Implementation and Analysis of Fuzzy Mamdani Logic Algorithm from Digital Platform and Electronic Resource

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Implementation and Analysis of Fuzzy Mamdani Logic Algorithm from Digital Platform and Electronic Resource

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Abstract **–The fuzzy logic Mamdani model is a fuzzy reasoning system that can be used to calculate values based on various criteria for evaluating teacher performance. In this study, three fuzzy sets were used to determine the level of success of teachers in teaching through online media in one of the vocational schools in North Sumatra: the teacher set, the value set, and the success rate set. The teacher set is divided into three criteria: bad, sufficient, and good teachers. The set of values is also divided into three categories: bad, sufficient, and good. Furthermore, the set of success rates is divided into three categories: low, medium, and high success rates. The goal of this study is to use the mamdani fuzzy logic method to assess the level of success in teaching teachers using online media. According to the study's findings, the mamdani method could be used in this situation.**

Keywords **– fuzzy, performance appraisal, Mamdani method, electronic resource.**

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1. Introduction

Teachers are professionals with important functions, roles and responsibilities in the nation's intellectual life. Professional teachers are expected to participate in national development, in order to create people who have noble character and personality, who are pious and excellent in science and technology [1], [2], [3]. The future of the nation and state is largely influenced by teachers. It is not exaggeration to say. The teaching profession has to thus be continuously and proportionately developed in accordance with the teacher's functionality [4], [5], [6], [7]. Furthermore, an assessment of the performance of teachers is required to perform the functions and tasks attached to the functional positions of teachers in accordance with the rules applicable [8], [9], [10], [11]. Performance is a teacher's success in providing students with learning material. Including performance evaluations of how well a teacher performs the tasks and work assigned to him/her [5], [6], [7]. Usually for a certain period of time, this teacher performance evaluation takes place once a year.

The unexpected situation of COVID-19 in various areas, for example the fields of industry [13], extraction, agriculture [14], trading, education and services, changed very significantly at the end of December, 2019. COVID-19 has developed so rapidly and extensively worldwide [15]. By making rules on social distance, the COVID-19 pandemic has caused significant changes. In the field of education, there are changes that make online learning a reality in schools [15]. During the COVID-19 pandemic, every unit in the education sector uses online learning as the only way to continue the learning process; the use of learning media and creativity in it

are key points for successful learning [16]. Based on this, an analysis using intelligent computing to determine the success rate of teaching a teacher online as an evaluation material is required. The intelligent computing in question is a mathematical assessment model based on computerization that uses the fuzzy logic method to determine the level of success in teaching a teacher online. Fuzzy logic has characteristics and advantages in dealing with these problems [17], it is appropriate for use in solving uncertainty problems [18], [19]. Mamdani [16] is a well-known fuzzy logic method, Fuzzy Mamdani is frequently used to create systems with reasoning that resembles human intuition or feelings. As a result, the Mamdani model can be used to represent human guesses [12], [20], [21].

This study is similar to several previous studies on evaluating teacher performance using the same algorithm, including (Alam & Pandey, 2017) [22]. Two teacher performance modules are used in the assessment. The first module assesses teaching performance, while the second assesses academic and administrative performance. This study, however, differs from the previous studies in one way: data preparation. The difference between the author's research and Alam and Pandey's research is in the processed data and variables. The data for the study will be collected using three variables: the teacher variable, the value variable, and the success rate variable. These factors distinguish the research conducted from the existing research.

2. Research Methodology

Professor Lotfali Asker Zadeh University Berkley introduced Fuzzy logic theory in 1965. The Fuzzy Logic Controller is a good methodology as it gives better results than conventional control algorithms. Fuzzy logic is an alternative way of representing real world linguistic and subjective computing attributes [1]. Figure 1 shows a fundamental architecture of the fluttered logic controller.

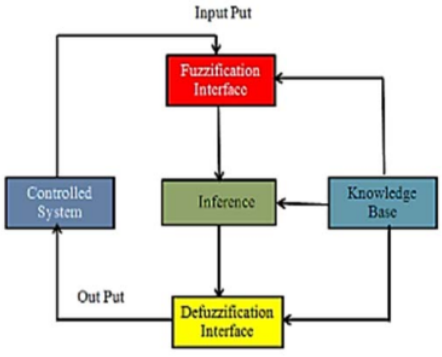

Figure 1. Fuzzy logic controller

According to (Ardi et al., 2018) [18], the membership value of a firm set can be written as A[x], which means that the membership value of object x is in set A and has two possibilities:

a) If the value is one (1), the item is a member of the set;
b) If the value is zero (0), the item does not belong to the set.

Both antecedent and consequent are linguistic terms in Mamdani fuzzy systems, and the output corresponds to the superposition of individual outputs provided by each rule. The fuzzification, inference fuzzy engine, and defuzzification processes are distinct in a Mamdani fuzzy system. During the fuzzification process, a specific value is introduced into the system and converted into a membership level for each rule. Figure 2 depicts the fundamental structure of a Mamdani-type system [23].

