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MODELLING STUDENT'S PERFORMANCE EVALUATION USING FUZZY LOGIC TECHNIQUES

[1]Praveen Kumar, [2]Gopal Singh

[1]Professor, Department of Mathematics, J V Jain College Saharanpur, UP, INDIA

[2]Research Scholar, Department of Mathematics, J V Jain College Saharanpur, UP, INDIA

Abstract: The educational systems employ many interesting and challenging techniques to examine the student's performance evaluation. A classical, fuzzy-1 and fuzzy-2 method are used to evaluate the variation in performance of students. These techniques or methods can help to improve the quality of educational institutions. In this system, student's performance is evaluated by fuzzy inference system (FIS) according to the input variables. Processing and implementations of data is covered under the concept of fuzzy expert system. Here Gaussian and Trapezoidal membership functions are used for input variables and Trapezoidal membership functions is used for output. A case study is also considered for the support to this methodology. MATLAB software is used to evaluate the performance of students from IMS university courses campus, Ghaziabad, INDIA. When the management runs a college or schools, the performance evaluation model provides the best performance evaluation results. The defuzzification also considered for the data into crisp output. Fuzzy logic evaluation techniques provide many other evaluations options, while the classical methods are used to constant mathematical evaluation. As per the student's performance data, the fuzzy-1 and fuzzy-2 methods are calculated by RMSE are as 0.068 and 0.061 degree of precession. As a result, the performance evaluation is Fuzzy-2 is much better that the fuzzy-1 methods. However, it is concluded that both fuzzy-1 and fuzzy-2 models exhibited a high-performance evaluation according to obtained result.

Index Terms **- Fuzzy logic, Expert system, Membership functions, Intelligent Tutoring system (ITS), fuzzy inference system (FIS).**

1. Introduction

Student's performance evaluation needs to development of the educational societies. Evaluation is key factor at the entire platform where accuracy required. For the betterment and implementation in the academic result, we have needed to evaluate the student's performance. Student's performances allow us to get positive feedback and identify the area of improvements so that we get the better result in the evaluation. A plan can be implemented for the skills and performance so that it could support to make a good merit. Students improved skills can provide to become self reliant and confident. Present time, in the educational institutions or universities students overall performance is evaluated according their exam result and other institutional activities also. In the proposed work, we have considered Madnani techniques for the comparison in several characteristics and many practical approaches [Hossein S & other]. The proposed work is based on literatures which is determined in qualitative and quantitative criteria. The required data is designed and developed pair wise comparisons and evaluations through a survey to get opinion of experts. The proposed performance evaluation criteria are used to measure the institutions academic performances of the students [Yousif M.K. & other]. On the other hand, fuzzification of crisp data in the form of students activities data which is evaluated for the improvement and implementation in the required strategies so that, the result become extraordinary comparing to previous result. The crisp data depends on extreme values which exist in the given data. In the performance evaluation data is based on input variables and vagueness. Results are compared with crisp outputs [Thakre T.A. & others]. Fuzzy logic reasoning approaches have been implemented in institutions or universities. Attributes of performances are considered and evaluated which are used to eliminate the issue of rule explosion. Fuzzy approaches make a comparison between traditional average methods and fuzzy techniques [Kharola A & other]. Student's performance evaluation according the norm and regulation of an institute is frame through a conventional system. The results generated by the expert system and conventional method both are compared and test the difference for the real data [Meenakshi & other]. The study proposes fuzzy logic techniques to evaluate the performance of the students and compare the study of the result of fuzzy logic techniques with classical methods. Sample study is considered for the student's performance evaluation. Variation in the results of fuzzy logic techniques and classical method is shown in the study of evaluation [Sakthivel E & other]. The prediction of student's performance based on their quantitative observations and a fuzzy probabilistic model is introduced to predict customized performance of students which was seen in comparisons of customary statistical models or conventional back propagation neural network and classify to likely successful and unsuccessful students [Arora N & others]. The fuzzy evaluation system proposed a linguistic hedges (LHs) evaluation system with a standard fuzzy logic system. Evaluation is based on fuzzy rules and empirical evaluation and such results shows comparisons of linguistic hedges (LHs) and standard fuzzy logic which is not significant [Hameed I.A., & others]. Evaluation in teacher's academic performance, fuzzy logic technique is

introduced. Fuzzy inference mechanism and fuzzy rules developed. The proposed work explains how the fuzzy logic works behind the model of evaluation and evaluates the annual reports of employs [Jyothi G & others].

