Application of Rules Gaining Based on Rough Set in Business Decision Support System

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Abstract—**Rough set is a tool in analyzing and processing the imprecise, inconsistent and incomplete information, and finding the connotative knowledge, potential regulations and methods. Aiming at the imprecise and uncertainty of factors in business decision support system, the paper brings out an algorithm based on rough set for rules gaining to analyze and process data, minimal decision-making rules are proposed. Finally, an example in decision support system is introduced to confirm the algorithm's validity.**

Index Terms— **Rough set, reduction, rules gaining.**

I. Introduction

Rough set [1][2] is a kind of mathematical tools that engraves incomplete and indeterminate information. It can effectively analyze imprecise, inconsistent, not integrity and so on each kind of incomplete information, but also discovers the concealed knowledge and promulgates the latent rule according to analyzing and reasoning data. Comparing to others theories which processes indefinite and imprecise question, the most remarkable difference is it does not need outside the data acquisition which provides the question to examine the information, therefore it is quite objective to the indefinite description or processing questions. Because this theory has not been able to contain processing imprecise or indefinite primary data mechanism, so this theory and the theory of probability, the fuzzy mathematics and the evidence theory and so on other theory which processes indefinite or imprecise questions are complementary.

In the business decision support program, massive incomplete and indefinite information have brought the certain difficulty for the business decision-making support. In view of these difficulties, this article uses rule gaining based on rough set, according to analyze and process data, the smallest policy-making rules are proposed, and uses an example to confirm its validity.

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II. Rules Gaining in Rough Set Theory

The basic thought that discovers the classified rule in the decision support system based on rough set theory as follows:

Step1: the user proposes the duty of discover. The user takes some or many attributes as the classified policy-making attributes in the database, according to different values of these attributes, the data divides into the different category in the database, the duty of discover is produces these different determination rules.

Step2: using the algorithm based on rough set theory for gaining classification rules.

Some definitions are given follows:

Definition one: discernibility matrix [3][5]. A mathematician named Skowron in Warsaw University proposes a discernibility matrix. There is a information system $S=(U,A,V,F)$, $U=\{x_1,x_2,...,x_n\}$ is the universe of discourse, A is the attribute set, $A=C\bigcup D$, C is the condition attribute, D is the policy-making attribute, $a(x)$ is a value with x on the attribute a, the resolution matrix is

$$c(ij)=\begin{cases} a\in A \quad : a(x_i)\neq a(x_j) & D(x_i)\neq D(x_j) \\ 0 \qquad\qquad \phi & D(x_i)=D(x_j) \\ -1 \qquad a(x_i)=a(x_j) & D(x_i)\neq D(x_j) \end{cases}$$

Definition two: Equal Class. Regarding an attribute set $B\subset A$ in information system $S=(U,A,V,F)$, if it satisfies $IND(B)=\{(x,y)\in UXU \mid a(x)=a(y),\forall a\in B\ \}$, then equal relates $IND(B)$ called dual relates that can't distinguish each other. $B(x)$ expresses a equal class which object x in it.

Definition three: CORE [4]. Opposite to attribute set D, core is an attribute set, which is the intersect of reduction belongs to the attribute set C, records is CORE (C, D). The core is these attributes with its group divisible number is 1 in discernibility matrix.

Definition four: Reduction: U is the universe of discourse, R is an equal relational race, r∈R, $IND(R)$ is the intersect ion of equal relation in R, if $U/IND(R)$ is equal to $U/IND(R-\{r\})$, then r is may be cancelled in R. Otherwise r is not be cancelled in R. If any element in p ($P=R-\{r\}$) is not being cancelled, then called P is the reduction of R.

Definition five: Equal set description: if an equal set named E_i, then we descript its character by using $Des(E_i) = (a = v)$. $a \in A$, $v \in V_a$

Definition six: Rules gaining. Assume that the division of A in U is E, the division of A' is Y. E Look upon as the classification condition, Y looks upon as the classification conclusion. We may get classified rule as follows:

(1) If $E_i \cap Y_j \neq \phi$, then we get $r_{ij} : Des(E_i) \rightarrow Des(Y_j)$

a. If $E_i \cap Y_j = E_i$, then, the rule r_{ij} is ascertained. Rule confidence level is one ($cf = 1$).

b. If $E_i \cap Y_j \neq E_i$, then, the rule r_{ij} isn't ascertained. Rule confidence level is $cf = \frac{|E_i \cap Y_j|}{|E_i|}$

(2) if $E_i \cap Y_j = \phi$, there isn't establish rule.

