

A COMPARATIVE STUDY ON MAMDANI FUZZY MODEL IMPLEMENTED IN QTFUZZYLITE AND MATLAB FOR STUDENT'S ACADEMIC PERFORMANCE ASSESSMENT

ABSTRACT

In this research paper a comparative study is done on Mamdani Fuzzy Model (MFM) [3] implemented in qtfuzzylite and Matlab for Student's Academic Performance Assessment. Mamdani Fuzzy Model for student academic performance evaluation has been implemented in an open-source software, qtfuzzylite and Matlab (online) [1]. The Mamdani Fuzzy Model was tested with internal mark in English of 10 Grade XI students from Govt Higher secondary school, Patamadai, Tirunelveli. The student's academic performance scores implemented in the MFM in qtfuzzylite and Matlab was compared and analysed using paired t test in Ms excel. Analysis of MFM implemented in qtfuzzylite and Matlab reveals no significance differences in the performance values of students.

Keywords : Mamdani Fuzzy Model, open -source software, qtfuzzylite, Matlab, Student's academic performance assessment.

Introduction

Student's Academic Performance Assessment for higher learning is, an area of concern for teacher [2]. Student's Academic Performance Assessment is the way to find about the extent to which students are successfully meeting learning objectives [5]. Assessment of Student's Academic Performance play a significant role in proving feedback both to the learner and the teacher. Uncertainty, an aspect of information [6]. Fuzzy logic paves way to comprehend the information in words and helps in quantification of that linguistic information such that it is well processed and a desired output is obtained [3]. Fuzzy logic system helps to comprehend and also gives description of the assessment result [5]. Literature review revealed the importance of fuzzy inference system in assessment and almost all the fuzzy inference system is implemented in Matlab The focus of this paper is to study the Mamdani Fuzzy Model

(MFM) implemented in an open-source software, qtfuzzylite in comparison with the Matlab, for Student's Academic performance assessment

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Preliminaries

For, Fuzzy-theoretic terminologies, the reader can refer to [6]

Definition 2.1[6] If X is a set of elements denoted by x , then a fuzzy set \tilde{A} in X is a set of ordered pairs $\tilde{A} = \{(x, \mu_{\tilde{A}}(x)) / x \in X\}$; $\mu_{\tilde{A}}(x)$ is called the membership function or grade of membership of x in \tilde{A} such that, $\mu_{\tilde{A}}(x) : X \rightarrow [0,1]$.

Definition 2.2[6] Gaussian membership function is the typical Gauss bell, defined by its midvalue c and the value of $\sigma > 0$. The smaller σ is, the narrower the bell. It is defined by parameter, c, σ , in the following way.

Gaussian($x; c, \sigma$) = $e^{-\frac{1}{2}(\frac{x-c}{\sigma})^2}$, where c represents the centre and σ determines the width of the membership function.

Definition 2.3[6] Let two fuzzy sets be \tilde{A} and \tilde{B} , the universe of information U and an element y of the universe, the following relations express the union operation on fuzzy sets, $\mu_{\tilde{A} \cup \tilde{B}}(y) = \mu_{\tilde{A}} \vee \mu_{\tilde{B}} \forall y \in U$. Note. Here \vee represents the 'max' operation

Definition 2.4[6] Let two fuzzy sets be \tilde{A} and \tilde{B} , the universe of information U and an element y of the universe, the following relations express the intersection operation on fuzzy sets, $\mu_{\tilde{A} \cap \tilde{B}}(y) = \mu_{\tilde{A}} \wedge \mu_{\tilde{B}} \forall y \in U$.

Note. Here \wedge represents the 'min' operation.

Working principle

The working principle is explained below.

A. Data collection

For the Student Academic performance evaluation, the internal mark in English of 10 Grade XI students from Govt Higher secondary school, Patamadai, Tirunelveli has been collected.

B. Soft ware

Student Academic Performance evaluation is implemented in the open-source software qtfuzzylite and the Matlab (online). [1]

C. Functional operation in Mamdani

Fuzzy Model

1. Fuzzification
2. Fuzzy Inferencing using Mamdani fuzzy model
3. Defuzzification

1. Fuzzification

Let x_1 and x_2 be the input values, and y is the output value. Subset A_i , subset B_j and subset Y_k . such that $i = \{1,2,3\}, j = \{1,2,3\}$ and $k = \{1,2,3\}$ are fuzzy subsets with the corresponding membership functions μ_{A_i}, μ_{B_j} , and μ_{Y_k} . Let Subset A_i , subset B_j describe linguistically student's academic performance and is given as inputs to the Mamdani fuzzy model. Each measured numeric value (test mark) $x_i \{i = 1,2, \dots, k\}$ takes its values in a set of positive numbers X . Thus, we define the numeric input $X = \{x_1, \dots, x_i, \dots, x_k\}$ to the Mamdani

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fuzzy model [3], where X is the universe of discourse.

