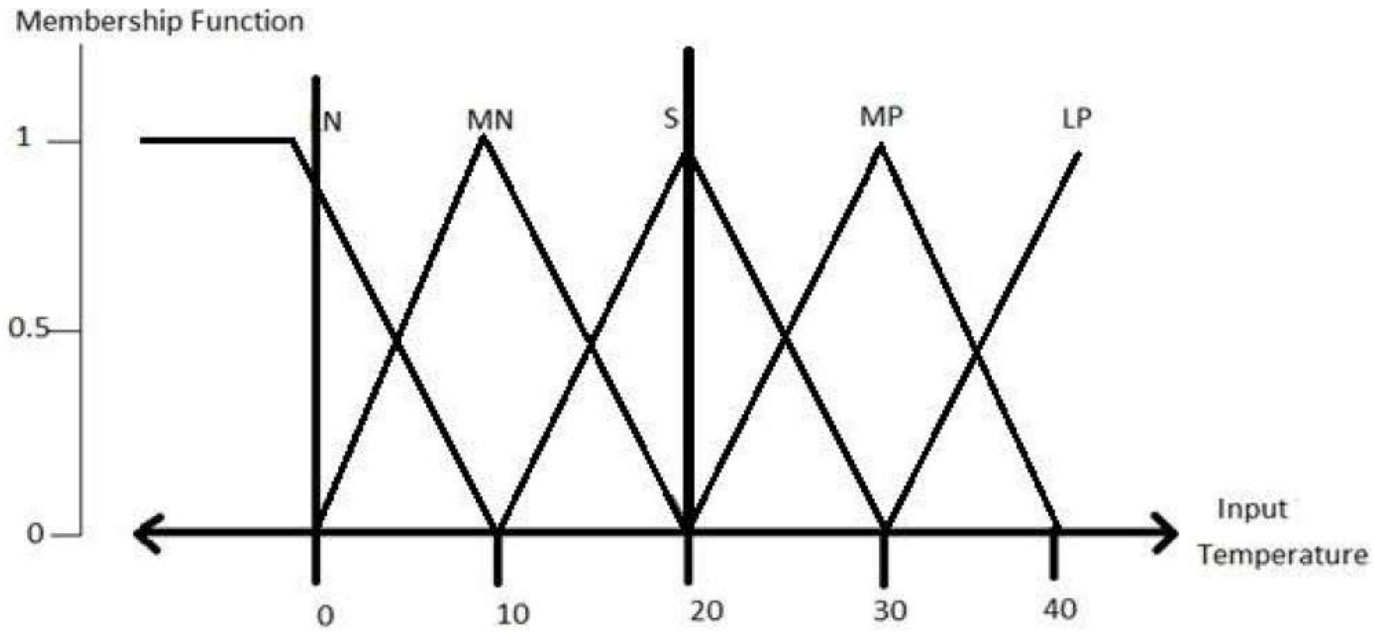
LOGIC DEVELOPMENT

- **Step 1: Define linguistic variables and terms**

- Linguistic variables are input and output variables in the form of simple words or sentences. For room temperature, cold, warm, hot, etc., are linguistic terms.
- Temperature *t* = {very-cold, cold, warm, very-warm, hot}

LOGIC DEVELOPMENT

- **Step 2: Construct membership functions for them**
- The membership functions of temperature variable are as shown –



LOGIC DEVELOPMENT

- **Step3: Construct knowledge base rules**

- Create a matrix of room temperature values versus target temperature values that an air conditioning system is expected to provide.

RoomTemp. /Target	Very_Cold	Cold	Warm	Hot	Very_Hot
Very_Cold	No_Change	Heat	Heat	Heat	Heat
Cold	Cool	No_Change	Heat	Heat	Heat
Warm	Cool	Cool	No_Change	Heat	Heat
Hot	Cool	Cool	Cool	No_Change	Heat
Very_Hot	Cool	Cool	Cool	Cool	No_Change

LOGIC DEVELOPMENT

- Build a set of rules into the knowledge base in the form of IF-THEN-ELSE structures.