The idea of fuzzy sets was presented in 1965 by Lotfi (Zadeh L.A., 1965) as methods for speaking to vagueness in applications. Fuzzy logic is the logic corresponding to fuzzy sets. In classical two-valued logic, or Boolean logic or binary logic, a recommendation is either valid or false. The main allowed membership esteems are 0 or 1. Two valued logic works well for issues which are straight and frameworks that can be displayed absolutely and it has demonstrated to be compelling in tackling such issues. In multi-valued logic, a recommendation might be valid, false or have a middle of the road truth esteem. The arrangement of truth esteems is thought to be equally partitioned over the interval [0, 1]. In fuzzy logic, the membership function can have qualities going from 0 to 1.

1.1 AN OVERVIEW OF STUDENTS PERFORMANCE EVALUATION:

The modelling for student's performance evaluation develop a change in the present evaluation criteria, however, it has many applications in education systems to increase the academic performance of the students. The fuzzy logic modelling for student's performance depends on many observations as observed by physically on the basis of many parameters. Student's interest in learning seeks the objective with the current learning capability and moves the step up as per their achievement's quality of work. Student's academic skills evaluated according to the expectations for claim the performance to make the progress toward the quality of work and set forth additional endeavors to guarantee for the quality work. Student's demonstrated capacity in problem solving break down to select the best course of activity. Problem solving capacity enhances the performance of students. The evaluation of students in team work or work of students in a group setting affects the overall performance of the students. The way in which students introduce them in workspace or in their classes is known for steadfastness in their performances. Response of supervision, reflection, valuation of diversity, Entrepreneurial Introduction, written communication, oral communication, interpersonal communication etc are points to understand the overall performance of the students.

2 Methodology:

2.1 EXPERT SYSTEM

Expert system is a elementary methods directly related to the behavior of fuzzy logic. Expert system method can formulate a number of advantages to a evaluation system. The engineering of an expert system can really control the general system. Expert system methods manage direction and information in knowledge-oriented problems. This method can improve the presentation with respect to development productivity, system quality and speed of implementation. Expert system offers to an opportunity to create better information-based system application, addressing the need to deal with permeability ambiguities and mistakes associated with real world problem. An Expert System having a lot of program that controls and encoded the area of learning and evaluating. Expert system deal with issue in a particular area that regularly requires human expertise. Learning and evaluating process in expert system acquired from expert sources and coded in a structure appropriate for the system and after that used in its derivation or thinking forms. The expert learning and evaluating must be acquired from various continual efficiency, for example, compositions, diary articles and database. This sort of learning normally requires much preparing and involvement in some particular field, for example, prescription, topography, system setup, or building plan. When an adequate assortment of expert information has been procured, it must be encoded in some structure, stacked into a learning base, by then tried, and refined consistently for the term of the life of the system. Expert system contrasts from traditional PC system in a few significant ways: The information is encoded and kept up as a thoroughly independent from the control program.

- The information is encipher and kept as a completely free from the control program.
- Expert systems are fit for elucidate how a specific end was come to, and why mentioned data is required during an end.
- Expert system uses emblematic portrayals for learning (guidelines, systems, or outlines) and play out their deduction through representative calculation that intently take after controls of normal language.
- MEMBERSHIP FUNCTIONS

In this paper, Gaussian and Trapezoidal Membership Functions are used for changing the crisp set into fuzzy set. The Gaussian and trapezoidal Membership Functions are representing as per the following formulation.

$$Trapezoidal(x,p,q,r,s) = max\left(min\left(\frac{x-p}{q-p},1,\frac{s-x}{s-r}\right)\right)$$

$$Gaussion\mu_{A^t}(x) = e^{-\left(\frac{(c_i-x)^2}{2\sigma_i{}^2}\right)}$$

Where $c_i$is the centre and $\sigma_i$is the center and width of the i^{th} fuzzy set $A^i[10]$. The membership function presents a graphical representation of magnitude of each involved input and graph defines the membership value [0,1]. As per rules of the basic recipe and computational effectiveness, the Trapezoidal Membership and Gaussian Membership Functions attached with fuzzy logic and been utilized broadly in student's performance evaluation. The rules in membership functions determine the influence on the final output conclusion and when the functions scaled and derived then the functions are defuzzified into a crisp output.

