

Applications of Mathematics

Stochastic Modelling and Applied Probability

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**Jiongmin Yong
Xun Yu Zhou**

Stochastic Controls

**Hamiltonian Systems and
HJB Equations**



Springer

Stochastic Controls Hamiltonian Systems And Hjb Equations

Frank T. Smith, Hemen Dutta, John N. Mordeson



Stochastic Controls Hamiltonian Systems And Hjb Equations:

Stochastic Controls Jiongmin Yong, Xun Yu Zhou, 1999-06-22 Stochastic Controls Jiongmin Yong, Xun Yu Zhou, 2012-12-06 As is well known Pontryagin's maximum principle and Bellman's dynamic programming are the two principal and most commonly used approaches in solving stochastic optimal control problems. An interesting phenomenon one can observe from the literature is that these two approaches have been developed separately and independently. Since both methods are used to investigate the same problems, a natural question one will ask is the following: What is the relationship between the maximum principle and dynamic programming in stochastic optimal controls? There did exist some researches prior to the 1980s on the relationship between these two. Nevertheless, the results usually were stated in heuristic terms and proved under rather restrictive assumptions which were not satisfied in most cases. In the statement of a Pontryagin type maximum principle, there is an adjoint equation which is an ordinary differential equation (ODE) in the finite dimensional deterministic case and a stochastic differential equation (SDE) in the stochastic case. The system consisting of the adjoint equation, the original state equation, and the maximum condition is referred to as an extended Hamiltonian system. On the other hand, in Bellman's dynamic programming, there is a partial differential equation (PDE) of first order in the finite dimensional deterministic case and of second order in the stochastic case. This is known as a Hamilton-Jacobi-Bellman (HJB) equation.

Lectures on BSDEs, Stochastic Control, and Stochastic Differential Games with Financial Applications Rene Carmona, 2016-02-18 The goal of this textbook is to introduce students to the stochastic analysis tools that play an increasing role in the probabilistic approach to optimization problems including stochastic control and stochastic differential games. While optimal control is taught in many graduate programs in applied mathematics and operations research, the author was intrigued by the lack of coverage of the theory of stochastic differential games. This is the first title in SIAM's Financial Mathematics book series and is based on the author's lecture notes. It will be helpful to students who are interested in stochastic differential equations, forward-backward, the probabilistic approach to stochastic control, dynamic programming, and the stochastic maximum principle, and mean field games and control of McKean-Vlasov dynamics. The theory is illustrated by applications to models of systemic risk, macroeconomic growth, flocking, schooling, crowd behavior, and predatory trading, among others.

Stochastic Control Theory Makiko Nisio, 2014-11-27 This book offers a systematic introduction to the optimal stochastic control theory via the dynamic programming principle, which is a powerful tool to analyze control problems. First, we consider completely observable control problems with finite horizons. Using a time discretization, we construct a nonlinear semigroup related to the dynamic programming principle (DPP) whose generator provides the Hamilton-Jacobi-Bellman (HJB) equation, and we characterize the value function via the nonlinear semigroup besides the viscosity solution theory. When we control not only the dynamics of a system but also the terminal time of its evolution, control stopping problems arise. This problem is treated in the same frameworks via the nonlinear semigroup. Its

results are applicable to the American option price problem Zero sum two player time homogeneous stochastic differential games and viscosity solutions of the Isaacs equations arising from such games are studied via a nonlinear semigroup related to DPP the min max principle to be precise Using semi discretization arguments we construct the nonlinear semigroups whose generators provide lower and upper Isaacs equations Concerning partially observable control problems we refer to stochastic parabolic equations driven by colored Wiener noises in particular the Zakai equation The existence and uniqueness of solutions and regularities as well as It s formula are stated A control problem for the Zakai equations has a nonlinear semigroup whose generator provides the HJB equation on a Banach space The value function turns out to be a unique viscosity solution for the HJB equation under mild conditions This edition provides a more generalized treatment of the topic than does the earlier book Lectures on Stochastic Control Theory ISI Lecture Notes 9 where time homogeneous cases are dealt with Here for finite time horizon control problems DPP was formulated as a one parameter nonlinear semigroup whose generator provides the HJB equation by using a time discretization method The semigroup corresponds to the value function and is characterized as the envelope of Markovian transition semigroups of responses for constant control processes Besides finite time horizon controls the book discusses control stopping problems in the same frameworks

