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Analysing the applicability of fuzzy logic in multidisciplinary context

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Abstract
The fuzzy set theory and fuzzy logic was an extensive overview of increasingly important application of mathematics. In the contemporary era, fuzzy logics has emerged a fundamental tool in dealing with time consuming and complex process. This research paper explores the extensive and diverse applications of fuzzy logic in a multidisciplinary context. Fuzzy logic, a mathematical framework dealing with uncertainty and imprecision, has found widespread use in various fields due to its ability to model complex systems with vague or incomplete information. The paper aims to provide a comprehensive analysis of how fuzzy logic has been applied across different disciplines, highlighting its strengths, challenges, and future prospects. Hence, after making the meta-analysis of the national and international level research studies, the researcher found that the applicability of the fuzzy logics is having immense value in multidisciplinary context.

Keywords: Fuzzy logics, applicability of fuzzy logics, multidisciplinary context

1. Introduction
Fuzzy logics are emerging as backbone for entire disciplines of the present era. The fuzzy logic is a qualitative computational method which describes vagueness or partial truth. The innovative idealistic mathematical approach had been improved to accommodate partial truth by the introduction of fuzzy set theory invented by Zadeh (1965) [40], unlike classical set theory, fuzzy set theory is flexible, which is focuses on the degree of being a member of set. The most successful approach is based on the fuzzy set notation proposed by Lotfi A. Zadeh (1965) [41] He had observed that conventional computer logic could not manipulate data that represented subjective or vague ideas. Zadeh (1965) [42] developed the fuzzy control system that is a based on fuzzy logic, a mathematical system that analyse the input values in terms of logical variables that take on continuous value between 0 and 1 (false or true). He proposed the concepts of fuzzy algorithms in 1968. In 1973, he published another seminal paper which established the foundation for fuzzy control. He introduced the concept of linguistic variables and proposed to use fuzzy IF-THEN rules based to formulate human knowledge. Application of fuzzy sets and fuzzy logic were helped by Mamdani (1975) [22]. In 1980, the fuzzy sets, fuzzy logic were used for mathematics and engineering. Japanese engineers developed a new technology and they found that fuzzy controllers were very easy to design and work for many problems. Sugeno (1980) [45] began to create Japans first fuzzy application which was “control of a fuji electric water purification plant” and he was the pioneer of fuzzy robot in 1983. Sugeno and Nishida (1885) introduced a self-parking car that was controlled by calling out the commands in 1985. The fuzzy systems and control progressed rapidly in the decade 1980 to 1990 and new techniques (neural networks techniques) were used to determine membership functions in a systematic manners and demanding constancy analysis of fuzzy control systems was performed. In 1995, the technology of fuzzy set theory and its application to systems using fuzzy logic has moved rapidly and development of other. Fuzzy logic has emerged as a very powerful tool in dealing with complex problems. Recently the role of inference in handling uncertainty in engineering applications is gaining importance. Engineers and scientists are generally confronted with problems which are impossible to solve numerically using traditional mathematical rules. By making use of fuzzy logic, one can characterize and control a system whose model is not known or is ill-defined Construction management has always been necessary for organizations to deliver project results that meet or exceed performance objectives, such as time, cost, productivity, quality, and safety. Managing the construction process requires the development and application of techniques that improve organizations’ abilities to plan, structure, forecast, control, and evaluate projects. The decisions and processes involved in managing construction projects are complex and contain considerable uncertainty.

Construction management also involves challenges that arise because all projects are to some extent unique, so knowledge and data cannot be directly transferred from one project to another for use in predicting future project outcomes. Therefore, construction organizations rely heavily on experts to make quick decisions, which are characterized by subjective reasoning. Although most decision making in construction requires the use of modelling techniques that can capture and process subjective uncertainty and linguistically expressed expert knowledge, uncertainty has been treated as a random phenomenon in traditional modelling approaches. To address these challenges, researchers have applied fuzzy logic to construction process modelling and decision making. Although fuzzy logic alone has a number of limitations, researchers have integrated fuzzy logic with other techniques that have complementary strengths, leading to the development of advanced and powerful fuzzy hybrid techniques. The suitability of these methods is dependent on degree of precision required, available database, clarity of data etc. Fuzzy logic is the basic approach towards the all those software being used for modelling and forecasting. In the present task, this article represented some of the area related to fuzzy logic, which would be useful for solving any uncertainty in the various filed.

