Students Performance Evaluation: A fuzzy logic reasoning approach

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Abstract

This paper presents a new fuzzy logic reasoning based approach for performance evaluation of students in school or college. The attributes considered for evaluation cover academic as well as personality traits of the students. A Stage-wise fuzzy reasoning approach has been used to eliminate the issues of rule explosion. The comparison between fuzzy and traditional average technique shows the advantage of weightage allocation in fuzzy approach. The modeling and simulation was performed in Matlab-Simulink using fuzzy logic toolbox. The simulation results proved the validity of proposed technique.

Keywords: Fuzzy, FIS, MF's, Mamdani, Simulink, FLC

1.0 Introduction

Jamsandekar and Mudholkar (2013) performed the performance evaluation of students based on fuzzy inference technique. They proposed an approach which is a combination of two membership functions. The fuzzy approach was further compared with traditional methods for evaluating the variance. Yadav and Singh (2011) proposed a fuzzy expert system for evaluation of student academic performance. They also proposed several approaches using fuzzy logic techniques to provide practical method for evaluating students' performance and comparison with existing statistical methods. (Jyothi et al. 2014) proposed a fuzzy expert system for evaluating teachers overall performance based on fuzzy logic techniques. The authors presented an optimization evolution model for evaluating academic performance of the faculty's based on teaching activity series of qualitative reports.

Nunes and Neill (2011) described an experiment where team performance was evaluated using fuzzy logic reasoning approach. The results showed that intelligent fuzzy controllers were able to perceive and evaluate the Team's performance. Ingoley and Bakal (2012) proposed a fuzzy based system which considers vagueness of question paper besides accuracy rate, complexity and importance. The proposed technique provides more transparent and fairer results to all students. (Yadav et al. 2014) presented a New fuzzy expert system (NFES) for performance evaluation of students. The authors proposed several approaches using fuzzy logic techniques to provide a practical method for evaluating student academic performance and compared the results with existing statistical methods. Yildiz and Baba (2014) proposed a new approach based on fuzzy decision support systems for evaluation of students' performance. The model was based on fuzzy multi-criteria method for evaluating students' performance in laboratory activities. The results showed better performance of fuzzy systems over classical systems.

(Patil et al. 2012) presented a fuzzy based approach to evaluate performance of student using numeric grading without involving the human judgmental component. The results show the potential application of the fuzzy logic in the student performance evaluation. Arora and Saini (2013) presented a Neural network model for modeling of academic profile of students. The model predicts students' performance based on their qualitative observations. They used Probabilistic neural network (PNN) which was a feed-forward neural network. PNN needs less time to determine network architecture and train the network. Saleh and Kim (2009) proposed a methodology for evaluation of students answer scripts using fuzzy systems. The proposed system applies fuzzification, fuzzy inference and defuzzification while considering the difficulty, importance and complexity of question. (Wang et al. 2014) developed an adaptive item selection strategy mechanism to choose the student's current estimated ability. Their mechanism shows how student and teachers uses some useful information to assist in their future teaching and guidance.

In this paper a new methodological approach using fuzzy logic reasoning has been proposed for performance evaluation of students. This study considers academic as well as personality traits of students for better evaluation of their performances. The attributes considered for overall evaluation of students were academics, communication, behavior, attendance and extra-curriculum activities. The study illustrates an advantage of different weightage allocation to different attributes using fuzzy logic. In this study more weightage is given to academic performance as compared to other attributes. A Matlab-Simulink model has been built and the results were further compared to traditional average methods. The simulation results are shown with the help of figures and tables which validates the advantages of proposed technique over traditional average techniques.

2.0 Fuzzy logic reasoning approach

Fuzzy logic theory was introduced by L.A. Zadeh in 1965 (Zadeh, 1965). Fuzzy logic comes in when conventional logic fails. It is a computational paradigm which is based on human thinking. An important concept in fuzzy logic is the application of linguistic variables i.e. variables whose values are words or sentences in natural language (Zadeh, 1975). The fuzzy reasoning approach has found a wide application in designing of certain complex industrial and management systems which cannot be modeled precisely under various assumptions and approximations (Tzafestas et al. 1994).

