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Indukcja reguł akcji na podstawie metody sekwencyjnego pokrywania

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Action Rules Induction by Sequential Covering

Abstract

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Decision rules have been widely used as a Knowledge Discovery tool during past 30 years. This method excels especially when the clarity and comprehensibility of the model is required. Based on the notion and algorithms used for decision rules induction, a new category of rules called Action Rules has been created. An action rule is a special type of rule representing a dependency showing a possible way to move examples from the so-called source decision class to another one called a target decision class. Action rules were first described by Raś in year 2000, and since then many algorithms that discover action rules were published.

Whilst a decision rule represents a statement about data in the form ,,If set of conditions is met, given object belongs to a certain class", an action rule answers a question ,,Which changes are required in order for an object to change its class".

There are two aspects at which we can look at action rules. First, they represent a knowledge about changes in attribute values required to move examples between classes in given dataset. Second, they can be used as a tool to propose, for a given example, which attributes and how to change them to achieve expected change in the decision attribute value.

So far, the Sequential Covering approach that is considered extremely effective in decision rules discovery has not been used for action rules induction. Application of this paradigm to discover interesting action rules directly from the data have been broadly discussed in the thesis.

The work introduces three classes of algorithms and a testing workflow. First, induction of action rules for classification data using the sequential covering approach is presented. The algorithm features two variations: the induction can be conducted starting from the source class or from the target class. The sequential covering method is also adapted to induce action rules for regression problems, where the decision attribute is a continous value. Introduced algorithms can be easily amended to specific needs of the user, by changing the quality measure used to supervise induction of action rules. The algorithms can induce action rules directly from the data, from both numeric and nominal attributes, without need to discretize the continous value up front.

Third algorithm allows to discover recommendations. A recommendation is a special type of action rule that was created for a specific example. Induction of recommendations helps to overcome the issue of contradicting sets of actions rules (where one example can be covered by rules having contradicting conclusion) and selection of the action rule to be applied to the object. It is a common feature of rule sets created by sequential covering approach, that there can be many rules covering one example. Presented algorithm created recommendations based on previously induced sets of action rules.

The action rule provides a synthetic recipe how to change values of some attributes of an object in order to observe the change in its classification. By manipulation of the values of the attributes, we can simulate the application of action rules to the real objects. The work described here introduces also a testing workflow. In the workflow it is assumed that a strong classifier is a judge, deciding whether an example manipulated according to some action rule has been sucesfully transferred to a target class. Some metrics are proposed in the work to help assess the usability of action rule induction methods. The only certain method of assesing the usability of action rules is to influence real-life objects, so that their attributes are amended as requested by the action rules, and then observe whether the object changes its class as expected. This process might be expensive and time consuming. Proposed method of testing helps to discard action rule sets that are ineffective according to a classifier of high accuraccy. This testing method can be also used for regression problems.

In the work a set of experiments have been conducted. The experiments used the described testing process to assess action rule and regression induction methods are introduced in the work. It was shown that both application of different rule quality measures to supervise the induction of a rules and changing the direction of induction leads to rule sets of good descriptive and predictive abilities, where by descriptive capabilities we understand the consciseness of description of the knowledge discovered, and by predictive abilities – the performance in the task of moving the examples from source to target class. Especially, the $C2$ and $WeightedLaplace$ measures are highly effective in moving the examples between classes, while $C2$ excels in regression problems.