Stochastic Relations

This book provides a systematic and general theory of probability within the framework of constructive mathematics.

Molecular Dynamics

Coherent introduction to techniques also offers a guide to general theory of accessibility, which is a major contribution to the literature on statistical models in primitivcs (wavelets). It also combines the structure-based and appearance-based methods in the literature. At the end of the review, three case studies are presented to illustrate the proposed approach. A Stochastic Grammar of Images is an important contribution to the literature on structured statistical models in computer vision.

Stochastic Methods in Engineering

This volume is a textbook on linear control systems with an emphasis on stochastic optimal control with solution methods using spectral factorization in line with the original approach of N. Wiener. Continuous and discrete-time versions are presented in parallel. Two appendices introduce functional analytic concepts and probability theory, and there are 78 references and an index. The chapters (except for the last two) end with problems. [The book presents in a clear way I important concepts of control theory and can be used for teaching. —Zentralblatt Math] This is a textbook intended for use in courses on linear control and filtering. It has as its main purpose to introduce both deterministic and stochastic control and estimation. Topics are treated in both continuous and discrete-time versions. Each chapter involves problems and exercises, and the book is supported by appendices, where fundamentals on Hilbert and Banach spaces, operator theory, and measure theoretic probability may be found. The book will be very useful for students, but also for a variety of specialists in the field of mathematics and computer science. The book under review lies in the choice of specialized topics it contains, which may not be found in this form elsewhere. Also, the first half would make a good standard course in linear control. —Journal of the Indian Institute of Science

Applied Stochastic Analysis

The handbook covers systematically and in simple language the foundations of Markov systems, stochastic differential equations, Fokker-Planck equations, approximations in Markov processes. Chemical master equation and quantum-mechanical Markov processes are placed on systematic approximations methods for solving problems. Stochastic adiabatic elimination is newly formulated. The book contains the 'folklore' of stochastic methods in systematic form, and is suitable for use as a reference work. In this second edition extra material has been added with recent progress in stochastic methods taken into account.

Stochastic Simulation and Monte Carlo Methods

SAGA 2001, the 3rd Symposium on Stochastic Algorithms, Foundations and Applications, took place on December 13–14, 2001 in Berlin, Germany. The present volume comprises contributed papers and four invited talks that were included in the 3rd program of the symposium. Stochastic algorithms constitute a general approach to finding approximate solutions to a wide variety of problems. Although there is no formal proof that stochastic algorithms perform better than deterministic ones, there is evidence by empirical observations that stochastic algorithms produce for a broad range of applications near-optimal solutions in a reasonable time. The symposium aims to provide a forum for presentation of original research in the design and analysis, experimental evaluation, and real-world application of stochastic algorithms. It focuses, in particular, on new algorithmic ideas involving stochastic decision and exploiting probabilistic properties of the underlying problem domain. The program of the symposium reflects the effort to promote cooperation among practitioners and theoreticians and among algorithmic and complexity researchers of the field. In this context, we would like to express our special gratitude to DaimlerChrysler AG for supporting SAGA 2001. The contributed papers included in the proceedings results in the following areas: Network and distributed algorithms; local search methods for combinatorial optimization with application to constraint satisfaction problems, manufacturing systems, motor control unit calibration, and packing flexible jobs; and computational learning theory.

Monte Carlo Methods in Financial Engineering

This book examines optimization problems that in practice involve random model parameters. It details the computation of robust optimal solutions, e.g., optimal solutions that are insensitive with respect to random parameter variations, where appropriate deterministic substitute problems are needed. Based on the probability distribution of the random data and using decision theoretical concepts, optimization problems under stochastic uncertainty are converted into appropriate deterministic substitute problems. Due to the probabilities and expectations involved, the book also shows how to apply approximative solution techniques. Several deterministic and stochastic approximation methods are provided: Taylor expansion methods, regression and response surface methods (RSM), and stochastic approximation methods, convex approximation/deterministic descent directions/efficient points, stochastic approximation and gradient procedures and differentiation formulas for probabilities and expectations. In the third edition, this book further develops stochastic optimization methods. In particular, it now shows how to apply stochastic optimization methods to the approximate solution of important concrete problems arising in engineering, economics and operations research.

