CHAPTER-46

FUZZY EXPERT SYSTEM FOR PREDICTING STUDENT'S PERFORMANCE EVALUATIONS: A CASE STUDY

[1]BHAVANA SINGH
[1]Research Scholar, Department of Mathematics, Agra College, Agra (India)
Affiliated to Dr. Bhimrao Ambedkar University, Agra (India)

[2]MANJU SHARMA
[2]Associate Professor, Department of Mathematics, Agra College, Agra (India)
Affiliated to Dr. Bhimrao Ambedkar University, Agra (India)

Chapter ID: NSP/ICAAR-2023/A-46

ABSTRACT

The evaluation of students' performance in schools uses a wide variety of exciting and difficult methods. Fuzzy inference system (FIS) is used to assess students' progress here by considering a number of criteria. Fuzzy expert systems are used for processing and implementing data. In this case, both input and output variables are pimfs, or π-shaped membership functions. In order to back up this methodology, a case study is also studied. RBS Engineering Technical Campus at Bichpuri, Agra (India) uses MATLAB software to assess its students' abilities. The management of a university or school benefits most from the performance evaluation approach. Data into crisp output has also been examined using MOM (Mean of maxima) method for defuzzification.

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 sample of 15 students from the data is tested in the proposed expert system.

Keywords: *Defuzzification, Fuzzy expert system, Membership plot function, Rule base, Performance evaluation*

INTRODUCTION

Clusters (or classes) are constructed according to students' IQs, and the number of students in each class must not exceed the maximum allowed by the system, so the evaluation of students' academic achievement can be seen as a clustering problem. It would be difficult to provide high-quality educational services to a highly diversified student population without the use of intelligence level wise grouping to maintain group homogeneity. The academic performance outcomes would be more fair, realistic, and comparable if students were placed into classes based on their rankings (or other metrics of similarity). When comparing students or ranking them based on their scores, the current practice of aggregating scores from different score combinations is unrealistic. The Grade Point Average (GPA) is a common score aggregation based statistic used by universities. Exam scores are commonly used as a quantitative measure of a student's progress. The traditional method of grading students is to add up their marks from all of their tests, assignments, and other forms of coursework. Evaluation and assessment are motivating and fundamental features of teaching and learning. Using this technique, you pass or fail depending on a certain percentage of your overall grade. This is not a reliable means of gauging a student's competence. A student in engineering, for instance, who gets 80s in theories and 89s in projects but only 40s in labs, will have a 70 in classical method. We would deem him successful if the criterions were 65, but this would be incorrect because he lacks the necessary skills to successfully complete projects.

Evaluating the progress of one's students is a crucial part of every educational institution's mission. Fair evaluation is a top priority, thus it's important that students' grades reflect their actual abilities. Attendance, in-class tests, final exams, and other assessments all play a role in determining a student's overall grade. The cumulative grade takes them into account. In many schools, attendance is measured solely by the number of classes attended. Since most colleges in underdeveloped countries like Bangladesh have huge class sizes and students often do not attend class of full time, it is important to evaluate not just how many classes a student attends but also how much time they spend in class. A piece of specialised hardware is used to keep track of the number of classes attended and the total amount of time invested in each.

Zadeh (1965) first proposed the concept of fuzzy sets. In recent years, it has seen widespread usage in several areas of study, including the educational system, with the goal of clarifying concepts where previous approaches had failed. An approach based on genetic algorithms and fuzzy sets was proposed by **Wilson et al. in 1998**. **In 2006, Bai and Chen** proposed a method for the automatic generation of the membership function of fuzzy rules. Then, we may use this student's marks using this membership function in fuzzy logic. It came up with a fair and efficient method of grading pupils' written responses. **Biggs (2007)**, who agreed with this strategy, argued that the assessments pupils take more seriously would have a significant impact on what and how they learned. The importance of a course or programme can be clearly communicated to students through the learning outcomes and assessment methods utilized by teachers. According to a report by **Zukhri and Omar (2008)**, the Genetic Algorithm was successfully used to the challenging optimization task of allocating new students. An developing rule-based approach for detection of multiple intelligences has been published by **Mankad et al. (2011)**. Their hypothesis of human intelligence is a combination of genetic and fuzzy logic. Based on data warehousing and data mining techniques that heavily employ soft computing, **Sreenivasarao and Yohannes (2012)** created a model for better evaluating students' academic achievement. According to their findings, having similar classmates in a classroom helps everyone learn more. **Yadav and Ahmed (2012)** investigated the use of K-means and fuzzy C-Means clustering algorithms to solve the student allocation problem, which places new students into groups with a predetermined number of available spots, and then examines the impact of these placements on students' academic outcomes. The evaluation of student performance is viewed as a clustering problem by **Yadav and Singh (2012)**, with the number of clusters (classes) being constrained to be less than or equal to the established capacity. Based on Fuzzy Logic methods, **Yadav et al. (2014)** introduced a New Fuzzy Expert System (NFES) for assessing students' academic progress. It explains the ideas behind fuzzy logic and shows how they could be used in the classroom to assess students' work. When evaluating student performance, **Surya et al. (2016)** opted for Fuzzy logic over traditional approaches. Classical methods also made extensive use of mathematical computations, which were primarily used by engineering students. **Petra and Aziz (2021)** demonstrated that fuzzy logic is highly adaptable, with the added bonus of allowing alternative weights to be assigned to each feature depending on the specifics of the educational institution's demands and requirements. Student performance was measured using a fuzzy inference system (FIS) according to the input variables by **Kumar and Singh (2023)**. Input variables were distributed using the Gaussian distribution, and output variables were distributed using the trapezoidal distribution.

