CHAPTER: 03

FUZZY LOGIC-ENABLED STUDENT PERFORMANCE EVALUATION FOR ACCURATE BEST STUDENT AWARD SELECTION

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ABSTRACT

Our proposal in this study was to build an initiative tool called Initiative Systematic Performance Evaluation (ISPE), which would be based on the Fuzzy Logic Approach and would be used to measure the abilities of students. Data gathered from a leadership program that was carried out at Dr. A.P.J. Abdul Kalam Technical University in Lucknow, India, is the basis for the selection of the top student, which is the primary subject of this study. Because of the subjectivity and intricacy of estimating models, the ongoing practice includes various hindrances that are both tedious and hard to recognize. During the evaluation process, ISPE helps to provide evaluators with a better decision-making solution, which is why it is so important. The experts are able to incorporate any ambiguity and subjectivity into the evaluation system by utilizing fuzzy logic techniques, which were used in the developmental process of ISPE. A total of four attributes-leadership, communication, discipline and CGPA are used as the basis for the formulation of fuzzy rules in this model. With regard to the conventional technique, the results that were obtained show that the proposed model ISPE is capable of enhancing the efficiency of decision-making, which would result in fairness in the selection of the best candidate.

Keyword: *Fuzzy logic, ISPE, Defuzzification, CGPA*

10. INTRODUCTION

An organization might decide to perceive future understudies who are extraordinary scholastically as well as have excellent initiative capacities by giving them the Smartest Understudy Grant. This is one of the motivating forces that were made by the foundation. It is also possible to improve these skills, which will ultimately contribute to the development of society in the future. Uncertainty and imprecise data in the process of measuring the students' leadership qualities are, nevertheless, one of the most

significant obstacles that assessors encounter during the selection process. In order to capture the complexity of student achievement, a system that is enabled with fuzzy logic that is used for evaluating student performance and selecting the best student award uses a multi-criteria approach.

The intrinsic vulnerability and equivocalness that is available in genuine information can be overseen by the framework through the meaning of fuzzy enrollment capabilities for an assortment of execution markers. These markers incorporate scholarly grades, extracurricular exercises, participation, and conduct. Through processes of fuzzification, rule-based inference, and defuzzification, the system integrates these fuzzy inputs, resulting in an all-encompassing assessment of each student's performance. This technique makes it conceivable to lead a refined assessment that considers the different levels of greatness across the different rules. This ensures that the system gives a picture of student achievement that is both fair and exact. The refined and defuzzified execution numbers are then utilized by the framework to choose the most meriting understudy for the honor.

To assess the response contents of understudies, Saleh and Kim (2009) recommended a procedure that utilizes fuzzy frameworks. Considering the trouble, importance, and intricacy of the inquiry, the proposed framework utilizes fuzzification, fuzzy deduction, and defuzzification. Gokmen et al. (2010) supported for the improvement of an original way to deal with execution assessment that is established on fuzzy rationale frameworks. A correlation was made between the customary method of assessment and the understudy execution of control that was completed utilizing fuzzy rationale. Saxena and Saxena (2010) presented a method that could better improve these two criteria by evaluating each student's performance. They did this by isolating the whole information, which incorporated the imprints that were gotten and the participation, into various reaches. A fuzzy rationale thinking approach was utilized to assess the exhibition of a group in a trial that was itemized by Nunes and Neill (2011). Canny fuzzy regulators had the option to see and assess the exhibition of the Group, as shown by the discoveries within reach. A methodology that depends on fuzzy rationale was given by Patil et al. (2012). This approach utilizes mathematical reviewing to assess the presentation of understudies without requiring the human critical part. Utilizing fuzzy rationale to assess understudy execution is a suitable application, as shown by the outcomes. A better approach to assessing the exhibition of students in everyday schedule was given by Kharola et al. (2015). Fuzzy logic reasoning is the foundation of this strategy. The scholarly and character attributes of the understudies were thought about for assessment purposes. A fuzzy model of execution assessment of understudies was recommended by Barlybayev et al. (2016). This model was applied to the most common way of laying out execution. As well as this, we will try to show the advantages of utilizing fuzzy rationale during the time spent surveying the understudies' degree of understanding. A proficient strategy for estimating the presentation of an understudy was proposed by Akkur and Rao (2018). This method makes use of the fuzzy logic technique. An internal assessment, a score in theory, and a score in practical are the three characteristics that are utilized to evaluate the pupils. When contrasted with the regular assessment approach, the exhibition is assessed in the fuzzy area in an effective way. Fresh upsides of the boundaries are changed to fuzzy boundaries, and the correlation is made. Pilli et al. (2018) offered insights about the movement of understudy execution connected with the utilization of fuzzy rationale through the ANN Technique.They were able to determine, in a shorter amount of time, which students on the student database were merit students. Utilizing the idea of the unwavering quality of data (level of certainty) through the "level of match" and fuzzy derivation framework in understudies' presentation assessment, Salunkhe et al. (2018) brought the Zadeh-Deshpande formalism for evaluating the answer scripts of students up to date. This was done to assess the capabilities of the students. Krouska et al. (2019) taught the engineering course "Compilers" during their time there. A novel approach to enhancing student performance evaluation in a socially integrated intelligent tutoring system was presented. As a drive instrument to test understudies' skills in view of the Fuzzy Rationale Approach, Ajol et al. (2020) was proposed Initiative-Systematic Performance Evaluation (ISPE). This was essential for their proposition. At the Mukah Campus of Universiti Teknologi MARA (UiTM) Cawangan Sarawak, a leadership program known as Program Kepimpinan Pewaris Bangsa was implemented. The current review centers around the choice of the smartest understudy in view of the information acquired from the program. In the review

that was done by Hegazi et al. (2023), fuzzy concepts were looked at to see if they could be used in research on how to evaluate, analyze, predict, or make decisions about student academic performance. To reason and estimate the scholastic accomplishment of students, they proposed a fuzzy model that they named the FPM (Fuzzy Propositional Model).

