

# A STUDY ON FUZZY LOGIC AND ITS APPLICATIONS ON ACCURATE METHODS FOR PROCESSING DATA FINDINGS

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**Abstracts-**The purpose of this research is to provide light on the ways in which the use of fuzzy logic may assist in the resolution of problems and the enhancement of human prosperity and health across a broad variety of domains. We came to the conclusion that fuzzy logic may be used in a broad variety of industries, such as business, politics, the environment, chemistry, physics, statistics, medical, computer science, engineering, agriculture, and many more. We show how it may be used as a tool for regulating complex systems and processes, together with other expert systems, electronics for the home and entertainment, and screening for production potential, accuracy, and so on. The process of creating fuzzy decisions, which may be carried out in a variety of different ways, is an essential part of fuzzy logic systems. The level of accuracy that is necessary, the databases that are accessible, the clarity of the data, and a variety of other factors are what decide whether or not these approaches can be used. All modeling and forecasting software relies heavily on fuzzy logic as their primary method of analysis.

**Keywords:** Fuzzy set, Fuzzy logic, Fuzzy inference system, Fuzzy logic controller, Fuzzy logic applications.

## 1. INTRODUCTION

A thorough investigation of the ever-

growing importance of mathematics in the fields of fuzzy set theory and fuzzy logic. A qualitative computing method known as fuzzy logic may be used to convey ambiguity or just part of the truth. The development of Zadeh's fuzzy set theory, which is adaptable and places more emphasis on the degree of belonging to the set rather than the set itself, facilitated an improvement in the creative idealistic mathematical method by making it possible to just reveal part of the truth. The fuzzy set notation, which was created by Lotfi A. Zadeh in 1965, is the foundation of the method that has shown to be the most effective. It was a discovery of his that standard computer logic could not be used to govern data that reflected arbitrary or ambiguous conceptions.

Zadeh came up with the idea for the fuzzy control system, and he used a mathematical technique called fuzzy logic to make it work. Fuzzy logic is an approach to mathematics that analyses input data in terms of logical variables that may take on continuous values between 0 and 1 (false or true). In 1968, he made the first proposal for fuzzy algorithms. In 1973, he released yet another significant piece of research that would eventually form the basis of fuzzy control. In order to communicate human knowledge, he advocated for the use of IF-THEN rules, which are based on fuzzy logic, and he was a pioneer in the idea of linguistic variables. A significant

contribution to the implementation of fuzzy sets and fuzzy logic was made by Mamdani 1975. Fuzzy sets and fuzzy logic were used in the fields of engineering and mathematics around the year 1980. Japanese engineers who were working on a new technology found that fuzzy controllers were both very simple to construct and beneficial for a broad variety of issues. This was discovered by the engineers when they were working on the new technology. In the year 1980, Sugeno produced his very first fuzzy application, which was titled "control of a Fuji electric water purification plant." In 1983, he was the one who invented the fuzzy robot. In 1985, Sugeno and Nishida debuted a self-parking automobile that could be directed by the driver by calling out instructions. Between the years 1980 and 1990, advancements were made quickly in fuzzy systems and control. In addition, a complex consistency analysis of fuzzy control systems was carried out by using cutting-edge methods (neural network approaches) to generate membership functions in a methodical fashion. Since 1995, there has been a significant increase in the research of fuzzy set theory, as well as its application to fuzzy logic systems, as well as the development of brand new theories like possibility theory and evidence theory.

The number of real-world applications of fuzzy set theory is continuously increasing, and its reach is expanding into a wide variety of new fields. Examples of knowledge-based information systems include those found in the fields of engineering, computer science, physics, chemistry, biology, ecology, political science, geology, meteorology, nuclear engineering, medical science, medicine, economics, psychology, agriculture, and a number of other disciplines. The ultimate objective of ongoing research and development on fuzzy applications in software design is

to construct self-learning fuzzy control systems. This research and development includes fuzzy expert systems as well as the integration of fuzzy logic with neural network and genetic software systems. Ambiguity serves as the backbone of the complexity definition, and uncertainty is often the root cause of ambiguity. Since the beginning of time, individuals have instinctively found solutions to challenges that are characterized by complexity and ambiguity; these traits are visible in the majority of the social, technological, and economic difficulties that the human race encounters today. Before deciding on a technique that is suitable for expressing the uncertainty, engineers need to do a comprehensive analysis of the nature of the uncertainty that is present in the current job. A mathematical account of the ambiguity and fuzziness that may be found in humanistic systems can be found in fuzzy sets. The concepts of fuzzy logic and fuzzy set theory may be used in a variety of contexts. These include information and knowledge base systems, a variety of scientific and technical fields, and almost every aspect of decision-making. The notion of fuzzy logic may be simplified to say that it is a superset of either Boolean or crisp logic. Fuzzy logic is an effective method for issue resolution. The word "fuzzy logic" refers to a kind of logic that can cope with conceptions that can only be defined as "partially true" or "partially false" rather than "true" or "false," which makes it simpler to automate occupations that people can already execute well on their own. Fuzzy logic is referred to by the term "fuzzy logic." The level of accuracy that is necessary, the databases that are accessible, the clarity of the data, and a variety of other factors are what decide whether or not these approaches can be used. Fuzzy logic should be considered an essential method of operation for any modeling and forecasting program. This article provided an illustration of a variety of fuzzy logic applications that

could be put to use to clear up any ambiguities that were present in the work that was provided.

