



Nicole Bäuerle
Ulrich Rieder

Markov Decision Processes with Applications to Finance

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Teemu Pennanen, Ari-Pekka Perkiö



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Markov Decision Processes with Applications to Finance Nicole Bäuerle, Ulrich Rieder, 2011-06-06 The theory of Markov decision processes focuses on controlled Markov chains in discrete time The authors establish the theory for general state and action spaces and at the same time show its application by means of numerous examples mostly taken from the fields of finance and operations research By using a structural approach many technicalities concerning measure theory are avoided They cover problems with finite and infinite horizons as well as partially observable Markov decision processes piecewise deterministic Markov decision processes and stopping problems The book presents Markov decision processes in action and includes various state of the art applications with a particular view towards finance It is useful for upper level undergraduates Master s students and researchers in both applied probability and finance and provides exercises without solutions

Stochastic Analysis, Filtering, and Stochastic Optimization George Yin, Thaleia Zariphopoulou, 2022-04-22 This volume is a collection of research works to honor the late Professor Mark H A Davis whose pioneering work in the areas of Stochastic Processes Filtering and Stochastic Optimization spans more than five decades Invited authors include his dissertation advisor past collaborators colleagues mentees and graduate students of Professor Davis as well as scholars who have worked in the above areas Their contributions may expand upon topics in piecewise deterministic processes pathwise stochastic calculus martingale methods in stochastic optimization filtering mean field games time inconsistency as well as impulse singular risk sensitive and robust stochastic control

Engineering of Computer-Based Systems Jan Kofron, Tiziana Margaria, Cristina Secleanu, 2023-11-28 This book constitutes the refereed proceedings of the 8th International Conference on Engineering of Computer Based Systems ECBS 2023 which was held in Västerås Sweden in October 2023 The 11 full papers included in this book were carefully reviewed and selected from 26 submissions and present software hardware and communication perspectives of systems engineering through its many facets The special theme of this year is Engineering for Responsible AI

Dynamic Optimization Karl Hinderer, Ulrich Rieder, Michael Stieglitz, 2017-01-12 This book explores discrete time dynamic optimization and provides a detailed introduction to both deterministic and stochastic models Covering problems with finite and infinite horizon as well as Markov renewal programs Bayesian control models and partially observable processes the book focuses on the precise modelling of applications in a variety of areas including operations research computer science mathematics statistics engineering economics and finance Dynamic Optimization is a carefully presented textbook which starts with discrete time deterministic dynamic optimization problems providing readers with the tools for sequential decision making before proceeding to the more complicated stochastic models The authors present complete and simple proofs and illustrate the main results with numerous examples and exercises without solutions With relevant material covered in four appendices this book is completely self contained

Convex Stochastic Optimization Teemu Pennanen, Ari-Pekka Perkkiö, 2024-12-18 This book studies a general class of convex

stochastic optimization CSO problems that unifies many common problem formulations from operations research financial mathematics and stochastic optimal control We extend the theory of dynamic programming and convex duality to allow for a unified and simplified treatment of various special problem classes found in the literature The extensions allow also for significant generalizations to existing problem formulations Both dynamic programming and duality have played crucial roles in the development of various optimality conditions and numerical techniques for the solution of convex stochastic optimization problems

Multiple Stopping Problems Georgy Sofronov, Krzysztof Szajowski, 2024-12-24 This book presents the theory of rational decisions involving the selection of stopping times in observed discrete time stochastic processes both by single and multiple decision makers Readers will become acquainted with the models strategies and applications of these models It begins with an examination of selected models framed as stochastic optimization challenges emphasizing the critical role of optimal stopping times in sequential statistical procedures The authors go on to explore models featuring multiple stopping and shares on leading applications particularly focusing on change point detection selection problems and the nuances of behavioral ecology In the following chapters an array of perspectives on model strategies is presented elucidating their interpretation and the methodologies underpinning their genesis Essential notations and definitions are introduced examining general theorems about solution existence and structure with an intricate analysis of optimal stopping predicaments and addressing crucial multilateral models The reader is presented with the practical application of models based on multiple stopping within stochastic processes The coverage includes a diverse array of domains including sequential statistics finance economics and the broader generalization of the best choice problem Additionally it delves into numerical and asymptotic solutions offering a comprehensive exploration of optimal stopping quandaries The book will be of interest to researchers and practitioners in fields such as economics finance and engineering It could also be used by graduate students doing a research degree in insurance economics or business analytics or an advanced undergraduate course in mathematical sciences

