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Fuzzy Logic Based Evaluation of Performance of Students in Colleges

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Abstract - **Performance of students in colleges is difficult to assess before the final results are declared. The performance depends on many factors such as student attendance, teaching effectiveness, facilities etc. Generally, when one is interested in assessing these dependency factors, a physical inventory of the items involved is done and a decision is recommended to the management. But its impact on performance of students is not carried out. This paper aims at presenting the idea of evaluating this performance using fuzzy logic. The paper describes the procedure that can be used to assess the performance of students. The process is based entirely on the principle of taking non-precise inputs on the factors affecting the performance: student attendance, teaching effectiveness and infrastructure facilities and subjecting them to fuzzy arithmetic and obtaining a crisp value of the performance. It is quite clear from the paper itself that this method can be used in practice to analyse further with more additional factors affecting the performance.**

Index Terms **– Fuzzy logic, Fuzzy inference system, Triangular membership functions, Fuzzy editor in MATLAB software.**

I. Problem Definition

When one is required to carry out an assessment of performance of students in a college, we have to consider the factors that are affecting the performance. Generally the factors that are affecting the performance are student attendance, teaching effectiveness, facilities such as hostel, laboratory equipment, teaching aids including blackboard, white board, computer and projector, recreation arrangements, toilets, cleanliness, hygienic conditions etc. It is possible to analyse these factors qualitatively such as poor, good, very good etc. Even if quantitative figures are available such as 50% attendance, 80% attendance, it cannot directly be used for performance assessment using traditional methods. In this paper an attempt has been made to assess the performance of students using fuzzy inference system. This has been used because precise model of the input/output relationship in this case is sparsely available.

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A. Details About The Problem

The problem in this paper has been simplified by using only three input variables or factors. These are:

1. Student Attendance
2. Teaching Effectiveness
3. Facilities

Fig. 1 shows the basic approach to the problem [1, 2]. The fuzzy inference system takes linguistic inputs (as stated for simplification), processes the information and outputs the performance. How to get these three inputs is for the college management to decide. Inputs pertaining to student attendance may be obtained through actual attendance of students in the class. Teaching effectiveness and Facilities inputs can be obtained from students by doing a survey or a questionnaire.

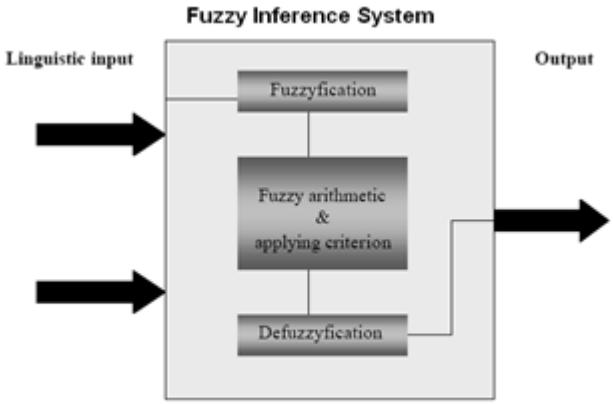

Fig. 1 Basic block diagram of the process

II. Details About The Set Applied

Before the details of the fuzzy system are dealt with, the range of possible values for the input and output variables are determined. These (in language of Fuzzy Set theory) are the membership functions (Input variable vs. the degree of membership function) used to map the real world measurement values to the fuzzy values, so that the operations can be applied on them. Fig. 2 shows the labels of input and output variables and their associated membership functions. Values of the input variables are considered in terms of percentage.

The decision which the fuzzy inference system makes is derived from the rules which are stored in the database. These are stored as a set of rules. Basically the rules are 'If-Then' statements that are intuitive and easy to understand, since they are nothing but common English statements. 'If" refers to an antecedent that is compared to the inputs, and "Then" refers to a consequent, which is the result or output [1]. All the rules that have any truth in their antecedent will fire and contributes towards the fuzzy conclusion set. Rules used in this paper are derived from experience of the author and discussion with her colleagues.