One of the famous applicationx of fuzzy logic and fuzzy set theory is Fuzzy inference system (FIS) (Guillaume, 2001). FIS are knowledge-based or rule-based systems that contain descriptive if-then rules created from human knowledge and experience (Kharola and Gupta, 2014). A basic fuzzy architecture consists of three components fuzzifier, FIS and defuzzifier. Fuzzifier maps crisp numbers into fuzzy sets whereas the defuzzifier maps output sets into crisp numbers. The FIS represents the core of fuzzy logic controllers (FLC's). It is built of rule-base and data-base, which constitute the knowledge base and inference engine. A view of basic architecture of fuzzy system is shown in figure 1.0.

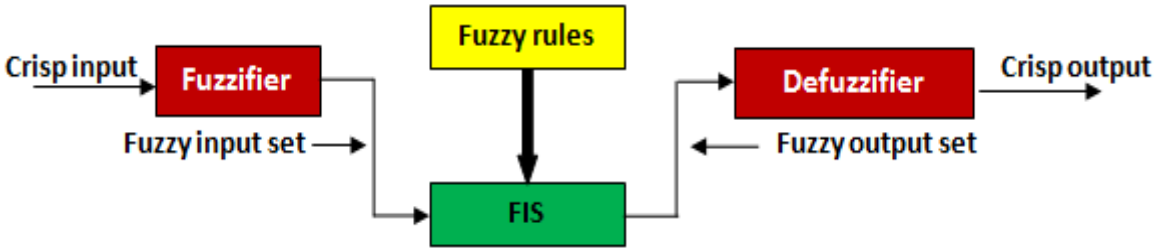

Table 1.0 Basic architecture of fuzzy system

3.0 Designing of Fuzzy logic controllers (FLC's)

In this study a stage-wise fuzzy logic reasoning approach (Shaout and Yousif, 2014) has been used for designing of Fuzzy inference system (FIS) for the controllers. The stage-wise approach allows for combination of attributes in several stages resulting in elimination of rule explosion problem. A view of stage-wise approach is shown in figure 1.1. It can be observed from the figure that in stage 1, academics and communication skills were combined to give knowledge analysis, behaviour and attendance were combined to give punctuality analysis. Similarly in stage 2, knowledge and punctuality were combined to performance analysis which was further combined in stage 3 with extra-curriculum activities to give overall rating of the student.

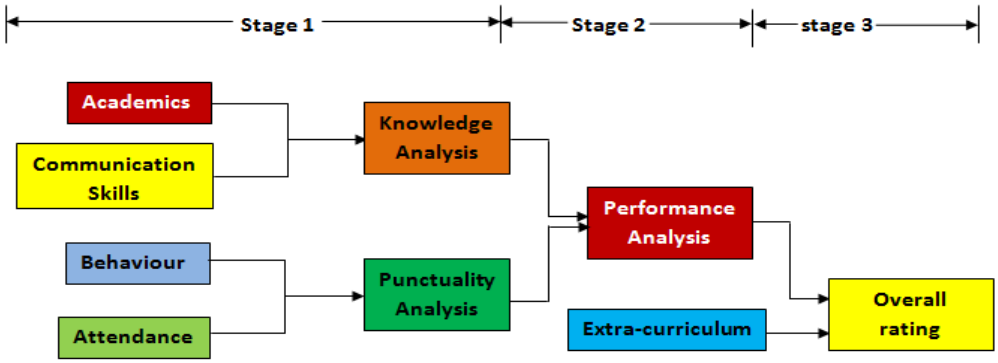

Figure 1.1 Stage-wise fuzzy logic reasoning

A Mamdani type FIS has been used for building the proposed model (Kaur and Kaur, 2012). A view of FIS for knowledge controller is shown in figure 1.2. In this study each of the input and output attribute is fuzzified with five linguistic variables (i.e. very poor, poor, average, good and very good) and given a universe of discourse (UOD) of [0 100]. The membership functions (MF's) considered for the analysis were of triangular shape (Nakamura and Kehtarnavaz, 1995). A view of input MF's for input attributes i.e. academic and communication skills are shown in figure 1.3 and figure 1.4 respectively.

