



A REVIEW ON THE APPLICATION AND CONCEPT OF FUZZY THEORY

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Abstract:

Mathematics is regarded to be both the highest form of art and the highest form of science. The vast majority of mathematical concepts and operations are applicable to a wide variety of other fields, including engineering, robotics, physics, and many more. Fuzzy logic is an example of one of these terms. This concept is gaining more and more favour in the field of mathematics, as well as in other disciplines, such as engineering, medical science, robotics, and other areas, and even in homes. The idea of fuzzy logic and the ways in which it might be used in a variety of fields are discussed in this article. This study demonstrates the use of the fuzzy logic technique in a variety of fields, including the fields of chemical science, medical science, agricultural, political science, operations research, environmental science, and household. According to the findings of this study, the fuzzy logic technique is comprised mostly of three stages: fuzzification, rule or inference, and defuzzification. According to the results of the study, fuzzy logic is not a mathematical logic but rather a broad approach that may be used in a variety of different domains.

Keywords: *Fuzzy logic, fuzzy logic application*

Introduction:

The phrase "fuzzy logic" comes from the area of mathematics and has been put to use by a wide variety of researchers working in a variety of disciplines and historical periods. The use of fuzzy logic has resulted in a significant paradigm shift. The use of fuzzy logic has made a number of tasks more simpler, which has resulted in significant time, financial, and resource savings. In 1965, Lotti Zadeh was the first person to put up the idea of fuzzy logic. Before Zadeh, a great deal of work had already been done in this area by a variety of academics, including Plato, Hegel,

Marx, and Lukasiewicz, amongst others [1]. Some of them presented logic with three values, some of them presented logic with four values, and some of them presented logic with five values. These are extensions of Boolean logic, which only takes the values true and false (0 or 1).

In his work titled "Fuzzy sets," Lotti Zadeh developed mathematical concepts as fuzzy sets and fuzzy logic. Before the development of fuzzy logic, mathematics could only reach one of two conclusions: either true or false (0 or 1). This range, however, has been expanded to include real numbers thanks to fuzzy logic (0, 1).

This article provides an introduction to the idea of fuzzy logic as well as a short survey of its applications in a variety of domains. This research illustrates how fuzzy logic has been used in a variety of contexts and the ways in which its application simplifies both processes and ideas.

Concept of Fuzzy Logic:

The only two values that are acceptable in Boolean logic are true and false (0 or 1). In this context, one may discuss either low or high. It makes no reference to anything that occurs in between the two of them, which means that it does not take the idea of a medium into account. This may be accomplished by the use of a more expanded notion known as fuzzy logic, which accepts values between [0, 1]. As a result of this idea, it is possible to speak not only of low, high, and medium, but also of very low and very high. In other words, it is an expanded form of the Boolean logic.

The word "fuzzy" refers to anything that is not widely known or is not clear enough. A proposition in fuzzy logic may be either true or false, or it may have some true value in between the two extremes. It is constructed such that it may deal with the idea of partial truth. The membership function serves as a representation of the level of truth. Any function from a set X to a real unit interval [0, 1] may be considered a membership function on that set. The number 0 denotes a false value, while the value 1 denotes the truth value. A value that falls somewhere in the middle of the two denotes an

incomplete or qualified truth. The similarity between fuzzy logic and human thinking is one of the most significant benefits offered by this kind of logic. In this, the complexity is reduced through the use of linguistic variables.

Fuzzy Logic Control:

There are three stages involved in the fuzzy logic controller's process. The initial process is called fuzzification. This crisp variable will be turned into a fuzzy variable in this step. In the second stage, certain rules are established by using an If-Then structure, and the inference system is put to use. The defuzzification process is the third phase. This results in a fuzzy output, which is then converted into a crisp variable [2].

