Raport Badawczy

Research Report

Przykłady zastosowań wybranych metod uczenia maszynowego.

K.Mańczak, G.Szkatuła, M.Krawczak

Instytut Badań Systemowych
Polska Akademia Nauk

Systems Research Institute
Polish Academy of Sciences

POLSKA AKADEMIA NAUK

Instytut Badań Systemowych

ul. Newelska 6

01-447 Warszawa

tel.:   (+48) (22) 8373578

fax: (+48) (22) 8372772

Kierownik Pracowni zgłaszający pracę:
Prof. dr hab. inż. Janusz Kacprzyk

Warszawa 2004

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Contents

ANALYSIS OF RULES DESCRIBING ELECTORATE PREFERENCES GENERATED BY MACHINE LEARNING METHODS [1]

1. INTRODUCTION

The publications to date, [2, 3, 4, 5, 6, 7, 13, 14, 15], concerning application of the methods of machine learning from examples to the analysis of voting preferences of the electorate and of the program promises of political parties, placed the primary emphasis on the analysis of attributes used in the description of the program promises of parties participating in elections. Thus, in [5, 6] attention was paid to the fact that currently in Poland – similarly as in the western countries – the electoral success of a given party depends not only on the announced elements of their programs, but also on the attributes associated with images of parties involved.

The present paper is concentrated on the program promises of the parties. We will carry on the analysis of decision rules obtained with the use of the approach proposed by the authors.

The considerations will concern the example of the elections to the Polish Parliament, which took place on September 23rd, 2001. The data published, quoted, in particular in [5], show that the intention of participating in the elections was expressed by 16 political parties and two coalitions. The parties had to exceed the 5% threshold of votes on the national scale, while the coalitions – the 8% threshold. Ultimately, the following political organizations took part in the elections (the outcomes of elections in terms of percentages of votes and the MPs in the 460-member Parliament are given in brackets): 1) the Coalition of Alliance of Democratic Left and Union of Labour (SLD-UP) (41.04% of votes and 216 MPs); 2) the Coalition Election Committee – Election Action of the Solidarity of the Right (AWSP);

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[1] Coauthors: J. Hołubiec and D. Wagner

3) Election Committee of the Union of Freedom (UW); 4) Election Committee of the Self-Defence of the Republic of Poland (SO) (10.20% of votes and 53 MPs); 5) Election Committee "Law and Justice" (PiS) (9.50% of votes and 44 MPs); 6) Election Committee of the Polish Peasant Party (PSL) (8.98% of votes and 42 MPs); 7) Election Committee of Voters "Civic Platform" (PO) (12.68% of votes and 65 MPs); 8) Election Committee Alternative Social Movement; 9) Election Committee of the Polish National Community; 10) Election Committee of the League of Polish Families (LPR) (7.87% of votes and 38 MPs); 11) Election Committee of Voters "German Minority" (0.36% of votes and 2 MPs); 12) Election Committee of the Polish Economic Union; 13) Election Committee of the Polish Socialist Party; 14) Election Committee of Voters "German Minority of the Upper Silesia". It should also be noted that the coalition SLD-UP encompassed also the National Party of the Retired and Pensioners, the Democratic Party, and the People's-Democratic Party.

A detailed description of the approach applied is given in [8], [11], [12]. Therefore we will limit the analysis in Section 2 only to these elements of the approach, which are necessary to understand the further considerations. The results of computations are given in Section 3.

2. BASIC ELEMENTS OF THE APPROACH APPLIED

The task of machine learning from examples can be formulated as follows: we have a finite set of examples U, called the learning set. In the situation considered in the paper it is the set of eight political parties: SLD-UP, PO, SO, PiS, PSL, LPR, AWSP and UW. Only first six of these political organizations ultimately entered the Parliament.

The examples are described with conditions associated with the finite set of attributes $A = \{a_1, ..., a_K\}$. $V_{a_j} = \{v_{i_1}^{a_j}, ..., v_{i_l}^{a_j}\} \neq \varnothing$ is the set of values of the attribute a_j, for $j = 1, ..., K$, and

$V = \bigcup_{j=1,...,K} V_{a_j}$. A function $f: U \times A \to V$ such that $\forall e \in U, \quad \forall a_j \in A, \quad f(e,a_j) \in V_{a_j}$ defines the value, which is taken in the example $e \in U$ by the attribute a_j.

