Fuzzy Logic Based Students Performance Analysis Model for Educational Institutions

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Abstract:
Students play a very important role in the growth of any institute. Basically the rating or ranking of any institute fully depends upon the performance of its students. The performance of a student includes two major factors: one is the marks obtained and other is the number of classes that he/she attended i.e. attendance. It's very necessary to monitor these two factors for a good result and a smooth growth of any institute. This paper presents a methodology to improve these two factors by analyzing the performance of individual student. For this purpose, the whole data i.e. obtained marks and attendance is divided into various ranges. This can be easily done by fuzzy logic system. A fuzzy system is a mathematical model that analyzes input values in terms of logical values. While variables in mathematics take numerical values, in fuzzy logic applications, the non-numeric linguistic variables are often used to facilitate the expression of rules and facts. This paper includes the role of fuzzy logic, fuzzy system, various characteristics of fuzzy logic system, linguistic variables, rules and membership functions and the implementation of performance analysis methodology with the help of fuzzy logic system.

Keywords: Performance, Methodology, Fuzzy logic, Linguistic Variables, Rules and Facts, Membership Function.

1. Introduction

Students and institutions have a tight relationship. Students expect the things more and more in their favor or support from the institution and vice versa. Reputed institutions focus on the performance of students and try to do it better, so that they could stand in rank position as compared to the other institutions. There are two main factors, on which the performance of the students mostly depends: first is 'obtained marks' and other is 'attendance'. We are considering here that both the factors are necessary. If a student, has any one factor is good and other is less, he/she'll not be put in to the category of good students. The reason for this, is mostly institutions/universities are having their cut off marks for passing and they have certain minimum percentage of attendance that every student has to attend. On the basis of these factors, the performance of a student can be evaluated and consider the students those are in the category of 'poor' and 'very poor', for the performance improvement process.

2. Role of Fuzzy Logic

There are many factors which account for the increase in question but the most prominent among them is the rapidly growing use of soft computing and especially fuzzy logic in the conception and design of intelligent systems [3]. As one of the principal constituents of soft computing, fuzzy logic is playing a key role in the conception and design of various systems. There are two concepts within fuzzy logic which play a central role in its applications. The first is that of a linguistic variable, i.e., a variable whose values are words or sentences in a natural or synthetic language. The other is that of a fuzzy if-then rule in which the antecedent and consequent are propositions containing linguistic variables. The essential function served by linguistic variables is that of granulation of variables and their dependencies. In effect, the use of linguistic variables and fuzzy if-then rules results — through granulation — in soft data compression which exploits the tolerance for imprecision and uncertainty. In this respect, fuzzy logic mimics the crucial ability of the human mind to summarize data and focus on decision-relevant information. A student, having zero marks (out of 100), is fail and a student, having 29 marks is also fail. So, for the refinement of such type of parameters, we prefer to use fuzzy logic.

3. Fuzzy System

Fuzzy system is an alternative to traditional notions of set membership and logic that has its origins in ancient Greek philosophy, and applications at the leading edge of Artificial Intelligence. Yet, despite its long-standing origins, it is a relatively new field, and as such leaves much room for development [1].

4. Characteristics of Fuzzy Logic System

Fuzzy logic is a superset of conventional (Boolean) logic that has been extended to handle the concept of partial truth- truth values between "completely true" and "completely false". As its name suggests, it is the logic underlying modes of reasoning which are approximate rather than exact. The importance of fuzzy logic derives from the fact that most modes of human reasoning and especially common sense reasoning are approximate in nature [5].

5. Linguistic Variables

While variables in mathematics usually take numerical values, in fuzzy logic applications, the non-numeric linguistic variables are often used to facilitate the expression of rules and facts.
Here, we have two inputs ‘obtained marks’ and ‘attendance’ and one output ‘performance’. We are using the following linguistic variables in our approach:

1. obtained_marks

very_less
less
good
very_good

2. attendance
very_less
less
good
very_good

3. performance
very_poor
poor
fine
excellent

6. Rules and Membership Functions

Both factors are very important in fuzzy logic based systems. We can divide the input and output parameters in to different ranges with the help of membership functions [2]. After that, rule formation is done i.e. define certain rules or conditions, on the basis of that system analysis is done.

6.1. Membership Function

The membership function of a fuzzy set is a generalization of the indicator function in classical sets. In fuzzy logic, it represents the degree of truth as an extension of valuation. Degrees of truth are often confused with probabilities, although they are conceptually distinct, because fuzzy truth represents membership in vaguely defined sets, not likelihood of some event or condition. Assume range for: obtained_marks is in %, attendance is Maximum 40 lectures and Performance is in %.