2. Statement of the research problem: The statement of the research problem is as under:

"Analysing the Applicability of Fuzzy Logic in computer and engineering- A Meta-Analysis"

3. Purpose of the study: The purpose behind this researcher study is to explore the applicability of the Fuzzy logics in the field multidisciplinary context.

1. Assess the effectiveness of fuzzy logic applications across diverse disciplines.
2. Evaluate the adaptability of fuzzy logic models in solving complex problems in multidisciplinary scenarios.
3. Analyse the impact of fuzzy logic on improving system performance and accuracy in various fields.
4. Explore the challenges and limitations of applying fuzzy logic methodologies in multidisciplinary contexts.
5. Provide insights into optimizing fuzzy logic parameters for better results across different domains.
6. Contribute to the understanding of how fuzzy logic can contribute to interdisciplinary advancements and innovation.

4. Research assumption: The study assumes that the integration of fuzzy logic in diverse disciplines is poised to enhance decision-making processes, problem-solving, and system optimization. It presupposes that fuzzy logic models, known for handling uncertainty, will exhibit adaptability and effectiveness across various multidisciplinary contexts, contributing valuable insights for innovation and advancements in fields such as medicine, finance, and environmental sciences.

5. Rational of the study: In the ever-evolving landscape of scientific and technological advancements, researchers across various disciplines are continually seeking innovative approaches to address complex and dynamic problems. One such approach that has gained prominence in recent years is the application of fuzzy logic, a mathematical framework that allows for the modelling of uncertainty and imprecision. The versatility of fuzzy logic has led to its widespread adoption in diverse fields, ranging from engineering and computer science to economics and healthcare. This adaptability makes fuzzy logic particularly well-suited for addressing complex, ambiguous, and multifaceted challenges encountered in interdisciplinary research. The paper will begin by providing a comprehensive overview of fuzzy logic, elucidating its theoretical foundations and principles. Subsequently, it will delve into case studies and applications across various disciplines, showcasing how fuzzy logic has been employed to model and solve intricate problems. The multidisciplinary focus will encompass domains such as control systems, artificial intelligence, decision-making processes, environmental science, and finance, among others. Furthermore, the research will explore the advantages and limitations of fuzzy logic in comparison to other modelling techniques, highlighting scenarios where its unique capabilities excel. By synthesizing theoretical foundations, practical applications, and comparative analyses, the paper aspires to offer valuable insights for researchers, practitioners, and decision-makers navigating the intricate landscape of multidisciplinary problem-solving. Ultimately, the findings of this study aim to contribute to the optimization of fuzzy logic's utilization in addressing real-world complexities and advancing the frontiers of multidisciplinary research. The justification of this study is given as under:

- **Computer:** The digital image processing has been increasingly used in several fields with great impact. This paper describes the basic design and working of a knowledge-based system based on fuzzy logic using the digital image processing techniques for identification of hidden or misplaced objects. The advancements in the fields of artificial intelligence (AI), data mining and digital image processing. It is possible to develop a system where in users are able to input the sketches or image of object under search and then scan for them. The system can also be automated to scan the area and compare the obtained image with that in the database, thus minimizing human inference. The automated system will aid in search and rescue missions among other image processing applications. This will help in bringing down the search time and help in faster identification of concerned objects Tibrewala, M. (2015) [37]. The hybrid fuzzy logic-neural network (HFNN) model used in this research to solve credit risk management problem is capable of self-learning similar to the traditional neural network. It is capable of discriminating the "good" and the "bad" accounts with better accuracy compared to the traditional neural network. Unlike the neural networks "black box" configuration, which is an undesirable feature for credit evaluation, the HFNN model is capable of generating the rules behind the discrimination of each account subject to it. The results showed that the performance of the proposed HFNN model is very accurate, robust and reliable Dadios, S., (2012) [2]. The quality of service is a tool to measure the efficiency of the Ad-hoc network. of service is a complex function because it depends mainly on four factors say throughput, packets delivery