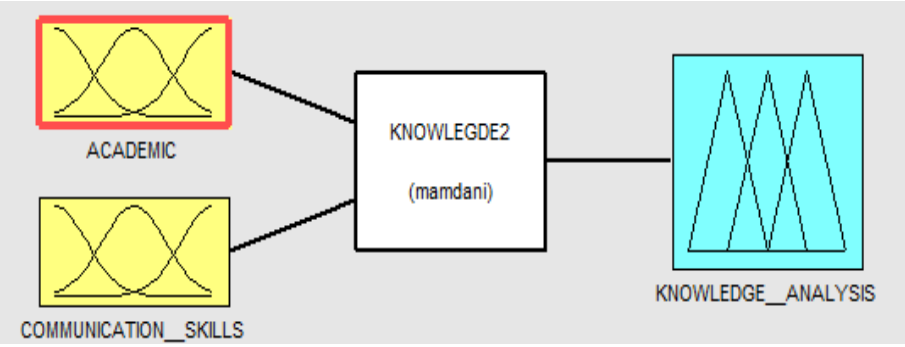

Figure 1.2 FIS for Knowledge controller

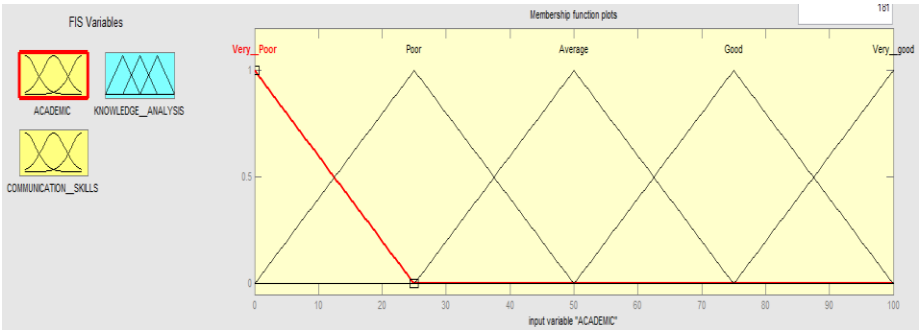

Figure 1.3 MF's for Input 'Academic'

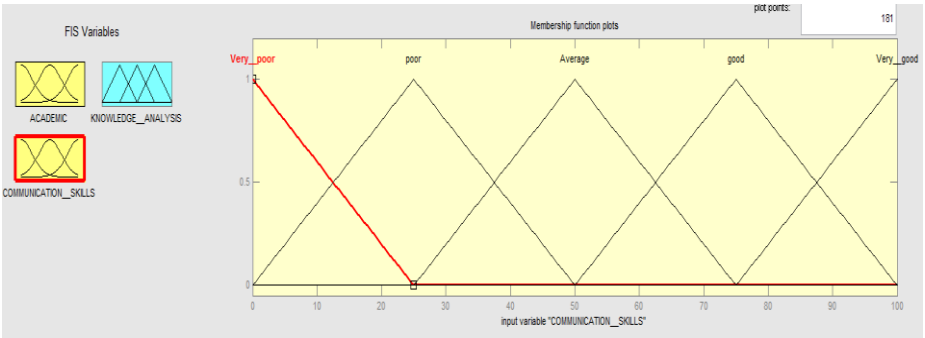

Figure 1.4 MF's for Input 'Communication Skills'

This study considers a total of 25 if-then fuzzy rules (Nakashima et al. 2007) for all the controllers. A view of if-then fuzzy rules for Knowledge and Punctuality analysis are shown in table 1.0 and table 1.1 respectively. The rules for other controllers were designed similarly. The fuzzy rules were built using knowledge and experience of experts, and vary from one expert to another. Fuzzy logic toolbox provides an advantage of representing the fuzzy rules in a 3-dimensional form with the help of surface viewer. A surface viewer for knowledge analysis is shown in figure 1.3.

