

Fuzzy Based Prediction of Student's Performance in University Exam: A Case Study

Minakshi Chauhan

*KIET Group of Institutions,
Ghaziabad, UP, India*

Archit Rastogi

*KIET Group of Institution
Ghaziabad, UP, India*

Utkarsh Kapoor

*KIET Group of Institution
Ghaziabad, UP, India*

ABSTRACT

Student performance prediction is an important tool to impart good quality education among students. Poor academic performance among students is a common factor that affects the reputation of an educational institution. This proposed model will help the institutes towards improving the grades of students and ensuring that their teaching methodology is efficient. This case study discusses the building of a model to predict the performance of students in the coming semester exams based on previous semester data. Soft computing techniques are being used in decision-making applications with indefinite and uncertain knowledge. This model is based on a fuzzy inference system. The proposed model was tested on 100 student records with RMSE of 0.36.

Keywords: *Educational Data mining, Soft Computing Techniques, Fuzzy Logic*

I. INTRODUCTION

Education is a very important issue regarding the development of a country. Higher education helps the youth of the country to be skilful and work oriented which pumps the quality lifestyle of the individual and the economic growth of the country. The main objective of higher education institutions is to provide quality education to its students [1]. The higher education institutions focus on the teaching methodology and curriculum in order to maintain the quality education among their students. But they certainly miss that result compilation can help them. The performance of students in the university exams serve as an input to the system and the system predicts their future performance. This predicted data helps the institution to keep a track of their performance projectile. This will help them to verify their desired outputs and hence they can review their teaching policies.

If the outputs are not desirable, then it indicates that there are loop holes in imparting knowledge to the students. Either the students are not concentrating on their academics or they are not willing to grasp the things or the teacher is not doing ample efforts. These loop holes can highly degrade the performance of students which lowers the university ranking. This system will help them to detect the loop holes so that the university can take early actions and work to overcome them and hence ensuring the quality of education and reclaiming their position in rankings. Further, this will guide the students through their academic journey so that they can have a strong knowledge domain and good skills. In subsequent sections, Section II presents the related work done by different researcher in field of Educational data mining. Section III explains methodology to build the proposed fuzzy inference system. Section IV describes the implementation of proposed system along with some discussion of results retrieved. Conclusion is presented in section V.

II. RELATED WORK

Educational data mining is gaining popularity as institutions are producing large amount of student data [2]. Further analysis of this student data for discovering the inherent knowledge to assess the performance of student is a critical task. Many researchers have been proposed different approaches based on data mining techniques, soft computing techniques and machine learning techniques to discover that knowledge [3][4][5]. Some researchers proposed hybrid models using multiple soft computing techniques, data mining techniques and machine learning techniques [6] [7]. During the survey of different approaches for student performance prediction, it has been observed that the classification techniques are being used frequently while neural networks, fuzzy logic and decision tree among all techniques are mostly being used to predict the performance [8] [9] [10][11][12]. Some researchers evaluated students' performance in theory classes where some of them in laboratory classes [8]. Researchers also focussed on identifying the parameters which affect the student performance [3] [13]. After identifying the factors for affecting students' performance or predicting their performance in upcoming semesters, some improving action can be recommended [14]. In this paper we opted the methods based on fuzzy logic to predict the student performance because fuzzy logic technique works well in decision-making applications with imprecise and uncertain knowledge.

III. PROPOSED METHODOLOGY

The fuzzy system comprises of input, output and fuzzy inference. The proposed fuzzy system includes five input parameters and two output parameters composing of 30 inference rules. Input parameters include Atten3, Atten4, Atten5, Marks3, and Marks4. The input parameters of this fuzzy system consist of crisp sets given by attendance of third, fourth and fifth semesters and marks of third, fourth semesters. We have chosen attendance of student as an input attendance of a student in class plays a vital role in his/her academic performance. Further internal assessment and internal marks also depend upon attendance. A student having low attendance is not allowed to give internal exams conducted by the institute. That would directly affect the university exam performance of a student. Subsequent semester's marks help to understand the strength of a student. So we have chosen marks as input to predict the future performance. This system predicts fifth semester marks along with overall strength of a student as output named as Marks5 and Strength respectively. These input and output parameters are modelled using a blend of following functions: Gaussian membership function, Trapezoidal membership function, sigmoidal membership function. Ranges and labels used for the input and output parameters are shown in Table 1.

