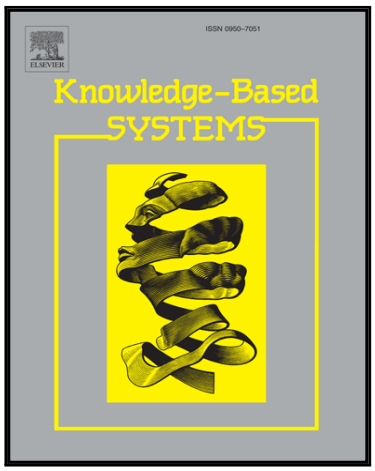

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Actionable Strategies in Three-way Decisions

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Abstract

This paper introduces actionable strategies to the trisecting-and-acting three-way decision model. We present four change-based actionable models according to action benefit and action cost. Two of the four models provide the bounds of the cost and benefit and the other two models quantify the maximum benefit under limited cost and the minimum cost for a desired benefit, respectively. We design and analyze algorithms for these models. Finally, we report experimental results to support the proposed models.

Keywords: Three-way decision, actionable strategy, actionable rule, action, maximum benefit, minimum cost

1. Introduction

In a set-theoretical setting, three-way decisions can be formulated as a two-step process within a trisecting-and-acting framework [43]. The trisecting step divides a universal set of objects into three pairwise disjoint regions. The acting step adopts strategies to process objects in the three regions. We use election as an example to illustrate the main ideas of the trisecting-and-acting model of three-way decisions. Based on an opinion poll, one typically divides a set of voters into three groups: voters who support the candidate, voters who oppose the candidate, and voters who are undecided or not willing to tell their decisions. According to the poll result, the candidate may take some actions to retain the group of supporters, to persuade the undecided voters, and to change the non-supporters.

Existing studies on three-way decisions focus mainly on the trisecting step [1, 5, 6, 9, 40, 49]. There is relatively little investigation on the acting step for devising actionable strategies. In this paper, we combine ideas from actionable rule mining and three-way decisions to build a model of actionable strategies in three-way decisions. Drawing from the example of election, we look at a model in which actionable strategies facilitate movement of voters from non-favorable regions to favorable regions. We represent and interpret actionable strategies in terms of the notation of actionable rules and action rules in machine learning and data mining [26, 27, 33, 34, 37, 39].

Silberschatz and Tuzhilin [33] introduced the concept of actionability that a user can react to realize his or her advantage. Ras and Wieczorkowska [27] adopted action rules to mine profitable pattern for banks. Yang et al. [39] introduced a postprocessing decision tree method to find actions for benefit. Su et al. [36] searched actionable behavioral rules with a high utility. Many studies on actionable rules cover topics in data mining and machine learning, such as association rule mining [18, 31], classfication [7, 26, 27, 38, 39], clustering [13, 20, 46], and outlier detection [4, 15]. To calculate action cost or measure actionability of rules, attributes are categorized into two types [26, 27, 39]: attributes whose values are changeable and attributes whose values are unchangeable, called flexible attributes and stable attributes, respectively. Rules constructed from flexible attributes are actionable and those constructed from stable attributes are non-actionable. Issues of actionable rules such as comparative study are discussed in [14]. In the context of

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