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INTRODUCTION TO FUZZY LOGIC AND ITS APPLICATIONS IN DAILY LIFE

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ABSTRACT :

Fuzzy Set is any set that allows its members to have unlike grades of membership (membership function) in the interval [0, 1]. The membership function of the combination of two fuzzy sets A and B with membership functions is defined as the maximum of the two individual membership functions. The different operations on fuzzy sets such as complement, DeMorgan's laws, associativity, commutativity distributivity are studied in this article. Fuzzy logic is not logic that is used to describe ambiguity. With the help of different examples we can understand the concept of fuzzy logic. Fuzzy logic was suggested by Zadeh as a method for mimicking the ability of human way of thinking using a small number of rules and still producing a smooth output via a process of interruption. Rules are built up which are based upon multi-valued logic and so introduced the concept of set membership. With fuzzy logic an element may perhaps to some extent belong to a set and this is represented by the set membership.

KEYWORDS : *Membership function, fuzzy set, fuzzy logic, multi-valued logic, fuzziness, associativity.*

INTRODUCTION:

Fuzzy logic starts with and constructs on a set of user-supplied human language rules. The fuzzy systems alter these rules to their mathematical equivalents. This deduces the job of the system designer and the computer, and results in much more accurate representations of the way systems behave in the real world. Supplementary benefits of fuzzy logic include its cleanness and its elasticity. Fuzzy logic [1] can handle problems with imprecise and incomplete data, and it can model nonlinear functions of arbitrary complexity. Fuzzy logic models, called fuzzy inference systems, consist of a number of restricted "if-then" rules. The designer who understands the system, these rules are uncomplicated to write, and as many rules as necessary can be supplied to illustrate the system adequately. In fuzzy logic, dissimilar standard conditional logic, the truth of any statement is a theme of degree. Fuzzy inference systems [2] rely on membership functions to explain to the computer how to calculate the correct value between 0 and 1. The measure to which any fuzzy statement is factual is denoted by a value between 0 and 1.

FUZZY SETS:

Fuzzy Set Theory was dignified by Professor Lofti Zadeh at the University of California in 1965. A model is a set of rules and regulations which defines boundaries and tells us what to do to be flourishing in solving problems within these boundaries. For example the use of transistors instead of vacuum tubes is a paradigm shift - likewise the development of Fuzzy Set Theory from conventional bivalent set theory is

a paradigm shift. Bivalent Set Theory can be rather limiting if we wish to depict a 'humanistic' problem mathematically. For example, Fig 1 below illustrates bivalent sets to differentiate the temperature of a room.

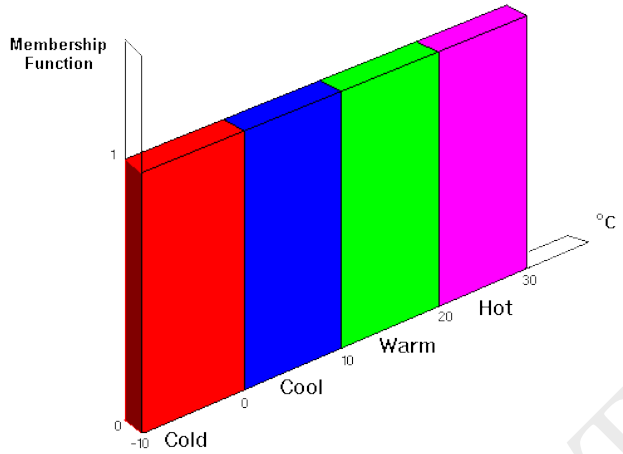


Fig. 1 : Bivalent Sets to Characterize the Temp. of a room.

The mainly understandable limiting aspect of bivalent sets that can be seen clearly from the diagram is that they are mutually exclusive - it is not possible to have membership of more than one set. Undoubtedly, it is not exact to define a transition from a quantity such as 'warm' to 'hot' by the application of one degree Fahrenheit of heat. In the factual world a smooth (unnoticeable) drift from warm to hot would take place. This natural incident can be described more truthfully by Fuzzy Set Theory. Fig.2 below shows how fuzzy sets quantifying the matching information can express this natural drift.