## **2. FUZZY LOGIC AND ITS APPLICATIONS IN SOME AREA**

### **➤ Commerce**

Recently, fuzzy logic has been used in corporate settings. The construction of an expert system that employs a fuzzy logic method in order to examine the attributes of business-to-consumer websites from the viewpoint of customers and to explain which elements further influence users' inclinations to make purchases. Websites that connect businesses directly with customers place a premium on information, security, and privacy protections. An online survey was given to students who had previously made purchases online via business-to-consumer websites. The data collected from this survey was utilized for research. Alongside the FIS, a fuzzy logic-based assessment system was developed for the purpose of analyzing the attributes; this system was based on three aspects of the B2C website. The outputs of the FIS model were represented by the Triangular MFs, whilst all of the variables' English phrases were transformed into Gaussian MFs before being utilized as inputs. It was found that the FIS made use of fuzzy rules, and those rules stipulated that MFs should be used for all fuzzy system inputs and outputs. The findings of the expert system demonstrated that fuzzy logic is capable of accurately assessing the qualities of business-to-consumer websites. When contrasted with other qualities of business-to-consumer websites, security had the greatest impact on customer trust, with maximum levels averaging approximately 0.656 when compared to the other characteristics.

It is generally acknowledged that trust is one of the most important factors in the ongoing development of business-to-customer electronic commerce (B2C EC). The bulk of the trust models that have been produced are subjective and fail to take into consideration the ambiguity and vagueness of electronic commerce trust, as well as the customers' intuitions and experiences when doing online transactions. Although many trust models have been developed, the vast majority of them have been developed. The researchers devised a model of fuzzy trust that is based on fuzzy reasoning so that it may be used to quantify EC trust. It has been shown that using this trust model, which is based on the information that customers anticipate seeing on an EC website, increases users' confidence in online retailers. They contend that fuzzy logic, similar to human interactions, is often represented by linguistic phrases rather than numerical values and that it is appropriate for evaluating trust since it takes into account ambiguities in e-commerce data. The suggested model will be examined using two case studies and compared to two evaluation models in order to illustrate the efficacy of using fuzzy logic. The comparison will take place using two evaluation models. They provided a method that was based on fuzzy logic in order to simplify the process of evaluating and quantifying confidence in EC. Despite the fact that it has resolved several problems that previous systems have not, such as leveraging a great number of variables and taking into consideration the fuzziness of trust, we feel that the system may be enhanced in a variety of different ways. Other factors, besides trust, may affect whether or not an online transaction is successfully completed, as numerous models of trust have hypothesized. This includes the cost of the item, how rare it is, and the whole experience the client has with it. In order

to build an efficient decision-support system, every future development should handle at least some of the factors listed above, if not all of them. The price of the item is certainly significant since several studies have shown that customers are willing to assume the greatest amount of risk in order to get an item provided the price is sufficiently low. Personality and life experience of the buyer are additional factors that play a role in online shopping decisions. It's possible that certain buyers may place a greater emphasis on some factors than others. As a consequence of this, we think that in the not-too-distant future, systems will need to provide users the ability to rate various trust criteria according to their own views and experiences.

Both the management of financial crises and the conduct of research related to finance may benefit from the use of fuzzy logic. Web of Science and Scopus were used to collect the data, and after that, the records were evaluated in accordance with the criteria that had been defined. Finally, the records were organized along two primary axes: corporate finance and financial markets. This investigation revealed an important finding: fuzzy logic has not yet been used to handle financial crises or as an alternative to secure bank resolvability while reducing economic damage. Neither of these outcomes has been achieved to far. This study is important for supervisory and regulatory agencies, banks, and university academics since it opens up a number of new research avenues in the application of artificial intelligence to the analysis of financial crises. As a result of this, the study is noteworthy.

The fuzzy system was designed to assist in the assessment and measurement of trust in online commerce, and it does so by being based on a specific trust model. These days, dependability is a popular

subject in the information technology industry all around the globe, particularly in relation to service-oriented systems. The promise that was held out by e-commerce has not yet been fully realized, despite the fact that there are now some prosperous businesses operating in the field of e-commerce on a global scale. People's mistrust of companies that do business online is at the heart of this problem. Once again, there is a lack of practical ways that may be used to evaluate the reliability of various online commercial firms. The vast majority of trust models that are used in practice today are subjective and neglect the ambiguity and vagueness that exist in a variety of domains. In order to take into consideration the ambiguity and vagueness that exists in a variety of domains, a brand-new Certain Trust model that is based on fuzzy logic has been developed. Systems such as cloud computing, the internet, websites, and e-commerce platforms might all benefit from the implementation of the Fuzzy Based Certain Trust Model, which is a model for determining trustworthiness that is based on specific values that are offered by industry professionals and software developers.

