

# Constrained Markov Decision Processes Stochastic Modeling Series

19th International Conference, LPAR-19, Stellenbosch, South Africa, December 14-19, 2013, Proceedings

Theory and Applications, V.III

Stochastic Network Optimization with Application to Communication and Queueing Systems

Radio Resource Allocation Over Fading Channels Under Statistical Delay Constraints

Markov Decision Processes with Applications to Finance

Examples In Markov Decision Processes

Stochastic Processes, Finance and Control

Selected Topics on Continuous-time Controlled Markov Chains and Markov Games

Simulation-Based Algorithms for Markov Decision Processes

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Stochastic Models

Stochastic Differential Systems, Stochastic Control Theory and Applications

Stochastic Model Checking

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Markov Decision Processes with Their Applications

Modeling, Stochastic Control, Optimization, and Applications

Markov Decision Processes in Practice

Markov Decision Processes

Constrained Markov Decision Processes

From Filtering to Controlled Sensing

The PowerWeb Program at TU Delft

Handbook of Markov Decision Processes

Continuous-Time Markov Decision Processes

Modern Trends in Controlled Stochastic Processes:

Control Techniques for Complex Networks

Proceedings of a Workshop, held at IMA, June 9-19, 1986

Seventh Symposium on Probability and Stochastic Processes, June 23-28, 2002, Mexico City, Mexico

Continuous-Time Markov Decision Processes

Intelligent Integrated Energy Systems

Stochastic Methods in Optimization and Machine Learning

Stochastic Approximations for Finite-State Markov Chains

Constrained Markov Decision Processes

Dynamic Optimization

Theory and Applications

Optimal Control of Random Sequences in Problems with Constraints

Distributed Computer and Communication Networks

A Festschrift in Honor of Robert J Elliott

Competitive Markov Decision Processes

*Constrained Markov Decision Processes Stochastic Modeling Series*

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## MADILYNN NOVAK

19th International Conference, LPAR-19, Stellenbosch, South Africa, December 14-19, 2013, Proceedings World Scientific

From foundations to state-of-the-art; the tools and philosophy you need to build network models.

**Theory and Applications, V.III** Springer

Constrained Markov Decision Processes Routledge

Stochastic Network Optimization with Application to Communication and Queueing Systems American Mathematical Soc.

The field of applied probability has changed profoundly in the past twenty years. The development of computational methods has greatly contributed to a better understanding of the theory. A First Course in Stochastic Models provides a self-contained introduction to the theory and applications of stochastic models. Emphasis is placed on establishing the theoretical foundations of the subject, thereby providing a framework in which the applications can be understood. Without this solid basis in theory no applications can be solved. Provides an introduction to the use of stochastic models through an integrated presentation of theory, algorithms and applications. Incorporates recent developments in computational probability. Includes a wide range of examples that illustrate the models and make the methods of solution clear. Features an abundance of motivating exercises that help the student learn how to apply the theory. Accessible to anyone with a basic knowledge of probability. A First Course in Stochastic Models is

suitable for senior undergraduate and graduate students from computer science, engineering, statistics, operations research, and any other discipline where stochastic modelling takes place. It stands out amongst other textbooks on the subject because of its integrated presentation of theory, algorithms and applications.

*Radio Resource Allocation Over Fading Channels Under Statistical Delay Constraints* Constrained Markov Decision Processes

This book consists of a series of new, peer-reviewed papers in stochastic processes, analysis, filtering and control, with particular emphasis on mathematical finance, actuarial science and engineering. Paper contributors include colleagues, collaborators and former students of Robert Elliott, many of whom are world-leading experts and have made fundamental and significant contributions to these areas. This book provides new important insights and results by eminent researchers in the considered areas, which will be of interest to researchers and practitioners. The topics considered will be diverse in applications, and will provide contemporary approaches to the problems considered. The areas considered are rapidly evolving. This volume will contribute to their development, and present the current state-of-the-art stochastic processes, analysis, filtering and control. Contributing authors include: H Albrecher, T Bielecki, F Dufour, M Jeanblanc, I Karatzas, H-H Kuo, A Melnikov, E Platen, G Yin, Q Zhang, C Chiarella, W Fleming, D Madan, R Mamon, J Yan, V Krishnamurthy.