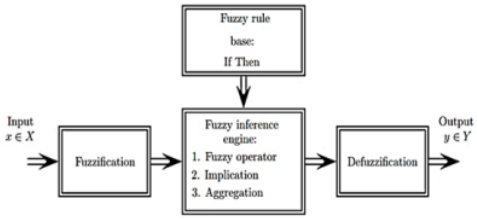

Figure 2. Mamdani systems

The issue raised is how to use Mamdani Fuzzy logic to determine the level of success in teaching teachers using online media with the help of Matlab R2013a software based on the Mamdani Fuzzy Inference System. This study was carried out at one of North Sumatra's vocational schools. Problem solving begins with the collection of secondary data required in the calculation and analysis of the problem through the distribution of teacher questionnaires and student score data. After obtaining the data, it was calculated using the Mamdani Fuzzy Inference System method and analyzed using the Matlab R2013a GUI.

3. Results and Discussion

In this study, three fuzzy sets are used to determine the level of success of teachers in teaching online at one of the vocational schools in North Sumatra: the set of teachers, the set of values, and the set of success rates. The teacher set will be divided into three criteria: bad, sufficient, and good teachers. The set of values will also be divided into three categories: bad, sufficient, and good. In addition, the set of success rates will be divided into three categories: low, medium, and high success rates.

The development of a fuzzy set, the application of the implication function, the composition of the rules, and the affirmation are the four phases that lead to the output.

A. *Formation of Fuzzy Sets*

Furthermore, the fuzzy set of each variable will be determined as shown in Figure 3.

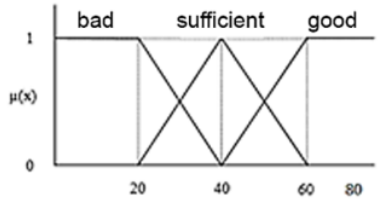

Figure 3. Fuzzy set on the set of teachers (x)

The universe of talks for the teacher's association: [0 80]
Fuzzy set domain:
Bad = [0 40]
Sufficient = [20 60]
Good = [40 80]
Membership functions for the set of teachers as function below and figure 4.

$$\mu bad = \begin{cases} 1 & ; x \le 20 \\ \frac{(40-x)}{(40-20)} & ; 20 \le x \le 40 \\ 0 & ; x \ge 40 \end{cases}$$

$$\mu sufficient = \begin{cases} 0 & ; x \le 20 \text{ atau } x \ge 60 \\ \frac{(x-20)}{(40-20)} & ; 20 \le x \le 40 \\ \frac{(60-x)}{(60-40)} & ; 40 \le x \le 60 \end{cases}$$

$$\mu good = \begin{cases} 0 & ; x \le 40 \\ \frac{(x-40)}{(60-40)} & ; 40 \le x \le 60 \\ 1 & ; x \ge 60 \end{cases} \quad (1)$$

Figure 4. Fuzzy set on the set of values (y)

The universe of talk for the set of values: [0 100]
Fuzzy set domain:
Bad = [0 60]
Sufficient = [50 70]
Good = [60 100]
Membership functions for the set of values and Figure 5.

$$\mu bad = \begin{cases} 1 & ; y \le 50 \\ \frac{(60-y)}{(60-50)} & ; 50 \le y \le 60 \\ 0 & ; y \ge 60 \end{cases}$$

$$\mu sufficient = \begin{cases} 0 & ; y \le 50 \text{ atau } y \ge 70 \\ \frac{(y-50)}{(60-50)} & ; 50 \le y \le 60 \\ \frac{(70-y)}{(70-60)} & ; 60 \le y \le 70 \end{cases}$$

$$\mu good = \begin{cases} 0 & ; y \le 60 \\ \frac{(y-60)}{(70-60)} & ; 60 \le y \le 70 \\ 1 & ; y \ge 70 \end{cases} \quad (2)$$

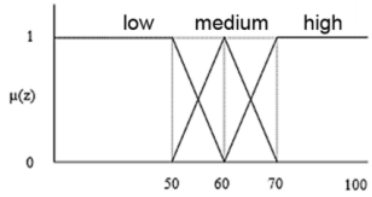

Figure 5. Fuzzy set on success rate variable (z)

The universe of talks for a collection of success rates: [0 100]
Fuzzy set domain:
Low = [0 60]
Medium = [50 70]
High = [60 100]
Membership function for the set of success rates

$$\mu low = \begin{cases} 1 & ; z \le 50 \\ \frac{(60-z)}{(60-50)} & ; 50 \le z \le 60 \\ 0 & ; z \ge 60 \end{cases}$$

$$\mu medium = \begin{cases} 0 & ; z \le 50 \text{ atau } z \ge 70 \\ \frac{(z-50)}{(60-50)} & ; 50 \le z \le 60 \\ \frac{(70-z)}{(70-60)} & ; 60 \le z \le 70 \end{cases}$$

$$\mu high = \begin{cases} 0 & ; z \le 60 \\ \frac{(z-60)}{(70-60)} & ; 60 \le z \le 70 \\ 1 & ; z \ge 70 \end{cases} \quad (3)$$

B. Application Function Implication

In the Mamdani method, the implication function used in the study to determine the success rate of online teaching teachers is the MIN function. Whereas in the sample cases raised, it is expected that the success rate of teachers teaching through online media is at least 60, with the teacher's score of 50 and the variable's value of 65.

