# HOTEL SELECTION SYSTEM USING FUZZY CLASSIFICATION

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**ABSTRACT**

*Fuzzy sets and fuzzy logic are used to treat various types of uncertainty that exists in decision making problem. Fuzzy logic is being integrated in many expert systems for real world problems. This fuzzy rule based expert system is designed to facilitate the searching hotel for tourists. The tourist's preferred information for hotels is selected as an input. These inputs are converted to fuzzy values by using membership function. The fuzzy values are matched with the rules in the knowledge base by applying the inference mechanism. Finally, the system will select the best hotel for the tourists with their preferences.*

**Keyword**: - *Fuzzy logic, expert system, fuzzy values, knowledge base, membership function*

## 1. INTRODUCTION

Since technology rapidly develops, web based applications have been developed in various fields such as business, education, medical and so on. Today, E-commerce, E-banking E-tourism and E-learning systems are very popular in web applications. Similarly, the tourist who wants to visit our country, can directly search and choice the desired hotels using online system. So, decision-making system plays an important role to support a suitable decision for web applications in the various fields [3].

There are three major types of pattern recognition trends: unsupervised, semi-supervised and supervised learning. In the supervised category, also called classification or regression, each object of the data comes with a pre-assigned class label. In other hand, there is a teacher saying the true answer. The task is to train a classifier to perform the labeling, using the teacher. A procedure which tries to leverage the teacher‘s answer to generalize the problem and obtain his knowledge is learning algorithm. Most often this procedure cannot be described in a human understandable form, like Artificial Neural Networks classifiers. In these cases, the data and the teacher‘s labeling are supplied to the machine to run the procedure of learning over the data. Although the classification knowledge learned by the machine in this process might be obscure, the recognition accuracy of the classifier will be the judge of its quality of learning or its performance [6].

In some new classification systems, it is tried to investigate the errors and propose a solution to compensate them [4]. There are many classification and clustering methods as well as the combinational approaches.

While the supervised learning tries to learn from the true labels or answers of the teacher, in semi-supervised the learner conversely uses teacher just to approve or not to approve the data in total. It means that in semi-supervised learning there is not really available teacher or supervisor. The procedure first starts with fully random manner, and when it reaches the state of final, it looks to the condition whether he win or lose. For example in the chess game, take it in consideration, that there may be none supervisor, but you gradually train to play better by trail-and-error process and looking at the end of the game to find you win or lose. Fuzzy classification is one of the most fundamental and simple classification methods. Fuzzy set theory provides a systematic calculus to deal with such information linguistically and it performs numerical computation by using linguistic labels stipulated by membership functions [2]. Fuzzy set theory provides a framework for handling the uncertainties. Fuzzy logic is conceptually easy to understand. The mathematical concepts behind fuzzy reasoning are very simple.

Fuzzy logic is applied to a wide variety of decision making problems in many areas such as medical diagnosis, weather forecasts and teacher performance prediction. In this system, fuzzy logic and fuzzy rules are applied for expert system for hotel selection. Selecting suitable accommodation considering cost, star rating, facilities and location are very important for tourists. The fuzzy expert system choice the suitable hotel for tourists based on their interest and priorities. This system uses Triangular and Linear membership functions to convert the crisp inputs to fuzzy sets and the Max-min operation for fuzzy inference for hotel selection. .

## 2. RELATED WORK

Essam Al-Daoud proposed cancer diagnosis using modified fuzzy network. In his proposed system, the author described a modified fuzzy c-means radial basis function network. The modified model is implemented and compared with Adaptive Neuro-Fuzzy Inference System (ANFIS). The both models are applied on "Wisconsin Breast Cancer" dataset. The main purpose of the suggested model is to diagnose the cancer diseases by using fuzzy rules with relatively small number of linguistic labels, reduce the similarity of the membership functions and preserve the meaning of the linguistic labels. Three rules are needed to obtain the classification rate 97% by using the modified model. On the contrary, more rules are needed to get the same accuracy by using ANFIS. Moreover, their results indicate that the model with ANFIS is more accurate than the state-of-art prediction methods [1].
Rahim F, Deshpande A and Hosseini A discussed [7] about fuzzy expert system for fluid management in general anaesthesia. The authors have selected 71 patient ASA I–II classes, aged between 15 and 50 years and weight between 40 and 85 kg. Mean Arterial Pressure (MAP) and Hourly Urine Output (HUO) are the fuzzy input to the fuzzy expert system as the antecedent parts of the rule and the output is the defuzzified value of Intravenous Fluid Rate (IFR) at the desired level. They organized fuzzy rules and developed a fuzzy expert system for fluid management in general anaesthesia.
Cho et al. [6] argued that hotels could improve their concierge service, both human and electronic, by developing an electronic system that makes use of expert system technology. This system engaged hotel guests in an on-screen dialogue to help them find information about hotel services and other attractions in the area.
Ngai and Wat et al. [12] proposed the design and development of a fuzzy expert system for hotel selection the research and development of a fuzzy expert system for hotel selection. . They provided the best match between the customer's requirements and available hotel services and facilities.