*Markov Decision Processes with Applications to Finance* Springer

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.

*Examples In Markov Decision Processes* Springer Science & Business Media

In a unified form, this monograph presents fundamental results on the approximation of centralized and decentralized stochastic control problems, with uncountable state, measurement, and action spaces. It demonstrates how quantization provides a system-independent and constructive method for the reduction of a system with Borel spaces to one with finite state, measurement, and action spaces. In addition to this constructive view, the book considers both the information transmission approach for discretization of actions, and the computational approach for discretization of states and actions. Part I of the text discusses Markov decision processes and their finite-state or finite-action approximations, while Part II builds from there to finite approximations in decentralized stochastic control problems. This volume is perfect for researchers and graduate students interested in stochastic controls. With the tools presented, readers will be able to establish the convergence of approximation models to original models and the methods are general enough that researchers can build corresponding approximation results, typically with no additional assumptions.

**Stochastic Processes, Finance and Control** Springer

The Wiley-Interscience Paperback Series consists of selected books that have been made more accessible to consumers in an effort to increase global appeal and general circulation. With these new unabridged softcover volumes, Wiley hopes to extend the lives of these works by making them available to future generations of statisticians, mathematicians, and scientists. "This text is unique in bringing together so many results hitherto found only in part in other texts and papers. . . . The text is fairly self-contained, inclusive of some basic mathematical results needed, and provides a rich diet of examples, applications, and exercises. The bibliographical material at the end of each chapter is excellent, not only from a historical perspective, but because it is valuable for researchers in acquiring a good perspective of the MDP research potential." —Zentralblatt für Mathematik ". . . it is of great value to advanced-level students, researchers, and professional practitioners of this field to have now a complete volume (with more than 600 pages) devoted to this topic. . . . Markov Decision Processes: Discrete Stochastic Dynamic Programming represents an up-to-date, unified, and rigorous treatment of theoretical and computational aspects of discrete-time Markov decision processes." —Journal of the American Statistical Association

*Selected Topics on Continuous-time Controlled Markov Chains and Markov Games* Springer Science & Business Media

This book covers formulation, algorithms, and structural results of partially observed Markov decision processes, whilst linking theory to real-world applications in controlled sensing. Computations are kept to a minimum, enabling students and researchers in engineering, operations research, and economics to understand the methods and determine the structure of their optimal solution.

**Simulation-Based Algorithms for Markov Decision Processes** Springer

This book constitutes the proceedings of the 19th International Conference on Logic for Programming, Artificial Intelligence and Reasoning, LPAR-19, held in December 2013 in Stellenbosch, South Africa. The 44 regular papers and 8 tool descriptions and experimental papers included in this volume were carefully reviewed and selected from 152 submissions. The series of International Conferences on Logic for Programming, Artificial Intelligence and Reasoning (LPAR) is a forum where year after year, some of the most renowned researchers in the areas of logic, automated reasoning, computational logic, programming languages and their applications come to present cutting-edge results, to discuss advances in these fields and to exchange ideas in a scientifically emerging part of the world.

