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Application of *Interval Type-1 Fuzzy Inference System* to analyze *the quality of memorization Qur'an*

Application of *Interval Type-1 Fuzzy Inference System* to analyze *the quality of memorization Qur'an*

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Abstract. In this modern world, the use of artificial intelligence needed. One of the intelligence methods raised in this study is to use the *Interval Type-1- Fuzzy Inference System (IT-1-FIS)*. In Muslim schools *(Madrasah Ibtidaiyah)* where there is subject matter memorizing the Qur'an. The fluency determines the quality of memorization of the Qur'an i*n pronouncing letters (Input-1)*, *Tajweed Rules (Input-2)*, and *reading fluency (Input-3)*. These three points become input for forecasting Memorization Quality Of The Qur'an. *IT-1-FIS* requires primary inputs and rules to obtain the output of forecasting *Memorization Quality Of The Qur'an*. By using *IT-1-FIS*, it can predict that students will get the quality of memorization based on the trace value obtained on each point. So from the beginning the teacher will know the quality of a student's memorization in the future. The estimated *condition in memorization of the Qur'an* can be known faster, and the teacher will be able to increase the points that are less to get the desired *quality of memorization of the Qur'an* by the habits practiced by students. These students' patterns are the basic rules of input in the *IT-1-FIS* process.

1. Introduction

In the last ten years, the development of artificial intelligence is speedy. This development is shown by the increasing variety of new algorithms that help every side of life. The more advanced the algorithm used is more straightforward and has a higher processing speed [1,2]. More and more electronic devices are using artificial intelligence. So that the smaller the electronic dimensions, the more complex the ability and the faster.

Among the artificial intelligence algorithms is Fuzzy logic. Fuzzy Logic was introduced by Prof. Zadeh in 1965 [3,4]. He explained that among logical binary numbers, one has a meaning, Yes and 0 have a sense No. Fuzzy logic will discuss the area between 1 and 0. Therefore Fuzzy logic is also known as obscurity logic. It means that analysis in areas outside 1 and 0 will be discussed in this Fuzzy logic [4,5]. So this Fuzzy Logic has a higher level of precision when compared to other algorithms.

Utilization of Fuzzy Logic, among others, in the field of forecasting. In the field of forecasting Fuzzy Logic is used to predict the growth of electrical loads. For flood forecasting, for forecasting production and forecasting the graduation rate of a school and so on. In other fields, that can be used as a method for analyzing a process. Fuzzy logic in analyzing a process that is as a control device to carry out a particular process. For example, a washing machine using Fuzzy logic [6]. The robot of fire extinguisher devices using Fuzzy logic to increase precision in finding hotspots and so on [7].

In its development, Fuzzy Logic is the better method of analysis. In this inference process, Fuzzy Logic incorporates basic rule elements for its analysis [8]. This basic rule is obtained based on experience or previous research. Therefore, in its development, Fuzzy logic is known as *the Interval type 1 Fuzzy Inference system (IT-1 FIS).*

In this study, *IT-1-FIS* is used to analyze and predict how good the level of Qur'an memorization is in a Madrasah Ibtidaiyah [9,10]. For this analysis, three input variables are needed. These 3 variables are: *fluency in pronouncing letters (Input-1); Tajweed Rules (Input-2);* and *reading fluency (Input-3).* These three variables will be analyzed with the basic rules, then the results of the *IT-1 FIS* analysis will be obtained in the form of how good the Qur'an Recitation level is. Secondly, the teachers can estimate the current conditions for some time in the future they will have the ability to memorize the Qur'an how well [11,12].

2. Experimental methods

2.1. Variabel and membership function

In *IT-1 FIS* processing, the path that must be traversed is to prepare the input variables and the output variables. Input variables that will be used are a. *Fluency in pronunciation of letters* (Input-1); b. *Tajweed Rules* (Input-2); and c. *Reading fluency* (Input-3). Each of these inputs is a value with a range between 55-100 with grouping: Good: 80-100; Medium: 65-85; Less: 50-70. As for the output that is the quality of memorization has a value: Good Pass: 80-100; Graduated Medium: 65-85; Passed Less: 50-70. Each of these variables uses a set of triangles. Triangle Membership Function (Trimf), as shown in figure1.

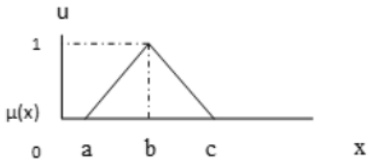

Figure. 1. Triangle membership function.

The membership function of the triangle above has the following equation:

$$f(x,a,b,c) = \begin{cases} 0, & x \le a \\ \frac{x-a}{b-a}, & a \le x \le b \\ \frac{c-x}{c-b}, & b \le x \le c \\ 0, & c \le x \end{cases} \quad (1)$$

or can be defined as follows:

$$f(x,a,b,c) = \max(\min\left(\frac{x-a}{b-a}, \frac{c-x}{c-b}\right), 0) \quad (2)$$

The x parameter is the input of crisp, a and c represent the toe of the triangle, while b represents the peak of the triangle. *Fuzzy Logic* Process is known as the *Fuzzy Inference System (FIS).*

2.2. Fuzzy Inference System

The fuzzy inference is doing reasoning using fuzzy input and fuzzy rules that have been determined to produce fuzzy output [13,14]. The five sequences of the Max-Min FIS method are as follows [13]:

- Fuzzy set formation (input and output variables)

- Operational membership function
- Application function implications (implication), Min functions are generally used
- Rule composition (aggregation)
- Defuzzification

Defuzzification is a mapping process from the results of areas of fuzzy inference to non-Fuzzy regions (Crisp). In the implementation of fuzzy real-time controls, the Center of Area (COA) defuzzification process is used.

