FUZZY TSUKAMOTO METHOD IN DETERMINING CORN QUALITY FOR ANIMAL FEED

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Abstract

Animal feed is the largest cost component in the livestock industry. The existence of a solution to reduce the percentage of feed costs can have a tremendous positive impact for farmers. Animal feed is generally obtained by buying factory-produced animal feed that tends to be expensive or by making their own animal feed. However not all breeders can make their own animal feed because to make good feed the formulation process is. Fuzzy Tsukamoto is one of the fuzzy logic in which the methodology of the problem solving control system is suitable to be implemented on the system. Keywords: Fuzzy Tsukamoto, Quality Corn.

1. Introduction

Today our country still imports livestock products in the form of meat, milk, and eggs to meet the animal protein needs of the community. The cause of the incapableness of our country to be able to meet the animal protein needs of the community is caused because the number of livestock that is still lacking is also caused by the low level of livestock productivity cultivated by our society. As for the cause of the low level of productivity of our livestock is influenced by many factors, including the availability of erratic feed, the quality and quantity of feed is relatively low and the price of feed that tends to rise at any time, where the increase in the price of feed is often can not be offset by the rising price of products from livestock itself, so this often makes people's livestock businesses go out of business. [1]–[4]

Animal feed is the largest cost component in the livestock industry. The existence of a solution to reduce the percentage of feed costs can have a tremendous positive impact for farmers. Animal feed is generally obtained by buying factory-produced animal feed that tends to be expensive or by making their own animal feed. But not all breeders can make their own fodder because to make good feed it is necessary to process the formulation. The Tsukamoto system is the least popular fuzzy system. Although its purpose is to combine the advantages of the Mamdani and the Sugeno system, it has found only limited application due to the constraint imposed by the special type monotonic fuzzy membership functions for the outputs [5]–[9].

Based on some of the above statements underlying the authors conducting the study, the authors decided to raise a title "Fuzzy Tsukamoto Method In Determining The Quality of Corn For Animal Feed" in the writing of this study. The benefit obtained after this research was successfully carried out is that it can provide convenience in determining the quality of corn for animal feed. [10]

2. Method

Method is a systematic way or technique to work on a case. Therefore, the author uses several ways to obtain it, including, Field research is a way to get data, which is done by doing research directly to the study site. The data collection techniques carried out by the author are:

1. Interview
   Interviews are data collection techniques by conducting direct Q&A with relevant sources.
2. Observation
   It is one of the most effective methods of collecting data to study a system.
3. Literature Studies (Library Research)
   The author conducted a library study to obtain data related to research writing from various reading sources such as: books, internet, and others.

3. Result and Discussion

3.1 Fuzzy Logic
   In his journal [3] said that fuzzy logic is a powerful concept for nonlinear handling, different timing, and adaptive systems. This allows the use of linguistic values of variables and improper relationships for system modeling behavior.

3.2. Tsukamoto Fuzzy Method
   The Fuzzy Inference System is a computational framework based on fuzzy set theory, IF-THEN-shaped fuzzy rules, and fuzzy reasoning. So far several methods have been known in FIS, such as the Tsukamoto method, the Mamdani method and the Sugeno method. In the Tsukamoto method, each consequent to the IF-THEN-shaped rule must be represented by a fuzzy set with a monotonous membership function. As a result, the output of inference results from each rule is given expressly (crisp) based on $\alpha$-predicate (firestrength). The final result uses a weighted mean [2].

   In general, Tsukamoto's fuzzy model form is [2]:
   
   If (X IS A) and (Y IS B) Then (Z IS C)
   
   Where A, B, and C are fuzzy sets.
   
   Suppose known the following 2 rules.
   
   IF (x is $A_1$) AND (y is $B_1$) THEN (z is $C_1$)
   IF (x is $A_2$) AND (y is $B_2$) THEN (z is $C_2$)

   In its inference, the Tsukamoto method uses the following stages:

1. Fuzzyfikasi
2. Establishment of Fuzzy knowledge base (Rule in the form of IF.... THEN)
3. Inference Machine
   Use the MIN implication function to get $\alpha$-predicate value of each rule ($\alpha_1$, $\alpha_2$, $\alpha_3$, ..., $\alpha_n$). Then each of these $\alpha$ values is used to calculate the output of inference results expressly (crisp) each rule ($z_1$, $z_2$, $z_3$, ..., $z_n$).
   