**Quantized Models and Asymptotic Optimality** Springer Science & Business Media

This book consists of a series of new, peer-reviewed papers in stochastic processes, analysis, filtering and control, with particular emphasis on mathematical finance, actuarial science and engineering. Paper contributors include colleagues, collaborators and former students of Robert Elliott, many of whom are world-leading experts and have made fundamental and significant contributions to these areas. This book provides new important insights and results by eminent researchers in the considered areas, which will be of interest to researchers and practitioners. The topics considered will be diverse in applications, and will provide contemporary approaches to the problems considered. The areas considered are rapidly evolving. This volume will contribute to their development, and present the current state-of-the-art stochastic processes, analysis, filtering and control. Contributing authors include: H Albrecher, T Bielecki, F Dufour, M Jeanblanc, I Karatzas, H-H Kuo, A Melnikov, E Platen, G Yin, Q Zhang, C Chiarella, W Fleming, D Madan, R Mamon, J Yan, V Krishnamurthy. Contents: Stochastic Analysis: On the Connection Between Discrete and Continuous Wick Calculus with an Application to the Fractional Black-Scholes Model (C Bender and P Parczewski) Malliavin Differentiability of a Class of Feller-Diffusions with Relevance in Finance (C-O Ewald, Y Xiao, Y Zou and T K Siu) A Stochastic Integral for Adapted and Instantly Independent Stochastic Processes (H-H Kuo, A Sae-Tang and B Szozda) Independence of Some Multiple Poisson Stochastic Integrals with Variable-Sign Kernels (N Privault) Differential and Stochastic Games: Strategies for Differential Games (W H Fleming and D Hernández-Hernández) BSDE Approach to Non-Zero-Sum Stochastic Differential Games of Control and Stopping (I Karatzas and Q Li) Mathematical Finance: On Optimal Dividend Strategies in Insurance with a Random Time Horizon (H Albrecher and S Thonhauser) Counterparty Risk and the Impact of Collateralization in CDS Contracts (T R Bielecki, I Cialenco and I Iyigunler) A Modern View on Merton's Jump-Diffusion Model (G H L Cheang and C Chiarella) Hedging Portfolio Loss Derivatives with CDS's (A Cousin and M Jeanblanc) New Analytic Approximations for Pricing Spread Options (J van der Hoek and M W Korolkiwicz) On the Polynomial-Normal Model and Option Pricing (H Li

and A Melnikov) A Functional Transformation Approach to Interest Rate Modelling (S Luo, J Yan and Q Zhang) S&P 500 Index Option Surface Drivers and Their Risk Neutral and Real World Quadratic Covariations (D B Madan) A Dynamic Portfolio Approach to Asset Markets and Monetary Policy (E Platen and W Semmler) Mean-Variance Portfolio Selection Under Regime-Switching Diffusion Asset Models: A Two-Time-Scale Limit (G Yin and Y Talafha) Filtering and Control: Existence and Uniqueness of Solutions for a Partially Observed Stochastic Control Problem (A Bensoussan, M Çakanyildirim, M Li and S P Sethi) Continuous Control of Piecewise Deterministic Markov Processes with Long Run Average Cost (O L V Costa and F Dufour) Stochastic Linear-Quadratic Control Revisited (T E Duncan) Optimization of Stochastic Uncertain Systems: Entropy Rate Functionals, Minimax Games and Robustness (F Rezaei, C D Charalambous and N U Ahmed) Gradient Based Policy Optimization of Constrained Markov Decision Processes (V Krishnamurthy and F J Vázquez Abad) Parameter Estimation of a Regime-Switching Model Using an Inverse Stieltjes Moment Approach (X Xi, M R Rodrigo and R S Mamon) An Optimal Inventory-Price Coordination Policy (H Zhang and Q Zhang) Readership: Researchers and professionals in stochastic processes, analysis, filtering and control. Keywords: Stochastic Processes; Filtering; Stochastic Control; Stochastic Analysis; Mathematical Finance; Actuarial Sciences; Engineering Key Features: This is a festschrift of Professor Robert J Elliott, who is a world leader in the areas of stochastic processes, filtering, control as well as their applications. Includes contributions of many world-leading scholars in the fields. Contains many original and fundamental results in the fields rare in competing titles.

