A Study on "Role of Fuzzy Logic in Educational Assessment"

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Abstract—**This paper surveys on Fuzzy logic development in Educational Assessment using classification and literature review over the last decade (2010-2020) to explore how various Fuzzy models developed and plays a major role in Educational Assessment. Based on selected journals on different Fuzzy logic applications, this article surveys on two different categories such as Students learning Assessment, Assessing students intelligence and skills. For each of these categories, this paper mentions brief future outline. This review study indicates mainly five types of future development directions for fuzzy logic methodologies, domains and article types:(1) fuzzy logic methodologies are tending to be developed toward expertise orientation.(2) Fuzzy logic concept is utilized for evaluating the trust. (3) The ability to perform accurate analysis and learning capability is the driving power of Fuzzy logic methodologies and will be the key for future Educational Assessment.(4) Performance of the load frequency control may further be enhanced by implementing different intelligent control algorithms like Fuzzy-Genetic, Evolutionary algorithm and Adaptive Neuro Fuzzy Inference System (ANFIS). (5) The fuzzy controller design can be optimized by using the optimization techniques such as Hybrid Genetic algorithm, Particle Swarm optimization, Ant colony and Bee colony techniques.**
Keywords: Fuzzy logic, Fuzzy sets, Educational Assessment, Supervised Learning, Approximate Reasoning

I. INTRODUCTION

Student evaluation is the process of determining the performance levels of individual students in relation to educational learning objectives. A high quality evaluation system certifies, supports, and improves individual achievement and ensures that all students receive a fair evaluation in order not to constrain students' present and future prospects. Thus, the system should regularly be reviewed and improved to ensure that it is suitable, fair, impartial and beneficial to all students. It is also desirable that the system is transparent and automation measures should be embedded in the evaluation. Fuzzy reasoning has proven beneficial to infer scores of students (e.g. Saleh & Kim, 2009). However, in order to improve the reliability and robustness of the system, Gaussian membership functions (MFs) are proposed as an alternative to the traditional triangular MFs.

II. LITERATURE REVIEW

Since its introduction in 1965 by Lotfi Zadeh (1965), the fuzzy set theory has been widely used in solving problems in various fields, and recently in educational evaluation. Biswas (1995) presented two methods for evaluating students' answer scripts using fuzzy sets and a matching function; a fuzzy evaluation method and a generalized fuzzy evaluation method. Chen and Lee (1999) presented two methods for applying fuzzy sets to overcome the problem of rewarding two different fuzzy marks the same total score which could result from Biswas' method (1995). Echauz and Vachtsevanos (1995) proposed a fuzzy logic system for translating traditional scores into letter-grades. Law (1996) built a fuzzy structure model for an educational grading system with its algorithm aimed at aggregating different test scores in order to produce a single score for an individual student. He also proposed a method to build the MFs of several linguistic values with different weights. Wilson, Karr and Freeman (1998) presented an automatic grading system based on fuzzy rules and genetic algorithms. Ma and Zhou (2000) proposed a fuzzy set approach to assess the outcomes of Student-centered learning using the evaluation of their peers and lecturer. Wang and Chen (2008) presented a method for evaluating students' answer scripts using fuzzy numbers associated with degrees of confidence of the evaluator. From the previous studies, it can be found that fuzzy numbers, fuzzy sets, fuzzy rules, and fuzzy logic systems are and have been used for various educational grading systems.

Evaluation strategies based on fuzzy sets require a careful consideration of the factors included in the evaluation. Weon and Kim (2001) pointed out that the system for students' achievement evaluation should consider three important factors of the questions which the students answer: the difficulty, the importance, and the complexity. Singleton functions were used to describe the factors of each question reflecting the effect of the three factors individually, but not collectively. Bai and Chen (2008b) stressed that the difficulty factor is a very subjective parameter and may cause an argument about fairness in the evaluation.