#### ➤ **Politics**

Everyone has an interest in politics since it's such an important topic. In spite of the fact that they talk about elections, predictions, and results, fuzzy logic provides an effective solution to the issue. It was feasible to construct a fuzzy inference system that permits the interaction of a large number of different elements linked to political marketing. This assisted in the analysis of the potential effects a candidate may have on their chances of winning an election. The student representative has to be capable of developing a campaign that is both of high quality and high effectiveness, and it has to cater to the requirements of students in a particular market. You can enhance the fuzzy cognitive map by

using modern tools like Facebook and Twitter, which will enable you to add new variables and collect student feedback as you continue to analyze both negative and positive causal relationships with the statistics obtained at the conclusion of the advertising campaign. This will help you determine whether or not the advertising campaign was successful. Under conditions of uncertainty, the element of chance connected with the choices made by students at the University of Guayaquil when selecting a candidate to serve as a student representative; similarly, the efficacy of electoral marketing strategies done by parties and student organizations in an effort to win over voters. In this article, a methodology for developing causality models based on expert criteria and making these models useful for decision making is proposed. Additionally, an analysis of fictitious scenarios based on the underlying concept structures with the most significant causal weight related to the effectiveness of electoral marketing strategies is presented. It uses techniques such as fuzzy logic and cognitive mapping as its foundation.

The Mexican government initiated the conservation initiative known as "Productive Reconversion" (PRP) in the Upper Gulf of California and the Colorado River Delta Biosphere Reserve (UGCCRDBR). In order to measure the effect of the integration of fuzzy logic (FL), the term "efficiency perception" was utilized. They developed a program as well as an efficiency-perception effect evaluation based on the incorporation of FL derived from the Productive Reconversion. The inherent ambiguity and imprecision that are connected with people's judgements and conclusions are addressed by this method. This paper discusses the use of FL to program efficiency evaluations, illustrating how subjective judgments may be transformed into quantitative values that

are simple to verify throughout the decision-making process. The application of FL to program efficiency assessments is examined.

In order to provide insight into how knowledge might be expressed and preserved in order to help the intelligent decision-making process, a fuzzy ontology method was used. The process of making political decisions is becoming more difficult as a result of events that are occurring on a regional and global scale. This is particularly true when it comes to the choice of whether or not to enhance the economic linkages that exist between friendly nations. Certain aspects and components that are based on information that is not reliable and that is unclear have an effect on the judgments. The challenge of creating an efficient political decision support system (DSS) with a wide variety of components is one of the most significant obstacles that the decision maker must overcome. The fundamental idea is based on a linguistic variable that has word values rather than quantitative values, which is because word values are easier for people to grasp than numerical values. Natural language serves as the foundation for fuzzy logic, which can accommodate incorrect input and is hence more forgiving. In addition, fuzzy cognitive mapping, also known as FCM, is very helpful in the field of political science and other areas of soft knowledge. In that line of study, an FCM diagram is utilized to illustrate the tangential connections that exist between the various components in order to get a deeper comprehension of the ways in which these elements interact with one another. The research presented here makes use of fuzzy algebra as a means to govern the causal propagation on FCMs.

Every member of the party has an interest in the party's electoral success, which is contingent on putting forth the

most qualified candidates for office. It is possible to pick any team leader for an election, regardless of whether it is a municipal election, legislative or parliamentary election, senate election, or any other election. In point of fact, political parties choose their candidates via the assistance of a wide range of organizations; yet, there are some essential standards that must be satisfied by all political parties. As a direct consequence of this, each election often has hundreds of candidates. Voters who don't participate in politics very often, on the other hand, would have a tough time selecting the best candidate. As a consequence of this, it is the duty of the party leader to choose an excellent candidate who has a strong chance of winning the election by taking into consideration a number of positive characteristics. These characteristics may include notoriety, the amount of time a person has spent involved in politics, responsiveness, temperament, criminal records, age, and education, amongst others. It is recommended to make use of a selection evaluator that is based on fuzzy rules if the goal is to choose the most qualified candidate to win an election. In addition, it reduces the amount of paperwork that has to be done and fosters more trust, collaboration, and understanding among party members, all of which contribute to the increased likelihood that a party will win.

