

# A Study of Fuzzy Logic

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## Abstract:

Fuzzy logic is the of part of artificial intelligence. Fuzzy Logic is a system of reasoning that resembles human reasoning. The approach of Fuzzy Logic system emulate the way of decision making in humans that involves all intermediate possibilities between digital values YES and NO.

The idea of fuzzy logic was given by Dr. Lotfi Zadeh in the university of California in 1965. In the fuzzy logic system the values are indicated by a number in the range from 0 to 1. Here 1.0 describe as absolute truth and 0.0 describe as absolute falseness. The number which indicates the value in fuzzy logic systems is called the truth value.

## Keywords:

Fuzzy logic, Fuzzy set, Fuzzy logic Architecture, Fuzzy markup language.

## 1. Introduction

Fuzzy Logic is a system of reasoning that resembles human reasoning. It come up with Fuzzy Logic emulate the way of decision making in humans that involves all intermediate possibilities between digital values YES and NO. Fuzzy Logic resembles the human decision-making methodology. The traditional logic block that a computer can understand takes good input and produces a definite output as TRUE or FALSE, which is equivalent to human's YES or NO. The idea of fuzzy logic was given by Dr. Lotfi Zadeh in the university of California in 1965. In fuzzy logic systems, the values are indicated by a number in the range from 0 to 1. Here 1.0 describe as absolute truth and 0.0 describe as absolute

falseness. The number which indicates the value in fuzzy logic systems is called the truth value.

The creator of fuzzy logic, Lotfi Zadeh, observed that unlike computers, the human decision making includes a range of possibilities between YES and NO.

Fuzzy logic is implement in systems with various sizes of micro-controllers and various capabilities ranging, networked, workstation-based control systems. It can be also implement in hardware, software, or a combination of both.

## 2. Fuzzy Set

### 1. Finite Set

A set which contains a definite values of elements is called a finite set. Definite is a natural number like 1,2,3... . **Example** –  $S = \{x | x \in \mathbb{N} \text{ and } 30 > x > 10\}$

### 2. Infinite Set

A set which contains infinite values of elements is called an infinite set. **Example** –  $S = \{x | x \in \mathbb{N} \text{ and } x > 10\}$

### 3. Subset

A set Y is a subset of set Z (Written as  $Y \subseteq Z$ ) if every element of Y is an element of set Z.

**Example** – Let,  $Y = \{11, 22, 33, 44, 55\}$  and  $Z = \{11, 22\}$ .

### 4. Empty Set or Null Set

An empty set contains no elements. It is denoted by  $\Phi$ . **Example** –  $S = \{x|x \in \mathbb{N} \text{ and } 4 < x < 5\} = \Phi$

### 5. Equal Set

If the two sets contain the same elements, they are said to be equal. **Example** – If  $A = \{11,22,33\}$  and  $B = \{33,11,22\}$ , they are equal as every element of set A is an element of set B and every element of set B is an element of set A.

### 6. Overlapping Set

In two sets that have at least one common element are is available called overlapping sets.

**Example** – Let,  $A = \{3,22,66\}$  and  $B = \{66,12,42\}$ . There is a common element ‘66’, hence these sets are overlapping sets.

## 3. Operations on Classical Sets

### 1. Union

The union of sets X and B (denoted by  $X \cup Y$  or  $Y \cup X$ ) is the set of elements which are in X, in Y, or in both X and Y. Hence,  $X \cup Y = \{x|x \in X \text{ OR } x \in Y\}$ . **Example** – If  $X = \{1,2,3\}$  and  $Y = \{3,4,5\}$ , then  $X \cup Y = \{1,2,3,4,5\}$  – The common element occurs only once.

### 2. Intersection

The intersection of sets X and Y (denoted by  $X \cap Y$ ) is the set of elements which are in both X and Y.

Hence,  $X \cap Y = \{x|x \in X \text{ AND } x \in Y\}$ .

### 3. Difference/ Relative Complement

The set difference of sets X and Y (denoted by  $X - Y$ ) is the set of elements which are only in X

but not in Y. Hence,  $X - Y = \{x|x \in X \text{ AND } x \notin Y\}$ . **Example** – If  $X = \{1,2,3\}$  and  $Y = \{3,4,5\}$ , then  $(X - Y) = \{1,2\}$  and  $(Y - X) = \{4,5\}$ . Here, we can see  $(X - Y) \neq (Y - X)$ .

### 4. Complement of a Set

The complement of a set X (denoted by  $X'$ ) is the set of elements which are not in set X. Hence,  $X' = \{x|x \notin X\}$ . More specifically,  $X' = (U - X)$  where U is a universal set which contains all objects. **Example** – If  $X = \{x|x \text{ belongs to set of add integers}\}$  then  $X' = \{y|y \text{ does not belong to set of odd integers}\}$ .

