

In Pursuing Better Academic Result In University: A Case of Fuzzy Logic Analysis

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Abstract—A fuzzy logic approach is applied in this proposed system as a method to predict the performance student in pursuing better academic results in university. Fuzzy logic is used because the technique is suitable for statistical database as well as suitable to obtain general classification between excellence and moderate students. The main issue in this project is the difficulties to predict the student's performance and to sustain their result. The fuzzy logic approach is suitable for data classification and the performance will be analyzed by using Matlab simulink. Besides that, several difference methods of membership were also been investigated in order to design and propose the most stable and reliable system. Based on the results obtained from simulation, it has provided meaningful characteristics that are significant and able to advice student getting better grades in academics program (BEE & BEP). Moreover, the system will provide better study to student whose do not understand the university system during their early years in university.

Keywords—fuzzy logic; performance; classification; grades; university.

I. INTRODUCTION

Fuzzy logic is a theory concepts that offer a basis for thinking about vague concepts using a tool to model the knowledge, and also approach for kind of problem consider [13, 2]. There are many positive feedbacks about fuzzy from research paper that I found. They choose fuzzy logic because characteristic of fuzzy logic can be modeled as human thinking system and it can be better from traditional method [3]. Also, it can transform the experiences of man to mathematical expressions is a quite better manner [3].

Fuzzy logic is used because the technique is suitable for statistical database as well as suitable to obtain general classification between excellence and moderate students. Fuzzy logic is problem-solving control system methodology that leads itself to implementation in systems ranging [5]. The concept of fuzzy logic was conceived by Lotfi Zadeh, a professor at the University of California at Berkley, and presented not as a control methodology, but as a way of processing data by allowing partial set membership rather than crisp set membership or non-membership [5].

Nowadays, many students are busy for competing to get excellent academic result due to the competitive courses and facilities. Besides, it is undeniable that student performance can affect the university rank as well as for accreditation

references. Unfortunately sometimes student did not find the proper and suitable way on how to make sure their performance can be maintain for every semesters. Normally the performance can be analyzed by measuring student cumulative grade point average (CGPA) upon their graduation. When the performance is good, then the same is expected on their overall courses. Eventually, we can use the first semester result student as a variable for the next semester references.

The academic performance is one of the factors to be referred when they thinking about job recruitment. The first thing will be judged from their resume is their academic results. After that companies will shortlist the nominees by evaluating their experience and other skills. If their CGPA is not competitive, then the possibility of recruitment can be decreased. To overcome this problem, student must be alert about their study plan and struggle for better results. To make sure the student always consider this, we propose the fuzzy logic based inference system. From here, they can always be aware about their result and also plan wisely for their future courses.

This project uses the fuzzy logic approach as a method to predict the performance student in pursuing better academic result in university. Fuzzy systems are built to replace the human expert with a machine using the logic as human would use to perform the task [1].

The main issue in this project is the difficulties to predict the student's performance and to sustain their result especially from the day they entering university until graduated. The academic performance of students is very important which demonstrates what they have achieved in university especially when it comes to apply a job in any company. If the student has scored from the first semester, and they continue to maintain their performance especially considering the core courses in Electrical and Electronics Engineering, then it is expected that they will get an excellent result at every semester until the final year. But if the student just takes easy with their study during the first semester, then their grades performance will not be satisfied and expected. Another issue that comes up is the difficulties of subjects because not all students can carry a high level subject. Thus, it makes them hard to understand and carry on with the subject. The fuzzy logic approach is suitable for the classification data and the performance will be analyzed by using the Matlab simulink.

II. METHODOLOGY

In Mamdani-Style Inference, there are four step of process which is fuzzification, rule evaluation, rule aggregation and defuzzification. Fuzzification is to finds crisp from membership. Fuzzification process is based on producing fuzzy information provided and each concept analyzed into trapezoidal membership functions of fixed or variable widths. If it is assumed that the input data do not contain noise of vagueness, a fuzzy singleton can use. In this stage, first step is taking the inputs and determines the degree to which they belong to each of fuzzy sets via membership function. In this project, the interval for core subject is between 44 and 100 and rate for the output performance is between 0 and 4.0. This setting is fixed for this project.

