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Brilliant but Needy Students Selection Using Fuzzy Logic

Paul Aazagreyir[1], John Bosco K Damnyag[2] and Marcellinus Kuuboore[3]

[1, 2, 3] University of Professional Studies, Accra, University of Ghana

[1]zayir18@gmail.com, 2john.damnyang@upsamail.edu.gh, 3marcellinuskuuboore@gmail.com

ABSTRACT

It is famous that, one of the ways to break even the inequality between richer students and Brilliant but Needy Students(BbNSs) is via scholarships. However, the selection process of brilliant but needy students is often entangle with uncertainty, lack of transparency and unfairness from the experts and the vagueness of the experts' language used linguistically. The fuzziness inherent in human reasoning couple with the biases of human by nature preclude some highly qualified brilliant but needy students from getting selected for scholarships. This study deploys Fuzzy Logic Approach(FLA) to develop an evaluation model for selecting brilliant but needy students for scholarships. The paper uses the Mamdani Inference algorithm with four input variables that constituted the input membership function and the output membership function is made of one output variable. The research concludes that; FLA objectively select the truly qualified brilliant but needy students for scholarships based on degree of membership.

Keywords: *Brilliant but Needy, Fuzzy Logic, Selection, Students.*

1. INTRODUCTION

The selection of Brilliant but Needy Students(BbNSs) is an imperative process for smarter and harder working poorer students and everyone who has a stake on the subject matter. If the selection process is just and fair, BbNSs will have the chance to rob shoulders academically with smarter and harder working richer students in Universities. For example, Jaston, (2017) explores the cost of university education in Ghana: A privilege or right?. Onuko et al., (2012) study the impact of bursary schemes on retention of students in public secondary schools in Gem district, Kenya. Su, (2003) present student evaluation through membership functions in CAT systems. Su's study was to manage students' performance in a variation of a computerized adaptive testing administration process. Furthermore, a hybrid MCDM approach to assess the sustainability of students' preferences for university selection by (Kabak, 2014), found that, Some students, particularly those from low family income, are choosing to live at home during their university education and also poor students tend to attend universities with low tuition fees. Agbedor, (2013) conducted a study on some approaches to modelling need-based financial aid to needy students in the University of Ghana. Tanko and Muazu (2017) also researched on the economics of tertiary education: a decade of experimenting with tertiary reforms and cost sharing therapies in Ghana.

Uncertainty and vagueness of language linguistically assumed by an expert should be objectively deal with (Garcia-jimenez et al., 2016).Several studies have been conducted using Fuzzy Logic(FL). Afful-dadzie, Nabareseh, & Komínková, (2016) researched on model for assessing quality of online health information: a fuzzy vikor based method. Ibn, Panford, Hayfron-, & Base, (2014) studied fuzzy logic approach to credit scoring for micro finances in Ghana. Also, Stephen & Anthony, (2014) conducted a study on fuzzy TOPSIS framework for selecting fragile states for support facility. Grace, Williams, & Engineering, (2016) studied comparative analysis of neural network and fuzzy logic techniques in credit risk evaluation. Recently Zhang, Pérez-Fernández, & De Baets, (2019) research on fuzzy betweenness relations and their connection with fuzzy order relations. Yang & Hu, (2019) also examined fuzzy neighbourhood operators and derived fuzzy coverings.

In this paper we propose a FL model for selecting Brilliant but Needy Students. We include School Type, Grade, Financial Status and Interview Marks as the input variables for the input membership function. Selection Decision the only output variable formed the output membership function. According to Ruspini, Bonissone, & Pedrycz, (1998) fuzzy logic is viewed as a system of concepts, principles, and methods for dealing with modes of reasoning that are approximate based on natural connection using linguistic terms, between degrees of membership in fuzzy sets and degrees of truth of associated fuzzy propositions rather than exact. Fuzzy logic is determined as a set of mathematical principles for

knowledge representation based on degrees of membership rather than on crisp member-ship of classical binary logic (Borhanazad, n.d.).This allows us to reduce the uncertainties, unclearness, vagueness and imprecision inherent in Brilliant but Needy Students Selection. This study shows that; fuzzy logic is appropriate for objectively modelling Brilliant but Needy Students selection

2. MATERIAL AND METHODS

2.1 Research Process

Four input variables were identified to help in the selection process.The input variables are: School Type, Grade, Financial Status and Interview Marks. These variables formed the input membership function for the fuzzy logic model.

