

# Impact of various linguistic factors on the Academic Performance of the students

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**Abstract**—In real world, the academic performance of students is affected by various factors such as ‘Faculty Teaching Level’, ‘Management Support’ and ‘Quality of Students’. These linguistic factors cannot be measured by classical set theory. In such cases, fuzzy expert system play very important role for designing such factors. Therefore, fuzzy expert system is used for designing these factors to analyze the performance of students. Subsequently, centroid defuzzification method is used to examine the impact of these factors on the academic performance of students.

**Keywords**—fuzzy inference system, defuzzification, linguistic factors

## 1. INTRODUCTION

Fuzzy set theory is one of the best tools to represent imprecise concepts that use linguistic variables rather than quantitative variables [1]. Linguistic variables take the values in words or sentences in a given language like less, moderate, more, intelligent etc. These attributes cannot be defined precisely with the help of classical set theory. In such cases, a model is needed to express these imprecise terms. Fuzzy set theory provides us not only meaningful and powerful representation of measurement of these imprecise terms but also with meaningful representation of vague concepts expressed in natural language.

In this study, we are analyzing the academic performance of students, which may be affected by three important factors like ‘Faculty Teaching level’, ‘Management Support’ and ‘Quality of Students’. These factors are in linguistic terms which are modeled using fuzzy expert system. A survey has been conducted to collect the data from the hundred students for modeling these factors.

## 2. LITERATURE REVIEW

For last few years, Fuzzy expert system is used by many researchers for modeling the linguistic variables in various fields [2], [3], [4], [5], [6]. Fuzzy sets and its various applications are detailed out by Klir and Yuan [7]. Various researchers have used fuzzy expert system to evaluate the academic performance of students [8], [9], [10]. Fuzzy inference system has also been used to obtain the performance of students for different input values of ‘Teaching Effectiveness’, ‘Student Attendance’, and other Facilities [11]. Yadav et al. [12] presented a new fuzzy expert system (NFES) for performance evaluation of students.

## 3. PROPOSED WORK

The objective of this study is to design a fuzzy expert system for analyzing the academic performance of students. Fuzzy expert system is used for modeling the important and most common factors like ‘Faculty Teaching level’, ‘Management Support’ and ‘Quality of Students’ which affect the performance of students. Thereafter academic performance of students is examined.

## 4. METHODOLOGY

Proposed work has been modeled using fuzzy logic toolbox in MATLAB. Fuzzy logic toolbox contains graphic user interface editors in which basic FIS editor, membership function editor, rule editor, rule viewer, fuzzy inference diagram and output surface can be viewed. It also has different membership functions of different shapes as triangular, trapezoidal, etc.

The detailed methodology is defined in the following sub-sections.

### A. *Building a fuzzy inference system for analyzing the academic performance*

The first step in designing the fuzzy expert system is determination of input and output factors. There are three input and one output factor. Input variables are Faculty Teaching level (FTL), Management Support (MS) and Quality of Students (QS). The output factor is the Academic Performance (AP). The Structure of this fuzzy inference system is shown in Fig. 1.

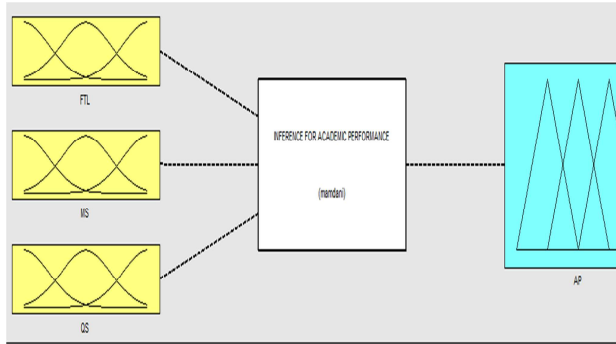


Fig.1. Structure of fuzzy inference System

**B. Membership functions for the input and output variables**

Next most important step is to define the membership functions for input and the output variables. In this paper trapezoidal membership function is used for input and output variables.

The membership functions of input factor FTL is shown in Fig. 2 and mathematical formulation of its membership functions 'low', 'moderate', 'high', and 'very high' are given by equations (1), (2), (3) and 4 respectively.