On the Theoretical Foundations of Stochastic Reduced Basis Methods

The book deals with several closely related topics concerning approximations and perturbations of random processes and their applications to some important and fascinating classes of problems in the analysis and design of stochastic control systems and nonlinear filters. The basic mathematical methods which are used and developed are those of the theory of weak convergence. The techniques are quite powerful for getting weak convergence or functional limit theorems for broad classes of problems and many of the techniques are new. The original need for some of the techniques which are developed here arose in connection with our study of the particular applicability of this book, and related problems of approximation in control theory, but it will be clear that they have numerous applications elsewhere. The second part of the book is a continuation of the author's ongoing work in the approximation of stochastic processes and its applications to problems arising in control and communication theory and related areas. In fact, the techniques used here can be fruitfully applied to many other areas. The basic random processes of interest can be described by solutions to either (multiple time scale) Lto differential equations driven by small state dependent white noise, or which are singularly perturbed. They might be controlled or not, and their state values might be fully observable or not (e.g., in the nonlinear filtering problem).

Stochastic Networked Control Systems

A stochastic Grammar of Image is the first book to provide a foundational review and perspective of grammatical approaches to computer vision in its quest for a stochastic and context-sensitive analysis of images, it is intended to serve as a reference work for researchers working in a large number of object categories. It starts out by addressing the historical trends in the area and overviewing the main concepts such as the and or graph the parallel and the dictionary and goes on to learning issues, semantic gaps between symbols and pixels dataset for learning and algorithms. The proposal grammar presented integrates three prominent representations in the literature stochastic grammar for composition, Markov (or graphical) models for contexts, and sparse coding with primitives (wavelets). It also combines the structure-based and appearance-based methods in the vision literature. At the end of the review three case studies are presented to illustrate the proposed grammar. A Stochastic Grammar of Images is an important contribution to the literature on structured statistical models in computer vision.
Foundations of Stochastic Analysis

This book gives an introduction to the mathematical theory of cooperative behavior in active systems of various origins, both natural and artificial. It is based on a lecture course in synergics which I held for almost ten years at the University of Moscow. The first volume deals mainly with the problems of pattern formation and the properties of self-organized regular patterns in distributed active systems. It also contains a discussion of distributed analog information processing which is based on the cooperative dynamics of active systems. The second volume is devoted to the stochastic aspects of self-organization and the properties of self-established chaos. I have tried to avoid delving into particular applications. The primary intention is to present general mathematical models that describe the principal kinds of cooperativa behavior in distributed active systems. Simple examples, ranging from chemical to economics, serve only as illustrations of the typical context in which a particular model can apply. The manner of exposition is more in the tradition of theoretical physics than of mathematicians. Elaborate formal proofs and rigorous estimates are often replaced in the text by arguments based on an intuitive understanding of the relevant models. Because of the interdisciplinary nature of this book, its readers might well come from very diverse fields of endeavor. It was therefore desirable to minimize the required preliminary knowledge. Generally, a standard university course in differential calculus and linear algebra is sufficient.

Trends in Stochastic Analysis

A new edition of a graduate-level machine learning textbook that focuses on the analysis and theory of algorithms. This book is a new introduction to machine learning that can serve as a textbook for graduate students and a reference for researchers. It covers fundamental modern topics in machine learning while providing a self-contained and comprehensive treatment of algorithms. It also describes several key aspects of the application of these algorithms. The authors aim to present novel theoretical tools and concepts while giving concise proofs even for relatively advanced topics. Foundations of Machine Learning is unique in its dimensionality and theory of algorithms. The first four chapters lay the theoretical foundation for what follows. The next six chapters include the Probably Approximately Correct (PAC) learning framework, generalization bounds based on Rademacher complexity and VC-dimension; Support Vector Machines (SVMs); kernel methods; boosting; on-line learning; multi-class classification; ranking; regression; algorithmic stability; dimensionality reduction; learning automata and languages; and reinforcement learning. Each chapter ends with a set of exercises. This second edition offers additional chapters on new and changing concepts. New material in the appendices includes a major section on Fenchel duality, expanded coverage of concentration inequalities, and an entirely new entry on information theory. More than half of the exercises are new to this edition.