4. Defuzzyfikasi
   Using the Averagemethod
   
   $z^* = \frac{\sum a_i z_i}{\sum a_i}$  (1)

   DeFuzzyfikasi Process
   The final result of output (z) is obtained by using the weighting average:
   
   $z = \frac{\alpha_1 z_1 + \alpha_2 z_2}{\alpha_1 + \alpha_2}$  (2)

3.3 System Design
   The system design uses several forms of UML diagrams, namely: Use Case Diagram, Class Diagram, Activity Diagram, and Sequence Diagram.

1. Use Case Diagram
   Use case is a series / description of a group that is interconnected and forms a system regularly carried out or supervised by an actor. Generally use cases described with an ellipse with a solid line, usually containing a name. Use case describes the system process (system needs from the user's point of view). Then drawn a form of Use Case diagram that can be seen in figure 1.
2. Method Implementation

The process of applying Fuzzy Tsukamoto method in the supporting system of the best corn determination decision for animal feed at PT. Intraco Agro Industry as follows: Corn with code ID-0001 will be assessed to find out whether the quality of corn is good or not to be used as animal feed. The water content of corn is lacking, the quality is good, and the vitamin content is also good. The criteria used in the process of determining the best corn can be seen in table 1.

Table 1. Criteria and Sub Criteria

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>SUB CRITERIA</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOISTURE CONTENT</td>
<td>Good</td>
<td>100</td>
</tr>
<tr>
<td>QUALITY</td>
<td>Less</td>
<td>50</td>
</tr>
<tr>
<td>VITAMIN</td>
<td>Good</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Less</td>
<td>50</td>
</tr>
</tbody>
</table>

The highest and lowest values on each valuation variable can be seen in table 2.

Table 2. Variable Highs and Lows

<table>
<thead>
<tr>
<th>№.</th>
<th>VARIABLE NAME</th>
<th>HIGHEST RATED</th>
<th>LOWEST VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Moisture Content</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>2.</td>
<td>Quality</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>3.</td>
<td>Vitamin</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>4.</td>
<td>Final Value</td>
<td>100</td>
<td>50</td>
</tr>
</tbody>
</table>
a. Stage 1: Establishment of Rule

Formation rules in the form of IF ... THEN which are invincible with the variables used. The rules that are formed are as follows:

R1] if high moisture content and high quality and high vitamins then high value
[R2] if water content is high and high quality and vitamin is low then value is high
[r3] if high water content and low quality and high vitamin then high value
[r4] if low water content and high quality and high vitamin then high value
[r5] if the water content is low and the quality is low and the vitamins are low then the value is low
[r6] if low water content and low quality and high vitamin then low value
[r7] if water content is low and high quality and vitamin is low then value is low
[r8] if water content is high and quality is low and vitamin is low then value is low

b. Stage 2: Inference Engine

In the inference engine, apply the MIN function to each rule to the implication function.

[R1] IF Water Content HIGH AND Quality HIGH AND Vitamin HIGH THEN Value HIGH
\[ \alpha_{-\text{predikat}_1} = \mu_{\text{HIGH}} \cap \mu_{\text{HIGH}} \cap \mu_{\text{HIGH}} \]
\[ = \min(0 ; 1 ; 1) \]
\[ = 0 \]

Look at the HIGH set in the final Value variable membership graph:
\[ \frac{d - 50}{50} = 0 \]
\[ d - 50 = 0 * 50 \]
\[ d = 0 + 50 \]
\[ d_1 = 50 \]

[R2] IF Water Content HIGH AND Quality HIGH AND Vitamin LOW THEN Value HIGH
\[ \alpha_{-\text{predikat}_2} = \mu_{\text{HIGH}} \cap \mu_{\text{HIGH}} \cap \mu_{\text{LOW}} \]
\[ = \min(0 ; 1 ; 0) \]
\[ = 0 \]

See the HIGH set on the final Value variable membership graph:
\[ \frac{d - 50}{50} = 0 \]
\[ d - 50 = 0 * 50 \]
\[ d = 0 + 50 \]
\[ d_2 = 50 \]

[R3] IF Water Content HIGH AND Quality LOW AND Vitamin HIGH THEN Value HIGH
\[ \alpha_{-\text{predikat}_3} = \mu_{\text{HIGH}} \cap \mu_{\text{LOW}} \cap \mu_{\text{HIGH}} \]
\[ = \min(0 ; 0 ; 1) \]
\[ = 0 \]

Look at the HIGH set in the final Value variable membership graph:
\[ \frac{d - 50}{50} = 0 \]
\[ d - 50 = 0 * 50 \]
\[ d = 0 + 50 \]
\[ d_3 = 50 \]