The attributes used to describe examples (that is the program promises of the respective parties) are presented below. The value that a given attribute can assume is given in brackets.

a_1: *unemployment* {1 - to make the Labour Code more flexible; 2 - to take actions making working personnel more mobile and to decrease cost of establishing new work places; 3 - to start public and interventional works; 4 – other proposals}.

a_2: *education and research* {1 - to increase governmental spending on education and research; 2 - free education at all the levels; 3 - to stop elimination of rural schools and to establish vocational colleges in small cities; 4 - to provide common access to Internet and learning of foreign languages}.

a_3: *personal income tax* {1 - to simplify the personal income tax system and to introduce linear personal income tax in the future; 2 - to introduce progressive personal income tax, tax on stock exchange transactions and tax on capital; 3 - to decrease the lowest rate of personal income tax and to establish pro-family policy; 4 – other proposals}.

a_4: *economic policy* {1 - government control of all strategic and monopolistic enterprises; 2 - government control of chosen strategic and monopolistic enterprises; 3 - restructurization of the public finance sector; 4 - government support of inexpensive housing projects}.

a_5: *health care system* {1 - to improve the existing health-care system and to increase governmental spending on this system; 2 - to eliminate the existing health-care system and to establish a new one; 3 – other proposals}.

a_6: *agriculture and regional policy* {1 - to protect the Polish agriculture against foreign competition with the use of, among others, monitoring and making the frontier traffic control more tight; 2 - to make the industrial-agricultural complex a fly wheel of economy by, among

others, increasing the acting capital of agricultural holdings and developing agricultural consulting activities; 3 - to develope non-agricultural activities in villages and to promote infrastructural investments}.

a_7: *internal safety* {1 - to increase the efficiency of judiciary system by, among others, the increase of governmental spending on this system; 2 - to make the Penal Code more repressive; 3 - to roll into one municipal guard and police; 4 - to develop citizen self-defence; 5 – other proposals}.

a_8: *attitude towards the European Union* {1 - to enter the European Union under advantageous conditions; 2 - pronounced backing the accession to the European Union; 3 - stout resistance to the accession to the European Union }.

One can choose various decision attributes in the problem considered. The following two attributes are to be investigated in detail:

$a_9^{\,1}$: *election to the Parliament* {1 – yes; 2 - no),

$a_9^{\,2}$: *membership of the group* {1 - SLD – UP; 2 – the remaining parties except for SLD – UP;   3 - the political parties not having entered the Parliament },

An expression of the form $(a_j = v_i^{a_j})$, where $v_i^{a_j} = f(e, a_j)$, $v_i^{a_j} \in V_{a_j}$, is called the *elementary condition* for the attribute a_j, $j = 1,...,K$, and the example $e \in U$. This notation simply means that the attribute a_j takes the value $v_i^{a_j}$ in the example e. Hence, every example $e \in U$ can be described in the form of conjunction of K elementary conditions in the following manner:

$$e = \bigwedge_{j=1}^{K} (a_j = v_i^{a_j}).$$ (1)

With the use of the above notation for $K=9$, the coalition SLD and UP (noted e') can be described in the following manner:

$$e^1 = (a_1 = 1) \wedge (a_2 = 2) \wedge (a_3 = 2) \wedge \ldots \wedge (a_9^1 = 1)$$

what means

e^1 = (*unemployment* = to make the Labour Code more flexible) $\wedge$ (*education and research* = free education at all the levels) $\wedge$ (*personal income tax* = to introduce progressive personal income tax, tax on stock exchange transactions and tax on capital) $\wedge \ldots \wedge$ (*election to the Parliament* = yes).

Table 1 presents the values of the attributes taken into account for the particular political organizations.

Table 1.