School Type: The rank of the school the student completed. The school rank or type is denoted with linguitics terms such as weak,fair and strong schools.All members(Schools) within the membership function in Figure 1 and Table 1 are all capable of being selected.However, schools who degree of membership to the membersip function is zero or approaching zero are the most preferred.The aim is to give a level ground for both harder working poorer students and harder working richer students' selections.

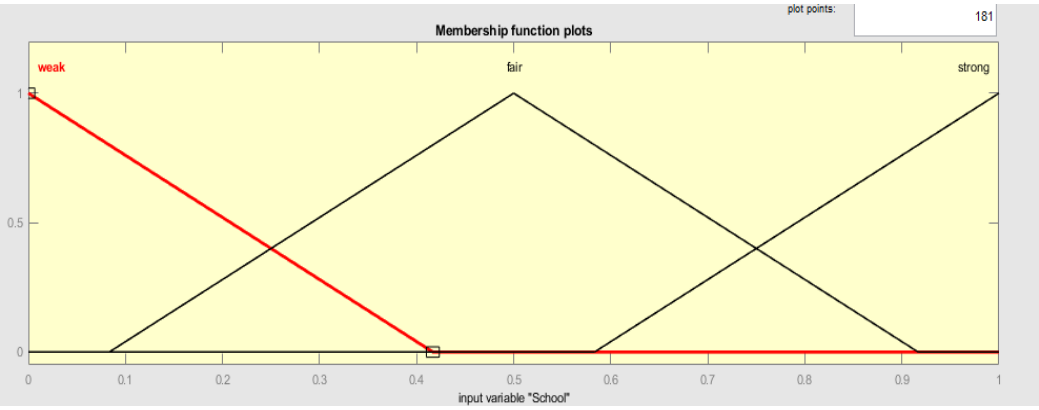

Figure. 1. Input Membership (School)

Academic Grade: The academic grades obtained by the students from his/her school.The simulation output in Figure.2 and Table 1, the researchers used examination aggregate of students for the simulation.It means that, any student who obtains an examination aggregate of between aggregate 0 – 18 is a potential student/likely member of the membersip function for selection.However, students who examination aggregate is approaching zero are preferred.The aim is selection academically strong students.

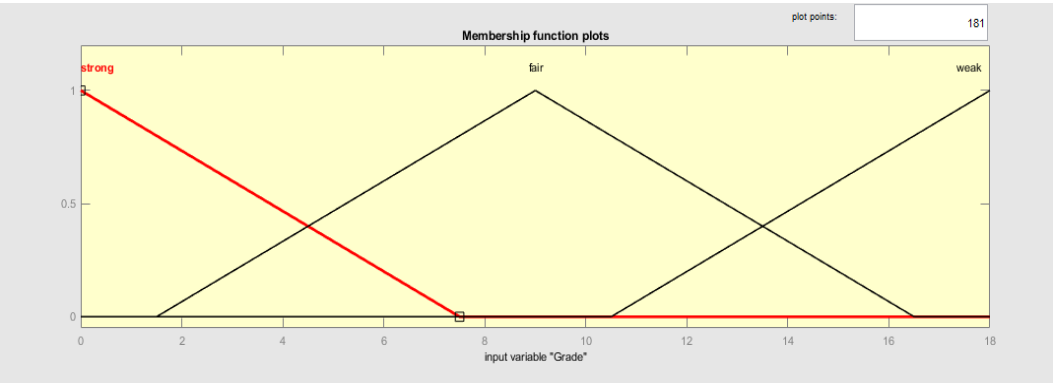

Fig. 2. Input Membership (Academic Grade)

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Financial Status: In this research,the degree of poorness of the student is determined by the financial status of the student parents or caretaker.According to Touray, (2016) an individual is considered poor if the person's income cannot acquire him/her basic material needs; meaning the person spend less than five($5) in a day. This study considered this definition particularly the $5 spending per day. Hence anybody who spends an amount in Ghana cedi between Gh₵0 - Gh₵25 per day is considered poor in this study. Students who spending is zero or is approaching zero are most considered as needy students. This is depicted in Table 1 and Figure 3.

