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USING ROUGH SET APPROACH FOR CONFLICT IDENTIFICATION IN MAKING STRATEGIC GROUP DECISIONS

RUPJU KOPU PIEEJAS IZMANTOŠANA KONFLIKTU IDENTIFIKĀCIJĀ STRATĒĢISKU LĒMUMU GRUPVEIDA PIEŅEMŠANĀ

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Abstract - The conceptual basics for rough set theory have been developed by Z.Pawlak and presented in his monograph [1]. This theory enables the processing of massive amounts of unordered data and extracting of new knowledge on the basis of it. Rough set theory has found a wide application in information system analysis, decision table analysis, pattern classification [4], decision making and many other scientific and practical areas. One direction of practical application of rough set approach that is less widespread is conflict identification and analysis. Conflicts may occur in group expert evaluation as well as in making multiaspect strategic decisions when the participant opinions on possible action options are quite different. The identification and analysis of conflicts of that kind is an important task. Rough set approach allows one to formally model conflict situations and identify with confidence the sources of such conflicts. This paper provides a short introduction to the basics of rough set theory. Relevant practical applications of the theory such as information system analysis and decision table analysis are considered concisely. Possibilities of using rough set approach for conflict identification and resolution are examined on a practical example dealing with developing practical activities aimed to overcome consequences of economic crisis in a region.

A Brief Introduction to Rough Set Theory

Nowadays it is commonly accepted that all global tasks of uncertain information processing can be divided into three large classes:

- -dealing with incomplete knowledge;
- -combining contradictory parts of information;
- -using rough (unprocessed) massive data sets.

To solve the tasks of the first kind, a number of useful methods have been elaborated so far. They include different extrapolation and interpolation methods, expert estimation, interval estimation etc. Most famous approaches to solving tasks of the second kind are Dempster-Schafer theory [2], its different modifications including Dezert-Smarandache theory [3] and conflict redistribution rules by Dezert-Smarandache. Rough set theory is intended for solving tasks belonging to the third class; the basic framework of rough set theory was proposed by Z.Pawlak [1]. The methods suggested within that theory enable processing massive amounts of unordered data and obtaining new knowledge on its basis.

This section discusses basic concepts and definitions of rough set theory. Let $U \neq \varnothing$ be a finite set (the universe) of elements that is characterised by a set of features (attributes) $A = \{a_i / i = 1,...,n\}$. Based on the equivalence relationship R that is based on the values of attributes from subset $B \subseteq A$, elements of the universe can be partitioned into equivalence classes. The set of all equivalence classes is denoted U / R. The members of that set are called ***categories*** or ***concepts***. By $[x]_R$ there is denoted a category in U containing element $x \in U$. By ***knowledge base*** there is understood a relation system $K = (U, \mathbf{R})$ where $U \neq \varnothing$ is the universe of elements and $\mathbf{R}$ is a set of equivalence relations in U .

It should be noted that elements in each category selected on the basis of specified equivalence relation, are indiscernible. That indiscernibility is due to that in any category elements of the universe are included that have similar values of classification attributes.

If $\mathbf{P} \subseteq \mathbf{R}$, then $\cap P \in \mathbf{P}$ is equivalence relation denoted $IND(\mathbf{P})$.

$$[x]_{IND(\mathbf{P})} = \cap_{P \in \mathbf{P}} [x]_P .$$

Hence it is correct to state that the partition $U / IND(\mathbf{P})$ means knowledge related to relation family $\mathbf{P}$, that are called $\mathbf{P}$- ***basic knowledge*** with regard to U in knowledge base K.

Let $K = (U, \mathbf{P})$ and $K' = (U, \mathbf{Q})$ denote two databases. K and K' ($\mathbf{P}$ and $\mathbf{Q}$) are said to be ***equivalent*** (this fact is denoted $K \square K'$), if $U / \mathbf{P} = U / \mathbf{Q}$. If $IND(\mathbf{P}) \subset IND(\mathbf{Q})$, knowledge $\mathbf{P}$ (knowledge base K) is said to be ***more precise*** than knowledge $\mathbf{Q}$ (knowledge base K'). If $\mathbf{P}$ is more precise than $\mathbf{Q}$, then $\mathbf{P}$ is called ***specialisation*** of $\mathbf{Q}$ and $\mathbf{Q}$ is called ***generalisation*** of $\mathbf{P}$. The specialisation in essence consists in partitioning some categories into smaller parts but the generalisation consists in combining certain categories.