2.2 MODELLING PROCESS

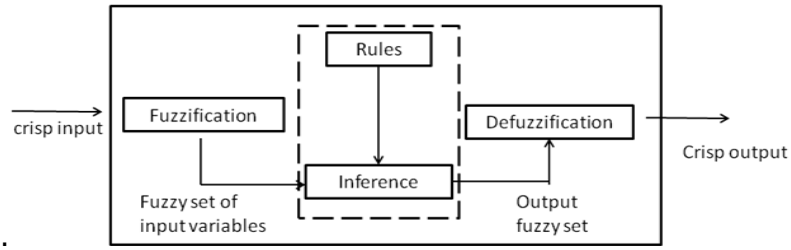


Figure 1: Fuzzy Validation Expert System

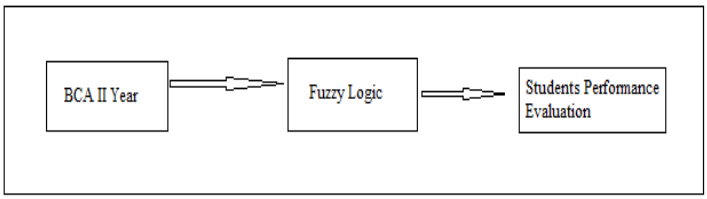


Figure 2: New Fuzzy Expert System for Student's Performance Evaluation

2.3 Defuzzification:

The center of gravity (COG) method is the most popular technique which is widely utilized in many applications, here, the COG techniques is used for the defuzzification. In this technique, the weighted membership function of each output membership function is multiplied by their own respective output membership function's center points and summed and at the end the given area is divided by the sum of the weighted membership function strength and after that the result is taken as per the crisp output. The COG method can be defined as [Saade J.J. & others] :

$$Output\ Data = \frac{\sum_i x_i . m(x_i)}{\sum_i m(x_i)} \quad , i = x_{min}, \ldots\ldots x_{max}$$

Defuzzification

3 CRITERIA OF PERFORMANCE EVALUATION

For the purpose of illustration, we consider that the performance evaluation of the students using four inputs viz Class Attendance X1, Assignments Marks X2, Internal Marks X3 and External Marks X4.

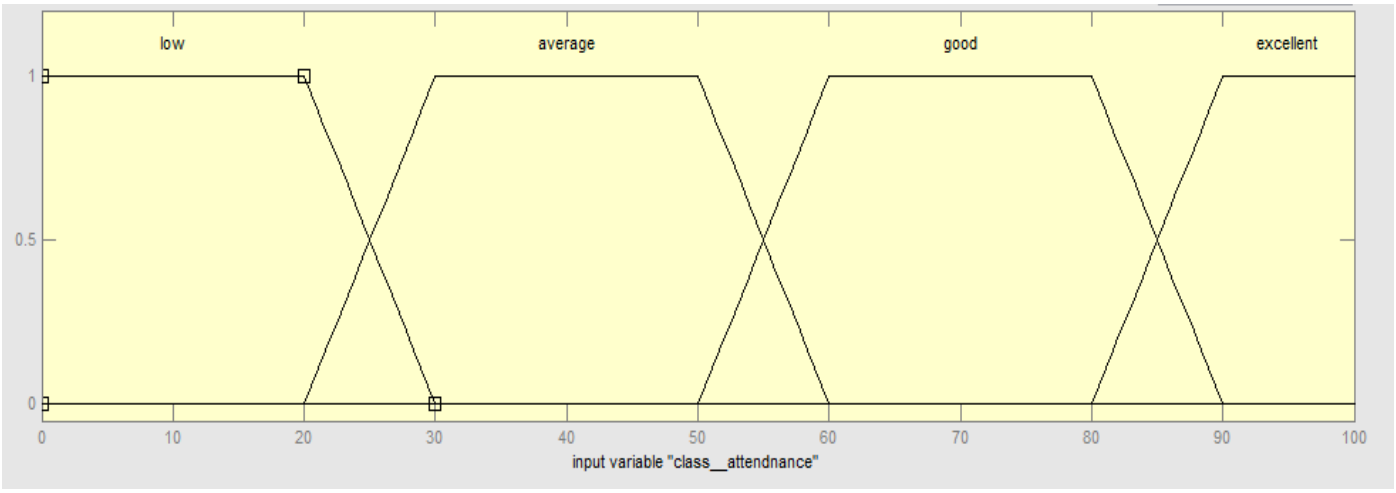
MEMBERSHIP FUNCTIONS FOR THE PERFORMANCE EVALUATION

Here, we will use four input parameters and try to find the level of Performance of the students in the output.