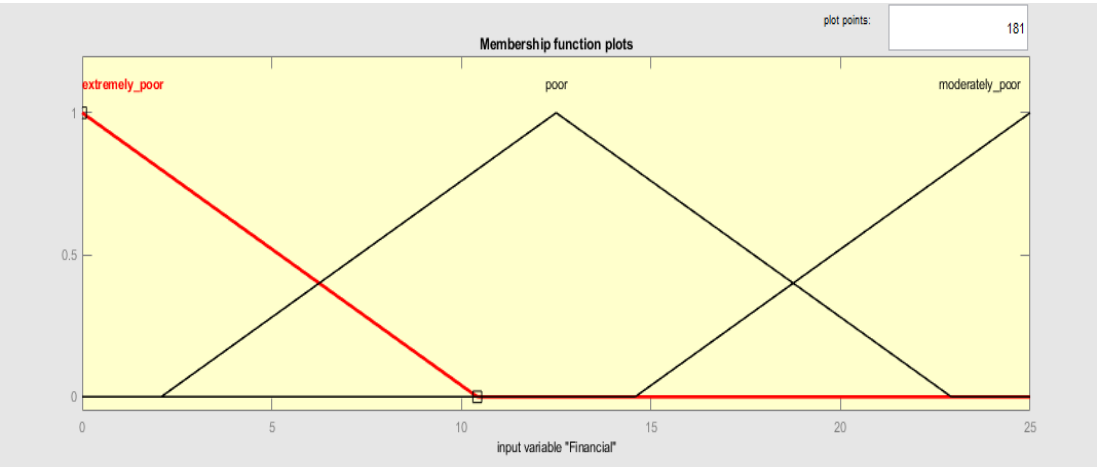

Fig. 3. Input Membership (Financial Status)

Interview Marks: The interview marks the student scored on a 0 – 1 scale. The interview mark is denoted with linguitics terms such as weak,fair and strong schools.All interview marks within the membership function in Figure 4 and Table 1 are all capable of being selected. However, Interview marks that degree of membership to the membersip function is zero or approaching zero are the most preferred.The aim is to give a level ground for both harder working poorer students and harder working richer students for the selections.

