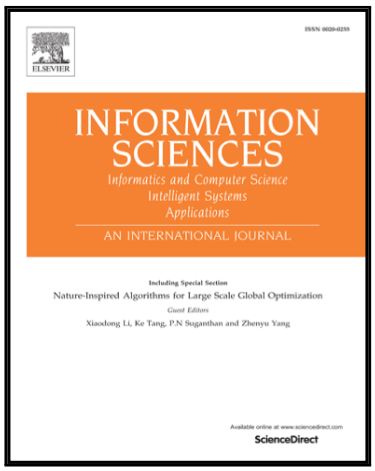

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PII: S0020-0255(17)30182-2
DOI: 10.1016/j.ins.2017.01.032
Reference: INS 12717

To appear in: *Information Sciences*

Received date: 22 December 2014
Revised date: 11 January 2017
Accepted date: 12 January 2017

Please cite this article as: Xun Ge, Pei Wang, Ziqiu Yun, The rough membership functions on four types of covering-based rough sets and their applications, *Information Sciences* (2017), doi: 10.1016/j.ins.2017.01.032

Available online at www.sciencedirect.com
ScienceDirect
Information Sciences 00 (2017) 1–18
Information Sciences

The rough membership functions on four types of covering-based rough sets and their applications

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Abstract

Pawlak's rough membership functions not only give numerical characterizations of Pawlak's rough set approximations, but also establishes the relationships between Pawlak's rough sets and fuzzy sets or probabilistic rough sets. However, it is noteworthy that Pawlak's rough membership functions have limitations when handling incomplete data that exist widely in the real world. As will be shown in this paper, one way to overcome this is to construct rough membership functions for covering-based rough sets. In this paper, we first use an example in evidence-based medicine to illustrate how to use Pawlak's rough membership function on numerically characterizing decisions under the circumstances where data are complete. Then, we construct covering-based rough membership functions for four types of covering-based rough sets which were examined by Zhu and Wang (in IEEE Transactions on Knowledge and Data Engineering 19(8)(2007) 1131-1144 and Information Sciences 201(2012) 80-92), and use them to characterize these covering-based rough sets numerically. Finally, we present theoretical backgrounds for these covering-based rough membership functions, and illustrate how to apply them on numerically characterizing decisions under the circumstances where data are incomplete.

Keywords: Rough membership function, Covering-based rough set, Incomplete decision table, Probabilistic rough set, Fuzzy set.

1. Introduction

The concept of rough sets was originally proposed by Pawlak [25]. It is a mathematical tool to handle uncertain knowledge, and has been successfully applied in pattern recognition, data mining, machine learning, etc. In Pawlak's rough set theory, a partition or equivalence relation is explicitly used in the definition of lower and upper approximations. Such a partition or equivalence relation is restrictive for many applications since it can only handle system with complete information. Generalizations of rough set theory were therefore studied by scholars in order to deal with complex practical problems. One approach was to extend equivalence relations to tolerance relations, similarity relations, ordinary binary relations and others. Another approach was to relax the partition to a covering. Zakowski first extended Pawlak's rough set theory by using a covering rather than a partition of the universe and obtained the covering-based rough sets[44]. This new model is often referred to as the first type of covering-based rough sets. Based on the mutual correspondence of the concepts of extension and intension, Bonikowski et al. proposed the second type of covering-based rough sets [1]. Pomykala explored the second type of covering-based rough sets [30].

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