Table 1: Ranges and labels used for the input and output parameters

ATTENDANCE RANGE	MARKS RANGE	STRENGTH
POOR: < 50	E: < 40	WEAK: 0 – 2.5
LOW: 50 – 65	D: 40 – 55	AVERAGE: 2.5 – 5.0
AVERAGE: 65 – 80	C: 55 – 70	GOOD: 5.0 – 7.5
GOOD: 80 – 100	B: 70 – 85	EXCELLENT: 7.5 – 10.0
	A: 85 - 100	

Any decision making process depends on a strong knowledgebase. In case of fuzzy logic, fuzzy rules create that knowledgebase and can be easily represented in IF-Then rule form. During the decision making when several rules are applicable for the same output membership function, this system uses Mamdani inference. This system consists of 30 fuzzy rules. Some of these are given below from R1 to R15.

- R1. If (Atten3 is poor) or (Atten4 is poor) or (Atten5 is poor) then (Marks5 is E)(Strength is WEAK).
- R2. If (Marks3 is E) or (Marks4 is E) then (Marks5 is E)(Strength is WEAK).
- R3. If (Atten3 is low) and (Marks3 is D) and (Atten4 is low) and (Marks4 is D) and (Atten5 is low) then (Marks5 is D)(Strength is WEAK).
- R4. If (Atten3 is low) and (Marks3 is D) and (Atten4 is low) and (Marks4 is C) and (Atten5 is low) then (Marks5 is C)(Strength is WEAK).
- R5. If (Atten3 is low) and (Marks3 is D) and (Atten4 is low) and (Marks4 is C) and (Atten5 is average) then (Marks5 is C)(Strength is WEAK).
- R6. If (Atten3 is low) and (Marks3 is D) and (Atten4 is average) and (Marks4 is C) and (Atten5 is average) then (Marks5 is C)(Strength is AVERAGE).
- R7. If (Atten3 is low) and (Marks3 is C) and (Atten4 is low) and (Marks4 is C) and (Atten5 is average) then (Marks5 is C)(Strength is AVERAGE).
- R8. If (Atten3 is low) and (Marks3 is C) and (Atten4 is low) and (Marks4 is D) and (Atten5 is low) then (Marks5 is D)(Strength is WEAK).
- R9. If (Atten3 is low) and (Marks3 is C) and (Atten4 is average) and (Marks4 is C) and (Atten5 is average) then (Marks5 is C)(Strength is AVERAGE).
- R10. If (Atten3 is average) and (Marks3 is C) and (Atten4 is low) and (Marks4 is C) and (Atten5 is average) then (Marks5 is C)(Strength is AVERAGE).
- R11. If (Atten3 is average) and (Marks3 is C) and (Atten4 is average) and (Marks4 is C) and (Atten5 is average) then (Marks5 is C)(Strength is AVERAGE).
- R12. If (Atten3 is average) and (Marks3 is C) and (Atten4 is average) and (Marks4 is B) and (Atten5 is average) then (Marks5 is B)(Strength is AVERAGE).
- R13. If (Atten3 is average) and (Marks3 is B) and (Atten4 is average) and (Marks4 is B) and (Atten5 is average) then (Marks5 is B)(Strength is GOOD).
- R14. If (Atten3 is average) and (Marks3 is B) and (Atten4 is average) and (Marks4 is B) and (Atten5 is low) then (Marks5 is C)(Strength is AVERAGE).
- R15. If (Atten3 is average) and (Marks3 is C) and (Atten4 is average) and (Marks4 is C) and (Atten5 is low) then (Marks5 is D)(Strength is AVERAGE).

