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Multi Attribute Decision Making Model Using Multi Rough Set: Case Study Classification of Anger Intensity of Javanese Woman

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***Abstract*—Decision-making process typically involves multiple attributes. It is using a part or whole attributes to find the best decision from the alternatives. Some methods such as rough set are used to solve this problem but it has worse time complexity with respect to the numerous attributes. Hence, Multi Rough Set is proposed to improve the performance of rough set. In this study, this method used to classify the anger of Javanese woman's which require numerous attributes but has limited number of object. We divided the information table into several groups which has similarity attribute and it is computed simultaneously. The decision of each group as result of rough set and then used fuzzy rule set to obtain the final result. Using leave one out cross validation obtained 79% more accurate than using single rough set for all attribute.**

Keywords—multi rough set; multiple attribute; simultaneously; decision-making

I. INTRODUCTION

Indonesia, the world's largest archipelago nation has diverse cultures. Indonesia consists of all or part of some of the world's largest islands such as Sumatra, Java, most of Kalimantan, Sulawesi, Halmahera, the west half of New Guinea (Papua), Bali, and numerous smaller islands. Cultures of Indonesia vividly reflect adaptation to land, climate, and seas [1]. Societies in Indonesia reflect the natural diversity. And this diversity makes every place in Indonesia has culture that influence the way of thinking, as well as Java.

The Javanese cultures accentuate the balance, harmony and congeniality. All elements of life should be harmonious and coexisted. Every incompatibility must be avoided. This effort to maintain harmony made Javanese people did not like open conflict. They would rather avoid the conflict [2]. One of the Javanese cultures is patriarchy ideology which tends to subordinate the woman in public and makes women susceptible to gender unfair, such as violence, poverty and double loads [3]. Many studies show the unfair and oppression phenomenon toward woman and these fact already happened for long time ago [3]. Culture and tradition play great role in creating stereotype that caused the dependence of woman to man. In the other hand, Javanese woman must uphold politeness and harmony. They prosecuted to be an ideal Javanese woman who conceived as refined figure, patient, kindly, resigned, submissive, and loyal to her husband. This cultures influence not only the way of life of Javanese women but also personality. Javanese woman rarely exhibit their emotion because the culture requires them to obey it. According to this culture the anger of Javanese woman is influenced by her surroundings i.e. husband, children, parents, brother and sister, occupation, etc. For the purpose of visual representation from computer agent in the human-machine dialogue system, we want to know when and in what condition Javanese woman are angry.

For experimental setup, we achieve dataset from environment of Javanese woman lived in Malang using questionnaire survey. From the data we acquire numerous attributes which may influence the intensity of anger of Javanese Woman. It becomes challenge for us because of these numerous attributes and limited number of object. The data we are collecting contain incomplete and uncertain information.

Due to the vagueness and uncertainty of objective world, the limitation of understanding of people, the decision maker's evaluation on attributes is only rough, which includes incomplete and uncertain information. Rough set and evidence theory are powerful tools to deal with uncertain information [4].

Several researches have been done to solve problem deal with many attributes and uncertainties. They used various method based on rough set theory [5-18].

In this case, if we used original rough set, many equivalences class would be performed, so it is potentially to arise huge error. It is worst time complexity with respect to the number of attributes[19]. Hence, we proposed Multi Rough Set to deal with numerous attribute and limited object. We divided the attribute into several groups. And each group is computed in parallel. Simultaneously, every group produces decision rule. In order to examine new object, the attributes of the object would be divided into five groups. Using decision

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rule we acquire result from each group that would obtain final result using fuzzy rule set.

II. ROUGH SET

Rough Set theory, introduced by Pawlak [20] expresses vagueness, inaccurate, uncertain, and incomplete data only using its own information and do not need any prior knowledge. In this research we mention this method as single rough set. The main goal of the rough set analysis is induction of approximation of concepts. It can be used for feature selection, feature extraction, data reduction, decision rule generation, etc. Rough Set offers two data representations i.e. first is Information System which defined as IS= $\{U, A\}$, where U= $\{P_1, P_2, Pn\}$ and A= $\{O_1, O_2, O_n\}$ is couple of object and condition attribute. The second is Decision System defined as DS= $(U, \{A, D\})$, that is information system which conceives a decision attribute. A decision system expresses all the knowledge about the model.

A decision table contains the information relative to a set of object, described by a certain number of attributes. Traditional rough set analysis of such a table consist in approximating the classifications induces by decision attributes[18].

