Fuzzy Logic: A Tool for Evaluation of Students' Performance.

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Abstract

Assessment of students performance in colleges is a greater challenge in schools and colleges. The performance evaluation will depend on many factors such as student attendance, quality of the teachers, infrastructure facilities provided by the management etc. This paper presents an effective method of evaluating the performance of a student using fuzzy logic technique. Three parameters of the students used are internal assessment, score in theory and the score in the practical. Crisp values of the parameters are converted to fuzzy parameters and the performance is evaluated in the fuzzy domain in an effective manner compared to the conventional evaluation method. The performance of the student can be simulated using fuzzy inference system in MATLAB. The method explained in this paper can also be extended for other parameters.

***Index Terms* – Fuzzy logic, Crisp values, Fuzzy parameters, Fuzzy inference system, MATLAB.**

Introduction:

In education system, the valuation of the students is a major challenge. It should include all the possible parameters. Usually the traditional evaluation method is being used where the average of the actual scores is used. An efficient evaluation technique can be implemented using Fuzzy logic. This technique will have no restriction of number of parameters and kind of parameters. The parameter are converted in a set of rules called Fuzzy rules and analysed using fuzzy inference method. This fuzzy inference method can be developed and implemented depending on the performance in different subjects opted by a student and also the performance in the other related parameters. In this paper the fuzzy inference method is used to evaluate the performance of a student in a particular subject with three parameters internal assessment (IA), Theory Marks (TM) and Practical Marks (PM).

Fuzzy Logic:

Usually the natural languages are vague because most of the concepts in the real world have no boundaries. For example short, tall, hot, cool, more, less etc are not defined with boundaries in natural languages. Hence these are true as well as false to some extent. In fuzzy logic these concepts will be converted in to fuzzy rules. These fuzzy rules mathematically represent the fuzzy sets with degree of membership. Fuzzy logic is getting more popularity in advanced intelligent system because of its simplicity and flexibility.

Fuzzy logic starts with and builds on a set of user-supplied human language rules. The fuzzy systems convert these rules to their mathematical equivalents. This simplifies the job of the system designer and the computer and results in much more accurate representations of the way systems behave in the real world. Additional benefits of fuzzy logic include its simplicity and its flexibility. The typical architecture of fuzzy system is shown in fig.1 below. Fuzzy inference systems make

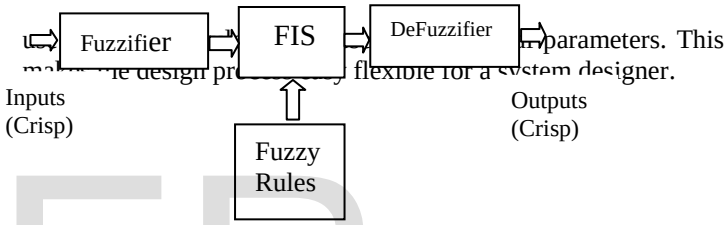

Fig.1. Architecture of fuzzy system

METHODOLOGY

The fuzzy expert system designed by using the following methodology.

The Algorithm

1. Collect and type crisp data: IA, Theory and Practical marks;
2. Create fuzzy logic membership function;
3. Create fuzzy logic decision matrix (syntax) as the knowledge base of the system;
4. Match input variable to the fuzzy logic syntax in the knowledge base;
5. Determine the overall performance using centre of Gravity Method;
6. Stop.

Crisp Data

The values for input variables may be collected from the records of the students' end term result with internal assessment (IA), Theory Marks (TM) and Practical Marks (PM) shown in Table I.