When the rule confidence level is one, this kind of rule can simplify. The rule reduction is that some attributes are deleted from condition attributes; the rule confidence level was still one.

III. THE ALGORITHM BASED ON ROUGH SET FOR RULES GAINING

Now we describe the algorithm based on rough set for rules gaining.

Step 1: Foundation data processing. In this step, we need input $S = (U, A, V, F)$, then, according to given classification method, data are standardized.

Step 2: The smallest attributes set is obtained.

The algorithm as follows:

```
Begin
    For i=1 to n
  For j=i to n
   M=[c(ij)]
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$$/*\ \ (c(ij) = \begin{cases} a \in A & : a(x_i) \neq a(x_j) \quad D(x_i) \neq D(x_j) \\ 0 & \phi \quad D(x_i) = D(x_j) \\ -1 & a(x_i) = a(x_j) \quad D(x_i) \neq D(x_j) \end{cases})\ \ */$$

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  End for
 End for
 P={union of single attribute in M.}
End
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Step 3: Rules gaining and reducing. When attributes are reduced, we get a new policy-making table. First, equal sets of condition attributes and equal sets of policy attributes are obtained. Second, according to definition six, we can gain rules and reduce rules. At last, the same conclusions of rules are union.

IV. APPLICATIONS OF EXAMPLES

In this section, an example in decision support system is introduced to confirm the algorithm's validity.

Table I is the appraisal data from eight enterprises 's economic efficiency; we use benefit decision support system to gain the rule.

Table I: Foundation data from eight enterprises

Enter-prise	Profit ability	Enter-prise life	Produc-tivity	Property manage-ment ability	Economic efficiency
X1	77	8	95	65	Good
X2	95	9	78	83	Good
X3	82	11	65	62	General
X4	62	2	85	60	Bad
X5	64	14	84	95	Good
X6	82	9	70	70	General
X7	65	7	72	71	Bad
X8	90	6	80	68	General

Step 1: Foundation data processing.

Profit ability/productivity/property management ability: 85-100 divides into 2, 71-84 divides into 1, 60-70 divides into 0.

Enterprise life: Below 5 years divides into 0, 6-10 years divides into 1, above 10 years divides into 2.

Table II is a dimension unitize policy-making table.

Table II: Policy table.

U	a	b	c	d	f
X1	1	1	2	0	2
X2	2	1	1	1	2
X3	1	2	0	0	1
X4	0	0	2	0	0
X5	0	2	1	2	2
X6	1	1	0	0	1
X7	0	1	1	1	0
X8	2	1	1	0	1

Step 2: Obtaining the smallest attributes set. According to definition three and step two from section 3,we use algorithm to calculate discernibility matrix M, and obtain the smallest attributes set P.

$$M = \begin{vmatrix} \phi & \phi & bc & ab & \phi & c & acd & ac \\ & \phi & abcd & abcd & \phi & acd & a & d \\ & & \phi & abc & acd & \phi & abcd & \phi \\ & & & \phi & bcd & abc & \phi & abc \\ & & & & \phi & abd & bd & abd \\ & & & & & \phi & acd & \phi \\ & & & & & & \phi & ad \\ & & & & & & & \phi \end{vmatrix}$$

$$P = \{a, c, d\}$$

Table III is Policy-making table of reduction.

Table III: Policy-making table of reduction.

U	a	c	d	f
X1	1	2	0	2
X2	2	1	1	2
X3	1	0	0	1
X4	0	2	0	0
X5	0	1	2	2
X7	0	1	1	0
X8	2	1	0	1

Step 3: Rules gaining and reducing. According to definition six and step three from section 3, we can get the last policy.
When $cf = 1$, policy rules are below:

(1) $a_0 d_2 \vee a_0 d_1 \vee a_0 c_3 \rightarrow f_0$

(2) $a_2 d_1 \vee c_2 d_1 \vee c_1 \rightarrow f_1$

(3) $d_3 \vee a_1 c_3 \vee a_2 d_2 \rightarrow f_2$

From what has been discussed above, we may come to the conclusion that the benefit quality has nothing to do with the enterprise survival time length.

V. CONCLUSION

In the paper, an algorithm based on rough set for rules gaining is introduced to analyze and process data, minimal decision-making rules are proposed in decision support system. At last, an example in decision support system confirms the algorithm's validity. With the constant improvement of the technology and theory in rough set, it will play a very important effect in business decision support system research.

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