Introduction To Stochastic Dynamic Programming

This book gives a systematic treatment of singularly perturbed systems that naturally arise in control and optimization, queueing networks, manufacturing systems, and financial engineering. It presents results on asymptotic expansions of solutions of Kolmogorov forward and backward equations, properties of policy functions, and optimal strategies. The chapters of this book are based on the strong solution results of the state space. They cover major classical themes, at the same time exploring a new range of applications that address the production of renewable forms of energy, environmental footprints and sustainable use of resources and water.

Invasive species are one of the strongest drivers of global environmental change, and invasive species are now often in the public discourse. At the same time, ecologists have begun to take a real interest in determining how invasive species interact with economic systems, and how invaders should be controlled. The book "Evolution of Invasive Species" for example, explores the relationship between environmental and economic factors that influence the invasion process. It presents new ways to address the question of how invasive species interact with economic systems, and how invaders should be controlled.

Recent Advances in Reinforcement Learning addresses current research in an exciting area that is gaining a great deal of interest among researchers. The book contains over 200 pages of cutting-edge research on topics such as robotics, autonomous vehicles, and machine learning.

The 24th European Symposium on Computer Aided Process Engineering creates an international forum where scientific and industrial contributions are presented with applications in process modeling and simulation, process synthesis and design, operation, and process optimization. The symposium has organized the broadest series of Process Systems Engineering by involving contributions at different scales of modeling and demonstrating vertical and horizontal integration. Contributions range from applications at the molecular level to the strategic level of the supply chain and sustainable development. The organizers have broadened the boundaries of Process Systems Engineering by involving contributions at different levels of modeling and demonstrating vertical and horizontal integration. Contributions range from applications at the molecular level to the strategic level of the supply chain and sustainable development. They cover major classical themes, at the same time exploring a new range of applications that address the production of renewable forms of energy, environmental footprints and sustainable use of resources and water.

Uninvited Verankerung der Theorie wird großer Wert auf realitätsnahe Beispiele gelegt. Das Buch enthält eine Vielzahl dieser Anwendungen aus den verschiedensten Gebieten.

explosive growth of this discipline lies in two adjectives that more appropriately refer to Computational Science and its applications: interoperable and ubiquitous. Numerous examples of interoperable and interoperable tools and applications are given in the present volume, and the contributions delivered at the 2004 International Conference on Computational Science and its Applications (ICCSA 2004) held in Athens, Italy, May 14–17, 2004.

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 are a component of an unbound encyclopedia of Mathematical Sciences in the global Encyclopedia of Life Support Systems (EOLSS), which is an integrated compendium of twenty one Encyclopedias. The Theme on Optimization and Operations Research is organized into six distinct topics which represent the main scientific areas of the theme: 1. Fundamentals of Operations Research; 2. Advanced Deterministic Operations Research; 3. Optimization in Infinite Dimensions; 4. Game Theory; 5. Stochastic Operations Research; 6. Decision Analysis, which are then expanded into multiple subtopics, each as a chapter. These four volumes are aimed at the following five major target audiences: University and College students Educators, Professional Practitioners, Research Personnel and Policy Analysts, Managers, and Decision Makers and NGOs.

The book introduces the stochastic control problem in discrete and continuous time. The beginning reader may find it useful first to study the discussion of deterministic optimal control problems before tackling the stochastic problems in Chapters 1 and 2. The book contains over 650 exercises, with solutions provided in the last seven chapters.
learn the main results, corollaries, and examples. These tend to be found in the earlier parts of each chapter. We have deliberately postponed some difficult technical proofs to later parts of these chapters. In the second part of the book we give an introduction to stochastic optimal control for Markov processes. This chapter follows an introduction to the dynamic programming method, and hinges on the intimate relationship between second-order partial differential equations of parabolic type and stochastic differential equations. This relationship is reviewed in Chapter V, which may be read independently of Chapters I-IV. Chapter VI is based to a considerable extent on the authors’ work in stochastic control since 1961. It also includes two other topics important for applications, namely, the solution to the stochastic linear regulator and the separation principle.

This book consists of, apart from the introduction, the chapters: DA Stochastic Dynamic Programming with Random Disturbances, - The Problem of Stochastic Dynamic Distance Optimal Partitioning (SDDP problem), - Partitions-Requirements-Matrices (PRMs), DA (“decision after” stochastic dynamic programming with random disturbances) is characterized by the fact that these random disturbances are observed before the decision is made at each state. In the past, only very moderate attention was given to problems with this characteristic. In Chapter 2 specific properties of DA stochastic dynamic programming problems are worked out for theoretical characterization and for more efficient solution strategies of such problems. The (DA) Stochastic Dynamic Distance Optimal Partitioning problem (SDDP problem) is an extremely complex Operations Research problem. It shows several connections with other problems of operations research and informatics such as stochastic dynamic transportation and facility location problems or meter task systems and more specific k-server problems. Partitions of integers as states of SDDP problems require an enormous amount of storage space for the corresponding computer programs. Investigations of inherent characteristic structures of SDDP problems are also important as a basis for heuristics. Partitions-requirements-matrices (PRMs) (Chapter 4) are matrices of transition probability equations of SDDP problems which are formulated as Markov decision processes. PRMs, in the strict meaning include optimal decisions of certain reduced SDDP problems, as is shown in (many cases) toward the end of the book. PRMs in the strict meaning therefore represent interesting (almost selfevident) combinatorial structures, which are not otherwise found in literature. In order to understand the investigations of this book, previous knowledge about stochastic Dynamic Programming and Markov decision processes is useful, however not absolutely necessary since the concerned models are developed from scratch.

