Development of Classification Features of Mental Disorder Characteristics Using The Fuzzy Logic Mamdani Method

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Abstract—Mental disorders are related to self-injurious behavior problems of mind, such as the tendency to commit suicide. This research has built a system to classify the disorder. It explains that a system is used to help the people recognize mental illness as a diagnosis detection. Diagnosis can be done in the form of automation system using data mining with Fuzzy Logic method. This system can make decision to classify the mental illnesses based on symptoms. The first stage of the research was collecting and preprocessing the data by type. There are six types of psychiatric disorders that are determined, namely Schizophrenia Paranoid, Phobia, Depression, Anxiety, Obsessive Compulsive Disorder (OCD), and Anti-Social. The source of the data were questionnaires that consisted of the list of symptoms and types of disorders that were distributed to 16 selected respondents, including psychiatric specialists, psychology lecturers, general practitioners, psychiatric hospital nurses, and psychology students. The next stage was building the fuzzy process to determine ten inputs in the form of symptoms. Outputs system were six types of the disease. The fuzzy inference system used Mamdani model and obtained 65 rules in determining the classification. The result of system test is done for both training and testing data and accuracy level of 91.67% for training data and 81.94% for testing data.

Keywords—mental disorders, classify, fuzzy logic, data, symptom.

I. INTRODUCTION

Mental disorders are a serious problem to be resolved because they affect emotional stability and security for both the person and the environment [1][2]. This problem was shown from the results of data on mental disorders in Indonesia, which was approximately 6% for the age of 15 years and above or approximately 14 million people of the Indonesian population. More specifically, the suicide rate was approximately 0.5% of the 100.000 population or 1,170 suicides and more than 400,000 people suffer from severe mental disorders (psychosis) [3].

Normally, the mental health condition of a good person allows an individual to be able to develop all of his/her potential optimally. Hence, if this condition changes drastically, uncontrollably and for a long time will interfere directly or indirectly because the sufferer is unable to judge reality or control him/herself to prevent disturbing others or

damage and hurt him/herself. This disease affect emotions, thoughts and behavior beyond one's cultural and personality beliefs, and will have negative effects on their lives. This disorder has negative effects such as reducing the level of trust in the personality of the person or his/her family [2][3].

To prevent the addition of a number of mental disorders, it is important to make an effort as early as possible to recognize psychiatric conditions, so the factors are detected as a diagnosis. Detection that is usually done was by recognizing the symptoms of irregularities in a person's psyche. The importance of early detection can also help in knowing and understanding the psychological condition of individuals in tackling the occurrence of mental disorders and can provide better handling. Theoretically, the diagnosis of mental disorders can be learned as a knowledge and through a routine training process. The problem was that if the identifying officer is not too skilled, the time needed for a series of diagnostic activities will be longer[4].

It is necessary to diagnose the disease automatically using a method that is applied in a system that uses the data mining method of Fuzzy Logic. The fuzzy method has been used in various fields, such as signal processing, control, communication, business, health and others[5][6][7][8]. This method has been widely applied in several systems using pattern classification such as heart abnormality pattern [9], diagnosis of hyperthyroid disease [10][11], cloud image classification[12], where all these systems are able to properly clarify patterns. Utilization of data processing systems such as data mining that utilizes artificial intelligence fuzzy logic method makes it possible to create an automation system to overcome these psychological problems. This system allows users (in this case the patient's family or frontline society or medic) to be able to detect mental disorders more quickly and accurately.