Weak Convergence Methods and Singularity Perturbed Stochastic Control and Filtering Problems

Stochastic Simulation and Applications in Finance with MATLAB Programs explains the fundamentals of Monte Carlo simulation techniques, their use in the numerical resolution of stochastic differential equations and their current applications in finance. Building on an integrated approach, it provides a pedagogical treatment of the need-to-know materials in risk management and financial engineering. This book takes readers through the basic concepts, covering the most recent research and problems in the area, including: the quadratic re-sampling technique, the Least Squared Method, the dynamic programming and Stratified States and price American options and the retrieval of the optimal exercise strategy to estimate Greeks. The authors also present modern term structure of interest rate models and pricing swaptions with the BGM market model, and give a full explanation of the use of variance reduction techniques. The text is richly illustrated based on the structural approach of Merton. Case studies on financial guarantees illustrate how to implement the simulation techniques in pricing and hedging. NOTE TO READER: The CD has been converted to URL. Go to the following website: www.wiley.com/go/huyhnsthocatic which provides MATLAB programs for the practical examples and case studies, which will give the reader confidence in using and adapting specific ways to solve problems involving stochastic processes in finance.

Stochastic Algorithms: Foundations and Applications

This monograph presents the main complexity theorems in convex optimization and their corresponding algorithms, which begins with the fundamental theory of black-box optimization and proceeds to guide the reader through recent advances in structural optimization and stochastic optimization. The presentation of black-box optimization, strongly influenced by the seminal book by Nemeter, includes the analysis of cutting plane methods, as well as (accelerated) gradient descent schemes, which are also given to n-dimensional problems in the Euclidean space, in d-dimensional spaces, and in general analytic manifolds, and discussing their relevance in machine learning. The text provides a gentle introduction to structural optimization with FISTA (to optimize a sum of a smooth and a simple non-smooth term), saddle-point mirror prox (Nemeter’s alternative to Nemeter’s smoothing), and a concise description of interior point methods. In stochastic optimization and randomized gradient descent, and subgradient methods. The text also briefly touches upon convex relaxation of combinatorial problems and the use of randomness to round solutions, as well as random walk based methods.

Optimization Under Stochastic Uncertainty

The increasing industrial demand for reliable quantitative and management of uncertainty in product performance forces engineers to employ probabilistic models in analysis and design, a fact that has occasioned considerable research and development activities in the field. Notes on Stochastics eventually address the topic of stochastic optimization. The single volume uniquely presents tutorials on essential probabilistics and statistics, recent finite element methods for stochastic analysis by Taylor series expansion as well as Monte Carlo simulation techniques. Design improvement and robust optimization represent key issues as does reliability. The subject of Chapter 2 is modeling of elastic and elasto-plastic solids and large displacements and rotations in finite deformation processes; principles are transferable to various disciplines. A chapter is devoted to the statistical comparison of systems exhibiting random scatter. Where appropriate examples illustrate the theory, problems to solve appear instructive; applications are presented with relevance to engineering practice. The book’s volume offers a core course in the analysis and optimization of computational and decision-making models and advanced engineering education. It is intended for advanced students in engineering and for professionals who wish to extend their knowledge and skills in computational mechanics to the domain of stochastics.

Contents: Introduction, Randomness, Structural analysis by Taylor series expansion, Design optimization, Robustness, Monte Carlo techniques for system response and design improvement, Reliability, Time variant phenomena, Material deformation processes, Analysis and comparison of data sets, Probability distribution of test functions.