Class Attendance:

We make a trapezoidal membership function for the following information.

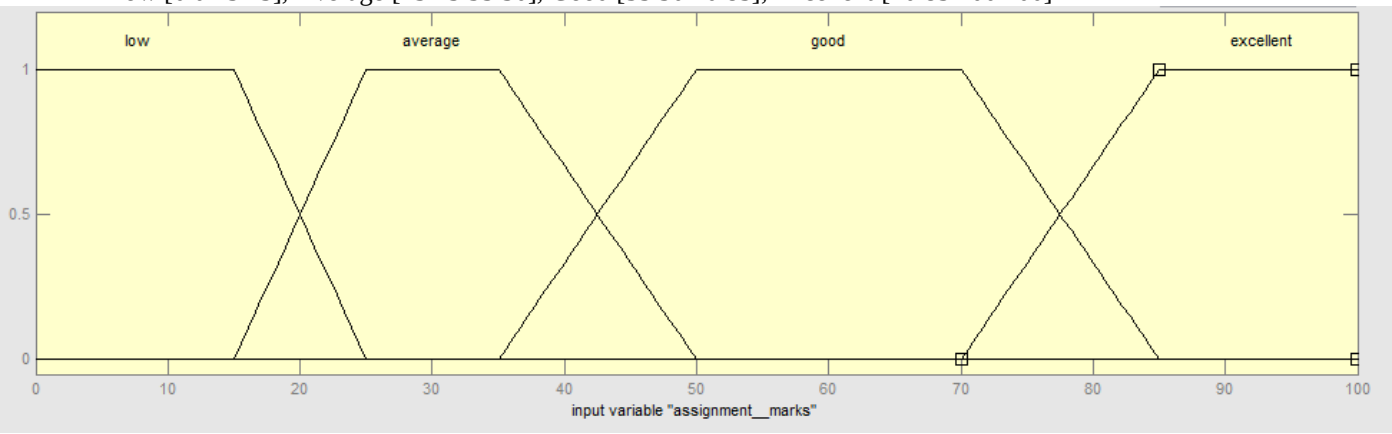
Low [0 0 20 30], Average [20 30 50 60], Good [50 60 80 90], Excellent [80 90 100 100]



Assignments Marks:

We make a trapezoidal membership function for the following information.

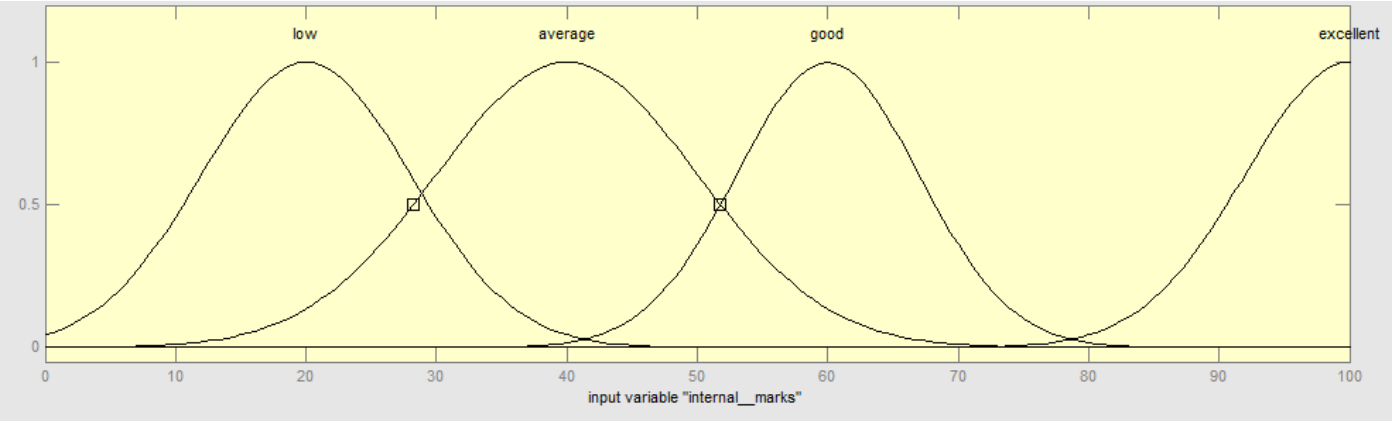
Low [0 0 15 25], Average [15 25 35 50], Good [35 50 70 85], Excellent [70 85 100 100]



Internal Marks:

We make a Gauss membership function for the following information.