The rules framed for this study is provided below:
If Student Attendance is *Medium*, Teaching Effectiveness is *Less Effective* and Facilities is *Medium* then Performance of Students is *Poor*.
If Student Attendance is *Good*, Teaching Effectiveness is *Less Effective* and Facilities is *Medium* then Performance of Students is *Medium.*
If Student Attendance is *Very Good*, Teaching Effectiveness is *Less Effective* and Facilities is *Medium* then Performance of Students is *Medium.*

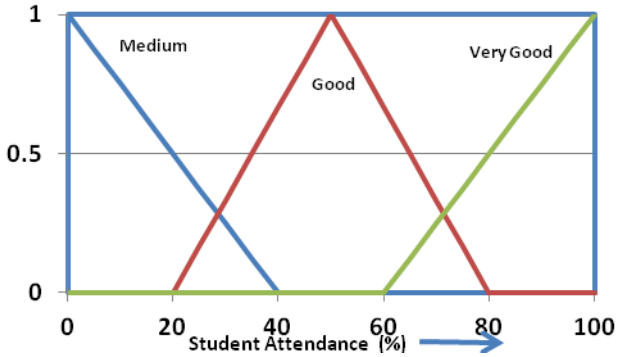

Figure 2a. Fuzzy Membership Function for the Input Variable

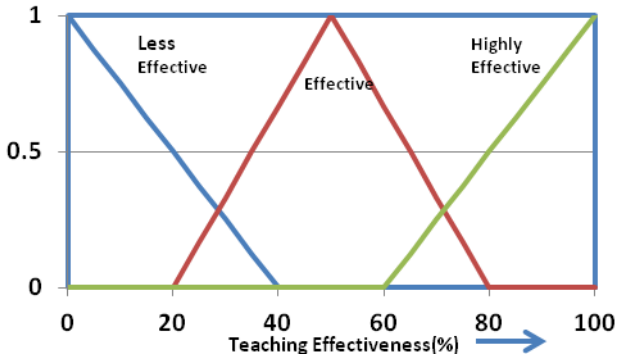

Figure 2b. Fuzzy Membership Function for the Input Variable – Teaching Effectiveness

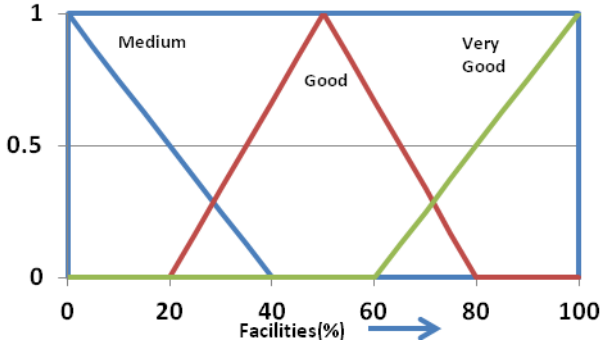

Figure 2c. Fuzzy Membership Function for the Input Variable - Facilities

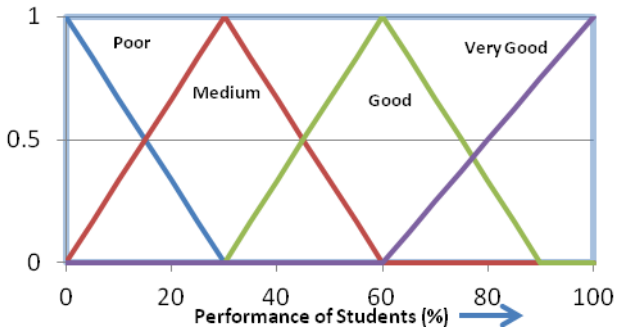

Figure 2d. Fuzzy Membership Function for the Output Variable – Performance of Students

If Student Attendance is *Medium*, Teaching Effectiveness is *Effective* and Facilities is *Medium* then Performance of Students is *Poor*.
If Student Attendance is *Good*, Teaching Effectiveness is *Effective* and Facilities is *Medium* then Performance of Students is *Medium.*
If Student Attendance is *Very Good*, Teaching Effectiveness is *Effective* and Facilities is *Medium* then Performance of Students is *Good.*
If Student Attendance is *Medium*, Teaching Effectiveness is *Highly Effective* and Facilities is *Medium* then Performance of Students is *Poor*.
If Student Attendance is *Good*, Teaching Effectiveness is *Highly Effective* and Facilities is *Medium* then Performance of Students is *Medium.*
If Student Attendance is *Very Good*, Teaching Effectiveness is *Highly Effective* and Facilities is *Medium* then Performance of Students is *Good.*
If Student Attendance is *Medium*, Teaching Effectiveness is *Less Effective* and Facilities is *Good* then Performance of Students is *Poor*.
If Student Attendance is *Good*, Teaching Effectiveness is *Less Effective* and Facilities is *Good* then Performance of Students is *Poor*.
If Student Attendance is *Very Good*, Teaching Effectiveness is *Less Effective* and Facilities is *Good* then Performance of Students is *Medium.*
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If Student Attendance is *Very Good*, Teaching Effectiveness is *Highly Effective* and Facilities is *Good* then Performance of Students is *Very Good.*
If Student Attendance is *Medium*, Teaching Effectiveness is *Less Effective* and Facilities is Very *Good* then Performance of Students is *Poor*.