Then it will continue with the next step which is rule evaluation. There are 4 input variables(courses offered) being identified such as Circuit Analysis, Digital Electronic, Computer Programming and Electromagnetic Field Theory in this fuzzy logic system. The rules are constructed by referring to the sample and the system. The total rules defined for this system is about 6561 rules. In rule evaluation, multiple antecedents was use, so fuzzy operator (AND or OR) are using to obtain a single number to represents the result of the antecedent evaluation. Now the result of the antecedent evaluation can be applied to the membership function of the consequent (THEN). Then process of unification of output of all rules is said as aggregation.

The last step in this process is defuzzification. This stage evaluates the rules but the final output of fuzzy system will be presented in crisp number. The implication result obtained for each rule should be aggregated and defuzzified to obtain a single crisp values. This implies the defuzzification strategy to convert output fuzzy variable into corresponding crisp value. The most popular method in this stage is known as the *centre of gravity* (COG).

As the system has been designed, now the first and second year student can predict their result especially for the final year, or in other words their CGPA upon graduation. Based on the four core subjects selected, student can infer how their performance in the future will be look like. Thus, an immediate action can be taken if they found that their performance is not up to what they have planned. Meanwhile, for the excellent students, they must keep up their efforts in maintaining their excellent result. Else, they could not sustain a good performance in later semester. Configured by this flow of processes, interestingly to found that this system is actually giving a motivation for the students especially for those who are in condition KG (Fails) and P1 (Need Attention) to double up their efforts in getting good results.

Without implementing this system in education, students can hardly predict their results in the next semester or overall performance from the semester taken. Thus, students will only studies to finish up their course without knowing that they can also get better results when they planned promptly and wisely in getting a good grade for the next semester.

Moreover, some of them could probably take actions such as repairing their courses that has lower grade. So, if they are in KG (Kedudukan Gagal-Fails) or P1 (Pemulihan-Need Attention) conditions, they might improve their grade to better position; KB (Kedudukan Baik-Satisfactory).

III. RESULT AND ANALYSIS

This proposed system comes with 6561 rules when four inputs and one output are considered. The system is build and compared with three different memberships which are Trapezoid, Triangular and Gaussian memberships. For each membership type, the results come out differently. However, there is time that they presented almost the same performance or prediction. As mentioned previously, the system uses four core subjects which are Circuit Analysis (CA), Digital Electronic (DE), Computer Programming (CP) and Electromagnetic Field Theory (EMT). This four core subjects act as inputs for the system and the output is performance student which Cumulative Grade Point Average (CGPA). For the membership function, there are nine fuzzy set in membership function which are designed by referring to the grade of the subject.

Table 1: The Grade on Courses

No	Input	Lingustic	Range
1	Circuit Analysis (CA)	D+	44-46
		C-	47-49
		C	50-54
		C+	55-59
		B-	69-64
		B	65-69
		B+	70-74
		A-	75-79
		A	80-100
2	Digital Electronic (DE)	D+	44-46
		C-	47-49
		C	50-54
		C+	55-59
		B-	69-64
		B	65-69
		B+	70-74
		A-	75-79
		A	80-100
3	Computer Programming (CP)	D+	44-46
		C-	47-49
		C	50-54
		C+	55-59
		B-	69-64
		B	65-69
		B+	70-74
		A-	75-79
		A	80-100

4	Electromagnetic Field Theory (EMT)	D+	44-46
		C-	47-49
		C	50-54
		C+	55-59
		B-	69-64
		B	65-69
		B+	70-74
		A-	75-79
A	80-100		

Table 2: CGPA

No	Output	Linguistic	Range
1	Cumulative Grade Point Average (CGPA)	KG	0.00-1.66
		PI	1.67-1.99
		KB	2.00-3.66
		KC	3.67-4.00

A. Trapezoid membership method case

For the output from Trapezoid methods, we can see that the result output of CGPA is near with the actual sample CGPA student. The range of membership is importance to get the actual result. It must tune and sees what the output that nears with the actual result. In fuzzy system, CGPA cannot get same with real result or maybe it just near only. It is because, for the input, we put minimum mark. So it can affect the output.