[R1] IF Teacher is bad and Score is bad then Success Rate is low:
αPredicate1 = μBad Teacher ∩ μBad Grade
= min(μBadTeacher(50), μBadScore(65))
= min(0;0)
= 0

[R2] IF Teacher is bad and Score is sufficient then Success Rate is medium:
αPredicate2 = μBad Teacher ∩ μSufficient Grade
= min(μBadTeacher(50), μSufficientScore(65))
= min(0;0,5)
= 0

[R3] IF Teacher is bad and Grade is good then Success Rate is high:
αPredicate3 = μBad Teacher ∩ μGood Grade
= min(μBadTeacher(50), μGoodScore(65))
= min(0;0,5)
= 0

[R4] IF Teacher is sufficient and Score is bad then Success Rate is low:
αPredicate4 = μSufficient Teacher ∩ μBad Score
= min(μSufficientTeacher(50), μBadScore(65))`
= min(0,5;0)
= 0

[R5] IF Teacher is sufficient and Score is sufficient then Success Rate is medium:
αPredicate5 = μSufficient Teacher ∩ μSufficient Grade
= min(μSufficientTeacher(50), μSufficientScore(65))`
= min(0,5;0,5)
= 0.5

[R6] IF Guru sufficient and Grades good then Success Rate is high:
αPredicate6 = μSufficient Teacher ∩ μGood Grade
= min(μSufficientTeacher(50), μGoodScore(65))
= min(0,5;0,5)
= 0.5

[R7] IF Teacher is good and Score is bad then Success Rate is low:
αPredicate7 = μGood Teacher ∩ μBad Grade
= min(μGoodTeacher(50), μBadScore(65))
= min(0,5;0)
= 0

[R8] IF Teacher is good and grade is sufficient then Success Rate is medium:
αPredicate8 = μGood Teacher ∩ μSufficient Grade
= min(μGood Teacher(50), μSufficientScore(65))
= min(0,5;0,5)
= 0.5

[R9] IF Teacher is good and Grade is good then Success Rate is high:
αPredicate9 = μGood Teacher ∩ μGood Grade
= min(μGoodTeacher(50), μGoodScore(65))
= min(0,5;0,5)
= 0.5

C. Composition of Rules

If the system is made up of multiple rules, the inference is derived from the combination of the rules. In order to perform fuzzy system inference, three methods are used: max-min, additive, and probabilistic OR (probor). The MAX function can be used to generate fuzzy regions from existing - predicate rules. The MAX method obtains the fuzzy set solution by taking the maximum value of the rule, modifying the fuzzy area, and applying it to the output using the OR (union) operator. If all propositions have been evaluated, the output will contain a fuzzy set that reflects each proposition's contribution as shown in Figure 6.

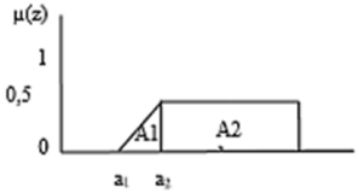

Figure 6. Composition of Rules

In the picture above, the result area is divided into two parts, namely A1 and A2. Now we find the value of a1.
(a1 – 60) / 70 = 0 →a1= 60
(a1 – 60) / 70 = 0.5 →a2= 95
Thus, the membership function for the result of this composition is:

$$\mu[z] = \begin{cases} 0 & ; z \leq 60 \\ \frac{(z-60)}{70} & ; 60 \leq z \leq 95 \\ 0{,}5 & ; z \geq 95 \end{cases}$$

D. Affirmation (Defuzzy)

Fuzzification is the process of transforming a sharp value into fuzzy variables in the form of linguistic variables, which are then grouped into fuzzy sets. As a result, this stage takes the crisp values and determines how much of them belong to each appropriate fuzzy set. The centroid technique method will be used for affirmation. This method determines the aggregate set's center of gravity (COG).

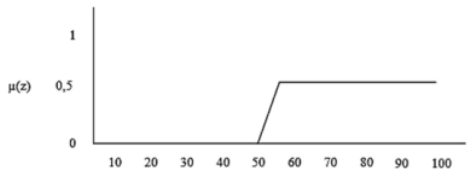

Figure 7. COG

Z =
((0+10+20+30+40+50)*0+(60+70+80+90+100)*0.5)
/(0+0+0+0+0+0+0.5+0.5+0.5+0.5+0.5)
Z = (0+200)/2.5= 80
So the success rate of the teacher teaching is 80.

4. Conclusion

Based on the description, the following conclusions are reached:

1) The use of Mamdani fuzzy logic can be used to determine the level of success of teaching teachers using online media using indicators as fuzzy input data, namely teacher variables, value variables, and success rate variables.
2) The Mamdani model's fuzzy logic makes determining the level of success of teaching teachers using online media fairer and more accurate by paying attention to the proportional value for each criterion used.
3) Mamdani fuzzy logic can be used as a decision support tool in determining a teacher's level of teaching success.

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