Simulation and the Monte Carlo Method

This book examines application and methods to incorporating stochastic parameter variations into the optimization process to decrease expense in corrective measures. Basic types of deterministic substitute problems occurring mostly in practice involve i) minimization of the expected primary costs subject to expected recourse cost constraints (reliability constraints) and remaining deterministic constraints, e.g. box constraints, as well as ii) minimization of the expected total costs (costs of construction, design, recourse costs, etc.) subject to the remaining deterministic constraints. After an introduction into the theory of dynamic control systems with random parameters, the major control laws are described, as open-loop control, closed-loop, feedback control and open-loop feedback control, used for iterative construction of feedback controls. For approximate solution of optimization and control problems with random parameters and involving expected cost/loss-type objective, constraint functions, Taylor expansion procedures, and Homotopy methods are considered. Examples and applications to stochastic optimization of regulators are given. Moreover, for reliability-based analysis and optimal design problems, corresponding optimization-based limit state functions are considered, and the complexity of reliability problems and their lack of the mathematical model is emphasized, in particular, for optimization by Monte Carlo techniques, other optimization techniques, like random search methods (RSM) became increasingly important. Basic results on the convergence and stability of random search methods are presented. Moreover, for the improvement of the - sometimes very low - convergence rate of RSM, search methods based on optimal stochastic decision processes are presented. In order to improve the convergence behavior of RSM, the random search procedure is embedded into a stochastic decision process for an optimal control of the probability distributions of the search variables (mutation random variables).

Foundations and Methods of Stochastic Simulation

Networked control systems are increasingly ubiquitous today, with applications ranging from vehicle communication and adaptive power grids to space exploration and more. The design of such systems requires the application of tools from various disciplines, including electrical engineering, control theory, and applied mathematics such as decentralized control, stochastic control, information theory, and quantization. A thorough, self-contained book, Stochastic Networked Control Systems: Stabilization and Optimization under Information Constraints aims to help designers develop these diverse disciplines with precision and rigor, while describing design guidelines to solve the problems of interest in the literature. It lays a comprehensive theoretical foundation for the study of networked control systems, and introduces an array of concrete tools for use in the field. salient features included: - Characterization, comparison and optimal design of information structures in static and dynamic systems. - Characterization and comparison of structural and topological properties of information structures in optimal decision making, with a systematic program for generating optimal structures. - The notion of structural stability and its utilization in the design and optimization of information networks. - Mathematical methods for stochastic stability analysis of networked control systems using random-time, state-dependent drift conditions and martingale methods. - Characterization and study of information channels leading to various forms of stochastic stability such as stationarity, ergodicity, and quadratic stability; and connections with information and quantization theories. Analysis of various classes of centralized and decentralized control systems. - Jointly optimal design of encoding and control policies over various information channels and under general optimization criteria, including a detailed coverage of linear-quadratic-Gaussian models. - Decentralized agreement and dynamic optimization under information constraints. This monograph is geared toward a broad audience of academic and industrial researchers interested in control theory, information theory, communication, and applied mathematics. It could likewise serve as a supplemental text for students.
Stochastic Simulation: Algorithms and Analysis

From the reviews: "Paul Glasserman has written an astonishingly good book that bridges financial engineering and the Monte Carlo method. The book will appeal to graduate students, researchers, and most of all, practicing financial engineers! So often, financial engineering texts are very theoretical. This book is not." —Glyn Holton, Contingency Analysis

Stochastic Processes

This book constitutes the refereed proceedings of the Third International Symposium on Stochastic Algorithms: Foundations and Applications, SAGA 2005, held in Moscow, Russia in October 2005. The 14 revised full papers presented together with 5 invited papers were carefully reviewed and selected for inclusion in the book.

A Stochastic Grammar of Images

This accessible new edition explores the major topics in Monte Carlo simulation that have arisen over the past 30 years and presents a sound foundation for problem solving Simulation and the Monte Carlo Method, Third Edition reflects the latest developments in the field and presents a fully updated and comprehensive account of the state-of-the-art theory, methods and applications that have emerged in Monte Carlo simulation since the publication of the classic First Edition over more than a quarter of a century ago. While maintaining its accessible and intuitive approach, this revised edition features a wealth of up-to-date information that facilitates a deeper understanding of problem solving across a wide array of subject areas, such as engineering, statistics, computer science, mathematics, and the physics of disordered systems.

Methods and Models in Mathematical Biology

Readership: Undergraduate and researchers in probability and statistics; applied, pure and financial mathematics; economics; chaos.

Foundations of Data Science

This book describes the mathematical underpinnings of algorithms used for molecular dynamics simulation, including both deterministic and stochastic numerical methods. Multilevel Monte Carlo method • New enhancements of the cross-entropy (CE) method, including the “improved” CE method, which uses sampling from the zero-variance distribution to find the optimal importance sampling parameters • Over 100 algorithms in modern pseudo code with flow control • Over 25 new exercises Simulation and the Monte Carlo Method, Third Edition is an excellent text for upper-undergraduate and beginning graduate courses in stochastic simulation and Monte Carlo techniques. The book also serves as a valuable reference for professionals who would like to achieve a more formal understanding of the Monte Carlo method.