Let us consider a simple example to illustrate some basic concepts of rough sets.

Example 1. Table 1 shows a set of elements (the universe) and the values of their classification attributes.

Table 1

Initial data for the task

	Attribute values				
Elements (U)	a_1	a_2	a_3	a_4	a_5
x_1	1	2	0	1	1
x_2	1	2	0	1	1
x_3	2	0	0	1	0
x_4	0	0	1	2	1
x_5	2	1	0	2	1
x_6	0	0	1	2	2
x_7	2	0	0	1	0
x_8	0	1	2	2	1
x_9	2	1	0	2	2
x_{10}	2	0	0	1	0

Elements of the universe have to be partitioned into equivalence classes with regard to all five attributes and attributes a_3, a_4.

Solution. Based on all five attributes, we have the following partition of universe's elements into equivalence classes:

$$E_1 = \{\{x_4\}, \{x_6\}, \{x_8\}, \{x_1, x_2\}, \{x_3, x_7, x_{10}\}, \{x_5\}, \{x_6\}.$$

Based on attributes a_3, a_4 we get this partition of universe elements into equivalence classes:

$$E_2 = \{\{x_1, x_2, x_3, x_7, x_{10}\}, \{x_4, x_6\}, \{x_5, x_9\}, \{x_8\}\}.$$

Let us introduce the following concepts and definitions. The target set $X \subseteq U$ is called R-***definable***, if it is a union of certain categories separated in the universe U by relation R. Otherwise the target set $X \subseteq U$ is called R-***undefinable***, or R-***rough***.

Rough set theory was developed to deal with sets that are rough in the above-defined sense. This theory suggests approximation of any rough set $X \subseteq U$ by two subsets

$$\underline{R}X = \cup\{Y \in U / R / Y \subseteq X\}; \qquad (1a)$$

$$\overline{R}X = \cup\{Y \in U / R / Y \cap X \neq \varnothing\}, \qquad (1b)$$

which are called, respectively, R - ***lower*** and R - ***upper*** approximations of the rough set X.

Let us introduce these concepts:

- $POS_R(X) = \underline{R}X$ - R - positive region of the rough set X;

- $NEG_R(X) = U - \overline{R}X$ - R - negative region of the rough set X;

- $BN_R(X) = \overline{R}X - \underline{R}X$ - R - boundary region of the rough set X.

By definition, the R - positive region of the rough set X coincides with its lower approximation and contains those elements of the universe U that definitely belong to set X. The R - negative region of the rough set X contains all those elements of the universe U that definitely do not belong to set X. Since R - upper approximation of the rough set X includes all elements of its lower approximation, the boundary region $BN_R(X)$ contains all those elements of the universe U, that cannot be classified unambigously as belonging or not belonging to the rough set X.

Let us consider a simple example.

Example 2. Let us take as a base the partition of element set of the universe U performed in Example 1 with regard to all five attributes. Let there be two target sets

$$X_1, X_2 \subset U : X_1 = \{x_1, x_2, x_4, x_5\}, X_2 = \{x_1, x_2, x_3, x_4\}.$$

It is necessary to determine

$$\underline{R}X_1, \overline{R}X_1, POS_R(X_1), NEG_R(X_1), BN_R(X_1),$$

$$\underline{R}X_2, \overline{R}(X_2), POS_R(X_2), NEG_R(X_2), BN_R(X_2).$$

Solution.

$$\underline{R}X_1 = \overline{R}X_1 = \{x_1, x_2, x_4, x_5\};$$

$$POS_R(X_1) = \underline{R}X_1 = \{x_1, x_2, x_4, x_5\};$$

$$NEG_R(X_1) = U - \overline{R}X_1 = \{x_3, x_6, x_7, x_8, x_9, x_{10}\};$$

$$BN_R(X_1) = \overline{R}X_1 - \underline{R}X_1 = \varnothing;$$

$$\underline{R}X_2 = \{x_1, x_2, x_4\}; \quad \overline{R}X_2 = \{x_1, x_2, x_3, x_4, x_7, x_{10}\};$$

$$POS_R(X_2) = \underline{R}X_2 = \{x_1, x_2, x_4\};$$

$$NEG_R(X_2) = U - \overline{R}X_2 = \{x_5, x_6, x_8, x_9\};$$

$$BN_R(X_2) = \overline{R}X_2 - \underline{R}X_2 = \{x_3, x_7, x_{10}\}.$$

It is apparent that set X_1 is R - crisp, but set X_2 is R - rough. In general, an arbitrary set X is R - crisp iff $\underline{R}X = \overline{R}X$ and R - rough if $\underline{R}X \neq \overline{R}X$.