### ➤ **Environment**

Today, every natural resource is diminishing, which is why it is necessary to manage them. The management of water, water quality, pollution, and a variety of other environmental issues are all handled using fuzzy logic systems. Water is essential to life, and the quality of that water is critical to its survival. Because the existing indices have inconsistencies that need to be resolved, it is required to adopt a methodology that is more reasonable for calculating the

water quality index. When calculating the Water Quality Index (WQI), each index makes use of its own set of water quality characteristics. In order to make decisions on the quality of the water, a complicated computational method that is able to cope with hazy, inconsistent, and inaccurate data is necessary. As a consequence of this, a strategy that is more reliable and that is able to handle the ambiguity and uncertainty that are inherent in the evaluation of water quality is required. The use of fuzzy set theory has shown to be an effective method for reducing the amount of subjectivity, uncertainty, ambiguity, and vagueness that is associated with environmental issues. The old name of "Water Quality Index" (WOI) was changed to "Fuzzy Water Pollution Index" (FWPI), reflecting the usage of fuzzy set theory and fuzzy logic in the process of quantifying water pollution. When looking at FWPI, a greater value indicates a higher overall concentration of pollutants.

The management of water quality is an essential topic that is still relevant in the modern world. When constructing water quality indices for classification, parametric data on water quality data, as well as the expert's interpretation of the importance and weights assigned to each parameter, are taken into consideration. The objective method of calculating the water quality index is often used as a tool in the management of water quality reduction initiatives. This is done in order to present a clear and simple image of the overall trends in water quality. One of the most important things that a fuzzy logic system does is something called fuzzy decision making, which may be carried out in a number of different ways. The level of accuracy that is necessary, the databases that are accessible, the clarity of the data, and a variety of other factors are what decide whether or not these approaches can be used. The methodology of fuzzy logic is

the cornerstone around which all modeling and forecasting software is built. The answer to challenging simulated issues that include a number of input and output variables may often be found via the use of a sophisticated mathematical technique known as fuzzy logic. In the field of environmental engineering, it may be challenging for non-specialists to evaluate the severity of the contamination. The fuzzy rule-based approach may be effective in environmental modeling systems because it offers a pleasant method for generating judgements utilizing a variety of criteria. This is due to the fact that the approach gives a pleasant process. They are effective because an approach based on fuzzy logic was used for calculating the air quality index.

#### ➤ Chemistry

The fields of chemistry and chemical engineering have both made use of fuzzy logic. In the field of chemical research, fuzzy logic may be used in a number of different ways. Target tracking, pattern recognition, robotics, power systems, controller design, chemical and biological engineering, vehicle technology, economic management, electrical and civil engineering, communications and networking, and decision-making are just some of the applications that make use of fuzzy logic. Product quality features are often classified by human specialists due to the fact that many chemical engineering systems lack the necessary measurement equipment. The process of establishing mathematical models for such systems is challenging since there are no equations that can be offered that are based on fundamental principles. In the field of chemical engineering, fuzzy logic has been used to the problem of identifying gases and detecting chemical agents. Kinetics, separation processes, batch distillation columns, and process control are among more applications of this concept. The investigation delved into

much more depth about these applications. Conventional logic may be thought of as a subset of fuzzy logic, which can be thought of as a superset that has been expanded to account for fuzzier truths. It had become one of the most effective methods for designing complicated control systems during the course of its history. The design strategy known as fuzzy logic may be used to provide solutions to issues that are present in the actual world. In the field of chemical engineering, fuzzy logic has been used in the following processes and products: the batch crystallizer, the separation process, the combustion process, the food product, the risk assessment for piping, the safety analysis, and the fluidized catalytic cracking unit. Additionally, it has been used in the fields of processes and kinetics.

To construct a mathematical model for the fuzzy logic controller (FLC), which manages the liquid level in the second tank of a coupled-tanks plant by varied manipulation of the liquid pump in the first tank, using basic physical ideas from science and engineering. After the model has been constructed, it is used in simulation studies via the usage of MatlabR12a for Simulink. In the research, FLC adverse PID controllers were compared, and the behavior of the system was presented in terms of time response. This behavior included the steady state error increase time, as well as overshoot. A novel FLC has been designed to solve a class of level control challenges that are encountered in industry and have unclear dynamics or unanticipated time delays. These problems may occur when there is a combination of both of these factors. The FLC is comprised of a limited set of rules that are straightforward to implement. In order to achieve desirable outcomes while dealing with a level control issue, it is possible to combine the FLC with an altogether other industrial level regulating device. It is

possible that in the not too distant future, an FLC for a system with two tanks will be created. This FLC will be an adaptive fuzzy logic controller akin to the PID algorithm. Such a controller will provide systems with excellent performance and intelligence.

