Preface

Since G.B. Dantzig invented the celebrated simplex method around 1947, linear programming, an optimization method for maximizing or minimizing a linear objective function subject to linear constraints, attracted an immense amount of interest from both practitioners and academicians. Nowadays, with the significant advances in computer technology, linear programming, together with its extensions, has been widely used in the fields of operations research, industrial engineering, systems science, management science, and computer science.

From a probabilistic point of view, between 1955 and 1960, linear programming problems with random variable coefficients, called stochastic programming problems, were introduced. They are two-stage models and chance constrained programming. In two-stage models including simple recourse models, a shortage or an excess arising from the violation of the constraints is penalized, and then the expectation of the amount of the penalties for the constraint violation is minimized. Considering the stochastic constraints are not always satisfied, it is natural to permit constraint violations up to specified probability levels, which leads to the idea of chance constraints meaning that the constraints involving random variables need to be satisfied with a certain probability or over. For reflecting the diversity of criteria for optimizing the stochastic objective functions, optimization criteria different from expectation and variance are also provided to maximize the probability of the objective functions being smaller than or equal to target values as well as to minimize the target values under a given probability.

However, the consideration of several criteria in the actual decision-making process requires multiobjective approaches rather than that of a single objective. One of the major systematic approaches to multicriteria decision making under constraints is multiobjective programming as a generalization of traditional single-objective programming. For such multiobjective programming problems, it is significant to realize that multiple objectives are often incommensurable and conflict with each other. With this observation, in multiobjective programming problems, the notion of Pareto optimality or efficiency has been introduced instead of the optimality concept for single-objective problems. However, decisions with Pareto optimality or efficiency are not uniquely determined; the final decision must be selected by a decision maker, which well represents the subjective judgments, from the set of Pareto optimal or efficient solutions. For deriving a compromise or satisficing solution through interactions with the decision maker, interactive methods for multiobjective programming have been developed.

Recalling the imprecision or fuzziness inherent in human judgments, however, two types of inaccuracies of human judgments should be incorporated in multiobjective optimization problems. One is the fuzzy goal of the decision maker for each of the objective functions, and the other is the experts' ambiguous understanding of the nature of the parameters in the problem-formulation process. For handling and tackling such kinds of imprecision or vagueness in human judgments, it is not hard to imagine that the conventional multiobjective optimization approaches, such as a deterministic or even a probabilistic approach, cannot always be applied. The motivation for multiobjective optimization under imprecision or fuzziness comes from this observation.

In most practical situations, however, it is natural to consider that the uncertainty in real-world decision-making problems is often expressed by a fusion of fuzziness and randomness rather than either fuzziness or randomness. Through the use of stochastic models including the expectation model, the variance model, the probability model, the fractile model, and the simple recourse model together with chance constrained programming techniques, several multiobjective stochastic programming problems were formulated. By considering the imprecision of a decision maker's judgments for stochastic objective functions and/or constraints in multiobjective problems, fuzzy multiobjective stochastic programming problems were introduced and several interactive fuzzy satisficing methods to derive a satisficing solution for the decision maker have been developed.

Such five major topics, linear programming, multiobjective programming, fuzzy programming, stochastic programming, and fuzzy stochastic programming, are presented in a comprehensive manner in this book. In particular, the last four topics together comprise the main characteristics of this book, and special stress is placed on interactive decision-making aspects of multiobjective programming for human-centered systems in most realistic situations under fuzziness and/or randomness. Chapter 2 is a concise and condensed description of the theory of linear programming and its algorithms. Chapter 3 discusses fundamental notions and methods of multiobjective linear programming and concludes with interactive multiobjective linear programming. In Chap. 4, starting with clear explanations of fuzzy linear programming and fuzzy multiobjective linear programming, interactive fuzzy multiobjective linear programming is presented. Multiobjective linear programming problems involving fuzzy parameters are then formulated and linear programming-based interactive fuzzy programming is also discussed. Chapter 5 gives detailed explanations of fundamental notions and methods of stochastic programming including two-stage programming and chance constrained programming. As a natural extension of Chaps. 5 and 6 develops several interactive fuzzy programming approaches to multiobjective stochastic programming problems. Applications of linear programming, multiobjective programming, fuzzy programming, stochastic programming, and fuzzy stochastic programming to purchase and transportation planning for food retailing are considered in Chap. 7. Throughout this book, as well as comparing a number of solution methods including interactive ones, simple examples with two decision variables of production planning are provided to illustrate their main ideas. At the end of each chapter, an adequate number of problems can be found. Some of these problems test basic understanding and give routine exercise, while others concentrate on theoretical aspects. The readers could test and develop their understandings of the material. The book is self-contained because of the three appendices and solutions to problems. Appendix A contains a brief summary of the topics from linear algebra. Pertinent results from nonlinear programming are summarized in Appendix B. Appendix C is a clear explanation of the Excel solver, one of the easiest ways to solve optimization problems, through the use of simple examples of linear and nonlinear programming.

The intended readers of this book, which can be used both as a reference and as a textbook, are undergraduate students, graduate students, and researchers and practitioners in the fields of operations research, industrial engineering, systems science, management science, computer science, and other engineering disciplines that deal with the subjects of linear programming, multiobjective programming, fuzzy programming, stochastic programming, and fuzzy stochastic programming. The book can be used in several ways. Chapters 1, 2 and Appendix C with selected applications from Chap. 7 comprise the material for a basic undergraduate course on linear programming. As time permits, material from Chap. 3 can be included. It can be used in a one semester advanced undergraduate course on linear and multiobjective programming and then in a one semester graduate course emphasizing fuzzy and stochastic programming. The book can also be utilized in a one semester course on linear and multiobjective programming with fuzzy stochastic extensions by omitting some topics.

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Springer

http://www.springer.com/978-1-4614-9398-3

Linear and Multiobjective Programming with Fuzzy Stochastic Extensions

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2013, XIII, 339 p. 59 illus., 21 illus. in color., Hardcover
ISBN: 978-1-4614-9398-3