By ***knowledge reduction*** we will understand the process of separation of the essential part of the existing knowledge that is necessary for defining all the relevant concepts. Let us introduce initial concepts and definitions. Let $\mathbf{R}$ - be a set of equivalence relations in the specified universe U and $R \in \mathbf{R}$. Relation R is ***inessential*** in $\mathbf{R}$, if $IND(\mathbf{R}) = IND(\mathbf{R} - \{R\})$, otherwise relation R is ***necessary*** in $\mathbf{R}$. A set of relations $\mathbf{R}$ is called ***independent*** if every relation $R \in \mathbf{R}$ is necessary in $\mathbf{R}$, otherwise a set of relations $\mathbf{R}$ is called ***dependent***. From the intuitive point of view the interpretation of concepts of inessentiality and necessity of relation $R \in \mathbf{R}$ is quite simple. Assume that based on the set of equivalence relations $\mathbf{R}$ determination of elements categories in the universe U is made. If we delete some relation R from set $\mathbf{R}$ and based on the remaining subset of relations $\mathbf{R} - \{R\}$ obtain the same classification results as on the basis of the whole set $\mathbf{R}$, it is apparent that relation R is inessential (unnecessary) for classification process. Instead, if we obtain other categories of elements as a result of relation R deletion, it gives evidence that the relation R is necessary (essential) for classification process.

A subset of equivalence relations $\mathbf{Q} \subseteq \mathbf{P}$ is ***reduction of*** $\mathbf{P}$, if $\mathbf{Q}$ is independent and

$$IND(\mathbf{Q}) = IND(\mathbf{P}) \qquad (2)$$

Knowledge core (equivalence relation family core) is defined as follows:

$$CORE(\mathbf{P}) = \cap RED(\mathbf{P}), \qquad (3)$$

where

$\cap RED(\mathbf{P})$ is a family of all reductions of the set of equivalence relations $\mathbf{P}$.

The concept of knowledge reduction can be extended in order to get useful for practice results. Let P and Q be equivalence relations in the universe U. By P-***positive*** region Q we will understand a set of elements

$$POS_P(Q) = \cup_{X \in U/Q} \underline{P}X. \qquad (4)$$

In essence, a region $POS_P(Q)$ is a set of elements of the universe which can be correctly ascribed to equivalence classes U/Q on the basis of classification U/P.

The concept of P- positive region Q might be extended to the case when $\mathbf{P}$ and $\mathbf{Q}$ are sets of equivalence relations. Then $POS_{\mathbf{P}}(\mathbf{Q})$ is $\mathbf{P}$- positive region of $\mathbf{Q}$ that is interpreted by analogy with (4), but here the question is not about separate equivalence relations but sets of such relations.

Let us introduce some important definitions. Equivalence relation $P \in \mathbf{P}$ is $\mathbf{Q}$- ***inessential*** in $\mathbf{P}$, if

$$POS_{IND(\mathbf{P})}(IND(\mathbf{Q})) = POS_{IND(\mathbf{P}-\{P\})}(IND(\mathbf{Q})). \qquad (5)$$

Otherwise, relation P is $\mathbf{Q}$- ***necessary*** in $\mathbf{P}$.

If every relation $P \in \mathbf{P}$ is $\mathbf{Q}$- necessary, then $\mathbf{P}$ is $\mathbf{Q}$- ***independent*** (alternatively, $\mathbf{P}$-independent with regard to $\mathbf{Q}$).

A set of relations $\mathbf{S} \subseteq \mathbf{P}$ is $\mathbf{Q}$- ***reduction of*** $\mathbf{P}$, if and only if $\mathbf{S}$ is $\mathbf{Q}$- independent and $POS_{\mathbf{S}}(\mathbf{Q}) = POS_{\mathbf{P}}(\mathbf{Q})$.

A set of all $\mathbf{Q}$- necessary elementary relations is called $\mathbf{Q}$- ***core*** of $\mathbf{P}$:

$$CORE_{\mathbf{Q}}(\mathbf{P}) = \cap RED_{\mathbf{Q}}(\mathbf{P}), \qquad (6)$$

where

$\cap RED_{\mathbf{Q}}(\mathbf{P})$ is a set of all $\mathbf{Q}$- reductions of $\mathbf{P}$.