## 4. Fuzzy Logic Architecture

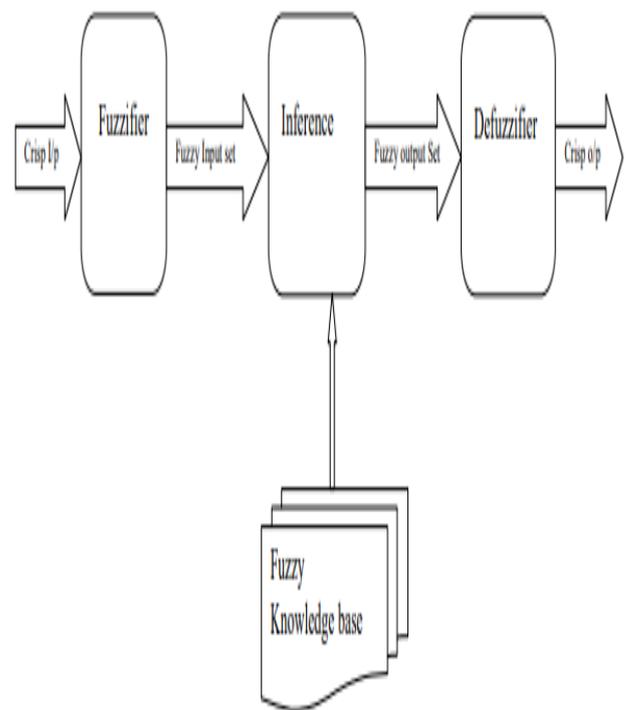


Figure 1 Fuzzy Logic Architecture<sup>[1]</sup>

### Rule Base:

The rules base define the rules and the if-then(if-else) condition present by the expert to control the decision-making system. In last

update of fuzzy logic theory it's provides the various type of methods for the design and tuning of fuzzy controllers. In last update reduce the number of the fuzzy set of rules.

**Fuzzification:**

Fuzzification step helps to convert inputs. It permits you to convert, crisp numbers into fuzzy sets. Crisp inputs measured by sensors and passed into the system for any process. Like Room temperature, pressure, etc.

**Inference Engine:**

It helps you to Determines the degree of match between input and the rules. Based on

the % match, it determines which rules need implement according to the given input field. After this, the applied rules square measure combined to develop the management actions.

**Defuzzification:**

This is the last stage of process in this stage the the fuzzy set convert into the crisp value. There are many types of techniques available like center of area, center of gravity, first of maximum etc.

**4.1 Real World Application**

Product	Company	Fuzzy Logic
Anti-lock brakes	Nissan	Use fuzzy logic to controls brakes in hazardous cases depend on car speed, acceleration, wheel speed, and acceleration
Auto transmission	NOK/ Nissan	Fuzzy logic is used to control the fuel detection and ignition based on throttle setting, cooling water temperature, RPM, etc.
Auto engine	Honda, Nissan	Use to select geat based on engine load, driving style, and road conditions.
Dishwasher	Matsushita	Fuzzy logic is used for adjusting the cleaning cycle, rinse and wash strategies based depend upon the number of dishes and the amount of food served on the dishes.
Fitness management	Omron	Fuzzy rules implied by them to check the fitness of his employees.
Microwave oven	Mitsubishi Chemical	Sets cooking strategy
Palmtop computer	Hitachi, Sharp, Sanyo, Toshiba	Recognizes handwriting Kanji characters
Plasma etching	Mitsubishi Electric	Sets dig time and strategy

*Table 1 Real World Application*

**5.Fuzzy Markup Language**

FML Developed by Giovanni Acampora.

Fuzzy Markup Language is xml base so it is a hardware independently.

The opening or first tag of the fuzzy makeup language is <fuzzycontroller>. This tag has two attributes name and ip. The name attribute is define the name of the fuzzy controller and ip define the location of controller in a computer network.

The second tag is <KnowledgeBase> tag. It is define fuzzy concepts used to model the fuzzy rule base.

The <FuzzyVariable> tag defines the fuzzy concept.

The <FuzzyTerm> tag defines a linguistic term describing the fuzzy concept.

## 6. Conclusion

The term fuzzy mean things that aren't terribly clear or imprecise.

The term formal logic was initial used with 1965 by Lotfi Zadeh a prof of UC Berkeley in California.

Fuzzy logic simple to implement machine learning technique.

Fuzzy logic should not be used when you can use your common sense.

Fuzzy Logic architecture has four main parts 1) Rule Base 2) Fuzzification 3) Inference Engine

4) Defuzzification. Fuzzy logic takes truth degrees as a mathematical basis on the model of the uncertainty while probability is a mathematical model of ignorance.

Crisp set has strict boundary T or F whereas Fuzzy boundary with a degree of membership.

A classical set is wide utilized in digital system style whereas fuzzy set used solely in fuzzy controllers.

Fuzzy logic management, anti-lock brakes, Dishwasher, Copy machine are some applications areas of fuzzy logic.

Fuzzy logic helps you to regulate machines and client merchandise.

## 7. References

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