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LECTURE NOTES IN ECONOMICS
AND MATHEMATICAL SYSTEMS

Kurt Marti
Yuri Ermoliev · Georg Pflug
Editors

Dynamic Stochastic Optimization



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Dynamic Stochastic Optimization Lecture Notes In Economics And Mathematical Systems

**Ulrich Derigs, Achim Bachem, Andreas
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Uncertainties and changes are pervasive characteristics of modern systems involving interactions between humans economics nature and technology These systems are often too complex to allow for precise evaluations and as a result the lack of proper management control may create significant risks In order to develop robust strategies we need approaches which explicitly deal with uncertainties risks and changing conditions One rather general approach is to characterize explicitly or implicitly uncertainties by objective or subjective probabilities measures of confidence or belief This leads us to stochastic optimization problems which can rarely be solved by using the standard deterministic optimization and optimal control methods In the stochastic optimization the accent is on problems with a large number of decision and random variables and consequently the focus of attention is directed to efficient solution procedures rather than to analytical closed form solutions Objective and constraint functions of dynamic stochastic optimization problems have the form of multidimensional integrals of rather involved in that may have a nonsmooth and even discontinuous character the typical situation for hit or miss type of decision making problems involving irreversibility of decisions or and abrupt changes of the system In general the exact evaluation of such functions as is assumed in the standard optimization and control theory is practically impossible Also the problem does not often possess the separability properties that allow to derive the standard in control theory recursive Bellman equations

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Uncertainties and changes are pervasive characteristics of modern systems involving interactions between humans economics nature and technology These systems are often too complex to allow for precise evaluations and as a result the lack of proper management control may create significant risks In order to develop robust strategies we need approaches which explicitly deal with uncertainties risks and changing conditions One rather general approach is to characterize explicitly or implicitly uncertainties by objective or subjective probabilities measures of confidence or belief This leads us to stochastic optimization problems which can rarely be solved by using the standard deterministic optimization and optimal control methods In the stochastic optimization the accent is on problems with a large number of decision and random variables and consequently the focus of attention is directed to efficient solution procedures rather than to analytical closed form solutions Objective and constraint functions of dynamic stochastic optimization problems have the form of multidimensional integrals of rather involved in that may have a nonsmooth and even discontinuous character the typical situation for hit or miss type of decision making problems involving irreversibility of decisions or and abrupt changes of the system In general the exact evaluation of such functions as is assumed in the standard optimization and control theory is practically impossible Also the problem does not often possess the separability properties that allow to derive the standard in control theory recursive Bellman equations

Lectures on Stochastic Programming Alexander Shapiro, Darinka

Dentcheva, Andrzej Ruszczyński, 2014-07-09 Optimization problems involving stochastic models occur in almost all areas of science and engineering such as telecommunications medicine and finance Their existence compels a need for rigorous ways of formulating analyzing and solving such problems This book focuses on optimization problems involving uncertain parameters and covers the theoretical foundations and recent advances in areas where stochastic models are available In Lectures on Stochastic Programming Modeling and Theory Second Edition the authors introduce new material to reflect recent developments in stochastic programming including an analytical description of the tangent and normal cones of chance constrained sets analysis of optimality conditions applied to nonconvex problems a discussion of the stochastic dual dynamic programming method an extended discussion of law invariant coherent risk measures and their Kusuoka representations and in depth analysis of dynamic risk measures and concepts of time consistency including several new results

Stochastic Optimization Kurt Marti, 2012-12-06 This volume includes a selection of refereed papers presented at the GAMM IFIP Workshop on Stochastic Optimization Numerical Methods and Technical Applications held at the Federal Armed Forces University Munich May 29 31 1990 The objective of this meeting was to bring together scientists from Stochastic Programming and from those Engineering areas where Mathematical Programming models are common tools as e g Optimal Structural Design Power Dispatch Acid Rain Management etc The first theoretical part includes the papers by S D Flam H Niederreiter E Poehinger and R Schultz The second part on methods and applications contains the articles by N Baba N Grwe and W Roemisch J Mayer E A Mc Bean and A Vasarhelyi

Duality in Stochastic Linear and Dynamic Programming Willem K. Klein Haneveld, 2013-04-17

Operations Research Proceedings 1994 Ulrich Derigs, Achim Bachem, Andreas Drexl, 2012-12-06 An insight into the latest results from the world of operations research a wide ranging field as is shown by the book's 24 sections corresponding to the conference program itself Although problems of a primarily methodological nature are discussed the emphasis is placed firmly on practical subjects such as reports from the fields of healthcare environmental protection logistics and traffic engineering This selection also clearly illustrates the extent to which OR is spreading into and already interwoven in other scientific disciplines

