The Mamdani Fuzzy Logic Engineering Analysis for Determining Weather Forecast

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Abstract. Many people rely on life in the form of climate cycles, such as farmers, fishermen, traders, and so on. This resulted in the emergence of a lot of pressure from various groups of people who needed accurate information on climate information and created various ways to carry out weather forecasts. Weather forecasts are examples of problems that often have unclear or obscure answers. Fuzzy Logic is a technique to solve this problem, so the technique used is The Mamdani as its application in the weather forecast system. Analyzing the results of weather forecasts that occur in Indonesia requires a system to know the accuracy of the data generated, so it is necessary to create a system for forecasting weather based on parameters that are inputted using the Fuzzy The Mamdani technique so that weather forecasts can be more accurate and efficient. This study predicts the weather using fuzzy The Mamdani logic techniques using the Fuzzy and Matlab toolbox as a determinant of an estimate of the weather cycle that is prioritized to be determined, namely the degree of membership functions and the rules used. Fuzzy logic with The Mamdani technique is very good to use as a weather forecast because it has an accuracy level of above 60%. Therefore, the more variables that are used as input, the better (accurate) output will be.

Keywords: Weather, Fuzzy Logic, The Mamdani, Matlab.

1. Introduction

Weather is a form in which the upper atmosphere at a point passes through a collection of an area that is narrowing as a relatively relative time. The part that affects weather conditions is the shape that results from climatic elements related to the level of altitude temperature, humidity, air pressure and volume of light intensity (Ervina, 2014).

Many of the people rely on life in the form of climate cycles, such as farmers, fishermen, traders and so on. This resulted in the emergence of a lot of pressure from various groups of people who needed accurate information on climate information and created various ways to carry out weather forecasts. Weather forecasts are examples of problems that often have unclear or obscure answers. Fuzzy Logic is a technique to solve this problem, so the technique used is The Mamdani as its application in the weather forecast system.

Weather forecast is a summary of the results of the examination of the physical condition and dynamics of the air from various circles of inspection areas which are then combined, in which the combined summary of the results of this examination is processed in a mathematical system by observing space and time, the tendency to the physical condition of the air is so similar as to one can estimate. Fuzzy logic is the element of soft computing. The basis of Fuzzy Logic is the science
of Fuzzy collections. Based on this science of Fuzzy assemblies, the contribution at a time of extreme importance such as the existence of elements as a group is considered important. Membership functions as an important identity in thinking through this Fuzzy Logic (Irmawan, 2008). As Fuzzy Logic, several techniques are found to solve a problem, one of which is the Fuzzy The Mamdani technique. The formulation of the problem taken by this thesis is how to create a weather forecast system using the The Mamdani technique and how the weather forecast results use the The Mamdani technique. The purpose of this study is to analyze the results of the The Mamdani technique weather forecast. While the results of the follow-up of this study are prioritized to produce a system that can predict climate by applying the The Mamdani technique and knowing weather forecasts using the Fuzzy The Mamdani technique tested by MATLAB R2013a.

2. Research Methods
Fuzzy Logic is defined as a technique that is suitable for concentrating one input space in the output. Regarding the lack of clarity, this theory has objects of Fuzzy elements that have an imprecise delivery and the degree of membership as a collection of Fuzzy, but as a true or false form, but a degree. Fuzzy Logic is one of them. The constituent elements of Soft Computing (Kusuma, 2010). The basis of Fuzzy logic is the theory of Fuzzy sets, the contribution of the degree of membership such as the decision maker for the existence of objects as a collection is very much taken into account. The value of the degree of membership or membership functions is an important identity for thinking through Fuzzy Logic itself (Kusuma, 2010).

This theory continued to grow until finally in 1965, Prof. Lutfi A. Zadeh divides the Fuzzy collection object which does not directly indicate not only using the theory of an opportunity that can be used to present the problem of obscurity. Also, the theory of fuzzy logic sets is not an alternative to the theory of fuzzy sets, an important element that is very important to take into account, namely the functions of membership. The membership functions display a degree of closeness to the object in certain attributes, as well as the probability of being more likely to use relative frequency (Ross, 2005).

The The Mamdani technique is often known as the Max-Min technique. The Mamdani's technique works based on linguistic rules. This technique was introduced by Ebrahim The Mamdani in 1975. To deliver the output, four stages are required:

a. Formation of Fuzzy Sets
Determine all the variables involved as the procedure to be centered. For each output variable, determine appropriate fuzzification functions. Based on the The Mamdani technique, both the output variable and the input variable. Broken down as Fuzzy sets.

b. Application Functions Implication
To conclude the rule base, namely the rule in the form of Fuzzy implications that explain the relationship between input variables through output variables. For the The Mamdani technique, the implication functions used are min. If a is A¡ and b is B¡, then c is C¡ through A¡, B¡ and C¡ are Fuzzy predicates which are the linguistic value of each variable. The number of rules is determined by the number of linguistic values for each variable.

3. Identification Problems
Analyzing the results of weather forecasts that occur in Indonesia requires a system to know the accuracy of the data generated, so it is necessary to create a system for forecasting weather based on parameters that are inputted using the Fuzzy The Mamdani technique so that weather forecasts can be more accurate and efficient.

4. Result and Discussion
As a compilation of the application of fuzzy logic, to estimate the weather, several steps are taken to make valid information as the compilation. After calculating and experimenting, the results of the weather forecast using Matlab are made. The system design analysis stages consist of fuzzy logic and data requirements analysis software. The design analysis phase includes an explanation of
fuzzy variables, fuzzy sets, universe of formation, domain fuzzy sets, membership functions, fuzzy settings and steps on The Mamdani techniques. A collection whose elements have a degree of membership. At this stage, several cryptic collections of four output variables are formed.