11. DEFINITION OF INPUT AND OUTPUT VARIABLES

Both information and result factors are significant parts that are used in a Fuzzy Rationale Framework (FLS) to display and controlling convoluted frameworks. The boundaries or conditions that affect the working way of behaving of the framework are alluded to as information factors. In a framework we took the four inputs leadership, communication, discipline and CGPA factors and one output student's competency. The phonetic expressions, (for example, "poor", "fair" "good" and "excellent") and the participation works that are connected with them characterize the information factors. These participation capabilities show how much a specific worth matches each term. Based on the information factors and the principles that have been set, the result factors show the reaction or move that the framework initiates.

Output variables, like input variables, are defined by linguistic terms and membership functions; however, they represent the reaction of the system rather than the inputs that it receives. The combination of input and output variables gives FLS the ability to process and understand data from the actual world in a manner that is highly reminiscent of human reasoning. FLS is able to efficiently manage imprecise and uncertain information because it incorporates linguistic concepts and fuzzy sets.

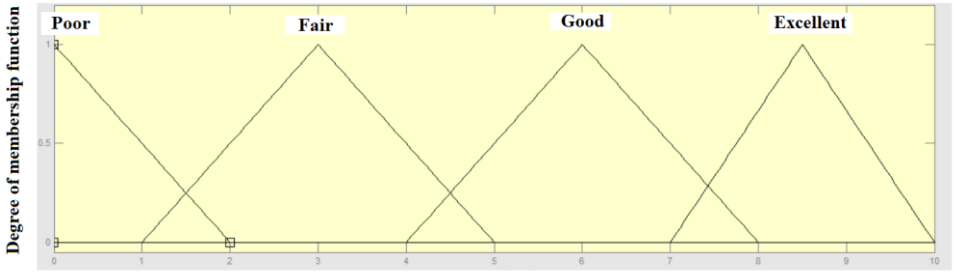


Figure 1: Membership function plot for leadership (input variable '1')

Let x_1 is the leadership variable and defined by

$$\mu_{Poor}(x_1) = \left\{1 - \frac{x_1}{2} \quad 0 \le x_1 \le 2\right\}$$

$$\mu_{Fair}(x_1) = \begin{Bmatrix} \frac{x_1 - 1}{2} & 1 \le x_1 \le 3 \\ \frac{5 - x_1}{2} & 3 \le x_1 \le 5 \end{Bmatrix}$$

$$\mu_{Good}(x_1) = \begin{Bmatrix} \frac{x_1 - 4}{2} & 4 \le x_1 \le 6 \\ \frac{8 - x_1}{2} & 6 \le x_1 \le 8 \end{Bmatrix}$$

$$\mu_{Excellent}(x_1) = \begin{Bmatrix} \frac{x_1 - 7}{1.5} & 7 \le x_1 \le 8.5 \\ \frac{10 - x_1}{1.5} & 8.5 \le x_1 \le 10 \end{Bmatrix}$$

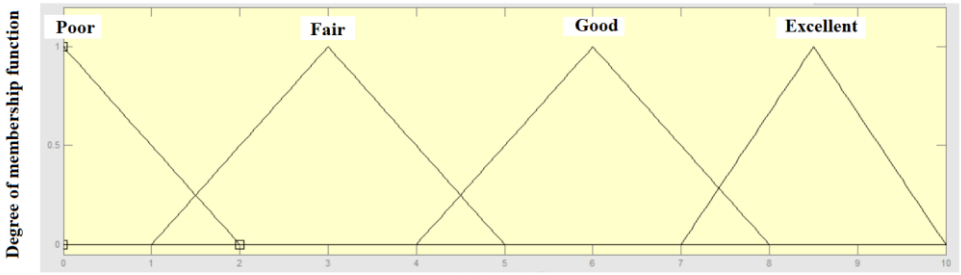


Figure 2: Membership function plot for communication (input variable '2')

Let x_2 is the communication variable and defined by

$$\mu_{Poor}(x_2) = \left\{1 - \frac{x_2}{2} \quad 0 \le x_2 \le 2\right\}$$

$$\mu_{Fair}(x_2) = \begin{Bmatrix} \frac{x_2-1}{2} & 1 \le x_2 \le 3 \\ \frac{5-x_2}{2} & 3 \le x_2 \le 5 \end{Bmatrix}$$

$$\mu_{Good}(x_2) = \begin{Bmatrix} \frac{x_2-4}{2} & 4 \le x_2 \le 6 \\ \frac{8-x_2}{2} & 6 \le x_2 \le 8 \end{Bmatrix}$$

$$\mu_{Excellent}(x_2) = \begin{Bmatrix} \frac{x_1-7}{1.5} & 7 \le x_2 \le 8.5 \\ \frac{10-x_2}{1.5} & 8.5 \le x_2 \le 10 \end{Bmatrix}$$

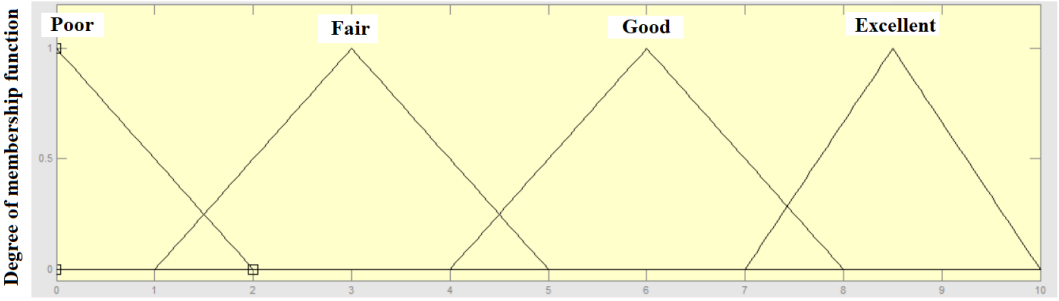


Figure 3: Membership function plot for discipline (input variable '3')

