Evaluation of Students' Performance using Fuzzy Logic

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Abstract- Students' participation and performance in academic activities is fast reducing; however, this study is focused on establishing that students who do not perform well in academic activities seldom deliver an excellent project. In this research, fuzzy logic is used to determine the performance of the engineering students in final year, the results of their industrial training which comprises of an external supervisor' score, technical report score, defence of the technical report score; will serve as the input in the model. MATLAB simulation tool was used to simulate the model. The crisp value gotten from the simulation was used to compare with the result of the traditional statistical method.

Index Terms- Fuzzy Logic, Fuzzy Set, Membership Function, Simulate, Student Performance, Technical Report, Performance Evaluation

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1 Introduction

Fuzzy Logic is a super set that promotes flexible reasoning which is an extension of the Boolean logic by Lofti Zadeh (1965) from the mathematical theory of fuzzy sets[1], it is a general expression of the classical set theory; i.e the classical set is a subset of fuzzy set. The feature of flexible reasoning accommodates all inaccuracies and uncertainties and it has an advantage of setting its rules in natural language. This means that it handles the concept of in-between values or truth - i.e values in between completely truth and completely false.

Set Theory: The set theory is a branch of Mathematics that uses set to describe inclusion or exclusion of classified numbers (integers), individuals (population), assumptions, functions, etc. [1]. For example:

7, 4, 9, 3, 10 is a set of integers between 3 and 10. There can be set of words or characters such as "'d', 'f', 'e', 'y' " , "'for', 'at', 'word', 'set', 'fuzzy'".

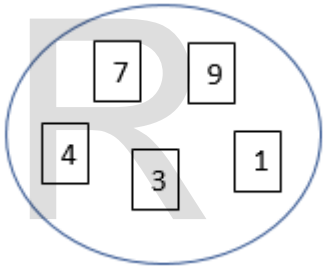

Figure 1. Graphical Representation of the set {7,4,9,3,10}.

Fuzzy Sets: The theory of fuzzy sets is the foundation of fuzzy logic and a generalization of the classical set theory. In other words, the classical set theory is a subset of the fuzzy set theory [1][2]. This is as shown in figure 2. Fuzzy sets and Fuzzy logic handle the bridge between mathematical model and the physical reality [5].

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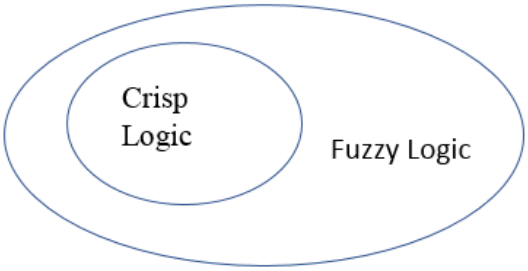

Figure 2. Classical Set Theory a subset of the Theory Fuzzy Sets [1]

Human reasoning most times are approximate in nature especially when common sense is used, that is why fuzzy logic is important to solve the problems of "inconclusive conclusions" [2]

Membership Function: Membership function is an important function in the application of fuzzy logic and the representation of the fuzzy logic performance [3]. It is the foundation blocks of the fuzzy set theory and thus aids in representing a fuzzy set. The shape of a membership function is dependent on the problem that is being solved[3], Figure 3 shows different membership functions, they can be triangular, Gaussian, trapezoidal, or customized function Membership function satisfies a condition that must be between 0 and 1. It can be defined mathematically as shown in equation 1.

X is defined as $\mu_A : X \rightarrow [0,1]$

(1)

Where elements of X is mapped to a value between 0 and 1. The values between 0 and 1 are referred to as membership value or degree of membership in X to the fuzzy set.

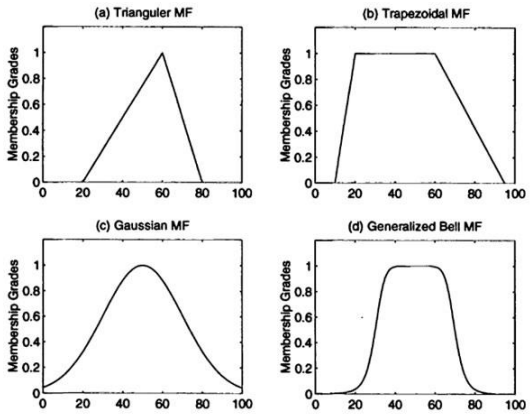

Figure 3. Shapes of Membership functions [4]

Applications of Fuzzy Logic

Fuzzy Logic systems are applied in a wide range of problem fields from the industry to the academia. Some examples are as follows: control systems, pattern recognition problems, system identification, mechanical engineering, etc. [3].

2 Related Works

Fuzzy Logic has been used by a lot of researchers to evaluate and test the fuzziness of certain problems that have inaccurate solutions or result.

