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IMPLEMENTATION OF FUZZY LOGIC USING SUGENO METHOD OF SCHOLARSHIP DETERMINATION

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Abstract

Scholarships are funding that does not come from own funding or parents, but is provided by the government, educational institutions, private companies, universities, and schools that can provide opportunities to increase human resource capacity through education. To increase student interest in learning in the school environment by providing scholarships or assistance to students who are economically disadvantaged. The process of selecting scholarship recipients includes three variables, namely report cards, attendance, and student attitudes. Based on the variables above, the data will be processed to produce student decisions that deserve scholarships with a success rate of 88.88%. In order to produce fast and precise decisions and to avoid mistakes in selecting students, we need an appropriate method that can be used to assist decision makers in carrying out their duties. By using the right method, the school will be easier to make decisions. The method to overcome this problem is through the application of fuzzy logic with the Sugeno method.

Keywords: *Scholarship, Fuzzy Logic, Sugeno, Selection*

1. Introduction

Scholarships are funding that does not come from own funding or parents, but is provided by the government, educational institutions, private companies, universities, and schools that can provide opportunities to increase human resource capacity through education[1]. The scholarships are awarded to eligible students based on classification, quality, and competence. To increase student interest in learning in the school environment by providing scholarships or assistance to students who are economically disadvantaged. Referring to Law Number 20 of 2003 concerning the National Education System, Chapter V article 12 (1.c), it states that every student in each educational unit is entitled to a scholarship for outstanding achievers whose parents cannot afford to pay for their education. The process of selecting and selecting scholarship recipients who are underachieved/underprivileged includes three variables, namely report cards, attendance, and student attitudes. Based on the variables above, the data will be processed to produce a decision of students who are eligible for scholarships, eligible or not eligible. In order to be able to produce fast and accurate decisions and to avoid mistakes in selecting students, we need an appropriate method that can be used to assist decision makers in carrying out their duties. By using the right method, the school will be easier to make decisions[2].

The method to overcome this problem is through the application of fuzzy logic with the Sugeno method[3], [4]. Fuzzy logic is considered capable of mapping an input into an output without ignoring the existing factors. Fuzzy Logic, a branch of artificial intelligence, which means knowledge that allows computers to imitate human intelligence so that things that humans do can be done with computers[5]. Fuzzy Logic can also be said as fuzzy logic, which means a way that can map an input space into an output space based on the concept of fuzzy sets[6]. The Sugeno method is a reasoning method that is very similar to the Mamdani method[7],[8], where the consequence of the output of the system is not in the form of a fuzzy set, but in the form of a linear equation (constant). The sugeno method has two orders, namely Zero-Order and First-Order[9].

2. Research Methodology

The method used by the author in this study is a quantitative method because in this study the author uses an approach that can be solved by numerical computation, which uses more numbers. In general, the methods used in data collection to solve problems in solving the cases raised are observation, interviews and literature studies. Data Analysis is done after collecting the data, it was processed using the Sugeno method. using the following formula[10],[11]:

Membership Function: Linear Curve Up

$$\mu[x]\begin{cases} 0 & x \le a \\ (x-a)/(\mathrm{b}-a); & a \le x \le b \\ 1; & x \ge b \end{cases}$$

Membership Function: Triangle Curve

$$\mu[x]\begin{cases} 0;\ x \le a\ atau\ x \ge c \\ (x-a)/(\mathrm{b}-a);\ \ a \le x \le b \\ (c-x)/(c-b) \quad b \ \le \ \ x \le c \end{cases}$$

Membership Function: Trapezoidal Curve

$$\mu[\mathrm{x}] = \begin{cases} 0; & x \le a\ atau\ x \ge c \\ (x-a)/(b-a); & a \le x \le b \\ 1; & b \le x \le c \\ (c-x)/(c-b); & c \le x \le d \end{cases}$$

2.1. Research Work Activity Diagram

In this study, UML (Unified Modeling Language) diagrams were used for work activities for system design that the author built. Figure 1 below describes the workflow that will be carried out in this research