## 3. EXPERT SYSTEM

An Expert System is a computer program that simulates the reasoning of a human expert to solve problems or give advices to the user. The power of reasoning with knowledge resides in the possibility of the system reaching to new and unpredictable situations, in mostly the same way as humans do. This reasoning process is focused on heuristics and approximate methods which help the system to discover the right answer to a specific problem. However, it is not guaranteed that the system always find the correct solution. Expert systems are also characterized by having an advice procedure and by being capable of explaining to the user its own reasoning process.
Expert Systems are a wide area of research with many applications implemented. According to Liao in his survey about expert systems from 1995 to 2004, they can be classified into the following methodologies [8]: rule-based systems, knowledge based systems, neural networks, fuzzy expert systems, object-oriented methodology, case-based reasoning, system architecture, intelligent agent systems, database methodology, modeling and ontology; and in each of these methodologies, it can be sub-classified in their concrete applications. Liao also suggested that expert systems could be implemented in different scientific areas such as psychology, cognitive science, and human behavior. Hence, they can conceivably be applied in the domain of Building Automation Systems as well.

### 3.1 Rule Based System

To simulate the reasoning process of humans, automatic reasoning systems incorporate rules to represent knowledge and use them to reason about the facts of the surrounding world. These kinds of systems are called rule-based systems, and are composed of two different components:

- The knowledge base which contains the rules of the system
- The inference mechanism which is responsible for the reasoning process based on the rules of the system.

In a rule-based system, knowledge consists of a set of if-then rules where each one has two different parts, if the part named by antecedent, and the then part called consequent. These rules have the representation:

***if A then C,***

Where A is the antecedent condition and C is the consequent part which consists of actions and assertions. It is important to notice that the conditions used in these rules are Boolean conditions. Hence, the antecedent can only assume the value ***true*** and ***false***.

## 4. FUZZY LOGIC

Fuzzy Logic (FL) is a problem-solving control system methodology that lends itself to implementation in systems ranging from simple, small, embedded micro-controllers to large, networked, multi-channel PC or workstation-based data acquisition and control systems. It can be implemented in hardware, software, or a combination of both. FL provides a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise, noisy, or missing input information. FL's approach to control problems mimics how a person would make decisions, only much faster [10].

### 4.1 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 [5].

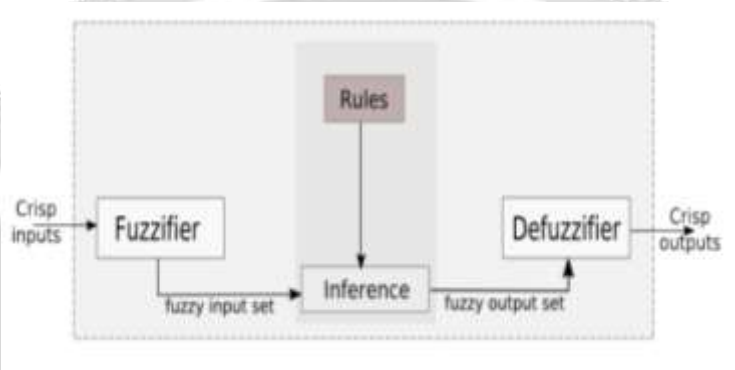


Fig-1Fuzzy logic system

A FLS consists of four main parts: fuzzifier, rules, inference engine, and defuzzifier. These components and the general architecture of a FLS are shown in Fig-1.

### 4.1 Fuzzy Logic System

The process of fuzzy logic is explained in as follows:

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

Firstly, a crisp set of input data are gathered and converted to a fuzzy set using fuzzy linguistic variables, fuzzy linguistic terms and membership functions. This step is known as fuzzication. Afterwards, an inference is made based on a set of rules. Lastly, the resulting fuzzy output is mapped to a crisp output using the membership functions, in the defuzzication step.