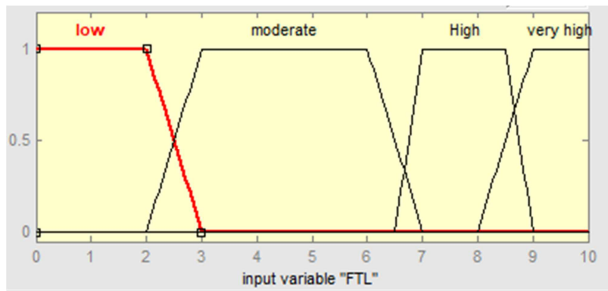


Fig.2. Membership function of the FTL

$$low(x) = \begin{cases} 1 & ; 0 \leq x < 2 \\ 3-x & ; 2 \leq x < 3 \end{cases} \quad (1)$$

$$moderate(x) = \begin{cases} x-2 & ; 2 \leq x < 3 \\ 1 & ; 3 \leq x < 6 \\ 7-x & ; 6 \leq x < 7 \end{cases} \quad (2)$$

$$high(x) = \begin{cases} \frac{x-6.5}{0.5} & ; 6.5 \leq x < 7 \\ 1 & ; 7 \leq x < 8.5 \\ \frac{9-x}{0.5} & ; 8.5 \leq x < 9 \end{cases} \quad (3)$$

$$very\ high(x) = \begin{cases} x-8 & ; 8 \leq x < 9 \\ 1 & ; 9 \leq x < 10 \end{cases} \quad (4)$$

The membership functions of input factor MS is shown in Fig. 3 and mathematical formulation for its membership functions 'less', 'average', and 'more' are illustrated by equations (5), (6) and (7) respectively.

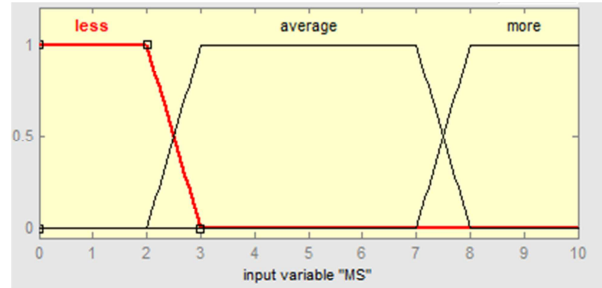


Fig.3. Membership function of the MS

$$less(x) = \begin{cases} 1 & ; 0 \leq x < 2 \\ 3-x & ; 2 \leq x < 3 \end{cases} \quad (5)$$

$$average(x) = \begin{cases} x-2 & ; 2 \leq x < 3 \\ 1 & ; 3 \leq x < 7 \\ 8-x & ; 7 \leq x < 8 \end{cases} \quad (6)$$

$$more(x) = \begin{cases} 8-x & ; 7 \leq x < 8 \\ 1 & ; 8 \leq x < 10 \end{cases} \quad (7)$$

The membership functions of input factor QS is shown in Fig. 4 and mathematical formulation for its membership functions 'poor', 'average', and 'good' are demonstrated by equations (8), (9) and (10) respectively.

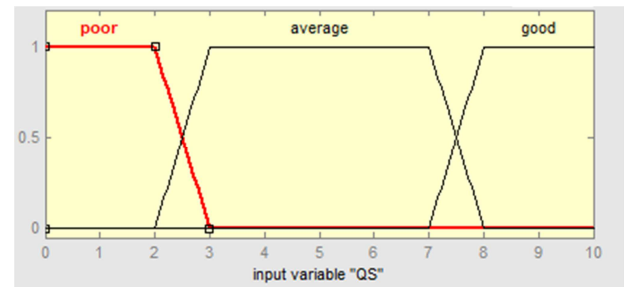


Fig.4. Membership function of the QS

$$poor(x) = \begin{cases} 1 & ; 0 \leq x < 2 \\ 3-x & ; 2 \leq x < 3 \end{cases} \quad (8)$$

$$average(x) = \begin{cases} x-2 & ; 2 \leq x < 3 \\ 1 & ; 3 \leq x < 7 \\ 8-x & ; 7 \leq x < 8 \end{cases} \quad (9)$$

$$good(x) = \begin{cases} 8-x & ; 7 \leq x < 8 \\ 1 & ; 8 \leq x < 10 \end{cases} \quad (10)$$

The membership functions of output factor (AP) are shown in the Fig. 5 and its mathematical formulations are given by equations (11), (12), (13) and (14) respectively.

