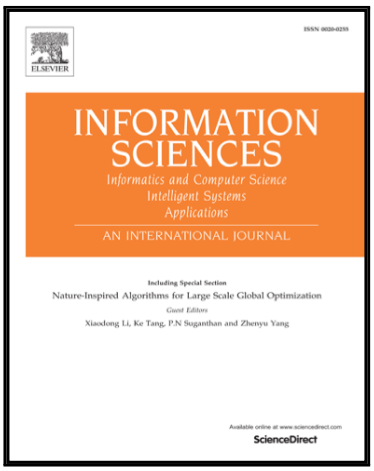

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PII: S0020-0255(16)31227-0
DOI: 10.1016/j.ins.2017.06.032
Reference: INS 12954

To appear in: *Information Sciences*

Received date: 9 October 2016
Revised date: 20 June 2017
Accepted date: 23 June 2017

Please cite this article as: Chen Hao, Jinhai Li, Min Fan, Wenqi Liu, Eric C.C. Tsang, Optimal scale selection in dynamic multi-scale decision tables based on sequential three-way decisions, *Information Sciences* (2017), doi: 10.1016/j.ins.2017.06.032

Optimal scale selection in dynamic multi-scale decision tables based on sequential three-way decisions

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Abstract

It has been recognized that optimal scale selection in rough set theory is one of the most important problems in the study of multi-scale decision tables. Recently, much attention has been paid to this issue and quite a few appealing results have been obtained. However, the existing results are not applicable to the situation where the objects or attributes in a multi-scale decision table are sequentially updated, although this situation is frequently encountered in many real-world problems. Motivated by the fact that sequential three-way decisions are an effective mathematical tool in dealing with the data with information sequentially updated, we therefore use this methodology to investigate the optimal scale selection problem in a dynamic multi-scale decision table. Specifically, a sequential three-way decision model is first developed in multi-scale information tables, which can be viewed as multi-granularity of the universe of discourse. Then, this model is employed to present an optimal scale selection approach for such multi-scale decision tables that the number of objects is increasing. Finally, numerical experiments are conducted to evaluate the performance of the proposed optimal scale selection approach. Compared to the existing methods, the current approach does not need to consider the consistent and the inconsistent multi-scale decision tables separately and is especially suitable for updating the optimal scales of the multi-scale decision tables with new objects added.

Keywords: Multi-scale decision tables; Rough set theory, Dynamic data; Three-way decisions; Optimal scale selection

1. Introduction

The three-way decision (3WD) model was originally introduced by Yao [37, 38, 39]. The basic idea of this model is to divide a whole into three distinctive and related parts, and then to devise effective strategies to act upon the three parts. The three parts in a 3WD are respectively labeled by acceptance, rejection and non-commitment (or uncertain decision), where the non-commitment will generally be set when the available information is too sparse to make the decision of acceptance or rejection. To the best of our knowledge, one of the most appealing 3WD methodologies is perhaps the sequential or dynamic 3WD [16, 40, 43] in which the key strategy is to gradually transfer non-commitment decision into acceptance or rejection decision with the help of newly input information [8, 19, 21]. As a result, the sequential 3WD has been an effective and flexible mathematical tool for dealing with the data with information updated sequentially. Nowadays, 3WD has been combined with other theories such as game theory, formal concept analysis, cognitive computing and others (see, e.g., [1, 6, 15, 30, 41, 42] for details), and has been applied in many fields including risk decision-making [18, 20], spam e-mail filtering [9], face recognition [16], recommender system design [49], clustering analysis [45] and so on.

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