Providing an introduction to stochastic optimal control in infinite dimension, this book gives a complete account of the theory of second-order Ito equations in infinite-dimensional Hilbert spaces, focusing on its applicability to associated stochastic optimal control problems. It features a general introduction to optimal stochastic control, including basic results (e.g. the dynamic programming principle) with proofs, and provides examples of applications. A complete and up-to-date exposition of the existing theory of viscosity solutions and regular solutions of second-order Ito equations in Hilbert spaces is given, together with an extensive survey of other methods, with a full bibliography. In particular, Chapter 6, written by M. Fathi and G. Tessitore, surveys the theory of regular solutions of Ito equations arising in infinite-dimensional stochastic control, via BSDEs. The book is of interest to both pure and applied researchers working in control theory of stochastic PDEs, and in control in infinite dimension. Readers from other fields who want to learn the basic theory will also find it useful. The prerequisites are: standard functional analysis, the theory of semigroups of operators and its use in the study of PDEs, some knowledge of the dynamic programming approach to stochastic optimal control problems in finite dimensions, and the basics of stochastic analysis and stochastic equations in infinite-dimensional spaces.

Introduction to Stochastic Dynamic Programming presents the basic theory and examines the scope of applications of stochastic dynamic programming. The book begins with a chapter on various finite-stage methods, illustrating the wide range of applications of stochastic dynamic programming. Subsequent chapters study infinite-stage models: discounting future returns, minimizing nonnegative costs, maximizing nonnegative returns, and maximizing the long-run average return. Each of these chapters first considers whether an optimal policy need exist—providing counterexamples where appropriate—and then presents methods for obtaining such policies. In addition, general avenues of application are presented. The final two chapters are concerned with more specialized models. These include stochastic scheduling models and a type of process known as a multi-project bandit. The mathematical prerequisites for this text are relatively few. No prior knowledge of dynamic programming is assumed and only a moderate familiarity with probability—including the use of conditional expectation—is necessary.

Applied Stochastic Models and Control for Finance and Insurance presents at an introductory level some essential stochastic models applied in economics, finance and insurance. Markov chains, random walks, stochastic differential equations and other stochastic processes are used throughout the book and systematically applied to economic and financial applications. In addition, a dynamic programming framework is used to deal with some basic optimization problems. The book begins by introducing problems of economics, finance and insurance which involve time, uncertainty and risk. A number of cases are treated in detail, spanning risk management, volatility, memory, the structure of preferencies, interest rates and yields, etc. The second and third chapters provide an introduction to stochastic models and their application. Stochastic differential equations and stochastic calculus are presented in an intuitive manner, and numerous applications and exercises are used to facilitate their understanding and their use in Chapter 3. A number of other processes which are increasingly used in finance and insurance are introduced in Chapter 4. In the fifth chapter, ARCH and GARCH models are presented and their application to modeling volatility is emphasized. An outline of decision-making procedures is presented in Chapter 6. Furthermore, we also introduce the essentials of stochastic dynamic programming and control, and provide first steps for the student who seeks to apply these techniques. Finally, in Chapter 7, numerical techniques and approximations to stochastic processes are studied. This book can be used in business, economics, financial engineering and decision sciences schools for second year Master's students, as well as in a number of courses widely given in departments of statistics, systems and decision sciences.

Some simple examples; Functional equations: basic theory. One-dimensional dynamic programming: analytic solutions; One-dimensional dynamic programming: computational solutions; Multidimensional problems; Reduction of state dimensionality and approximations; Stochastic processes and dynamic programming: Dynamic programming and the calculus of variations; Applications of dynamic programming: Set, Convexity, and n-dimensional geometry.

This book is concerned with a class of discrete-time stochastic control processes known as controlled Markov processes (CMP), also known as Markov decision processes or Markov dynamic programs. Starting in the mid 1950's with Richard Bellman, many contributions to CMP's have been made, and applications to engineering, statistics and operations research, among other areas, have also been developed. The purpose of this book is to present some recent developments on the theory of adaptive CMP's, i.e., CMP's that depend on unknown parameters. Thus at each decision time, the controller or decision-maker must estimate the unknown parameter or parameters, and then adopt the control policy that maximizes the expected performance. This book is a valuable reference for those interested in the design of optimal control systems, particularly in the context of parameter estimation and probability theory at the level of, say, Ash (1972) or Royden (1968), but no previous knowledge of control or decision processes is required. The pre-seen, on the other hand, is meant to be self-contained in the most relevant, but generally only in a formal and rigorous sense. Several appendices are provided for this purpose. The material is divided into six chapters. Chapter 1 contains the basic definitions about the stochastic optimal control problems we are interested in; a brief description of some applications is also provided. This book presents practical Risk Management and Trading applications for the Electricity Markets. The book emphasizes the relationship between trading, hedging and generation asset management.

