Implementation of Fuzzy *Mamdani* Logic Method for Student Drop Out Status Analytics

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**Abstract.** One of The Contribution of Information Technology in the World of Education at University is the System of Executive. the Information that needed by the Executive Department is an Information Student Data that supposed to be drop out. all this time the Process to determine the Student Faculty of Science and Technology Status as Drop out at *Sunan Gunung Djati* (SGD) States Islamic University Bandung, had not to apply the Automatic System, based on this case, therefore we need a Solution to handle it, by Develop the Executive Information System. The Method that we need for Developing this System is by using the Fuzzy *Mamdani* Logic Method, there are 4 Steps to bring the Output of this Method 1.) Creating a Fuzzy se t, 2.) Application of Function Implication 3.) Composition Law, 4.) Defuzzification. Based on this research, we will make a comparison between Manual Calculation and System Calculation, with the Accuracy 100%. The final result of this Method can be referenced for System Executive to Analyze the Student that should be given a Warning or Drop Out.

1. Introduction

One of the role of Information Technology in the world of education at the University is the existence of an information system for executives. Executive Information System (EIS) is one type of information system management to facilitate and support the information and making a decision that needed for Executive[1]–[4].

One of the information needed by the executive is to find out which students should be given a warning or should drop out. Drop out is when a student is discontinued his study based on certain criteria. For the sake of effectiveness and efficiency of work the right decision-making to decide on drop-out status for students is completely necessary[5], [6].

The method that can be used in this study is the Fuzzy *Mamdani* logic method. Fuzzy *Mamdani* Logic Method also is known as the Max-Min method. This method was introduced by Ebrahim Mamdani in 1975. To obtain an output, several steps are needed, namely the formation of fuzzy sets, application of implication functions, the composition of rules, and confirmation (deffuzi)[4], [7]–[9].
There have been several previous studies in line with this research which have also been conducted, one of which is the research conducted by Rabiatul Adawiah and Ruliah is to build a system of determining scholarship recipients for STMIK Banjarbaru students, in order to decide whether or not a scholarship is submitted by a student will be accepted [10].

In a study conducted by Dwi Martha Sukandy, Agung Triongko Basuki, Shinta Puspasari aims to create an application that applies the Fuzzy Mamdani method to predict the amount of palm oil production based on inventory data and the number of requests[11].

In a study conducted by Mochamad Adhari Adiguna and Adi Muhajirin explained the application of fuzzy logic methods to the assessment of the quality of lecturers on the tri dharma of higher education. This study aims to assist in the evaluation of lecturers in the field of quality control[12], [13].

2. Methodology
A. Research Data
The Data that will be used to decide the Status of the College Student with the Fuzzy Mamdani Logic Method is the Data of all the Student of Department of Science and Technology from States Islamic University SGD Bandung, also the Academic Guide Book to knowing the Drop Out Criteria. the result from the Observation and Collection of Data that we conducted, will be arranged into Table of Database[14], [15].

B. Decision Table Analytic
The Accumulation of Date from the research then arranged into a table to review the referred Rules[12], [16].

| Input Variable | Fuzzy Set Name | Domain     |
|----------------|----------------|------------|
| GPA            | Good           | 2 to 4     |
|                | Insufficient   | 1 to 3     |
|                | Bad            | Less than 1|
| Study Period   | Standard       | Less than 9 semester |
|                | Excess         | 8 to 12 semester |
|                | Excessive      | 11 to 14 semester |
| Day off        | Never          | 0 time     |
|                | Rarely         | 0 to 3 times |
|                | Often          | More than Twice |
| Did not apply SPC | Never       | 0 time     |
|                | Rarely         | 0 to 3 times |
|                | Often          | More than Twice |

While the output variable in determining student status can be seen in the following table:

| Output       | Nilai |
|--------------|-------|
| Good Student Status | More than 60 |
| Warning      | 40 to 50 |
| Drop Out     | Less than 40 |

C. Fuzzy Mamdani Analytics
There are 3 Steps for Fuzzy Logic Calculations.
1) Fuzzification
   a. Fuzzy set with GPA as Variable (x)
   GPA Variable categorized into Fuzzy sets as Bad, Insufficient, and Good. you can see the Fuzzy set GPA Variable from figure 1

   ![Figure 1. Fuzzy sets of GPA Variable](image1)

   Universal sets of GPA Variable: [0 4]
   Fuzzy sets Domain:
   BAD = [0 1]
   Insufficient = [0 3]
   GOOD = [2 4]

   b. Fuzzy set Study Period Variable (x)
   Study Period variables are categorized in fuzzy sets of Standard, Excess, and Excessive. Fuzzy sets Variable Study Period on figure 2

   ![Figure 2. Fuzzy set of Study Period Variable](image2)

   Universal set of Study Period Variable: [0 14]
   Fuzzy set Domain:
   STANDARD = [0 9]
   EXCESS = [8 14]
   EXCESSIVE = [13 14]
c. Fuzzy sets Variable Day off (x)

Day off variables is categorized in fuzzy sets Never, Rarely, Often. The Fuzzy set of Day off variables can be seen in figure 3.