Sr. No.	Condition	Action
1	IF temperature=*ColdORVery*$_C$*old* AND target=Warm THEN	Heat
2	IF temperature=*HotORVery*$_H$*ot* AND target=Warm THEN	Cool
3	IF *temperature* = *Warm* AND *target* = *Warm* THEN	No_Change

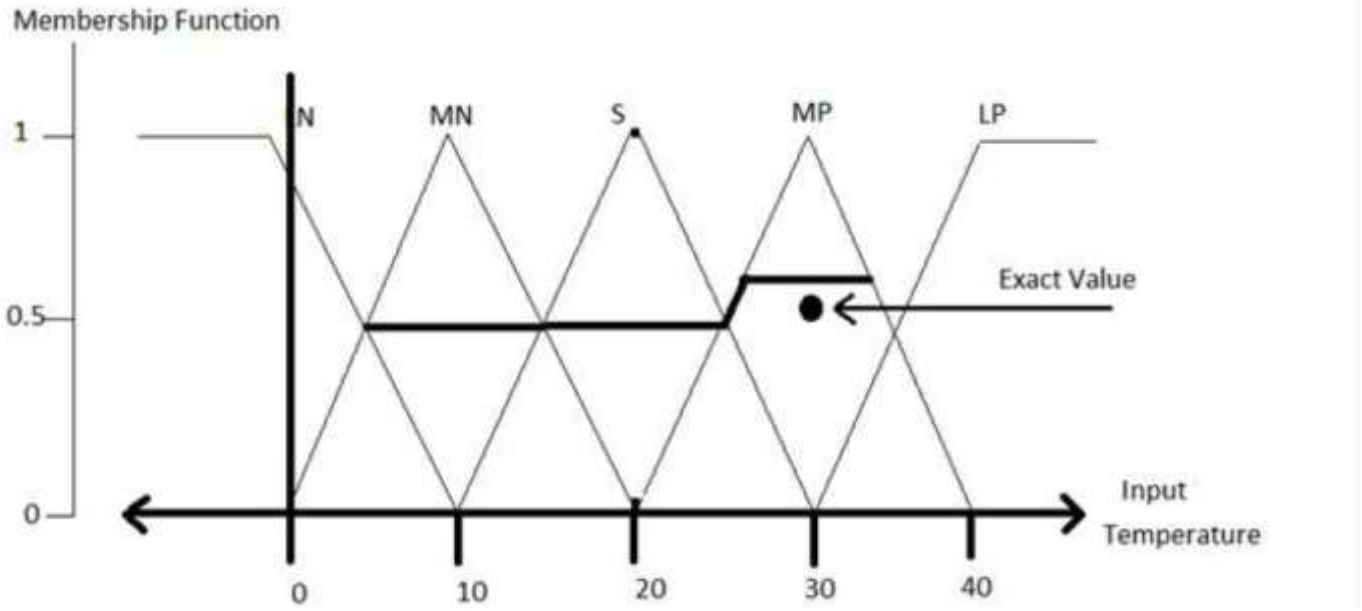
- **Step 4: Obtain fuzzy value**

- Fuzzy set operations perform evaluation of rules. The operations used for OR and AND are Max and Min respectively. Combine all results of evaluation to form a final result. This result is a fuzzy value.

LOGIC DEVELOPMENT

- **Step 5: Perform defuzzification**

- Defuzzification is then performed according to membership function for output variable.



APPLICABILTY

The key application areas of fuzzy logic are as given −

- ***Automotive Systems***
  - Automatic Gearboxes
  - Four-Wheel Steering
- ***Consumer Electronic Goods***
  - Hi-Fi Systems
  - Television
- ***Domestic Goods***
  - Microwave Ovens
  - Refrigerators
- ***Environment Control***
  - Air Conditioners/Dryers/Heaters
  - Humidifiers


obrigado
Dank U
Merci
mahalo
Köszi
спасибо
Grazie
Thank you
mauruuru
Takk
Gracias
Dziękuję
Děkuju
danke
Kiitos