*Energy-Efficient Scheduling Under Delay Constraints for Wireless Networks* Springer Science & Business Media

This book concerns continuous-time controlled Markov chains and Markov games. The former, which are also known as continuous-time Markov decision processes, form a class of stochastic control problems in which a single decision-maker has a wish to optimize a given objective function. In contrast, there are two or more decision-makers (or players, or controllers) trying to optimize its own objective function in a Markov game. Both decision-making processes appear in a large number of applications in economics, operations research, engineering, and computer science among other areas. The main features of the control and game models studied in the book are the continuous time variable, the denumerable state space, and that the control (or action) sets are Borel spaces. Moreover, the transition and reward rates of the dynamical system may be unbounded. The authors are interested in some aspects of controlled Markov chains and Markov games such as characterizing the optimal reward functions, and determining optimal policies for each of the optimality criteria studied here. The main focus is on advanced optimality criteria (such as bias, variance, sensitive discount, and Blackwell optimality), though they also deal with the basic optimality criteria (discounted and average reward). A particular emphasis is made on the application of the results presented in this book. One of the main concerns is to propose assumptions on the control and game models that are easily verifiable (and verified) in practice. Moreover, algorithmic and computational issues are also analyzed. In particular, the authors propose approximation results that allow precise numerical approximations of the solution to some problems of practical interest.

Applications to population models and epidemic processes are also shown.

**Stochastic Models** Springer Science & Business Media

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.

*Stochastic Differential Systems, Stochastic Control Theory and Applications* Springer Science & Business Media

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 illustrate 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.

**Stochastic Model Checking** John Wiley & Sons

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.

**Logic for Programming, Artificial Intelligence, and Reasoning** Routledge

In constrained Markov decision problems, optimal policies are often found to depend on quantities that are not readily available due to either insufficient knowledge of the model parameters or computational difficulties. This motivates the on-line estimation (or computation) problem investigated in this paper in the context of a single parameter family of finite-state Markov chains. The computation is implemented through an algorithm of the Stochastic Approximations type, which recursively generates on-line estimates for the unknown value. A useful methodology is outlined for investigating the strong consistency of the algorithm, and the proof is carried out under a set of simplifying assumptions to illustrate the key ideas unencumbered with technical details. An application to constrained Markov decision processes is briefly discussed.

Markov Decision Processes with Their Applications Morgan & Claypool Publishers

This book is intended as a text covering the central concepts and techniques of Competitive Markov Decision Processes. It is an attempt to present a rigorous treatment that combines two significant research topics: Stochastic Games and Markov Decision Processes, which have been studied extensively, and at times quite independently, by mathematicians, operations researchers, engineers, and economists. Since Markov decision processes can be viewed as a special noncompetitive case of stochastic games, we introduce the new terminology Competitive Markov Decision Processes that emphasizes the importance of the link between these two topics and of the properties of the underlying Markov processes. The book is designed to be used either in a classroom or for self-study by a mathematically mature reader. In the Introduction (Chapter 1) we outline a number of advanced undergraduate and graduate courses for which this book could usefully serve as a text. A characteristic feature of competitive Markov decision processes - and one that inspired our long-standing interest - is that they can serve as an "orchestra" containing the "instruments" of much of modern applied (and at times even pure) mathematics. They constitute a topic where the instruments of linear algebra, applied probability, mathematical programming, analysis, and even algebraic geometry can be "played" sometimes solo and sometimes in harmony to produce either beautifully simple or equally beautiful, but baroque, melodies, that is, theorems.

*Modeling, Stochastic Control, Optimization, and Applications* Springer Science & Business Media

Presents a number of new and potentially useful self-learning (adaptive) control algorithms and theoretical as well as practical results for both unconstrained and constrained finite Markov chains-efficiently processing new information by adjusting the control strategies directly or indirectly.