![Fuzzy sets of Day off Variable](image)

**Figure 3.** Fuzzy sets of Day off Variable

Universal set of Day off Variable: [0 4]
Fuzzy set Domain:
- NEVER = [0]
- RARELY = [0 2]
- OFTEN = [1 4]

d. Fuzzy sets of Variable -Did not apply SPC-(x)

-Did not apply SPC- Variable are categorized in fuzzy sets: Never, Rarely, Often. Fuzzy sets -did not apply SPC- can be seen in figure 4.

![Fuzzy set on Variable: did not apply SPC](image)

**Figure 4.** Fuzzy set on Variable: did not apply SPC

Universal set of –Did not apply SPC- Variable: [0 4]
Fuzzy set Domain:
- NEVER = [0]
RARELY = [0 2]
OFTEN = [1 4]

2) Inference Engine
There are 81 rules we obtained in Fuzzy Program with the inference engine. Below are some examples of rules that used in our testimony

[R1] IF GPA Good AND Study Period Standard AND Day Off Never AND Did Not Apply SPC Rarely THEN Status Safe
[R4] IF GPA Good AND Study Period Standard AND Day Off Moderate AND Did Not Apply SPC Often THEN Status Safe
[R40] IF GPA Moderate AND Study Period Excess AND Day Off Moderate AND Did Not Apply SPC Rarely THEN Status Warning
[R60] IF GPA Bad AND Study Period Standard AND Day Off Moderate AND Did Not Apply SPC Often THEN Status DropOut
[R81] IF GPA Bad AND Study Period Excessive AND Day Off Often AND Did Not Apply SPC Often THEN Status DropOut

3) Defuzzification
Input from the Defuzzification process is a fuzzy set that is obtained from the composition of fuzzy rules, while the resulting output is a number in the domain of the fuzzy set. thus, if a given fuzzy set, set in a certain range, then a certain crisp value must be taken as the output. In this report defuzzification uses the centroid method with a formula:

\[ Z^* = \frac{\sum y \mu_R(y)}{\sum \mu_R(y)} \]

3. Result and Discussion
A. Data Sample

| SRN | Name  | Variable  | Score |
|-----|-------|-----------|-------|
| 1   | Mawar | GPA       | 2.5   |
|     |       | Study Period | 14   |
|     |       | Day Off    | Never |
|     |       | Did not Apply SPC | Never |

B. Fuzzy sets Formation
1) GPA 2.5 is included in the INSUFFICIENT and MODERATE/FAIR Fuzzy sets with a Component Level according to the following functions:

\[ \mu_{\text{GPAInsufficient}[2.5]} = \frac{3-2.5}{3-2} = \frac{0.5}{1} = 0.5 \]

\[ \mu_{\text{GPAGood}[2.5]} = \frac{2.5-2}{3-2} = \frac{0.5}{1} = 0.5 \]
2) Study Period 14 semesters is included in the EXCESSIVE Fuzzy set with a Component Level according to this following function:

\[ \mu_{SPVeryLong[14]} = 1 \]

**Figure 5.** Component function of GPA Variable 2,5

3) Never (took) Day Off or (0) included in Fuzzy set NEVER, with a component level according to the following function:

\[ \mu_{DayOffNever[0]} = \frac{1-0}{1-0} = \frac{1}{1} = 1 \]

**Figure 6.** Component Function of Study Period 14 Semesters Variable

3) Never (took) Day Off or (0) included in Fuzzy set NEVER, with a component level according to the following function:

\[ \mu_{DayOffNever[0]} = \frac{1-0}{1-0} = \frac{1}{1} = 1 \]