Knowledge Analysis	Academics					
Communication Skills		**Very poor**	**Poor**	**Average**	**Good**	**Very good**
	Very poor	Very poor	Poor	Poor	Average	Average
	Poor	Very poor	Poor	Poor	Average	Good
	Average	Very poor	Poor	Average	Good	Good
	Good	Very poor	Poor	Average	Good	Very good
	Very good	Very poor	Poor	good	Very good	Very good

Table 1.0 If-then fuzzy rules for Knowledge analysis

Punctuality Analysis	Behavior					
Attendance		**Very poor**	**Poor**	**Average**	**Good**	**Very good**
	Very poor	Very poor	Very poor	Poor	Poor	Average
	Poor	Very poor	Poor	Average	Average	Average
	Average	Poor	Poor	Average	Good	Good
	Good	Poor	Average	Good	Good	Very good
	Very good	Poor	Average	Good	Very good	Very good

Table 1.1 If-then fuzzy rules for Punctuality analysis

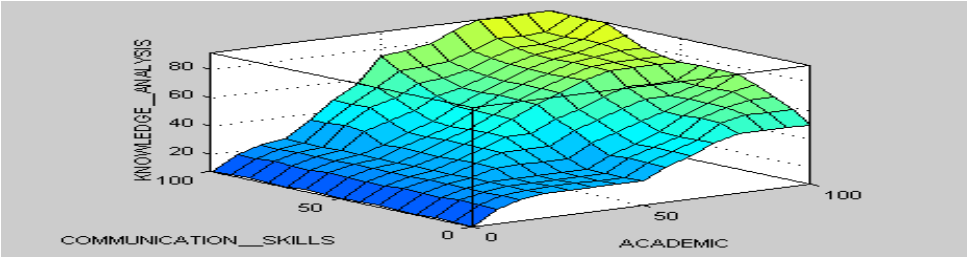

Figure 1.5 Surface viewer for knowledge analysis

4.0 Results and Comparison

The simulation results and comparison of fuzzy and traditional average method are shown from table 1.3 to table 1.7. A total of 5 experiments were conducted using different values of attributes. The results clearly show the advantage of weightage allocation of fuzzy logic controllers. It is also observed that the results of fuzzy approach were close to the results obtained by the average method for almost all the experiments. The alphabetic symbols considered for each attribute is mentioned in table 1.2. The rating of each attribute was done out of 100.

S.No	Attribute	Symbol
1	Academics	A
2	Communication	C
3	Behaviour	B
4	Attendance	T
5	Extra-curriculum	E