The automatic construction of the grade MFs of fuzzy rules for evaluating student's learning achievement has been attempted (Bai & Chen, 2008a). Also, Bai and Chen (2008b) proposed a method for applying fuzzy MFs and fuzzy rules for the same purpose. To solve the subjectivity of the difficulty factor embedded in the method of Weon and Kim (2001), Bai and Chen (2008b) acquired the difficulty parameter as a function of accuracy of the student's answer script and time used for each question. However, their method still has the subjectivity problem, since the resulting scores and rankings are heavily dependent on the values of several weights which are assessed by the subjective knowledge of domain experts. Saleh and Kim (2009) proposed a three node fuzzy logic approach based on Mamdani's fuzzy inference engine and the centre-of-gravity (COG) defuzzification technique as an alternative to Bai and Chen's method (2008b). The transparency and objective nature of the fuzzy system makes their method easy to understand and enables teachers to explain the results of the evaluation to sceptic students. The method involved conventional triangular MFs of fixed

parameters which could result in different results when changed. In this chapter, the Gaussian MFs are proposed as an alternative and a sensitivity study is conducted to get the appropriate values of their parameters for a more robust evaluation system.

III. METHODOLOGY

The main emphasizes will be on classification of the existing literature, is to differentiate between approaches, each approaches are presented using same template and same type of tables (for easier understanding) by developing a perspective on the area, and evaluating trends.

For this survey study, research papers published from 1997 – 2020 in various indexed Journals were identified on the basis of how effectively fuzzy logic plays a major role on the education and also in future there will be more interesting researches can be done in this field

IV. CLASSIFICATION

The main research themes, trends, challenges/issues, and results of that field are classified in the tables:
    i. Table 1: Students learning Assessment
    ii. Table 2: Assessing Students intelligence and skills:
    iii. Table 3: Summary of work done in successive years

The tabulated information were explained in detail using seven Ws (**W**ho, **W**hat, **W**hen, **W**here, **W**hy, for **W**hom, ho**W**).

V. SCOPE FOR FURTHER RESEARCH

Many researches have been gone through the Fuzzy logic in educational Assessment Field but during this covid-19 pandemic some researchers working on the project which is to conduct online exam by using facial recognition and handwriting recognition as an ideal one where it Analyzes the students and check whether that the uploaded answer scripts handwriting matches to the students handwriting. In this Domain Fuzzy logic plays an important role where it can be used for accurate analysis of facial recognition and handwriting recognition. Supervised Learning and Approximate Reasoning are the methodologies would be used in this paper .So this is the Further Research going on this Fuzzy logic Field by various researchers.

VI. CONCLUSION

Fuzzy logic is an AI science through which human reasoning is implemented through computer devices so that the devices can imitate human intelligence. Fuzzy logic enables the computer devices to explain ambiguous concept. Fuzzy logic is described as uncertainty defining logic. It adopts human intelligence and attempts to describe human decision making and saying. In its process, fuzzy logic predicts and draws conclusions based on its expertise by which it becomes tool for users to consult. In education, the application of fuzzy logic is helpful, not only in learning but also in decision making process. Designated applications and experiments have important roles in student performance because group studies and classical student evaluation methods are no longer sufficient for quality education. The application of fuzzy logic in education, from the 13 journals that have been reviewed by the literature, confirmed that the application of fuzzy logic in education is very helpful and proven to give solution in finding conclusions and predicting problems related to the education matters. Developing fuzzy logic is highly recommended, especially in the field of education, to support the process of education.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

Authors/Year	Methodology	Domain	Article type
Akrivi krouska, christos Troussas, and Cleo Sgouropoulou (2019)	Reinforcement learning	Intelligent tutoring system	Experimental
Chahid Fourali (1997)	Fuzzy sets	Portfolio Assessment	Descriptive
Ibrahim A. Hameed and Claus G.sorenson (2010)	Fuzzy rule base	Student Evaluation	Simulation
Constanza Huapaya (2019)	Approximate Reasoning	Students learning Assessment model	Experimental
Shilpa Ingoley &J.W.Bakal (2012)	Supervised Learning	Evaluating Students learning performance	Simulation

TABLE 2: ASSESSING STUDENTS INTELLIGENCE AND SKILLS:

Author/Years	Methodology	Domain	Article type
Shubhanjan Chakrabarty, Shubham Zanwar, Namita Ramakrishna	Dataset	Student profiling	Simulation
Nia Amelia, Ade Gafar Abdullah, Yadi Mulyadi	Meta-analysis	Student Performance	Experimental
Michael Gr.voskoglou	Fuzzy sets	Student knowledge Assessment	Simulation
James R Nolan	Supervised Learning	Human Scoring	Descriptive
Faouzi Bouslama, Michelle Housley, Andrew Steel	Supervised Learning	Intelligence Framework	Experimental
Mohd Nor Akmal Khalid, Umi Kalsom Yusof, Looi Guo Xiang	Approximate Reasoning	Student modelling	Classification

TABLE 3: SUMMARY OF WORK DONE IN SUCCESSIVE YEARS

Years	Summary of Paper review
1997	This paper highlights the relevance of a relatively new quantitative methodology known as fuzzy logic to the task of measuring educational achievement. It introduces the principles behind fuzzy logic and illustrates how these principles could be applied by educators in the area of assessment using portfolio evidence. Presently, and particularly in the UK, the assessment of portfolios is very much perceived as the way forward in measuring achievement. The paper argues that fuzzy logic could offer some useful insight when trying to rationalise assessors' deliberations with respect to complex portfolio types of evidence. Illustrations are drawn from issues being tackled by the UK's National Council for Vocational Qualifications (NCVQs) to support the argument. The need expressed in this paper for an improvement in current educational measurement is supported by developments in other fields of enquiry, where new perspectives were adopted to warrant advances in these areas of study. Finally the paper argues that although fuzzy logic has had many successes in industry its contribution should be very significant in the social sciences.
1998	This paper reports on the design and development of an expert t% zzy classification scoring system for grading student writing samples. The growing use of.. m-iHm..-sn.. n.. na+ a,+, in, k, e &&. a&rx sectoi WllCwz 'l 'szqJ" ux LbaLU provides fertile domain areas for new and innovative applications of soft computing and expert systems technology. The main function of the expert fuzzy classification scoring system is to support teachers in the evaluation of student writing samples by providing them with a uniform Framework for generating ratings based on the consistent application of scoring rubrics. The system has been tested using actual student response data. A controlled experiment demonstrated that teachers using the expert fuzzy classification scoring system can make assessments in less time and with a level of accuracy comparable to the best teacher graders.
2008	Innovative Techniques in Instruction Technology, E-Learning, E-Assessment and Education is a collection of world-class paper articles addressing the following topics:(1) E-Learning including development of courses and systems for technical and liberal studies programs; online laboratories; intelligent testing using fuzzy logic; evaluation of on line courses in comparison to traditional courses; mediation in virtual environments; and methods for speaker verification.(2) Instruction Technology including internet textbooks; pedagogy-oriented markup languages; graphic design possibilities; open source classroom management software; automatic email response systems; tablet-pcs; personalization using web mining technology; intelligent digital chalkboards; virtual room concepts for cooperative scientific work; and network technologies, management, and architecture.(3) Science and Engineering Research Assessment Methods including assessment of K-12 and university level programs; adaptive assessments; auto assessments; assessment of virtual environments and e-learning.
2010	Student evaluation is the process of determining the performance levels of individual students in relation to educational learning objectives. A high quality evaluation system certifies, supports, and improves individual achievement and ensures that all students receive a fair evaluation in order not to constrain students' present and future prospects.
2012	Every student is unique. Evaluation of student answersheet should be done in more fair and transparent manner. Whenever subjective evaluation is there it may lead to difference of opinion. Fuzziness arises by virtue of difference in opinion. To improve the classical statistics of the teaching assessment this paper combines the various methods. It uses fuzzy logic to solve the said problem of Evaluating Student learning achievement