Let x_3 is the discipline variable and defined by

$$\mu_{Poor}(x_3) = \left\{1 - \frac{x_3}{2} \quad 0 \le x_3 \le 2\right\}$$

$$\mu_{Fair}(x_3) = \begin{Bmatrix} \frac{x_3-1}{2} & 1 \le x_3 \le 3 \\ \frac{5-x_3}{2} & 3 \le x_3 \le 5 \end{Bmatrix}$$

$$\mu_{Good}(x_3) = \begin{Bmatrix} \frac{x_3-4}{2} & 4 \le x_3 \le 6 \\ \frac{8-x_3}{2} & 6 \le x_3 \le 8 \end{Bmatrix}$$

$$\mu_{Excellent}(x_3) = \begin{Bmatrix} \frac{x_3-7}{1.5} & 7 \le x_3 \le 8.5 \\ \frac{10-x_3}{1.5} & 8.5 \le x_3 \le 10 \end{Bmatrix}$$

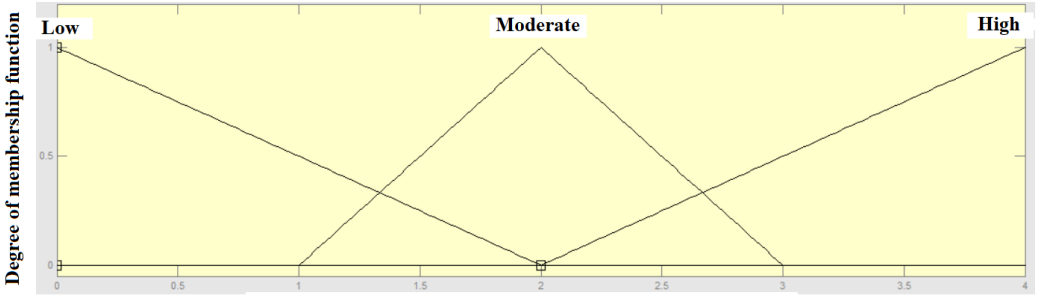


Figure 4: Membership function plot for CGPA (input variable '4')

Let x_4 is the CGPA variable and defined by

$$\mu_{Low}(x_4) = \left\{\frac{2-x_4}{2} \quad 0 \le x_4 \le 2\right\}$$

$$\mu_{Moderate}(x_4) = \begin{Bmatrix} \frac{x_4-1}{1} & 1 \le x_4 \le 2 \\ \frac{3-x_4}{1} & 2 \le x_4 \le 3 \end{Bmatrix}$$

$$\mu_{High}(x_4) = \left\{-1 + \frac{x_4}{2} \quad 2 \le x_4 \le 4\right\}$$

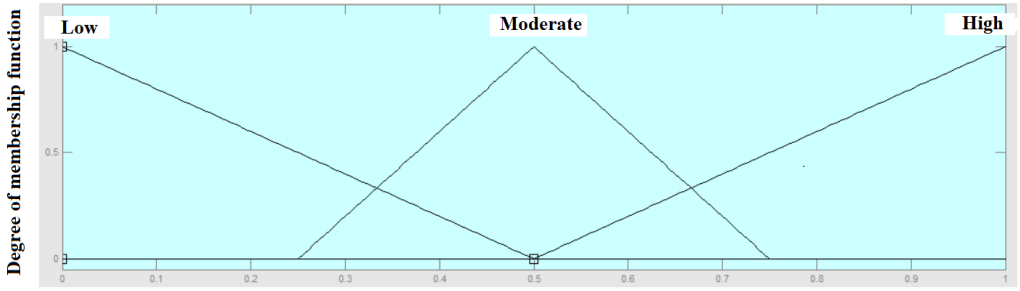


Figure 5: Membership function plot for students' competencies (output variable)

Let x_5 is the students' competencies variable and defined by

$$\mu_{Low}(x_5) = \left\{\frac{0.5-x_5}{0.5} \quad 0 \le x_5 \le 0.5\right\}$$

$$\mu_{Moderate}(x_5) = \begin{Bmatrix} \frac{x_5-0.25}{0.25} & 0.25 \le x_5 \le 0.5 \\ \frac{0.75-x_5}{0.25} & 0.5 \le x_5 \le .75 \end{Bmatrix}$$

$$\mu_{High}(x_5) = \left\{-1 + \frac{x_5}{0.5} \quad 0.5 \le x_5 \le 1\right\}$$

12. FUZZY RULE BASE

The process of developing a collection of rules that map fuzzy inputs (such as exam scores, assignment grades, attendance, and so on) to fuzzy outputs (student performance evaluations) is something that is required in order to create a rule

base for a Fuzzy Logic-Enabled Student Performance Evaluation system. These regulations ought to be reflective of the criteria that will be used to choose the most deserving student for the prize. It is dependent on the combination of linguistic words for each input variable as well as the number of linguistic terms for the output variable that the total number of rules in a Fuzzy Logic System (FLS) is considered to be. To determine the total number of rules contained in a FLS, the following formula should be used:

Total Number of Rules$= 4 \times 4 \times 4 \times 3 = 192$

Table 1: Rule base constructed by expert knowledge

S.No.	Leadership	Communication	Discipline	CGPA	Students' Competencies
1	Poor	Poor	Poor	Low	Low
2	Poor	Poor	Poor	Moderate	Low
3	Poor	Poor	Poor	High	Low
4	Poor	Poor	Fair	Low	Low
5	Poor	Poor	Fair	Moderate	Low
6	Poor	Poor	Fair	High	Low
7	Poor	Poor	Good	Low	Low
8	Poor	Poor	Good	Moderate	Low
9	Poor	Poor	Good	High	Moderate
10	Poor	Poor	Excellent	Low	Low
11	Poor	Poor	Excellent	Moderate	Moderate
12	Poor	Poor	Excellent	High	Moderate
13	Poor	Fair	Poor	Low	Low
14	Poor	Fair	Poor	Moderate	Low
15	Poor	Fair	Poor	High	Low
16	Poor	Fair	Fair	Low	Low
17	Poor	Fair	Fair	Moderate	Low
18	Poor	Fair	Fair	High	Moderate
19	Poor	Fair	Good	Low	Low
20	Poor	Fair	Good	Moderate	Moderate
21	Poor	Fair	Good	High	Moderate
22	Poor	Fair	Excellent	Low	Low
23	Poor	Fair	Excellent	Moderate	Moderate
24	Poor	Fair	Excellent	High	Moderate
25	Poor	Good	Poor	Low	Low
26	Poor	Good	Poor	Moderate	Low
27	Poor	Good	Poor	High	Moderate
28	Poor	Good	Fair	Low	Low
29	Poor	Good	Fair	Moderate	Moderate
30	Poor	Good	Fair	High	Moderate
31	Poor	Good	Good	Low	Low
32	Poor	Good	Good	Moderate	Moderate
33	Poor	Good	Good	High	Moderate
34	Poor	Good	Excellent	Low	Moderate
35	Poor	Good	Excellent	Moderate	Moderate

Table 1 (Contd.): Rule base constructed by expert knowledge

S.No.	Leadership	Communication	Discipline	CGPA	Students' Competencies
36	Poor	Good	Excellent	High	Moderate
37	Poor	Excellent	Poor	Low	Low
38	Poor	Excellent	Poor	Moderate	Moderate
39	Poor	Excellent	Poor	High	Moderate
40	Poor	Excellent	Fair	Low	Low
41	Poor	Excellent	Fair	Moderate	Moderate
42	Poor	Excellent	Fair	High	Moderate
43	Poor	Excellent	Good	Low	Moderate
44	Poor	Excellent	Good	Moderate	Moderate
45	Poor	Excellent	Good	High	Moderate
46	Poor	Excellent	Excellent	Low	Moderate
47	Poor	Excellent	Excellent	Moderate	Moderate
48	Poor	Excellent	Excellent	High	High
49	Fair	Poor	Poor	Low	Low
50	Fair	Poor	Poor	Moderate	Low
51	Fair	Poor	Poor	High	Low
52	Fair	Poor	Fair	Low	Low
53	Fair	Poor	Fair	Moderate	Low
54	Fair	Poor	Fair	High	Moderate
55	Fair	Poor	Good	Low	Low
56	Fair	Poor	Good	Moderate	Moderate
57	Fair	Poor	Good	High	Moderate
58	Fair	Poor	Excellent	Low	Low
59	Fair	Poor	Excellent	Moderate	Moderate
60	Fair	Poor	Excellent	High	Moderate
61	Fair	Fair	Poor	Low	Low
62	Fair	Fair	Poor	Moderate	Low
63	Fair	Fair	Poor	High	Moderate
64	Fair	Fair	Fair	Low	Low
65	Fair	Fair	Fair	Moderate	Moderate
66	Fair	Fair	Fair	High	Moderate
67	Fair	Fair	Good	Low	Low
68	Fair	Fair	Good	Moderate	Moderate
69	Fair	Fair	Good	High	Moderate
70	Fair	Fair	Excellent	Low	Moderate

Table 1 (Contd.): Rule base constructed by expert knowledge

S.No.	Leadership	Communication	Discipline	CGPA	Students' Competencies
71	Fair	Fair	Excellent	Moderate	Moderate
72	Fair	Fair	Excellent	High	Moderate
73	Fair	Good	Poor	Low	Low
74	Fair	Good	Poor	Moderate	Moderate
75	Fair	Good	Poor	High	Moderate
76	Fair	Good	Fair	Low	Low
77	Fair	Good	Fair	Moderate	Moderate
78	Fair	Good	Fair	High	Moderate
79	Fair	Good	Good	Low	Moderate
80	Fair	Good	Good	Moderate	Moderate
81	Fair	Good	Good	High	Moderate
82	Fair	Good	Excellent	Low	Moderate
83	Fair	Good	Excellent	Moderate	Moderate
84	Fair	Good	Excellent	High	High
85	Fair	Excellent	Poor	Low	Low
86	Fair	Excellent	Poor	Moderate	Moderate
87	Fair	Excellent	Poor	High	Moderate
88	Fair	Excellent	Fair	Low	Moderate
89	Fair	Excellent	Fair	Moderate	Moderate
90	Fair	Excellent	Fair	High	Moderate
91	Fair	Excellent	Good	Low	Moderate
92	Fair	Excellent	Good	Moderate	Moderate
93	Fair	Excellent	Good	High	High
94	Fair	Excellent	Excellent	Low	Moderate
95	Fair	Excellent	Excellent	Moderate	High
96	Fair	Excellent	Excellent	High	High
97	Good	Poor	Poor	Low	Low
98	Good	Poor	Poor	Moderate	Low
99	Good	Poor	Poor	High	High
100	Good	Poor	Fair	Low	Low
101	Good	Poor	Fair	Moderate	Moderate
102	Good	Poor	Fair	High	Moderate
103	Good	Poor	Good	Low	Low
104	Good	Poor	Good	Moderate	Moderate
105	Good	Poor	Good	High	Moderate