Analysis of Information Systems and Decision Tables on the Basis of Rough Set Approach

Information system is a pair $S = (U, A)$, where U is a finite set of elements (objects) but A is a finite set of attributes. Each attribute $a \in A$ can be represented by function $a : U \to V_a$, where V_a is a set of values of a called ***region*** A. With each subset of attributes $B \subseteq A$ there can be associated relation $IND(B)$ called ***indiscernibility relation***:

$$IND(B) = \{(x, y) \in U^2 / \forall a \in B, a(x) = a(y)\}. \qquad (7)$$

It is apparent that relation $IND(B)$ is equivalence relation and

$$IND(B) = \cap_{a \in B} IND(a). \qquad (8)$$

The difference between a database and information system is as follows. In each database there is explicitly assigned equivalence relation R (or a set of equivalence relations $\mathbf{R}$), on whose basis the partition of the elements of the universe into classes is made. With this, it implicitly supposed that the classification of elements is made on the basis of the values of relevant features (attributes). In the information system it is explicitly supposed that object classification is made on the basis of attribute values and it is implicitly supposed that attribute values constitute the relevant equivalence relation.

Attribute $a \in B$ is inessential for object classification if $IND(B - \{a\}) = IND(B)$, otherwise attribute a is considered necessary.

In general, analysis of any information system is reduced to the execution of the following sequence of procedures:

1. Removing from consideration those attributes that have the same values for all the objects in the table. Such attributes do not affect analysis results and their removal helps avoid unnecessary calculating.
2. Removing inessential attributes from consideration. If a task of object classification with

regard to some set of attributes is stated, the attributes that do not impact classification results, have to be deleted.

Further procedures are executed in accordance with the task stated. If necessary, the importance of each attribute for classification can be evaluated using special expressions.

Decision tables are a specific kind of information systems. Assume there is a set of conditions and we receive a particular result (solution) at every possible set of the values of these conditions. In essence, each row of the table represents a decision rule.

Let us introduce some formal definitions. A decision table can be defined in terms of the information system as follows. Let $S = (U, A)$ be standard information system where U is the universe of elements (objects) and A is a set of attributes. If we can distinguish subsets $C, D \subset A$, where C is a ***subset of conditions***, D is a subset of decision attributes, then all the initial data can be represented as a table $T = (U, A, C, D)$, that is referred to as ***decision table***. With every $x \in U$ there can be associated a function $dx : A \rightarrow V$, such that $d(x) = a(x)$ for each attribute $a \in C \cup D$. Function dx is called ***decision rule*** in the decision table. Let us denote as dx / C the part of the decision rule dx that refers to the set of conditions and as dx / D the part of the decision rule dx, that relates to the decision. These parts of the decision rule dx are referred to as conditions and decisions, respectively.

Decision rule dx is ***compatible*** in the decision table T, if for any $y \neq x, y, x \in U$ from $dx / C = dy / C$ it follows that $dx / D = dy / D$. Otherwise, decision rule dx is considered ***incompatible***. Decision table T is compatible if all its decision rules are compatible, otherwise that table is incompatible.

The concept of compatibility and incompatibility of decision rules is underlying in decision table analysis.

In general, analysis of any decision table is performed as a sequence of these procedures:

1. Removal of duplicate columns for condition and decision attributes. The duplicate columns have the same attribute values for all decision rules.
2. Reduction of duplicate rows in the decision table. If certain decision rules have the same values of both condition attributes and decision attributes, then a single decision rule is left for further analysis. Note that a procedure of this kind unacceptable for information systems. But because the duplicate decision rules have the same sense the removal of duplicate decision rules is a reasonable operation.
3. Checking the set of decision rules for compatibility. If such a check reveals incompatibility of the initial set of decision rules, then a subset of compatible decision rules might be separated for further analysis.
4. Checking the necessity of condition attributes. If the removal of a certain condition attribute leads to the destruction (spoiling) of the initial set of decision rules, this attribute is considered necessary; otherwise the attribute is considered inessential and may be removed from further consideration.
5. Determination of reductions and core of the set of condition attributes. This procedure is performed on the basis of the execution results of the previous procedure.
6. Removal of inessential values of condition attributes. This procedure is performed on the basis of specific calculations. It is aimed at removing those values of condition attributes that do not affect the compatibility of the set of decision rules. In this way the amount of redundant information can be significantly reduced.
7. Formation of minimal subsets of decision rules on the basis of the performed previous procedures.