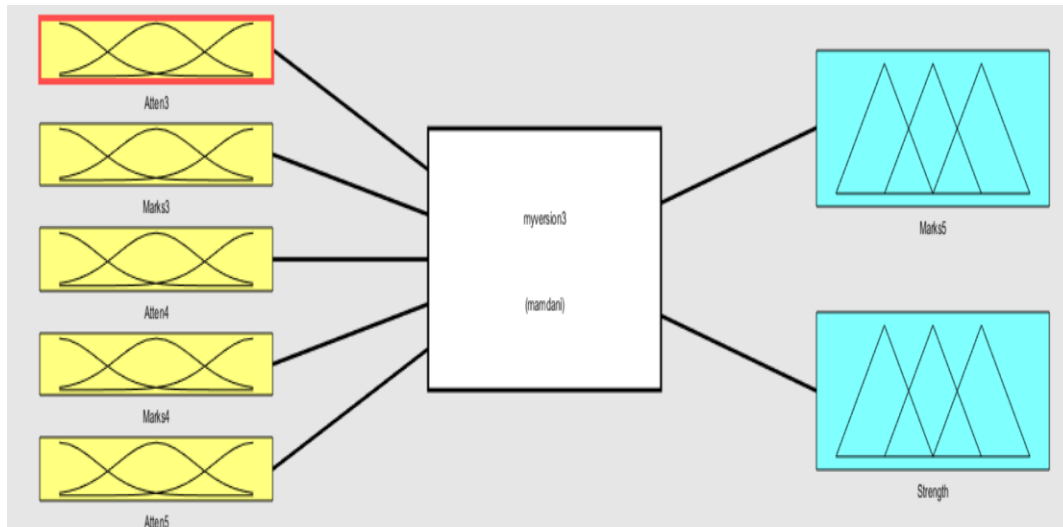


Figure 1: FIS for student performance prediction system.

IV. EXPERIMENTAL RESULTS

The proposed system was implemented with the help of MatLab Fuzzy tool [15]. The Fuzzy inference system is shown in Fig.1. Membership function implementations for input parameters Atten3, Atten4, Atten5, Marks3, and Marks4 have been shown in Fig.2, Fig.3, Fig.4, Fig.5, and Fig. 6 respectively. Membership function implementations for output parameters Marks5 and Strength is shown in Fig. 7, Fig. 8 respectively.

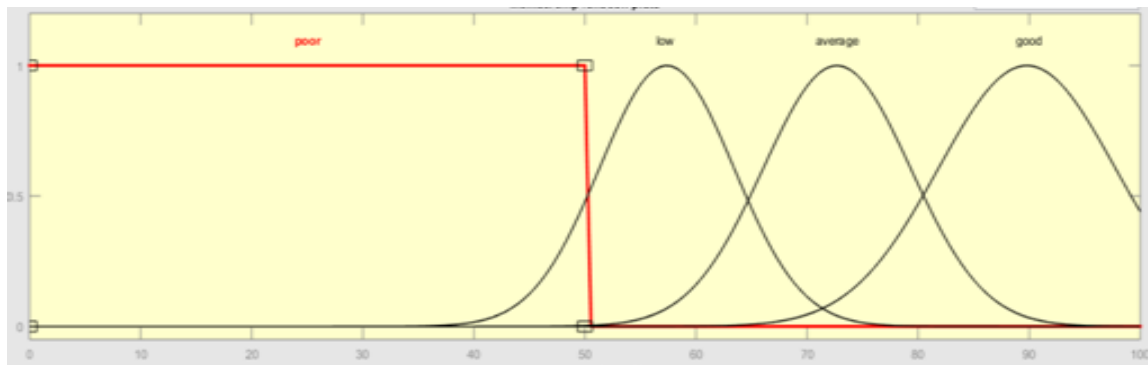


Figure 2: membership function plot for input parameter Atten3.

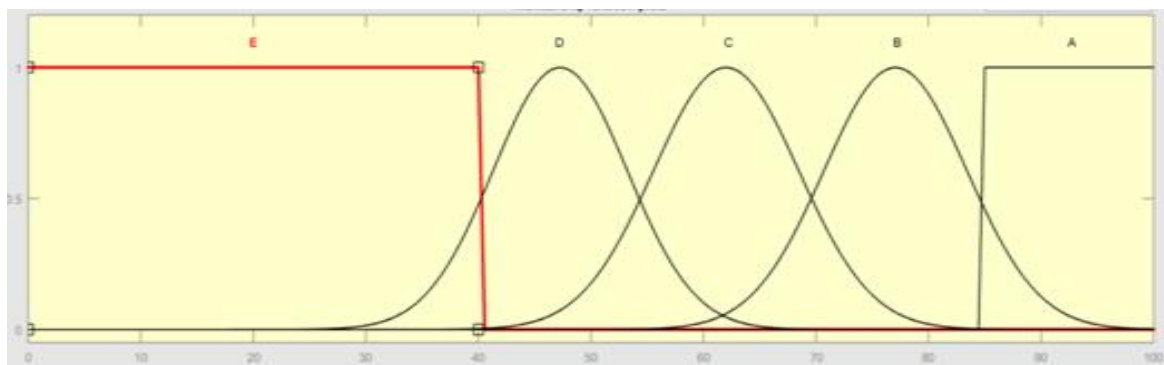


Figure 3: membership function plot for input parameter Marks3.