### 4.2 Membership Function

A membership function for a fuzzy set A on the universe of discourse X is defined as $\mu A: X \rightarrow [0,1]$, where each element of X is mapped to a value between 0 and 1. This value, called membership value or degree of membership, quantifies the grade of membership of the element in X to the fuzzy set A. Membership functions allow us to graphically represent a fuzzy set. The x axis represents the universe of discourse, whereas the y axis represents the degrees of membership in the [0,1] interval. Simple functions are used to build membership functions. Because we are defining fuzzy concepts, using more complex functions does not add more precision [9]. The membership functions are as follows:

**Triangular function**: Triangular function is defined by a lower limit a, an upper limit b, and a value m, where a < m < b.

$$\mu_A(x) = \begin{cases} 0, & x \le a \\ \frac{x-a}{m-a}, & a \le x \le m \\ \frac{b-x}{b-m}, & m \le x \le b \\ 0, & x \ge b \end{cases}$$

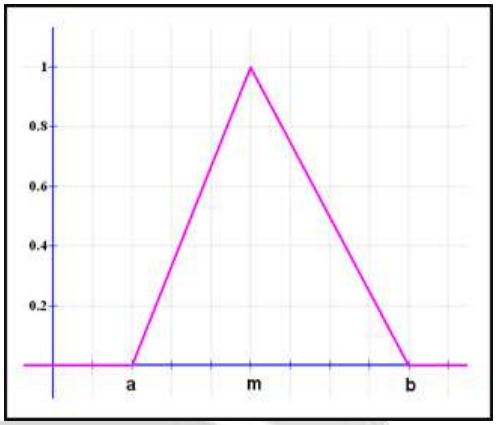


Fig-2 Triangular membership function

**Trapezoidal function**: Trapezoidal function is defined by a lower limit a, an upper limit d, a lower support limit b, and an upper support limit c, where a < b < c < d.

$$\mu_A(x) = \begin{cases} 0, & (x < a) \text{ or } (x > d) \\ \frac{x-a}{b-a}, & a \le x \le b \\ 1, & b \le x \le c \\ \frac{d-x}{d-c}, & c \le x \le d \end{cases}$$

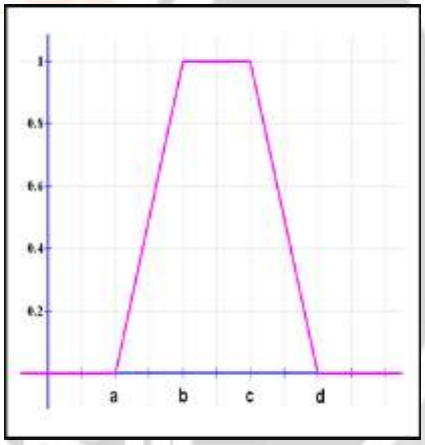


Fig- 3 Trapezoidal membership function

There are two special cases of a trapezoidal function, which are called R-functions and L-functions:

- **R-functions**: with parameters c = d = - ∞

$$\mu_A(x) = \begin{cases} 0, & x > d \\ \frac{d-x}{d-c}, & c \le x \le d \\ 1, & x < c \end{cases}$$

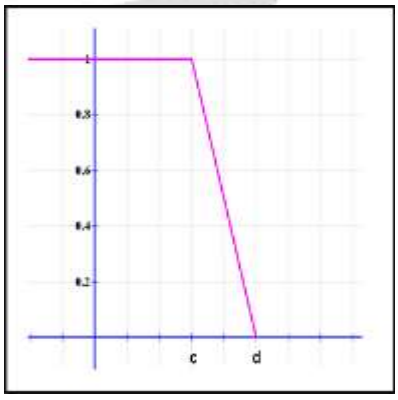


Fig-4 R function

- **L-Functions:** with parameters a = b = + ∞

$$\mu_A(x) = \begin{cases} 0, & x < a \\ \frac{x-a}{b-a}, & a \le x \le b \\ 1, & x > b \end{cases}$$

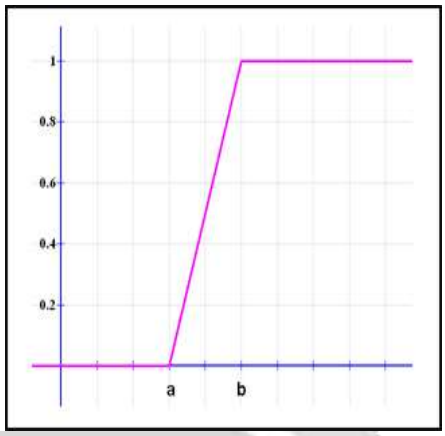


Fig-5 L function

**Gaussian function**: Gaussian function is defined by a central value m and a standard deviation k > 0. The smaller k is, the narrower the "bell" is

$$\mu_A(x) = e^{-\frac{(x-m)^2}{2k^2}}$$

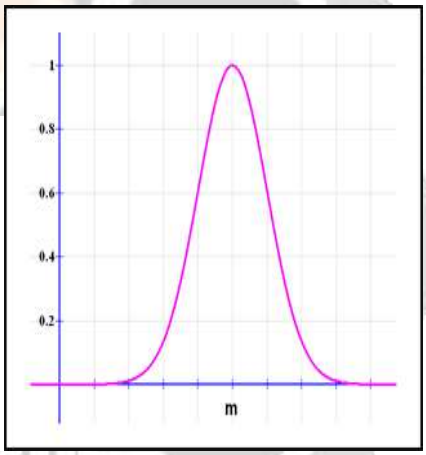


Fig- 6 Gaussian function

### 4.3 Fuzzification

The fuzzification comprises the process of transforming crisp values into grades of membership for linguistic terms of fuzzy sets. The membership function is used to associate a grade to each linguistic term.