Application of Rough Set Approach to Conflict Identification

When multilateral discussions about multiple important political, economic, social and other problems take place, the opinions of the parties involved may often not coincide.. A clear identification of those discussion points that cause the largest conflicts of opinions is quite a complicated task. This section addresses possibilities of such conflict identification on the basis of the rough set approach.

Let us consider a practical example. Facing the economic crisis, local government have made a decision to develop a complex program aimed to improve the economic situation in the region. To discuss the problem, the representatives of political parties and non-governmental organizations were invited. Let us denote groups of discussion participants as I, K, L, M, N, O and P. As prioritive directions, these options were suggested:

a: introduce extra taxes on real estate and services;
b: organise social works for unemployed;
c: ensure favourable conditions for the development of small and medium size businesses;
d: more actively draw in external finances;
e: arrange concert hall construction on the basis of the credit;
f: enlarge interaction with the regions of neighbouring state;
g: promote citizens going abroad for job search.

As a result of preliminary discussion, the parties involved have expressed their attitude to each of possible actions. Discussion results are given Table 2, where “1” in table cells means that this group positively considers the corresponding action and “0” represents their negative attitude to the respective action.

Table 2
Results of evaluation of different actions aimed to overcome the crisis situation by discussion participants

Participant of discussion	Possible actions						
	a	b	c	d	e	f	g
I	1	1	0	1	1	0	0
K	1	1	1	1	0	0	0
L	0	1	0	1	0	1	0
M	0	1	1	1	0	1	0
N	0	1	1	1	0	1	0
O	0	1	1	1	0	1	0
P	0	1	1	1	1	1	0

As can be seen from the table, the opinions of the participants regarding suggested ways of actions essentially differ. Our goal is to determine those potential ways of action regarding which the participants have the largest disagreement. It will then enable one to focus on discussing such critical points and achieve compromise decisions

We will consider Table 2 as a specific decision table in which condition and decision attributes coincide. Each participant of the discussion is treated as a decision rule, but ways of actions are interpreted, on the one hand, as condition attributes, i.e. as conditions of escaping from the crisis situations. On the other hand, these ways of actions are interpreted as decision attributes, i.e. as actions that have to be undertaken in reality to escape from the crisis situation.

A simple analysis of Table 2 shows that in all its cells corresponding to attributes b and d is located 1. This gives evidence of that all the participants of the discussion positively evaluate the given actions. We can correctly remove attributes *b* and *d* from the table; this, however, does not mean that corresponding to them actions are totally excluded from further consideration. Instead, they are prioritive for further implementation. The removal of attributes *b* and *d* from the table is only due to they are not relevant for the task under consideration.

Since the values of attribute g are equal to 0 in all cells of the table, we can fully exclude that attribute from further consideration.

Next, the values of all attributes for decision rules M, N and O are the same. There is no necessity to consider all those decision rules; let us keep for further consideration decision rule M and exclude decision rules N and O from the table.

As a result, we obtain the following decision table (see Table 3).

Table 3
Decision table after reduction of decision rules and condition attributes

Decision rules	Attribute values			
	a	c	e	f
I	1	0	1	0
K	1	1	0	0
L	0	0	0	1
M	0	1	0	1
P	0	1	1	1

Since all the decision rules in Table 3 have different values of condition attributes, this set of decision rules is considered compatible. The next step in solving the task is to evaluate the necessity or inessentiality of condition attributes for the set of decision rules in Table 3. For that purpose we will remove condition attributes and analyse thus obtained sets of decision rules.

- Removal of attribute *a*:

$$c_0e_1f_0 \rightarrow a_1c_0e_1f_0;$$
$$c_1e_0f_0 \rightarrow a_1c_1e_0f_0;$$
$$c_0e_0f_1 \rightarrow a_0c_0e_0f_1;$$
$$c_1e_0f_1 \rightarrow a_0c_1e_0f_1;$$
$$c_1e_1f_1 \rightarrow a_0c_1e_1f_1.$$

The set of obtained decision rules is compatible since all the left-hand sides of these rules are different. Due to that, *a* is inessential in the present task.