Attributes / Parties	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	a_9^1	a_9^2
SLD UP	1	2	2	2	2	3	1	2	1	1
PO	1	4	1	3	2	2	3	2	1	2
SO	3	2	4	1	2	1	2	3	1	2
PiS	2	1	3	4	1	1	2	1	1	2
PSL	2	3	2	2	2	1	5	1	1	2
LPR	4	1	3	1	3	2	1	3	1	2
AWSP	2	4	3	4	1	3	2	1	2	3
UW	1	1	1	3	3	3	4	2	2	3

The conjunction of l elementary conditions, $l \le K$, for all the attributes belonging to a certain subset $P \subseteq A$, $P = \{a_{j_1}, \ldots, a_{j_l}\}$, $\{j_1, \ldots, j_l\} \subseteq \{1, \ldots, K\}$ such that $card(P) = l$, is written down as

$$kon_P = \bigwedge_{a_j \in P}(a_j = v_i^{a_j}) = (a_{j_1} = v_i^{a_{j_1}}) \wedge \ldots \wedge (a_{j_l} = v_i^{a_{j_l}}) \tag{2}$$

where $v_i^{a_{j_1}} \in V_{a_{j_1}}, \ldots, v_i^{a_{j_l}} \in V_{a_{j_l}}$.

We say that the conjunction kon_P [cf. (2)] *covers* an example $e \in U$ [cf. (1)] (or, otherwise, that e fulfils the conjunction kon_P), if $\forall a \in P$ the condition $f(kon_P, a) = f(e, a)$ is satisfied. For instance, for the problem considered, the conjunction

$kon_{\{a_1, a_6\}}$ =(*unemployment*=to make the Labour Code more flexible) $\wedge$ (*election to the Parliament=yes*)

covers the example e^1 but does not cover the example e^8 (i.e. UW)

e^8 = (*unemployment* = to make the Labour Code more flexible) $\wedge$ (*education and research* = to increase governmental spending on education and research) $\wedge$ (*personal income tax* = to simplify the personal income tax system and to introduce linear personal income tax in the future) $\wedge$ ... $\wedge$ (*election to the Parliament* = no).

Thus, the examples described by the conjunction kon_P are indiscernible with application of P attributes. The set of all the examples described by the conjunction kon_P will be denoted $[kon_P]$.

If we select from the set of attributes A an attribute a_d, then we can perform the partition of the entire set of examples into the disjoint classes with respect to the values taken by this particular attribute. The elements of the set $A \backslash \{a_d\}$ are referred to as *conditional attributes*, and the attribute a_d is referred to as the *decision attribute*. We assume that the number and character of attributes are sufficient for the correct split of examples belonging to different classes.

The *partition of the set of examples U with respect to the decision attribute $a_d \in A$* having the domain $V_{a_d} = \{v_{i_1}^{a_d}, ..., v_{i_d}^{a_d}\}$ is constituted by non-empty subsets of the set of examples $\{Y_{v_{i_1}^{a_d}}, Y_{v_{i_2}^{a_d}}, ..., Y_{v_{i_d}^{a_d}}\}$, where $Y_{v_{i_t}^{a_d}} = \{e \in U: f(e, a_d) = v_{i_t}^{a_d}\}$, $v_{i_t}^{a_d} \in V_{a_d}$, for every $i_t = i_1, ..., i_d$, and $Y_{v_{i_1}^{a_d}} \cup ... \cup Y_{v_{i_d}^{a_d}} = U$, $Y_{v_i^{a_d}} \cap Y_{v_j^{a_d}} = \varnothing$ for $i \neq j$.

In the paper two problems are considered. They correspond to two decision attributes.

<u>Problem 1.</u> Given the set $A_1 = \{a_1,\ a_2,\ a_3,\ a_4,\ a_5,\ a_6,\ a_7,\ a_8\} \cup \{a_9^{\ 1}\}$. The decision attribute $a_9^{\ 1}$: *election to the Parliament* with the values {yes; no), which divides the set of examples into two disjoint classes: $\{Y_{yes},\ Y_{no}\}$ in the following manner: class Y_{yes} contains the political parties having entered the Parliament, class Y_{no} contains the political parties not having entered the Parliament.

<u>Problem 2.</u> Given the set $A_2 = \{a_1,\ a_2,\ a_3,\ a_4,\ a_5,\ a_6,\ a_7,\ a_8\} \cup \{a_9^{\ 2}\}$. The decision attribute $a_9^{\ 2}$: *membership of the group* with the values {1 - SLD – UP; 2 - remaining parties which having entered the Parliament except for SLD – UP, 3 - the political parties not having entered the Parliament}, which divides the set of examples into three disjoint classes: $\{Y_{SLD-UP},\ Y_{remaining\ parties},\ Y_{parties\ not\ in\ the\ Parliament}\}$.