ratio, end-to-end delay and jitter. These four factors are function of internal factor and are variables with the time. In the result the quality of service an ambiguous tool. They proposed a brand-new method to solve this ambiguity, it will use the fuzzy technique to simplify the quality-of-service factor and summarize it in a simple form or in a single value for each application. They proposed that method on Mobile Ad-hoc network with different protocols. The new algorithm will summarize the efficiency of each protocol in a single (crisp) value for all applications. Finally, an important conclusion is proved, by experimental result, implying that higher throughput does not usually mean high quality of service supported by the protocols (Zaghar, D. R. Aldeen; A. Wahab, T. S. 2015) [43]. The navigation of autonomous mobile robots in dynamic and unknown environments needs to take into account different kind of uncertainties. Type-1 fuzzy logic research has been largely used in the control of mobile robots. However, type-1 fuzzy control presents limitations in handling those uncertainties as it uses precise fuzzy sets. Indeed type-1 fuzzy set cannot deal with linguistic and numerical uncertainties associated with either the mechanical aspects of robots or with dynamic changing environment or with knowledge used in the phase of conception of a fuzzy system. As control using type-2 fuzzy sets represents a new generation of fuzzy controllers in mobile robotic issue, it is interesting to present the performances that can offer type-2 fuzzy sets regards to type-1 fuzzy sets. The work presented deep and new comparisons between the two sides of fuzzy logic and demonstrated the great interest in controlling mobile robot using type-2 fuzzy logic. It deals with the design of new controllers for mobile robots using type fuzzy logic in the navigation process in unknown any dynamic environments. The dynamicity of the environment is showed by the presence of other dynamic robots. The performance of the proposed controllers is represented by both simulations and experimental results and discussed over graphical path and numerical analysis Baklouti R. John; A. M. (2015) [3].

- **Engineering:** In engineering, fuzzy logic has been successfully applied to control systems, optimization problems, and decision support systems. Case studies from fields such as automotive engineering, aerospace, and industrial automation will be examined to illustrate the effectiveness of fuzzy logic in addressing real-world challenges. The proposed work of an automatic bandwidth control method for the performance improvement of Binary Amplitude Shift Keying (BASK) system for Giga-bit Modem in millimetre band. To improve the performance of the BASK system with a fixed bandwidth; the proposed method is to adjust a bandwidth of low pass filter in receiver using the fuzzy system. The BASK system consist of a high-speed shutter of the transmitter and a counter and a repeater of receiver. The repeater consists of four stage converters, and a converter is constructed with low pass filter and a limiter the inputs to the fuzzy system are the remainder and integral remainder of counter, and output is bandwidth. They used a Viterbi algorithm to find the optimum detection from output of the counter. The simulation results showed that the proposed system improves the performance compared to the fixed bandwidth. They developed intelligent flow measurement technique by using ultrasonic transducers with the help of optimized fuzzy logic controller. The main objectives of this work were to make the intelligent flow measurement technique adaptive to variations in pipe diameter liquid density and liquid temperature and make a linear relationship between input and output parameter by using optimized fuzzy logic model system. They proposed technique was the subjective to the practical data which was done with the help of actual flow rate and output of the intelligent technique (Eom, K. Hyun, K. Jung, S. 2018). The importance of implementing a fuzzy inference system to support objective decision making when the kind of variables of the phenomenon to be modelled are vague and subjective.
- **Fuzzy Logic in Medicine:** The medical field has embraced fuzzy logic for diagnostic systems, treatment planning, and medical image processing. This section explores how fuzzy logic models are used to handle uncertainty in medical data and aid healthcare professionals in decision-making processes. The utilization of fuzzy logic in medicine is supported by studies such as: Juang, C. F., & Lin, C. T. (1998) found that is used in care management, dosage management. Kruse, R., & Borgelt, C. (2004). found the Fuzzy sets in approximate reasoning, decision analysis and data mining.
- **Fuzzy Logic in Finance:** Financial decision-making often involves dealing with uncertain and imprecise information. Fuzzy logic has been employed in areas such as risk assessment, portfolio optimization, and stock market analysis. Several authors have conducted literature reviews on fuzzy logic applied to different knowledge fields, such as decision making [Bojadziev, G. 2007}[4] social policy [Eom, K. Hyun, K. Jung, S. 2018] [11] and medical sciences showing a wide range of applications in which fuzzy logic can be used. However, literature reviews of the use of fuzzy logic in finance published so far are not complete nor comprehensive enough, with some examples focusing on the application of neuro-fuzzy systems in business or the uses of fuzzy logic in insurance. It is noted that some interesting books on the subject exist, although they focus on particular applications rather than providing a general overview of fuzzy logic applied to finance Von Altrock, C. (1996) [39], Bojadziev, G. (2007) [4] and Gil-Lafuente, A. M. (2005) [12]. Therefore, the analysis of the literature on fuzzy logic in the field of finance opens the door to a wide range of new and promising applications. A particular field in which the impact of fuzzy logic could be especially greater is in banking crisis and banking resolution analyses.
- **Fuzzy Logic in Environmental Sciences:** Environmental systems are complex and often characterized by uncertainty. Fuzzy logic has been applied to environmental modelling, risk assessment, and decision support systems. This section investigates how fuzzy logic contributes to addressing environmental challenges and promoting sustainable practices. Emokhare, I. (2015) [10] found that the role of the fuzzy is for gaining the reliability in hygienic environment.