- Removal of attribute *c*:

$$a_1e_1f_0 \rightarrow a_1c_0e_1f_0;$$
$$a_1e_0f_0 \rightarrow a_1c_1e_0f_0;$$
$$a_0e_0f_1 \rightarrow a_0c_0e_0f_1;$$
$$a_0e_0f_1 \rightarrow a_0c_1e_0f_1;$$
$$a_0e_1f_1 \rightarrow a_0c_1e_1f_1.$$

The 3rd and the 4th decision rules have the same left-hand sides at different right-hand sides. So the obtained set of decision rules is incompatible and attribute *c* is considered necessary in this task.

- Removal of attribute *e*:

$$a_1c_0f_0 \rightarrow a_1c_0e_1f_0;$$
$$a_1c_1f_0 \rightarrow a_1c_1e_0f_0;$$
$$a_0c_0f_1 \rightarrow a_0c_0e_0f_1;$$
$$a_0c_1f_1 \rightarrow a_0c_1e_0f_1;$$
$$a_0c_1f_1 \rightarrow a_0c_1e_1f_1.$$

The 4th and the 5th decision rules have the coinciding 4 left-hand parts under different right-hand parts. Due to that, the obtained set of decision rules is incompatible but attribute *e* is considered necessary in this task.

- Removal of attribute *f*:

$$a_1c_0e_1 \rightarrow a_1c_0e_1 f_0;$$
$$a_1c_1e_0 \rightarrow a_1c_1e_0 f_0;$$
$$a_0c_0e_0 \rightarrow a_0c_0e_0 f_1;$$
$$a_0c_1e_0 \rightarrow a_0c_1e_0 f_1;$$
$$a_0c_1e_1 \rightarrow a_0c_1e_1 f_1.$$

The set of obtained decision rules is compatible because all the left-hand parts of these rules are different. Hence, attribute *a* is considered inessential in this task.

We have the following reductions of condition attributes:

$$\{a,c,e\},\{c,e,f\}$$

with the core

$$CORE = \{a,c,e\} \cap (c,e,f\} = \{c,e\}.$$

The set of decision rules corresponding to reduction $\{a,c,e\}$ is shown in Table 4. The set of decision rules corresponding to reduction $\{c,e,f\}$ is shown in Table 5.

Table 4
A set of decision rules satisfying reduction of condition attributes $\{a,c,e\}$

Decision rules	Attribute values		
	a	c	e
I	1	0	1
K	1	1	0
L	0	0	0
M	0	1	0
P	0	1	1

Table 5
A set of decision rules satisfying reduction of condition attributes $\{c,e,f\}$

Decision rules	Attribute values		
	c	e	f
I	0	1	0
K	1	0	0
L	0	0	1
M	1	0	1
P	1	1	1

In principle, it is possible to make reduction of inessential attribute values in Tables 4 and 5 and to make solving the task even simpler. Such a reduction, however, requires rather large calculations. Taking into account that the tables are relatively simple, in this task it is possible to develop a strategy of further discussion without simplifying the existing data.

Since attributes c and e constitute the reduction core of all relevant attributes of conditions, the participants of the discussion have to focus their efforts on searching for the tradeoff just regarding these potential ways of action: “ensuring favourable opportunities for small and medium scale business in the region” and “construction of a concert hall on the basis of the credit”.

The consideration of that sufficiently small example evidently demonstrates the possibilities of the rough set approach in conflict identification during negotiations and discussions in case of a large number of participants and a large number of topics under consideration. The representation of the full set of factors of the task in decision table format allows one to visually represent all those factors as well as their interrelations. Decision table analysis helps to get rid of inessential factors and distinguish those critical factors that have to be further estimated and discussed in more detail.

Conclusions

1. Rough set theory enables a correct and effective processing of large amounts of unordered data.
2. Over its short history the rough set theory has found multiple applications in data analysis, decision table analysis, pattern recognition, machine learning and other research areas.
3. This paper discusses possibilities of using the rough set approach to analyse differences in data. These possibilities are illustrated using a simple and visual example of conflict analysis of the parties involved in the discussion of possible actions intended for coping with consequences of economic crisis in the region.
4. Solving the general task includes the following stages (procedures):
   - removing unnecessary condition attributes (columns) from the decision table;
   - removing duplicate rows in decision table;
   - estimating the necessity and inessentiality of certain attributes for further task analysis;
   - defining attribute reductions and determinating the core of those reductions;
   - removing unnecessary attribute values (because of the simplicity of the task and necessity of labour consuming calculations the procedure was not considered in the study);
5. Based on the results obtained, clear recommendations are made as to how to reach the consensus on the critical discussion topics (in the example under consideration these are potential ways of actions aimed to overcome the consequences of the economic crisis in the region: “ensuring favourable opportunities for small and medium scale business in the region” and

“construction of a concert hall on the basis of the credit”.