Handbook of Markov Decision Processes Eugene A. Feinberg, Adam Shwartz, 2012-12-06 Eugene A Feinberg Adam Shwartz This volume deals with the theory of Markov Decision Processes MDPs and their applications Each chapter was written by a leading expert in the respective area The papers cover major research areas and methodologies and discuss open questions and future research directions The papers can be read independently with the basic notation and concepts of Section 1.2 Most chapters should be accessible by graduate or advanced undergraduate students in fields of operations research electrical engineering and computer science

1.1 AN OVERVIEW OF MARKOV DECISION PROCESSES The theory of Markov Decision Processes also known under several other names including sequential stochastic optimization discrete time stochastic control and stochastic dynamic programming studies sequential optimization of discrete time stochastic systems The basic object is a discrete time stochastic system whose transition mechanism can be controlled over time Each control policy defines the stochastic process and values of objective

functions associated with this process The goal is to select a good control policy In real life decisions that humans and computers make on all levels usually have two types of impacts i they cost or save time money or other resources or they bring revenues as well as ii they have an impact on the future by influencing the dynamics In many situations decisions with the largest immediate profit may not be good in view of future events MDPs model this paradigm and provide results on the structure and existence of good policies and on methods for their calculation

Continuous-Time Markov Decision Processes Alexey Piunovskiy, Yi Zhang, 2020-11-09 This book offers a systematic and rigorous treatment of continuous time Markov decision processes covering both theory and possible applications to queueing systems epidemiology finance and other fields Unlike most books on the subject much attention is paid to problems with functional constraints and the realizability of strategies Three major methods of investigations are presented based on dynamic programming linear programming and reduction to discrete time problems Although the main focus is on models with total discounted or undiscounted cost criteria models with average cost criteria and with impulsive controls are also discussed in depth The book is self contained A separate chapter is devoted to Markov pure jump processes and the appendices collect the requisite background on real analysis and applied probability All the statements in the main text are proved in detail Researchers and graduate students in applied probability operational research statistics and engineering will find this monograph interesting useful and valuable

Markov Decision Processes with Their Applications Qiying Hu, Wuyi Yue, 2007-09-14 Markov decision processes MDPs also called stochastic dynamic programming were first studied in the 1960s MDPs can be used to model and solve dynamic decision making problems that are multi period and occur in stochastic circumstances There are three basic branches in MDPs discrete time MDPs continuous time MDPs and semi Markov decision processes Starting from these three branches many generalized MDPs models have been applied to various practical problems These models include partially observable MDPs adaptive MDPs MDPs in stochastic environments and MDPs with multiple objectives constraints or imprecise parameters Markov Decision Processes With Their Applications examines MDPs and their applications in the optimal control of discrete event systems DESs optimal replacement and optimal allocations in sequential online auctions The book presents four main topics that are used to study optimal control problems a new methodology for MDPs with discounted total reward criterion transformation of continuous time MDPs and semi Markov decision processes into a discrete time MDPs model thereby simplifying the application of MDPs MDPs in stochastic environments which greatly extends the area where MDPs can be applied applications of MDPs in optimal control of discrete event systems optimal replacement and optimal allocation in sequential online auctions This book is intended for researchers mathematicians advanced graduate students and engineers who are interested in optimal control operation research communications manufacturing economics and electronic commerce