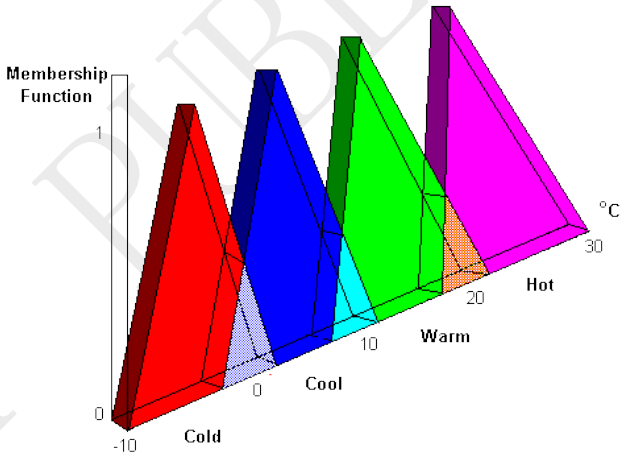


Fig. 2 - Fuzzy Sets to characterize the Temp. of a room.

DEFINITIONS:

- Universal set - The Universal set is the range of all possible values for an input to a fuzzy system.
- Fuzzy Set - A Fuzzy Set is any set that allows its members to have diverse grades of membership (membership function) in the interval [0,1].
- Support -The Support of a fuzzy set F is the crisp set of all points in the Universal set U such that the membership function of F is non-zero.

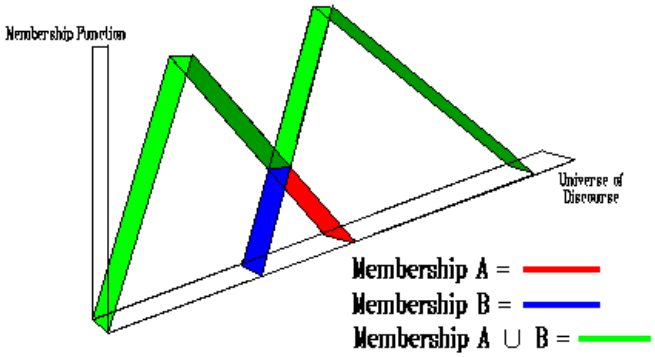
- Crossover point - The Crossover point of a fuzzy set is the component in U at which its membership function is 0.5.
- Fuzzy Singleton - A Fuzzy singleton is a fuzzy set whose support is a on its own point in U with a membership function of one.

FUZZY SET OPERATIONS:

Union

The membership function [3] of the Union of two fuzzy sets A and B with membership functions μ_A and μ_B respectively is defined as the maximum of the two individual membership functions

$$\mu_{A \cup B} = \max(\mu_A, \mu_B)$$

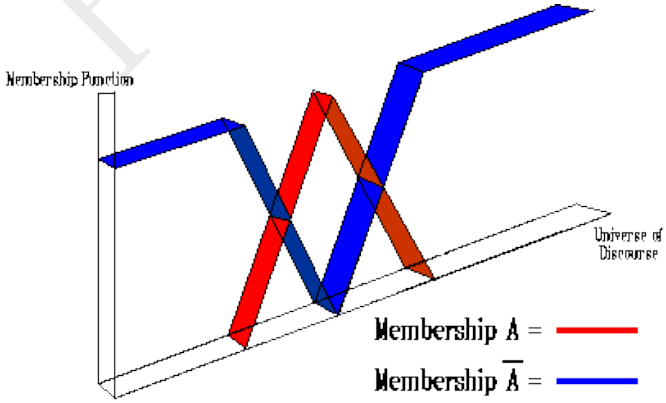


The Union operation in Fuzzy set theory is the alike of the OR operation in Boolean algebra.

Complement

The membership function of the Complement of a Fuzzy set A through membership function μ_A is defined as

$$\mu_{\overline{A}} = 1 - \mu_A$$



The following rules which are widespread in classical set theory also be valid to Fuzzy set theory.

De Morgans law

$$\overline{(A \cap B)} = \overline{A} \cap \overline{B} \;,\; \overline{(A \cup B)} = \overline{A} \cap \overline{B}$$

Associativity

$$(A \cap B) \cap C = A \cap (B \cap C)$$
$$(A \cup B) \cup C = A \cup (B \cup C)$$

Commutativity

$$A \cap B = B \cap A \;,\; A \cup B = B \cup A$$

Distributivity

$$A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$$
$$A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$$

FUZZY LOGIC:

The word fuzzy itself tells us which are not clear or are vague. Any event, process, or function that is changing continuously cannot always be defined as either true or false, which means that we need to define such activities in a Fuzzy manner. Fuzzy Logic resembles the human decision-making methodology [4]. It deals with vague and imprecise information. This is unpleasant generalization of the real-world problems and based on degrees of truth rather than usual true/false or 1/0 like Boolean logic. Take a look at the following diagram. In fuzzy systems, the values are indicated by a integer in the range from 0 to 1. Here 1 represents absolute truth and 0 represents absolute falseness. The number which indicates the worth in fuzzy systems is called the truth value.