TABLE I. INPUT VARIABLES (ELEMENTS) OF THE PROPOSED EVALUATION MODEL

Reg.No	IA	TM	PM
001	45	65	70
002	68	75	80

003	79	68	47
004	54	81	55
005	94	87	96
006	40	43	45
007	95	96	94
008	42	95	86
009	96	45	92
010	91	94	50

Fuzzification

In the process of Fuzzification the actual or crisp values of data input are converted as fuzzy values using fuzzy membership functions. This can be represented mathematically as X= fuzzifier (x0). Where xo is a crisp input value, X is the corresponding fuzzy logic set and fuzzifier represents a Fuzzification function. There are different Fuzzification functions. Fuzzification of the input variables is done by using variables as used in natural language. In this paper the performance of a student is defined as poor, average, good, very good and excellent accordingly. Then each input variable is assigned a trapezoidal Membership function. Here lower limit is 'a', upper limit 'd', lower support limit is 'b' and upper support limit is 'c', where a < b < c < d, for the degree of association for respective linguistic variables is represented by eqn.(1).

$$\mu_A(x) = \begin{cases} 0, & (x<a) \text{ or } x>d \\ \frac{x-a}{b-a}, & a \le x \le b \\ 1, & b<x<c \\ \frac{d-x}{d-c}, & c \le x \le d \end{cases} \quad \text{.....(1)}$$

Membership functions of input variables are named IA (IA marks), TM(Theory marks) and PM(Practical marks). These membership functions are generated from MATLAB fuzzy inference tool.

Fuzzification of Input Variable Students Internal Assessment(IA):

The Students' Internal assessment marks in the subject Electronics was taken from the records. The percentage of the IA is calculated from the marks obtained by the students in the subject. IA marks in terms of linguistic variables is shown in table II and its membership function is shown in Fig.2.

TABLE II.STUDENTS' IA IN TERMS OF LINGUISTIC VARIABLES

Student's Performance in IA	Poor	Average	Good	Very Good	Excellent
IA	<50	50-54.9	55-64.9	65-75	>75

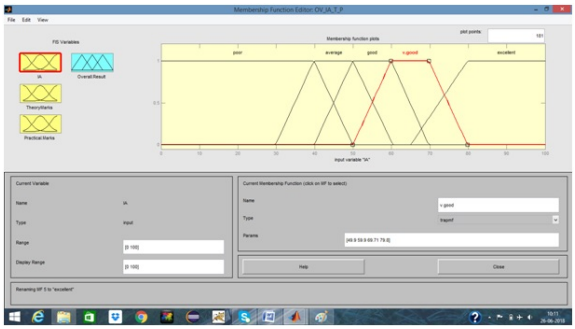

Fig.2.Membership function of input Internal Assessment Marks (PM)

Fuzzification of Input Variable Theory Marks(TM)

TABLE III THEORY MARKS IN TERMS OF LINGUISTIC VARIABLES

Student's Performance in Theory	Poor	Average	Good	Very Good	Excellent
TM	<50	50-54.9	55-64.9	65-75	>75

Membership Function of the input variable Theory Marks (TM) is shown in Fig.2.

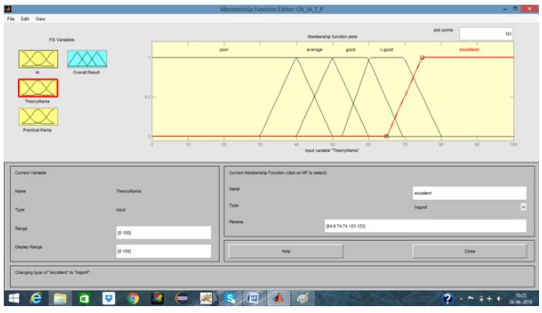

Fig.2.Membership function of input variable Theory Marks (TM)

Fuzzification of Input Variable Practical Marks

After the end of the term, final exam is conducted for all subjects. The crisp value of practical marks in Electronics.

TABLE IV. RANGE FOR LINGUISTIC VARIABLES OF THE PRACTICAL MARKS(PM) FOR FUZZY INPUT, PM.