Table 1 (Contd.): Rule base constructed by expert knowledge

S.No.	Leadership	Communication	Discipline	CGPA	Students' Competencies
106	Good	Poor	Excellent	Low	Moderate
107	Good	Poor	Excellent	Moderate	Moderate
108	Good	Poor	Excellent	High	Moderate
109	Good	Fair	Poor	Low	Low
110	Good	Fair	Poor	Moderate	Moderate
111	Good	Fair	Poor	High	Moderate
112	Good	Fair	Fair	Low	Low
113	Good	Fair	Fair	Moderate	Moderate
114	Good	Fair	Fair	High	Moderate
115	Good	Fair	Good	Low	Moderate
116	Good	Fair	Good	Moderate	Moderate
117	Good	Fair	Good	High	Moderate
118	Good	Fair	Excellent	Low	Moderate
119	Good	Fair	Excellent	Moderate	Moderate
120	Good	Fair	Excellent	High	High
121	Good	Good	Poor	Low	Low
122	Good	Good	Poor	Moderate	Moderate
123	Good	Good	Poor	High	Moderate
124	Good	Good	Fair	Low	Moderate
125	Good	Good	Fair	Moderate	Moderate
126	Good	Good	Fair	High	Moderate
127	Good	Good	Good	Low	Moderate
128	Good	Good	Good	Moderate	Moderate
129	Good	Good	Good	High	Moderate
130	Good	Good	Excellent	Low	Moderate
131	Good	Good	Excellent	Moderate	High
132	Good	Good	Excellent	High	High
133	Good	Excellent	Poor	Low	Moderate
134	Good	Excellent	Poor	Moderate	Moderate
135	Good	Excellent	Poor	High	Moderate
136	Good	Excellent	Fair	Low	Moderate
137	Good	Excellent	Fair	Moderate	Moderate
138	Good	Excellent	Fair	High	High
139	Good	Excellent	Good	Low	Moderate
140	Good	Excellent	Good	Moderate	High

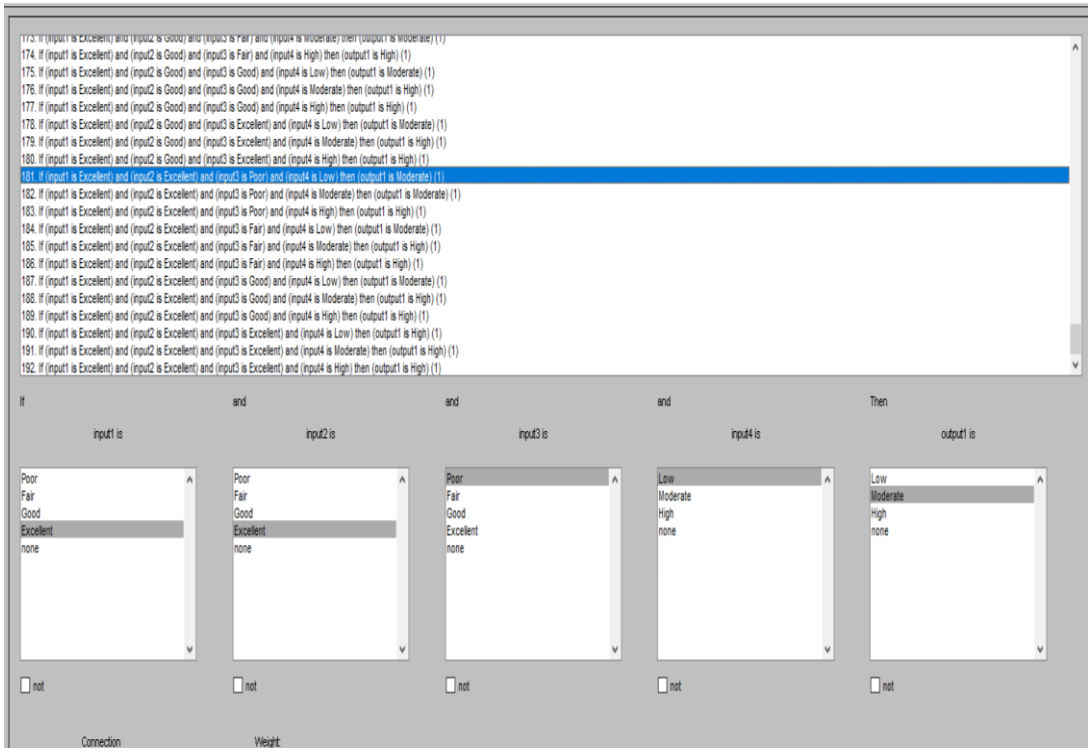
Table 1 (Contd.): Rule base constructed by expert knowledge