Continuous-Time Markov Jump Linear Systems Oswaldo Luiz do Valle Costa, Marcelo D. Fragoso, Marcos G. Todorov, 2012-12-18 It has been widely recognized nowadays the importance of introducing mathematical models that take into account possible sudden changes in the dynamical behavior of a high integrity systems or a safety critical system Such systems can be found in aircraft control nuclear power stations robotic manipulator systems integrated communication networks and large scale flexible structures for space stations and are inherently vulnerable to abrupt changes in their structures caused by component or interconnection failures In this regard a particularly interesting class of models is the so called Markov jump linear systems MJLS which have been used in numerous applications including robotics economics and wireless communication Combining probability and operator theory the present volume provides a unified and rigorous treatment of recent results in control theory of continuous time MJLS This unique approach is of great interest to experts working in the field of linear systems with Markovian jump parameters or in stochastic control The volume focuses on one of the few cases of stochastic control problems with an actual explicit solution and offers material well suited to coursework introducing students to an interesting and active research area The book is addressed to researchers working in control and signal processing engineering Prerequisites include a solid background in classical linear control theory basic familiarity with continuous time Markov chains and probability theory and some elementary knowledge of operator theory *Machine Learning and Intelligent Communications* Xiangping Bryce Zhai, Bing Chen, Kun Zhu, 2019-10-27 This volume constitutes the refereed post conference proceedings of the Fourth International Conference on Machine Learning and Intelligent Communications MLICOM 2019 held in Nanjing China in August 2019 The 65 revised full papers were carefully selected

from 114 submissions The papers are organized thematically in machine learning intelligent positioning and navigation intelligent multimedia processing and security wireless mobile network and security cognitive radio and intelligent networking IoT intelligent satellite communications and networking green communication and intelligent networking ad hoc and sensor networks resource allocation in wireless and cloud networks signal processing in wireless and optical communications and intelligent cooperative communications and networking

Stochastic Optimal Control of Structures Yongbo Peng,Jie Li,2019-06-27 This book proposes for the first time a basic formulation for structural control that takes into account the stochastic dynamics induced by engineering excitations in the nature of non stationary and non Gaussian processes Further it establishes the theory of and methods for stochastic optimal control of randomly excited engineering structures in the context of probability density evolution methods such as physically based stochastic optimal PSO control By logically integrating randomness into control gain the book helps readers design elegant control systems mitigate risks in civil engineering structures and avoid the dilemmas posed by the methods predominantly applied in current practice such as deterministic control and classical linear quadratic Gaussian LQG control associated with nominal white noises

Modeling, Stochastic Control, Optimization, and Applications George Yin,Qing Zhang,2019-07-16 This volume collects papers based on invited talks given at the IMA workshop in Modeling Stochastic Control Optimization and Related Applications held at the Institute for Mathematics and Its Applications University of Minnesota during May and June 2018 There were four week long workshops during the conference They are 1 stochastic control computation methods and applications 2 queueing theory and networked systems 3 ecological and biological applications and 4 finance and economics applications For broader impacts researchers from different fields covering both theoretically oriented and application intensive areas were invited to participate in the conference It brought together researchers from multi disciplinary communities in applied mathematics applied probability engineering biology ecology and networked science to review and substantially update most recent progress As an archive this volume presents some of the highlights of the workshops and collect papers covering a broad range of topics