As complex systems, chemical facilities and processes need in-depth scientific expertise on a broad variety of topics, one of which is the Process Safety Analysis (PSA). The combination of fuzzy set analysis and possibility theory is what we mean when we talk about fuzzy logic. The PSA of fuzzy logic may make use of arbitrary or approximate data. The influence that fuzzy set theory has on the fundamental PSA tools. It also emphasizes the many kinds of uncertainty, as well as the causes for and potential solutions to those uncertainties that might arise in PSA. The quality of the PSA may be improved using a variety of approaches, including statistical analysis, fuzzy logic, expert systems, and sensitivity analysis. One way for determining dependability is via the use of fuzzy logic. Utilizing fuzzy logic helped streamline and eliminate uncertainty in more conventional PSA methods, such as fault tree analysis (FTA) and event tree analysis (ET). Now, thanks to these gadgets, the procedure is secure, and just the proper amount of danger is there. The mathematical model that is based on fuzzy logic indicates the safety barriers that need to be put in place in order to avoid the top event from happening and to manage the effects of it if it does happen. The findings of the PSA showed that safety modeling based on fuzzy logic techniques may give safety analysts and designers with helpful tools to utilize at different phases of the design of chemical processes.

#### ➤ Physics

The use of fuzzy logic is possible in the field of applied physics. It has been used

effectively to find solutions to issues. In this particular investigation, fuzzy logic is used in order to deal with uncertainty that is associated with physics. The method that is used in mathematical theory in order to deal with various kinds of uncertainty. It is impossible for mathematical models that are based on classical set theory or two valued logic to properly represent obstacles that include the human factor. These challenges include utility theory, behavioral models of various aspects, and decision-making. Fuzzy set theory and fuzzy logic are used in order to address these types of problems. Black-and-white models are incapable of effectively depicting the fuzziness of human sentiments due to the complexity of human thought and emotions. As a result of this extension, fuzzy set theory may be used in contexts more extensively than can abstract set theory. These contexts include situations that call for some degree of subjective judgment. The theory of fuzzy sets and fuzzy sets in general were investigated throughout the whole of the article.

People who create nonlinear control principles for electrical or electromechanical systems may find it to be an appealing option to go in this direction. They make advantage of a recently developed on-site tuning strategy for a fuzzy logic controller that is similar to PID. They were a pre-defined set of parameters for an open loop stable or evaluative process that was electrotechnical in nature. A single loop identification test serves as the foundation for the fuzzy controller of this kind. In his study, Ziegler-Nichols compared the methods of on-site tuning to those that are used with standard controllers. The next step is to suggest a brand new group of pre-established criteria. It is a reliable one that takes into account the FLC's resilience to white noise, open loop process misidentification, and high order processes throughout the design process.



However, in order for this sort of arrangement to be steady, it is necessary for the user to be aware of (or able to get) the amount of the solicitation. As a result of this, it is ultimately advised that a second set of robust settings be used, which includes the Taguchi quality design process mapped out over three dimensions. They developed an approach based on experimental design that may be used in the future to establish new pre-determined parameters.

### ➤ **Statistics**

Practical applications of statistics and fuzzy sets are only two examples of the vast range of contexts in which fuzzy logic may be used. The presented methods make it possible to make use of personal statistics, which may be used to enhance the patient-specific construction of health monitoring systems and provide trustworthy conclusions based on prior data. To accomplish this objective, it is possible to achieve this aim by either adjusting or modifying the membership function or by using a preprocessing method that determines whether or not a certain circumstance is usual. It's possible that these needs may be satisfied by the deployment of a statistics-based, anytime fuzzy decision support system. In the event of a potential emergency, the system is able to make decisions far more quickly. In addition, the technique is helpful in determining whether or not a situation is crucial, as well as in adapting the model to the specific needs of an individual. The method that has been suggested involves the use of personal information in the decision-making process. This makes the approach more sensitive, in the sense that it more closely matches the patient's typical values, and as a consequence, it has a higher chance of excluding severe conditions. It is possible to add personal data that reflects the patient's typical responses in order to enhance the functions of the input membership.

Because of this improvement, the membership function is now closer to the predicted values, which makes the evaluation more reliable. Using this method, individuals who seem to have similar characteristics yet exhibit distinct behaviors when confronted with analogous challenges are uncovered.

The conventional approach to statistical analysis is founded on distinct data, theories of random variable relationships, decision-making standards, and other factors. There have been a number of different efforts attempted to make use of fuzzy set theory in order to do an analysis of the multiple scenarios in which the previously stated assumptions are somewhat suspect. Since the conception and growth of fuzzy set theory, a number of research have been carried out to investigate the possibility of combining statistical methods with the theory. A wide range of industries has contributed to the development of a new kind of work known as fuzzy statistics. This includes significant articles on topics such as fuzzy estimating, fuzzy hypothesis testing, fuzzy regression, fuzzy Bayesian statistics, and other areas of relevance.

### ➤ **Medical**

During a medical examination, a broad range of characteristics, which are referred to as symptoms in the medical field, may be formed and characterized. However, the majority of the medical information that is now accessible to clinicians will always be unclear, mostly due to the complexity of the human body. It is challenging to determine what constitutes an appropriate maximum limit for the many different factors. On the other hand, fuzzy logic has been used to the resolution of difficult problems. In the field of medicine, specific applications of fuzzy expert systems were built using these tactics as the foundation. An example of a condition that may be predicted with the help of the fuzzy expert system includes prostate

cancer, coronary heart disease, iron deficiency anemia, children's anemia, periodontal disease, and medication dosages. The fuzzy expert systems that were individually designed by the doctors assisted each one in making their diagnosis. He is of the opinion that in the not-too-distant future, the field of medicine will make use of fuzzy logic, fuzzy control, and hybrid fuzzy neuro systems.