Student's Performance in practicals	Poor	Average	Good	Very Good	Excellent
PM	<50	50-54.9	55-64.9	65-75	>75

Membership Function of the input variable Practical Marks (PM) is shown in Fig.3

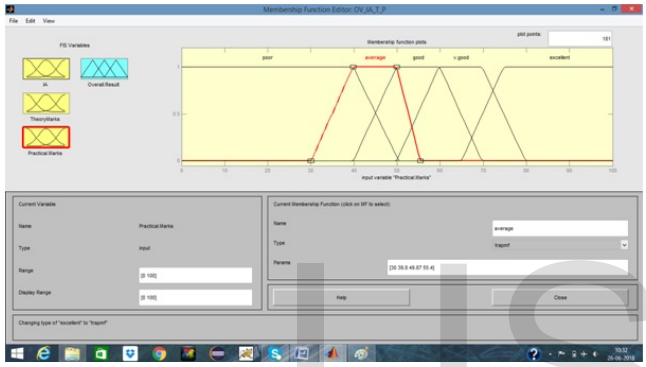

Fig.3.Membership function of input variable Practical Marks (PM)

Development of Fuzzy Rules and Inference Mechanism

To relate the inputs and output membership functions, fuzzy inference rules are used in inference process. These linguistics rules use "IF-THEN" statements. These rule are flexible and can be formulated depending upon the importance to be given to a particular input by the academic experts.

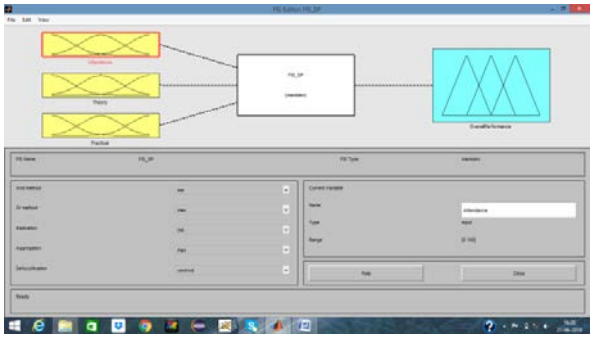

Fig.4 FIS System with input and output

Table V represents the rules for the three inputs and corresponding output

TABLE VI. STUDENTS' OVERALL PERFORMANCE IN TERMS OF LINGUISTIC VARIABLE

Student's Overall Performance	Poor	Average	Good	Very Good	Excellent
OVR	<50	50-54.9	55-64.9	65-75	>75

Membership Function of the output variable Overall Performance of a student (P) is shown in Fig. 5

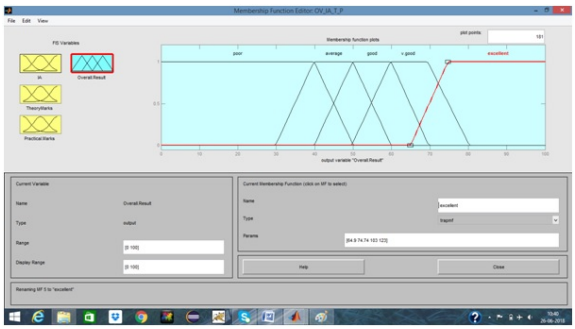

Fig.5.Membership function of students' overall performance

Inference Engine

Fuzzified inputs are then were match with the syntax and a set of fuzzy logic rules or actions are generated. Sampling of the rules is shown below:

Defuzzification

The overall performance of a student is determined by the Defuzzification method. Defuzzification is the conversion of fuzzy to crisp. Defuzzification is also known as "Rounding off" method. There are many Defuzzification methods.

Output

Output is the overall performance of the student. This is the defuzzified value and is the crisp value. In this FIS system there is one output membership function as overall performance. The overall performance is tried for three Defuzzification methods, COG, IOM bisector and MOM for comparison.

EXPERIMENTAL RESULTS

MATLAB is used to implement the proposed fuzzy inference system for students' performance evaluation in the subject of Electronics. The proposed FIS was experimented with 10 Students' internal assessment marks, theory marks and practical marks. The results from both the fuzzy expert system and the

conventional method of assessment is shown in Table VII The results are found to be similar.

