Preface

Since introduction of rough set methodology by Zdzisław Pawlak in the early eighties, we have witnessed its great advances in both theory and applications. There is a growing research interest in foundations of rough sets, with some relationships to other already established methodologies. As a result, rough sets are linked with decision support and intelligent systems, soft and granular computing, data mining and KDD, as well as pattern recognition and machine learning. A wide range of applications of rough sets, alone or combined with other techniques, have been proposed in bioinformatics and medicine, business and finances, environmental and social studies, multimedia data mining and processing, and many others.

The objective of this book is to provide a representative and authoritative source of current research results and methodology in the area of rough set methods and applications. The book consists of 12 chapters organized in three section. Section I (four chapters) presents the foundations of rough sets, including comparison with other methodologies and discussion on future perspectives. This part will be useful for the beginners and students who are interested in carrying out his/her research projects on the rough sets.

Section II (four chapters) continues with current trends of extending, combining, as well as applying rough set techniques. Section III (four chapters) discusses hybrid intelligent systems involving the elements of rough set techniques, as well as illustrates the place for rough sets in real-life applications. These two parts will be useful for the professionals who are interested in catching a new idea or using the book as a reference work.

Chapter I, by **Piotr Wasilewski** and **Dominik Ślęzak**, presents the algebraic foundations behind the rough set theory. Algebraic structures arise from various types of data-based knowledge and information. The authors examine those structures with respect to satisfying or violating different versions of the excluded middle principle. Besides some novel results, the chapter may be also treated as a survey on the rough-set-based methodologies of representing and analyzing the information systems.

Chapter II, by **Hung Son Nguyen**, presents the approximate Boolean reasoning approach to problem solving. It is based on the general framework for the concept approximation. It combines classical Boolean reasoning with modern methods in machine learning and data mining. The author shows advantages of approximate Boolean reasoning using examples of some representative challenges of KDD, emphasizing ability of balancing between the quality of the designed solution and its computational cost.

Chapter III, by **Richard Jensen** and **Qiang Shen**, introduces the fundamental ideas behind rough-set-based approaches and reviews the related feature selection methods. The authors discuss extensions to the traditional rough set approach, including recent feature selection methods based on tolerance rough sets, variable precision rough sets and fuzzy rough sets. The chapter reports also the latest developments in the search methods supporting the rough-set-based feature selection search methods, including hill climbing, genetic algorithms, and ant colony optimization.

Chapter IV, by **Yiyu Yao** and **Yaohua Chen**, reviews the existing studies on the comparisons and combinations of rough set analysis and formal concept analysis. Such unified framework provides a better understanding of the current data analysis challenges. The authors also report some new results important for both the theoretical foundations and applications.

Chapter V, by **Theresa Beaubouef** and **Frederick E. Petry**, discusses how rough sets can enhance databases by allowing for management of uncertainty. The authors discuss the rough relational database and rough object-oriented database models, as well as their fuzzy and intuitionistic extensions. Benefits of those various methods are discussed, illustrating usefulness and versatility of rough sets for the database extensions.

Chapter VI, by **Cory J. Butz** and **Wen Yan**, reviews a recently developed framework for reasoning from data, called the rough set flow graphs (RSFG). The authors examine two methods for conducting inference in RSFG. They further show how the order of variable elimination affects the amount of computation. The culminating result is the incorporation of an algorithm for obtaining a good ordering into the RSFG inference.

Chapter VII, by **Annibal Parracho Sant'Anna**, presents a new index of quality of approximation. It measures the mutual information between the relations respectively determined by conditional and decision attributes. It is based on comparison of two graphs, each one representing a set of attributes. Applications in the context of indiscernibility and dominance relations are considered. Combination with the idea of transformation into probabilities of classes being a preferred option is explored as well. The algorithmic procedure to select the most important attributes is outlined.

Chapter VIII, by **Zbigniew W. Ras** and **Elzbieta M. Wyrzykowska**, focuses on a novel strategy of construction of action rules, directly from single classification rules instead of the pairs of classification rules. This way, not only the simplicity of the algorithm, but also its reduced time complexity is achieved. The chapter also presents a modified tree-based strategy for constructing action rules, with comparative analysis included.

Chapter IX, by **James F. Peters**, **Maciej Borkowski**, **Christopher Henry**, and **Dan Lockery**, discusses the monocular vision system that learns to control the pan and tilt operations of a digital camera that tracks a moving target. The authors consider various forms of the actor critic learning methods. Rough set approximation spaces are applied to handle degrees of overlapping of the behavior patterns. The conventional actor critic methods are successfully extended with the built-in run-and-twiddle rough-set-based control strategy mechanism.

Chapter X, by **Tomasz G. Smolinski**, **Astrid A. Prinz**, and **Jacek M. Zurada**, proposes hybridization of rough set theory and multiobjective evolutionary algorithms to perform the task of signal decomposition in the light of the underlying classification problem itself. The authors present results for several variants of implementation of the introduced methodology.

Chapter XI, by **Jerzy W. Grzymala-Busse**, **Zdzisław S. Hippe**, **Teresa Mroczek**, **Edward Roj**, and **Boleslaw Skowronski**, presents application of two rough set approaches to mining the data sets related to bed caking during the hop extraction process. The authors use direct rule induction by the MLEM2 algorithm; they also generate belief networks conversed into the rule sets within the BeliefSEEKER system. Statistics for the rule sets are presented. Six rule sets are also ranked by the expert. The overall results show that both approaches are of approximately the same quality.

Chapter XII, by **Krzysztof Pancerz** and **Zbigniew Suraj**, constitutes the continuation of research trend binding rough set theory with concurrency. Automatic methods of discovering concurrent system models from data tables are presented. Data tables are created on the basis of observations or specifications of the process behaviors in the modeled systems. The proposed methods are based on rough set theory and colored Petri nets.

Overall, this book provides a critical analysis of many important issues in rough sets and applications, including introductory material and research results, as well as hybrid intelligent systems involving the elements of rough set techniques.