Research in Stochastic Programming John R. Birge, 2001

Stochastic Optimization Techniques Kurt Marti, 2002 Optimization problems arising in practice mostly contain several random parameters Hence in order to get robust optimal solutions with respect to random parameter variations the available statistical information about the random data should be considered already at the planning phase Thus the original problem with random coefficients must be replaced by an appropriate deterministic substitute problem This proceedings volume of the 4th GAMM IFIP Workshop on Stochastic Optimization Numerical Methods and Technical Applications held June 27 29 2000 at the Federal Armed Forces University Munich Neubiberg Munich contains new methods for the approximation and numerical solution of deterministic substitute problems especially the handling of mean value and probability functions as objective and or constraint functions Moreover many concrete applications from engineering and

operations research can be found in this book

Decision Making Under Uncertainty Claude Greengard, Andrzej Ruszczyński, 2012-12-06 In the ideal world major decisions would be made based on complete and reliable information available to the decision maker We live in a world of uncertainties and decisions must be made from information which may be incomplete and may contain uncertainty The key mathematical question addressed in this volume is how to make decision in the presence of quantifiable uncertainty The volume contains articles on model problems of decision making process in the energy and power industry when the available information is noisy and or incomplete The major tools used in studying these problems are mathematical modeling and optimization techniques especially stochastic optimization These articles are meant to provide an insight into this rapidly developing field which lies in the intersection of applied statistics probability operations research and economic theory It is hoped that the present volume will provide entry to newcomers into the field and stimulation for further research

Encyclopedia of Optimization Christodoulos A. Floudas, Panos M. Pardalos, 2008-09-04 The goal of the Encyclopedia of Optimization is to introduce the reader to a complete set of topics that show the spectrum of research the richness of ideas and the breadth of applications that has come from this field The second edition builds on the success of the former edition with more than 150 completely new entries designed to ensure that the reference addresses recent areas where optimization theories and techniques have advanced Particularly heavy attention resulted in health science and transportation with entries such as Algorithms for Genomics Optimization and Radiotherapy Treatment Design and Crew Scheduling

Stochastic Two-stage Programming Karl Frauendorfer, 1992 Stochastic Programming offers models and methods for decision problems wheresome of the data are uncertain These models have features and structural properties which are preferably exploited by SP methods within the solution process This work contributes to the methodology for two stagemodels In these models the objective function is given as an integral whose integrand depends on a random vector on its probability measure and on a decision The main results of this work have been derived with the intention to ease these difficulties After investigating duality relations for convex optimization problems with supply demand and prices being treated as parameters a stability criterion is stated and proves subdifferentiability of the value function This criterion is employed for proving the existence of bilinear functions which minorize majorize the integrand Additionally these minorants majorants support the integrand on generalized barycenters of simplicial faces of specially shaped polytopes and amount to an approach which is denoted barycentric approximation scheme

Optimization of Stochastic Systems Masanao Aoki, 1989 From the Preface The first edition of this book was written mainly for audiences with physical science and engineering backgrounds Nevertheless it reached some readers with economic and management science training Analytical training of graduate students in economics and management sciences had progressed much in the last 20 years and many new research results and optimization algorithms have also become available My own interest in the meantime has shifted to the analysis of dynamics and optimization problems of economic and management science origin With these developments

and changes I decided to rewrite much of the first edition to make it more accessible to graduate students and professionals in social sciences I have also incorporated some new analytic tools that I deem useful in analyzing the dynamic and stochastic problems which confront these readers I hope that my efforts successfully bring intertemporal optimization problems closer to economics professionals New topics introduced into this second edition appear mostly in Chapters 2 4 5 6 and 8 Martingales and martingale differences are introduced early in Chapter 2 Some limit theorems and asymptotic properties of linear state space models driven by martingale differences are presented Because many excellent books are available on martingales and their limit theorems derivations and proofs are mostly sketchy and readers are referred to these sources The results in Chapter 2 are applied in Chapters 5 6 and 8 among other places The notion of dynamic aggregation and its relation to cointegration and error correction models are developed in Chapter 4 Some recursive parameter estimation schemes and their statistical properties are included in Chapters 5 and 6 Here again books devoted entirely to these topics are available in the literature and much had to be omitted to keep the second edition to a manageable size In an appendix to Chapter 7 a potentially very powerful tool in proving convergence of adaptive schemes is outlined Rational expectations models and their solution methods are developed in Chapter 8 because of their wide spread interest to economists A very important class of problems in sequential decision problems revolves around questions of approximating nonlinear dynamics or more generally complex situations with a sequence of less complex ones Chapter 9 does not begin to do justice to this class of problems but is included as being suggestive of works to be done When I first started contemplating the revision of the first edition I benefited from a list of excellent suggestions from Rick van der Ploeg though I did not necessarily incorporate all of his suggestions Conversations with Thomas Sargent and Victor Solo were useful in organizing the material into the form of the second edition I also benefited from discussions with Hashem Pesaran and correspondences with L Broze in finalizing Chapter 8 Some material in this book was used as lecture notes in a graduate course in the Department of Economics University of California Los Angeles the winter quarter of 1987 I thank the participants in the course for many useful comments