II. METHODOLOGY AND MENTAL DISORDERS SYSTEM DESIGN

This study consisted of several stages: The first stage was data collection and data processing. At this stage data collection was carried out to obtain information and data needed in conducting research. The data used in this study

were the results of the questionnaire. This data was used as input data and based on system requirements, it was separated as training and testing data. The second stage was the process of classification. The development process of data mining was used to find patterns. This process used statistic calculation and artificial intelligence/machine learning to extract and identify the information from the large data [7][12]. Fuzzy logic is one of artificial intelligence types that has a continuous value. It can be expressed in degrees of a membership. The membership functions used in this research was the triangular membership function curve that as shown in the Eq. 1[13]. This process has several stages carried out in the Fuzzy Logic Mamdani process. This stage was ilustrated in Fig.1. The fuzzy membership function using Triangular function was illustrated in Fig.2. To get the output, an implication function was needed where the function of this implication was used to determine the composition of the rule in the system. The implication function used MIN-MAX and the defuzzyfication method was the centroid. The third stage was analyzed system testing and determines the value of accuracy. This values was searched by using the formula at Eq.2.

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

$$Accuracy = \frac{Amount \quad of \quad The \quad Correct \quad Data}{Total \quad Data} x100\% \quad (2)$$
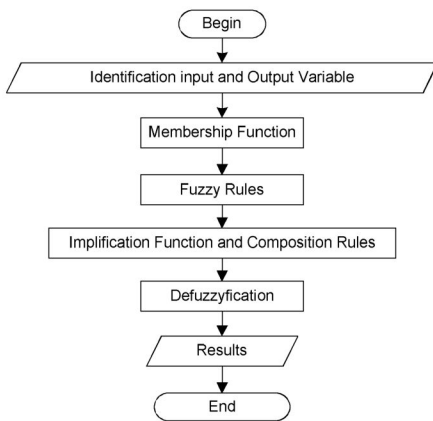

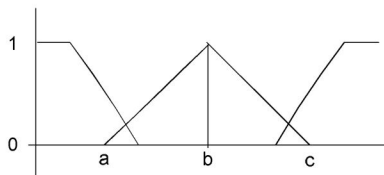Fig. 1. The process of classification of mental disorders using Fuzzy Logic Mamdani

Fig. 2. Triangular fuzzy membership function

III. PARAMETRIC STUDY

In this study, a system was created to determine the classification of mental disorders based on symptoms. The symptoms were the diagnostic data that were made in a form of questionnaire values from respondents. Respondents were the people who were related to the medical mental illness such as mental specialists, psychology lecturers, psychology nurses, general practitioners and psychology students at the final level. The type of data was divided into two types, training data and testing data. Respondents for the training data are four people, two mental specialists and two psychology lecturers. Whereas for the testing data were twelve respondents including one psychology lecturer, two general practitioners, four psychology students, and five nurses in mental hospitals. The questionnaire lists the symptoms of mental disorders from six types of mental disorders consisting of forty symptoms of mental disorders obtained from literatures. Then, the symptoms were compared and reduced by combining symptoms that have the same meaning or having the same symptoms with another generate disease after discussed with the experts so that obtained ten main symptoms for six types of the disease. Each respondent was given three parameters (low, medium, high) which selected symptoms according to the characteristics of each disease. The low parameter indicates that the disease was rare/very infrequent, medium means more often and high means often or very often suffered. The data preprocessing was done to get the average value of the respondents and determine the range of parameter values of each symptom.

A. Input and Output Variable

Inputs of this process were ten symptoms of mental disorders as shown in Table.1. Those symptoms symbolized by I1 to I10. The output variables were six types of mental disorders, namely Paranoid Schizophrenia, Phobia, Depression, Anxiety, OCD, and Antisocial.