2012	The cognitive diagnosis is defined as the abstract process of gathering information about the student's learning and transforming that information based on instructional decisions. A model that captures the expert knowledge of experienced professors and is used to design a cognitive diagnostic model based on Fuzzy Logic is presented in this article. Particularly, a diagnosis system with four variables (three input variables and one output variable) and 27 fuzzy rules
2013	Fuzzy logic, which is based on fuzzy sets theory introduced by Zadeh in 1965, provides a rich and meaningful addition to standard logic. The applications which may be generated from or adapted to fuzzy logic are wide-ranging and provide the opportunity for modeling under conditions which are imprecisely defined. In this article we develop a fuzzy model for assessing student groups' knowledge and skills. In this model the students' characteristics under assessment (knowledge of the subject matter, problem solving skills and analogical reasoning abilities) are represented as fuzzy subsets of a set of linguistic labels characterizing their performance, and the possibilities of all student profiles are calculated. In this way, a detailed quantitative/qualitative study of the students' group performance is obtained.
2015	In this paper, a set of EI tests covering four general areas of EI is proposed to evaluate the emotional literacy of the new intakes at the HCT colleges. These tests will help identify students who lack experience with non-cognitive capabilities including competencies and skills that may influence their abilities to succeed in coping with educational environmental demands and pressures which are related to the graduate outcomes. Also, these EI skills will often be used as parts of rubrics for assessing students' learning and achievements of the learning outcomes. A fuzzy-based emotional intelligence modelling and processing framework is proposed to better model and capture uncertainties in surveys of new intakes, and which will deal well with the complexities of the classification system.
2016	In an educational institution, various students criteria contributed to the main reason the student is nominated as a model student. This includes cumulative grade point average (CGPA) of academic courses taken, co-curriculum involvement, soft skills, hard work, leadership, attitude, time management, attendance, attire, and technical skill in order to make the selection decision. The distinctive student is identified firstly based on their overall score. It is a tedious task and time consuming for examiner or reviewer to analyze students individually in order to select a student that showed desirable performance. In addition, as a human has its limitation, there is a high degree of error in judgment in decision making. With the aim of bridging this gap, fuzzy logic is applied to imitate human analytic thinking or the ability to make a depcision in the model student selection process.
2017	In this paper, we present a fuzzy-logic based model for the diagnosis of the so-called students' learning profile. The fuzzy logic module is coupled with an interactive open learning environment that incorporates the text comprehension theory by Denhière and Baudet, the dialogue theory of Collins and Beranek, and the learning styles theory of Felder and Silverman. This intelligent learning environment is used for diagnosis, assistance and evaluation of engineering students. Preliminary tests for student assessment displayed high influence on the performance and motivation of its users.
2017	This paper develops a methodology to analyse various parameters of student data and predict the probability of the student, getting placed in super dream or dream or mass placement company. This is based on fuzzy logic. Fuzzy logic is an approach to computing based on "degrees of truth" rather than the usual "true or false" (1 or 0) Boolean logic on which the modern computer is based. Fuzzy logic is a form of many valued logic; it deals with reasoning that is approximate rather than fixed and exact. The applications of fuzzy logic ranges from control theory to artificial intelligence. Fuzzy logic will normalise a data set and give values between 0-1. In intelligent student analysis, we normalise the student data and then analyse the normalised data. Analysis completely depends on the data set.
2019	The assessment system generally requires transparency and objectivity to assess student performance in terms of abstraction. Fuzzy logic method has been used as one of the best methods to reduce this uncertainty. Therefore, we have conducted a literature review to examine the application of fuzzy logic in assessing the performance of different students. The Preferred Reporting Items for the Systematics Review and Meta-Analysis Method (PRISMA) were used as the basic method for conducting systematic reviews and meta-analyses.
2019	Intelligent tutoring systems have been widely used for optimizing the educational process by creating a student-centered learning environment. As a matter of fact, an integral part of intelligent tutoring systems is the evaluation of the learners' performance. In traditional learning, the instructors calculate the grade of the students derived from the assessment units and other factors, such as the difficulty of the exercises or their effort, in order to produce the final students' score in the course. However, in most cases, the evaluation of learners' performance in intelligent tutoring systems takes place by calculating an average grade of students without taking into account the aforementioned factors. In view of the above, this paper presents a novel way for refining the evaluation of students' performance using fuzzy logic.

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