Fuzzy logic was recommended by Zadeh as a method for mimicking the capability of human reasoning using a small number of rules and still producing a smooth output via a process of interpolation. It builds rules that are depends upon multi-valued logic and so introduced the concept of set membership. Fuzzy logic is an element partially belongs to a set and this is represented by the set membership. A fuzzy logic control system [5], [6], [7] is one which has at least one system part that uses fuzzy logic for its internal knowledge representation. While it is possible for fuzzy systems to converse information using fuzzy sets, the majority applications have a single fuzzy system component communicating with conventional system components via deterministic values.

FUZZY LOGIC – APPLICATIONS:

The concepts of Fuzzy Logic are extensively applied in the various fields as follows.

Robotics:

Fuzzy Logic control is one of the mainly successful techniques in the design and coordination of behaviors for mobile robots navigation. The Fuzzy control addressed a practical mechanism to design different behaviors by the use of linguistic rules. It also provides a robust methodology for combination of behaviors. Then, two fuzzy controllers designed to show influence and robustness of the fuzzy control in a navigation system. The obtained results proved the successful operation and efficiency of the fuzzy control in generating smooth motion, sinking navigation time and increasing the robot safety.

Aerospace

In aerospace, fuzzy logic is used in the Altitude control of spacecraft, e Satellite altitude control and Flow and mixture regulation in aircraft deicing vehicles.

Automotive

In automotive, fuzzy logic is used in the Trainable fuzzy systems for idle speed control, Shift scheduling method for automatic transmission, intelligent highway systems Traffic control and improving efficiency of automatic transmissions.

Business

In business, fuzzy logic is used in the Decision-making support systems, Personnel evaluation in a large company.

Defense

In defense, fuzzy logic is used in the areas as underwater target recognition, Automatic target recognition of thermal infrared images, Naval decision support aids and Control of a hypervelocity interceptor.

Electronics

In electronics, fuzzy logic is used in the areas such as Control of automatic exposure in video cameras, Humidity in a clean room, Air conditioning systems, Washing machine timing, Microwave ovens and Vacuum cleaners.

Finance

In the finance field, fuzzy logic is used in the Banknote transfer control, and Fund management Stock market predictions.

Industrial Sector

In industrial, fuzzy logic is used in the areas such as Cement kiln controls heat exchanger control, Activated sludge wastewater treatment process control, Water purification plant control, Quantitative pattern analysis for industrial quality assurance, Control of constraint satisfaction problems in structural design and Control of water purification plants.

Manufacturing

In the manufacturing industry, fuzzy logic is used in Optimization of cheese production and Optimization of milk production.

Marine

In the marine field, fuzzy logic is used in the areas such as Autopilot for ships, Optimal route selection, Control of autonomous underwater vehicles and Ship steering.

Medical

In the medical field, fuzzy logic is used in the Medical diagnostic support system, Control of arterial pressure during anesthesia, Multivariable control of anesthesia, Radiology diagnoses, Fuzzy inference diagnosis of diabetes and prostate cancer.

Securities

In securities, fuzzy logic is used in the Decision systems for securities trading and Various security appliances.

Transportation

In transportation, fuzzy logic is used in the Automatic underground train operation, Train schedule control, Railway acceleration and Braking and stopping.

Pattern Recognition and Classification

In Pattern Recognition and Classification, fuzzy logic is used in the Fuzzy logic based speech recognition, Fuzzy logic based Handwriting recognition, Fuzzy logic based facial characteristic analysis, Command analysis and Fuzzy image search.

CONCLUSIONS:

Fuzzy Logic provides a unlike technique to approach a control or classification problem. This article focuses on what the system should do rather than trying to model how it works. On the other hand the fuzzy approach requires a adequate expert knowledge for the formulation of the rule base, the combination of the sets and the defuzzification. In General, the employment of fuzzy logic might be helpful, for very complex processes, when there is no simple mathematical model, for highly nonlinear processes or if the processing of expert knowledge is to be performed. According to literature the employment of fuzzy logic is not recommendable, if the conventional approach yields a agreeable result, an without difficulty solvable and adequate mathematical model already exists or the problem is not solvable.

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