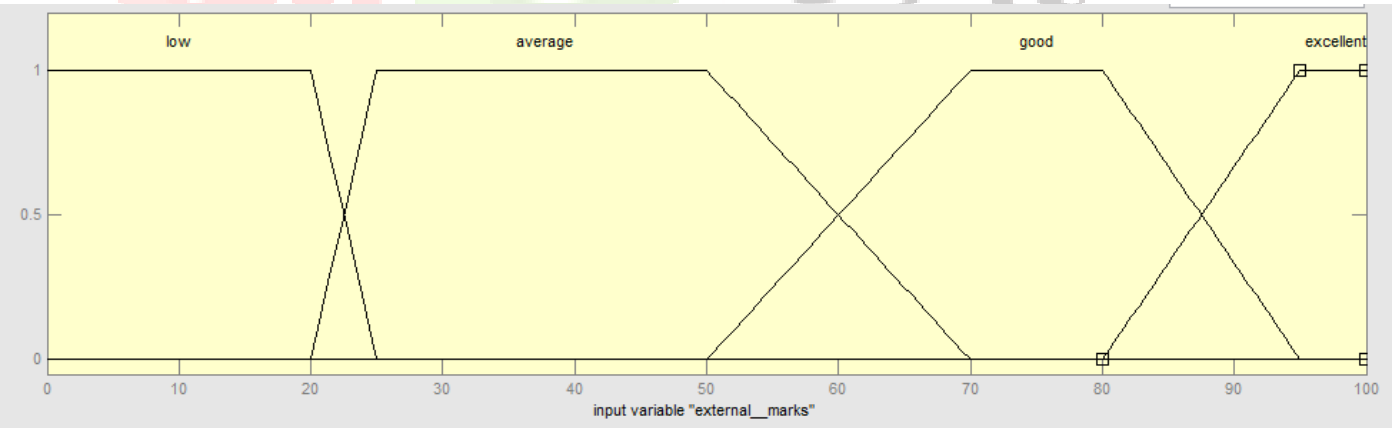
Low [8 20], Average [10 40], Good [7 60], Excellent [8, 100]



External Marks:

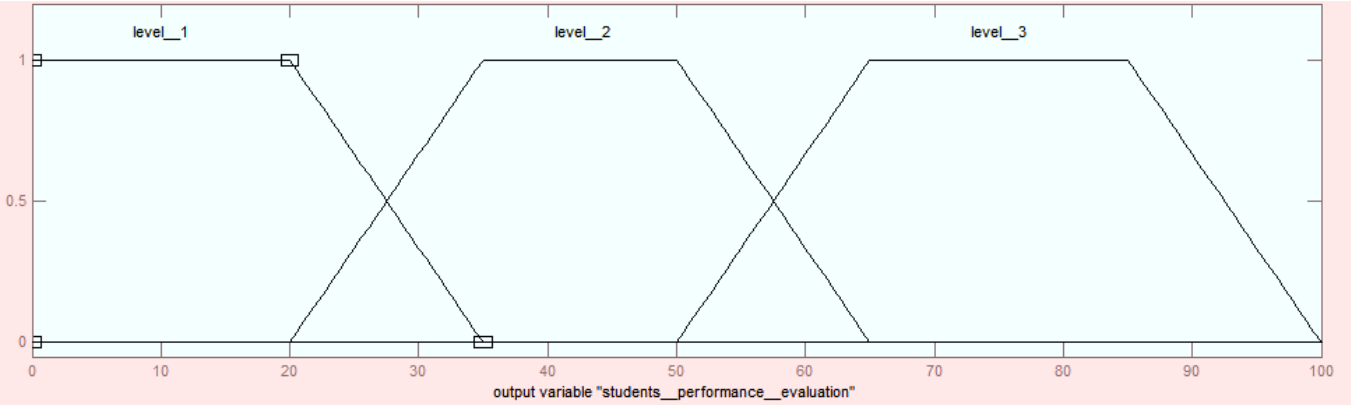
We make a trapezoidal membership function for the following information.

