Chapter 13

DECISION RULE APPROACH

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Abstract
We present the methodology of Multiple-Criteria Decision Aiding (MCDA) based on preference modelling in terms of “if..., then ...” decision rules. The basic assumption of the decision rule approach is that the decision maker (DM) accepts to give preferential information in terms of examples of decisions and looks for simple rules justifying her decisions. An important advantage of this approach is the possibility of handling inconsistencies in the preferential information, resulting from hesitations of the DM. The proposed methodology is based on the elementary, natural and rational principle of dominance. It says that if action $x$ is at least as good as action $y$ on each criterion from a considered family, then $x$ is also comprehensively at least as good as $y$. The set of decision rules constituting the preference model is induced from the preferential information using a knowledge discovery technique properly modified, so as to handle the dominance principle. The mathematical basis of the decision rule approach to MCDA is the Dominance-based Rough Set Approach (DRSA) developed by the authors. We present some basic applications of this approach, along with didactic examples whose aim is to show in an easy way how DRSA can be used in various contexts of MCDA.

Keywords: Dominance, rough sets, decision rules, multiple criteria classification, choice and ranking.
1. Introduction

Multiple-criteria decision support aims at giving the decision maker (DM) a recommendation [51] in terms of the best actions (choice), or of the assignment of actions to pre-defined and preference-ordered classes (classification, called also sorting), or of the ranking of actions from the best to the worst (ranking). None of these recommendations can be elaborated before the DM provides some preferential information suitable to the preference model assumed.

There are two major preference models used until now in multiple-criteria decision analysis: Multi-Attribute Utility Theory (MAUT; see [40] and Chapter 7) and the outranking approach (see Chapter 4 and [50]). These models require specific preferential information more or less explicitly related to their parameters. For example, the DM is often asked for pairwise comparisons of actions from which one can assess the substitution rates for a MAUT model or the importance weights for an outranking model (see [5], [44]). This kind of preferential information seems to be close to the natural reasoning of the DM. She is typically more confident exercising her decisions than explaining them. The transformation of this information into MAUT or outranking models seems, however, less natural. According to Slovic [53], people make decisions by searching for rules which provide good justification of their choices. So, after getting the preferential information in terms of exemplary decisions, it would be natural to build the preference model in terms of “if..., then ...” rules. Examples of such rules are the following:

- “if maximum speed of car $x$ is at least 175 km/h and its price is at most $12000$, then car $x$ is comprehensively at least medium”,

- “if car $x$ is at least weakly preferred to car $y$ with respect to acceleration and the price of car $x$ is no more than slightly worse than that of car $y$, then car $x$ is at least as good as car $y$”.

The rules induced from exemplary decisions represent a preferential attitude of the DM and enable her understanding of the reasons of her preference. The acceptance of the rules by the DM justifies, in turn, their use for decision support. This is concordant with the principle of posterior rationality by March [43] and with aggregation-disaggregation logic by Jacquet-Lagrèze [39].

The set of decision rules accepted by the DM can be applied to a set of potential actions in order to obtain specific preference relations. From the exploitation of these relations, a suitable recommendation can be obtained to support the DM in decision problem at hand.

So, the preference model in the form of decision rules induced from examples fulfills both representation and recommendation tasks (see [51]).

The induction of rules from examples is a typical approach of artificial intelligence. This explains our interest in rough set theory [46, 47, 49, 54] which