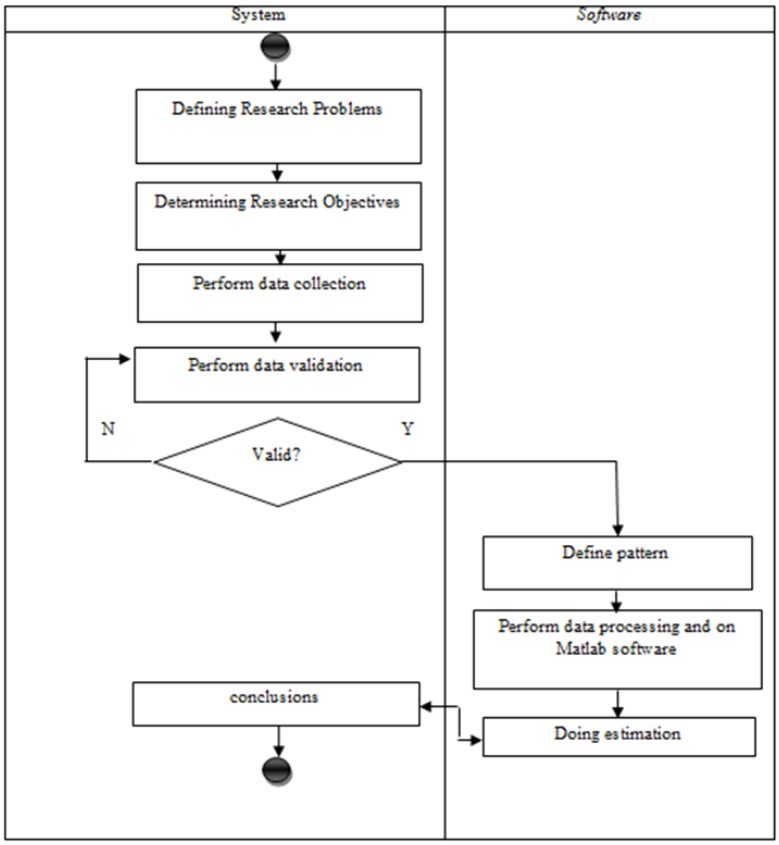

Figure 1. Research Work Activity Diagram

2.2. Variable Operation

Research variable is an attribute or nature or value of other people, objects or activities that have certain variations that are determined by researchers to be studied and then conclusions are drawn. The research consists of input variables and output variables.

a. Report Value
b. Presence
c. Student attitude

While the output variable is the determination of students who deserve scholarships

Table 1. Variable Operation

	Variable	Indicator	Domain
Determination of Scholarship Recipients	Report Score	Low	0 0 30 50
		Mid	40 50 70
		High	60 80 100 100
	Presence	Low	0 0 30 50
		Mid	40 50 70
		High	60 80 100 100
	Attitude	Low	0 0 30 50
		Mid	40 50 70
		High	60 80 100 100
	Decision	Worthy	1
		Not Worthy	0

2.3. Fuzzy Rule

The formation of rules in fuzzy logic is done by combining each variable in the fuzzy set and matching it with the data that has been taken previously. The following are the rules contained in the Matlab application that are used to get the results.

Table 2. Fuzzy Rules

Rule	Raport Score	Presence	Attitude	Impication Function	Decision
R1	Low	Low	Low	→	Not Worthy
R2	Low	Low	Mid	→	Not Worthy
R3	Low	Low	High	→	Not Worthy
R4	Low	Mid	Low	→	Not Worthy
R5	Low	Mid	Mid	→	Not Worthy
R6	Low	Mid	High	→	Not Worthy
R7	Low	High	Low	→	Not Worthy
R8	Low	High	Mid	→	Not Worthy
R9	Low	High	High	→	Not Worthy
R10	Mid	Low	Low	→	Not Worthy
R11	Mid	Low	Mid	→	Not Worthy
R12	Mid	Low	High	→	Not Worthy
R13	Mid	Mid	Low	→	Not Worthy
R14	Mid	Mid	Mid	→	Worthy
R15	Mid	Mid	High	→	Worthy
R16	Mid	High	Low	→	Not Worthy
R17	Mid	High	Mid	→	Worthy
R18	Mid	High	High	→	Worthy
R19	High	Low	Low	→	Not Worthy
R20	High	Low	Mid	→	Not Worthy
R21	High	Low	High	→	Not Worthy
R22	High	Mid	Low	→	Not Worthy
R23	High	Mid	Mid	→	Worthy
R24	High	Mid	High	→	Worthy
R25	High	High	Low	→	Not Worthy
R26	High	High	Mid	→	Worthy
R27	High	High	High	→	Worthy

3. Results And Discussion

The implementation of fuzzy logic determines scholarship recipients using the Sugeno method using the Matlab version 6.1 application.