Stochastic Modeling

This is a textbook for advanced undergraduate students and beginning graduate students in applied mathematics. It presents the basic mathematical foundations of stochastic analysis (probability theory and stochastic processes) as well as some important practical tools and applications (e.g., the connection with differential equations, numerical methods, path integrals, random fields, statistical physics, chemical kinetics, and rare events). The book strikes a nice balance between mathematical formalism and intuitive arguments, a style that is most suited for applied mathematicians. Readers can learn both the rigorous treatment of stochastic analysis as well as practical applications in modeling and simulation. Numerous exercises nicely supplement the main exposition.

Stochastic Optimization Methods

This book provides an introduction to the mathematical and algorithmic foundations of data science, including machine learning, high-dimensional geometry, and analysis of large networks. Topics include the counterintuitive nature of data in high dimensions, important linear algebraic techniques such as singular value decomposition; the theory of random walks and Markov chains, the fundamentals of and important algorithms for machine learning, algorithms and analysis for clustering, probabilistic models for large networks, representation learning including topic modelling and non-negative matrix factorization, wavelets and compressed sensing. Important probabilistic techniques are developed including the law of large numbers, tail inequalities, analysis of random projections, generative models, denoising, estimation of sparse vectors, and matrix completion.

Methods of Mathematical Finance

This book develops the theory of continuous and discrete stochastic processes within the context of cell biology. A wide range of biological topics are covered.
including normal and anomalous diffusion in complex cellular environments, stochastic ion channels and excitable systems, stochastic calcium signaling, molecular motors, intracellular transport, signal transduction, bacterial chemotaxis, robustness in gene networks, genetic switches and oscillators, cell polarization, polymerization, cellular length control, and branching processes. The book also provides a pedagogical introduction to the theory of stochastic processes - Fokker Planck equations, stochastic differential equations, master equations and jump Markov processes, diffusion approximations and the system size expansion, first passage times, stochastic hybrid systems, mode-hopping master equations, stochastic chemical reactions, and processes, Wick-boson stochastic calculus, and numerical methods. This text is primarily aimed at graduate students and researchers working in mathematical biology and applied mathematicians interested in stochastic modeling. Applied probabilists and theoretical physicists should also find it of interest. It assumes no prior background in statistical physics and introduces concepts in stochastic processes via motivating biological applications. The book is highly illustrated and contains a large number of examples and exercises that further develop the models and ideas in the body of the text. It is based on a course that the author has taught at the University of Utah for many years.

Stochastic Simulation and Applications in Finance with MATLAB Programs

This sequel to Brownian Motion and Stochastic Calculus by the same authors develops contingent claim pricing and optimal consumption/investment in both complete and incomplete markets, within the context of Brownian-motion-driven asset prices. The latter topic is extended to a study of equilibrium, providing conditions for existence and uniqueness of market prices which support trading by several heterogeneous agents. Although much of the incomplete-market material is available in research papers, these topics are treated for the first time in a unified manner. The book contains an extensive set of references and notes describing the field, including tools not treated in the book. This book will be of interest to researchers wishing to see advanced mathematics applied to finance. The material on optimal consumption and investment, leading to equilibrium, is addressed to the theoretical finance community. The chapters on contingent claim valuation present techniques of practical importance, especially for pricing exotic options.

Stochastic Systems

Stochastic Calculus

This volume considers fundamental theories and contrasts the natural interplay between real and abstract methods. No prior knowledge of probability is assumed. Numerous problems, most with hints. 1981 edition.

Fundamentals of Stochastic Filtering

This book developed from classes in mathematical biology taught by the authors over several years at the Technische Universität München. The main themes are modeling principles, mathematical principles for the analysis of these models and model-based analysis of data. The key topics of modern biomathematics are covered: topology, biochemistry, regulatory networks, neuronal networks and population genetics. A variety of mathematical methods are introduced, ranging from ordinary and partial differential equations to stochastic graph theory and branching processes. A special emphasis is placed on the interplay between stochastic and deterministic models.