Application of Fuzzy Logic:

The basis of fuzzy mathematics may be found in fuzzy sets and fuzzy logic. Fuzzy mathematics is an extension of classical mathematics. The idea of fuzzy logic covers a lot of ground. A wide variety of disciplines, in addition to mathematics, have made use of it. In this study, we will examine a few different fields where fuzzy logic has been effectively implemented. The following is a description of a selection of them:

Chemical science:

The field of chemical chemistry has made use of fuzzy logic. Davidson and Hayward [3] looked at a wide variety of cases that included the use of fuzzy logic. The research conducted by Almaridy used a fuzzy control system to limit the amount of electricity required to safeguard a

lengthy underground pipeline [3]. This was accomplished by applying current to a sequence of anodes using the system. According to the findings of the research, he accomplished this by establishing a fuzzy control system with 126 rules and obtaining output by modifying the output membership functions. In their study on managing the pH of flowing waste water, Adroer et al. showed that fuzzy error, also known as the discrepancy between the intended and real pH, existed [3]. The fuzzy approach that was used by Adroer et al. discovered that an appropriate pH control could be given with a tiny mixer in a short amount of time. The results of the research demonstrate that fuzzy logic has significant applications in the field of chemical chemistry.

Healthcare Industry:

There have been applications of fuzzy logic in the medical field. Many people think of biomedicine as a part of science, but in reality, it is more of an art than a science. as a result of the use of human knowledge, experience, and skills in the diagnosis and treatment of illnesses. Systems used in biomedicine are inherently nonlinear, time-varying, and delayed in their responses. A real-time fuzzy control medication delivery system was tested in the 1980s [10] to see whether it might help manage patients' blood pressure who had had open-heart surgery. According to the findings of the research carried out by Davidson and Hayward [3,] Warren et al. proposed a decision support system that used fuzzy logic in order to automate the process of applying clinical practise guidelines. According to the

findings of the research, the test report provides probability estimates rather than confirmation of the existence or absence of the illness. In the fuzzy technique, likelihood estimates may be treated as membership values and utilised as such in the fuzzy inference model. As a result, the research demonstrates that fuzzy logic has a significant contribution to the medical field.

Agriculture:

Research conducted by Philomine Roseline T and N. Ganesan [4] on the use of fuzzy logic in the agricultural sector. This article presents an application of fuzzy logic in the control of pests, diseases, and weeds; the development of an expert system for a variety of crops; and the investigation and analysis of soil. According to the research published in the study titled "Design and development of Fuzzy Expert System for Integrated Disease management in Finger Millets," illnesses might be immune, extremely resistant, resistant, moderately resistant, susceptible, or very susceptible. The expert system uses a technique called fuzzification and defuzzification to reason things out that were previously only possible for agricultural researchers or experienced farmers. The research presented in the article titled "Integrated pest management system utilising fuzzy expert system" demonstrated three inputs in the fuzzy logic method based on pests. These were the number of pests, the size of pests, and the damages caused by pests. In the study titled "Design and development of expert system for potato crop," the soil condition was examined with the help of

fuzzy membership function using a fuzzy-based expert system. According to the findings of the research, the use of fuzzy logic has significant value in the field of agriculture.

Political Science:

The process of selecting a candidate for election, as well as the forecasting of election results and other similar activities, fall within the purview of political science, and a technique based on fuzzy logic may be used for these purposes. When choosing a candidate, the author of the study "Selection of candidate by political parties using fuzzy logic" [9] suggests taking into account the following five factors: conduct, age, character, publicity, and education. The research presented in the article demonstrates that there are no concrete guidelines or mathematical formulae that can accurately predict the outcome of a situation. Therefore, the use of fuzzy logic is recommended for this activity. The research published under the title "Election outcomes prediction system based on fuzzy logic" [5] illustrates the use of three stages of fuzzy logic in order to forecast the outcome of an election. According to the findings of the research, nine parameters were chosen for use in the research as input variables, and one was chosen to serve as an output variable. Following this, 91 rules were programmed into the fuzzy system, and MATLAB's fuzzy logic toolbox was used as the software's toolbox. The research also demonstrates that results are presented in the form of percentages, which illustrates the varying degrees of probabilities of

winning. As a result, fuzzy logic has made a significant contribution to the field of political science.