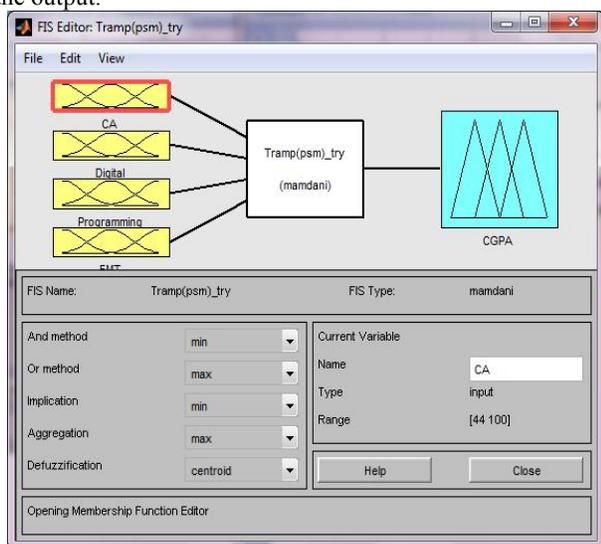


Figure 1: Fuzzy Inferences System with 4 inputs and 1 output

Figure 1 above describes that selection of four core subjects as inputs and CGPA as the output in pursuing better academic result. This system applies FIS to evaluate the performance of students. From figure, it shows that the system use Mamdani method with 6561 rules.

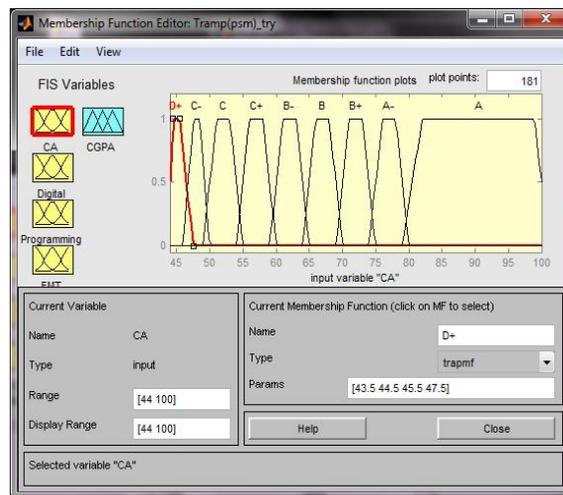


Figure2: Fuzzy Membership Function for the Input

Figure 2 shows the fuzzy membership function for the input variable – core subject. This figure describes the type of membership that is chosen for this system which is Trapezoid. As illustrated on the figure, the range of membership in Trapezoid type is including nine linguistic variables. This membership function range is selected from 44 until 100. The selection is based on the grade classification presented in Table 1.

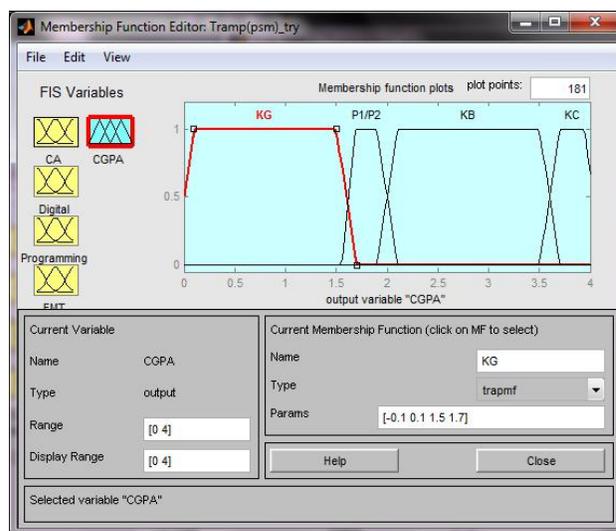


Figure 3: Fuzzy Membership Function for the Output

Figure 3 depicts the fuzzification stage for the output parameter performance with three membership function the range that designed to be in between 0 and 4 since there are four linguistic variables which refer to KC (Excellent), KB (Satisfactory), P1(Need Attention) and KG (Fails). The design is also based on the grade ranges defined by university.