Foundations of Constructive Probability Theory

Collecting information previously scattered throughout the vast literature, including the author’s own research, Stochastic Relations: Foundations for Markov Transition Networks (providing the theory of stochastic relations as a basis for Markov transition systems. After an introduction to the basic mathematical tools from topology, measure theory, and categories, the book examines the central topics of congruences and morphisms, applies these to the monoidal structure, and defines bisimilarity and behavioral equivalence within this framework. The author views developments from the general theory of coalgebras in the context of the subprobability functor. These tools show that bisimilarity and behavioral and logical equivalence are the same for general modal logics and for continuous time stochastic logic with and without a fixed point operator. With numerous problems and several case studies, this book is an invaluable study of an important aspect of computer science theory.

Convex Optimization

This compact yet thorough text zeros in on the parts of the theory that are particularly relevant to applications. It begins with a description of Brownian motion and the associated stochastic calculus, including their relationship to partial differential equations. It solves stochastic differential equations by a variety of methods and studies in detail the one-dimensional case. The book concludes with a treatment of semigroups and generators, applying the theory of Harris chains to diffusions, and presenting a quick course in weak convergence of Markov chains to diffusions. The presentation is unparalleled in its clarity and simplicity. Whether your students are interested in probability, analysis, differential geometry or applications in operations research, physics, finance, or the many other areas to which the subject applies, you’ll find that this text brings together the material you need to effectively and efficiently impart the practical background they need.

Stochastic Processes in Cell Biology

Since its origins in the 1940s, the subject of decision making under uncertainty has grown into a diversified area with application in several branches of engineering and in those areas of the social sciences concerned with policy analysis and prescription. These approaches required a computing capacity too expensive for the time, until the ability to collect and process huge quantities of data engendered an explosion of work in the area. This book provides succinct and rigorous treatment of the foundations of stochastic control; a unified approach to filtering, estimation, prediction, and stochastic and adaptive control; and the conceptual framework necessary to understand current trends in stochastic control, data mining, machine learning, and robotics.

Stochastic Local Search

This graduate-level text covers modeling, programming and analysis of simulation experiments and provides a rigorous treatment of the foundations of simulation and why it works. It introduces object-oriented programming for simulation, covers both the probabilistic and statistical basis for simulation in a rigorous but accessible manner (providing all necessary background material); and provides a modern treatment of experiment design and analysis that goes beyond classical statistics. The book emphasizes essential foundations throughout, rather than providing a compendium of algorithms and theorems and prepares the reader to use simulation in research as well as practice. The book is a rigorous, but concise treatment, emphasizing lastling principles but also providing specific training in modeling, programming and analysis. In addition to teaching readers how to do simulation, it also prepares them to use simulation in their research; no other book does this. An online solutions manual for end of chapter exercises is also be provided.

Foundations of Synergetics

Sampling-based computational methods have become a fundamental part of the numerical toolset of practitioners and researchers across an enormous number of different applied domains and academic disciplines. This book provides a broad treatment of such sampling-based methods, as well as accompanying mathematical analysis of the convergence properties of the methods discussed. The reach of the ideas is illustrated by discussing a wide range of applications and the models that have found wide usage. The first half of the book focuses on general methods; the second half discusses model-specific algorithms. Exercises and illustrations are included.

Handbook of Stochastic Methods for Physics, Chemistry, and the Natural Sciences

This book provides a rigorous mathematical treatment of the non-linear stochastic filtering problem using modern methods. Particular emphasis is placed on the theoretical analysis of numerical methods for the solution of the filtering problem via particle methods. The book should provide sufficient background to enable study of the recent literature. While no prior knowledge of stochastic filtering is required, readers are assumed to be familiar with measure theory, probability theory, and the basics of stochastic processes. Most of the technical results that are required are stated and proved in the appendices. Exercises and solutions are included.