S.No.	Leadership	Communication	Discipline	CGPA	Students' Competencies
141	Good	Excellent	Good	High	High
142	Good	Excellent	Excellent	Low	Moderate
143	Good	Excellent	Excellent	Moderate	High
144	Good	Excellent	Excellent	High	High
145	Excellent	Poor	Poor	Low	Low
146	Excellent	Poor	Poor	Moderate	Moderate
147	Excellent	Poor	Poor	High	Moderate
148	Excellent	Poor	Fair	Low	Low
149	Excellent	Poor	Fair	Moderate	Moderate
150	Excellent	Poor	Fair	High	Moderate
151	Excellent	Poor	Good	Low	Moderate
152	Excellent	Poor	Good	Moderate	Moderate
153	Excellent	Poor	Good	High	Moderate
154	Excellent	Poor	Excellent	Low	Moderate
155	Excellent	Poor	Excellent	Moderate	Moderate
156	Excellent	Poor	Excellent	High	High
157	Excellent	Fair	Poor	Low	Low
158	Excellent	Fair	Poor	Moderate	Moderate
159	Excellent	Fair	Poor	High	Moderate
160	Excellent	Fair	Fair	Low	Moderate
161	Excellent	Fair	Fair	Moderate	Moderate
162	Excellent	Fair	Fair	High	Moderate
163	Excellent	Fair	Good	Low	Moderate
164	Excellent	Fair	Good	Moderate	Moderate
165	Excellent	Fair	Good	High	High
166	Excellent	Fair	Excellent	Low	Moderate
167	Excellent	Fair	Excellent	Moderate	High
168	Excellent	Fair	Excellent	High	High
169	Excellent	Good	Poor	Low	Moderate
170	Excellent	Good	Poor	Moderate	Moderate
171	Excellent	Good	Poor	High	Moderate
172	Excellent	Good	Fair	Low	Moderate
173	Excellent	Good	Fair	Moderate	Moderate
174	Excellent	Good	Fair	High	High
175	Excellent	Good	Good	Low	Moderate

Table 1 (Contd.): Rule base constructed by expert knowledge

S.No.	Leadership	Communication	Discipline	CGPA	Students' Competencies
176	Excellent	Good	Good	Moderate	High
177	Excellent	Good	Good	High	High
178	Excellent	Good	Excellent	Low	Moderate
179	Excellent	Good	Excellent	Moderate	High
180	Excellent	Good	Excellent	High	High
181	Excellent	Excellent	Poor	Low	Moderate
182	Excellent	Excellent	Poor	Moderate	Moderate
183	Excellent	Excellent	Poor	High	High
184	Excellent	Excellent	Fair	Low	Moderate
185	Excellent	Excellent	Fair	Moderate	High
186	Excellent	Excellent	Fair	High	High
187	Excellent	Excellent	Good	Low	Moderate
188	Excellent	Excellent	Good	Moderate	High
189	Excellent	Excellent	Good	High	High
190	Excellent	Excellent	Excellent	Low	High
191	Excellent	Excellent	Excellent	Moderate	High
192	Excellent	Excellent	Excellent	High	High

Figure 6: Rule base interface of FLS



13. METHODOLOGY

To find the students' competencies for the given info values, we really want to fuzzify each info esteem utilizing the particular participation capabilities, then, at that point, apply the Mamdani fuzzy inference method, lastly defuzzify the result utilizing the centroid technique.

4.1. Input variables-

Let $x_1 = 3.2, x_2 = 4.4, x_3 = 6.6, x_4 = 1.8$

4.2. Fuzzification-

$\mu_{Fair}(3.2) = \frac{5-3.2}{2} = \frac{1.8}{2} = 0.9$

$\mu_{Fair}(4.4) = \frac{5-x_2}{2} = \frac{5-4.4}{2} = 0.3, \mu_{Good}(4.4) = \frac{4.4-4}{2} = \frac{0.4}{2} = 0.2$

$\mu_{Good}(6.6) = \frac{8-6.6}{2} = 0.7$

$\mu_{Low}(1.8) = \frac{2-x_4}{2} = \frac{2-1.8}{2} = 0.1 \ \ , \mu_{Moderate}(1.8) = \frac{1.8-1}{1} = 0.8$

4.3. Rules Evaluation- Utilizing the Mamdani fuzzy inference technique, we apply the "AND" operator for each sets of membership values from the input variables and select the base incentive for each rule

Rule 67: $\min[\mu_{Fair}(3.2), \mu_{Fair}(4.4), \mu_{Good}(6.6), \mu_{Low}(1.8)] = (0.9,0.3,0.7,0.1) = 0.1$

Rule 79: $\min[\mu_{Fair}(3.2), \mu_{Good}(4.4), \mu_{Good}(6.6), \mu_{Low}(1.8)] = (0.9,0.2,0.7,0.8) = 0.2$

Rule 80: $\min[\mu_{Fair}(3.2), \mu_{Good}(4.4), \mu_{Good}(6.6), \mu_{Moderate}(1.8)] = (0.9,0.3,0.7,0.8) = 0.3$

4.4. Aggregation- Combine the results of each rule:

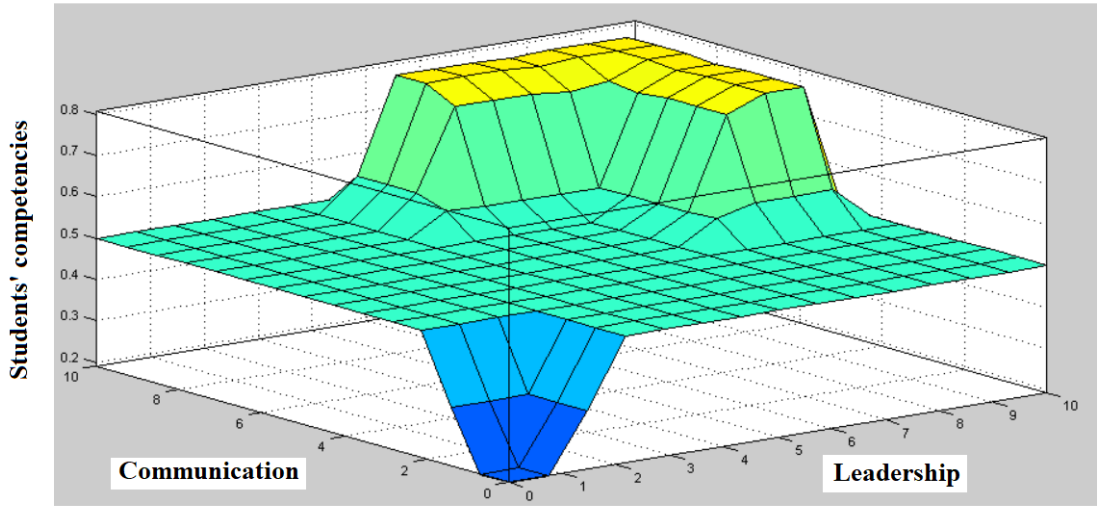
$\max(0.1,0.2,0.3) = 0.3$ (Rule 80) whose output is moderate.

