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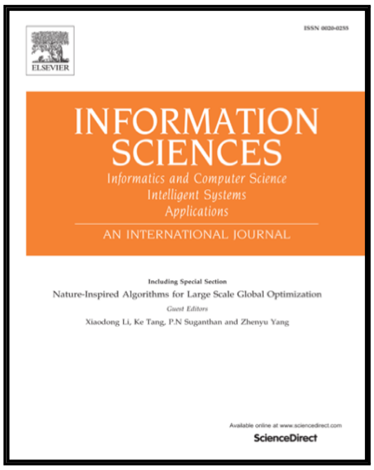

A Probabilistic Approach to Rough Set Theory with Modal Logic Perspective

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A Probabilistic Approach to Rough Set Theory with Modal Logic Perspective☆

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Abstract

We propose the notion of *probabilistic information system* (PIS) to capture situations where information regarding attributes of objects are not precise, but given in terms of probability. Notions of indistinguishability relations and corresponding approximation operators based on PISs are proposed and studied. It is shown that the deterministic information systems (DISs), incomplete information systems (IISs) and non-deterministic information systems (NISs) are all special instances of PISs. Moreover, the approximation operators defined on DIS (relative to indiscernibility), IISs and NISs (relative to similarity relations) are all originated from a single approximation operator defined on PISs. Further, a logic LPIS for PISs is proposed that can be used to reason about the proposed approximation operators. A sound and complete deductive system for the logic is given. Decidability of the logic is also proved.

Keywords: rough set theory, lower and upper approximations, modal logics, axiomatization

1. Introduction and preliminaries

Rough set theory, introduced by Pawlak, is based on the concept of *approximation space* [15] which is defined as a tuple (W, R), where R is an equivalence relation on the set W. Any concept represented as a subset (say) X of the partitioned domain W, is approximated from 'within' and 'outside', by its *lower* and *upper approximations* given as $\underline{X}_R := \{x : R(x) \subseteq X\}$ and $\overline{X}_R := \{x : R(x) \cap X \neq \emptyset\}$ respectively. Here, $R(x)$ denotes the set $\{y \in W : (x, y) \in R\}$. With time, Pawlak's simple rough set model has seen many generalizations due to demands from different practical situations (e.g. [6, 29, 19, 13, 20, 21]). A useful natural generalization is the one where the (in)distinguishability relation R is not necessarily an equivalence. For instance,

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