[R4] IF Water Content LOW AND Quality HIGH AND Vitamin HIGH THEN Value HIGH
\[ \alpha_{-\text{predikat}_4} = \mu_{\text{LOW}} \cap \mu_{\text{HIGH}} \cap \mu_{\text{HIGH}} \]
\[ = \min(1 ; 1 ; 1) \]
\[ = 1 \]

Look at the HIGH set in the final Value variable membership graph:
\[ \frac{d - 50}{50} = 1 \]
\[ d - 50 = 1 * 50 \]
\[ d = 50 + 50 \]
\[ d_1 = 100 \]

[R5] IF Water Content LOW AND Quality LOW AND Vitamin LOW THEN Value LOW
\[ \alpha \text{-predikat}_5 = \mu \text{LOW} \cap \mu \text{LOW} \cap \mu \text{LOW} \]
\[ = \min(1 ; 0 ; 0) \]
\[ = 0 \]

Look at the LOW set in the final Value variable membership graph:
\[
\begin{array}{c}
\text{100 - } d \\
\text{50} \\
\text{100 - d} = 0 \times 50 \\
\text{-d} = 0 - 100 \\
\text{-d} = -100 \\
\text{d}_5 = 100
\end{array}
\]

[R6] IF Water Content LOW AND Quality LOW AND Vitamin HIGH THEN Value LOW
\[ \alpha \text{-predikat}_6 = \mu \text{LOW} \cap \mu \text{LOW} \cap \mu \text{HIGH} \]
\[ = \min(1 ; 0 ; 1) \]
\[ = 0 \]

Look at the LOW set in the final Value variable membership graph:
\[
\begin{array}{c}
\text{100 - } d \\
\text{50} \\
\text{100 - d} = 0 \times 50 \\
\text{-d} = 0 - 100 \\
\text{-d} = -100 \\
\text{d}_6 = 100
\end{array}
\]

[R7] IF Water Content LOW AND Quality HIGH AND Vitamin LOW THEN Value LOW
\[ \alpha \text{-predikat}_7 = \mu \text{LOW} \cap \mu \text{HIGH} \cap \mu \text{LOW} \]
\[ = \min(1 ; 1 ; 0) \]
\[ = 0 \]

Look at the low set in the final Value variable membership graph:
\[
\begin{array}{c}
\text{100 - } d \\
\text{50} \\
\text{100 - d} = 0 \times 50 \\
\text{-d} = 0 - 100 \\
\text{-d} = -100 \\
\text{d}_7 = 100
\end{array}
\]

[R8] IF Water Content HIGH AND Quality LOW AND Vitamin LOW THEN Value LOW
\[ \alpha \text{-predikat}_8 = \mu \text{HIGH} \cap \mu \text{LOW} \cap \mu \text{LOW} \]
\[ = \min(0 ; 0 ; 0) \]
\[ = 0 \]

Look at the low set in the final Value variable membership graph:
\[
\begin{array}{c}
\text{100 - } d \\
\text{50} \\
\text{100 - d} = 0 \times 50 \\
\text{-d} = 0 - 100 \\
\text{-d} = -100 \\
\text{d}_8 = 100
\end{array}
\]

c. Phase 3: Defuzzyfication
Value tegas $d$ dapat dicari menggunakan rata-rata terbobot, yaitu:

$$d = \alpha_{pred_1} d_1 + \alpha_{pred_2} d_2 + \alpha_{pred_3} d_3 + \alpha_{pred_4} d_4 + \alpha_{pred_5} d_5 + \alpha_{pred_6} d_6 + \alpha_{pred_7} d_7 + \alpha_{pred_8} d_8$$

$$d = 0*50 + 0*50 + 0*50 + 1*100 + 0*100 + 0*100 + 0 + 0 + 0 + 0$$

$$d = \frac{100}{1} = 100$$

<table>
<thead>
<tr>
<th>VALUE</th>
<th>DECISION</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>Quality Good</td>
</tr>
<tr>
<td>50</td>
<td>Quality Not Good</td>
</tr>
</tbody>
</table>

The final value of corn with code ID-0001 is 100. Based on the decision table (table 3), the corn has good quality. Means that corn with code ID-0001 can be used for animal feed.

4. Conclusions

As for the conclusion of the Fuzzy Tsukamoto Method in Determining the Quality of Corn For Animal Feed that the author built as follows, Decision support system built can help and provide convenience in the process of determining the quality of corn for animal feed. Setting variable assessment is done through the system. So, if there is a change in the maximum value and minimum variables, the admin just update through the system without having to change the program. Fuzzy Tsukamoto method used is quite effective in providing the final result of determining the quality of corn for animal feed in accordance with the value owned by the corn. The accuracy of testing using fuzzy Tsukamoto method is 100%.

References


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