Akkur and Rao [6] evaluated students' performance in their research "Fuzzy Logic: A Tool for Evaluation of Students' Performance" using the Fuzzy Inference System and validated their performance value by defuzzification on three (3) methods - COG (Centroid), IOM and MOM (Mean of Maxima).

Sakthivel, Kannan and Arumugam [7] worked on a proposed method to evaluate students' performance in "Optimized Evaluation of Students' Performance Using Fuzzy Logic".They used the Centroid method for defuzzification of the performance value. Comparisons between the classical method (statistical method) and FLT performance value was made to validate their test rules.

Barlybayev, Sharipbay, Ulyukova, Sabyrov and Kuzenbayev [8] worked on evaluation of students' performance in "Student's performance evaluation by fuzzy logic". Their research proved that Fuzzy Logic method is more preferable than the traditional method of calculating students' performance with mean.

Menakshi and Nagar [9] worked students' performance evaluation in "Application of Fuzzy Logic for Evaluation of Students Academic Performance of Computer Application Course". In their research, they showed that Fuzzy Logic can be used to evaluate students' performance in comparison with the t-test method using MS-Excel. They were able to conclude that Fuzzy Logic is flexible as against the inflexibility of the conventional method.

Kharola, Kunwar and Choudhury [10] worked on students' performance in "Application of Fuzzy Logic for Evaluation of Students Academic Performance of Computer Application Course". They evaluated students' performance based on their social skill and their academic grade using fuzzy logic in MATLAB/Simulink; and compared their results with the traditional method.

Deshmukh and Rao [11] worked on students' performance in "Students Performance Evaluation Model Based on Bloom's Taxonomy Using Fuzzy Logic". They used Bloom's taxonomy to analyze the students' strengths and weaknesses, their developmental learning stages and formulated inputs for Fuzzy Inference System; comparison of the results were made with the classical aggregate scores. A summary of the reviewed literature is shown in Table 1.

Table 1. Summary of Related Works

S/N	Author	Research Work	Methodology	Remark
1	Akkur and Rao (2018)	Fuzzy Logic: A Tool for Evaluation of Students' Performance.	Fuzzy Inference System	
2	Sakthivel, Kannan and Arumugam (2013)	Optimized Evaluation of Students' Performance Using Fuzzy Logic	Fuzzy Inference System	They used the Centroid method for defuzzification of the performance value.
3	Barlybayev, Sharipbay, Ulyukova, Sabyrov and Kuzenbayev (2016)	Student's performance evaluation by fuzzy logic	Fuzzy Inference System	Their research proved that Fuzzy Logic method is more preferable than the traditional method
4	Menakshi and Nagar (2015)	Application of Fuzzy Logic for Evaluation of Students Academic Performance of Computer Application Course	Fuzzy Inference System	They were able to conclude that Fuzzy Logic is flexible as against the inflexibility of the conventional method.
5	Kharola, Kunwar and Choudhury (2015)	Application of Fuzzy Logic for Evaluation of Students Academic Performance of Computer Application Course	Fuzzy Logic	They used MATLAB /Simulink to simulate the students' performance and compared their result with the traditional method
6	Deshmukh and Rao (2018)	Students Performance Evaluation Model Based on Bloom's Taxonomy Using Fuzzy Logic	Fuzzy Logic and Bloom' Taxonomy	They were able to establish that the students' performance could be measured in stages of learning with respect to their strengths and weaknesses on a single course.

3. Methodology

In this research, we are evaluating the performance of final year engineering students on their projects with regards to their six (6) months industrial training using Fuzzy Inference System and using the Centroid method as shown in equation 1 for defuzzification of the model. The industrial training (IT) is graded based on the student technical report, IT placement supervisor's comments, defence of technical report. This evaluation will be done on twenty (20) students.The students' industrial training results as shown in table 3. Mathematical representation of the centroid method is as follows:

$$z^* \frac{\int \mu B(z).zdz}{\int \mu B(z)dz} \qquad (1)$$

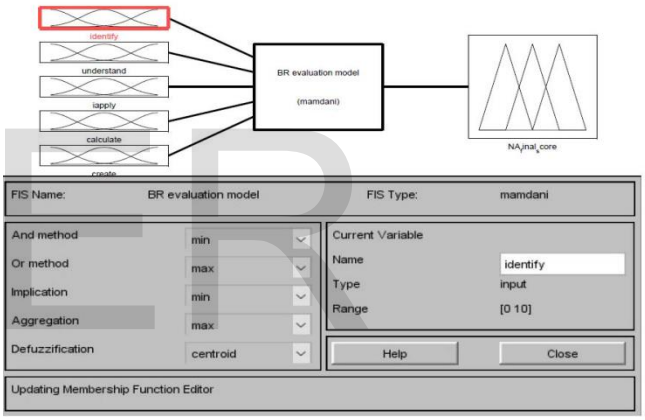

Figure 4. Existing Fuzzy Model of Students' Performance Evaluation (Source: Deshmukh and Rao, 2018)