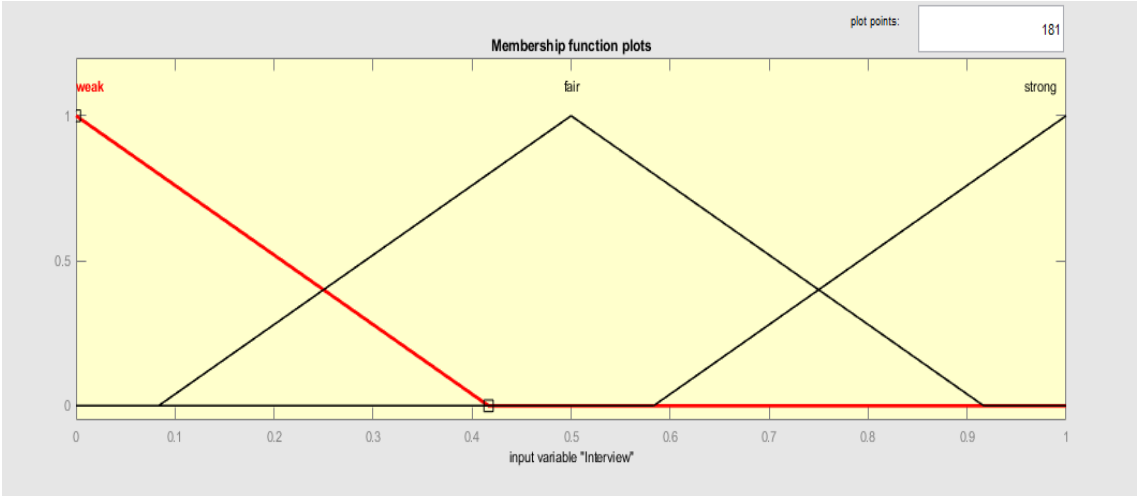

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Fig. 4. Input Membership (Interview Marks)

Table 1: Input Membership Functions

		School Types	
Range of Values based on school	Fuzzy Values (0 1)	Converted range of values (%)	Linguistic Term
0 - 0.3	**0-0.3**	**0-30**	**Weak**
0.4 – 0.69	**0.4 -0.69**	**40-69**	**Fair**
0.7 – 1.0	**0.7-1.0**	**70 -100**	**Strong**
	Grade		
Examination Aggregate/Final Grade Point Average	Fuzzy Values (0 1)	Converted range of values (%)	Linguistic Term
14 -18 /0-2.50	**0.77 – 1**	**77 – 100**	**Weak**
7-13/3.00-3.59	**0.38-0.72**	**38 – 72**	**Fair**
0-6/3.60-4.0	**0 – 0.33**	**0 - 33**	**Strong**
	Financial Status		
Range of Values in (GhȻ) per day	Fuzzy Values (0 1)	Converted range of values (%)	Linguistic Term
0 -9.5	**0 -0.38**	**0 – 38**	**Extremely Poor**
10-15	**0.4 – 0.6**	**40 – 60**	**Poor**
16 – 25	**0.64 – 1**	**64 – 100**	**Moderately Poor**
	Interview Marks		
Range of Interview Marks	Fuzzy Values (0 1)	Converted range of values (%)	Linguistic Term
0 - 0.3	**0-0.3**	**0-30**	**Weak**
0.4 – 0.69	**0.4-0.69**	**40 -69**	**Fair**
0.7 – 1.0	**0.7- 1.0**	**70- 100**	**Strong**

Table 2: Ouput Membership Function Selection

Output Variable	Range of Values	Linguistic Term
Selection Decision	**0-40**	**Excellent**
	41- 69	**Fair**
	70 -100	**Bad**

Selection: Is the output variable as depicted in Table 2 and Figure 4 and 5. The aim is to select students who degree of belonginess to the membership function is gravitating toward zero.

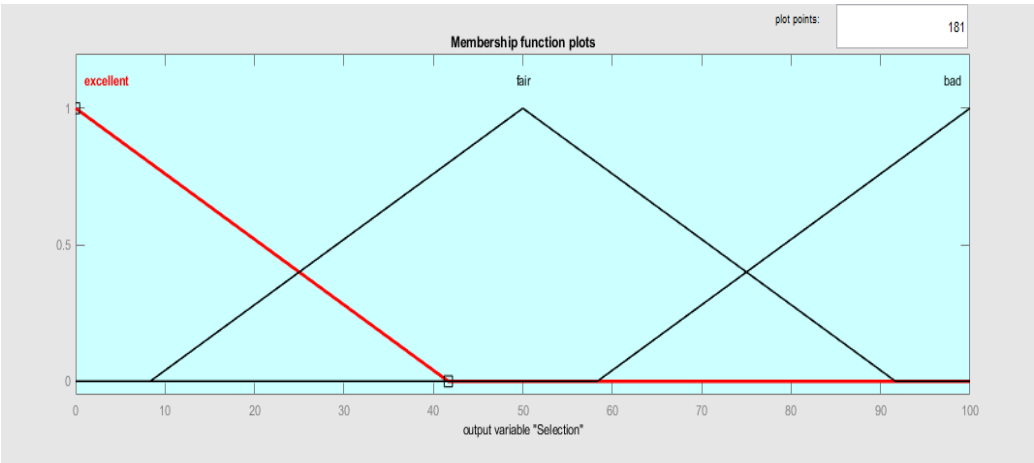

Fig. 4. Output Membership Function(Selection)