4.2. Defuzzification- Apply the centroid strategy,

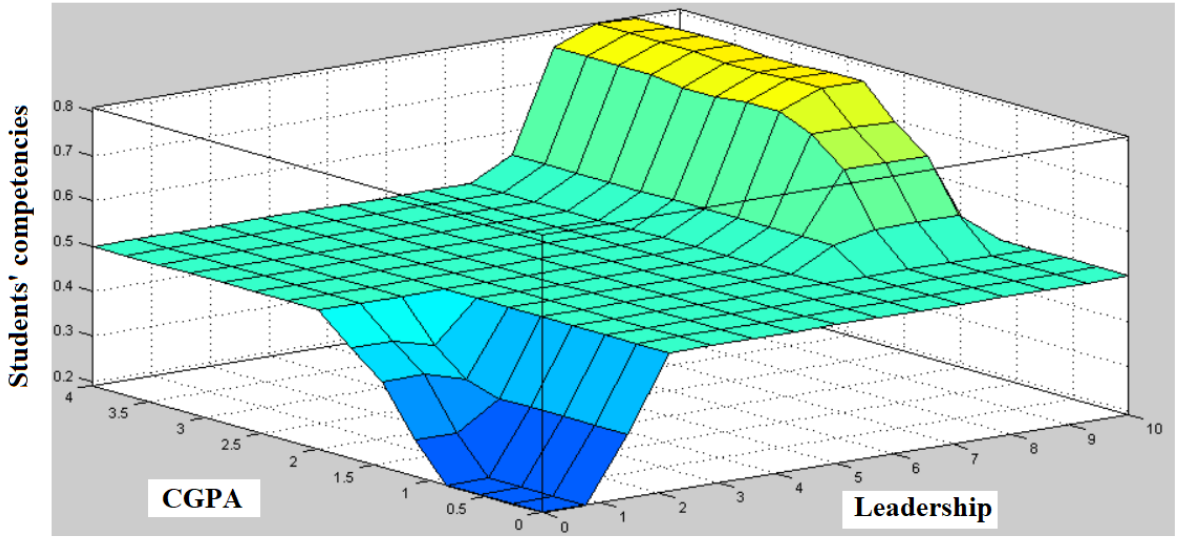
Centroid for Moderate Competency: $\frac{0.25+0.5+0.75}{3} = 0.5$

In this way, the defuzzified value for "students' Competencies" is roughly 0.5, which shows a moderate capability level.

14. 3D SURFACE PLOT OF OUTPUT VARIABLE FOR DIFFERENT INPUT VARIABLES:



Graph 1: 3D surface plot of students' competencies for different values of leadership and communication



Graph 2: 3D surface plot of students' competencies for different values of leadership and CGPA

The three-dimensional visualization helps in the identification of patterns or trends that might be used to guide decisions regarding the selection of the best student for an award, taking into consideration outstanding academic performance as well as leadership skills. Graph 1 displays a three-dimensional surface plot that illustrates how the student's competencies (represented by the Z-axis or color variation) change as a function of both leadership and communication competencies (represented by the X-axis and Y-axis, respectively). Areas of the plot with a higher surface imply that the students have higher levels of competency, whilst areas with a lower surface would indicate that the students have lower levels of competency. The appraisal of the student's

capabilities that is allowed by fuzzy logic is depicted in graph (2). We make use of fuzzy logic in this situation to deal with information that is imprecise or ambiguous during the evaluation process. When taking into account both leadership and cumulative grade point average, the Z-axis value or color variation represents the student's competencies. The surface plot provides a visual representation of the various ways in which the overall evaluation of a student's capabilities fluctuates as a function of the student's leadership competencies (X-axis) and their cumulative grade point average (Y-axis). Generally speaking, areas with a greater surface are indicative of higher levels of student competency, whereas those with a lower surface level signal lower levels of student competency.

15. RESULTS AND DISCUSSION

Taking into account four input parameters—leadership, communication, discipline, and CGPA—the suggested ISPE model was tested on 25 students from various departments at Dr. A.P.J. Abdul Kalam Technical University in Lucknow, India. Table (2) below shows the results of using the study's developed rubric scoring system as input values into a fuzzy logic system, which helped evaluators award grades to each student.

