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Partial Approximative Set Theory: A View from Galois Connections

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The rough set theory was introduced by the Polish mathematician, Z. Pawlak in the early 1980s. It was a new mathematical approach to *vagueness*.

Let U be a finite set of objects which is called the universe of discourse, and $\varepsilon \subseteq U \times U$ an equivalence relation on U. The elements of partition generated by ε are called ε-elementary sets. Any subset X of U can be naturally approximated by two sets, namely, by ε-lower approximation: the union of all those ε-elementary sets that are contained by X; and by ε-upper approximation: the union of those ε-elementary sets that have a non-empty intersection with X.

The basic idea of the Pawlak's rough set theory is that the vagueness of a set is described by the difference of its ε-upper and ε-lower approximations, called ε-boundary of the set. A set is *rough* if its ε-boundary is non-empty.

A natural way of the generalization of Pawlak's idea is the replacement of the equivalence relation by any other type of binary relations on U. A more general approach is the assumption that the starting point is an arbitrary covering of U. In these approaches mainly topological means are used to study rough sets.

We propose a much more general framework. Our starting point is an *arbitrary* family of subsets of U which does not necessarily cover U, and we will not assumed that the universe is finite as well.

Moreover, we model the approximation by the notation of the Galois connection. For two ordered sets P and Q, a pair (f, g) of maps $f : P \to Q$, $g : Q \to P$ is called a Galois connection between P and Q if $\forall p \in P \, \forall q \in Q (f(p) \leqslant q \Leftrightarrow p \leqslant g(q))$.

Within this framework, we investigate the possibly generalizations of the basic concepts and their fundamental properties of the Pawlak's classic rough set theory.

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