Low [0 0 20 25], Average [20 25 50 70], Good [50 70 80 95], Excellent [80 95 100 100]



Fuzzy sets for output variables:

The fuzzy sets for output variables are shown in trapezoidal membership functions with three levels of performance evaluations (Level- 1, Level -2 and Level-3), Where levels are in better performance as in increasing order.
Level- 1 [0 0 20 35], Level- 2 [20 35 50 65], level- 3 [50 65 85 100]



Fire the rule base that corresponds to the inputs:

Based on the value of fuzzy membership function values for the example under consideration, the following rules apply:

Sr. No	X1	X2	X3	X4	Student Performance Evaluation
1	low	Low	low	low	level 1
2	low	Low	low	good	level 1
3	low	average	average	average	level 1
4	low	Good	good	good	level 1
5	low	excellent	excellent	excellent	level 3
6	average	Low	low	low	level 1
7	average	Low	low	good	level 2
8	average	average	average	average	level 2
9	average	Good	good	good	level 3
10	average	excellent	excellent	excellent	level 3
11	good	Low	low	low	level 1
12	good	Low	low	good	level 1
13	good	average	average	average	level 2
14	good	Good	good	good	level 2
15	good	excellent	excellent	excellent	level 3
16	excellent	Low	average	good	level 2
17	excellent	average	average	excellent	level 3
18	excellent	Good	average	low	level 2
19	excellent	excellent	average	good	level 3
20	excellent	Low	average	average	level 2
21	excellent	Low	good	good	level 2
22	excellent	average	good	good	level 3
23	excellent	Good	good	excellent	level 3

Table 1: Rules and Inference Generation

4. EXPERIMENTAL RESULTS

In the present work, fuzzy expert system is proposed for the student's performance evaluation and calculation and testing is done under the MATLAB. A fuzzy tool also introduced for the research work evaluation and a samples of 10 students from the data is tasted in the proposed expert system. Table -2 shows the performance of BCA II year students of IMS University courses, Near Aadhyatmik Nagar, NH- 24, Ghaziabad, UP, India.

S.No	X1	X2	X3	X4	Classical Methods	Student Performance for proposed method
1	21.8	42.3	17.6	38	29.925	31.9
2	26.1	49.7	28.7	49.7	38.550	32
3	40.2	47.2	25	40.4	38.200	42.5
4	15	19.3	13.9	34.3	20.625	17
5	43.3	47.2	10.2	46.6	36.825	42.5
6	19.9	13.9	28.1	18.8	20.175	15.1
7	13.2	22.5	22.5	34.9	23.275	16.4
8	88	87.3	81.8	88.6	86.425	75
9	69	79.9	90.4	88.6	81.975	72
10	78.2	81.2	84.3	84.9	82.150	74.6