1. obtained_marks	Range
very_less	0 - 30
less	25 - 50
good	45 - 75
very_good	70 - 100

2. attendance	Range
very_less	0 - 12
less	10 - 24
good	24 - 32
very_good	30 - 40

3. performance	Range
very_poor	0 - 29
poor	30 - 49
fine	50 - 74
excellent	75 – 100

6.2. Rules Formation

Here, as the fact, both factors 'obtained_marks' and 'attendance' are necessary to analyze the accurate performance of a student. We are assuming that the performance of a student depends upon both the factors. So, for the fine/excellent performance of a student, it is mandatory that both factors must have good/very_good input values.
The various rules are formed with these two input variables and one output variable:

1. If attendance is (very_less) and obtained_marks is (very_less) then performance is (very_poor).
2. If attendance is (very_less) and obtained_marks is (less) then performance is (very_poor).
3. If attendance is (less) and obtained_marks is (very_less) then performance is (very_poor).
4. If attendance is (less) and obtained_marks is (less) then performance is (poor).
5. If attendance is (good) and obtained_marks is (good) then performance is (fine).
6. If attendance is (very_good) and obtained_marks is (good) then performance is (fine).
7. If attendance is (good) and obtained_marks is (very_good) then performance is (fine).
8. If attendance is (very_good) and obtained_marks is (very_good) then performance is (excellent).
9. If attendance is (very_less) and obtained_marks is (good) then performance is (very_poor).
10. If attendance is (very_less) and obtained_marks is (very_good) then performance is (very_poor).
11. If attendance is (less) and obtained_marks is (good) then performance is (poor).
12. If attendance is (less) and obtained_marks is (very_good) then performance is (poor).
13. If attendance is (good) and obtained_marks is (very_less) then performance is (very_poor).
14. If attendance is (good) and obtained_marks is (less) then performance is (poor).
15. If attendance is (very_good) and obtained_marks is (very_less) then performance is (very_poor).

16. If attendance is (very_good) and obtained_marks is (less) then performance is (poor).

7. Implementation of Performance Analysis Methodology with Fuzzy Logic System

We are implementing the performance analysis and improvement methodology with fuzzy logic. Figure-1 shows two input variables ‘obtained marks’ and ‘attendance’ and one output variable performance.
We have defined input variables ‘obtained marks’ and ‘attendance’ with the help of four membership functions very less, less, good and very good. Similarly, the output variable ‘performance’ is defined as very poor, poor, fine and excellent.

Figure 1 System analysis with input and output

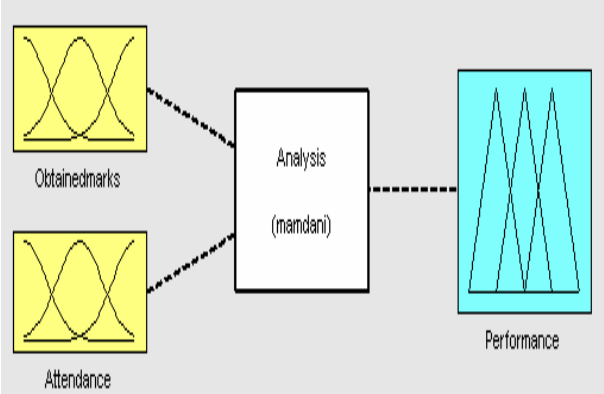


Figure 2 Membership functions for input variable ‘obtained marks’

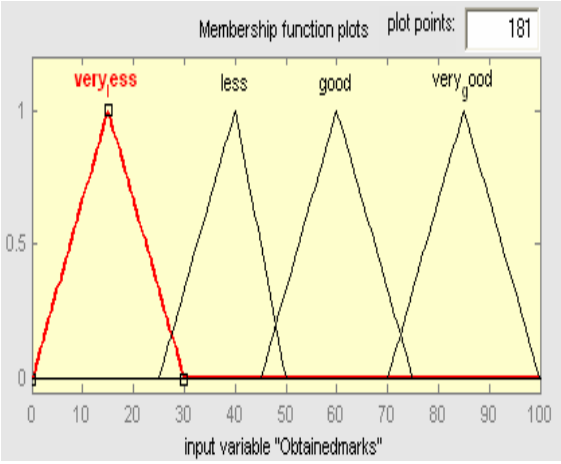


Figure 3 Membership functions for input variable ‘attendance’

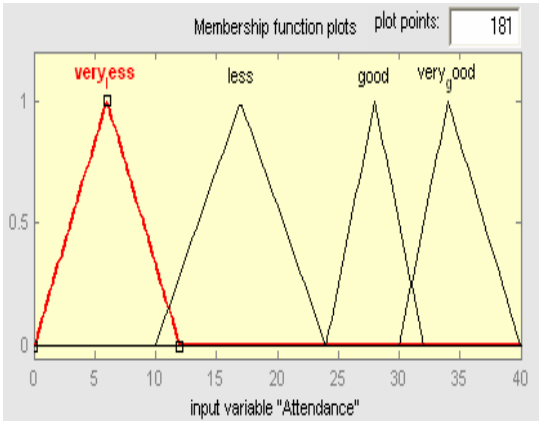


Figure 4 Membership functions for output variable ‘performance’

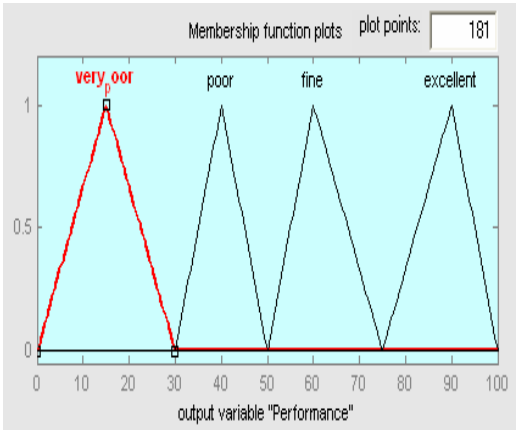


Figure 2 shows the membership functions for input variable ‘obtained marks’

Figure 3 shows the membership functions for input variable ‘attendance’

Figure 4 shows the membership functions for output variable ‘performance’.