If Student Attendance is *Good*, Teaching Effectiveness is *Less Effective* and Facilities is Very *Good* then Performance of Students is *Medium*
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The format of rules framed in MATLAB is shown in Fig. 3.

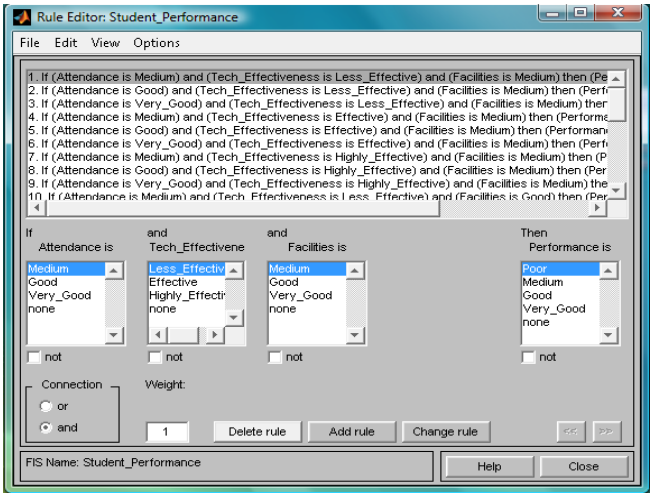

Figure 3. MATLAB format of rules framed on fuzzy inference system

The rules too have been defined in imprecise sense and hence they too are not crisp but fuzzy values. The three input parameters are fuzzified as per the triangular membership function of the respective variables. Zafiropoulos and Dialynas consider triangular membership functions for their fuzzy reliability analysis of an electronic device [3]. While providing a generic method to simplify the fuzzy logic-based failure mode and effect analysis (FMEA) methodology by reducing the number of rules that needs to be provided by FMEA users for the fuzzy risk priority number (RPN) modeling process, Tay and Lim used Gaussian membership functions [4]. Sharma, Kumar and Kumar have considered a combination of triangular and trapezoidal fuzzy membership functions for permitting system reliability analysts / managers / practitioners / engineers to analyse system failure behaviour more consistently and plan suitable maintenance actions accordingly [5].

The input fuzzy variables in addition with the membership function curve are utilized to come to a solution by means of fuzzy inference system. Fuzzy inference procedure is based on the compositional rule of inference proposed by Zadeh [1]. By using the inference procedure an output fuzzy set is obtained from the rules and the input variables. The two most common types of inference systems frequently used are the max-min and max-prod inference methods. In the study, the Mamdani's max-min inference method is used as it is typically used in modeling human expert knowledge. The min operator is used for the conjunction of the rule and for the implication function, and the max operator is used for the aggregation of the fuzzy sets.

At last, the crisp value of the 'Performance of Students' is obtained as an answer. This is done by defuzzifing the fuzzy output. There are many defuzzification methods available in the literature but most commonly used are 'CENTROID' and 'MAXIMUM' methods. The criteria used to select suitable defuzzification method are disambiguity (result in unique value), plausibility (lie approximately in the middle of the area), and computational simplicity. In the study 'CENTROID' defuzzification method is used, which is given by

$$\text{Defuzzified value} = \frac{\int_x \mu_A(x)\, x\, dx}{\int_x \mu_A(x)\, dx}$$

where A is the output fuzzy set and $\mu_A(\cdot)$ is the membership function.

