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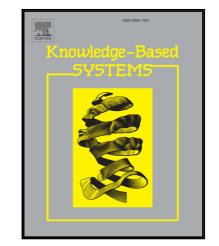
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Characteristics of three-way concept lattices and three-way rough concept lattices

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Abstract: In classical formal concept (Wille's concept) analysis, a basic theorem about concept lattices is that every concept lattice is a complete lattice and conversely, every complete lattice is isomorphic to a concept lattice. Three-way concept analysis is an extended theory of formal concept analysis. Similarly, three-way concept lattices and three-way rough lattices are also complete lattices. However, unlike the classical case, not every complete lattice arises as a three-way concept lattice (or as a three-way rough concept lattice). In this paper, we focus on characterising those complete lattices which can be represented by three-way concept lattices. In order to achieve this, we first discuss some properties of special elements such as atoms and irreducible elements, and complements of three-way concept lattices. Then we give our main theorem by displaying conditions under which any complete lattice can be realised as a three-way concept lattice. Similar results are discussed and obtained for three-way rough concept lattices.

Keywords: Complete lattice; Formal concept analysis; Three-way concept; Three-way rough concept

1 Introduction

The theory of three-way decisions (3WD), proposed by Yao [42], is an extension of two-way decision model with an added third option. The basic idea of 3WD is to classify a universal set into three pair-wise disjoint regions, called the positive, the negative and the boundary region, respectively. Corresponding to these three regions, one can build rules for making a decision of acceptance, rejection and non-commitment, respectively. Up to now, 3WD has received much attention in theory and applications [8,9,17,18,22,43,44].

Formal concept analysis (FCA) proposed by Wille [37] in 1982, is an order-theoretic method for the mathematical analysis of scientific data. The central notions of FCA are concept and concept lattice. A formal concept is determined by a pair of sets, that is, a set of objects (the extension) and a set of attributes (the intension). The set of formal concepts of a formal context forms a complete lattice called the concept lattice, which is the core structure of FCA. In the

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