2.2 Software Tool

Matlab R2019a which stands for Matrix Laboratory Released 2019 version A is an authoritative programming language for technical computing. According to Sivanandam, Sumathi, & Deepa, (2007) Matlab is both an environment and programming language, and the major advantage of the Matlab language is that it allows building our own reusable tools. It is deployed in modeling fuzzy systems and others. It was used to simulate the model. The various input membership function (School Types,Grade , Financial Status and Interview Marks) and the output function (Selection Decision) were captured. The various rules were also captured in the system too.

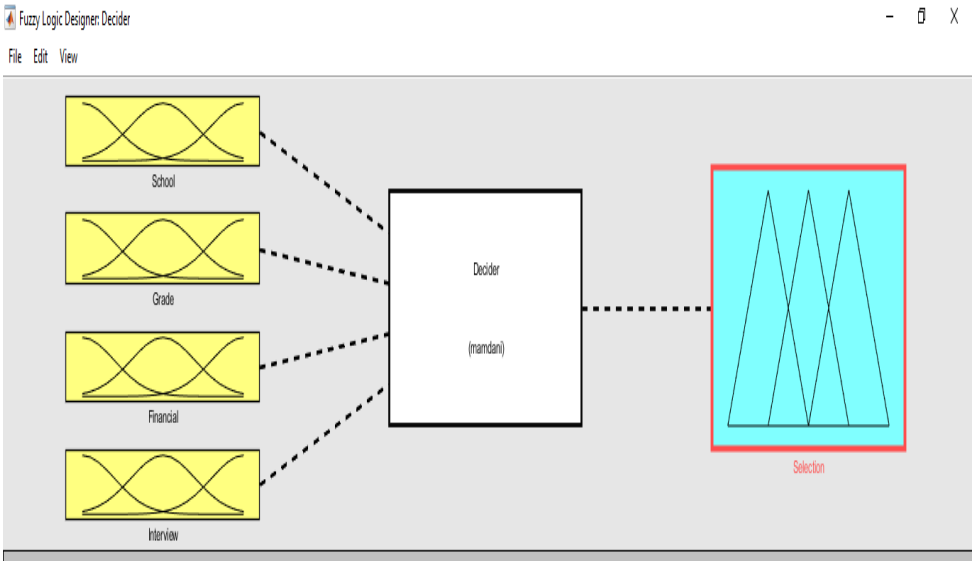

Fig. 5. Fuzzy logic design of the membership fuunctions(Both input and Output) using the Mamdani fuzzy inference system. Author constructed

The Mamdani Fuzzy Inference System in Figure 5 used twenty Fuzzy rules. According to Borhanazad, (n.d.) the term rule in Artificial Intelligence(AI), is defined as an IF-THEN structure that relates given information or facts in the IF part called antecedent (Premise or Condition) to some action in the THEN part also called the consequent (Conclusion or action). The Min-function of fuzzy(Fuzzy AND operator) logically combines the four(4) input membership function variables vlues.These twenty fuzzy rules eventually served as the guide for evaluation Brilliant but Needy Students Selection(Damnyag & Aazagreyir, 2019). Finally the Centroid Defuzzification method was chosen to find the crisp output which provides the decision to the driver buying the fuel. The centroid is repented mathematically as.

$$Centroid = \frac{\Sigma \mu v(yi)y}{\Sigma \mu v(yi)}$$ where $\mu v(yi) =$ membership value in the membership function and $y =$ centre of memberships function.