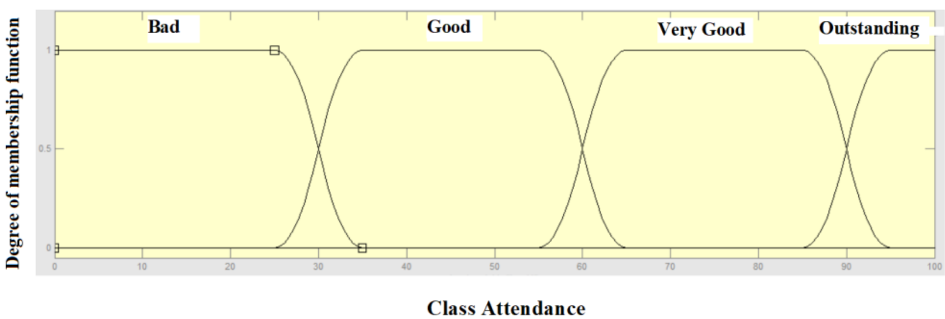
MEMBERSHIP PLOT FUNCTION OF INPUT AND OUTPUT VARIABLES

The π -shaped MF is a membership function that takes the form of a

$$f(x,p,q,r,s) = \begin{Bmatrix} 0 & x \le p \\ 2\left(\frac{x-p}{q-p}\right)^2 & p \le x \le \frac{p+q}{2} \\ 1-2\left(\frac{x-q}{q-p}\right)^2 & \frac{p+q}{2} \le x \le q \\ 1 & q \le x \le r \\ 1-2\left(\frac{x-r}{s-r}\right)^2 & r \le x \le \frac{r+s}{2} \\ 2\left(\frac{x-s}{s-r}\right)^2 & \frac{r+s}{2} \le x \le s \\ 0 & x \ge s \end{Bmatrix}$$

The feet, or starting points, of the curve can be adjusted by adjusting the values of p and . The left and right peaks, or shoulders, of the curve can be adjusted with the q and r parameters, respectively.

Figure 1: Membership plot function of input variable 1



$x = class\ \ attendance\ (\%)$

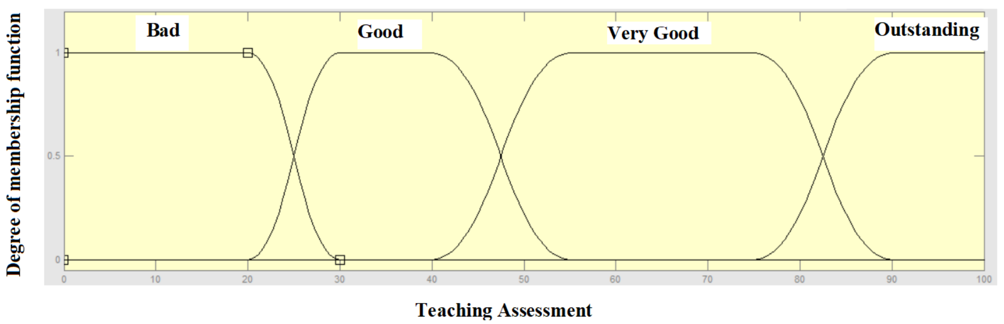
$$\mu_{BCL}(x) = \begin{Bmatrix} 1 & 0 \le x \le 25 \\ 1-2\left(\frac{x-25}{10}\right)^2 & 25 \le x \le 30 \\ 2\left(\frac{x-35}{10}\right)^2 & 30 \le x \le 35 \end{Bmatrix}$$

$$\mu_{GCL}(x) = \begin{Bmatrix} 2\left(\frac{x-25}{10}\right)^2 & 25 \le x \le 30 \\ 1-\left(\frac{x-35}{10}\right)^2 & 30 \le x \le 35 \\ 1 & 35 \le x \le 55 \\ 1-2\left(\frac{x-55}{10}\right)^2 & 55 \le x \le 60 \\ 2\left(\frac{x-65}{10}\right)^2 & 60 \le x \le 65 \end{Bmatrix}$$

$$\mu_{VGCL}(x) = \begin{cases} 2\left(\frac{x-55}{10}\right)^2 & 55 \le x \le 60 \\ 1-2\left(\frac{x-65}{10}\right)^2 & 60 \le x \le 65 \\ 1 & 65 \le x \le 85 \\ 1-2\left(\frac{x-85}{10}\right)^2 & 85 \le x \le 90 \\ 2\left(\frac{x-95}{10}\right)^2 & 90 \le x \le 95 \end{cases}$$

$$\mu_{OCL}(x) = \begin{cases} 2\left(\frac{x-85}{10}\right)^2 & 85 \le x \le 90 \\ 1-2\left(\frac{x-95}{10}\right)^2 & 90 \le x \le 95 \\ 1 & 95 \le x \le 100 \end{cases}$$

