Preface

Pawlak proposed rough set theory in 1982. It can be seen as an extension of set theory, in which a subset of a universe is formalized by a pair of sets, i.e., the lower and upper approximations. These approximations can be described by two operators on subsets of the universe.

In rough set theory, an equivalence relation, i.e., reflexive, symmetric, and transitive relation, plays an important role. Namely, the lower approximation of a given set is the union of all equivalence classes which are subset of the set, and the upper approximation is the union of all equivalence classes which have a non-empty intersection with the set.

The idea of a rough set has several connections with non-classical logics, in particular, modal logic. A lot of work has been done to provide a logical foundation for rough set theory. In the 1980s, a logic for reasoning about concepts, which is essentially the modal logic S5, was developed based on rough sets by Orlowska. A generalization of rough sets by modal logic using Kripke semantics was also worked out by Yao and Lin.

Now, rough set theory becomes one of the most important frameworks for imprecise and uncertain data and reasoning from data. It is also connected with granularity computing. In fact, there are many issues on various types of reasoning related to rough set theory.

This book explores reasoning with rough sets by developing some granularity-based frameworks. We begin with a brief description of rough set theory. Next, we examine some relations between rough set theory and non-classical logics including modal logic. We also develop a granularity-based framework for reasoning in which various types of reasoning can be formalized. This book will be of interest to researchers working on the areas of artificial intelligence, database, and logic.

The structure of the book is as follows.

Chapter 1 gives an introductory presentation to motivate our work on rough set theory. Rough set theory is interesting theoretically as well as practically, and a quick survey on the subject, including overview, history, and applications, is helpful to the readers.

Chapter 2 describes the foundations for rough set theory. We outline Pawlak's motivating idea and give a technical exposition. Basics of Pawlak's rough set theory and variable precision rough set model are presented with some related topics. We also present variants and related theories.

Chapter 3 surveys some non-classical logics. They are closely related to the foundations of rough set theory. We provide the basics of modal, many-valued, intuitionistic, and paraconsistent logic.

Chapter 4 introduces several logical characterizations of rough sets. We outline some approaches in the literature including double Stone algebras, Nelson algebras, and modal logics. We also discuss rough set logics, logics for reasoning about knowledge, and logics for knowledge representation.

Chapter 5 presents a granularity-based framework of deduction, induction, and abduction using variable precision rough set models proposed by Ziarko and measure-based semantics for modal logic proposed by Murai et al. This is of special importance as a general approach to reasoning based on rough set theory. We also discuss non-monotonic reasoning, association rules in conditional logic, and background knowledge.

Chapter 6 gives some conclusions with the summary of the book. We evaluate our work in connection with others. We also discuss several issues to be investigated.

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