TABLE I. THE INPUT VARIABLE

Input	Symtoms
I1	Unstable emotion
I2	Decreased Attention to Him/her_self
I3	Excessive anxiety
I4	Rampage
I5	Lack of the Ability to think realistically
I6	Restless
I7	Not caring about personal safety and others
I8	Repeated and persistent thoughts
I9	Excessive fear and desire to avoid an object or situation
I10	Easy to Suspect

TABLE II. THE INPUT PARAMETER

Input parameter	Parameter Level	Parameter Value
Unstable Emotions (I1)	Low	[1,2 1,45 2,68]
	Medium	[1,48 2,05 2,69]
	High	[1,62 2,72 2,9]
Decreased Attention to Him/her_self (I2)	Low	[0,8 1,18 2,26]
	Medium	[1,25 1,62 2,28]
	High	[1,7 2,3 2,5]
Excessive anxiety (I3)	Low	[1,3 1,45 2,68]
	Medium	[1,48 2,25 2,7]

Input parameter	Parameter Level	Parameter Value
	High	[2,24 2,75 3,2]
Rampage (I4)	Low	[0,8 1,25 2,51]
	Medium	[1,3 1,75 2,52]
	High	[1,8 2,55 2,7]
Lack of the ability to think realistically (I5)	Low	[0,8 1,1 2,35]
	Medium	[1,3 1,65 2,26]
	High	[1,7 2,37 2,5]
Restless (I6)	Low	[0,8 1,25 2,57]
	Medium	[1,31 1,75 2,26]
	High	[1,74 2,59 2,7]
Not caring about personal safety and others (I7)	Low	[0,8 1,35 1,9]
	Medium	[1,5 2 2,6]
	High	[1,65 2,7 3,2]
Repeated and Persistent Thoughts (I8)	Low	[1,8 1,95 3,01]
	Medium	[1,97 2,45 2,85]
	High	[2,5 3,28 3,3]
Excessive Fear and Desire to avoid an object or situation (I9)	Low	[1,2 1,45 3,01]
	Medium	[1,47 1,78 2,5]
	High	[1,65 3,2 3,3]
Easy to Suspect (I10)	Low	[0,8 1,3 3,01]
	Medium	[1,47 1,8 2,6]
	High	[0,98 3,2 3,3]

Fig. 3. Membership Function of 'Unstable Emotions (I1)' triangular type
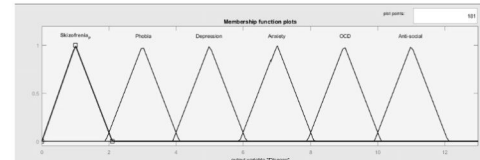
Fig. 4. The output variable membership function triangular type

TABLE III. THE OUTPUT VARIABLE

Output	Parameter Value
Paranoid Schizophrenia	[0 1 2,1]
Phobia	[1,9 3 4,1]
Depression	[3,9 5 6,1]
Anxiety	[5,9 7 8,1]
OCD	[7,9 9 10,1]
Anti-Social	[9,9 11 12.1]

B. Membership function

The parameters in each symptom has a certain range of values for each parameter [0.8 – 3.3]. The form of the membership function of each input variable is shown in Table. 2. The form of a system membership function with an example of input was 'an unstable emotions' is shown in Figure 3. The output variable has a range of values [0-13]. This output variable parameter can be seen in Table 3. The output variable membership function with the triangle type is shown in Figure 4.

C. Determine the Fuzzy Rule

Fuzzy rule was formed based on the value generated in thequestionnaire which contains the ten main symptoms of m ental disorders so that sixty five main fuzzy rules were obtained. The operator used to connect between inputs was the AND operator, and the function that maps between inputs to output was IF-THEN. The centroid position of defuzzyfication was obtained by taking the center of the
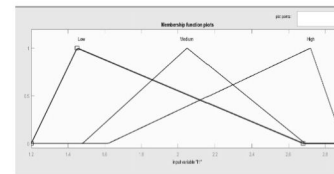
TABLE IV. EXAMPLE OF THE RULE OF FUZZY SYSTEM