Figure 2: Membership plot function of input variable 2



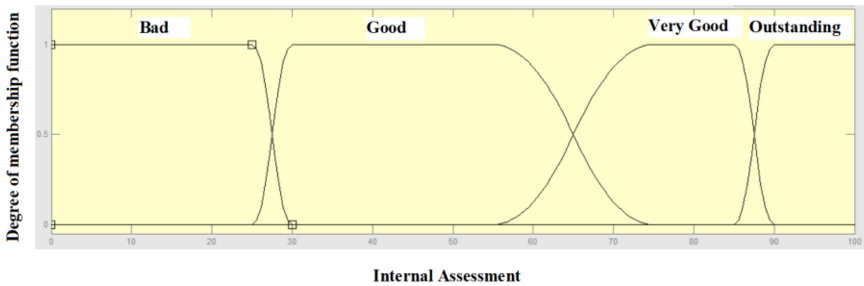
$y = teaching\ assesment\ (\%)$

$$\mu_{BTA}(y) = \begin{cases} 1 & 0 \le y \le 20 \\ 1-2\left(\frac{x-20}{10}\right)^2 & 20 \le y \le 25 \\ 2\left(\frac{x-25}{10}\right)^2 & 25 \le y \le 30 \end{cases}$$

$$\mu_{GTA}(y) = \begin{cases} 2\left(\frac{y-20}{10}\right)^2 & 20 \le y \le 25 \\ 1-\left(\frac{y-30}{10}\right) & 25 \le y \le 30 \\ 1 & 30 \le y \le 40 \\ 1-2\left(\frac{y-40}{15}\right)^2 & 40 \le y \le 45 \\ 2\left(\frac{y-55}{15}\right)^2 & 45 \le y \le 55 \end{cases}$$

$$\mu_{VGTA}(y) = \begin{pmatrix} 2\left(\frac{y-40}{15}\right)^2 & 40 \le y \le 47.5 \\ 1-2\left(\frac{y-55}{15}\right)^2 & 47.5 \le y \le 55 \\ 1 & 55 \le y \le 75 \\ 1-2\left(\frac{y-75}{15}\right)^2 & 75 \le y \le 82.5 \\ 2\left(\frac{y-90}{15}\right) & 82.5 \le y \le 90 \end{pmatrix} = \mu_{OTA}(y) = \begin{cases} 2\left(\frac{y-75}{15}\right)^2 & 75 \le x \le 82.5 \\ 1-2\left(\frac{y-90}{15}\right)^2 & 82.5 \le x \le 90 \\ 1 & 90 \le x \le 100 \end{cases}$$

Figure 3: Membership plot function of input variable 3



$z = internal\ assesment\ (\%)$

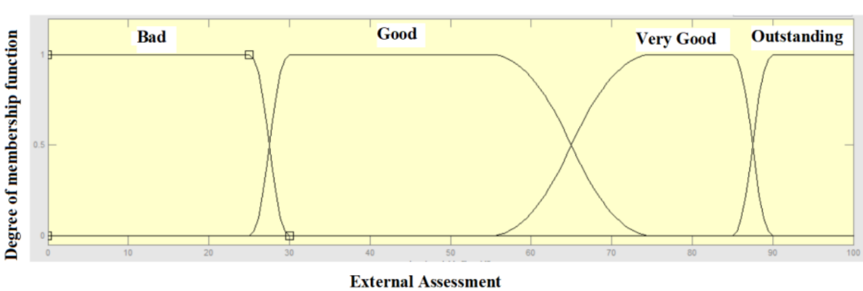
$$\mu_{BIA}(z) = \begin{cases} 1 & 0 \le z \le 25 \\ 1 - 2\left(\frac{z-25}{5}\right)^2 & 25 \le z \le 27.5 \\ 2\left(\frac{z-30}{5}\right)^2 & 27.5 \le z \le 30 \end{cases}$$

$$\mu_{GIA}(z) = \begin{cases} 2\left(\frac{z-25}{5}\right)^2 & 25 \le z \le 27.5 \\ 1 - 2\left(\frac{z-30}{5}\right)^2 & 27.5 \le z \le 30 \\ 1 & 30 \le z \le 55 \\ 1 - 2\left(\frac{z-55}{20}\right)^2 & 55 \le z \le 65 \\ 2\left(\frac{z-75}{20}\right)^2 & 65 \le z \le 75 \end{cases}$$

$$\mu_{VGIA}(z) = \left[\begin{array}{cc} 2\left(\frac{z-55}{20}\right)^2 & 55 \le z \le 65 \\ 1 - 2\left(\frac{z-75}{20}\right)^2 & 65 \le z \le 75 \\ 1 & 75 \le z \le 85 \\ 1 - 2\left(\frac{z-85}{5}\right)^2 & 85 \le z \le 87.5 \\ 2\left(\frac{z-90}{5}\right)^2 & 87.5 \le z \le 90 \end{array}\right]$$

$$\mu_{OIA}(z) = \begin{cases} 2\left(\frac{z-85}{5}\right)^2 & 85 \le z \le 87.5 \\ 1 - 2\left(\frac{z-90}{5}\right)^2 & 87.5 \le z \le 90 \\ 1 & 90 \le z \le 100 \end{cases}$$