Figure 5 shows the rule formation for these two input variables and one output variable. There are total sixteen combinations of various rules. After forming various rules, the performance of a student can be checked out by rule viewer. Figure 6 shows the performance analysis with rule viewer. We can take a 3-D view of these parameters i.e. obtained_marks, attendance and performance with the help of surface viewer. Figure 7 shows the 3-D surface viewer.

Figure-6 shows an example of the performance of a student, having ‘obtained_marks’ 72.9/100 (72.9%) and ‘attendance’ 31.1/40 (77.75%), is 75%.

Figure 5 Fuzzy logic rules formation

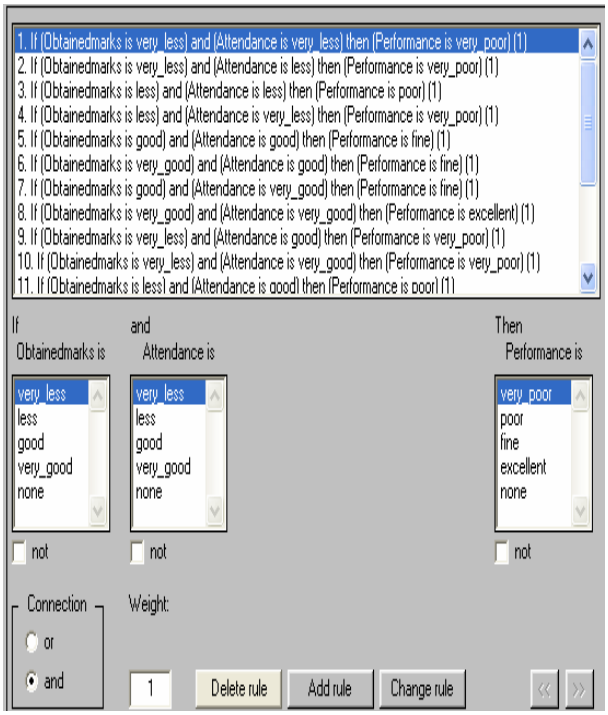


Figure 6 Performance analysis with fuzzy logic rule based system

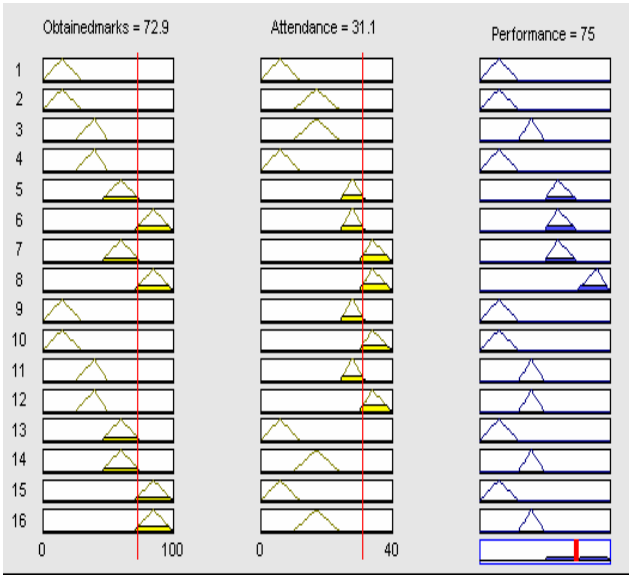
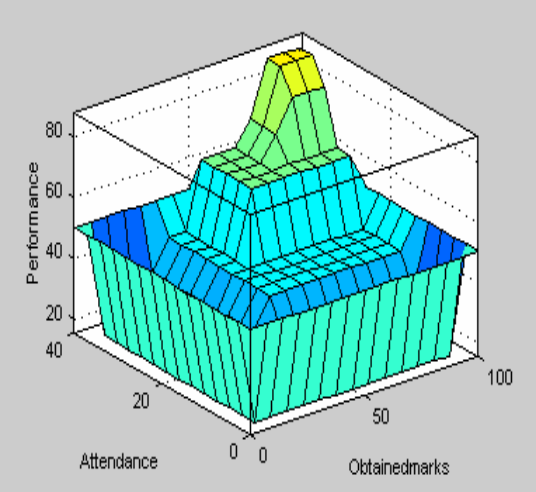


Figure 7 3-D Surface viewers



8. Conclusion

At the end it can be concluded that this system is very useful to analyze the performance of students. The improvement methodology can be applied to those students that are under the performance category of 'poor' or 'very poor'. This improvement methodology varies from institution/university to institution/university.

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