**Markov Decision Processes in Practice** Springer Science & Business Media

The use of stochastic models in computer science is wide spread, for instance in performance modeling, analysis of randomized algorithms and communication protocols which form the structure of the Internet. Stochastic model checking is an important field in stochastic analysis. It has rapidly gained popularity, due to its powerful and systematic methods to model and analyze stochastic systems. This book presents 7 tutorial lectures given by leading scientists at the ROCKS Autumn School on Stochastic Model Checking, held in Vahrn, Italy, in October 2012. The 7 chapters of this tutorial went through two rounds of reviewing and improvement and are summarizing the state-of-the-art in the field, centered around the three areas of stochastic models, abstraction techniques and stochastic model checking.

Markov Decision Processes CRC Press

This SpringerBrief presents radio resource allocation schemes for buffer-aided communications systems over fading channels under statistical delay constraints in terms of upper-bounded average delay or delay-outage probability. This Brief starts by considering a source-destination communications link with data arriving at the source transmission buffer. The first scenario, the joint optimal data admission control and power allocation problem for throughput maximization is considered, where the source is assumed to have a maximum power and an average delay constraints. The second scenario, optimal power allocation problems for energy harvesting (EH) communications systems under average delay or delay-outage constraints are explored, where the EH source harvests random amounts of energy from renewable energy sources, and stores the harvested energy in a battery during data transmission. Online resource allocation algorithms are developed when the statistical knowledge of the random channel fading, data arrivals, EH processes governing the system dynamics is unknown a-priori. This Brief continues with a source-relay-destination communications link with buffers available at both source and relay, as part of a multi-hop network. Optimal resource allocation schemes for this 3-node relaying system to maximize its effective capacity under a delay-outage constraint are proposed, with special emphasis on relay roles: Half-duplex (HD) or full-duplex (FD) relay operation. With HD relay, the adaptive link selection relaying problem jointly with both fixed and adaptive power allocation schemes is investigated. Within each transmission frame, either the source-relay link or the relay-destination link is selected to be active depending on the channel conditions. With FD relay under the presence of non-zero residual self-interference (SI). This Brief also presents source and relay power allocation schemes for both cases of available knowledge of the channel state information at transmitter (CSIT): instantaneous or statistical. Professional and researchers working in this related field and advanced-level students in electrical or computer engineering will find the content valuable as a reference.

**Constrained Markov Decision Processes** Springer Science & Business Media

This IMA Volume in Mathematics and its Applications STOCHASTIC DIFFERENTIAL SYSTEMS, STOCHASTIC CONTROL THEORY AND APPLICATIONS is the proceedings of a workshop which was an integral part of the 1986-87 IMA program on STOCHASTIC DIFFERENTIAL EQUATIONS AND THEIR APPLICATIONS. We are grateful to the Scientific Committee: Daniel Stroock (Chairman) Wendell Fleming Theodore Harris Pierre-Louis Lions Steven Orey George Papanicolaou for planning and implementing an exciting and stimulating year-long program. We especially thank Wendell Fleming and Pierre-Louis Lions for organizing an interesting and productive workshop in an area in which mathematics is beginning to make significant contributions to real-world problems. George R. Seil Hans Weinberger PREFACE This volume is the Proceedings of a Workshop on Stochastic Differential Systems, Stochastic Control Theory, and Applications held at IMA June 9-19, 1986. The Workshop Program Committee consisted of W.H. Fleming and P.-L. Lions (co-chairmen), J. Baras, B. Hajek, J.M. Harrison, and H. Sussmann. The Workshop emphasized topics in the following four areas. (1) Mathematical theory of stochastic differential systems, stochastic control and nonlinear filtering for Markov diffusion processes. Connections with partial differential equations. (2) Applications of stochastic differential system theory, in engineering and management science. Adaptive control of Markov processes. Advanced computational methods in stochastic control and nonlinear filtering. (3) Stochastic scheduling, queueing networks, and related topics. Flow control, multiarm bandit problems, applications to problems of computer networks and scheduling of complex manufacturing operations.