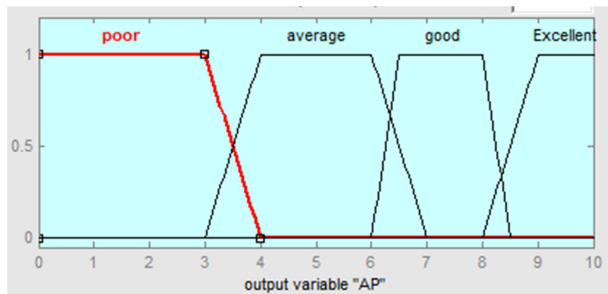


Fig.5. Membership function of the AP

$$poor(x) = \begin{cases} 1 & ; 0 \leq x < 3 \\ 4-x & ; 3 \leq x < 4 \end{cases} \quad (11)$$

$$average(x) = \begin{cases} x-3 & ; 3 \leq x < 4 \\ 1 & ; 4 \leq x < 6 \\ 7-x & ; 6 \leq x < 7 \end{cases} \quad (12)$$

$$good(x) = \begin{cases} \frac{x-6}{0.5} & ; 6 \leq x < 6.5 \\ 1 & ; 6.5 \leq x < 8 \\ 8.5-x & ; 8 \leq x < 8.5 \end{cases} \quad (13)$$

$$excellent(x) = \begin{cases} x-8 & ; 8 \leq x < 9 \\ 1 & ; 9 \leq x < 10 \end{cases} \quad (14)$$

### C. Fuzzy Rule Set

To determine the academic performance of the students 25 rules are designed on the basis of data collected from the 100 students. It is important to note that data is collected from the students by conducting a survey. For example some rules are mentioned here:

1. If (FTL is low) and (MS is less) and (QS is poor) then (AP is poor).
2. If (FTL is high) and (MS is more) and (QS is good) then (AP is good).
3. If (FTL is low) and (MS is more) and (QS is poor) then (AP is poor).
4. If (FTL is low) and (MS is more) and (QS is average) then (AP is average).
5. If (FTL is high) and (MS is average) and (QS is good) then (AP is Excellent).
6. If (FTL is high) and (MS is more) and (QS is poor) then (AP is poor).
7. If (FTL is moderate) and (MS is less) and (QS is good) then (AP is good).
8. If (FTL is high) and (MS is less) and (QS is poor) then (AP is poor).
9. If (FTL is very high) and (MS is more) and (QS is poor) then (AP is poor).
10. If (FTL is very high) and (MS is average) and (QS is good) then (AP is Excellent).

### D. Defuzzification

After defining all the membership functions and the rules of the fuzzy expert system, the fuzzy inference system

finally evaluates these rules with the help of membership functions. The result of this evaluation is a fuzzy set. This fuzzy set is then converted, into a single value that, in some sense, is the best representative of the fuzzy set. This process is known as Defuzzification. In this study, the designed expert system uses 'centroid' method for Defuzzification.

## 5. RESULTS

The designed fuzzy expert system is tested for the few values of input factors as shown in Table I.

Table I.

S.No	FTL	MS	QS	AP
1	8(high)	8(more)	2(poor)	1.74(poor)
2	2(low)	4 (less)	9(good)	5(average)
3	7(high)	8(average)	9(good)	8.12(Good)
4	9(very high)	5(average)	9(good)	9.25(Excellent)

For instant, if the value of 'Faculty Teaching Level' is 8 i.e. high in linguistic sense, the value of 'Management Support' is 8 i.e. more in linguistic sense and the value of 'Quality of Students' is 2 i.e. poor in linguistic sense, then the value of 'Academic Performance' is 1.74 i.e. poor in linguistic sense.

## 6. CONCLUSION

In this study, a fuzzy expert system is designed to analyze the academic performance of students. For this purpose three input factors have been considered which affects the performance of students. Mamdani defuzzification method as centroid method is used for producing and analyzing the performance of the students.

As we know education plays an important role in one's life for the overall growth in the society. If the right education and right environment is not provided then it somewhat distracts the person from his/her path. On the basis of this study, the performance of the students can be improved in real-time which are beneficial for the bright future of each student and society.

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