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3. MODEL IMPLEMENTATION

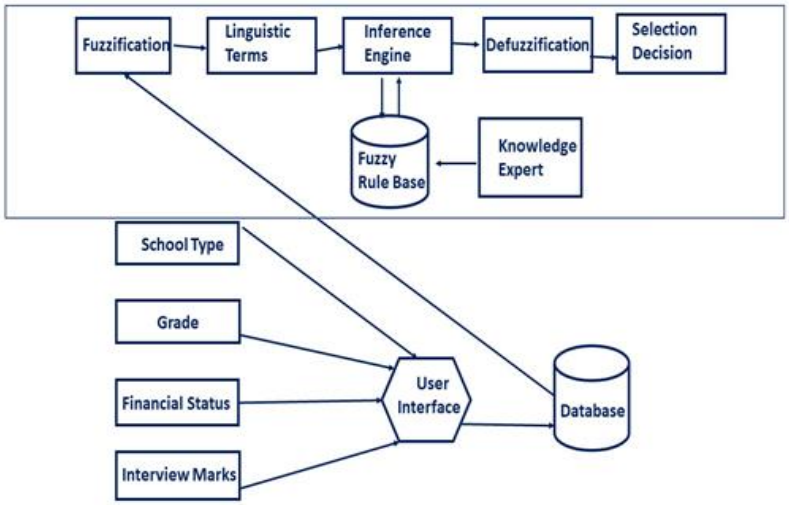


Figure 6: Detailed architecture of the evaluation model

When numeric values set are keyed into the database by a person via the User Interface, the fuzzification process transforms each value into one or more fuzzy values(Lima Junior, Carvalho, & Carpinetti, 2016). Fuzzification is the process of finding the membership grade of an input (Borhanazad, n.d.). The fuzzification task classify or define sets on each variable of the input membership function using numeric values and then linguistically using natural language to describe the defined sets of the variable with a more user friendly term called linguistic term. Considering the example in Table 1, assume that a student school is represented by the score 0.2. When it is presented to the system and converted to linguistic format, it value may be considered "weak" since the score 0.2 falls within the class of 0 – 0.3 as fuzified and stored in the database.

Successively the fuzzification, fuzzy values are given to a set of inference rules, establishing regression relations between the input and output variables. The activation of inference rules will occur to that which best represent the input fuzzy values, thereby determining a set of hypothesis about the behaviour of modelled problem(Lima Junior et al., 2016).The inference engine compares each rule stored in the knowledge base with facts contained in the database (Borhanazad, n.d.).

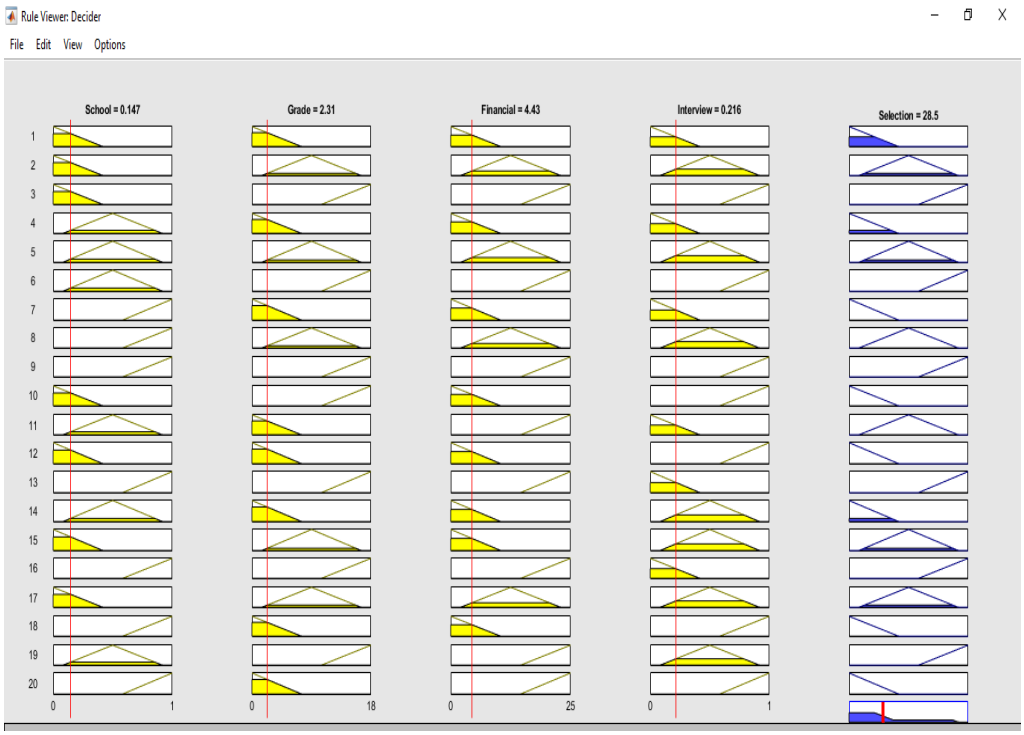
Defuzzification is a function that transforms fuzzy values or numbers into numerical crisp values (Musani & Jemain, 2013). Several dissimilar methods can be used for this conversion, but the most commonly used method is the centroid method. The centroid finds the Centre of gravity of the aggregated values (Damnyag & Aazagreyir, 2019).Table 3 summaries the entire fuzzy logic model.

