Theory and Practice of Uncertain Programming

Studies in Fuzziness and Soft Computing

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Baoding Liu

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To My Wife Jinlan

Preface

Real-life decisions are usually made in the state of uncertainty. How do we model optimization problems in uncertain environments? How do we solve these models? The main purpose of the book is just to provide uncertain programming theory to answer these questions.

By uncertain programming we mean the optimization theory in uncertain environments. The main topics of uncertain programming include stochastic programming, fuzzy programming, rough programming, fuzzy random programming, random fuzzy programming, random rough programming, rough random programming, fuzzy rough programming, rough fuzzy programming, birandom programming, bifuzzy programming, birough programming, and multifold uncertain programming.

This book provides a self-contained, comprehensive and up-to-date presentation of uncertain programming theory, including numerous modeling ideas and various applications in transportation problem, inventory system, feed mixture problem, production process, water supply problem, facility location and allocation, capital budgeting, topological optimization, vehicle routing problem, redundancy optimization, critical path problem, and parallel machine scheduling.

Numerous intelligent algorithms such as genetic algorithm, neural network, simulated annealing, and tabu search have been developed by researchers of different backgrounds. A natural idea is to integrate these intelligent algorithms to produce more effective and powerful hybrid intelligent algorithms. In order to solve uncertain programming models, a spectrum of hybrid intelligent algorithms are documented in the book. The author also maintains a website at http://orsc.edu.cn/~liu/uncertain_programming to post the C++ source files of hybrid intelligent algorithms.

This book consists of 7 parts. Part I offers the basic concepts of mathematical programming, genetic algorithms and neural networks. Part II lists various methods of generating random numbers, and deals with the law of large numbers, stochastic simulation, expected value model, chance-constrained programming, dependent-chance programming, hybrid intelligent algorithms, and applications in various decision problems. Part III introduces possibility space, fuzzy variable, possibility measure, necessity measure,

credibility measure, expected value operator, fuzzy simulation, and fuzzy programming theory. Part IV is devoted to rough space, rough variable, trust measure, expected value operator, rough simulation, and rough programming. As a byproduct, interval programming is also discussed. Part V deals with fuzzy random variable, expected value operator, chance measure, fuzzy random simulation, and fuzzy random programming. Part VI discusses random fuzzy variable, expected value operator, chance measure, random fuzzy simulation, and random fuzzy programming. We conclude the book with Part VII in which a spectrum of multifold uncertain variables is proposed, and an uncertain programming theory is sketched.

It is assumed that readers are familiar with the basic concepts of mathematical programming, and elementary knowledge of C++ language. In order to make the book more readable, some background topics that will be useful in reading the book are also presented. The book is suitable for researchers, engineers, and students in the field of operations research, management science, information science, system science, computer science, and engineering. The readers will learn numerous new modeling ideas, and find this work a stimulating and useful reference.

A special acknowledgment is due to Professor Chi-fa Ku for introducing me to the research area and for his constant encouragement. A number of my co-researchers contributed valuable insights and information, particularly K. Iwamura, M. Gen, T. Odanaka, A.O. Esogbue, K.K. Lai, Q. Zhang, and M. Lu. I would like to thank my graduate students, Q. Lü, X. Wang, R. Zhao, J. Zhong, H. Ling, G. Miao, J. Gao, J. Peng, Y.-K. Liu, J. Zhou, G. Wang, H. Ke, and Y. Jiang, who have done much work in this field and made a number of corrections. I am also indebted to a series of grants from National Natural Science Foundation, Ministry of Education, and Ministry of Science and Technology of China. Finally, I express my deep gratitude to Professor Janusz Kacprzyk for the invitation to publish this book in his series, and the editorial staff of Springer for the wonderful cooperation and helpful comments.

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February 26, 2002

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