Each of the classes contains the examples, which are indiscernible from the point of view of values of this decision attribute. Thus, the decision attribute splits the set of examples into the non-empty, disjoint and exhaustive subsets, that we call *decision classes*. The examples $e \in U$, for which the condition $f(e, a_d) = v_{i_i}^{a_d}$ is satisfied, are called *positive*, while the other – *negative*, for the class $Y_{v_{i_i}^{a_d}}$, $v_{i_i}^{a_d} \in V_{a_d}$.

The sets of the learning examples determined in this manner, along with their partition into classes, are the starting point in the process of machine learning, which is supposed to lead to the descriptions of the classes $Y_{v_{i_i}^{a_d}}$ considered. These descriptions can be represented in the form of *„elementary" rules* being the logical expressions of the form

IF certain conditions are fulfilled THEN membership in a definite class takes place.

In our case, the conditional part of the rules, will contain the conjunction of conditions related to the subset of attributes selected for the description of the political parties. *„Elementary" rule* for the class $Y_{v_{i_i}^{a_d}}$ is the expression

$$rul(P, v_{i_t}^{a_d}): \quad IF \; kon_P \; THEN \; (a_d = v_{i_t}^{a_d}) \tag{3}$$

where kon_P is defined by the formula (2), $v_{i_t}^{a_d} \in V_{a_d}$, $P = \{a_{j_i}, ..., a_{j_h}\} \subseteq A \setminus \{a_d\}$.

We say that a rule is consistent, if it distinguishes the positive from the negative examples. We say that a rule is *minimal* if removal of any condition from the conditional part of the rule, kon_P, would result in lack of fulfilment of the consistency condition. Each rule is characterised by the coefficient of the rule strength. The *strength of a rule*, which depends upon the number of examples described by the conditional part of the rule, belonging to a given class $Y_{v_{i_t}^{a_d}}$, is defined in the following manner:

$$q(rul(P, v_{i_t}^{a_d})) = \frac{card(\{e : e \in [kon_P] \; and \; f(e, a_d) = v_{i_t}^{a_d}\})}{card(\{e : e \in U\})} \tag{4}$$

The strength of a rule $q(rul(P, v_{i_t}^{a_d}))$ is the ratio of examples correctly classified to the total number of examples. It is evident that $0 \le q(rul(P, v_{i_t}^{a_d})) \le 1$. The more examples are described by the rule, the greater the value of the rule strength coefficient.

In this paper we consider the *rule for the class* $Y_{v_{i_t}^{a_d}}$, to be a set of „*elementary" rules* of type (3) for this class, i.e. $rul(P, v_{i_t}^{a_d})$, $P \subseteq A \setminus \{a_d\}$, consisting of conjunction of type (2).

It is obvious that not always all the attributes from the set $A \setminus \{a_d\}$ are necessary for ensuring the unchanged precision of classification of the examples. The key notion associated with the reduction of attributes in the rough set theory is the notion of reduct. Several types of reducts can be distinguished, depending upon the relation of indiscernibility. In general, a *reduct* of the set of attributes $P \subseteq A$ is the smallest subset of the set P ensuring the same distinguishability of the examples as the original set of attributes A. The problem of applying the theory of rough sets to determine a relationship describing what an influence exert programmes or electoral promises of political parties on the election of the party to the Parliament was analysed in the previous papers of the authors [5, 7].

The rules, mentioned above, can be formed by applying various algorithms of machine learning from examples. The present paper shows the application of the method, which creates the rules successively for each class. Each rule satisfies weakened requirements, i.e. must correctly describe all the examples belonging to a class and do not describe all of the examples not belonging to this class. They should have minimum „length" (e.g. in terms of the number of conditions forming them). The task of determining rules for a given class is represented in the form of a sequence of partial problems. Each partial problem is written down as the set-covering problem, which is a well-known NP-hard optimisation problem [1]. The details of the approach applied and the formal representation of a modification of the set covering problems obtained can be found in the papers [8, 11, 12]. The results of computations are given in Section 3.

