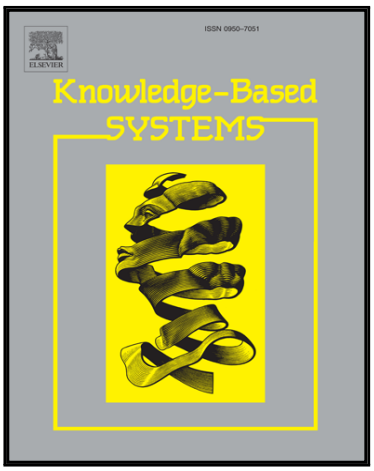

Stepwise optimal scale selection for multi-scale decision tables via attribute significance

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Stepwise optimal scale selection for multi-scale decision tables via attribute significance

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Abstract

Hierarchically structured data are very common or even unavoidable for data mining and knowledge discovering from the perspective of granular computing in real-life world. Based on this circumstance, multi-scale information system is introduced by Wu and Leung and extends the theory and application of information system. In such table, objects may take different values under the same attribute measured at different scales. Recently, scale selection is the main issue of multi-scale information system, and optimal scale selection is to choose a proper decision table for final decision making or classification. In this paper, we firstly propose the concept of multi-scale attribute significance, and, in the sense of binary classification, another two equivalent definitions are given. Then based on the concept of significance, this paper introduces a novel approach of stepwise optimal scale selection to obtain one optimal scale combination with less time cost compared with the lattice model. Specially, for inconsistent multi-scale decision tables, different types of consistence are considered with different requirements for optimal scale selection. Finally, five algorithms are designed and six numerical experiments are employed to illustrate the feasibility and efficiency of the proposed model.

Keywords: Granular computing, Multi-scale decision tables, Attribute significance, Optimal scale combination, Rough sets

1. Introduction

Granular computing (GrC), which derives from the topic of fuzzy information granulation firstly proposed by Zadeh in 1979 [58, 59], is employed as a powerful tool for complex problem solving, massive data mining and fuzzy information processing. Several decades have witnessed the rapid development of GrC [1, 2, 16, 20, 24, 25, 28, 35, 44, 46, 48, 49, 50, 52, 56, 60, 61]. As a primitive notion, granule is a clump of objects drawn together by the criteria of indistinguishability, similarity or functionality [59]. Satisfying a given specification, these elements within a granule are considered as a whole rather than individuals. Therefore, with respect to a particular level of granularity, a universe can be represented by a set of granules. This process is called information granulation, which provides an effective approach to solve a complex problem at a certain level of granulation. Partition model proposed by Yao [53], severing as a significant and commonly used model for GrC, is constructed by granulating a finite universe of discourse through a family of pairwise disjoint subsets under an equivalence relation. Furthermore, Bittner and Stell [3], Yao [50], Wu and Leung [42] have studied the multiple granulation hierarchies. Recently, Xu et al. [47] and Hu et al. [13] studied information fusion and machine learning from the viewpoint of GrC, respectively.

Rough set theory (RST) originally proposed by Palwak [29] has played a vital role in the extension and development of GrC. As a powerful tool of soft computing, it is able to perform well in construction, interpretation and representation of granules in a universe by an equivalence relation, and provide us with more precise concept to define and analyze notions of GrC. From the view of GrC, equivalence granules can be obtained in Pawlak approximation space based on an equivalence relation, and are the basic components for representing and approximating in Pawlak approximation space.

Some extensions of RST about acquisition of knowledge from information table via an objective knowledge induction process have been successively proposed, such as probabilistic rough set [39, 40, 41, 51, 54, 55], dominance-based rough set [4, 6, 7, 21, 37], multigranulation rough set [10, 11, 12, 14, 22, 26, 27, 31, 32, 33, 57], etc. In these literatures, the information table characterized by only taking on one value for each object at each

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