Dynamic programming (DP) has a rich history as a powerful and flexible optimization principle, but has a bad reputation as a computationally impractical tool. This book fills a gap between the statement of DP principles and their actual software implementation. Using MATLAB throughout, this tutorial gently gets the reader acquainted with DP and its potential applications, offering the possibility of actual experimentation and hands-on experience. The book assumes basic familiarity with probability and optimization, and is suitable to both practitioners and graduate students in engineering, applied mathematics, management science, and economics.

Praise for the First Edition: “Finally, a book devoted to dynamic programming and written with the language of operations research (OR)! This beautiful book fills a gap in the libraries of OR specialists and practitioners.” —Computing Reviews This new edition showcases a focus on modeling and computation for complex classes of approximate dynamic programming problems Understanding approximate dynamic programming (ADP) is vital in order to develop practical and high-quality solutions to complex industrial problems, particularly when those problems involve making decisions in the presence of uncertainty. Approximate Dynamic Programming, Second Edition uniquely integrates four distinct disciplines—Markov decision processes, mathematical programming, simulation, and statistics—to demonstrate how to successfully approach, model, and solve a wide range of real-life problems using ADP. The book continues to bridge the gap between simulation, optimization, and operations research and now adopts the vocabulary of reinforcement learning. The author outlines the essential algorithms that serve as a starting point in the design of practical solutions for real problems. The three curves of dimensionality that impact complex problems are introduced and detailed coverage of implementation challenges is provided. The Second Edition also features a new chapter describing four fundamental classes of policies for working with diverse stochastic optimization problems: myopic policies, look-ahead policies, policy function approximations, and policies based on value function approximations A new chapter on policy search that brings together stochastic search and simulation optimization concepts and introduces a new class of optimal learning strategies Updated coverage of the exploration exploitation problem in ADP, now including a recently developed method for doing active learning in the presence of a physical state, using the concept of the knowledge gradient A new section of chapters describing statistical methods for approximating value functions, estimating the value of a fixed policy, and value function approximation while searching for optimal policies The presented coverage of ADP emphasizes models and algorithms, focusing on related applications and computation while also discussing the theoretical side of the topic that explores proofs of convergence and rate of convergence. A related website features an ongoing discussion of the evolving fields of approximate dynamic programming and reinforcement learning, along with additional readings, software, and data. Including requirements only a basic understanding of statistics and probability, Approximate Dynamic Programming, Second Edition is an excellent book for industrial engineering and operations research courses at the upper- undergraduate and graduate levels. It also serves as a valuable reference for industry professionals and researchers who utilize dynamic programming, stochastic programming, and control theory to solve real world problems in their everyday work. The Handbook of Neural Computation is a unique and valuable source of information for neural networks. The book presents both the traditional aspects and the recent developments in neural networks. It covers the fundamentals of neural networks, including their architecture, learning algorithms, and applications. The book also includes chapters on specific neural network architectures, such as radial basis function networks, and deep learning techniques. The book is written in a clear and concise manner, making it accessible to both students and researchers in various fields of artificial intelligence. The book is divided into several sections, each focusing on a different aspect of neural networks. The first section provides an introduction to the fundamental concepts of neural networks, including the biological inspiration behind them and the mathematical foundations. The second section discusses the various architectures of neural networks, such as feedforward networks, recurrent networks, and convolutional networks. The third section covers the learning algorithms used in neural networks, including supervised learning, unsupervised learning, and reinforcement learning. The fourth section explores the applications of neural networks in various domains, such as computer vision, natural language processing, and robotics. Overall, the book provides a comprehensive overview of the field of neural networks, making it a valuable resource for students, researchers, and practitioners in artificial intelligence.
The aim of stochastic programming is to find optimal decisions in problems which involve uncertain data. This field is currently developing rapidly with contributions from many disciplines including operations research, mathematics, and probability. At the same time, it is now being applied in a wide variety of subjects ranging from agriculture to financial planning and from industrial engineering to computer networks. This textbook provides a first course in stochastic programming suitable for students with a basic knowledge of linear programming, elementary analysis, and probability. The authors aim to present a broad overview of the main themes and methods of the subject. Its prime goal is to help students develop an intuition on how to model uncertainty into mathematical problems, what uncertainty changes bring to the decision process, and what techniques help to manage uncertainty in solving the problems. In this extensively updated new edition there is more material on methods and examples including several new approaches for discrete variables, new results on risk measures in modeling and Monte Carlo sampling methods, a new chapter on relationships to other methods including approximate dynamic programming, robust optimization and online methods. The book is highly illustrated with chapter summaries and many examples and exercises. Students, researchers and practitioners in operations research and the optimization area will find it particularly of interest. Review of First Edition: "The discussion on modeling issues, the large number of examples used to illustrate the material, and the breadth of the coverage make 'Introduction to Stochastic Programming' an ideal textbook for the area." (Interfaces, 1998)