Int. J. Mach. Learn. & Cyber. (2017) 8:1–2
DOI 10.1007/s13042-016-0600-5

EDITORIAL

Editorial

Weihua Xu[1] · Jinhai Li[2] · Mingwen Shao[3] · Wen-Xiu Zhang[4]

Published online: 26 January 2017
© Springer-Verlag Berlin Heidelberg 2016

Concept lattice is an effective mathematical tool in formal concept analysis (FCA) which was proposed by Rudolf Wille in 1982. Concept lattice is constituted by formal concepts and their hierarchical order, so as to reflect the generalization-specialization relation of formal concepts hided in the data. After 34 years of development, it has shown a trend of multidisciplinary intersection and fusion and has widely been applied in a variety of fields including knowledge discovery, machine learning, software engineering, cognitive learning, and so on.

The theory of three-way decisions (3WD), presented by Yiyu Yao in 2009, was initially intended as a means to interpret classification/decision rules induced in probabilistic rough sets. A three-way decision model is usually to consider a decision-making problem as a ternary classification one (i.e. acceptance, rejection and non-commitment). Nowadays, this theory has been applied to spam e-mail filtering, investment decision-making, face recognition, recommender system design, clustering analysis, cognitive learning and many other aspects.

Moreover, concept lattice has recently been integrated with three-way decisions in order to support three-way decisions in formal contexts, in which the main strategy is to incorporate the idea of ternary classification into the design of the extension and/or intension of a formal concept. To the best of our knowledge, the combination of concept lattice and three-way decisions has obtained some preliminary achievements on three-way concept lattice construction, three-way concept lattice reduction, three-way concept analysis of incomplete information, three-way concept learning, etc.

The 14 papers in this special issue provide a snapshot of new advances in concept lattice and three-way decisions. They highlight the impact of concept lattice and three-way decisions in establishing new theories and methods of conceptual knowledge discovery and decision-making. In what follows, we give a brief summary of them.

Yiyu Yao proposes a common conceptual framework of the notions of interval sets and incomplete formal contexts for representing partially-known concepts in his paper entitled "Interval sets and three-way concept analysis in incomplete contexts". Within the framework, he identifies four forms of partially-known concepts and studies their relationships to existing notions.

In the second paper entitled "Three-way conceptual approach for cognitive memory functionalities", Radhika Shivhare and Ch. Aswani Kumar extend the formal concept analysis based on bidirectional associative memory to

✉ Jinhai Li
jhlixjtu@163.com

Weihua Xu
chxuwh@gmail.com

Mingwen Shao
smw278@126.com

Wen-Xiu Zhang
wxzhang@mail.xjtu.edu.cn

[1] School of Mathematics and Statistics, Chongqing University of Technology, Chongqing 400054, People's Republic of China

[2] Faculty of Science, Kunming University of Science and Technology, Kunming 650500, Yunnan, People's Republic of China

[3] College of Computer and Communication Engineering, China University of Petroleum, Qingdao 266580, Shandong, People's Republic of China

[4] Institute for Information and System Sciences, School of Mathematics and Statistics, Xi'an Jiaotong University, Xi'an 710049, Shaan'xi, People's Republic of China

three-way concept analysis in order to achieve both positive and negative recalls from memory.

Junhai Zhai, Yao Zhang and Hongyu Zhu present a new three-way decision model based on tolerance rough fuzzy set in their paper entitled "Three-way decisions model based on tolerance rough fuzzy set". The advantage of this new model is that it can directly deal with a special kind of fuzzy decision tables without discretization, while preserving the required information.

The paper entitled "Multi-level interval-valued fuzzy concept lattices and their attribute reduction", written by Lifeng Li, introduces the concept lattice of an interval-valued fuzzy formal context with the help of multi-level idea and discusses attribute reduction using discernibility matrix and Boolean function.

In the fifth paper entitled "Method for generating decision implication canonical basis based on true premises", Deyu Li, Shaoxia Zhang and Yanhui Zhai put forward an algorithm to generate a decision implication canonical basis which is a complete, non-redundant and optimal set of decision implications. The proposed algorithm is based on true premises and has some advantages in time complexity.

Prem Kumar Singh investigates how to represent a three-way fuzzy concept lattice in his paper entitled "Three-way fuzzy concept lattice representation using neutrosophic set". He analyzes the uncertainty and incompleteness in the given fuzzy attribute set characterized by truth membership, indeterminacy membership, and falsity membership functions of a single-valued neutrosophic set.

The paper entitled "Attribute reduction in inconsistent formal decision contexts based on congruence relations" is completed by Jun-Yu Li, Xia Wang, Wei-Zhi Wu and You-Hong Xu. It develops several new attribute reduction methods for inconsistent formal decision contexts. Besides, the proposed methods are also compared with the exiting ones to clarify its main contribution.

In the eighth paper entitled "Decomposition methods of formal contexts to construct concept lattices", Ting Qian, Ling Wei and Jianjun Qi use the decomposition of a formal context to generate its corresponding concept lattice. The obtained results may be beneficial to the open problem that the decomposition method of a formal context can be translated into that of its corresponding concept lattice.

Xin Li, Ming-Wen Shao and Xing-Min Zhao try to build the concept lattice of a formal context from the viewpoint of meet-irreducible attribute concepts in their paper entitled "Constructing lattice based on irreducible concepts". In order to improve the building efficiency, optimization is made during every key step.

In the paper entitled "Concept acquisition approach of object-oriented concept lattices", Jian-Min Ma, Ming-Jie Cai and Cun-Jun Zou employ the layered extension sets to acquire object-oriented concepts. An algorithm of computing all object-oriented concepts is given and some numerical experiments are conducted to demonstrate the running efficiency.

The eleventh paper entitled "Attributes reduction and rules acquisition in an lattice-valued information system with fuzzy decision", written by Xiaoyan Zhang, Ling Wei and Weihua Xu, proposes the notion of a lattice-valued information system with fuzzy decision by combining dominance relation and lattice structure. Moreover, attribute reduction and rule acquisition are also discussed.

Li Ma, Ju-Sheng Mi and Bin Xie present the multi-scaled concept lattice through inclusion degree in their paper entitled "Multi-scaled concept lattices based on neighborhood systems". Note that it introduces the inclusion degree with a covering of attribute set instead of a partition based on object set.

In the thirteenth paper entitled "Cognitive concept learning from incomplete information", Yingxiu Zhao, Jinhai Li, Wenqi Liu, et al. concern cognitive mechanism of learning approximate concepts from incomplete information, design a cognitive computing system for learning granular concepts, and discuss cognitive processes.

The final paper entitled "Name identification and extraction with formal concept analysis", written by Kazem Taghva, describes how FCA identifies and extracts personal names as units of thought similar to the decoding of text sequences by Viterbi algorithm as used with Hidden Markov Models. Moreover, some advantages of this FCA approach are discussed as well.

All in all, we hope that this special issue can provide some useful references for those who are interested in new advances in concept lattice and three-way decisions and particularly for those who are studying the machine learning model based on concept lattice and three-way decisions.