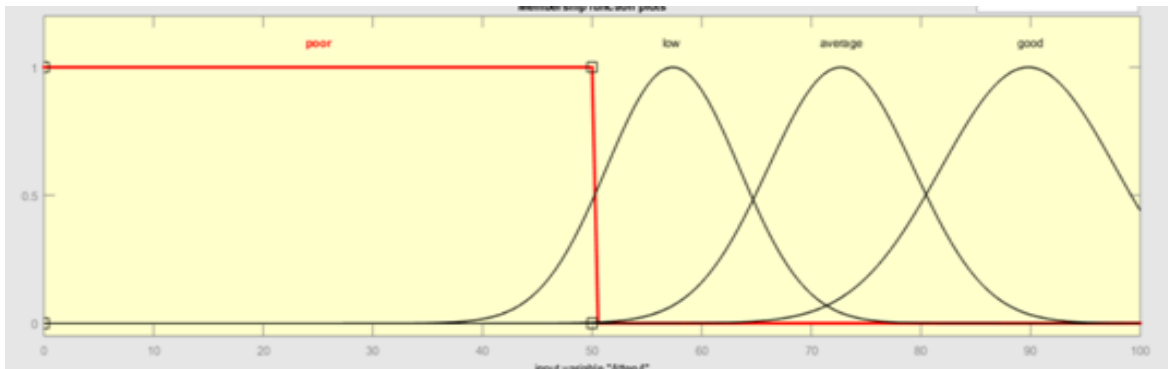


Figure 4: membership function plot for input parameter Atten4.

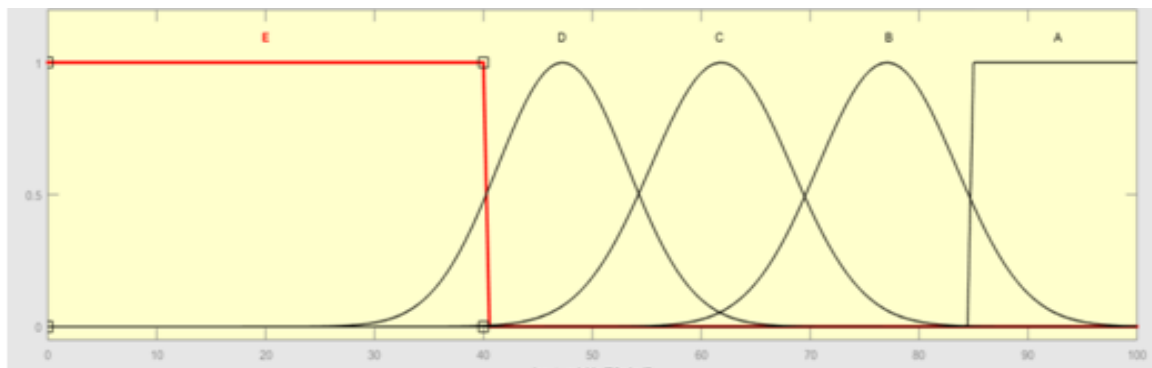


Figure 5: membership function plot for input parameter Marks4.

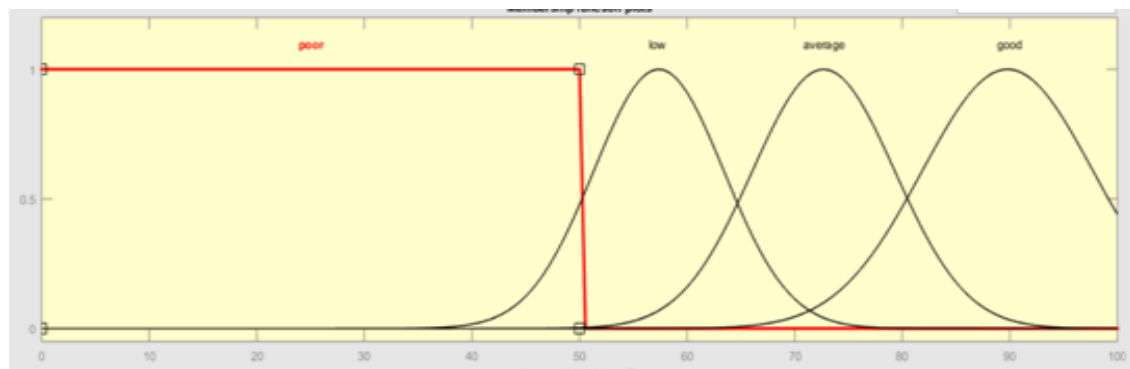


Figure 6: membership function plot for input parameter Atten5.