3. ANALYSIS OF DECISION RULES

The rules of the "IF..., THEN..." type were formed for the classes, into which the selected decision attribute divides the set of the learning examples (Problem 1 and Problem 2 given in Section 2). The assumption was adopted that the rules must correctly describe all the learning examples. These rules specify, what conditions have to be satisfied in order that the attributes chosen as the decision variable takes an assumed value.

According to the formulation of Problem 1 and 2 in Section 2 three classes were considered:

1) class Y_{yes} : the political parties having entered the Parliament,

2) class Y_{SLD-UP}: the coalition SLD – UP,

3) class $Y_{remaining\ parties}$: the remaining parties having entered the Parliament except for SLD-UP

An examples of the rules obtained are shown below; the strength of the rule is given for each case.

IF (*health care system"* = to eliminate the existing health-care system and to establish a new one) THEN (*election to the Parliament* = *yes*); $q = 0.500$

IF (*health care system"* = to eliminate the existing health-care system and to establish a new one) $\wedge$ (*internal safety* = to increase the efficiency of judiciary system by, among others, the increase of governmental spending on this system) THEN (*membership of the group* = SLD – UP); $q = 0.125$

IF (*agriculture and regional policy* = to protect the Polish agriculture against foreign competition with the use of, among others, monitoring and making the frontier traffic control more tight) THEN (*membership of the group* = the remaining parties except for SLD – UP); $q = 0.250$

For the sake of simplicity of notation it is assumed that the enumeration of rules is as follows: the first digit corresponds to the number of the class, the second – to the number of examples described by a given rule, the third – the number of conditions appearing in the conditional part of a given rule, and the fourth one is the sequential number of a given rule, within a particular class.

3.1 Analysis of decision rules obtained for the class Y_{yes}

Altogether 21 rules were obtained for the class Y_{yes}. No rule could be established that would describe all the six examples under discussion. The largest number of examples described was four, this case being described by exactly one rule.

Table 2 shows all the rules obtained for this class, with specification of the numbers of examples described and the numbers of conditions making up the rule (the strength of the rule, q, is given for each case).

Thus, there are nine rules describing two examples, and the highest number of rules (11) describes only one example. Of the latter, five rules describe PO, three rules describe

LPR, two rules correspond to SO, and only one describes PSL. There is no rule among the eleven ones that would describe PiS. It should be emphasised that among all the 21 rules obtained for the class Y_{yes} only one describes PiS. This result confirms the suggestion that the program promises of PiS differed significantly from those formulated by other parties. The difficulties in forming a coalition by PiS, either with PO, or with LPR, which one could observe in the period after the elections, make this proposition even more likely.

Table 2

The rules	The conditional part of a rule	The examples:					
		SLD-UP	PO	SO	PiS	PSL	LPR
$q = 0.500$							
R1.4.1.1	(a5=2)	X	X	X		X	
$q = 0.250$							
R1.2.1.2	(a2=2)	X		X			
R1.2.1.3	(a2=3)				X	X	
R1.2.1.4	(a3=2)	X				X	
R1.2.1.5	(a4=1)			X			X
R1.2.1.6	(a4=2)	X				X	
R1.2.1.7	(a6=1)			X		X	
R1.2.1.8	(a6=2)		X				X
R1.2.1.9	(a7=1)	X					X
R1.2.1.10	(a8=3)			X			X
$q = 0.125$							
R1.1.1.11	(a1=3)			X			
R1.1.1.12	(a1=4)						X
R1.1.1.13	(a3=4)			X			
R1.1.1.14	(a7=3)		X				
R1.1.1.15	(a7=5)					X	
R1.1.2.16	(a1 = 1) ∧ (a2 = 4)		X				
R1.1.2.17	(a2 = 1) ∧ (a3 = 3)						X
R1.1.2.18	(a2 = 4) ∧ (a3 = 1)		X				
R1.1.2.19	(a2 = 4) ∧ (a4 = 3)		X				
R1.1.2.20	(a2 = 4) ∧ (a8 = 2)		X				
R1.1.2.21	(a3 = 3) ∧ (a5 = 3)						X

3.2 Analysis of decision rules obtained for the class Y_{SLD-UP}

For the class Y_{SLD-UP} one can form 19 rules of classification on the basis of examples. It can be seen from Table 2 that the rule R1.4.1.1 describes four cases, including SLD-UP, while the rules R1.2.1.2, R1.2.1.4, R1.2.1.6 and R1.2.1.9 describe two cases each, including SLD-UP. It can be expected, on the basis of considerations concerning the class Y_{pu}, that the rules obtained for the class Y_{SLD-UP} would constitute extensions – due to addition of consecutive conditions – of the rules mentioned above. This proposition is confirmed by the contents of Table 3, showing 19 rules obtained for the class Y_{SLD-UP}.