3.1. Report value input variable function

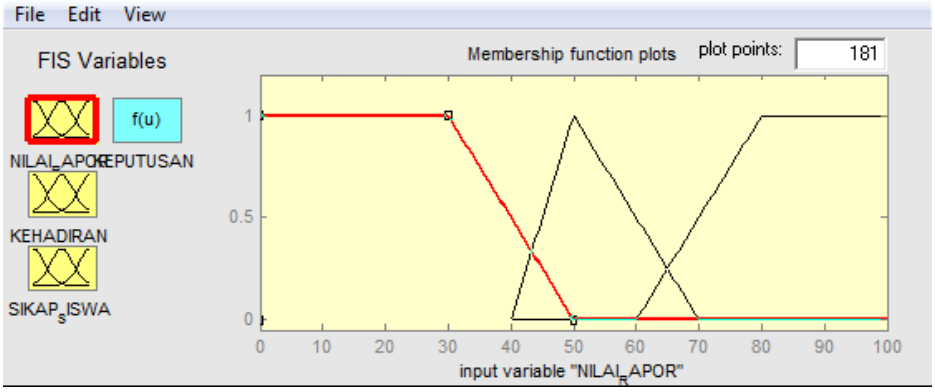

Figure 2. Input Variable Value Report

In Figure 2 it is explained that the input variable of report card values has three forms of fuzzy sets, namely: Low with a range value of [0,0,30,50]. Mid with range value [40,50,70]. High with a value range of [60,80,100,100].

3.2. Attendance input variable function

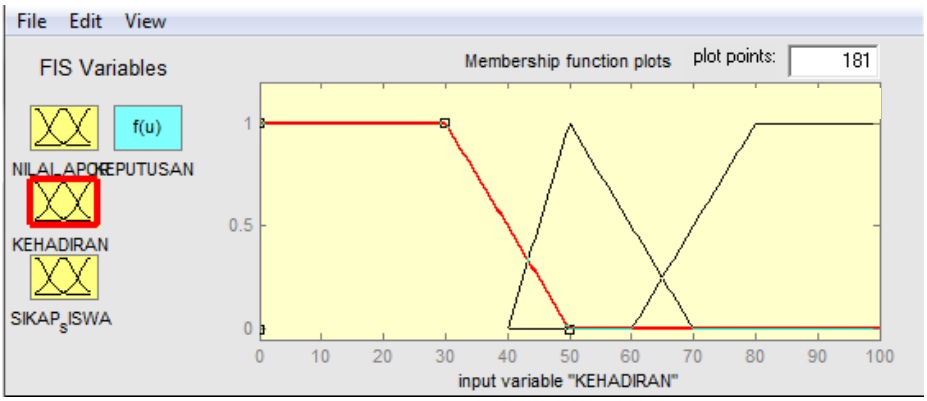

Figure 3. Attendance Input Variable

In Figure 3 it is explained that the presence input variable has three forms of fuzzy sets, namely: Low with a range value [0,0,30,50], Mid with a range value [40,50,70] and High with a range value [60,80,100,100].