Learning from Example Module version 2 (LEM2) for rule induction is used in this research. It is based on computing a single local covering for each concept from a decision table [19].

III. MULTI ROUGH SET FOR MULTI ATTRUBUTE DECISION MAKING

If we work with respect to the numerous of attribute, it will be deal with how to know which attribute is important and which is most affect the decision. We have to handle all the attributes. Using basic rough set would be time consuming in computing because each attribute was examined to find out the equivalence relation between attribute. Hence, Multi Rough Set was proposed to solve this problem. In this method, the attributes shown in information table was divided into several groups as shown in Fig 1. Each group would be computed using original rough set based on LEM2 algorithm and it is computed simultaneously.

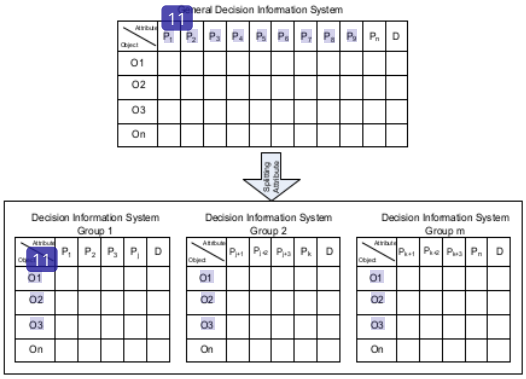

Fig 1. Division Attributes

As shown in general decision information system, it has P_1 attributes until P_n attributes $U = (P_1, P_2, P_3,.., P_n)$ A= $\{O_1, O_2, O_n\}$ which contain decision attribute D. The proposed method divides the information table with numerous attributes into several small information tables that each have decision attribute as shown in Fig 1. The partition table are first table which consist of attribute $U_1 = \{P_1, P_2, P_3, P_j\}$ Decision System defined as DS= $(U_1, \{A, D\})$, second table which consist of attribute $U_2 = \{P_{j+1}, P_{j+2}, P_{j+3}, P_k\}$ Decision System defined as DS= $(U_2, \{A, D\})$, until m table which consist of attribute $U_n = \{P_{k+1}, P_{k+2}, P_{k+3}, P_n\}$ Decision System defined as DS= $(U_n, \{A, D\})$.

Procedure LEM2
(**input**: a set B,
output: a single local covering $\mathcal{T}$ of set B);
begin
  $G := B$;
  $\mathcal{T} := \emptyset$;
  while $G \neq \emptyset$;
    begin
    $T := \emptyset$;
    $T(G) := \{t | [t] \cap G \neq \emptyset\}$;
    while $T = \emptyset$ **or not** $([T] \subseteq B)$
    begin
    select a pair $t \in T(G)$ such that $|[t] \cap G|$ is maximum; if a tie occurs, select a pair $t \in T(G)$ with the smallest cardinality of $[t]$;
    if another tie occurs, select first pair;
      $T := T \cup \{t\}$;
      $G := [t] \cap G$;
      $T(G) := \{t | [t] \cap G \neq \emptyset\}$;
      $T(G) := T(G) - T$;
      end {while}
    for each $t \in T$ **do**
      if $[T - \{t\}] \subseteq B$ **then** $T := T - \{t\}$;
    $\mathcal{T} := \mathcal{T} \cup \{T\}$;
    $G := B - \cup_{T \in \mathcal{T}} [T]$;
  end {while};
  for each $T \in \mathcal{T}$ **do**
    if $\cup_{S \in \mathcal{T} - \{T\}} [S] = B$ **then** $\mathcal{T} := \mathcal{T} - \{T\}$;
end {procedure}.

Fig 2. LEM2 Algorithm

Decision-making process for multi attribute using multi rough set divided into two main processes. First process is training process as shown in Fig 3 consist of division attributes and rule induction using LEM2 algorithm. The second process is testing process which consists of discretization of object value and fuzzification to obtain final result.

A. Division Attributes

From general information system table, all attributes which influence the decision will be used. And then similar attribute should be placed on the same group. From each of group it will create new information system which has the same decision attribute with decision attribute in the general information table.

B. Rule Induction

Rule induction used in this research is Learning from Example Module version 2 (LEM2).

Fig 3. Training Process

C. Testing

In the testing process illustrated in Fig 4, new data would be test using generating rule produced by each group to obtain decision from each group.