The defuzzification of the center of the area produces the center of gravity of the distribution of control actions stated in the equation:

$$z^* = \frac{\sum_{k=1}^{m} V_k \mu_v(V_k)}{\sum_{k=1}^{m} \mu_v(V_k)} \quad (3)$$

z^* = Output Value
m = level of quantization
V_k = element to –k
μ_V = membership degree element on fuzzy set V

The results of the defuzzification process are the result of a series of fuzzy processes.

To further facilitate the process of analysis, starting from creating variables, creating membership functions, and making basic rules, a list of symbols is made as follows:

2.2.1. The fluency in pronouncing letters (Input-1): F, with membership Function:

- The Fluency In Pronouncing Letters: F Good → FG (with value: 80 – 100).
- The Fluency In Pronouncing Letters: F Medium →FM (with value: 65 – 85).
- The Fluency In Pronouncing Letters: F Bad→ FB (with value: 50 – 70).

2.2.2. Tajweed rules (Input-2): W, with a membership function:

- Tajweed Rules: W Good → WG (with value: 80 – 100).
- Tajweed Rules: W Medium → WM (with value: 65 – 85).
- Tajweed Rules: W Bad → WB (with value: 50 – 70).

2.2.3. Reading fluency (Input-3): T, with membership function:

- Reading Fluency: T Good → TG (with value: 80 – 100).
- Reading Fluency : T Medium → TM (with value : 65 – 85).
- Reading Fluency: T Bad → TB (with value: 50 – 70).

While the output variable is only one, i.e., Memorization Quality Of The Qur'an is: L have membership function :

- Memorization Quality: L Good → LG (with value: 80 – 100).
- Memorization of Quality: L Medium → LM (with value: 65 – 85).
- Memorization of Quality: L Bad → LB (with value: 50 – 70).

Membership Function of each input variable is as follows: For the Fluency of Reciting Letters variable with the set: Good, Medium, and Bad can be seen in Figure 2.

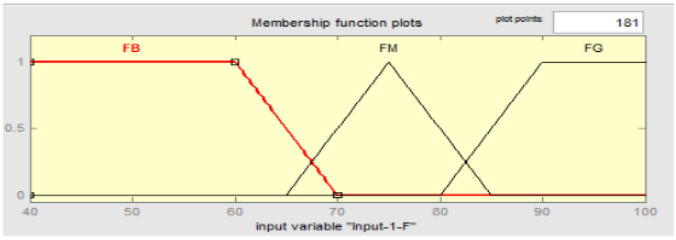

Figure 2. Membership function and the set of the fluency in pronouncing letters (F).

Other input variables can be recognized in the same way. For output has a Memorization Quality variable with the set: Good, Medium, and Bad can be seen in Figure 3.

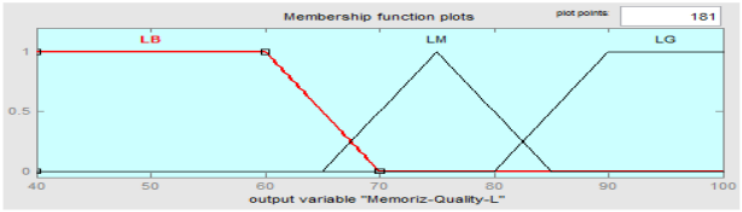

Figure 3. Membership function and the set of memorization quality (L).

As for the FIS editor, it can be seen in Figure 4.

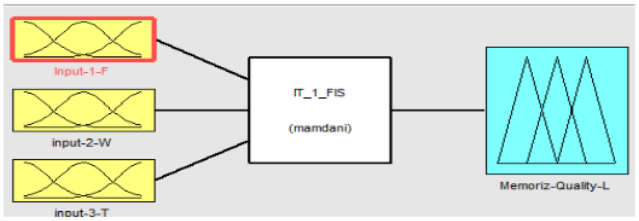

Figure 4. Schema *Fuzzy Inference System editor* (input and output).

Fuzzy Inference System Editor Schema with the number of input variables are three variables and one output variable. In the above process, the value limits of each set are entered into the variable so that the graph is obtained as in Figure 2 and 3. The next process is to make the basic rules of *FIS*. In more detail can be seen in the section below.

2.3. Rule-based

This basic rule is a rule made based on experience that has occurred either in the form of research or looking for qualitative data. In this study, it is stated that with three input variables, 27 basic rules are entered into the *Matlab* software. From this basic rule, each case will get a value of the degree of membership that greatly affects the results of the analysis set out in the output analysis. The basic rules used in this study are set out in Table 1.