Rule	Condition	Effect
Rule-1	*IF* Unstable emotions is **High** *AND* Decreased attention to oneself is **High** *AND* Excessive Anxiety is **Low** *AND* Raging is **High** *AND* Lack of the ability to think realistically is **Low** AND Restless is **High** *AND* Regardless of the safety of self and others is **Low** *AND* repetitive and persistent thoughts **is Low** *AND* excessive fear and the desire is **Low** *AND* excessive fear and desire to avoid an object or situation is **High**	*THEN* Skizophrenia Paranoid
Rule-2	*IF* Unstable emotions is **Medium** *AND* Decreased attention to oneself is **Low** *AND* Excessive Anxiety is **Medium** *AND* Raging is **Low** *AND* Lack of the ability to think realistically is **Medium** AND Restless is **Medium** *AND* Regardless of the safety of self and others is **Low** *AND* repetitive and persistent thoughts **is Low** *AND* excessive fear and the desire is **High** *AND* excessive fear and desire to avoid an object or situation is **Low**	*THEN* Phobia
...	...	...
Rule-65	*IF* Unstable emotions is **High** *AND* Decreased attention to oneself is **Low** *AND* Excessive Anxiety is **Low** *AND* Raging is **High** *AND* Lack of the ability to think realistically is **Low** AND Restless is **Low** *AND* Regardless of the safety of self and others is **Low** *AND* repetitive and persistent thoughts **is Medium** *AND* excessive fear and the desire is **Low** *AND* excessive fear and desire to avoid an object or situation is **High**	*THEN* Anti-Social

fuzzy area. Three model of membership function of Mental disorder rules was found in Table. 4. The system designed according to the rules, example, if the input fill ten of the symptoms: symptom1= low (I1=2.05), symptom2= low (I2=1.65), symptom3= low (I3=2.25), symptom4= medium (I4=1.75), symptom5= medium (I5=1.65), symptom6=

low (I6=1.75), symptom7= high (I7=2), symptom8= low (I8=2.55), symptom9= low (I9=2.25), symptom10= low (I10=2.05) then the system gave the classification of disease was anti-social (value=11).

D. Implementation

The system has an application to classify mental disorders. There are ten lists of symptoms that can be filled based on each symptom that is felt by the patient. Each symptom has three parameters: low, medium, and high and the parameter was at the certain value. After the user has filled the list of symptoms and proceed the system, the diagnosis will appear in the form of a classification of mental disorders. Whereas, if the diagnosis is not detected, it means that the symptoms entered are not included in one of the specified or undetectable type. The diagnostic display is shown in Figure 6.

IV. RESULT AND DICUSSION

A. Result of Experiments

The diagnosis results gave different values based on the respondent's background. The comparison of the results was illustrated in Figure 7. From the figure, psychology lecturers have the highest values, the second, mental specialist and general practitioner, then psychology student and the lowest were the nurses of mental hospital. It seems like the data from the experts more accurate than non-experts. Its means, the system has been running according to the right algorithm that has been compiled.

B. System Evaluation

System evaluation was performed by testing the system with inserting respondents which have expert mental medical background (training) and various background (testing). The first has accuracy as 91.67% while the second has accuracy as 86.81%. The errors occurs because of the incompatibility of the diagnosis result. It was declared 'undetected' or 'included in to another rule'. This error was caused by the different levels of expertise of each respondent. The result of the evaluation was shown in Figure 8.
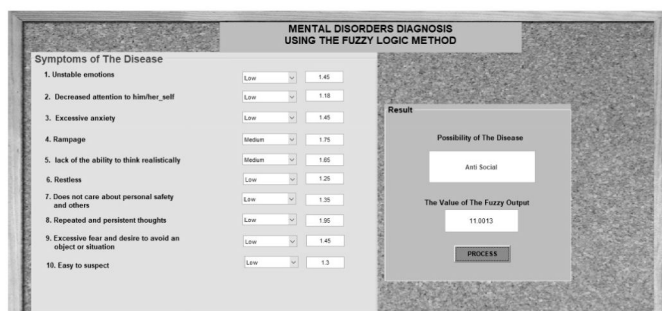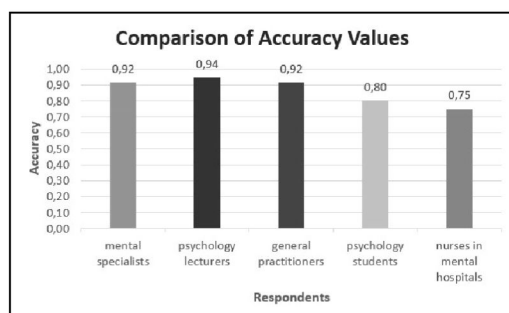