Fig 4. Testing Process

$$\bar{x} = \frac{x_1+x_2+x_3+\ldots+x_n}{n} \quad , x \neq 0 \qquad (1)$$

D. Fuzzification

In this process involves domain transformation where crisp inputs are transformed into fuzzy inputs. In this study, the fuzzy input is mean value which comes from the results of each group as described on eq 1. Mean value produced by testing process would be tested by fuzzy rule set to perceive final result. For each input and output variable selected, three triangle membership function are defined. As illustrated in fig 5, qualitative category is defined for each of them i.e. not angry, rather angry and angry.

Since we employ three emotion category therefore fuzzy membership for not angry as shown eq. 2, for rather angry function as shown eq. 3 and for angry function as shown eq. 4.

Fig 5. Fuzzy Membership Function

$$not\ angry\ (\bar{x}) = \begin{cases} 1 & ,\bar{x} \leq 0 \\ \dfrac{1.6-\bar{x}}{1.6-0} & ,0 < \bar{x} < 1.6 \\ 0, 1.6 & ,\leq \bar{x} \end{cases} \qquad (2)$$

$$rather\ angry\ (\bar{x}) = \begin{cases} 0 & ,\bar{x} \leq 1.4 \\ \dfrac{\bar{x}-1.4}{2-1.4} & ,1.4 < \bar{x} \leq 2 \\ \dfrac{2.6-\bar{x}}{2.6-2} & ,2 < \bar{x} \leq 2.6 \\ 0 & ,2.6 < \bar{x} \end{cases} \qquad (3)$$

$$angry\ (\bar{x}) = \begin{cases} 0 & ,\bar{x} \leq 2.5 \\ \dfrac{3-\bar{x}}{3-2.5} & ,2.5 < \bar{x} < 3 \\ 1 & 3 \leq \bar{x} \end{cases} \qquad (4)$$

IV. EXPERIMENT AND RESULT

For the purpose of this experiment, we have developed an application to obtain best result. We used 50 attributes which influence intensity of anger of Javanese women as an input. These attributes are obtained from data set which collected from survey to Javanese women who lived in Malang. The survey used questionnaire to derive information from surrounding of Javanese women i.e. husband, children, parent, brother or sister, and occupation. The conditions of Javanese women's husband that could trigger the anger of Javanese women are husband occupation status, salary, age, etc. The conditions of Javanese women's children that could trigger the anger of Javanese women are school achievement, gender, age, etc. The conditions of Javanese women's parent that could trigger the anger of Javanese women are age, occupation status, salary, etc. The conditions of Javanese women's sister that could trigger the anger of Javanese women are number of brother or sister, occupation status, age, etc. The conditions of Javanese women's occupation that could trigger the anger of Javanese women are salary, distance to the office, positions, etc.

In our experiment, we used dataset obtained by questionnaire survey. The dataset contain attribute which has crisp value. We split the dataset into five group based on attribute category. There are five category in this experiment such as husband category, child category, sister category, parent category and occupation category.

Rough set is one of the methods that used for classification. Process of classification is tested to the rule which generated to obtain decision of classification. In this study rough set was used to classify the intensity of anger of Javanese women. We divided the anger intensity into three class i.e. *not angry, rather angry and angry.* Dataset used in this experiment are not balanced. There are different amount of dataset for each class. Dataset for angry class are 34%, dataset for rather angry class are 58%, and dataset for not angry class are 8%.

A. Trainning Process

1) Division Attributes

The attributes P and decision atribute D that used in this experiment are $\{P_1,P_2,P_3,...P_{50},D\}$ devided into five groups of similar attribute i.e. group of husband attribute, group of child attribute, group of parent attribute, group of sister attribute, and group of occupation attribute. Group of husband attribute consist of eight attributes $\{P_1,P_2,...P_8,D\}$. Group of child attribute consist of ten attributes $\{P_9,P_{10},...P_{18},D\}$. Group of parent attribute consist of ten attributes $\{P_{19},P_{20},...P_{28},D\}$. Group of sister attribute consist of eleven attributes $\{P_{29},P_{30},...P_{39},D\}$. And group of occupation attribute consist of eleven attributes $\{P_{40},P_{41},...P_{50},D\}$.

2) Rule Induction

In this research limited object are used for the experiment. Its consist of 38 objects derived from survey of javanese wowan environment who lived in Malang. Every partition group have 38 object that computed simultaneously using Rough Set and LEM2 algorithm to obtain rule. As a result from induction rule process, group of husband attribute generated 17 rule, group of child attribute generated 14 rule, group of parent attribute generated 19 rule, group of sister attribute generated 14 rule, and group of occupation attribute generated 12 rule.