Table 2. Input Variables of Fuzzification Details

Input Variables		Poor	Average	Excellent
Industry Score		0-5	5-10	10-15
Technical Report	Fail	0-5 Poor	5-10 Average	10-15 Excellent
Technical Report Defence	0-17.5	17.5-35.0	35.0-52.5	52.5-70

4. Results and Discussions

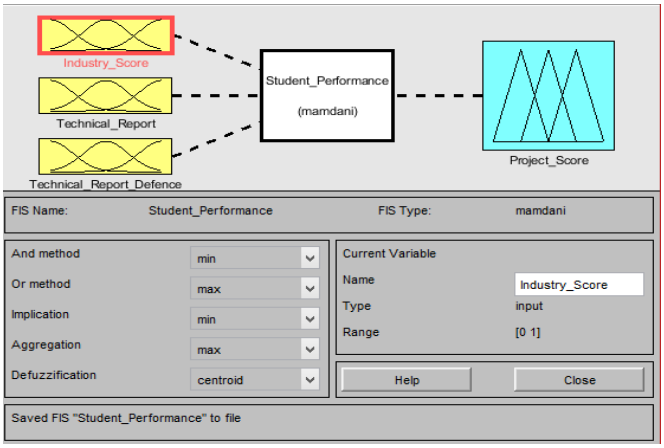

Figure 5. Proposed Fuzzy Logic Model for Student Performance Evaluation

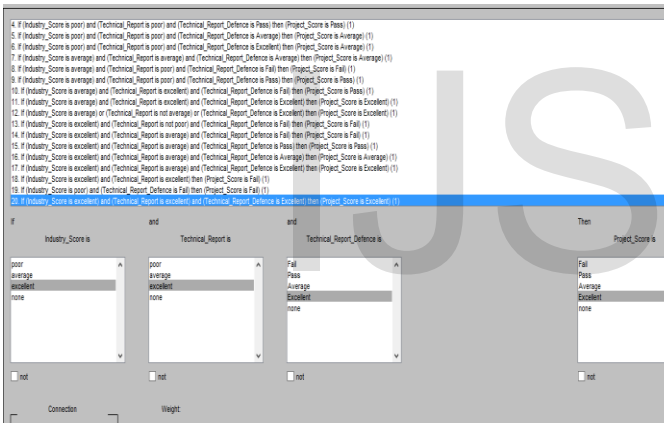

Figure 6. Rule Editor

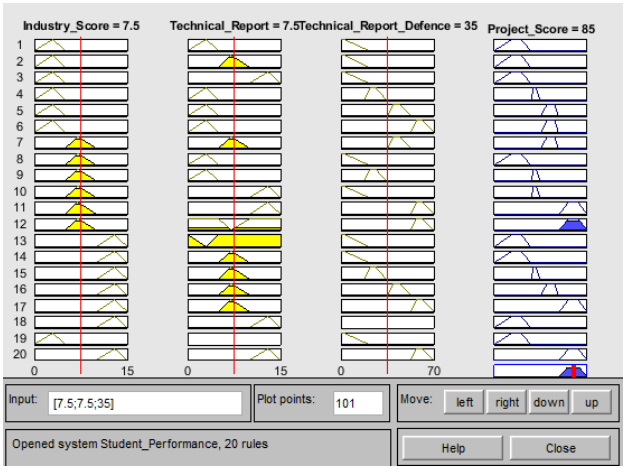

Figure 7. Rule Viewer of the Input Variables

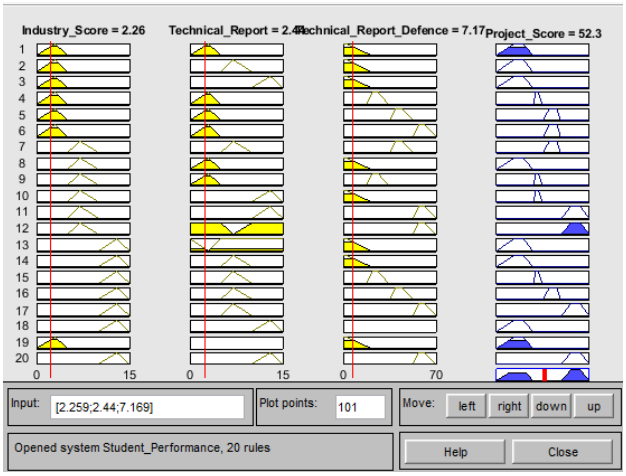

Figure 8. Rule Viewer of the Input Variables with Adjusted Values

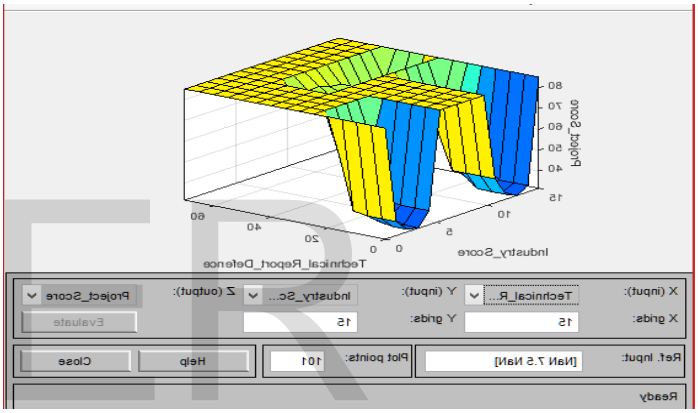

Figure 9. Surface view of Inputs and Output

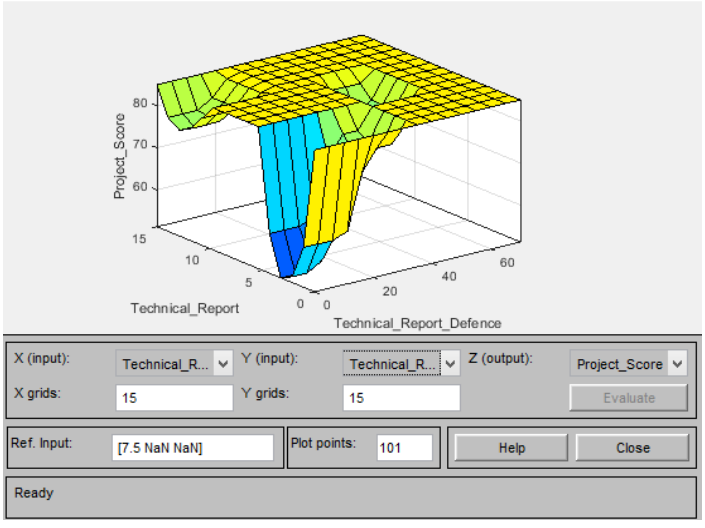

Figure 10. Surface View of Inputs and Output

In this research, the scores of twenty (20) students on their industrial training (IT) and project in table 3 were used to simulate for their performance evaluation. It is a further study on students' performance evaluation model as shown in figure 4. Figure 5 shows the proposed model for the students' performance evaluation. It comprises of the industry score which is the score from the industry supervisor where the student is undergoing his/her IT, the technical report scores and the score for the defence of the technical report. These will serve as the input based on the defined rules and the inferred project score will be the output. Figures 7 and 8 shows the rule viewer of the input variables after defining the rules using the rule editor as shown in figure 6. Figures 9 and 10 reveals the surface view of the simulation showing the input and