Figure 7: Input and output variables interface of FLS

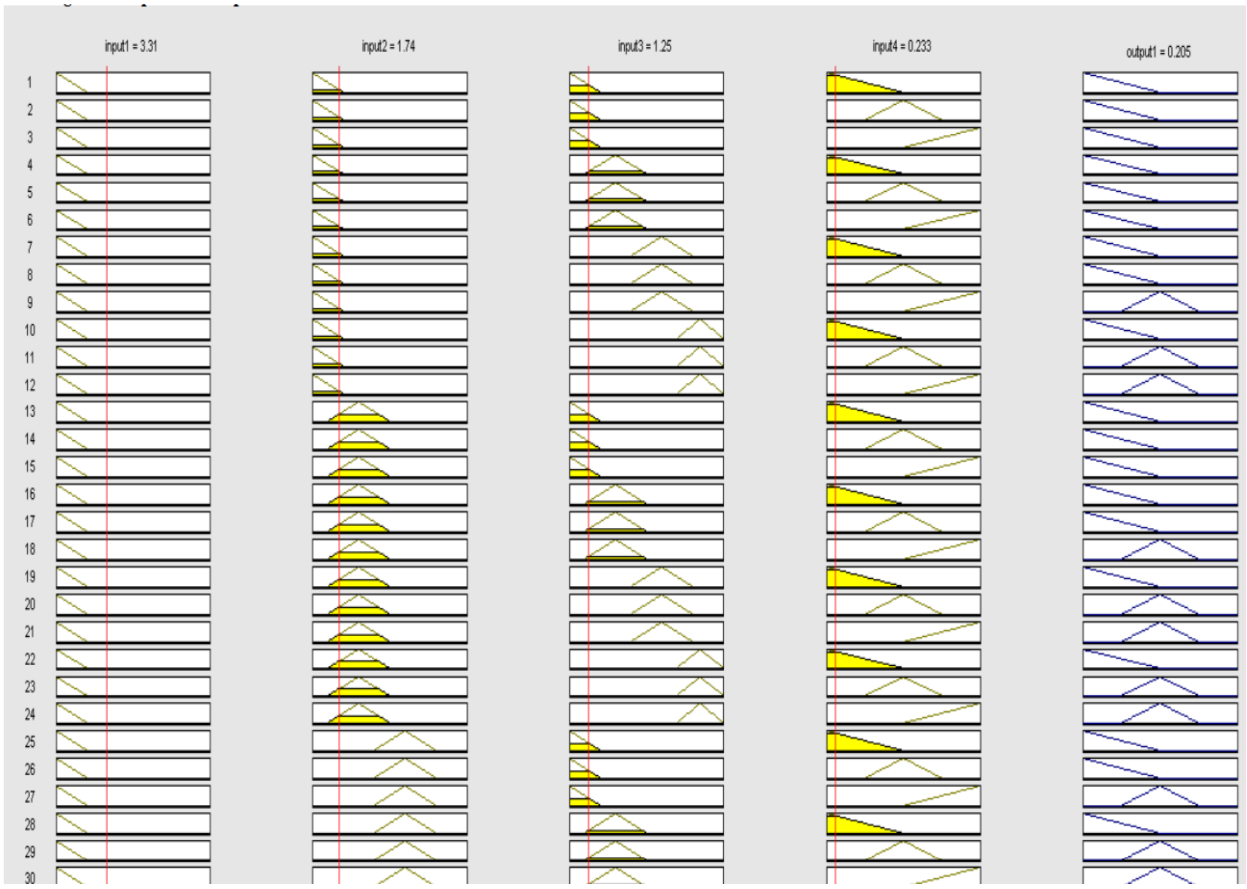


Table 2: Estimated values of Students' competencies for different input variables

S.No.	Leadership	Communication	Discipline	CGPA	Students' Competencies
1	5	5	5	2	0.5
2	3.19	6.44	9.97	2.72	0.63
3	2.36	1.52	2.36	0.856	0.217
4	4.92	5.28	3.97	1.48	0.478
5	8.08	2.85	6.97	2.52	0.547
6	6.53	1.57	5.31	1.59	0.384
7	8.53	5.28	6.92	2.97	0.807
8	5.47	4.45	4.53	0.7	0.366
9	4.25	6.38	9.47	3.7	0.793
10	5.03	5.06	8.53	2.68	0.792
11	3.36	4.61	3.58	1.23	0.333
12	2.36	2.57	2.19	0.478	0.183
13	5.58	5.94	7.36	2.19	0.622
14	8.42	3.01	4.86	3.1	0.762
15	9.31	6.1	5.36	2.34	0.805
16	1.97	1.96	4.25	2.59	0.488
17	5.47	7.1	8.25	2.59	0.8
18	3.53	2.35	2.36	0.744	0.181
19	4.14	8.2	5.14	2.12	0.537
20	1.58	1.52	9.19	1.14	0.363
21	3.42	7.87	4.08	0.678	0.468
22	5.75	1.91	2.25	0.544	0.196
23	3.53	2.4	3.14	1.63	0.43
24	8.36	1.69	8.42	3.46	0.792
25	3.31	1.74	1.25	0.233	0.205

16. CLOSING COMMENTS

When there are a variety of criteria included in the evaluation, qualitative evaluations that entail assessment are typically subjective. This can result in challenges in opinion, which in turn might come about difficulties in terms of selecting which pupils have higher performance. The results of this study revealed that the proposed model, ISPE, was capable of overcoming a number of challenges that were encountered by the assessors. Furthermore, it reduced the work of assessors because they did not need to do the hard and time-consuming operation. This is in contrast to the old method practices that are currently in place. In the end, the proposed systematic system is created expressly to ensure that the evaluation of student performance is conducted in a fair and transparent manner. In this way, it is possible to steer clear of any unfavorable and unethical behaviors exhibited by evaluators, such as favoritism, bias, stereotypes, injustice, and prejudice respectively. Through the utilization of a system that is not only dependent on human judgment, it is possible to reduce the level of dissatisfaction among students. This is because they are aware that the process of picking the best student is both fair and transparent. As a result, the purpose of this research, which was to find

solutions to the problems of uncertainty that evaluators encountered when choosing the award for the best student, has been accomplished effectively. During the assessment process, it was demonstrated that the development of ISPE was able to assist evaluators in giving an enhanced decision-making solution to the evaluators. Because of its clear explanation in assigning the value to be implemented as input value in the ISPE development, the designation of rubric assessment has also contributed to an increase in the efficiency of the implementation of the fuzzy logic approach that was utilized in this study.

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