In the fuzzy expert system, full blood counts are the method of choice for making a diagnosis of liver disease. For the purpose of the research, they measured a variety of blood parameters. In order to build the system, they made use of the MATLAB program, which is powered by the Mamdani inference engine. It has three output variables in addition to the four input variables that it has. The newly created liver disease diagnostics system is more efficient, cost-effective, and reliable than other standard diagnostic processes, such as those used in the past to diagnose liver illness.

An optimum control issue for the dynamics of the therapeutic hepatitis-C virus inspired the development of the fuzzy logic technique, which was then used to solve the problem. The study performed a numerical comparison with the direct way by obtaining the values of determinant parameters of this illness for those who were in charge of providing the medications. This was done so that the researchers could evaluate how effective this strategy was. The findings are in line with the data from the previous experiments. In order to find a solution to this issue, two different numerical algorithms were compared and contrasted in order to find the ideal paths for these determinant parameters that react to two different treatments (interferon and ribavirin) for hepatitis-C viral illness in a patient who takes

medication for a period of one year. The findings showed that both of the methods that were used were successful and completed successfully. The results demonstrate, in addition, that the hybrid technique, which makes use of fuzzy logic as a strategy, is more time efficient than the straight approach. As a direct result of this, it is an essential approach for working through the optimum control issue. It does this by precisely ensuring that the function of the hepatocytes is maintained and by delivering the optimal paths for both healthy and diseased hepatocytes.

Creating a controller in accordance with the principles of classical control theory sometimes calls for the use of a mathematical model. In most situations, the performance of the controller is negatively impacted by incorrect mathematical modeling of the plant. This is particularly true for nonlinear and complicated control issues. The creation of new resources for the potential future application of better and more efficient control has been stimulated by the invention of the Fuzzy Logic Controller (FLC) and neural controllers that are based on multilayered neural networks. The Fuzzy Neural Network, often known as FNN, is a system that combines fuzzy logic with neural networks. It has recently been suggested and developed. This system is often referred to by the acronym ANFIS, which stands for the Adaptive Neuro Fuzzy Inference System. In contrast to fuzzy logic, which has several inputs but only one output, neural networks have a large number of inputs and a large number of outputs. An application programming interface that is nonlinear is denoted by the acronym ANFIS. The researchers Akhil and colleagues (2013) discovered an ANFIS controller for a water bath system's temperature. When it comes to the adaptive temperature regulation of a water bath system, NFC that is based on ANFIS is the way to go. ANFIS is a

superior controller that is often used in comparison to those that are available from other manufacturers.

This system is a piece of computer software that takes use of the immense capabilities of the computer in order to simulate an actual-world scenario that involves artificial intelligence. In this method, rapid diagnosis of EHF is accomplished by using symptoms such as a high temperature, nausea and vomiting, bloody diarrhea, and aching muscles. This method has the benefit that it may detect an individual's EVD status based on the individual's fundamental language responses, which are evaluated from individuals who are suspected of having the disease. As a consequence of this, early detection and follow-up care will be provided to those who have traveled to regions where the Ebola virus is endemic. Tablet computers and mobile phones are only two examples of portable handheld devices that are compatible with the solution. The use of this tool considerably reduces the risk of incorrectly isolating individuals or of identifying sick people at a later stage than necessary. Due to this fact, it is an essential instrument for aiding with the manual laboratory diagnosis of Ebola, which takes around three weeks to complete. The application that has been built will contribute to a reduction in the death rate of Ebola patients. This will be achievable because the disease will be identified as quickly as possible, and the patients will get the right medication. While more work is being done to generate software that utilizes the technique, we are also encouraging other programmers to use it to create EHF diagnostic tools that are more effective and dependable.

#### ➤ Computer

The use of digital image processing is gaining widespread acceptance and has a significant bearing on a wide range of business sectors. This article takes a look

at the fundamental architecture and functioning of a knowledge-based system that is driven by fuzzy logic and makes use of digital image processing techniques to uncover objects that have been concealed or gone missing. technical developments in data mining, digital image processing, and artificial intelligence (AI). It is likely that in the future, a system may be created that would allow users to scan for things after submitting sketches or images of the objects they are looking for. It is possible that the system may be automated to scan the area and compare the resultant picture to the one that is stored in the database. This would reduce the amount of human inference required. The automated technology will, among other things, be of use in operations involving search and rescue. This will cut down on the amount of time spent searching and make it much easier to locate the pertinent information.