Table 3

The rules	The conditional part of a rule	The examples:					
		SLD-UP	PO	SO	PIS	PSL	LPR
$q = 0.125$							
R2.1.2.1	$(a2 = 2) \wedge (a1 = 1)$	X					
R2.1.2.2	$(a2 = 2) \wedge (a3 = 2)$	X					
R2.1.2.3	$(a2 = 2) \wedge (a4 = 2)$	X					
R2.1.2.4	$(a2 = 2) \wedge (a6 = 3)$	X					
R2.1.2.5	$(a2 = 2) \wedge (a7 = 1)$	X					
R2.1.2.6	$(a2 = 2) \wedge (a8 = 2)$	X					
R2.1.2.7	$(a3 = 2) \wedge (a1 = 1)$	X					
R2.1.2.8	$(a3 = 2) \wedge (a6 = 3)$	X					
R2.1.2.9	$(a3 = 2) \wedge (a7 = 1)$	X					
R2.1.2.10	$(a3 = 2) \wedge (a8 = 2)$	X					
R2.1.2.11	$(a4 = 2) \wedge (a1 = 1)$	X					
R2.1.2.12	$(a4 = 2) \wedge (a6 = 3)$	X					
R2.1.2.13	$(a4 = 2) \wedge (a7 = 1)$	X					
R2.1.2.14	$(a4 = 2) \wedge (a8 = 2)$	X					
R2.1.2.15	$(a5 = 2) \wedge (a6 = 3)$	X					
R2.1.2.16	$(a5 = 2) \wedge (a7 = 1)$	X					
R2.1.2.17	$(a7 = 1) \wedge (a1 = 1)$	X					
R2.1.2.18	$(a7 = 1) \wedge (a6 = 3)$	X					
R2.1.2.19	$(a7 = 1) \wedge (a8 = 2)$	X					

All the rules are composed of two conditions. Thus, rules R2.1.2.1 – R2.1.2.6 constitute an extension to the rule R1.2.1.2, rules R2.1.2.7 – R2.1.2.10 correspond to the rule

R1.2.1.4, rules R2.1.2.11 – R2.1.2.14 are associated with the rule R1.2.1.6, while rules R2.1.2.15 and R2.1.2.16 correspond to the rule R1.4.1.1. Then, rules R2.1.2.17 – R2.1.2.19 constitute an extension of the rule R1.2.1.9.

It is obvious that the rules obtained for the class Y_{SLD-UP} must also contain the combinations of conditions appearing in the rules R1.4.1.1, R1.2.1.2, R1.2.1.4, R1.2.1.6, as well as R1.2.1.9. This exactly is the form of the rules R2.1.2.2, R2.1.2.3, R2.1.2.5, R2.1.2.9, R2.1.2.13 and R2.1.2.16.

The remaining 13 rules resulted from adding new conditions. Thus, condition a1=1 ("more flexible labour law") appears in four rules, condition a6=3 ("developing non-agricultural activities and infrastructural projects in the countryside") appears in five rules, while a8=2 ("strong support for Polish accession to the EU") appears in four rules. The recent modification of the Labour Law and the positive result of the referendum concerning Polish accession to the EU demonstrate the significance of these additional conditions for the Polish society.

3.3 Analysis of decision rules obtained for the class $Y_{remaining\ parties}$

Problem, let us remind, consisted in determination of the rules that would define the conditions of the entry to the Parliament of the five parties except for the coalition SLD-UP. For the class $Y_{remaining\ parties}$ one can form 30 rules of classification on the basis of examples.

It should have been expected that all the rules determined for Y_{yes}, which describe one or two examples not encompassing the SLD-UP should also result from the procedure for class $Y_{remaining\ parties}$. Table 4 shows rules obtained for class $Y_{remaining\ parties}$.