Table 1. Rule-based analysis.

NO	Rule-Based IF			THEN	NO	Rule-Based IF			THEN
	F	W	T	L		F	W	T	L
1	FG	WG	TG	LG	15	FM	WM	TB	LB
2	FG	WG	TM	LM	16	FM	WB	TG	LM
3	FG	WG	TB	LB	17	FM	WB	TM	LM
4	FG	WM	TG	LM	18	FM	WB	TB	LB
5	FG	WM	TM	LM	19	FB	WG	TG	LM
6	FG	WM	TB	LB	20	FB	WG	TM	LM
7	FG	WB	TG	LM	21	FB	WG	TB	LB
8	FG	WB	TM	LM	22	FB	WM	TG	LM
9	FG	WB	TB	LB	23	FB	WM	TM	LM
10	FM	WG	TG	LM	24	FB	WM	TB	LB
11	FM	WG	TM	LM	25	FB	WB	TG	LM
12	FM	WG	TB	LB	26	FB	WB	TM	LM
13	FM	WM	TG	LM	27	FB	WB	TB	LB
14	FM	WM	TM	LM					

The numbers listed in table 1 are input in *Matlab* to produce a Rule-based graph. In figure 4, there appear three input variables and one output variable and their set. From the input and input variable data, each of them can be given a score on each set; then, the final result is as stated in the output graph, which is the rightmost part of the graph. The results of the analysis calculations can be shown in table 3. If seen in Figure 2, 3, it appears that the variable F has a triangle area on each of its rules according to the analysis picture, as shown in Figure 3. Similarly, for the variables W, T, and L.

3. Results and discussion

The results of the analysis of calculations using Matlab as can be seen in table 2. Table 2 shows the score of the variable F; W and T are entered into *Matlab*, then *Matlab* will analyze and produce an output calculation L.

Table 2. Results of Matlab calculations for research analysis.

CASE	F	W	T	RESULT (L)
1	50	75	85	75,00
2	55	75	85	75,00
3	60	75	85	75,00
4	65	75	85	75,00
5	70	75	85	75,00
6	75	75	85	75,00
7	80	75	85	75,00
8	85	75	85	75,00
9	90	75	85	75,00
10	95	75	85	75,00
11	100	75	85	75,00

Table 2 can be seen even though the input value of the variable F; W and T are entered into Matlab; then, output L shows the same result, which has a value of 75.00. This value is different if the final value or output is calculated using the sum of each input and divided by 3, as shown in table 3.

Table 3. Output values using ordinary calculations.

CASE	F	W	T	RESULT (L)
1	50	75	85	70,00
2	55	75	85	71,67
3	60	75	85	73,33
4	65	75	85	75,00
5	70	75	85	76,67
6	75	75	85	78,33
7	80	75	85	80,00
8	85	75	85	81,67
9	90	75	85	83,33
10	95	75	85	85,00
11	100	75	85	86,67

Output values Table 3 shows the different levels of each change in the value of the input variable. Meanwhile, if you use Matlab, then the results are flat in certain positions. Of course, this happens because of the influence of the basic rules applied to the analysis process using *IT-1 FIS*. The following graphically displayed a comparison between analyses using *IT-1 FIS* and ordinary calculations. As in figure 5.

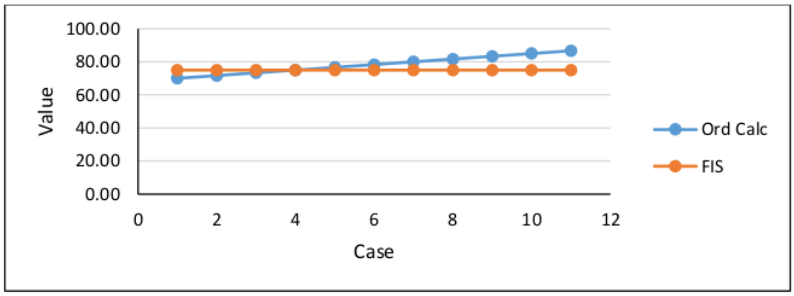

Figure 5. Comparison of the use of ordinary calculations and *IT-1 FIS*.

In figure 5, a graph showing the results of calculations and analysis of different *IT-1 FIS*. As in table 2, the results of Matlab calculations using IT-1-FIS have limited ground rules. The basic settings that produce good grades are only in 1 rule, which is rule 1. The rule 1 shows if FG WG TG LG. So the output produced has a flat value. If compared only using ordinary calculations, it will have different results. Then whether the results of the analysis use IT-1-FIS can be used. Of course it can be used by considering the existing rules, the results of the analysis can be used.

4. Conclusion

From the above explanation, it can be concluded that analyzing the ability to *memorize the Qur'an of madrasah ibtidaiyah* students by using *IT-1 FIS,* 3 inputs and one output gets the result that there is a difference between *IT-1 FIS* analysis with ordinary calculations. This shows that the *IT-1 FIS* calculation

includes elements of the basic rules of graduation. Not only based on values in ordinary mathematical calculations but also consider the experience factor that is inputted by the basic rules of the *IT-1 FIS*.

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