Operations Research:

In operations research, we focus on finding solutions to issues that arise while trying to maximize something. The goal of operations research is to maximize profits while minimizing costs associated with production, transportation, and other expenses. Operations research is another field where fuzzy logic may be useful. The cost of transportation may be cut down significantly by using fuzzy logic. Pappis and Mamdani (1977) [2] were effective in their use of fuzzy logic in operation research methodologies. The research demonstrates how fuzzy logic can be used to manage the intersection of two streets that only go in one direction. Teodorovic and Kalie (1996) selected the mode of transportation using fuzzy logic in order to minimize travel costs and travel times [2]. Additionally helpful in the field of traffic control is fuzzy logic. Jarkko and Esko (2003) used fuzzy logic to reduce the amount of time drivers had to wait at traffic lights and the likelihood of accidents occurring [2]. This aspect of the research exemplifies the use of fuzzy logic to the field of operations research. Therefore, fuzzy logic has a significant impact on the field of operations research.

Household:

Fuzzy logic is being included in an increasing number of household appliances these days in order to save costs and improve efficiency. A fuzzy logic system may be found in a variety of household appliances, including washing

machines, vacuum cleaners, air conditioners, and others. The two most prominent studies that make use of fuzzy logic are Tiryaki and Kazan's dish washer using fuzzy logic and Alhanjouri and Alhaddad's maximize wash time of washing machine using fuzzy logic. Both of these research were conducted by Tiryaki and Kazan. After then, a lot of researchers started working on this subject in order to shorten the amount of time it takes to wash things and use less time and water overall. The research presented in the article titled "Washing machine utilizing fuzzy logic" [7] demonstrates the use of fuzzy logic in washing machines. According to the findings of the research, there are four variables serving as inputs and five variables serving as outputs, along with eighty one rules to establish the relationships between these variables. Other researchers have employed sensors installed in washing machines to determine linguistic inputs such as the sort of garments being washed, the type of grime being washed with them, the amount of clothes being washed, and so on. These settings regulate the linguistic output, which includes the amount of time spent washing, spinning, rinsing, etc. The research demonstrates the use of fuzzy logic not only in air conditioners but also in air coolers. According to the findings of the research presented in the article titled "Application of Fuzzy Logic in Daily Life" [2], the process of designing the room cooler may include the use of many input and output values. The research looked at two input factors, namely temperature and humidity, as well as three

output variables, namely the speed of the cooler fan, the speed of the water pump, and the speed of the exhaust fan. In order to get the best possible outcome, fuzzy logic was used for the analysis. Therefore, fuzzy logic has a significant contribution to make in the domestic sphere.

Environment Science:

Fuzzy logic may be employed in Environment science aswell. It has been effectively used in the detection of natural disasters such as flooding, as well as changes in the environment, etc. The study "Prediction of flood detection system Fuzzy logic method" [8] was analysed, and the results indicated that a fuzzy logic model with If-Then rules is highly beneficial for the prediction of flood detection system based on the Mamdani approach. [Citation needed] [Review] In this particular piece of research, the water level and the climatic conditions are used as inputs, while control action is utilised as an output, and a total of twenty-five rules are established in order to facilitate the process of flood prediction. It is now feasible, because of fuzzy logic, to develop automobiles that are better, more efficient, and safer, which will help preserve the environment. Therefore, fuzzy logic has made a significant contribution to the field of environmental research.

Conclusion:

Two valued logic, often known as Boolean logic, is expanded upon to create fuzzy logic. Fuzzification, an inference system, and defuzzification are the primary three phases that are used in this process. It is simple to teach by using

fuzzier approaches to instruction in the classroom. Therefore, rather of using two-valued logic, it would be more acceptable to employ multivalued fuzzy logic. This article provides a concise introduction to fuzzy logic as well as its many applications in a variety of disciplines. This study just provides a high-level overview of fuzzy logic and the many fields in which it may be used since very little of the subject is discussed. However, it is useful in a wide variety of contexts, many of which have just recently been uncovered and brought to light. There is still a great deal more that has to be found out. The notion of fuzzy logic and its applications in the fields of chemical research, the healthcare business, and agriculture are discussed in this study. In the fields of political science, operations research, domestic science, and environmental science respectively. Therefore, fuzzy logic has developed into a useful tool not only in mathematics, but also in a great many other fields.

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