Table 1.2Symbols considered for each attribute

Experiment No. 1

A	C	B	T	E	Fuzzy rating	Average rating
30	90	90	90	90	69.06	78

Table 1.3 Results comparison

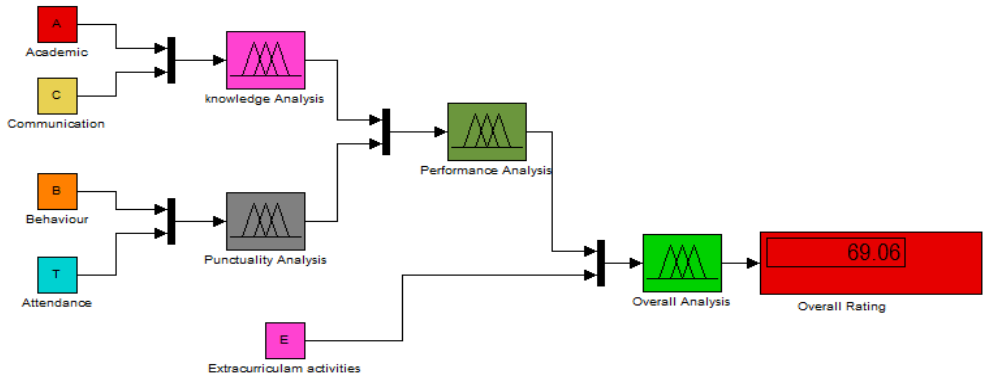

Figure 1.6 Simulation of FLC's

The simulation result clearly shows the advantage of fuzzy controller over traditional average approach i.e. If a student scores less marks in academics i.e. 30 still his overall rating is higher using average method i.e. 78 but using fuzzy approach the overall rating is reduced to 69.06.