1.1 Fuzzification of inputs and outputs in qtfuzzylite

For each student their internal test mark is given as input to Mamdani fuzzy model in qtfuzzylite and are given in figure 1. The inputs and output have three Gaussian membership functions implemented in qtfuzzylite which are given in figure 1.

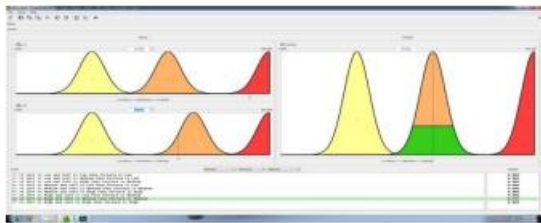


Figure 1 Fuzzification of inputs and outputs in qtfuzzylite

1.2 Fuzzification of inputs and outputs in Matlab (online)

The inputs and output have three Gaussian membership functions [6] with same parameter associated with input and output variables of Mamdani fuzzy model in qtfuzzylite and are shown in figure 2.

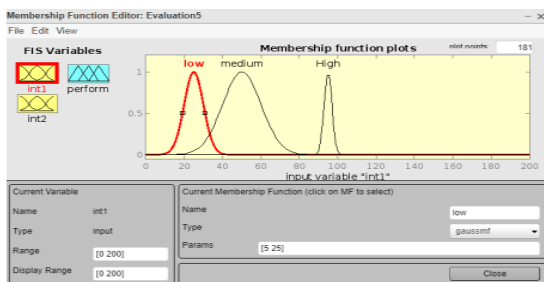


Figure 2 Fuzzification of inputs and outputs in Matlab (online)

2. Fuzzy Inferencing using Mamdani fuzzy model

The fuzzy rule base [6] is given a group of if-then control rules with two inputs, x_1 and x_2 , and one output, y . When x_1 and x_2 have three membership functions each, a representative rule set of nine fuzzy if-then rules can be stated as R^n : if x_1 is A_i and x_2 is B_j then y is Y_k ,

Where $R^n (n = 1, 2, \dots, 9)$ denotes the n -th implication. The x_1 and x_2 are the input values, and y is the output value. Subset A_i , subset B_j and subset Y_k , such that $i = \{1, 2, 3\}$, $j = \{1, 2, 3\}$ and $k = \{1, 2, 3\}$ are fuzzy subsets with the corresponding Gaussian membership functions μ_{A_i} , μ_{B_j} , and μ_{Y_k} . In this component, the Mamdani fuzzy model gives a fuzzy logic inferencing of student's academic performance. Mamdani fuzzy model [3] infers the linguistic terms [3] with the help of fuzzy preconditions [3] and applies fuzzy relations [6] operated with the max-min composition [6].

2.1 Fuzzy Inferencing in qtfuzzylite

The fuzzy rules developed in the Mamdani fuzzy model implemented in qtfuzzylite are given in figure 3

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Rules
if int1 is Low and int2 is Low then Perform is Low
if int1 is Low and int2 is Medium then Perform is Low
if int1 is Low and int2 is High then Perform is Medium
if int1 is Medium and int2 is Low then Perform is Low
if int1 is Medium and int2 is Medium then Perform is Medium
if int1 is Medium and int2 is High then Perform is High
if int1 is High and int2 is Low then Perform is Medium
if int1 is High and int2 is Medium then Perform is Medium
if int1 is High and int2 is High then Perform is High
#-----
# Total rules: 9. Good Rules: 9. Bad Rules: 0.
# Rules successfully processed at 4:57.06 pm (11/07/22)
# You may proceed to control the engine
    