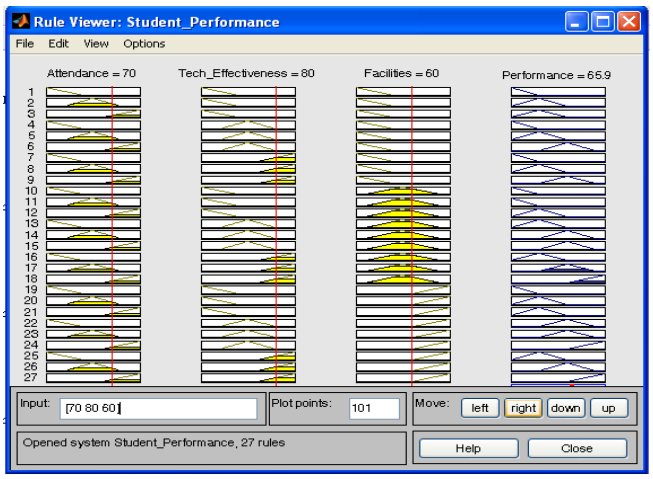

Figure 4. Fuzzy system output representation for 'Performance of Students'

III. Results And Discussion

With the input values and using the above model, the inputs are fuzzyfied and then by using simple if-else rules and other simple fuzzy set operations, the output fuzzy function is obtained and using the criteria, the output value for performance of students is obtained. Fig. 4 shows one clipping of fuzzy output for three different values of the input variables using the fuzzy if-then rules. Figure 5 shows the control- surface plot of two inputs and the output as determined by Fuzzy Inference System. The result (the

above plot) shows the way the Performance of Students in different conditions of the input variables. For ease of understanding, the fuzzy output for few different input values is provided in Table 1.

IV. SUMMARY

By the use of fuzzy inference system we have been able to obtain Performance of Students for different input values of Student Attendance, Teaching Effectiveness and Facilities. The conventional method may assume a probabilistic model to arrive at the performance of students. Though the analysis in this paper has been very crude, but this clearly depicts the advantage of using the fuzzy logic approach for the kind of problem considered.

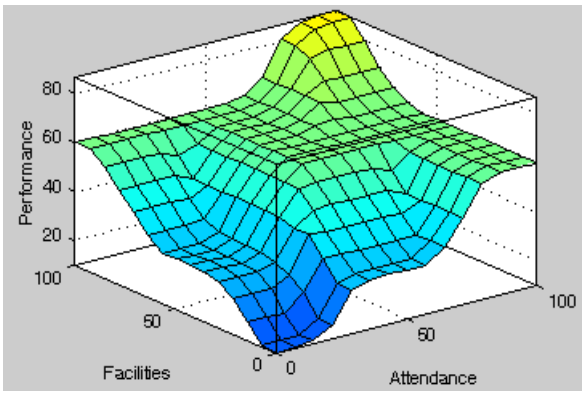

Figure 5a. Control surface plot between Student Attendance and Facilities with Performance of Students

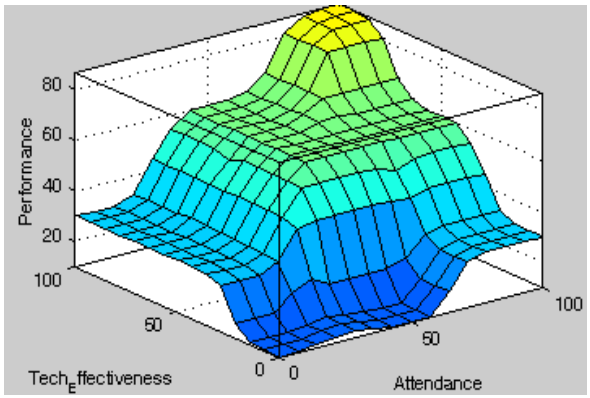

Figure 5b. Control surface plot between Teaching Effectiveness and Facilities with Performance of Students

Table 1. Performance of Students for Different Input Values

Sl No	Student Attendance (%)	Teaching Effectiveness (%)	Facilities (%)	Perform-ance of Students (%)
1	40	60	50	60.00
2	80	60	70	64.54
3	80	90	70	84.70
4	30	90	40	47.20
5	90	90	30	72.76

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BIOGRAPHY

Mamatha S Upadhya holds M.Sc. (Mathematics) from Kuvempu University, Karnataka and M.Phil., (Mathematics) from S.V University, Tirupathi. She has nearly 10 years of teaching experience for both undergraduate and postgraduate courses. Currently she is working as Assistant Professor at the Garden City College, Bangalore. Her areas of interest include Graph Theory, Fuzzy logic, Differential Calculus etc.