Experiment No. 2

A	C	B	T	E	Fuzzy rating	Average rating
80	80	80	80	30	56.03	70

Table 1.4 Results comparison

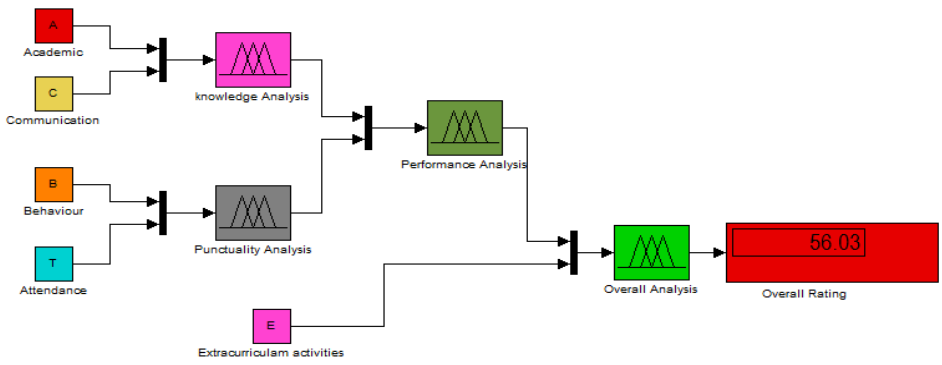

Figure 1.7 Simulation of FLC's

Experiment No. 3

A	C	B	T	E	Fuzzy rating	Average rating
35	40	35	40	30	36.2	36

Table 1.5 Results comparison

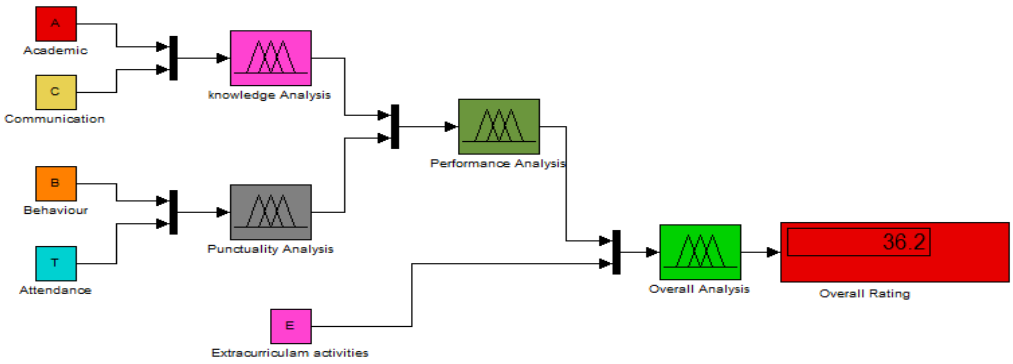

Figure 1.8 Simulation of FLC's

Experiment No. 4

A	C	B	T	E	Fuzzy rating	Average rating
88	92	25	75	70	68.89	70

Table 1.6 Results comparison

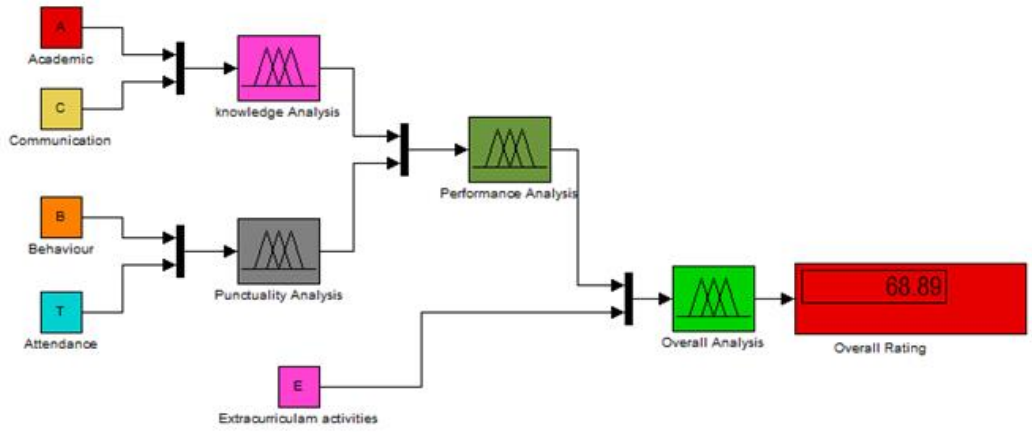

Figure 1.9 Simulation of FLC's

Experiment No. 5

A	C	B	T	E	Fuzzy rating	Average rating
60	55	65	60	60	61.20	60

Table 1.7 Results comparison

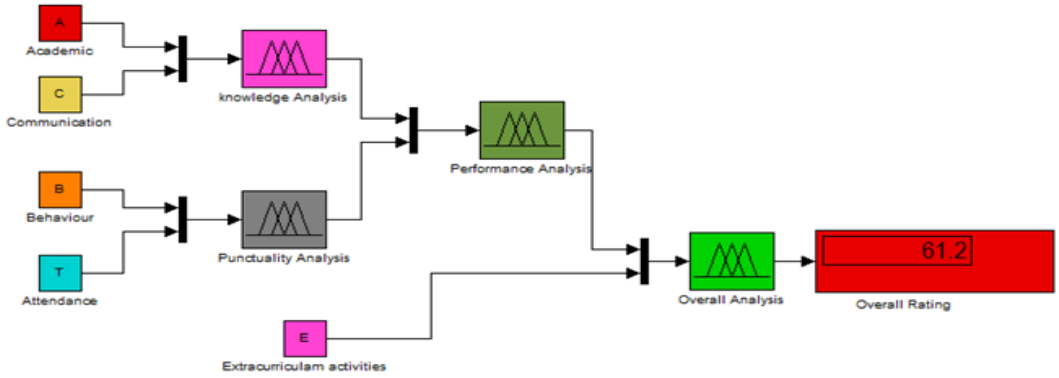

Figure 2.0 Simulation of FLC's

5.0 Conclusion

The research objective of obtaining a fuzzy logic reasoning based Matlab-Simulink model for performance evaluation of students has been achieved. The results show the superiority of proposed technique over traditional average methodology. The fuzzy reasoning approach provides an additional advantage of allocating different weightage to each attribute according to needs and requirements of the organization. In this study academic performance is given more importance as compared to other attributes for students. Therefore, for a very low academic marks (refer table 1.3) the overall rating using average approach is 78 which is very large as compared to fuzzy approach i.e. 69.06 (refer figure 1.6). It also observed that the results of fuzzy approach are close to the results evaluated by the average method for almost all the experiments.

Thus fuzzy model closely mimics the behaviour of traditional average method used for student performance evaluation. Further refinement of fuzzy rules can be done to optimize the results of fuzzy controllers. The proposed model can be further modified and used for performance evaluation of employees, faculty etc. Some other optimization techniques like Neural networks (NN's), Adaptive neuro fuzzy inference systems (ANFIS), Genetic algorithms (GA) etc. can also be employed for building effective performance evaluation models.

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