Table 2: Scores of performance of 10 students

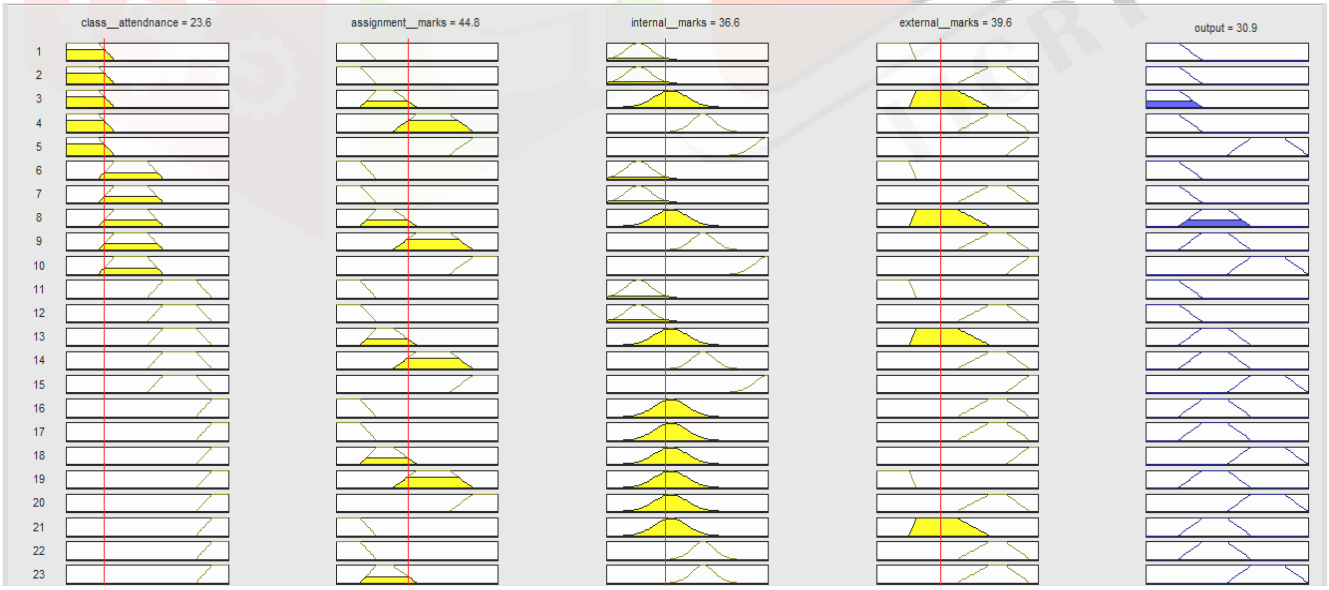


Figure 3: Active Rules and Students Performance Value

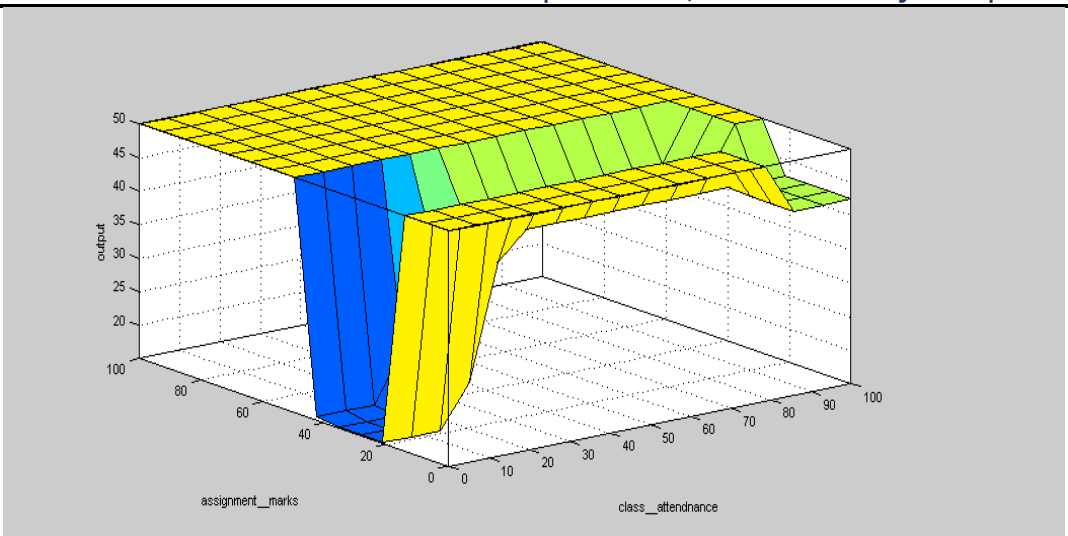


Figure 4: Surface viewer of Students Performance Value

Fuzzy -2 Method:

Here we are taking the input linguistic variable according to the below given intervals.

Input Linguistic Variable	Interval
LOW	(0 0 15 25)
AVERAGE	(15 25 35 50)
GOOD	(35 50 70 85)
EXCELLENT	(70 85 100 100)

Table 5.1: Fuzzy set of input for the student's performance evaluation (Fuzzy – 2)

S. No.	X1	X2	X3	X4	Fuzzy 2	
					Output	Grade
1	21.8	42.3	17.6	38	31.9	C
2	26.1	49.7	28.7	49.7	42.5	C
3	40.2	47.2	25	40.4	42.5	C
4	15	19.3	13.9	34.3	17	D
5	43.3	47.2	10.2	46.6	42.5	C
6	19.9	13.9	28.1	18.8	16	D
7	13.2	22.5	22.5	34.9	16.4	D
8	88	87.3	81.8	88.6	75	B
9	69	79.9	90.4	88.6	75	B
10	78.2	81.2	84.3	84.9	74.6	C

