Preface

There has been much recent progress in the theory of probabilistic functions and related applications. Probabilistic and quantile (percentile) functions are commonly used for the analysis of models with uncertainties or variabilities in parameters. For instance, financial applications consider the probability of profitable transactions or the probability of closing of a portfolio position at a specified price (limit order), in risk and reliability, performance functions, characterizing operation of systems, are formulated as probabilities of successful or unsuccessful accomplishment of their missions, e.g., core damage probability or frequency of a nuclear power plant, in rocket engineering - probability of successful landing of a rocket or an aircraft, and percentiles of risks in public risk assessments.

In financial applications, the percentile of the losses is called Value-at-Risk (VaR). VaR, a widely used performance measure, answers the question: what is the maximum loss with a specified confidence level? Percentiles are also used for defining other relevant risk performance measures, such as Conditional Value-at-Risk (CVaR). For continuous distributions, CVaR (also called Mean Excess Loss, Mean Shortfall) is the average of the worst x% losses (e.g., 5%).

This volume discusses various theoretical aspects of sensitivity analysis and optimization of probabilistic functions, quantiles, and related issues such as, robust Monte Carlo simulation methods, and statistical characteristics of optimal solutions of stochastic programs. The volume begins with an introductory review paper, which covers several recently developed topics:

- sensitivities of probabilistic functions;
- sensitivities of percentiles (VaR);
- optimization approaches for CVaR.

The main focus of this volume is on financial applications of probabilistic functions: (1) portfolio optimization with CVaR performance functions and constraints; (2) asset and liability management; and (3) optimal trading strategies for options. However, other important applications of probabilistic functions also are well covered, including reliability analyses and optimal design of the stochastic systems, optimization of the material flow systems, and multimedia networks.

Significant attention in this book is paid to estimating, evaluating, and comparing percentile risk measures, in particular, VaR and CVaR. CVaR is a more consistent measure of risk compared to VaR since it is sub-additive, convex and has other nice mathematical properties (see paper by Pflug in this volume). Moreover, it can be optimized using linear programming optimization algorithms, which can handle applications with very large numbers of variables and scenarios (see details in the introductory review paper). Numerical experiments indicate that the minimization of CVaR also leads to near optimal solutions in VaR terms because CVaR is always greater than or equal to VaR. Similar measures as CVaR have been earlier studied in the stochastic programming literature. The conditional expectation constraints and integrated chance constraints described in the book by Prekopa (*Stochastic Programming, Kluwer, 1995*) may serve the same purpose as CVaR.

The collection of papers in this book covers a diverse number of topics related to probabilistic functions. The book will be a valuable source of information to faculty, students, researchers, and practitioners in financial engineering, operation research, optimization, computer science, and related areas. I would like to take the opportunity to thank the authors of the papers, the anonymous referees, and Kluwer Academic Publishers for helping with the publication of this volume.

Stanislav Uryasev
University of Florida
May 2000