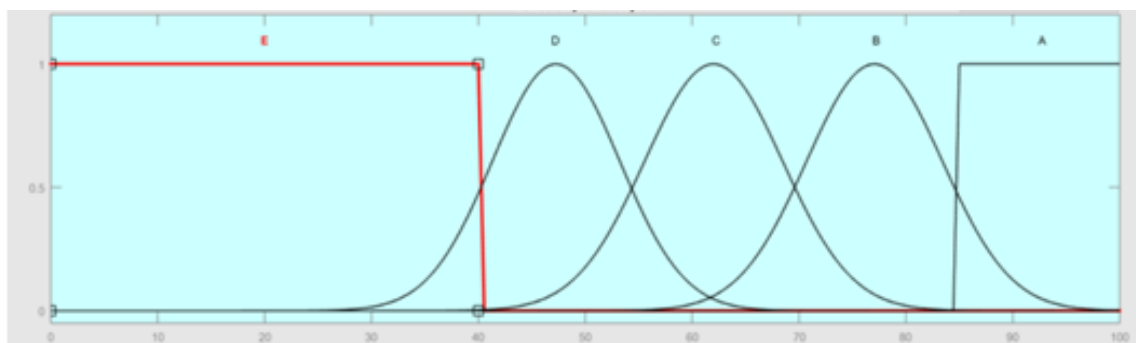


Figure 7: membership function plot for output parameter Marks5.

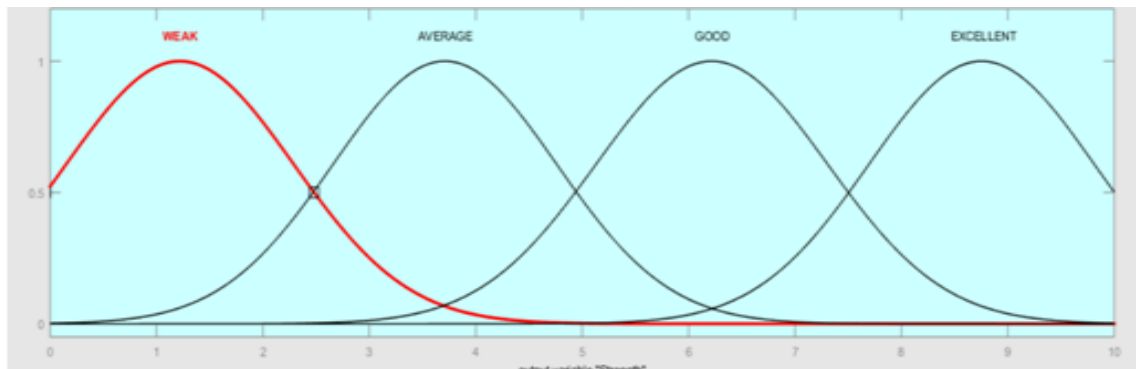


Figure 8: membership function plot for output parameter Strength.

This fuzzy system successfully developed and tested on real dataset obtained from IT department of KIET Group of Institution, Ghaziabad. We tested on 100 records of students for batch 2013-17. We further tested it for another 100 records from batch 2014-18. The sample output of this system for batch 2014-18 is given in Table 2. The performance of proposed system was evaluated by RMSE given in (1):

$$RMSE = \sqrt{\frac{\sum_{i=1}^n (Marks5_{obs} - Marks5_{pred})^2}{n}} \quad (1)$$

In (1) Marks5_{obs} denotes actual marks obtained by the student and Marks5_{pred} for predicted marks by the system. The RMSE for records from batch 2013-17 was calculated 0.36 and for records from batch 2014-18 as 0.71.