6. The considered example clearly shows the advantages of the rough set approach as applied to conflict identification in complicated multiaspect tasks when multiple parties with contradicting interests are present.

References

1. Pawlak Z. Rough sets. Theoretical Aspects of Reasoning about Data. Kluwer Academic Publishers, Dordrecht/Boston/London, 1991, 229 p.
2. Shafer G. A mathematical theory of evidence. Princeton University Press, 1976, 297 p.
3. Smarandache F. & Dezert J. (Editors). Advances and Applications of DSmT for Information Fusion. Volume 1, American Research Press, Rehobolth, 2004.
4. Tripathy H.K., Tripathy B.K., and Das P.K. An Intelligent Approach of Rough Set in Knowledge Discovery Databases. International Journal of Computer Science and Engineering, 2008, Vol.2, No.1, pp. 45-48.

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Olegs Užga-Rebrovs, Gaļina Kuļešova. Rupju kopu pieejas izmantošana konfliktu identifikācijā stratēģisku lēmumu grupveida pieņemšanā

Rupju kopu konceptuālo pamatu autors ir poļu zinātnieks Z.Pavlaks. Tie ir izklāstīti pamatlicēja monogrāfijā [1]. Šī teorija ļauj apstrādāt nesakārtotu datu lielus masīvus un uz šīs apstrādes pamata iegūt jaunas zināšanas. Rupju kopu teorijai ir plaši pielietojumi informācijas sistēmu analīzē, lēmumu tabulu analīzē, paraugu klasifikācijā [4], lēmumu pieņemšanā un daudzās citās zinātniskās un lietišķās nozarēs. Rupju kopu pieejas praktiskās lietošanas mazāk izplatīts virziens ir konfliktu identifikācija un analīze. Konflikti var rasties ekspertu grupveida novērtēšanā, daudzu aspektu stratēģisko lēmumu pieņemšanā, kad dalībnieku uzskati par iespējamiem darbības veidiem lielā mērā atšķiras. Tādu konfliktu atklāšana un analīze ir ļoti svarīgs uzdevums. Rupju kopu pieeja ļauj formālā veidā modelēt konfliktu situācijas un pārliecinoši identificēt konfliktu avotus. Šajā darbā tiek piedāvāts īss ievads rupju kopu teorijas pamatos. Konspektīvi tiek apskatīti nozīmīgākie praktiskie teorijas pielietojumi: informācijas sistēmu analīze un lēmumu tabulu analīze. Rupju kopu pieejas izmantošanas iespējas konfliktu identifikācijā un analīzē apskatītas ar praktiska piemēra palīdzību. Piemērs ir saistīts ar praktisko darbību izstrādi ekonomiskās krīzes seku novēršanai reģionā.

Олег Ужга-Ребров, Галина Кулешова. Применение подхода грубых множеств для идентификации конфликтов в групповом принятии стратегических решений

Концептуальные основы теории грубых множеств разработаны польским учёным З. Павлаком и изложены в основополагающей монографии [1]. Эта теория позволяет обрабатывать большие массивы неупорядоченных данных и на основе такой обработки извлекать новые знания. Теория грубых множеств нашла широкое применение в анализе информационных систем, анализе таблиц решений, классификации образцов [4], принятии решений и многих других научных и практических областях. Одно из менее распространённых направлений практического использования подхода грубых множеств – идентификация и анализ конфликтов. Конфликты могут возникать при групповом экспертном оценивании, принятии многоаспектных стратегических решений, когда взгляды участников на возможные способы действий в значительной степени различаются. Выявление и анализ такого рода конфликтов представляет собой важную задачу. Подход грубых множеств позволяет формально моделировать конфликтные ситуации и с уверенностью идентифицировать источники конфликтов. В настоящей работе представляется краткое введение в основы теории грубых множеств. Конспективно рассматриваются релевантные практические приложения теории: анализ информационных систем и анализ таблиц решений. Возможности использования подхода грубых множеств для идентификации и анализа конфликтов рассматриваются на примере разработки практических действий по преодолению последствий экономического кризиса в регионе.