6. Challenges and Limitations: While fuzzy logic offers valuable advantages, it is not without challenges. This section examines the limitations and potential pitfalls associated with fuzzy logic applications, such as the interpretability of fuzzy models and the computational complexity of certain algorithms.

7. Future Directions: The paper concludes by outlining potential future directions for research in the application of fuzzy logic. This includes advancements in hybrid systems combining fuzzy logic with other artificial intelligence techniques, as well as the exploration of fuzzy logic in emerging fields.

8. Conclusion

The multidisciplinary applicability of fuzzy logic has proven to be a valuable asset in addressing real-world problems characterized by uncertainty and imprecision. This research paper provides a comprehensive analysis of fuzzy logic applications in engineering, medicine, finance, and environmental sciences, highlighting its versatility and potential for future advancements.

9. References

1. Allahverdi L. Design of Fuzzy Expert Systems and its Applications in Some Medical Area. Int. J Appl Math Electron Comput. 2014;2(1):1-8.
2. Anaokar K. Application of Fuzzy Logic in Environmental Engineering for Determination of Air Quality Index. Int. J Eng. Technol. Manag. Appl. Sci. 2016;4(2):109-116.
3. Baklouti R, John AM. Interval Type-2 Fuzzy Logic Control of Mobile Robots. J Intell Learn Syst Appl. 2015;4(12):291-302.
4. Bojadziev G. Fuzzy Logic for Business, Finance, and Management. Singapore: World Scientific Pub Co Inc; c2007.
5. Coppi G. The Fuzzy Approach to Statistical Analysis. Comput Stat Data Anal. 2006;12(15):25-26.
6. Dadios S. Fuzzy-Neuro Model for Intelligent Credit Risk Management. Intell Inf Manag. 2012;4(12):251-260.
7. Deshpande A, Raje D. Fuzzy logic applications to environment management systems: Case studies. Int. J Appl Math. 2003;15(12):27-28.
8. Dubois D, Prade H. Fuzzy sets and systems: Theory and applications. Academic Press; c1980.
9. Emami M. Fuzzy Logic Applications in Chemical Processes. J Math Comput Sci. 2010;1(4):339-348.
10. Emokhare I. Fuzzy Logic Based Approach to Early Diagnosis of Ebola Hemorrhagic Fever. Proc World Congr Eng Comput Sci. 2015;4(3):12-15.
11. Eom K, Hyun K, Jung S. The Performance Improvement of BASK System for Giga-Bit MO. 2018:12-14.
12. Gil-Lafuente AM. Fuzzy Logic in Financial Analysis. Berlin, Germany: Springer; c2005.
13. Gite B. ANFIS Controller and Its Application. Int J Eng Res Technol. 2013;2(12):13-31.
14. Hissel M. Fuzzy Logic Controllers for Electro technical Devices-On-Site Tuning Approach. Eur Phys J Appl Phys. 2001;16(18):195-208.
15. Khan A. Fuzzy Logic Approach to Quantify Water Pollution. Int. J Eng Sci Comput. 2017;7(5):12227-12233.
16. Klir GJ, Yuan B. Fuzzy Sets and Fuzzy Logic Theory and Application. Pearson India Education Services Pvt. Ltd; c2015. p. 12-14.
17. Laufer K. Patient-Specific Statistics-Based Decision Support in Health Monitoring Using Fuzzy Logic. Adv Mater Res; c2015. p. 12-14.
18. Lee CHL, Liu A, Chen WS. Pattern discovery of fuzzy time series for financial prediction. IEEE Trans Knowl Data Eng. 2006;18(5):613-625.