Stochastic Algorithms: Foundations and Applications

A ‘stochastic’ process is a ‘random’ or ‘conjectural’ process, and this book is concerned with applied probability and statistics. Whilst maintaining the mathematical rigour this subject requires, it addresses topics of interest to engineers, such as problems in modelling, control, reliability maintenance, data analysis and engineering involvement with insurance. This book deals with the tools and techniques used in the stochastic process - estimation, optimisation and recursive logarithms - in a form accessible to engineers and which can also be applied to Matlab. Amongst the themes covered in the chapters are mathematical expectation arising from increasing information patterns, the estimation of probability distributions, the treatment of distribution of real random phenomena (in engineering,
Foundations of Machine Learning, second edition

Stochastic local search (SLS) algorithms are among the most prominent and successful techniques for solving computationally difficult problems. Offering a systematic treatment of SLS algorithms, this book examines the general concepts and specific instances of SLS algorithms and considers their development, analysis and application.

Foundations and Methods of Stochastic Simulation

In various scientific and industrial fields, stochastic simulations are taking on a new importance. This is due to the increasing power of computers and practitioners’ aim to simulate more and more complex systems, and thus use random parameters as well as random noises to model the parametric uncertainties and the lack of knowledge on the physics of these systems. The error analysis of these computations is a highly complex mathematical undertaking. Approaching these issues, the authors present stochastic numerical methods and prove accurate convergence rate estimates in terms of their numerical parameters (number of simulations, time discretization steps). As a result, the book is a self-contained and rigorous study of the numerical methods within a theoretical framework. After briefly reviewing the basics, the authors first introduce fundamental notions in stochastic calculus and continuous-time martingale theory, then develop the analysis of pure-jump Markov processes, Poisson processes, and stochastic differential equations. In particular, they review the essential properties of Itô integrals and prove fundamental results on the probabilistic analysis of parabolic partial differential equations. These results in turn provide the basis for developing stochastic numerical methods, both from an algorithmic and theoretical point of view. The book combines advanced mathematical tools, theoretical analysis of stochastic numerical methods, and practical issues at a high level, so as to provide optimal results on the accuracy of Monte Carlo simulations of stochastic processes. It is intended for master and Ph.D. students in the field of stochastic processes and their numerical applications, as well as for physicists, biologists, economists and other professionals working with stochastic simulations, who will benefit from the ability to reliably estimate and control the accuracy of their simulations.

Essentials of Stochastic Finance

The present lecture notes describe stochastic epidemic models and methods for their statistical analysis. Our aim is to present ideas for such models, and methods for their analysis; along the way we make practical use of several probabilistic and statistical techniques. This will be done without focusing on any specific disease, and instead rigorously analyzing rather simple models. The reader of these lecture notes could thus have a two-fold purpose in mind: to learn about epidemic models and their statistical analysis, and/or to learn and apply techniques in probability and statistics. The lecture notes require an early graduate level knowledge of probability and They introduce several techniques which might be new to students, but our statistics. intention is to present these keeping the technical level at a minimum. Techniques that are explained and applied in the lecture notes are, for example: coupling, diffusion approximation, random graphs, likelihood theory for counting processes, martingales, the EM-algorithm and MCMC methods. The aim is to introduce and apply these techniques, thus hopefully motivating their further theoretical treatment. A few sections, mainly in Chapter 5, assume some knowledge of weak convergence; we hope that readers not familiar with this theory can understand the these parts at a heuristic level. The text is divided into two distinct but related parts: modelling and estimation.

Foundations of Deterministic and Stochastic Control

Presenting important trends in the field of stochastic analysis, this collection of thirteen articles provides an overview of recent developments and new results. Written by leading experts in the field, the articles cover a wide range of topics, ranging from an alternative set-up of rigorous probability to the sampling of conditioned diffusions. Applications in physics and biology are treated, with discussion of Feynman formulas, intermittency of Anderson models and genetic inference. A large number of the articles are topical surveys of probabilistic tools such as chaining techniques, and of research fields within stochastic analysis, including stochastic dynamics and multifractal analysis. Showcasing the diversity of research activities in the field, this book is essential reading for any student or researcher looking for a guide to modern trends in stochastic analysis and neighbouring fields.

Stochastic Epidemic Models and Their Statistical Analysis

This book has a dual purpose: serving as an advanced textbook designed to prepare doctoral students to do research on the mathematical foundations of inventory theory, and as a reference work for those already engaged in such research. All chapters conclude with exercises that either solidify or extend the concepts introduced.

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