Figure 4: Membership plot function of input variable 4



$t = external\ assesment\ (\%)$

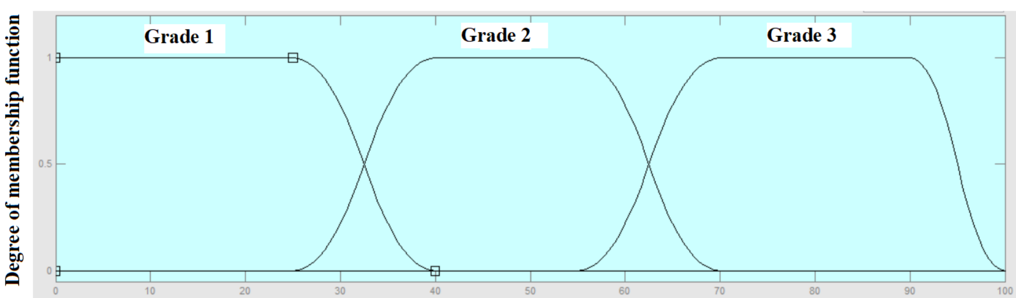
$$\mu_{BEA}(t) = \left\{ \begin{matrix} 1 & 0 \le t \le 25 \\ 1 - 2\left(\frac{t-25}{5}\right)^2 & 25 \le t \le 27.5 \\ 2\left(\frac{t-30}{5}\right)^2 & 27.5 \le t \le 30 \end{matrix} \right\}$$

$$\mu_{GEA}(t) = \left\{ \begin{matrix} 2\left(\frac{t-25}{5}\right)^2 & 25 \le t \le 27.5 \\ 1 - 2\left(\frac{t-30}{5}\right)^2 & 27.5 \le t \le 30 \\ 1 & 30 \le t \le 55 \\ 1 - 2\left(\frac{t-55}{20}\right)^2 & 55 \le t \le 65 \\ 2\left(\frac{t-75}{20}\right)^2 & 65 \le t \le 75 \end{matrix} \right\}$$

$$\mu_{VGEA}(t) = \left[\begin{matrix} 2\left(\frac{t-55}{20}\right)^2 & 55 \le t \le 65 \\ 1 - 2\left(\frac{t-75}{20}\right)^2 & 65 \le t \le 75 \\ 1 & 75 \le t \le 85 \\ 1 - 2\left(\frac{t-85}{5}\right)^2 & 85 \le t \le 87.5 \\ 2\left(\frac{t-90}{5}\right)^2 & 87.5 \le t \le 90 \end{matrix} \right]$$

$$\mu_{3OEA}(t) = \left\{ \begin{matrix} 2\left(\frac{t-85}{5}\right)^2 & 85 \le t \le 87.5 \\ 1 - 2\left(\frac{t-90}{5}\right)^2 & 87.5 \le t \le 90 \\ 1 & 90 \le t \le 100 \end{matrix} \right\}$$

Figure 5: Membership plot function of output variable



Performance Evaluation

u = performace evaluation (%)

$$\mu_{PEG1}(u) = \left\{ \begin{matrix} 1 & 0 \le u \le 25 \\ 1 - 2\left(\frac{u-25}{15}\right)^2 & 25 \le u \le 32.5 \\ 2\left(\frac{u-40}{15}\right)^2 & 32.5 \le u \le 40 \end{matrix} \right\}$$

$$\mu_{PEG2}(u) = \left\{ \begin{matrix} 2\left(\frac{u-25}{15}\right)^2 & 25 \le u \le 32.5 \\ 1 - 2\left(\frac{u-40}{15}\right)^2 & 32.5 \le u \le 40 \\ 1 & 40 \le u \le 55 \\ 1 - 2\left(\frac{u-55}{15}\right)^2 & 55 \le u \le 62.5 \\ 2\left(\frac{u-70}{15}\right)^2 & 62.5 \le u \le 70 \end{matrix} \right\}$$

$$\mu_{PEG2}(u) = \begin{cases} 2\left(\frac{u-55}{15}\right)^2 & 55 \le u \le 62.5 \\ 1-2\left(\frac{u-70}{15}\right)^2 & 62.5 \le u \le 70 \\ 1 & 70 \le u \le 90 \\ 1-2\left(\frac{u-90}{10}\right)^2 & 90 \le u \le 95 \\ 2\left(\frac{u-100}{10}\right)^2 & 95 \le u \le 100 \end{cases}$$

RULE IMPLICATIONS

Fuzzy expert systems are an interesting and useful use of artificial intelligence and fuzzy logic, and they can be used to anticipate how students will be graded. Because of their comfort with vague or incomplete data, fuzzy expert systems can be used in places where the strictness of binary logic would be counterproductive. Here's how a system like that might calculate an estimated grade for a pupil.

IF-THEN rules are laid out in Table-1, and the results are ranked from best to worst across three tiers (grades 1, 2, and 3). The following guidelines apply, depending on the value of the fuzzy membership function values in the proposed case study:

Table 1: Rule implications related to illustration

Rules	CA	TA	IA	EA	PE
1	BAD	BAD	BAD	BAD	GRADE 1
2	BAD	BAD	BAD	GOOD	GRADE 1
3	BAD	BAD	GOOD	GOOD	GRADE 1
4	BAD	GOOD	GOOD	GOOD	GRADE 1
5	BAD	BAD	BAD	VERY GOOD	GRADE 1
6	BAD	BAD	VERY GOOD	VERY GOOD	GRADE 1
7	BAD	BAD	OUTSTANDING	OUTSTANDING	GRADE 1
8	GOOD	GOOD	OUTSTANDING	OUTSTANDING	GRADE 2
9	GOOD	OUTSTANDING	OUTSTANDING	OUTSTANDING	GRADE 3
10	VERY GOOD	OUTSTANDING	OUTSTANDING	OUTSTANDING	GRADE 3
11	OUTSTANDING	OUTSTANDING	OUTSTANDING	OUTSTANDING	GRADE 3
12	VERY GOOD	VERY GOOD	OUTSTANDING	OUTSTANDING	GRADE 3
13	BAD	OUTSTANDING	OUTSTANDING	OUTSTANDING	GRADE 3
14	BAD	BAD	OUTSTANDING	OUTSTANDING	GRADE 2
15	BAD	GOOD	OUTSTANDING	OUTSTANDING	GRADE 2
16	BAD	VERY GOOD	OUTSTANDING	OUTSTANDING	GRADE 3
17	VERY GOOD	VERY GOOD	VERY GOOD	OUTSTANDING	GRADE 3
18	BAD	OUTSTANDING	OUTSTANDING	OUTSTANDING	GRADE 2
19	BAD	BAD	BAD	OUTSTANDING	GRADE 1
20	GOOD	GOOD	GOOD	OUTSTANDING	GRADE 2
21	GOOD	VERY GOOD	GOOD	VERY GOOD	GRADE 2
22	GOOD	GOOD	GOOD	VERY GOOD	GRADE 2
23	BAD	VERY GOOD	VERY GOOD	VERY GOOD	GRADE 2
24	BAD	BAD	VERY GOOD	OUTSTANDING	GRADE 2
25	BAD	GOOD	VERY GOOD	OUTSTANDING	GRADE 2
26	BAD	GOOD	GOOD	VERY GOOD	GRADE 2
27	GOOD	GOOD	GOOD	GOOD	GRADE 2
28	VERY GOOD	VERY GOOD	VERY GOOD	VERY GOOD	GRADE 3
29	VERY GOOD	VERY GOOD	GOOD	GOOD	GRADE 2
30	VERY GOOD	VERY GOOD	VERY GOOD	GOOD	GRADE 3
31	VERY GOOD	GOOD	GOOD	GOOD	GRADE 2
32	BAD	GOOD	VERY GOOD	OUTSTANDING	GRADE 2
33	BAD	GOOD	GOOD	OUTSATNDING	GARDE 2
34	BAD	GOOD	VERY GOOD	BAD	GRADE 1
35	GOOD	GOOD	VERY GOOD	BAD	GRADE 1
36	OUTSTANDING	GOOD	GOOD	OUTSTANDING	GRADE 3
37	OUTSTANDING	VERY GOOD	GOOD	GOOD	GRADE 3
38	OUTSTANDING	BAD	GOOD	GOOD	GARDE 2
39	OUTSTANDING	BAD	VERY GOOD	VERY GOOD	GARDE 2
40	OUTSTANDING	OUTSTANDING	VERY GOOD	GOOD	GARDE 3
41	GOOD	BAD	BAD	BAD	GRADE 1
42	BAD	GOOD	VERY GOOD	VERY GOOD	GRADE 2
43	BAD	VERY GOOD	GOOD	VERY GOOD	GRADE 2
44	GOOD	GOOD	VERY GOOD	VERY GOOD	GRADE 3

METHODOLOGY

For defuzzification, we have used MOM (Mean of maxima) method.

Let us consider the for crisps inputs as $x = 33\ \%, y = 42\%, z = 63\ \%, t = 74\%$

Using the membership function in section (2), we find the fuzzy corresponding fuzzy values

$\mu_{BCL}(33) = \frac{2}{25},\ \mu_{VGCL}(33) = \frac{23}{25}$
$\mu_{GTA}(42) = \frac{217}{225},\ \mu_{VGTA}(42) = \frac{8}{225}$
$\mu_{GIA}(63) = \frac{17}{25},\ \mu_{VGIA}(63) = \frac{8}{25}$
$\mu_{GEA}(74) = \frac{17}{25},\ \mu_{VGEA}(74) = \frac{8}{25}$
$min\{\mu_{BCL}, \mu_{GTA}, \mu_{GIA}, \mu_{GEA}\} = min\left\{\frac{2}{25}, \frac{217}{225}, \frac{17}{25}, \frac{17}{25}\right\} = \frac{2}{25}$ (Strength of Rule 4)
$min\{\mu_{VGCL}, \mu_{VGTA}, \mu_{VGIA}, \mu_{VGEA}\} = min\left\{\frac{23}{25}, \frac{8}{225}, \frac{8}{25}, \frac{8}{25}\right\} = \frac{8}{225}$ (Strength of Rule 28)
$min\{\mu_{BCL}, \mu_{VGTA}, \mu_{VGIA}, \mu_{VGEA}\} = min\left\{\frac{2}{25}, \frac{8}{225}, \frac{8}{25}, \frac{8}{25}\right\} = \frac{2}{25}$ (Strength of Rule 23)
$= min\{\mu_{VGCL}, \mu_{GTA}, \mu_{GIA}, \mu_{GEA}\} = min\left\{\frac{23}{25}, \frac{217}{225}, \frac{17}{25}, \frac{17}{25}\right\} = \frac{17}{25}$ (Strength of Rule 31)
$= min\{\mu_{BCL}, \mu_{GTA}, \mu_{VGIA}, \mu_{VGEA}\} = min\left\{\frac{2}{25}, \frac{217}{225}, \frac{8}{25}, \frac{8}{25}\right\} = \frac{2}{25}$ (Strength of Rule 42)
$min\{\mu_{VGCL}, \mu_{VGTA}, \mu_{GIA}, \mu_{GEA}\} = min\left\{\frac{23}{25}, \frac{8}{225}, \frac{17}{25}, \frac{17}{25}\right\} = \frac{8}{225}$ (Strength of Rule 29)
$min\{\mu_{BCL}, \mu_{GIA}, \mu_{VGTA}, \mu_{VGEA}\} = min\left\{\frac{2}{25}, \frac{17}{25}, \frac{8}{225}, \frac{8}{25}\right\} = \frac{2}{25}$ (Strength of Rule 43)
$min\{\mu_{GTA}, \mu_{GEA}, \mu_{VGCL}, \mu_{VGIA}\} = min\left\{\frac{217}{225}, \frac{17}{25}, \frac{23}{25}, \frac{8}{25}\right\} = \frac{8}{25}$ (Strength of Rule 44)
$Maximum\ strength = max\left\{\frac{2}{25}, \frac{8}{225}, \frac{2}{25}, \frac{17}{25}, \frac{2}{25}, \frac{8}{225}, \frac{2}{25}, \frac{8}{25}\right\} = \frac{17}{25}$ (Corresponds to Rule 31)
Rule (31) has the maximum strength and its output is grade 2.
$2\left(\frac{u-25}{15}\right)^2 = \frac{17}{25} \Longrightarrow u = 33.74,16.25$
$1 - 2\left(\frac{u-40}{15}\right)^2 = \frac{17}{25} \Longrightarrow u = 46,34$
$1 - 2\left(\frac{u-55}{15}\right)^2 = \frac{17}{25} \Longrightarrow u = 61,49$
$2\left(\frac{u-70}{15}\right)^2 = \frac{17}{25} \Longrightarrow u = 78.74,61.25$
Using MOM (Mean of maxima),
$u^* = \frac{33.74+46+61+78.4}{4} = 54.87$ (crisp output)
$u^* = \frac{16.25+34+49+61.25}{4} = 40.125$ (crisp output)

