Cooperative Discovery of Interesting Action Rules

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Abstract. Action rules introduced in [12] and extended further to e-action rules [21] have been investigated in [22], [13], [20]. They assume that attributes in a database are divided into two groups: stable and flexible. In general, an action rule can be constructed from two rules extracted earlier from the same database. Furthermore, we assume that these two rules describe two different decision classes and our goal is to re-classify objects from one of these classes into the other one. Flexible attributes are essential in achieving that goal since they provide a tool for making hints to a user what changes within some values of flexible attributes are needed for a given set of objects to re-classify them into a new decision class. There are two aspects of interestingness of rules that have been studied in data mining literature, objective and subjective measures [8], [1], [14], [15], [23]. In this paper we focus on a cost of an action rule which was introduced in [22] as an objective measure. An action rule was called interesting if its cost is below and support higher than some user-defined threshold values. We assume that our attributes are hierarchical and we focus on solving the failing problem of interesting action rules discovery. Our process is cooperative and it has some similarities with cooperative answering of queries presented in [3], [5], [6].

1 Introduction

There are two aspects of interestingness of rules that have been studied in data mining literature, objective and subjective measures [8], [1], [14], [15]. Objective measures are data-driven and domain-independent. Generally, they evaluate rules based on their quality and similarity between them. Subjective measures, including unexpectedness, novelty, and actionability, are user-driven and domain-dependent. A rule is actionable if user can do an action to his/her advantage based on this rule [8]. A formal definition of an action rule, constructed from certain pairs of classification rules, has been proposed in [12] and investigated further in [21], [22], [13], [20]. Interventions introduced in [7] are similar to action rules. The idea behind either action rules or interventions is to construct special kind of rules showing what changes in values of attributes,

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for a given object, are needed in order to re-classify this object the way user wants. Assuming, for instance, that objects are customers, this re-classification may mean that a consumer not interested in a certain product, now may buy it, and therefore may shift into a group of more profitable customers.

The notion of a cost of an action rule was introduced in [22] as an objective measure. An action rule is called interesting if its cost is below some user-defined threshold value. For a given user, the cost associated with changes of values within one of his features is usually different than the cost associated with changes of values within his another feature. A heuristic strategy for replacing the initially extracted action rule by a composition of new action rules, dynamically built, was proposed in the paper by [22]. This composition of rules uniquely defines a new action rule and it is built with a goal to lower the cost of reclassifying objects supported by the initial action rule. However, in some cases the process of interesting action rules discovery may fail.

We assume, in this paper, that attributes are hierarchical and we show that failing problem of discovering interesting action rules can be treated in a similar way to the failing problem of database queries [3], [5], [6].

2 Information System and Action Rules

An information system is used for representing knowledge. Its definition, given here, is due to Pawlak [9].

By an information system we mean a triple $S = (U, A, V)$, where:

- U is a nonempty, finite set called the universe,
- A is a nonempty, finite set of attributes i.e. $a : U \longrightarrow V_a$ is a function for $a \in A$,
- $V = \bigcup\{V_a : a \in A\}$, where V_a is a set of values of the attribute $a \in A$.

Elements of U are called objects. In this paper, they are often seen as customers. Attributes are interpreted as features, offers made by a bank, characteristic conditions etc.

By a decision table we mean any information system where the set of attributes is partitioned into conditions and decisions. Additionally, we assume that the set of conditions is partitioned into stable and flexible. For simplicity reason, we assume that there is only one decision attribute. Date of birth is an example of a stable attribute. Interest rate on any customer account is an example of a flexible attribute (dependable on bank). We adopt the following definition of a decision table:

By a decision table we mean an information system of the form $S = (U, A_{St} \cup A_{Fl} \cup \{d\}, V)$, where $d \notin A_{St} \cup A_{Fl}$ is a distinguished attribute called decision. The elements of A_{St} are called stable conditions, whereas the elements of A_{Fl} are called flexible conditions.

As an example of a decision table we take $S = (\{x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9\}, \{a, c\} \cup \{b\} \cup \{d\}, V)$ represented by Table 1. The set $\{a, c\}$ lists stable