```

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Figure 3 The fuzzy rules developed in the Mamdani fuzzy model implemented in qtfuzzylite

2.2 Fuzzy Inferencing in Matlab

The fuzzy rules developed in the Mamdani fuzzy model implemented in qtfuzzylite are used in Matlab and are shown in figure 4. The fuzzy rules activated for the given input mark 92 and 64 is shown in figure 5

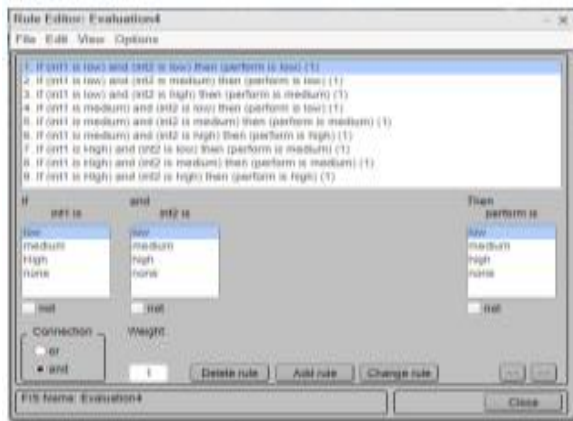


Figure 4 The fuzzy rules developed in the Mamdani fuzzy model implemented in Matlab

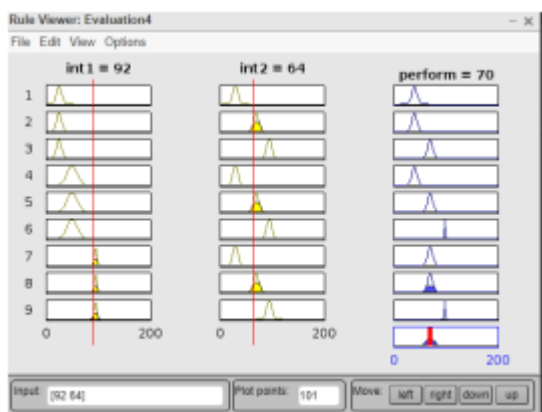


Figure 5 Rule viewer for input mark 92 and 64

3. Defuzzification

In this component, the Mamdani fuzzy model gives the fuzzy output which has to be defuzzified using suitable defuzzifier [6]. The crisp value of the output is obtained by

$$Z = \frac{\int \mu_C(z) \times x \times dz}{\int \mu_C(z) \times dz}$$

Where, $\mu_C(z)$ is the aggregated output membership function generated by the Mamdani fuzzy model. The output performance value obtained from Mamdani fuzzy model implemented in qtfuzzylite and Matlab is given in figure 6 and figure 7 respectively.

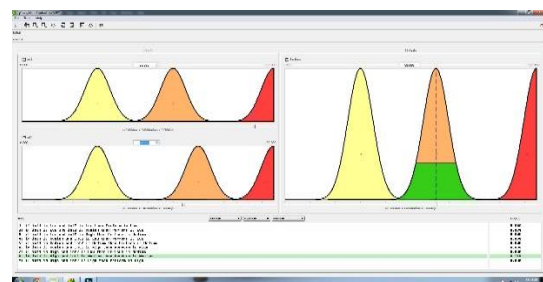


Figure 6 The output performance value from Mamdani fuzzy model implemented in qtfuzzylite

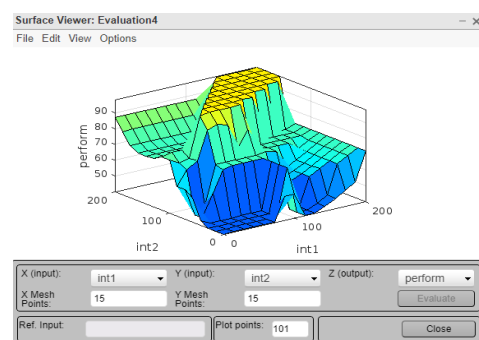


Figure 7 The output performance value from Mamdani fuzzy model implemented in Matlab

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Analysis of experiment

The Mamdani fuzzy model was tested with internal mark in English of 10 Grade X I students from Govt Higher secondary school, Patamadai, Tirunelveli. Table 1 shows the comparisons of performance scores with the MFM implemented in qtfuzzylite and Matlab. Then two set of score was analyzed using paired t -test in Ms excel 2003.

S.No.	int1	int2	Perform score (qtfuzzylite)	Perform score (Matlab)
1.	92	64	70	70
2.	92	80	70	70.6
3.	36	72	62.8	62.8
4.	92	36	69.97	70
5.	76	44	40	40
6.	84	68	70	70
7	80	72	70	70
8	32	64	51.39	51.4
9	76	44	40	40
10	32	64	51.39	51.4

Table 1 comparisons of performance scores with the FIS implemented in qtfuzzylite and Matlab.

Conclusion and Future research

Comparison of Mamdani Fuzzy Model implemented in qtfuzzylite and Matlab reveals no significant differences in the performance values of students. Given enormous number of application of fuzzy logic implemented in Matlab, this result throws light on the accessibility of the MFM in an open- source

software ,qtfuzzylite for its real purpose in student's academic performance evaluation. Further, this research paves way for the alternative regarding the accessibility of fuzzy tool [1] in the hands of teachers, researchers and any academicians for serving the real purpose of its application at grass root level.

Reference

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