A fuzzy expert system is suggested for the purpose of evaluating the student's performance and all calculations and testing are carried out using MATLAB. In addition, a fuzzy tool was presented for the purpose of assessing the quality of the study activity, and 15 students were chosen at random from the data in order to evaluate the proposed expert system. The results of the students in the first year of the Bachelor of Technology programme at RBS Engineering Technical Campus in Bichpuri, Agra, Uttar Pradesh (India) are presented in Table 2.

The suggested work has been estimated using the Mamdani techniques as well as the fuzzy expert system, both of which are presented in table 2. The total is broken down into 100 separate marks.

Table 2 provides an evaluation of performance based on the many input criteria that were considered. It can be used to analyze or compare each of the results of the performance evaluation, and section 2 explains the output variable. MATLAB was utilized throughout the entirety of the calculation to produce these results. As we have shown, the proposed system, which is called the Fuzzy Expert System, is more appropriate for assessing the pupils' overall performance.

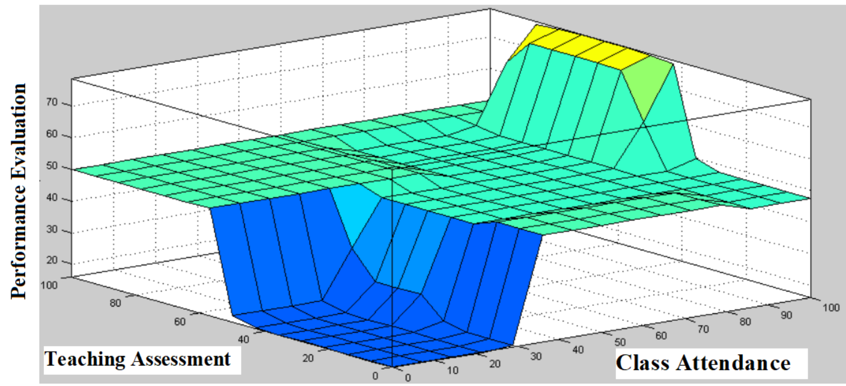
Table 2: Calculated values of performance evaluation for different activities of students

Rules	Class Attendance	Teaching Assessment	Internal Assessment	External Assessment	Performance Evalutaion
1	22.5	78.2	57.5	23.1	50
2	50.8	57.2	34.7	59.2	47.5
3	59.7	69.9	63.1	78.6	59.4
4	28.6	45.6	51.4	24.2	50
5	34.2	18	25.8	86.4	19.3
6	28.1	31.2	40.8	68.1	40.1
7	93.1	94.2	98.6	93.6	78.6
8	6.94	4.14	4.72	1.94	16.1
9	22.5	39	30.8	18.6	50
10	50.3	98.1	96.4	86.9	78.1
11	18.1	7.46	93.6	93.6	31
12	13.1	99.7	98.6	99.7	63.8
13	32.5	90.9	83.6	73.6	50
14	41.4	27.3	30.8	85.3	47.5
15	56.4	46.7	75.8	39.7	77.7