output variables. This simulation seeks to establish a comparison between the simulation result of the output and the actual project score to ascertain the performance level of the students thereby measuring the quality of graduates produced. On applying the centroid method in the FIS, we got the crisp value of 85 as shown in 7. However, applying the traditional statistical mean method, we get 62.9 Adjusting the input variables, we have a crisp value of 52.3 as shown in figure 8.

5. **Conclusion**

Fuzzy Logic is a very good approach to evaluate uncertainties and inaccurate results. Therefore, it is morebetter than the tradition statistical method because the input can be weighted in applying the membership functions. On a critical look on the inputs of the fuzzy model, an external score helps to determine the actual students' quality since the possibility of influencing the score will be an insignificant value.

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Table3. Students' Industrial Training and Project Scores.

S/N	Matric No.	Industry Score (15)	Technical Report (15)	Technical Report Defence(70)	Final Year Project Score
1	DE.2012/0731	8	8	40	70
2	DE.2012/0633	7	8	50	65
3	DE.2012/0578	10	9	47	80
4	DE.2012/0745	10	10	47	56
5	DE.2012/0743	9	9	48	60
6	DE.2012/0382	10	10	40	72
7	DE.2012/0923	11	12	50	45
8	DE.2012/0672	8	7	41	45
9	DE.2012/0293	8	9	39	60
10	DE.2012/0921	9	9	53	37
11	DE.2012/0451	10	11	43	86
12	DE.2012/0296	10	9	51	90
13	DE.2012/0821	10	10	47	65
14	DE.2012/1023	10	9	47	39
15	DE.2012/0538	8	8	51	73
16	DE.2012/0692	10	11	61	50
17	DE.2012/0439	11	12	60	44
18	DE.2012/0284	11	11	50	59
19	DE.2012/1045	9	10	48	87
20	DE.2012/1029	12	11	53	75