Studies in Fuzziness and Soft Computing

Volume 380

Series editor

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Hybrid Soft Computing Models Applied to Graph Theory

Springer

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ISSN 1434-9922 ISSN 1860-0808 (electronic)
Studies in Fuzziness and Soft Computing
ISBN 978-3-030-16019-7 ISBN 978-3-030-16020-3 (eBook)
https://doi.org/10.1007/978-3-030-16020-3

Library of Congress Control Number: 2019934792

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

We dedicate this book to Prof. Lotfi A. Zadeh!

Preface

Fuzzy set theory was introduced by Lotfi Zadeh in 1965, as a generalization of classical set theory, for representing imprecise and vague phenomena. The concept of fuzzy graphs was initiated by Kaufmann based on Zadeh's fuzzy relations. In 1975, Rosenfeld laid the foundations for fuzzy graph theory. Professors Mordeson and Nair made a real contribution in putting together a very comprehensive book on 'Fuzzy Graphs and Fuzzy Hypergraphs', which motivated us to work in this direction.

Due to recent advances in science and technology, traditional mathematical tools are not sufficient for dealing with the complex problems arising in our real world day by day. To address these increasing challenges, there is a need for novel and innovative mathematical tools. The biggest dilemma of our universe is uncertainty, and the traditional crisp methods fail to handle these uncertainties in some complex problems. Many researchers extended the classical sets to various new models like fuzzy sets, soft sets, intuitionistic fuzzy sets, rough sets, bipolar fuzzy sets and many others to address the problems related to vagueness and uncertainty. Due to the limitation of human's knowledge to understand the complex problems, it is very difficult to apply only a single type of uncertainty method to deal with such problems. Therefore, it is necessary to develop hybrid models by incorporating the advantages of many other different mathematical models dealing with uncertainty. Hybrid computational intelligence is an effective combination of intelligent techniques that performs superior or in a competitive way to simple standard intelligent techniques. The increased popularity of hybrid intelligent systems in recent times lies in the extensive success of these systems in many real-world complex problems. The work presented here intends to deal with different sets of data and complex problems through hybrid models. This monograph deals with some hybrid models and their applications. It is based on a number of papers by the authors, which have been published in various scientific journals. The book may be useful for researchers in mathematics, computer scientists and social scientists alike.

In Chap. 1, several basic notions concerning rough fuzzy digraphs are discussed. Different methods of construction of rough fuzzy digraphs are described. Applications of rough fuzzy digraphs in decision-making problems are presented.

In Chap. 2, the concept of fuzzy rough sets is applied to graphs. Some applications of fuzzy rough digraphs are presented. Moreover, a comparative study of fuzzy rough digraphs with rough fuzzy digraphs and fuzzy digraphs is done.

In Chap. 3, an intuitionistic fuzzy rough model is presented. Some operations and products of intuitionistic fuzzy rough graphs are discussed in detail. Some efficient algorithms are developed to solve decision-making problems.

In Chap. 4, the concept of fuzzy soft graphs is presented. Some notions, including strong fuzzy soft graphs, complete fuzzy soft graphs, regular fuzzy soft graphs, fuzzy soft trees, fuzzy soft cycles, fuzzy soft bridges and fuzzy soft cutnodes are discussed. Applications of fuzzy soft graphs in decision-making problems are also presented.

In Chap. 5, the concept of intuitionistic fuzzy soft graphs is presented. Some notions of possibility intuitionistic fuzzy soft graph, regular, irregular, edge regular, edge irregular and strongly edge irregular intuitionistic fuzzy soft graphs are also presented. Intuitionistic fuzzy soft graphs are applied to multi-attribute decision-making problems.

In Chap. 6, the notions of soft rough digraphs and soft rough fuzzy digraphs are presented. Soft rough fuzzy model is applied to describe and resolve some multi-criteria decision-making problems.

In Chap. 7, certain notions of bipolar fuzzy soft graphs are presented. Some of their properties are also investigated. Several applications of the bipolar fuzzy soft graphs in a multiple criteria decision-making problem are presented.

In Chap. 8, certain concepts including soft rough neutrosophic graphs, soft rough neutrosophic influence graphs, soft rough neutrosophic influence cycles and soft rough neutrosophic influence trees are presented. A decision-making problem is solved by using the proposed algorithm.

Acknowledgements. We are grateful to the administration of University of the Punjab, who provided the facilities which were required for successful completion of this monograph. We would like to express our gratitude to the researchers worldwide whose contributions are referenced in this book, especially L. A. Zadeh, Z. Pawlak, K. T. Atanassov, D. A. Molodtsov and J. N. Mordeson.

Lahore, Pakistan

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Dr. Muhammad Akram received his M.Sc. degree in Mathematics and Computer Science, M.Phil. in Computational Mathematics and Ph.D. in Fuzzy Mathematics. He is currently a Professor in the Department of Mathematics at the University of the Punjab, Lahore, Pakistan, where he has been serving as a Ph.D. supervisor of more than 10 students. Dr. Akram's research interests include numerical solutions of parabolic PDEs, fuzzy graphs, fuzzy algebras and fuzzy decision support systems. He has published 7 monographs and 300 research articles in international peer-reviewed journals. He has served as editorial board member of 10 international academic journals and as reviewer of 122 international journals, including Mathematical Reviews and Zentralblatt MATH.

Dr. Fariha Zafar received her Ph.D. degree in Mathematics and M.Phil. degree in Mathematics from the University of the Punjab, Lahore. She has introduced the notions of Soft Trees and Fuzzy Soft Trees during her M.Phil. research work. She has published 10 research articles in top-ranked international journals. Her research interests include fuzzy graphs, soft set theory, rough set theory and decision-making.

List of Figures

List of Tables