TABLE VII. STUDENTS' OVERALL PERFORMANCE IN TERMS OF LINGUISTIC VARIABLE

Reg.No	IA	TA	PA	Overall Result			
				Conventional Method	Fuzzy Logic Method		
					COG	IOM-Bisector	MOM
001	45	65	70	60	60.3	60	62
002	68	75	80	74.33	71.4	72	74
003	79	68	47	64.66	63.8	64	62
004	54	81	55	63.33	57.5	58	62
005	94	87	96	92.33	85.8	86	94
006	60	53	75	62.66	56.5	59	57.5
007	95	96	94	95	88.1	90	94.5
008	52	95	86	74.33	72.7	72	71.5
009	96	45	92	77.66	72	72	71.5
010	91	94	50	78.33	69.4	71	71.5

Fuzzy Rules editor

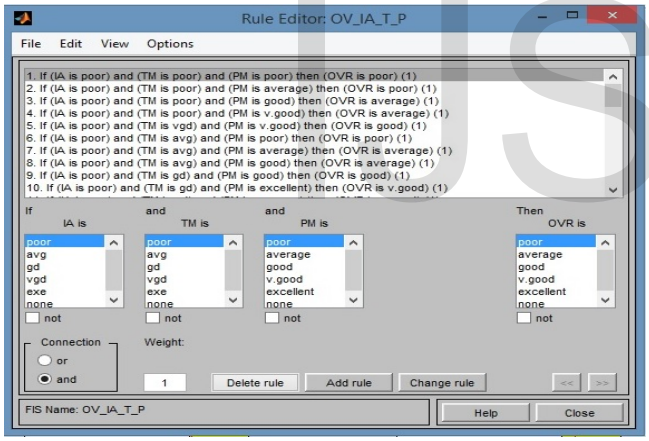

Fig.6 fuzzy rule editor of FIS System

Rule View of fuzzy expert system for performance of the student with Reg.No. 001

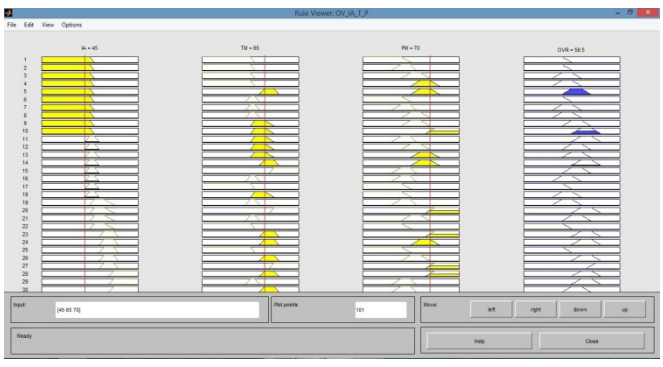

Fig.7 Rule View of fuzzy expert system

Surface View of fuzzy expert system for performance of the student with Reg.No. 001

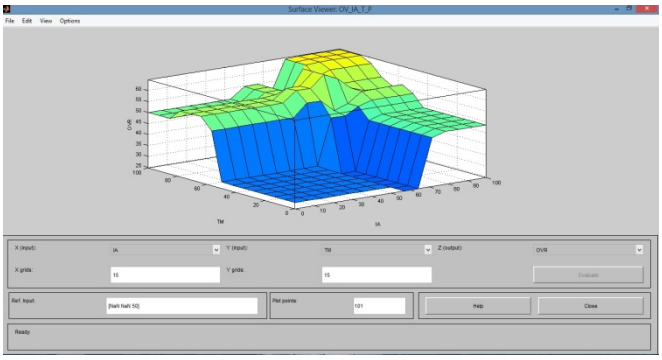

Fig.8 Surface View of fuzzy expert system.

Rule viewer of the proposed fuzzy expert system for the evaluation of overall students' performance is shown in Fig.7 and the corresponding surface view is shown in fig. 8.

CONCLUSION

The results show that the fuzzy expert system can provide the better analytical results than conventional method. Therefore Fuzzy System Approach can be used to evaluate the students performance in an effective manner. The overall performance is tried for three defuzzification methods, COG, IOM bisector and MOM for comparison. However, in some cases, the variations in results from fuzzy system have been observed for some students. It was due the difference in their IA and practical marks which are different from the theory marks. IA marks may include the activities and Practical marks depend on the nature of experimental tests. But no doubt from the experimental results that the fuzzy expert system is a better method than the conventional system and it is very much required for the present educational system.

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