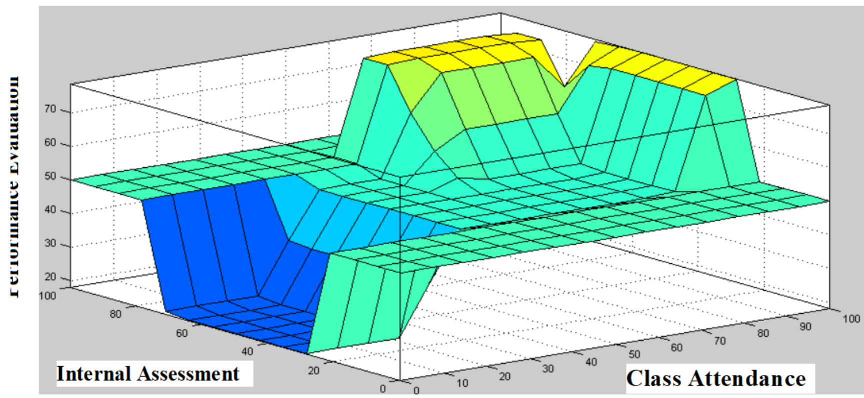
3D SURFACE PLOT DEPICTING THE STUDENTS' OVERALL PERFORMANCE FOR THE VARIOUS ACTIVITIES

The term "surface viewer" is commonly used to describe a visualization tool that helps us understand the interplay between different input variables and their impact on the predicted performance evaluation in the context of student performance prediction using a fuzzy expert system. It allows you to see the output surface, which shows how changing many inputs at once affects the predicted outcome. The resulting surface map graphically displays the complex interdependencies among the predictor variables. It can help teachers, researchers, and other stakeholders understand the many factors that go into students' academic success. Furthermore, it can be a useful tool for explaining the predictions of a fuzzy expert system to non-technical users since it provides an understandable method to comprehend how the model behaves across a variety of input combinations. This makes the tool a valuable asset. By rotating the map, we may interact with the surface viewer and watch how different attendance and assignment scores affect the expected performance evaluation. Discovering patterns, thresholds, and interactions between the input variables can be facilitated with the use of this.

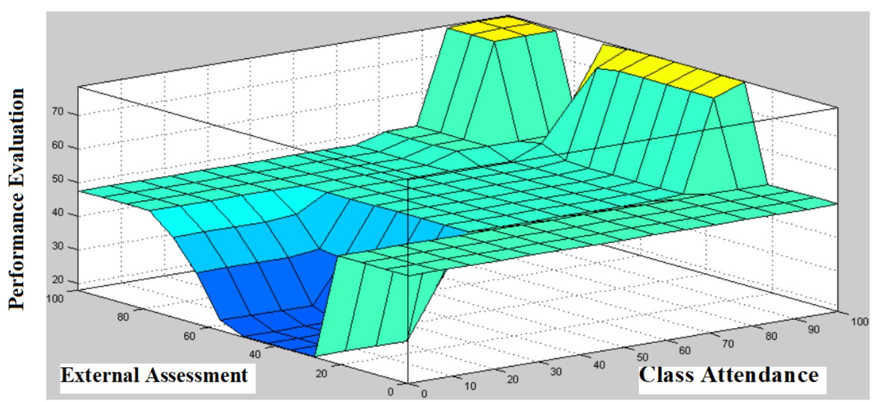
Graph 1: Performance evaluation for class attendance and teaching assessment



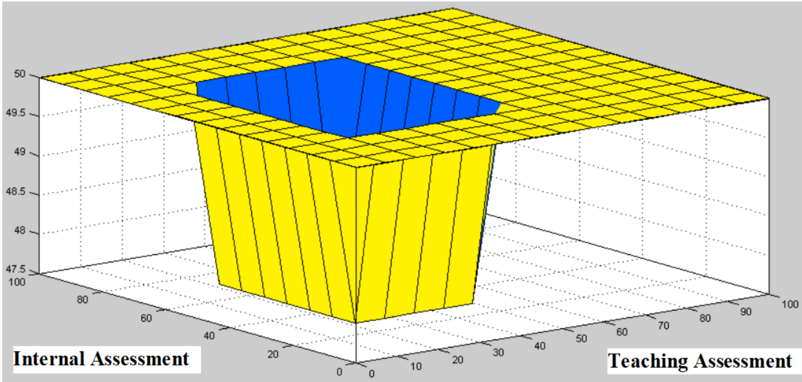
Graph 2: Performance evaluation for class attendance and internal assessment



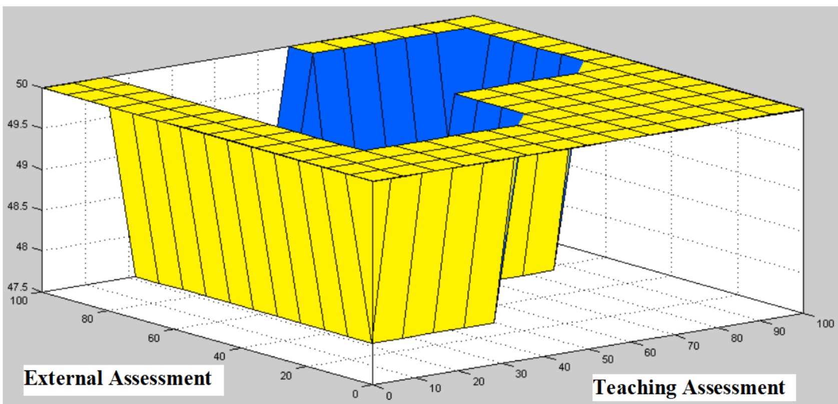
Graph 3: Performance evaluation for class attendance and external assessment