Table 1. Collection of Input Variables

| No | Input      | Fuzzy Level |
|----|------------|-------------|
| 1  | Temperature| Low         |
|    |            | Medium      |
|    |            | Hot         |
| 2  | Moist      | Moist       |
|    |            | Medium      |
|    |            | Not Moist   |
| 3  | Wind velocity| Slow       |
|    |            | Medium      |
|    |            | Tight       |

The degree of membership functions has an interval value of 0 to 1 which is taken based on the range of domain values for the fuzzy set of each variable. The following is an explanation that will explain the functions of the degree of membership of each variable.

a) Membership Functions of Temperature Variables

\[
\mu_{\text{cold}}(x) = \begin{cases} 
1; & x \leq 23.9 \\
\frac{26.7 - x}{26.7 - 23.9}; & 23.9 < x < 26.7 \\
0; & x \geq 26.7 \\
1; & x = 26.7 
\end{cases}
\]

\[
\mu_{\text{sedang}}(x) = \begin{cases} 
\frac{x - 22.4}{26.7 - 23.9}; & 23.9 < x < 26.7 \\
\frac{29.5 - x}{29.5 - 26.7}; & 26.7 < x < 29.5 \\
0; & x \geq 29, \text{ Satu} \leq 23.9 \\
1; & x \geq 29.5 
\end{cases}
\]

Figure 1 Temperature Membership Degree Functions Curve
b. Functions of Degree of Membership of Moisture Variable

| Moist | Medium | Not Moist |
|-------|--------|-----------|
| 69    | 84     | 100       |

Figure 2 Moisture Membership Degree Functions Curve

\[ \mu(\text{rendah}) = \begin{cases} 
1; & x \leq 69 \\
\frac{84 - x}{84 - 69}; & 69 < x < 84 \\
0; & x \geq 84 \\
1; & x = 84 
\end{cases} \]

\[ \mu(\text{sedang}) = \begin{cases} 
1; & x \leq 69 \\
\frac{x - 69}{84 - 69}; & 69 < x < 84 \\
\frac{99 - x}{99 - 84}; & 84 < x < 99 \\
0; & x \geq 99 \text{atau} x \leq 69 \\
1; & x \geq 99 
\end{cases} \]

c. Degree of Membership Functions of Wind Speed Variable

| Slow | Medium | Toned |
|------|--------|-------|
| 1    | 9.5    | 18    |

Figure 3 Wind Speed Membership Functions Curve

\[ \mu(\text{rendah}) = \begin{cases} 
1; & x \leq 1 \\
\frac{9.5 - x}{9.5 - 1}; & 1 < x < 9.5 \\
0; & x \geq 9.5 \\
1; & x = 9.5 
\end{cases} \]

\[ \mu(\text{sedang}) = \begin{cases} 
1; & x \leq 9.5 \\
\frac{9.5 - x}{9.5 - 1}; & 1 < x < 9.5 \\
\frac{18 - x}{18 - 9.5}; & 9.5 < x < 18 \\
0; & x \geq 18 \text{atau} x \leq 1 \\
1; & x \geq 18 
\end{cases} \]
Based on the theoretical basis of the weather forecast, the weighting of each fuzzy set is formed as follows:

a. For the temperature membership degree functions, the low-level group is divided into a weight of 1 divided by weight 2, and height divided by weight 3.

b. For the functions of humidity membership degree, the low-level group is divided by weight 1, divided by weight 2, and height divided by weight 3.

c. For the functions of wind speed membership degrees, the low-level group is divided by weight 1, divided by weight 2, and height divided by weight 3.

d. For the functions of the degree of membership of light intensity, the low-level group is divided by weight 3, divided by weight 2, and height divided by weight 1.

The defuzzification for the Mamdani technique used as this research is the centroid technique (Composite Moment) where the crisp solution can be made through the lifting technique at the point $(z^*)$ of the fuzzy shading area. To find the defuzzification result, the centered average technique is used.

$$Z = \frac{\int \mu(z) zdz}{\int \mu(z) dz}$$

\[(apredikat1 \ast Z1) + (apredikat2 \ast Z2) + (apredikat3 \ast Z3) + (apredikat4 \ast Z4)
\[(apredikat5 \ast Z5) + (apredikat6 \ast Z6) + (apredikat7 \ast Z7) + (apredikat8 \ast Z8) + (apredikat9 \ast Z9) + (apredikat10 \ast Z10) + (apredikat11 \ast Z11) \]

\[Z = \frac{apredikat1 + apredikat2 + apredikat3 + apredikat4 + apredikat5 + apredikat6 + apredikat7 + apredikat8 + apredikat9 + apredikat10 + apredikat11}{11.25 + 11.25 + 19.5 + 17.5 + 17.5 + 18.8 + 9.5 + 5.5 + 5.75 + 2.7 + 7.3} = \frac{126.5}{225} = 0.56222 = 56.2\]

5. Conclusion
This research predicts the weather using The Fuzzy The Mamdani logic technique using Fuzzy and Matlab toolbox as a determinant of an estimate of the weather cycle which is prioritized to be determined, namely the degree of membership functions and the rules used. Fuzzy logic with The Mamdani technique is very good to use as a weather forecast because it has an accuracy level of above 60%. Therefore, the more variables that are used as input, the better (accurate) output will be.
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