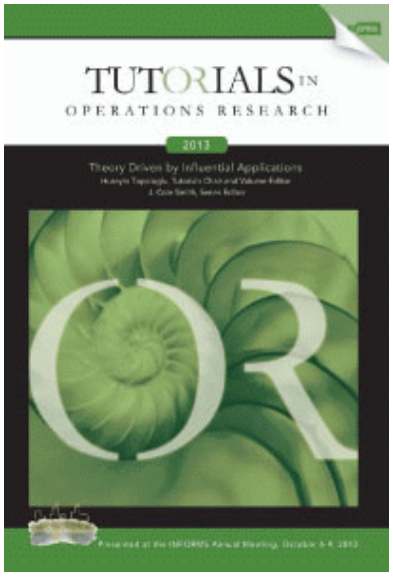

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Preface

Theory Driven by Influential Applications

I find myself lucky to be working in a field that is so flexible and quick to answer the changing needs of the world. Editing this volume prompted me to think for a minute about how operations research evolved in recent past, at least in the areas that I am somewhat familiar with. The rise of the Internet brought about a host of problems that lie at the heart of operations research, including analysis of data traffic, auctioning ad spaces and managing the logistics of Internet businesses. Various forms of risk analyses, capturing detailed transaction dynamics and the necessity to deal with innovative instruments gained importance in financial engineering. Healthcare emerged as a fertile application area. Moving into the electronic age, we have access to large amounts of data in virtually every field and operations research gives us the tools to harness the power of data. The list is by no means exhaustive and I am probably missing some of the most important opportunities, but I get excited to be an operations research person even after looking at such a short list. The goal of this volume was to document some of the progress we have achieved in our field in recent past.

The eleven chapters included in this volume span a variety of methodology and application areas. We start with a series of chapters in optimization. Chapter 1 provides a systematic analysis of non-intuitive performance variability issues observed in mixed integer programs. For example, it has been observed that adding a redundant constraint to a model or changing the computing platform may considerably affect the performance of optimization software. The chapter is directed at understanding and exploiting these performance variability issues. The focus of Chapter 2 is mixed integer second-order cone programming. The authors describe a variety of application areas where mixed integer second-order cone programming can provide an effective modeling framework. They give a comprehensive summary of algorithmic approaches for mixed integer second-order cone programs. In Chapter 3, the goal is to understand how sparsity of solutions naturally arises in numerous optimization settings. The optimal solution to many optimization models includes only a few non-zero elements. Such sparsity is important from application point of view since sparse solutions generally come with ease of implementation. The authors focus on where and why sparse solutions emerge.

In Chapter 4, we go into game-theoretic models. The focus of this chapter is search games over a network, where a searcher tries to find an object hidden by a hider. The model has numerous application areas, including discovering hazardous objects and search-and-rescue. The chapter gives a detailed account of the subject, starting from search games over trees and Eulerian networks, and documenting the more recent developments and extensions. The focus of Chapter 5 is stochastic variational inequality problems. These problems occur in traffic equilibrium, energy markets and communication networks. Variational inequality problems have a rich history, but there are significant methodological challenges in accommodating uncertainty in these problems and this chapter presents the progress made in resolving these challenges.

Chapter 6 concentrates on inference and optimization problems on large-scale networks. Even if the underlying problem can be solved reasonably well through a polynomial-time algorithm when the network is reasonably small, one faces significant computational challenges when the same problem arises in a large-scale network setting. Thus, it is desirable to resort to fast distributed or local algorithms that can be run in parallel. The chapter builds on the correlation decay property as a framework for studying the performance of

such local algorithms. Chapter 7 provides a detailed coverage of simulation optimization. Simulation optimization problems arise when the objective function and constraints of an optimization problem can only be observed through stochastic simulation. The chapter goes over ranking and selection type approaches where the solution space is finite, as well as stochastic approximation methods for continuous problems.

In Chapter 8, the authors give a detailed treatment of superquantiles, which are also referred to as conditional values at risk in financial applications. Superquantiles have been used in measuring the risk associated with a random outcome, but the chapter shows the use of this concept beyond measuring risk. It turns out superquantiles are essentially as fundamental to a random variable as its distribution function, have interesting connections to superexpectations and allow generalizations of regression. The topic of Chapter 9 is risk-averse optimization. Modeling the preferences between risky outcomes is an important problem studied by many researchers. The chapter describes utility theory, risk measures and stochastic order constraints as possible approaches to specifying such preferences. It describes how we can solve decision-making problems when different approaches are used to specify the preferences between risky outcomes. It gives extensions to multi-period decision-making problems as well.

The last two chapters of the volume consider problems and applications in financial engineering. The topic of Chapter 10 is algorithmic trading. In this chapter, the author studies the problem of optimally placing buy and sell orders within a time scale of milliseconds. The buy and sell orders are collected in a limit order book, with each order to buy or sell at a specific price being referred to as a limit order. The chapter reviews fundamental models of optimal order placement and contrasts the dynamics of a limit order book with multiclass queueing systems with reneging. Chapter 11 studies portfolio optimization problems. It uses the Markowitz mean-variance framework, where one tries to minimize the variance of the return from a portfolio subject to a constraint on the mean return. It shows how to incorporate practical considerations into this framework, such as limiting the cardinality of the portfolio and tracking a benchmark index. The focus is both on modeling portfolio optimization problems and coming up with algorithmic approaches.

I really enjoyed interacting with the authors on their topic selection and reading their finished chapters. I believe that these chapters will serve as cornerstone references in their respective fields, excite researchers to venture into new research areas and spark collaborations in our field.

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