Computational Financial Mathematics using MATHEMATICA® Srdjan Stojanovic,2012-12-06 Given the explosion of interest in mathematical methods for solving problems in finance and trading a great deal of research and development is taking place in universities large brokerage firms and in the supporting trading software industry Mathematical advances have been made both analytically and numerically in finding practical solutions This book provides a comprehensive overview of existing and original material about what mathematics when allied with Mathematica can do for finance Sophisticated theories are presented systematically in a user friendly style and a powerful combination of mathematical rigor and Mathematica programming Three kinds of solution methods are emphasized symbolic numerical and Monte Carlo Nowadays only good personal computers are required to handle the symbolic and numerical methods that are developed in this book Key features No previous knowledge of Mathematica programming is

required The symbolic numeric data management and graphic capabilities of Mathematica are fully utilized Monte Carlo solutions of scalar and multivariable SDEs are developed and utilized heavily in discussing trading issues such as Black Scholes hedging Black Scholes and Dupire PDEs are solved symbolically and numerically Fast numerical solutions to free boundary problems with details of their Mathematica realizations are provided Comprehensive study of optimal portfolio diversification including an original theory of optimal portfolio hedging under non Log Normal asset price dynamics is presented The book is designed for the academic community of instructors and students and most importantly will meet the everyday trading needs of quantitatively inclined professional and individual investors

The Future of Urban Living: Smart Cities and Sustainable Infrastructure Technologies Chakib El Mokhi,Hanaa Hachimi,Anand Nayyar,2025-08-18

This book provides a comprehensive manual for researchers practitioners policymakers as well as students striving to achieve environmental sustainment It is exploring advanced developments in smart cities infrastructure and sustainability engineering In addition this book delivers advanced methodologies emerging and innovative technologies that shape sustainable urban technologies Including the renewable energy systems of tomorrow to low impact manufacturing procedures today every section provides insight and real world implementation The book bridges the gap between theory and practice making it an essential tool to turn sustainability challenges into opportunities Salient characteristics comprise 1 Global perspective Allows for flexibility in solutions given a multitude of successful examples around the world from different cultural and geographic locations 2 Multidisciplinary approach Integrating perspectives from engineering environmental science economics and policy studies for holistic problem solving 3 Financial sustainability Innovative business models to make sustainable solutions good for the environment and even better economically This provoking literature questions conventional wisdom and promotes adventurous visions of sustainability By highlighting emerging trends in cloud computing cybersecurity and big data for urban development readers are prepared to lead the next paradigm shift in sustainable innovation

Contract Theory in Continuous-Time Models Jakša Cvitanic,Jianfeng Zhang,2012-09-26 In recent years there has been a significant increase of interest in continuous time Principal Agent models or contract theory and their applications Continuous time models provide a powerful and elegant framework for solving stochastic optimization problems of finding the optimal contracts between two parties under various assumptions on the information they have access to and the effect they have on the underlying profit loss values This monograph surveys recent results of the theory in a systematic way using the approach of the so called Stochastic Maximum Principle in models driven by Brownian Motion Optimal contracts are characterized via a system of Forward Backward Stochastic Differential Equations In a number of interesting special cases these can be solved explicitly enabling derivation of many qualitative economic conclusions

Optimal Control Theory Suresh P. Sethi,2022-01-03 This new 4th edition offers an introduction to optimal control theory and its diverse applications in management science and economics It introduces students to the concept of the maximum principle in

continuous as well as discrete time by combining dynamic programming and Kuhn Tucker theory While some mathematical background is needed the emphasis of the book is not on mathematical rigor but on modeling realistic situations encountered in business and economics It applies optimal control theory to the functional areas of management including finance production and marketing as well as the economics of growth and of natural resources In addition it features material on stochastic Nash and Stackelberg differential games and an adverse selection model in the principal agent framework Exercises are included in each chapter while the answers to selected exercises help deepen readers understanding of the material covered Also included are appendices of supplementary material on the solution of differential equations the calculus of variations and its ties to the maximum principle and special topics including the Kalman filter certainty equivalence singular control a global saddle point theorem Sethi Skiba points and distributed parameter systems Optimal control methods are used to determine optimal ways to control a dynamic system The theoretical work in this field serves as the foundation for the book in which the author applies it to business management problems developed from his own research and classroom instruction The new edition has been refined and updated making it a valuable resource for graduate courses on applied optimal control theory but also for financial and industrial engineers economists and operational researchers interested in applying dynamic optimization in their fields *Modelling Extremal Events* Paul