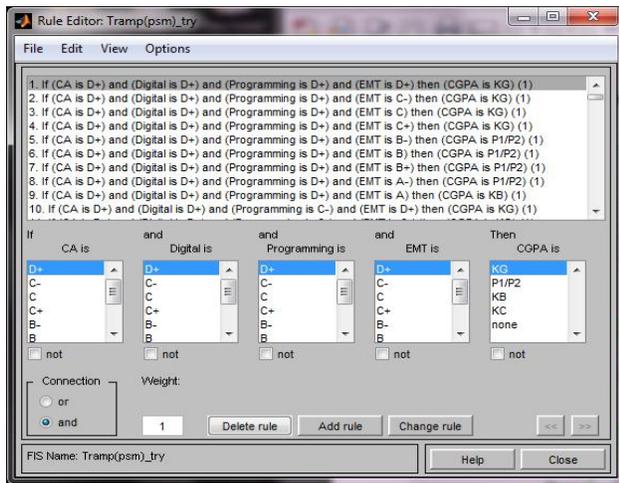


Figure 4: Rule Editor

In FIS illustrated in figure 4, Rule editor is used to set rule based on the 4 inputs and one output. Rules have been calculated taking into account the number of student samples. This is also then compared to actual student results prior on designing the rules.

With references to the input values and using the above model, the inputs are fuzzified. Then by using simple if-else rules and other simple fuzzy set operation, the output of the FIS is obtained. In FIS, the output is calculated automatically by analyzing the four core subject.

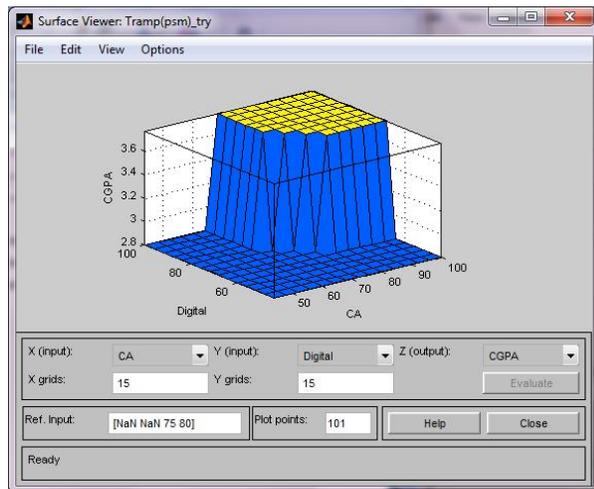


Figure 5: Surface viewer for two core subject

FIS surface viewer is used to plot those two inputs and the output. This figure directly exposes the relationships between each input and the output. If one would like to analyze the other two inputs, then it can be done by simply defining the inputs as the axis in FIS.

Finally, if above settings have been conducted, then the results can be analyzed and viewed. Table 3 to Table 5 demonstrates the result between actual conditions and results with fuzzy inference method. As explained by these tables,

the results are convincing and approximate the real situations. Most of the results being proposed by the system have lower CPA performance than the actual results. The system is designed in such a way that the student could predict the minimum achievement if these four courses are considered as their main references. It is worth to mention that, this consideration was also made due to there are only four courses being analyzed. There are also other courses that student must registered, and if these courses are registered, then the results could possibly change to be lower than actual. Therefore, the system attempts to provide the best minimum CPA that students can achieved in their study.