Begin Step 1. To identify input variables of the membership function; Step 2. To give a crisp values entrance to input variables; Step 3. To fuzzify the input values; Step 4. To verify which inference rules are activated by fuzified input values; Step 5. To determine each inference rule output using the consequent linguistic terms; Step 6 To Combine individual contribution of all the activated rules to produce a final answer; Step 7 To defuzzify the resultant fuzzy set of step Step 8 To present a crisp value output; End

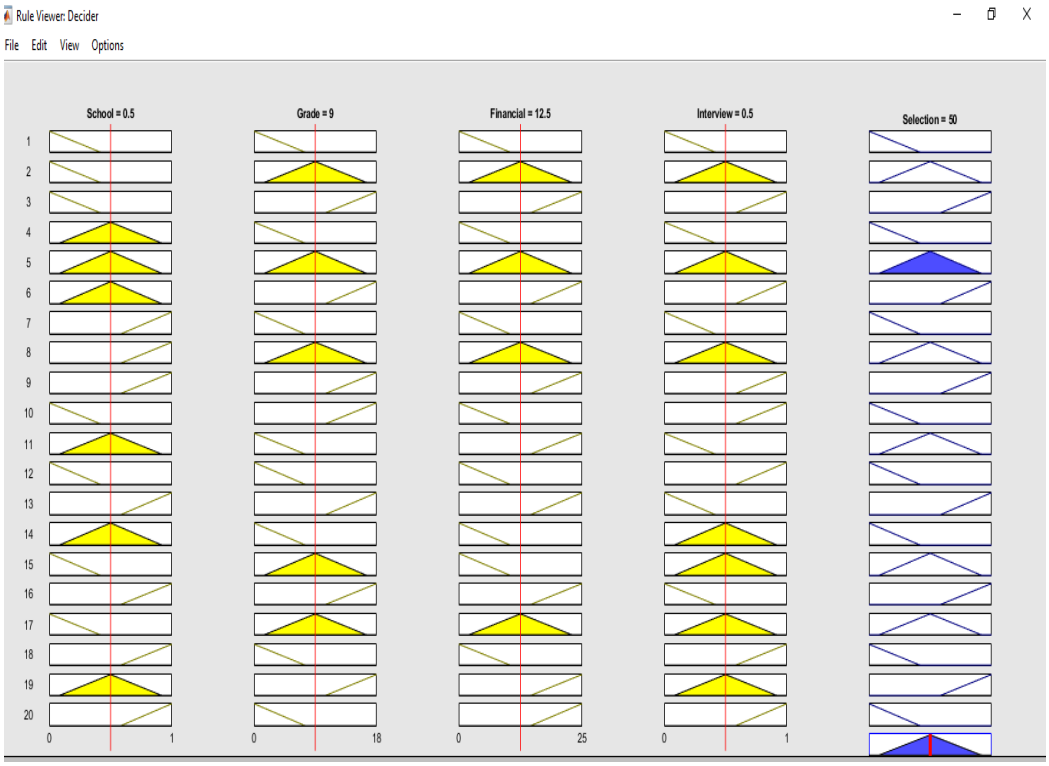
Table 3: Detailed Algorithms steps

Source: Author constructed

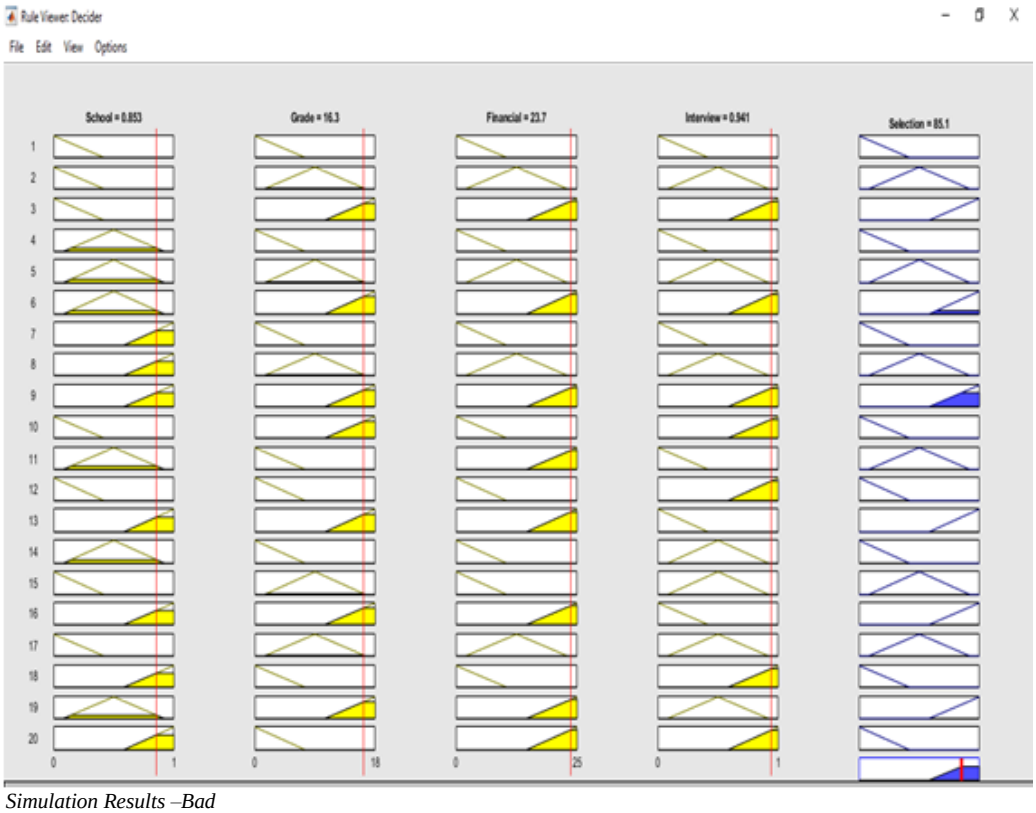
4. EXPERIMENTATION



Simulation Results -Excellent



Simulation Results -Fair



Simulation Results –Bad

5. CONCLUSION

In this paper, we present a Fuzzy Logic Evaluation Model for selecting Brilliant but Needy Students. Selection can be done by different methods. However, Brilliant but Needy Students Selecting must take into serious consideration the appropriateness of parameters or factors in the selection process and also consider how uncertainty and imprecision are approximately modelled since these plays a key role. The study uses four appropriate input parameters and employs the Mamdanai Inference Rules using twenty rules. The simulated result shows that; our proposed model is apt for the Brilliant but Needy Students Selection function. The researchers conclude that; fuzzy logic evaluation model is an effective technique for selecting Brilliant but Needy Students for scholarships. Future research can look at deploying the same approach to evaluate the recruitment function of Human Resource Management department of institutions**.**

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