Embrechts,Claudia Klüppelberg,Thomas Mikosch,2013-01-02 A reader s first impression on leafing through this book is of the large number of graphs and diagrams used to illustrate shapes of distributions and to show real data examples in various ways A closer reading reveals a nice mix of theory and applications with the copious graphical illustrations alluded to Such a mixture is of course dear to the heart of the applied probabilist statistician and should impress even the most ardent theorists MATHEMATICAL REVIEWS *Mathematics of Public Health* Jummy David,Jianhong Wu,2023-12-30 This volume addresses

SDG 3 from a mathematical standpoint sharing novel perspectives of existing communicable disease modelling technologies of the next generation and disseminating new developments in modelling methodologies and simulation techniques These methodologies are important for training and research in communicable diseases and can be applied to other threats to human health The contributions contained in this collection book cover a range of modelling techniques that have been and may be used to support decision making on critical health related issues such as Resource allocation Impact of climate change on communicable diseases Interaction of human behaviour change and disease spread Disease outbreak trajectories projection Public health interventions evaluation Preparedness and mitigation of emerging and re emerging infectious diseases outbreaks Development of vaccines and decisions around vaccine allocation and optimization The diseases and public health issues in this volume include but are not limited to COVID 19 HIV Influenza antimicrobial resistance AMR the opioid epidemic Lyme Disease Zika and Malaria In addition this volume compares compartmental models agent based models machine learning and network Readers have an opportunity to learn from the next generation perspective of evolving

methodologies and algorithms in modelling infectious diseases the mathematics behind them the motivation for them and some applications to supporting critical decisions on prevention and control of communicable diseases This volume was compiled from the weekly seminar series organized by the Mathematics for Public Health MfPH Next Generation Network This network brings together the next generation of modellers from across Canada and the world developing the latest mathematical models modeling methodologies and analytical and simulation tools for communicable diseases of global public health concerns The weekly seminar series provides a unique forum for this network and their invited guest speakers to share their perspectives on the status and future directions of mathematics of public health

Hybrid Switching Diffusions
G. George Yin, Chao Zhu, 2009-10-03 This book encompasses the study of hybrid switching diffusion processes and their applications The word hybrid signifies the coexistence of continuous dynamics and discrete events which is one of the distinct features of the processes under consideration Much of the book is concerned with the interactions of the continuous dynamics and the discrete events Our motivations for studying such processes originate from emerging and existing applications in wireless communications signal processing queueing networks production planning biological systems ecosystems financial engineering and modeling analysis and control and optimization of large scale systems under the influence of random environments Displaying mixture distributions switching diffusions may be described by the associated operators or by systems of stochastic differential equations together with the probability transition laws of the switching actions We either have Markov modulated switching diffusions or processes with continuous state dependent switching The latter turns out to be much more challenging to deal with Viewing the hybrid diffusions as a number of diffusions joined together by the switching process they may be seemingly not much different from their diffusion counterpart Nevertheless the underlying problems become more difficult to handle especially when the switching processes depend on continuous states The difficulty is due to the interaction of the discrete and continuous processes and the tangled and hybrid information pattern

Mathematical Control Theory and Finance Andrey Sarychev, Albert Shiryaev, Manuel Guerra, Maria do Rosário Grossinho, 2009-03-31 Control theory provides a large set of theoretical and computational tools with applications in a wide range of fields running from pure branches of mathematics like geometry to more applied areas where the objective is to find solutions to real life problems as is the case in robotics control of industrial processes or finance The high tech character of modern business has increased the need for advanced methods These rely heavily on mathematical techniques and seem indispensable for competitiveness of modern enterprises It became essential for the financial analyst to possess a high level of mathematical skills Conversely the complex challenges posed by the problems and models relevant to finance have for a long time been an important source of new research topics for mathematicians The use of techniques from stochastic optimal control constitutes a well established and important branch of mathematical finance Up to now other branches of control theory have found comparatively less application in financial problems To some extent deterministic and stochastic control

theories developed as different branches of mathematics. However, there are many points of contact between them and in recent years the exchange of ideas between these fields has intensified. Some concepts from stochastic calculus, e.g. rough paths, have drawn the attention of the deterministic control theory community. Also, some ideas and tools usual in deterministic control, e.g. geometric, algebraic or functional analytic methods, can be successfully applied to stochastic control.