TABLE I. EXPERIMENT RESULT IN LINGUISTIC VALUE

husband	child	parents	Brother and Sister	Occupation
rather angry	unclassified	angry	angry	angry
angry	unclassified	rather angry	unclassified	angry
rather angry	rather angry	rather angry	unclassified	rather angry
angry	angry	unclassified	angry	unclassified
rather angry	angry	unclassified	angry	angry
rather angry	angry	angry	angry	angry
rather angry	not angry	angry	rather angry	rather angry
angry	rather angry	angry	rather angry	angry
unclassified	rather angry	angry	angry	unclassified
rather angry	unclassified	unclassified	angry	rather angry
rather angry	angry	rather angry	angry	unclassified
rather angry	unclassified	rather angry	rather angry	unclassified
angry	not angry	unclassified	rather angry	rather angry
rather angry	rather angry	angry	rather angry	rather angry
unclassified	rather angry	not angry	unclassified	rather angry
angry	angry	unclassified	unclassified	rather angry
angry	angry	rather angry	unclassified	unclassified
rather angry	angry	unclassified	angry	rather angry
unclassified	rather angry	not angry	rather angry	rather angry

B. Testing Process

We used Leave One Out Cross Validation to find out the accuracy. 37 Data object used for training data and 1 object used for testing data. It's done repeatedly until 38 times.

1) Discretization

Using LOOCV algorithm for whole object, we obtain the experiment result as shown in Table I. New Data was tested using rules which produced by each group as a result of rough set process. And then from discretization process we obtain numerical value as shown in Table II. Discretization process is shown in table III.

As illustrated in Table I, there are four class as result of classification process i.e. *not angry, rather angry, angry and unclassified.* There are objects which appertain to unclassified class because value of attribute which tested did not appropriate with existing rule. As result from discretization process, the values of *unclassified* decision attribute are set to 0 (zero) as shown in Table III.

Table I shows us that each group has its own rule and the result of the rule is still linguistic value. Hence we have to convert it to numerical value as a crisp input for the fuzzy system to obtain final result.

TABLE II. EXPERIMENT RESULT IN NUMERICAL VALUE

husband	child	parents	brother	job	mean	Fuzzy Decision	Target Decision
2	0	3	3	3	2.75	angry	angry
3	0	2	0	3	2.67	angry	angry
2	2	2	0	2	2.00	rather angry	not angry
3	3	0	3	0	3.00	angry	angry
2	3	0	3	3	2.75	angry	angry
2	3	3	3	3	2.80	angry	angry
2	1	3	2	2	2.00	rather angry	not angry
3	2	3	2	3	2.60	angry	rather angry
0	2	3	3	0	2.67	angry	angry
2	0	0	3	2	2.33	rather angry	rather angry
2	3	2	3	0	2.50	rather angry	angry
2	0	2	2	0	2.00	rather angry	rather angry
3	1	0	2	2	2.00	rather angry	not angry
2	2	3	2	2	2.20	rather angry	rather angry
0	2	1	0	2	1.67	rather angry	rather angry
3	3	0	0	2	2.67	angry	rather angry
3	3	2	0	0	2.67	angry	angry
2	3	0	3	2	2.50	rather angry	rather angry
0	2	1	2	2	1.75	rather angry	rather angry

TABLE III. DISCRETIZATION

DECISION ATTRIBUTE	VALUE
ANGRY	3
RATHER ANGRY	2
NOT ANGRY	1
UNCLASSIFIED	0

2) Fuzzification

In this experiment, in order to go to next process, we convert the result shown in Table I into numerical value as

shown in Table II. Mean value is derived from each group as input for fuzzy inference system in order to obtain final result. Because of discretization process, the *unclassified* decision attribute does not affect the mean calculation. It is show that the multi attribute decision model using multi rough set could be used to reduce unclassified decision attribute.

From the experiment of multi attribute decision model using multi rough set, result of classification obtained 37 % *angry,* 63% *rather angry*, and 0% *not angry*. There is 0% classification for *not angry* because the dataset only 8% from whole object. Compare to experiment result using single rough set, we obtained 21% *angry*, 49% *rather angry*, 0% *not angry*, 30% *unclassified*. Accuracy for the classification using single rough set is 58%. However, we have better result for the classification using multi rough set i.e. 79%. Using multi rough set, every object is classified.

V. CONCLUSION

Based on the research, it is show that the multi attribute decision model using multi rough set could be used to reduce unclassified decision attribute. And it could enhance the accuracy of classification process.

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