Key Features This major revision of the First Edition addresses optimization problems stated in stochastic difference equations which often contain uncertain or randomly varying parameters Presents a set of concepts and techniques useful in analyzing or controlling stochastic dynamic processes with possible incompletely specified characteristics It discusses basic system properties such as Stability and observability Dynamic programming formulations of optimal and adaptive control problems Parameter estimation schemes and their convergence behavior Solution methods for rational expectations models using martingale differences

Technological Change, Employment and Spatial Dynamics Peter Nijkamp, 2012-12-06 Stochastic Programming RUSZCZYNSK, Alexander Shapiro, 2003-10-09 Brings together leading in the most important sub fields of stochastic programming to present a rigorous overview of basic models methods and applications of stochastic programming The text is intended for researchers students engineers and economists

who encounter in their work optimization problems involving uncertainty **Empirical Modeling of Exchange Rate Dynamics** Francis X. Diebold, 2012-12-06 Structural exchange rate modeling has proven extremely difficult during the recent post 1973 float The disappointment climaxed with the papers of Meese and Rogoff 1983a 1983b who showed that a naive random walk model distinctly dominated received theoretical models in terms of predictive performance for the major dollar spot rates One purpose of this monograph is to seek the reasons for this failure by exploring the temporal behavior of seven major dollar exchange rates using nonstructural time series methods The Meese Rogoff finding does not mean that exchange rates evolve as random walks rather it simply means that the random walk is a better stochastic approximation than any of their other candidate models In this monograph we use optimal model specification techniques including formal unit root tests which allow for trend and find that all of the exchange rates studied do in fact evolve as random walks or random walks with drift to a very close approximation This result is consistent with efficient asset markets and provides an explanation for the Meese Rogoff results Far more subtle forces are at work however which lead to interesting econometric problems and have implications for the measurement of exchange rate volatility and moment structure It is shown that all exchange rates display substantial conditional heteroskedasticity A particularly reasonable parameterization of this conditional heteroskedasticity which captures the observed clustering of prediction error variances is developed in Chapter 2

Stochastic Models in Operations Research: Stochastic optimization Daniel P. Heyman, Matthew J. Sobel, 1982

Stochastic Programming Werner Romisch, 2006 **Combinatorial Heuristic Algorithms with FORTRAN** Hang Tong Lau, 1986-11 In recent years researchers have spent much effort in developing efficient heuristic algorithms for solving the class of NP complete problems which are widely believed to be inherently intractable from the computational point of view Although algorithms have been designed and are notorious among researchers computer programs are either not implemented on computers or very difficult to obtain The purpose of this book is to provide a source of FORTRAN coded algorithms for a selected number of well known combinatorial optimization problems The book is intended to be used as a supplementary text in combinatorial algorithms network optimization operations research and management science In addition a short description on each algorithm will allow the book to be used as a convenient reference This work would not have been possible without the excellent facilities of Bell Northern Research Canada H T Lau Ile des Soeurs Quebec Canada August 1986 CONTENTS Page Introduction Part I INTEGER PROGRAMMING Chapter 1 Integer Linear Programming Chapter 2 Zero one Linear Programming 30 Chapter 3 Zero one Knapsack Problem 38 Part II NETWORK DESIGN Chapter 4 Traveling Salesman Problem 52 Chapter 5 Steiner Tree Problem 81 Chapter 6 Graph Partitioning 98 Chapter 7 K Median Location 106 Chapter 8 K Center Location 114 List of Subroutines 123 Bibliographic Notes 124 INTRODUCTION Following the elegant theory of NP completeness the idea of developing efficient heuristic algorithms has been gaining its popularity and significance **Stochastic Programming** Michael Alan Howarth Dempster, 1980 **Stochastic Programming**

Methods and Technical Applications Kurt Marti, Peter Kall, 1998-03-18 Optimization problems arising in practice usually contain several random parameters. Hence, in order to obtain optimal solutions being robust with respect to random parameter variations, the mostly available statistical information about the random parameters should be considered already at the planning phase. The original problem with random parameters must be replaced by an appropriate deterministic substitute problem, and efficient numerical solution or approximation techniques have to be developed for those problems. This proceedings volume contains a selection of papers on modelling techniques, approximation methods, numerical solution procedures for stochastic optimization problems, and applications to the reliability-based optimization of concrete technical or economic systems.

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