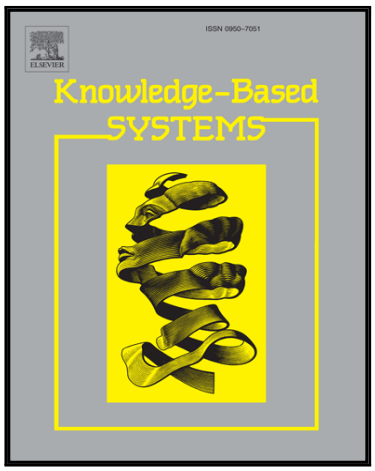

Knowledge Pairing Systems in Granular Computing

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KNOWLEDGE PAIRING SYSTEMS IN GRANULAR COMPUTING

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Abstract. In Pawlak's theory of information systems, one has a collection of objects and knows the values of any object with respect a certain class of properties, usually called attributes. An implicit assumption of this theory is that the difference between the nature of objects and attributes is well outlined. In our paper we generalize the concept of information system by analyzing the case in which there is no a priori distinction in the nature of objects and attributes and, hence, both the interpretations are admissible. We call the structure arising in the previous context *knowledge pairing system*. We study the indiscernibility relations induced in both the admissible interpretations by means of up-down operators, in such a way to have a direct analogy with the extent and intent operators used in Formal Context Analysis. In particular, we investigate three models of knowledge pairing systems arising from real contexts and modeled respectively by graphs, digraphs and hypergraphs. We show the real convenience to use the notion of knowledge pairing system focusing on interpretation of this structure and discussing the two admissible perspectives obtained by avoiding the difference between the roles of objects and attributes.

1. Introduction

In database theory there is a very frequent need to study finite tables having a very large quantity of data, therefore many researches have been directed towards the purpose of reducing and simplifying the interpretation of these data. With such an aim, Pawlak [47] developed the so called *rough set theory* (abbreviated RST). RST is an elegant and powerful methodology in extracting and minimizing rules from data tables (*information systems* or, also, *information tables* in Pawlak terminology).
However, RST has been considered as a part of the more general emerging methodological paradigm named *granular computing* (abbreviated GrC) [51, 52, 55, 68].
GrC deals with representing and processing information in the form of some type of aggregates. These aggregates are generally called *information granules* or simply granules and they arise in the process of data abstraction and knowledge derivation from data. The scope of GrC covers various fields of study related to knowledge representation and data extraction.
In 1979 the concept of *information granularity* was introduced by Zadeh [78] and it was related to the research on fuzzy sets. Next, the term *granular computing* was introduced again by Zadeh in 1997 (see [79]). Roughly speaking, information granules are collections of entities arranged together due to their similarity, functional or physical adjacency, indistinguishability, and so on.
Since 1979, granular computing has become a very developed area of research in the scope of both applied and theoretical information science [52, 68]. From a methodological perspective, GrC can be considered as an important attempt to investigate several research fields by means of the unifying granularity paradigm: rough set theory [44, 45, 46, 48, 49, 50, 77] and its generalizations [10, 11, 12, 76], mathematical morphology [64], temporal dynamics [8, 9, 13, 14, 16, 29], machine learning [74], formal concept analysis [67, 69], database theory [33, 34, 56], data mining [35, 42, 43, 71], fuzzy set theory [54, 79], interactive computing [61, 62], matroid theory [36, 37, 39, 40, 41, 80], hyergraph theory [15, 65, 66, 17], graph theory [18, 20, 63, 57], discrete dynamical systems [1, 2, 6, 7, 58].
The unifying perspective of GrC provides the useful interpretation tool which allows us to assign the same name for several notions used in different research fields. Under the umbrella of the granular paradigm, RST is developing new investigation potentialities, both a conceptual and computational level (for a detailed and philosophically pregnant discussion on this important topic see [77]). In our paper we try to give a further contribution to develop a conceptual vision of RST [77] within a granular perspective (abbreviated RST-GrC).
The original point of our work arises from the following remark.

Remark 1.1. *Starting by the relatively simple notion of information table, we can develop very refined mathematical and conceptual notions without additional hypotheses. In other terms, RST-GrC can be considered a theory that naturally can provide very complex structures by starting from very simple hypotheses.*

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