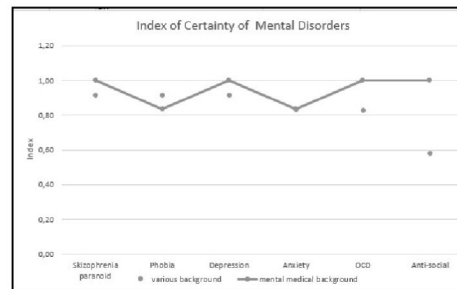Fig. 5. Dignostic input viewer

Fig. 6. Comparison between respondents

Fig. 7. Evaluation Result

V. CONCLUSION

The system was proposed and it has ability to classify the inputs almost in all certain classification and the difference of error was less than five percent. However there is a mismatch of the diagnosis by the system compared to the respondent, the rules made by the system has approached the real values and in accordance with expert logic. Furthermore, this system can be apply to the real person who has the real symptoms of the disease, not questionnaire, and also can help the people to diagnose the symptoms in wider use.

REFERENCES

[1] American Psychiatric Associotion, DSM-IV-TR Diagnostic and Statistical Manual of Mental Disorder, Washington, D.C: American Psychiatric Association, 2000.

[2] Tsou J. Y. Depression And Suicide Are Natural Kinds: Implications For Physician-Assisted Suicide. 2013. International Journal Of Law And Psychiatry. Volume 36, Pages 461-470

[3] Badan Penelitian Dan Pengembangan Kesehatan Kementerian Kesehatan RI, Riset Kesehatan Dasar tahun 2013, Jakarta: RISKESDAS, 2013.

[4] Nevid, J., Rathus, S. & Green, E., Abnormal psychology in changing world. New Jersey: Prentice Hall. 2003.

[5] D. T. Larose, Discovering Knowledge in Data: An Introduction to Data Mining, New Jersey : John Willey & Sons, Inc, 2005.

[6] Patterson, D. W., Introduction to artificial Intelligence and expert system, Inc: Prentice hall, 1990.

[7] L. Wang, A Course in Fuzzy Systems and Control, New Jersey : Prentice Hall International, Inc, 1997.

[8] Pusdekar, R. M. & Bawaskar, A. B., VLSI Architecture of Centre of Gravity Based Defuzzifier Unit, International Journal of Engineering and Innovative Technology (IJEIT), IV(10). 2015.

[9] Razia, Shaik and Narasinga, M. R, "Machine Learning Techniques for Thyroid Disease Diagnosis - A Review", in Indian Journal of Science and Technology, Vol. 9(28), 2016

[10] Nithya, R and Santhi, B. "Classification of Normal Abnormal Patterns in Diginal Mammograms for Diagnosis of Breast Cancer", In International Journal of Computer Application, vol. 28, 2011.

[11] Senthilkumar, N. Sheelarani and S. Paulraj, "Advances Classification of Multi-dimensional Thyroid Dataset Using Data Mining Techniques: Comparison Study" in Natural and Applied Sciences, 2015, p 24-28

[12] Devika & Sudhaman Parthasarathy, "Fuzzy statistics-based affinity propagation technique for clustering in satellite cloud image", in European Journal of Remote Sensing, vol. 51:1, p754-764, 2018

[13] Rahmadi Kurnia, Meza Silvana, Ikhwana.E, "A Skin and Clothes Matching Seeded by Color System Selection", TELKOMNIKA