The hybrid fuzzy logic-neural network (HFNN) model is self-learning, much like a standard neural network, which was employed in this study to handle the issue of credit risk management. When comparing "good" and "bad" accounts, it is able to make a distinction between them with more precision than a conventional neural network. The "black box" neural network architecture is not appropriate for use in credit assessment; nevertheless, the HFNN model could be able to give criteria for the discriminating of accounts that are vulnerable to it. In this regard, the system is fairly similar to the standard fuzzy logic system. The HFNN model, on the other hand, has an advantage over the conventional fuzzy logic system since it can learn. The possibility of suffering monetary loss as a direct result of a debtor's incapacity to honor the terms of a loan or other kind of line of credit. Because there are so many different possible permutations of risk, the procedure for determining whether or

not a consumer is creditworthy is complex and non-linear. In order to find a solution to this issue, this research makes use of the HFNN model to develop a credit rating strategy. Using actual bank data, the model will be applied to, evaluated, and validated for individual vehicle loans. While the neural network is in charge of learning, fuzzy logic is the one responsible for actually doing the task. The neural network will apply correct fuzzy rules when the fuzzy sets are updated, extraneous input variables are removed, and the network eliminates any variables that are not relevant. The best k numbers of rules from the recovered fuzzy rules are kept in order to ensure that an informed choice may be made. The research results demonstrated that the HFNN model that was suggested was successful in terms of its accuracy, robustness, and dependability.

One method that may be used to evaluate the efficiency of an ad hoc network is the quality of service analysis. Due to the fact that it is mostly determined by four factors—throughput, packet delivery ratio, end-to-end latency, and jitter—the quality of service is a challenging job to perform. These four qualities are influenced by factors inside their own environment and experience change throughout the course of time. As a consequence of this, the quality of the service is a questionable instrument. They disclosed an innovative approach to managing uncertainty by announcing that it would use the fuzzy method to simplify the quality of service component and condense it into a single value for each application. They suggested using that approach to a mobile ad hoc network while utilizing a number of different protocols. The new method will result in the generation of a single, concise number that provides a summary of the usefulness of each operation across all applications. In

conclusion, the findings of the experiments provide credence to the basic assertion that a rising throughput does not always equate to an improvement in the quality of service given by the procedures.

The navigation of autonomous mobile robots in situations that are both dynamic and uncharted requires taking into consideration a broad variety of elements. Research into type-1 fuzzy logic has been of tremendous assistance in the management of mobile robots. Because it uses accurate fuzzy sets, type-1 fuzzy control has difficulty dealing with the uncertainties involved in this situation. In actuality, type-1 fuzzy sets are incapable of coping with the linguistic and numerical uncertainties associated with robot mechanical qualities, dynamic changes in the environment, or information employed during the concept phase of developing a fuzzy system. In other words, type-1 fuzzy sets can't handle robots. Because control based on type-2 fuzzy sets constitutes a new generation of fuzzy controllers for mobile robots, it is essential to investigate the advantages that type-2 fuzzy sets have over type-1 fuzzy sets. The study highlighted how critical it is to manage mobile robots by using type-2 fuzzy logic and provided in-depth and novel comparisons between the two facets of fuzzy logic. It focuses on the creation of innovative mobile robot controllers for type-2 fuzzy logic navigation in surroundings that are unpredictable or dynamic. The dynamic nature of the environment is highlighted by the fact that there are also dynamic robots present in the environment. For the purpose of demonstrating the performance of the proposed controllers, both simulations and experimental data are employed. This performance is then explained by means of graphical routes and numerical analyses.

➤ **Engineering**

The performance of the Binary Amplitude Shift Keying (BASK) technology used in millimeter-band gigabit modems will be improved as a result of the method to autonomous bandwidth management that has been outlined. The suggested technique uses a fuzzy system to change the bandwidth of the low pass filter in the receiver. This is done in order to enhance the overall performance of the BASK system, which has a predetermined bandwidth. The BASK system consists of a high-speed transmitter shutter, a counter, and a repeater all working together. The repeater is constructed up of four stage converters, one of which is equipped with both a limiter and a low pass filter. The output of the fuzzy system is the bandwidth, whereas the inputs of the fuzzy system are the remaining and integral remainders of the counter. In order to determine the most effective counter output detection, they used a Viterbi algorithm. The results of the simulation show that the suggested system works better than the system with a fixed bandwidth. This is shown by the fact that the proposed system was chosen.

They came up with a smart solution for flow metering by combining an improved fuzzy logic controller with ultrasonic transducers. The primary objectives of the research were to implement an ideal fuzzy logic model system in order to build a linear connection between the input and output parameters and to make the intelligent flow measurement approach sensitive to changes in pipe diameter, liquid density, and liquid temperature. In addition, the study sought to determine whether or not a linear relationship could be established between the input and output parameters. The approach that they suggested might be affected by the real flow rate and output of the intelligent technology that was used to gather practical data.