### 4.4 Fuzzy Rules

A fuzzy rule is defined as a conditional statement in the form:

**IF x is A**
**THEN y is B**

Where x and y are linguistic variables; A and B are linguistic values determined by fuzzy sets on the universe of discourse X and Y, respectively [8].

### 4.5 Defuzzification

The resulting fuzzy set must be converted to a number that can be sent to the process as a control signal. This operation is called defuzzification. The resulting fuzzy set is thus defuzzified into a crisp control signal. A common and useful defuzzification technique is center of gravity (COG). The crisp output value u is the abscissa under the centre of gravity of the fuzzy set,

$$u = \frac{\sum_i \mu(x_i) x_i}{\sum_i \mu(x_i)}$$

Here $\mathbf{x_i}$ is a running point in a discrete universe and is its membership value in the membership function. The expression can be interpreted as the weighted average of the elements in the support set. For the continuous case, replace the summations by integrals.

## 5. OVERVIEW OF PROPOSED SYSTEM

The flow diagram of proposed system is as shown in Fig- 5.

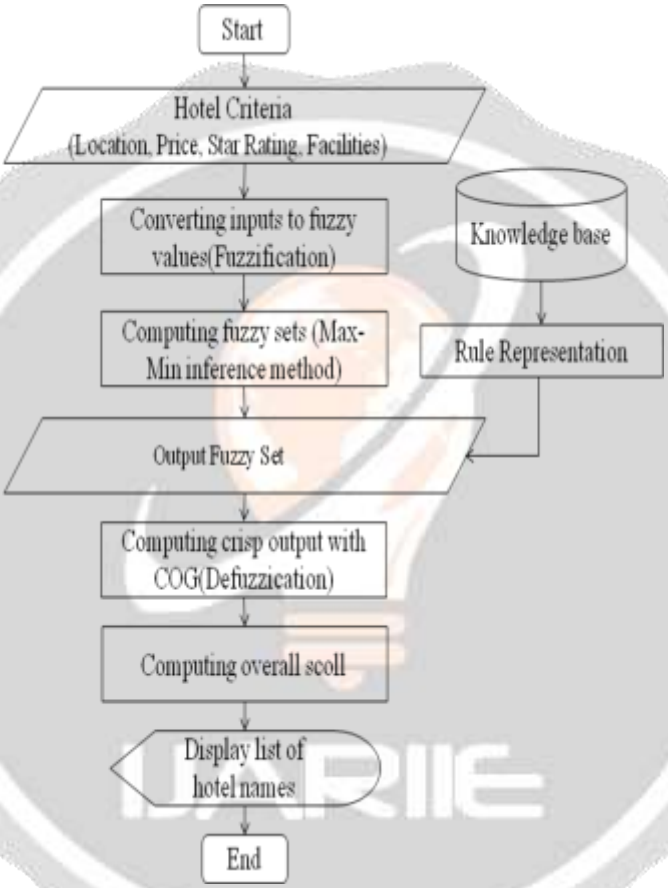


Fig-2 Flow chart of proposed system

In this system the user selects the criteria (Location, Price, Star rating and facilities) for desired hotel as input. And then the selected criteria are converted into fuzzy values to compute fuzzyfication with predefined rules in database using triangular membership function. After that computes the defuzzification using Center of Gravity and overall scroll. Finally, this system displays the list of appropriated hotels for selected criteria for the user.

## 6. CONCLUSIONS

The capabilities of fuzzy logic have been proved in many domains such as decision making and expert system. The ability of fuzzy logic makes them very flexible and powerful in the vendor selection.

This system is intended to be useful for tourists and visitors when making a decision about choosing hotels. This fuzzy rule based expert system is designed to suggest a list of accommodations to the tourists based on their interests and priorities.

The suitable accommodation considering cost, facilities, star rating and location are selected as hotel criteria. The selection of hotel includes a decision-making process and its results empower the tourists with more effective services for a better rate of satisfaction. It provides the customer valuable information and support decision to

choose required hotel. The users can save of time in searching required information and can be able to select the most suitable information.

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