**Figure 7.** Component Function of Never (took) Day Off Variable
4) Did not Apply SPC 0 time is included in Fuzzy set NEVER with a component level according to the following function:

$$\mu_{\text{SPCNever}}[0] = \frac{1-0}{1-0} = \frac{1}{1} = 1$$

C. Implication Function

Inference Machine

[R19] IF IPK High/Good AND StudyPeriod Excessive AND DayOff Never AND did not apply SPC Never THEN Drop Out

$$\alpha_{\text{Predicate1}} = \mu_{\text{IPKHigh}} \cap \mu_{\text{StudyPeriodExcessive}} \cap \mu_{\text{DayOffNever}} \cap \mu_{\text{DidntSPCNever}}$$

$$= \min (\mu_{\text{IPKHigh}}, \mu_{\text{StudyPeriodExcessive}}, \mu_{\text{DayOffNever}}, \mu_{\text{DidntSPCNever}})$$

$$= \min (0.5; 1; 1; 1) = 0.5$$

[R55] IF GPA Moderate AND study period Excessive AND dayoff Never AND Didnt SPC Never THEN Drop Out

$$\alpha_{\text{Predicate1}} = \mu_{\text{GPAModerate}} \cap \mu_{\text{StudyPeriodExcessive}} \cap \mu_{\text{DayOffNever}} \cap \mu_{\text{DidntSPCNever}}$$

$$= \min (\mu_{\text{GPAModerate}}, \mu_{\text{StudyPeriodExcessive}}, \mu_{\text{DayOffNever}}, \mu_{\text{DidntSPCNever}})$$

$$= \min (0.5; 1; 1; 1) = 0.5$$

D. Rules Composition

The method we use to make compositions between all commands is the MAX method.

$$\mu_{\text{StatusDO}} = \begin{cases} 
0; & x > 40 \\
\frac{35 - x}{35 - 30}; & 30 < x \leq 40 \\
1; & x \leq 30 
\end{cases}$$

$$a1 = 32.5$$

$$\mu[z]\text{status} = \begin{cases} 
0.5; & z \geq 32.5 \\
\frac{35 - z}{35 - 30}; & 32.5 < z \leq 35 \\
1; & z \leq 30 
\end{cases}$$
E. Defuzzification
The input from the defuzzification process is a fuzzy set obtained from the composition of fuzzy rules, while the resulting output is a number in the fuzzy set domain. Thus, if we give the fuzzy set a certain range, then a certain crisp value must be taken as the Output.

\[ \mu(z)_{\text{status}} = \begin{cases} 
0.5; & z \geq 32.5 \\
35 - z; & 32.5 < z \leq 35 \\
1; & z \leq 30 
\end{cases} \]

1) Moment Calculation

\[ M_1 = \int_0^{35} (7 - 0.2z) \, dz = 20.9 \]

\[ M_2 = \int_0^{32.5} (0.5z) \, dz = 264.0625 \]

2) Area Calculation

\[ A_1 = \frac{(35-32.5) \times 0.5}{2} = 0.625 \]

\[ A_2 = (32.5 - 0) \times 0.5 = 16.25 \]

3) Center Point Calculation

\[ Z^* = \frac{M_1 + M_2}{A_1 + A_2} = \frac{20.9 + 264.0625}{0.625 + 16.875} = 16.8 \]

As we see from the calculation, a student with name Mawar concluded with the final score **16.8**, according to the Output Variable, Mawar has declared with the status of **Drop Out**.

F. Program Accuracy Test
We have 5 Data for the testing, a comparison result between Manual Calculation and System Calculation.

| No | Alternative | Criteria | Score | Result Manual | Result System | Status Manual | Status System | Validation |
|----|-------------|----------|-------|---------------|---------------|---------------|---------------|-------------|
| 1  | A01         | GPA      | 2.5   | 16.8          | 16.88         | Drop Out      | Drop Out      | valid       |
|    |             | StudyPeriod | 14 semesters |
|    |             | Day off     | Never    |
|    |             | Didn’t SPC  | Never    |
| 2  | A02         | GPA      | 3.7   | 68.66         | 68.704        | Good          | Good          | valid       |
|    |             | StudyPeriod | 8 semesters |
From the result of the Program Accuracy Test we conducted, all the 5 Data are Valid, thanks to the final result of the Fuzzy \textit{mamdani} Calculation Method that we did both Manually and Systematically, and both are matched, the percentage of test result can be obtained from:

\[
\text{Amount of Data} = \frac{\text{Valid amount of Data}}{5} \times 100 \%
\]

\[
= 100 \%
\]

Based on the calculation result above, therefore the accuracy of the test results obtained by the program = 100%

4. Conclusion

The \textit{Mamdani} Fuzzy Logic method can be implemented in the executive information system application to analyze the drop out the status of students. This can facilitate/simplify/ease the executive in making decisions, making it more effective and efficient.

Based on the final results of testing the level of accuracy of the executive information system performance, we conducted 5 attempts with accuracy 100% and the results are same as manual Calculation, we categorized this Final result as: Very Good.

This final result can be used as a reference for the executive, to analyze which student should be given a warning or drop out.

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