It is very necessary to construct a fuzzy inference system in order to facilitate objective decision making when the variables that are to be represented are nebulous and subjective. The suggested research demonstrated how the fuzzy inference system (FIS) may be used for auditing functions in civil engineering projects in order to assess the level of success achieved in relation to set objectives. The interactions between these factors were developed with the intention of evaluating three distinct aspects of management: technical, financial, and administrative. The level of satisfaction experienced by customers is one metric that may be used to assess the success of a project. A cognitive map is a representation of the thought processes of an auditing expert, and it serves as a basis for fuzzy rules, which are the knowledge base of the system. When it comes to planning and carrying out an activity, being able to recognize both the strong and weak areas of the process enables the formulation of solutions that aim to improve. The suggested model generates findings that are consistent even when the researched input variables are given fictitious values; as a consequence, an objective assessment may be performed throughout the auditing process.

#### ➤ Agriculture

Agriculture expert systems provide farmers with excellent answers to all activities and complex circumstances they experience during sowing, weed control, disease diagnostics, pest management, storage, product marketing, and other similar activities and situations. In this article, a number of agricultural problems are addressed and solved with the use of fuzzy expert systems. Research and studies on this topic are now being carried out because of the many positive effects that almonds (Termanili acatappa) have on one's health. Unfortunately, almonds are not widely accessible in all nations. One of

the most often consumed types of tree nuts all over the globe is the almond. In order to better forecast and improve the process, we designed a specialized model that is based on the Type-2 Fuzzy Logic Controller (T2FLC) methodology. Although it is difficult to extract 100% of the oil from almond seeds, the amount of oil that can be extracted may range anywhere from 40 to 45% provided the appropriate process parameters are managed and the appropriate conditions are maintained. The different membership functions of the variables are used in the development of four Mamdani fuzzy inference systems. These systems make use of the four input parameters and one output parameter. T2FLC is able to aid in the organization of inputs and outputs for the purpose of forming inferences, which paves the way for several forms of oil yield and evaluation throughout the extraction process. It has been shown that doing a statistical research using a type-2 fuzzy data set may significantly enhance the management of process parameters, which, as a result, can be rapidly generated in a type-2 fuzzy prediction model and result in high yield.

The precision of the diagnosis as well as the ability to determine when to irrigate most effectively led to increased output and decreased losses. Agriculture is becoming more and more reliant on the usage of expert systems. In particular, the development of expert systems as a consequence of advances in technology will be of great assistance to farmers in resolving issues that emerge at various phases of growth. In industrialized nations, the employment of both expert advice and decision-support tools is common. The use of fuzzy logic about WHEN and HOW LONG to water the field was utilized in order to tackle this challenge. An intelligent drip irrigation system included the use of both artificial intelligence and fuzzy logic as supplemental problem-solving

approaches. By providing the fuzzy system with input such as soil moisture, relative humidity, temperature, and other elements that need to be addressed before watering, it will be able to make more accurate predictions. These inputs are then sent to the fuzzy inference system, which analyzes them and determines the precise amount of value that should be opened in order to obtain the best possible results.

The approach that is being offered has the potential to evaluate, evaluate, categorize, and identify images of fruits that are provided to the system based on their color, shape, size, and other characteristics. It is recommended that the Fuzzy C-Means (FCM) technique be used for the Fruits Recognition System since this classification methodology is both reliable and effective. The recognition system that may be constructed has the potential to correctly identify any and every test fruit photos chosen by a user from the fruits selection menu based on the Graphical User Interface (GUI) block in MATLAB that is shown on the system.

The practice of classifying fruits using an electronic nose both during and after harvesting, as well as when the fruits are being stored in a variety of environments. During the pre-packaging process, they devised a one-of-a-kind electronic nose that classifies and identifies guava fruits via the use of fuzzy logic as a pattern recognition technique. The system included an array of eight SnO<sub>2</sub>MOS gas sensors, a static order delivery mechanism, a signal conditioning circuit, and LABVIEW 2012 data gathering and pre-processing software. All of these components were connected to one another through a signal conditioning circuit. They made the discovery that the fuzzy logic-based pattern recognition used by the e-nose system is able to correctly distinguish guava fruits. This demonstrates that the technology may be successfully implemented in the real

world.

### 3. CONCLUSION

The research papers and articles that have been published on the topic have led us to believe that fuzzy logic is one of the most accurate methods for processing data and providing findings that can be used. The purpose of this research was to investigate the potential for fuzzy logic to be used in a variety of contexts to achieve the goals of improving human health and enhancing economic well-being. Applications of fuzzy logic and the difficulties that these applications provide in the field of science were the primary topics of conversation throughout the research project. Fuzzy logic should be considered an essential method of operation for any modeling and forecasting program. After that, they went on to formulate theories on the ways in which fuzzy thinking, in all of its guises, would influence our lives in the years to come. We are able to make forecasts regarding the way it will have an impact on areas such as business, politics, the environment, chemistry, physics, statistics, medicine, computer technology, engineering, agriculture, and other fields; however, we would much rather have the reader or researcher use their own imagination in conjunction with the information presented in this article to create their own hazy version of the future.

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