Table 5.2: Fuzzy set of output for the student's performance evaluation (Fuzzy – 2)

5. Comparison of Classical, Fuzzy-1 and Fuzzy-2 Methods

Comparisons of classical, fuzzy-1 and fuzzy-2 methods for student's performance evaluation are given in Table 5.1. Comparison of the classical method with fuzzy-2 revealed variation in the performance values. In the case of scores >0.50 and <0.25, the performance value of fuzzy-2 is smaller than the classical method; however, for scores <0.50 and >0.25, the performance value is greater than the classical method. The linear relationship among classical, fuzzy-1 and fuzzy- 2 can be seen in Fig. 5.1.

S. No.	X1	X2	X3	X4	Classical Method		Fuzzy -1		Fuzzy- 2	
					Output	Grade	Output	Grade	Output	Grade
1	21.8	42.3	17.6	38	29.93	D	31.9	C	31.9	C
2	26.1	49.7	28.7	49.7	38.55	C	32	C	42.5	C
3	40.2	47.2	25	40.4	38.20	C	42.5	C	42.5	C
4	15	19.3	13.9	34.3	20.63	D	17	D	17	D
5	43.3	47.2	10.2	46.6	36.83	C	42.5	C	42.5	C
6	19.9	13.9	28.1	18.8	20.18	D	15.1	D	16	D
7	13.2	22.5	22.5	34.9	23.28	D	16.4	D	16.4	D
8	88	87.3	81.8	88.6	86.43	A	75	B	75	B
09	69	79.9	90.4	88.6	81.98	A	72	B	75	B
10	78.2	81.2	84.3	84.9	82.15	A	74.6	B	74.6	C

Table 5.3: Comparison of student's Performance Evaluation

S. No.	Training and Testing (RMSE)	Fuzzy- 1	Fuzzy-2
1	Testing (RMSE)	**0.068**	**0.061**

Table 5.4: RMSE of Training and Testing Data Sets

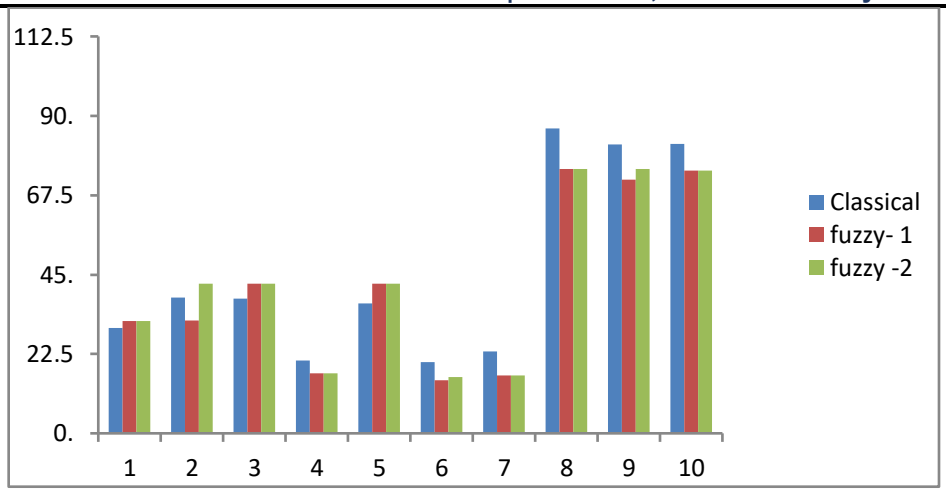


Fig. 5.1: Performance Value by Classical, Fuzzy-1 & Fuzzy-2 Methods

6. CONCLUSION:

In this paper, proposed work is calculated under the Madnani Techniques and fuzzy expert system which are given in table 2. The scores are divided in 100 marks. The Evaluation of performance according to the input factors are describe in Table-2. IF-THEN Rules are describing in Table-1 and also Output is taken in 3-levels as level-1, level-2 and level-3 and the better performance as in increasing order. All the results for the performance evaluation can be evaluated or compared from Table-2 and Output variable are described in the paper. MATLAB is used in the whole calculation for the results. As we have seen that the proposed method (Fuzzy Expert System) is more suitable for students 'performance evaluation in comparison to classical Method.

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