Markov Processes and Applications Etienne Pardoux, 2008-11-20 This well written book provides a clear and accessible treatment of the theory of discrete and continuous time Markov chains with an emphasis

towards applications The mathematical treatment is precise and rigorous without superfluous details and the results are immediately illustrated in illuminating examples This book will be extremely useful to anybody teaching a course on Markov processes Jean Fran ois Le Gall Professor at Universit de Paris Orsay France Markov processes is the class of stochastic processes whose past and future are conditionally independent given their present state They constitute important models in many applied fields After an introduction to the Monte Carlo method this book describes discrete time Markov chains the Poisson process and continuous time Markov chains It also presents numerous applications including Markov Chain Monte Carlo Simulated Annealing Hidden Markov Models Annotation and Alignment of Genomic sequences Control and Filtering Phylogenetic tree reconstruction and Queuing networks The last chapter is an introduction to stochastic calculus and mathematical finance Features include The Monte Carlo method discrete time Markov chains the Poisson process and continuous time jump Markov processes An introduction to diffusion processes mathematical finance and stochastic calculus Applications of Markov processes to various fields ranging from mathematical biology to financial engineering and computer science Numerous exercises and problems with solutions to most of them

Markov Decision Processes in Practice

Richard J. Boucherie, Nico M. van Dijk, 2017-03-10 This book presents classical Markov Decision Processes MDP for real life applications and optimization MDP allows users to develop and formally support approximate and simple decision rules and this book showcases state of the art applications in which MDP was key to the solution approach The book is divided into six parts Part 1 is devoted to the state of the art theoretical foundation of MDP including approximate methods such as policy improvement successive approximation and infinite state spaces as well as an instructive chapter on Approximate Dynamic Programming It then continues with five parts of specific and non exhaustive application areas Part 2 covers MDP healthcare applications which includes different screening procedures appointment scheduling ambulance scheduling and blood management Part 3 explores MDP modeling within transportation This ranges from public to private transportation from airports and traffic lights to car parking or charging your electric car Part 4 contains three chapters that illustrates the structure of approximate policies for production or manufacturing structures In Part 5 communications is highlighted as an important application area for MDP It includes Gittins indices down to earth call centers and wireless sensor networks Finally Part 6 is dedicated to financial modeling offering an instructive review to account for financial portfolios and derivatives under proportional transactional costs The MDP applications in this book illustrate a variety of both standard and non standard aspects of MDP modeling and its practical use This book should appeal to readers for practicing academic research and educational purposes with a background in among others operations research mathematics computer science and industrial engineering

Mathematical Reviews ,2004

Examples In Markov Decision Processes Alexey B Piunovskiy, 2012-09-21 This invaluable book provides approximately eighty examples illustrating the theory of controlled discrete time Markov processes Except for applications of the theory to real life problems like stock exchange queues

gambling optimal search etc the main attention is paid to counter intuitive unexpected properties of optimization problems Such examples illustrate the importance of conditions imposed in the theorems on Markov Decision Processes Many of the examples are based upon examples published earlier in journal articles or textbooks while several other examples are new The aim was to collect them together in one reference book which should be considered as a complement to existing monographs on Markov decision processes The book is self contained and unified in presentation The main theoretical statements and constructions are provided and particular examples can be read independently of others Examples in Markov Decision Processes is an essential source of reference for mathematicians and all those who apply the optimal control theory to practical purposes When studying or using mathematical methods the researcher must understand what can happen if some of the conditions imposed in rigorous theorems are not satisfied Many examples confirming the importance of such conditions were published in different journal articles which are often difficult to find This book brings together examples based upon such sources along with several new ones In addition it indicates the areas where Markov decision processes can be used Active researchers can refer to this book on applicability of mathematical methods and theorems It is also suitable reading for graduate and research students where they will better understand the theory