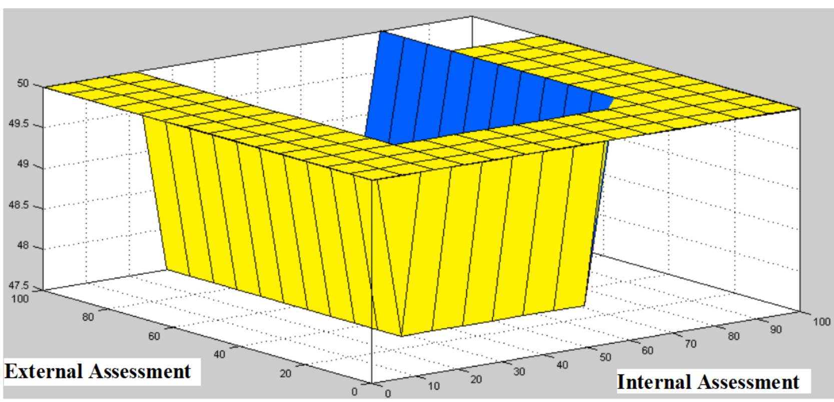
Graph 4: Performance evaluation for teaching assessment and internal assessment



Graph 5: Performance evaluation for teaching assessment and external assessment



Graph 6: Performance evaluation for internal assessment and external assessment



CONCLUDING REMARKS

Although the modelling for student performance evaluation alters the standard evaluation criteria, it finds widespread use in educational settings as a means of improving students' performance in the classroom. The physical observations made as part of the parameters used in the fuzzy logic modelling of students' performance. A student's motivation to study aligns with his or her existing level of cognitive capacity, and advancement occurs in accordance with the quality of his or her accomplishments. Academic abilities of students are evaluated in accordance with standards for making progress towards quality of work and establishing further efforts to guarantee quality of work. A student's ability to analyze a situation and determine the most effective next steps has been demonstrated. Students that are able to solve problems do better in school. Students' total grades are impacted by how they are evaluated in group or team projects. Students are well-known for their consistent performances, whether they are introducing themselves in the classroom or the workplace. We can get a sense of how well students did in general by looking at how they responded to supervision, what they reflected on, how they valued diversity, how they introduced themselves as entrepreneurs, how well they wrote, how well they spoke, how well they interacted with others, and so on.

Clearly, the process of examining and analyzing student performance is aided by the proposed fuzzy expert system. For today's college students to succeed in a competitive job market, it is crucial that they take stock of their own strengths and weaknesses. Teachers who can identify and address their students' weaknesses will have the greatest impact on their students' ability to take on greater personal accountability. However, knowing how their students are doing academically will help teachers improve their lessons, group work, games, and overall assessment of their progress. After all, getting a solid education that's in line with what employers and citizens want is the first step towards successful professional lives. This research demonstrates that fuzzy logic is highly adaptable, and that one of its benefits is that it allows for the attributes to be weighted differently depending on the institution's specific requirements. The performance of fuzzy controllers can be improved with further work on the fuzzy rules and membership function. The proposed method can be adapted for use in assessing the productivity of staff, students, and others.

REFERENCES

1. *Bai S.M., Chen S.M. (2006): "A new method for students' learning achievement evaluation using fuzzy membership functions", Proceeding of the 11th Conference of Artificial Intelligence and Applications, Kaohsiung, Taiwan, Republic of China, 177-184.*
2. *Biggs J. B., Tang C. (2007): "Teaching for quality learning at university: what the student does,"3rd ed. Buckingham, Philadelphia, PA: Society for Research into Higher Education: Open University Press.*
3. *Kumar P., Singh G. (2023): "Modeling student's performance evaluation using fuzzy logic techniques", International Journal of Creative Research Thoughts, 11(2): c973-c981.*
4. *Mankad K., Sajja P.S., Akerkar R. (2011): "Evolving rules using genetic fuzzy approach: an educational case study", International Journal on Soft Computing, 2(1):35-46.*
5. *Petra T., Aziz M. (2021): "Analyzing student performance in higher education using fuzzy logic evaluation", International Journal of Scientific & Technology Research, 10(1): 322-327.*

6. *Sreenivasarao V., Yohannes G. (2012): "Improving academic performance of students of defense university based on data warehousing and data mining", Global Journal of Computer Science and Technology, 12(2):201-209.*

7. *Surya A.A., Kurian M.K., Varghese S.M. (2016): "Overall performance evaluation of engineering students using fuzzy logic", International Journal on Cybernetics & Informatics (IJCI), 5(2): 71-78.*

8. *Wilson E., Karr C. L., Freeman L. M. (1998): "Flexible, adaptive, automatic fuzzy-based grade assigning system", In Proceedings of the North American fuzzy information processing society conference ,334-338.*

9. *Yadav R.S., Ahmed P. (2012): "Academic performance evaluation using fuzzy c-means", International Journal of Computer Science Engineering and Information Technology Research, 2(4):57-86.*

10. *Yadav R.S., Singh V.P. (2012): "Modeling Academic Performance Evaluation using Fuzzy C-Means Clustering Techniques", International Journal of Computer Applications 60(8):9034-9046.*

11. *Yadav R.S., Soni A.K., Pal S. (2014): "A study of academic performance evaluation using fuzzy logic techniques", International Conference on Computing for Sustainable Global Development, 48-53.*

12. *Zadeh L.A. (1965): "Fuzzy sets", Information and Control, (8):338-353.*

13. *Zukhri Z., Omar K. (2008): "Solving new student allocation problem with genetic algorithm: a hard problem for partition based approach", International Journal of Soft Computing Applications, 6-15.*