Table 2 Sample Test output

S. No.	Atten3	Marks3	Atten4	Marks4	Atten5	Marks5 (Observed)	Marks5 (Predicted)	Strength
1	76	72.3	73	82.5	69	73	73.9	5.13
2	74	70	77	76.9	72	72.7	73.6	4.99
3	81	72.4	81	77.4	70	72.4	73.2	5.03
4	82	77.6	90	84.7	79	79.8	80.2	5.93
5	72	70.7	81	82.6	73	76.1	76.3	5.02
6	94	74.8	91	83	79	79.8	79.9	5.61
7	94	64	93	69.7	77	67.4	67.5	4.06
8	93	73.4	91	79.9	75	76.1	76.1	5.32
9	81	74.6	80	78.5	76	76.8	76.8	5.27
10	75	74.1	84	81.7	82	79.7	78.7	5.17
11	76	54.2	69	51.9	60	54.3	54	3.19
12	86	80.2	91	78.5	72	76	75.6	5.96
13	64	60.2	72	67.9	51	59.1	58.6	2.85
14	77	76	78	76.8	77	75.8	75.3	5.44
15	85	75.8	79	75.6	64	68	67.4	4.98
16	67	72.9	74	77.1	68	70.3	69.6	5.07
17	78	72.2	78	74.3	68	69.5	68.8	5.08

18	89	72.9	92	81	76	78.4	77.6	5.62
19	58	64.8	57	67.6	52	64.7	63.7	3.59
20	64	50.5	65	55.4	67	58.4	57.4	2.62

V. CONCLUSION

This study presented a fuzzy rule-based system for predicting the performance of students in fifth semester university exams. We tested this system over 100 student records from batch 2013-2017 in Information Technology Department with RMSE of 0.36. The developed system was again tested on 100 records of students from batch 2014-2018 with RMSE 0.71. This system will help the institute management to assess the student performance and improve the quality of education. Students also may assess their performance and work towards improving their grades. Our future work is to make more generalized model using different soft computing techniques and machine learning models for large datasets.

REFERENCES

- [1] H. S. Akareem and S. S. Hossain, Determinants of education quality: what makes students' perception different?, *Open Review of Educational Research*, 3(1), 2016, 52-67.
- [2] C. Romero and S. Ventura, Educational data mining: a review of the state of the art. *IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews)*, 40(6), 2010, 601-618.
- [3] A. M. Shahiri and W. Husain, A review on predicting student's performance using data mining techniques. *Procedia Computer Science*, 72, 2015, 414-422.
- [4] M. Kumar, A.J. Singh and D. Handa, Literature Survey on Educational Dropout Prediction, *IJ Education and Management Engineering*, 2, 2017, 8-19.
- [5] M. Koutina and K.L. Kermanidis, Predicting postgraduate students' performance using machine learning techniques. In *Artificial Intelligence Applications and Innovations*, Springer, Berlin, Heidelberg, 2011, 159-168.
- [6] A. Altaher and O. BaRukab, Prediction of Student's Academic Performance Based on Adaptive Neuro-Fuzzy Inference, *International Journal of Computer Science and Network Security (IJCSNS)*, 17(1), 2017, 165.
- [7] H. Hamsa, S. Indiradevi and J. J. Kizhakkethottam, Student Academic Performance prediction model using decision tree and fuzzy genetic algorithm, *Elsevier Procedia Technology*, Vol. 25, 2016, 326-332.
- [8] G. Gokmen, T. C. Akinci, M. Tektaş, N. Onat, G. Kocyigit, and N. Tektaş, Evaluation of student performance in laboratory applications using fuzzy logic, *Procedia-Social and Behavioral Sciences*, 2(2), 2010, 902-909.
- [9] S. Patel, P. Sajja, and A. Patel, Fuzzy logic based expert system for student's performance evaluation in data grid environment, *International Journal of Scientific & Engineering Research*, 5(1), 2014.
- [10] R.S. Yadav, A. K. Soni, S. Pal, A study of academic performance evaluation using Fuzzy Logic techniques. *IEEE Conference on InComputing for Sustainable Global Development (INDIACom)*, 2014, 48-53.
- [11] A. B. Raut, and M. A. A. Nichat, Students Performance Prediction Using Decision Tree, *International Journal of Computational Intelligence Research*, 13(7), 2017, 1735-1741.

- [12] P. Thakar, Performance analysis and prediction in educational data mining: A research travelogue, arXiv preprint arXiv:1509.05176, 2015
- [13] S. Borkar and K. Rajeswari, Attributes selection for predicting students' academic performance using education data mining and artificial neural network, International Journal of Computer Applications, 86(10), 2014.
- [14] M. Goga, S. Kuyoro and N. Goga, A recommender for improving the student academic performance. Procedia-Social and Behavioral Sciences, 180, 2015, 1481-1488.
- [15] <https://in.mathworks.com/products/fuzzy-logic.html>