Partially Observable Linear Systems Under Dependent Noises Agamirza E. Bashirov, 2012-12-06 Noise is a rich concept playing an underlying role in human activity. Consideration of the noise phenomenon in arts and sciences respectively makes the distinction between both domains more obvious. Artists create deliberate noise: the masterpieces of literature, music, modern fine art etc. are those where a clear idea, traditionally related to such concepts as love, is presented under a skilful veil of deliberate noise. On the contrary, sciences fight against noise: a scientific discovery is a law of nature extracted from a noisy medium and refined. This book discusses the methods of fighting against noise. It can be regarded as a mathematical view of specific engineering problems with known and new methods of control and estimation in noisy media. The main feature of this book is the investigation of stochastic optimal control and estimation problems with the noise processes acting dependently on the state or signal and observation systems. While multiple early and recent findings on the subject have been obtained and challenging problems remain to be solved, this subject has not yet been dealt with systematically nor properly investigated. The discussion is given for infinite dimensional systems but within the linear quadratic framework for continuous and finite time horizon. In order to make this book self-contained, some background material is provided. Consequently, the target readers of this book are both applied mathematicians and theoretically oriented engineers who are designing new technology as well as students of the related branches. The book may also be used as a reference manual in that part of functional analysis that is needed for problems of infinite dimensional linear systems theory.

Statistics of Random Processes Robert Liptser, Al'bert Nikolaevich Shiryaev, Albert N. Shiryaev, 2001 These volumes cover non linear filtering, prediction and smoothing theory and its applications to the problem of optimal estimation, control with incomplete data, information theory and sequential testing of hypothesis. Also presented is the theory of martingales of interest to those who deal with problems in financial mathematics. These editions include new material, expanded chapters and comments on recent progress in the field.

Mathematics Applied to Engineering, Modelling, and Social Issues Frank T. Smith, Hemen Dutta, John N. Mordeson, 2019-03-14 This book presents several aspects of research on mathematics that have significant applications in engineering, modelling and social matters, discussing a number of current and future social issues and problems in which mathematical tools can be beneficial. Each chapter enhances our understanding of the research problems in a particular area of study and highlights the latest advances made in that area. The self-contained contributions make the results and problems discussed accessible to readers and provides references to enable those interested to follow subsequent studies in still developing fields. Presenting real world applications, the book is a valuable resource for graduate students, researchers,

and educators It appeals to general readers curious about the practical applications of mathematics in diverse scientific areas and social problems The Unaffordable Price of Static Decision-making Models Fouad El Ouardighi, Gustav Feichtinger, 2025-07-01 At the 15th Viennese Workshop on Optimal Control and Dynamic Games held in July 2022 experts in economics and the management sciences identified a concerning trend static decision making models while less effective than dynamic ones are becoming increasingly prevalent This book aims to address the economic and social costs associated with reliance on static models and to demonstrate the advantages of applying dynamic approaches Static models may be easier to formulate but they often overlook the long term consequences of decisions promoting myopic practices that can lead to poor outcomes In contrast dynamic models foster a more comprehensive perspective enabling foresight in decision making which is crucial for issues involving stock variables such as pollution reputation and inventory The book explores the limitations of static models including their inability to capture long term outcomes history dependent solutions and the impact of abrupt contextual changes It also highlights recent advances in dynamic modeling techniques that can enhance accuracy and help adapt to complex decision making environments By promoting the shift from static to dynamic models this book aspires to open new research opportunities and provide valuable insights for researchers students policymakers and managers in the fields of economics and the management sciences

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