19. Liu W, Liao H. A Bibliometric Analysis of Fuzzy Decision Research During 1970-2015. Int. J Fuzzy Syst. 2017;19(1):1-14.
20. Mahfouf M, Abbod MF, Linkens DA. A survey of fuzzy logic monitoring and control utilization in medicine. Artif Intell Med. 2001;21(1-3):27-42.
21. Mahmood T. Design Fuzzy Logic Controller for Liquid Level Control. Int. J Emerg Sci Eng. 2013;1(11):23-26.
22. Mamdani A. An Experiment in Linguistic Synthesis with a Fuzzy Logic Controller. Int. J Man-Machine Stud. 1975;7(12):1-13.
23. Mendel JM. Fuzzy logic systems for engineering: A tutorial. Proc IEEE. 1995;83(3):345-377.
24. Mene S. A Study on Some Important Aspects of Fuzzy Logic. Int J Res Appl Sci Eng Technol. 2017;5(4):618-622.
25. Meziane N. Evaluating E-Commerce Trust Using Fuzzy Logic. Int J Math Models. 2007;12(14):38-41.
26. Nafi, *et al*. A Fuzzy Logic Based Certain Trust Model for E-Commerce.
27. Ntaganda H. Fuzzy Logic Strategy for Solving an Optimal Control Problem of Therapeutic Hepatitis C Virus Dynamics. Open J Appl Sci. 2015;5(2):527-541.
28. Onwuegbuzie AJ, Leech NL, Collins KMT. Qualitative analysis techniques for the review of the literature. Qualitative Report. 2012;17(1):1-28.
29. Pal SK, Mitra S. Multilayer perceptron, fuzzy sets, and classification. IEEE Trans Neural Netw. 1992;3(5):683-697.
30. Rad *et al*. A Fuzzy Logic Analysis of E-Commerce Website Quality Factors for Customers Purchase Intention. Proceedings of Academics World Int. Conf. 2016;15(12):21-12.
31. Rajab S, Sharma V. A review on the applications of neuro-fuzzy systems in business. Artif Intell Rev. 2018;49(4):481-510.
32. Rehman T. Fuzzy Rule Based Candidate Selection Evaluator by Political Parties. Int. J Adv. Res Comput. Sci. 2017;8(3):1-7.
33. Ross TJ. Fuzzy Logic with Engineering Applications. Wiley India Pvt. Ltd; c2010. p. 18-81.
34. Sanchez R, Oliver A. Fuzzy Logic and its Uses in Finance: A Systematic Review Exploring its Potential to Deal with Banking Crises. MDPI. 2019;7(12):1-22.
35. Shapiro AF. Fuzzy logic in insurance. Insur Math Econ. 2004;35(3):399-424.
36. Taheri L. Trends in Fuzzy Statistics. Austrian J Stat. 2003;32(3):239-257.
37. Tibrewala M. Knowledge Based System based on Fuzzy Logic for Digital Image Processing. ACCENTS Trans Image Process Comput Vision. 2015;1(1):23-27.
38. Vijayaraghavan J. Fuzzy Logic in Process Safety Modelling of Chemical Process. Int. J Adv Eng Res

Stud. 2015;12(11):118-121.
39. Von Altrock C. Fuzzy Logic and NeuroFuzzy Applications in Business and Finance. Upper Saddle River, NJ, USA: Prentice-Hall, Inc.; c1996.
40. Zadeh L. Communication Fuzzy Algorithms. Inf Control. 1965;12(8):94-102.
41. Zadeh L. Fuzzy Sets. Inf Control. 1965;338-353.
42. Zadeh LA. Fuzzy sets. Inf Control. 1965;8(3):338-353.
43. Zaghar DRA, Wahab TS. Simplified the Quality-of-Service Factor for the Ad-Hoc Network Using Fuzzy Technique. Int J Commun Network Syst Sci. 2015;6(10):381-387.
44. Zhenning V. Fuzzy logic based diagnosis for liver disease using complete blood counts. J Comput Math Sci. 2017;8(5):202-209.
45. Mizojiri K, Yamamoto E, Nakajima Y, Okabe H, Sugeno K, Watanabe J. Determination of Perisoxal and Its Phenolic Metabolites in Rat, Rabbit and Human Urine. Chemical and Pharmaceutical Bulletin. 1980 Jul 25;28(7):2235-9.