Thus, rules R3.2.1.1 – R3.2.1.5 describe two cases each and contain just one condition each. Rules R3.1.1.6 – R3.1.1.10 describe only one case and contain only one condition. Then, rules R3.1.2.11 – R3.1.2.30 describe one case each and contain two conditions.

Conform to the expectations, rules R3.2.1.1 – R3.1.2.16 are identical with the rules describing one or two examples not encompassing the SLD-UP, shown in Table 2.

From among 14 additional rules describing single cases six concern the PSL. For both PO and LPR three rules were obtained. SO is described by two rules.

Table 4

The rules	The conditional part of a rule	The examples:					
		SLD-UP	PO	SO	PiS	PSL	LPR
$q = 0.250$							
R3.2.1.1	(a2=3)				X	X	
R3.2.1.2	(a4=1)			X			X
R3.2.1.3	(a6=1)			X		X	
R3.2.1.4	(a6=2)		X				X
R3.2.1.5	(a8=3)			X			X
$q = 0.125$							
R3.1.1.6	(a1=3)			X			
R3.1.1.7	(a1=4)						X
R3.1.1.8	(a3=4)			X			
R3.1.1.9	(a7=3)		X				
R3.1.1.10	(a7=5)					X	
R3.1.2.11	$(a1 = 1) \wedge (a2 = 4)$	X					
R3.1.2.12	$(a2 = 1) \wedge (a3 = 3)$						X
R3.1.2.13	$(a2 = 4) \wedge (a3 = 1)$	X					
R3.1.2.14	$(a2 = 4) \wedge (a4 = 3)$	X					
R3.1.2.15	$(a2 = 4) \wedge (a8 = 2)$	X					
R3.1.2.16	$(a3 = 3) \wedge (a5 = 3)$						X
R3.1.2.17	$(a1 = 2) \wedge (a3 = 2)$					X	
R3.1.2.18	$(a1 = 2) \wedge (a4 = 2)$					X	
R3.1.2.19	$(a1 = 2) \wedge (a5 = 2)$					X	
R3.1.2.20	$(a2 = 1) \wedge (a7 = 1)$						X
R3.1.2.21	$(a2 = 2) \wedge (a7 = 2)$			X			
R3.1.2.22	$(a2 = 4) \wedge (a5 = 2)$		X				
R3.1.2.23	$(a3 = 1) \wedge (a5 = 2)$		X				
R3.1.2.24	$(a3 = 2) \wedge (a8 = 1)$					X	
R3.1.2.25	$(a3 = 3) \wedge (a7 = 1)$						X
R3.1.2.26	$(a4 = 2) \wedge (a8 = 1)$					X	
R3.1.2.27	$(a4 = 3) \wedge (a5 = 2)$		X				
R3.1.2.28	$(a5 = 2) \wedge (a7 = 2)$			X			
R3.1.2.29	$(a5 = 2) \wedge (a8 = 1)$					X	
R3.1.2.30	$(a5 = 3) \wedge (a7 = 1)$						X

There was no new rule obtained for the PiS, which confirms the already mentioned specificity of this party's program.

The additional rules obtained contain conditions, which have not appeared in the rules determined for the Y_{yes}, namely (a1=2), (a5=3), (a8=1).

4. CONCLUDING REMARKS

It is shown that analysis of decision rules obtained for the case of the Parliamentary elections, which took place on September 23rd, 2001, can be of help for analyzing electorate preferences. The rules can also be used to identify the dependencies existing in the information set of the examples that have not been previously known explicitly. They can facilitate understanding existing relations between attributes or class definitions. The adequacy of decision rules depends upon the appropriate choice of attributes taken into consideration in the analysis carried out as well as values of these attributes.

The paper concentrated on the analysis of rules. Relations between rules obtained and attribute values are to be considered in detail in the future. Fore example, it should be emphasized that the attribute a1: "fighting the unemployment" appeared in three rules, and in two of them constituted the sole condition. Attribute a4: "economic policy" had the identical frequency of appearance. Attribute a7: "safety" appeared in three rules, as well. In each of these rules, though, it constituted the sole condition. It should be noted that no rule contained the conditions (a4=4), (a5=1), (a7=4). This observation implies that for the purpose of description of the subsequent elections to the Parliament the significance of individual attributes and of the values they take should be analysed in detail.

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