3.3. Student attitude input variable function

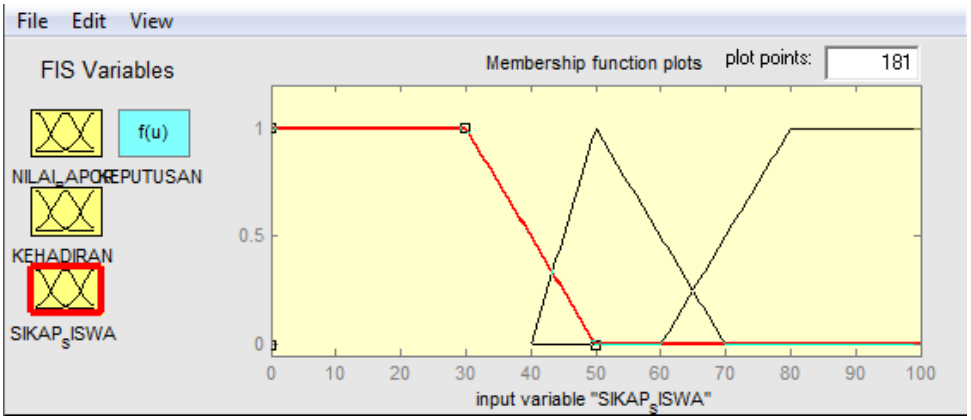

Figure 4. Student Attitude Input Variables

In Figure 4 it is explained that the student attitude input variable has three forms of fuzzy sets, namely: Low with a range value [0,0,30,50], Mid with a range value [40,50,70] and High with a range value [60, 80,100,100].

3.4. Fuzzy Set Formation

Based on the results of student data research, it can be concluded that the sample data in obtaining the following values:
Report Value (RV) = 60, Attendance (A) = 70 and Student Attitude (SA) = 60. Finding the degree of membership in each variable are:
Report value, which consists of three fuzzy sets, namely: Low, Mid, High. The report card value with an input of 60, hereinafter referred to as the value of x, is entered into the membership function formula using the trapezoidal formula as follows:
Report Score [60] = Low
The result will be zero (0) because the value of x is greater than the value of c.
Report Score [60] = Mid
= (c-x)/(c-b)
= (70-60)/(70-50)
= 10/20
= 0.5
Report Score [60] = High
= (x-a)/(b-a)
= (60-60)/(80-60)
= 0/20
= 0

a. Presence Value, consists of three fuzzy sets, namely: Low, Mid, High. Attendance with an input of 70, hereinafter referred to as the value of x, is entered into the membership function formula using the triangle formula as follows:
Attendance [70] = Low
The result will be zero (0) because the value of x is greater than the value of c.
Presence [70] = Mid
= (c-x)/(c-b)
= (70-70)/(70-50)
= 0/20
= 0
Presence [70] = High
= (x-a)/(b-a)
= (70-60)/(80-60)
= 10/20
= 0.5

b. Attitude value, consists of three fuzzy sets, namely: Low, Mid, High. The attitude of students with input 80, hereinafter referred to as the value of x, is entered into the membership function formula using the triangle formula as follows:
Student Attitude [80] = Low
The result will be zero (0) because the value of x is greater than the value of c.
Student Attitude [80] = Mid
The result will be zero (0) because the value of x is greater than the value of c.
Student Attitude [80] = High
= (x-a)/(b-a)
= (80-60)/(80-60)
= 20/20
= 1

c. Rules Component
R1] if (Rapor Score is Low) and (Attendance is Low) and (Student Attitude is Low) then (Decision is Not Worthy).
Minimum Value = [0; 0; 0;]
Z1 = 0
[R2] if (Rapor Score is Low) and (Attendance is Low) and (Student Attitude is Mid) then (Decision is Not Worthy).
Minimum Value = [0; 0; 0]
Z2 = 0
.
.
.

[R27] if (Rapor Score is High) and (Attendance is High) and (Student Attitude is High) then (Decision is Worthy).
Minimum Value = [0; 0.5; 1]
Z27 = 1

3.5. Testing With Matlab

The following is the test value to get the defuzzification value which is carried out using Matlab software as shown in Figure 4.5. below this.

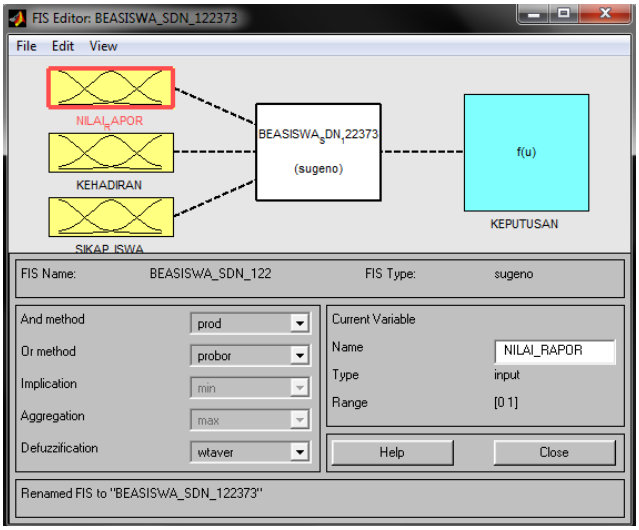

Figure 5. Matlab System Variable Display

The display rules used in testing matlab software are as shown in Figure 6 below:

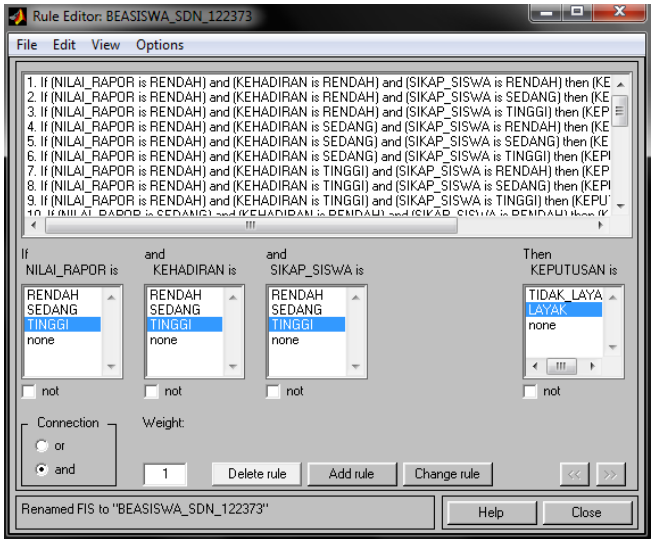

Figure 6. Matlab Rules Display

The results of the 1st case study matlab test are as follows:

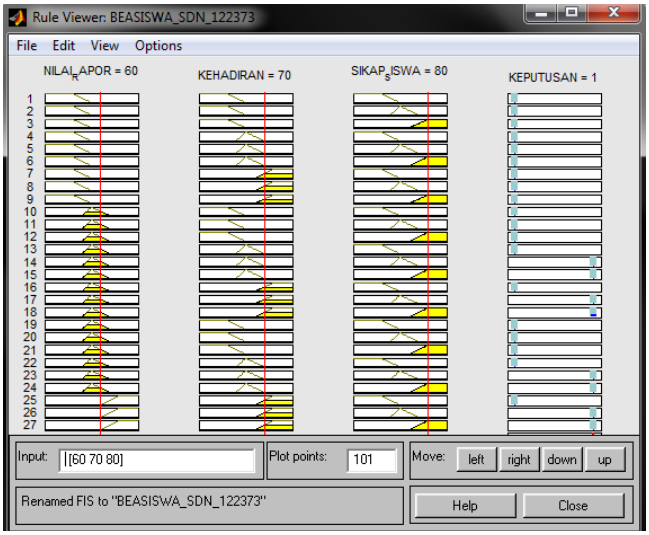

Figure 7. Display of Test Results for Case 1 Matlab System

After doing the calculations manually and systemically, then compare the two calculations. Of the six student data made as parameters, the results of the comparison can be seen from the following table.

Table 3. Comparison of Test Results Manually and System

No	Name	Manual Test Results	System Test Results	Decision
1	Data 1	1	1	Worthy
2	Data 2	1	1	Worthy
3	Data 3	0	0.5	Not Worthy
4	Data 4	0	0.5	Not Worthy
5	Data 5	1	1	Worthy
6	Data 6	1	1	Worthy
7	……	……..	……..	……..

Researchers in this test provide a range of values between 0 and 1 to get the results of the Worthy and Not Worthy decisions. From the results of testing manually and systemically, it can be concluded that the results obtained are appropriate. So using matlab software is easier and faster. So it is suitable for use in determining scholarship recipients.

4. Conclusion

Fuzzy logic with the Sugeno method can be used to determine scholarship recipients. In this study using three variables, namely, report cards, attendance, and student attitudes and based on the results of the comparison of manual calculations and using matlab software that there were no significant differences..

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