Student	CA	DE	CP	EMT	Actual result	Fuzzy result	
A	A	A	A-	A	3.78	KC	3.77
B	A-	A	A	C+	3.30	KB	2.85
C	A-	B+	B	B	3.44	KB	2.88
D	C-	C	B-	D+	2.20	KB	1.81

Table 3: Result analysis fuzzy logic in Trapezoid membership method

B. Triangular membership method

Student	CA	DE	CP	EMT	Actual result	Fuzzy result	
A	A	A	A-	A	3.78	KC	3.77
B	A-	A	A	C+	3.30	KB	2.85
C	A-	B+	B	B	3.44	KB	2.88
D	C-	C	B-	D+	2.20	KB	1.81

Table 4: Result analysis fuzzy logic in triangular membership method

C. Gaussian membership method

Student	CA	DE	CP	EMT	Actual result	Fuzzy result	
A	A	A	A-	A	3.78	KC	3.46
B	A-	A	A	C+	3.30	KB	3.46
C	A-	B+	B	B	3.44	KB	3.46
D	C-	C	B-	D+	2.20	KB	1.68

Table 5: Result analysis fuzzy logic in Gaussian membership method

D. Comparison between Memberships

From the table 3, 4 and 5, the results have shown different characteristics from different membership types. For the table 3 and 4, which illustrating inference from trapezoid and triangular; their fuzzy result is slightly similar. This is due to the tuning and similar membership. For this project, the best membership function is found to be the trapezoid membership. From a number of simulation analysis being carried in this research, it is found that trapezoid membership can adjusted to straight line. Nevertheless, other memberships could also be the best solution which is depend on the how the system tunes the membership function for the system and how the rules are constructed. Reason for the fuzzy result is not accurate or shows similar outcomes with sample is for this system it to predict the performance student by using minimum mark grade for the subject.

Beside the Trapezoid, Triangular membership also can use in this system. Each membership function can design whatever want but the difficulty is to tune membership function to get the accurate result. Some characteristic choose triangular as method is triangular membership function is ease to implement.

The relationship between the inputs and the outputs of the performance students is obtained by using rules having the form IF conditions THEN conclusion. The fuzzy logic toolbox of MATLAB is enables to create and to edit fuzzy inference systems.

The advantages of fuzzy logic expert systems compared to non-fuzzy expert systems are that they typically require fewer rules, need fewer variables, use a linguistic rather than a numerical description, and can relate output to input for any device without needing to understand the device's inner workings.

IV. DISCUSSION

After all the results have been analyzed, it proved that the accuracy of the system can be improved by adding the number of rules and consider more variables. The aim and objective of this project now are achieved where the best result is obtained after considering several factors in order to find the best way to predict result in university. For this system by using fuzzy logic tool, it can become easy system because it deal with linguistic and perceptions same with human language. Fuzzy logic also to the way our brains work. The aggregate data and number of partial truths which aggregate further into higher truths which in turn, when certain thresholds are exceeded, cause certain further results such as CGPA. The process also is used in artificial computer neural network and expert systems.

From the result of the simulation, it can be observed and concluded that Fuzzy Logic Toolbox as one of the MATLAB tools is very reliable software for predicts result in university and simulation that can provide and be helpful in term of research and development. The combination of the system with simulink makes the system able to simulate using many variables. Although that maybe some other existing software is available, MATLAB Fuzzy Logic Inference system is one of the competitive challenger that can give choice to the users. When the result comes to cost effective, this system is really recommended.

V. CONCLUSION

Actually, using Fuzzy Logic approach in education is generally something new in field education. But fuzzy logic now has reached wide range [8].

Student performance is importance to see the rank of university and performance of students. Once student graduated or finished their study, the main things that any company want to see is the academic transcript as it fully explained the performance and the abilities of the every student.

Student will improve their effort in study when seeing their performance analysis. It would lead to students being afraid to fail because the impression that failed subjects would drag the CGPA even further down. These systems also give motivation to student to get the excellent result. To those care about transcript it can give positive impact to their transcript average result.

This system is no actually for education in UMP, other university also can apply this system when grade for the core subject is same or way to classification is same. In industrial also can apply this system for classification performance worker in company.

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