Examples in Markov Decision Processes A. B. Piunovskiy, 2012 This invaluable book provides approximately eighty examples illustrating the theory of controlled discrete time Markov processes Except for applications of the theory to real life problems like stock exchange queues gambling optimal search etc the main attention is paid to counter intuitive unexpected properties of optimization problems Such examples illustrate the importance of conditions imposed in the theorems on Markov Decision Processes Many of the examples are based upon examples published earlier in journal articles or textbooks while several other examples are new The aim was to collect them together in one reference book which should be considered as a complement to existing monographs on Markov decision processes The book is self contained and unified in presentation The main theoretical statements and constructions are provided and particular examples can be read independently of others Examples in Markov Decision Processes is an essential source of reference for mathematicians and all those who apply the optimal control theory to practical purposes When studying or using mathematical methods the researcher must understand what can happen if some of the conditions imposed in rigorous theorems are not satisfied Many examples confirming the importance of such conditions were published in different journal articles which are often difficult to find This book brings together examples based upon such sources along with several new ones In addition it indicates the areas where Markov decision processes can be used Active researchers can refer to this book on applicability of mathematical methods and theorems It is also suitable reading for graduate and research students where they will better understand the theory

Continuous-Time Markov Decision Processes Xianping Guo, Onésimo Hernández-Lerma, 2009-09-18 Continuous time Markov decision processes MDPs also known as controlled Markov chains are used for modeling decision making problems

that arise in operations research for instance inventory manufacturing and queueing systems computer science communications engineering control of populations such as fisheries and epidemics and management science among many other fields This volume provides a unified systematic self contained presentation of recent developments on the theory and applications of continuous time MDPs The MDPs in this volume include most of the cases that arise in applications because they allow unbounded transition and reward cost rates Much of the material appears for the first time in book form

Continuous-Time Markov Decision Processes Xianping Guo, Onesimo Hernandez-Lerma, 2010-04-29 Continuous time Markov decision processes MDPs also known as controlled Markov chains are used for modeling decision making problems that arise in operations research for instance inventory manufacturing and queueing systems computer science communications engineering control of populations such as fisheries and epidemics and management science among many other fields This volume provides a unified systematic self contained presentation of recent developments on the theory and applications of continuous time MDPs The MDPs in this volume include most of the cases that arise in applications because they allow unbounded transition and reward cost rates Much of the material appears for the first time in book form

Subject Guide to Books in Print, 1993 **Optimization and Games for Controllable Markov Chains** Julio B. Clempner, Alexander Poznyak, 2023-12-13 This book considers a class of ergodic finite controllable Markov chains The main idea behind the method described in this book is to develop the original discrete optimization problems or game models in the space of randomized formulations where the variables stand in for the distributions mixed strategies or preferences of the original discrete pure strategies in the use The following suppositions are made a finite state space a limited action space continuity of the probabilities and rewards associated with the actions and a necessity for accessibility These hypotheses lead to the existence of an optimal policy The best course of action is always stationary It is either simple i.e. nonrandomized stationary or composed of two nonrandomized policies which is equivalent to randomly selecting one of two simple policies throughout each epoch by tossing a biased coin As a bonus the optimization procedure just has to repeatedly solve the time average dynamic programming equation making it theoretically feasible to choose the optimum course of action under the global restriction In the ergodic cases the state distributions generated by the corresponding transition equations exponentially quickly converge to their stationary final values This makes it possible to employ all widely used optimization methods such as Gradient like procedures Extra proximal method Lagrange's multipliers Tikhonov's regularization including the related numerical techniques In the book we tackle different problems and theoretical Markov models like controllable and ergodic Markov chains multi objective Pareto front solutions partially observable Markov chains continuous time Markov chains Nash equilibrium and Stackelberg equilibrium Lyapunov like function in Markov chains Best reply strategy Bayesian incentive compatible mechanisms Bayesian Partially Observable Markov Games bargaining solutions for Nash and Kalai Smorodinsky formulations multi traffic signal control synchronization problem Rubinstein's non cooperative bargaining

solutions the transfer pricing problem as bargaining *Markov Decision Processes* Thomas W. Gutjahr, 1986 **Recent**
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Manchester. Department of Decision Theory, Institute of Mathematics and Its Applications, 1980

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