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Introduction to the Theory of Random Processes Numerical Solution of Stochastic Differential Equations Brownian Motion Probability and Related Topics in Physical Sciences Stochastic Travelling Waves Driven by One-dimensional Wiener Processes A Benchmark Approach to Quantitative Finance An Introduction to Continuous-Time Stochastic Processes Counterexamples in Probability Quantitative Methods in Derivatives Pricing A Concise Course on Stochastic Partial Differential Equations The Black–Scholes Model Computational Intelligence Applications to Option Pricing, Volatility Forecasting and Value at Risk Stochastic Analysis and Diffusion Processes Almost Periodic Stochastic Processes Stationary Stochastic Models: An Introduction Stochastic Flows and Jump-Diffusions Tools for Computational Finance Stochastic Equations in Infinite Dimensions Séminaire de Probabilités XLVIII Probabilistic Numerics Oblivious Network Routing Stochastic PDEs and Dynamics Stochastic Processes Probability and Random Processes for Electrical and Computer Engineers Quantile Processes with Statistical Applications Numerical Solution of Stochastic

Differential Equations with Jumps in Finance Probability Methods for Approximations in Stochastic Control and for Elliptic Equations Stochastic Partial Differential Equations with Lévy Noise Random Processes by Example The Volterra and Wiener Theories of Nonlinear Systems Séminaire de Probabilités XLIII Statistics of Random Processes II Application of Stochastic Calculus to Option Pricing Intelligent Systems in Oil Field Development under Uncertainty Finance with Monte Carlo An Introduction to the Mathematical Structure of Quantum Mechanics Stochastic Methods in the Dynamics of Satellites Stochastic Lagrangian Models of Turbulent Diffusion Pattern Theory Physical and mathematical justification of scientific achievements

In financial and actuarial modeling and other areas of application, stochastic differential equations with jumps have been employed to describe the dynamics of various state variables. The numerical solution of such equations is more complex than that of those only driven by Wiener processes, described in Kloeden & Platen: Numerical Solution of Stochastic Differential Equations (1992). The present monograph builds on the above-mentioned work and provides an introduction to stochastic differential equations with jumps, in both theory and application, emphasizing the numerical methods needed to solve such equations. It presents many new results on higher-order methods for scenario and Monte Carlo simulation, including implicit, predictor corrector, extrapolation, Markov chain and variance reduction methods, stressing the importance of their numerical stability.

Furthermore, it includes chapters on exact simulation, estimation and filtering. Besides serving as a basic text on quantitative methods, it offers ready access to a large number of potential research problems in an area that is widely applicable and rapidly expanding. Finance is chosen as the area of application because much of the recent research on stochastic numerical methods has been driven by challenges in quantitative finance. Moreover, the volume introduces readers to the modern benchmark approach that provides a general framework for modeling in finance and insurance beyond the standard risk-neutral approach. It requires undergraduate background in mathematical or quantitative methods, is accessible to a broad readership, including those who are only seeking numerical recipes, and includes exercises that help the reader develop a deeper understanding of the underlying mathematics. This volume first introduces the mathematical tools necessary for understanding and working with a broad class of applied stochastic models. The toolbox includes Gaussian processes, independently scattered measures such as Gaussian white noise and Poisson random measures, stochastic integrals, compound Poisson, infinitely divisible and stable distributions and processes. Next, it illustrates general concepts by handling a transparent but rich example of a OC teletraffic modelOCO. A minor tuning of a few parameters of the model leads to different workload regimes, including Wiener process, fractional Brownian motion and stable L(r)vy process. The simplicity of the dependence mechanism used in the model enables us to get a clear understanding of long and short range dependence phenomena. The model also shows how light or heavy distribution tails lead to continuous Gaussian processes or to processes with jumps in the limiting regime. Finally, in this volume, readers will find discussions on the multivariate extensions that admit a variety of completely different applied interpretations. The reader will quickly become familiar with key concepts that form a language for many major probabilistic models of real world phenomena but are often neglected in more traditional courses of stochastic processes. Sample Chapter(s). Chapter 1: Preliminaries (367 KB). Contents: Preliminaries: Random Variables: A Summary; From Poisson to Stable Variables; Limit Theorems for Sums and Domains of Attraction; Random Vectors; Random Processes: Random Processes: Main Classes; Examples of Gaussian Random Processes; Random Measures and Stochastic Integrals; Limit Theorems for Poisson Integrals; L(r)vy Processes; Spectral Representations; Convergence of Random Processes; Teletraffic Models: A Model of Service System; Limit Theorems for the Workload; Micropulse Model; Spacial Extensions. Readership: Graduate students and researchers in probability & statist "While most mathematical examples illustrate the truth of a statement, counterexamples demonstrate a statement's falsity. Enjoyable topics of study, counterexamples are valuable tools for teaching and learning. The definitive book on the subject in regards to probability, this third edition features the author's revisions and corrections plus a substantial new appendix. 2013 edition"-- The Black–Scholes option pricing model is the first and by far the best-known continuous-time mathematical model used in mathematical finance. Here, it provides a sufficiently complex, yet tractable, testbed for exploring the basic methodology of option pricing. The discussion of extended markets, the careful attention paid to the requirements for admissible trading strategies, the development of pricing formulae for many widely traded instruments and the additional complications offered by multi-stock models will appeal to a wide class of instructors. Students, practitioners and researchers alike will benefit from the book's rigorous, but unfussy, approach to technical issues. It highlights potential pitfalls, gives clear motivation for results and techniques and includes carefully chosen examples and exercises, all of which make it suitable for self-study. In addition to its further exploration of the subject of peacocks, introduced in recent Séminaires de Probabilités, this volume continues the series' focus on current research themes in traditional topics such as stochastic calculus, filtrations and random matrices. Also included are some particularly interesting articles involving harmonic measures, random fields and loop soups. The featured contributors are Mathias Beiglböck, Martin Huesmann and Florian Stebegg, Nicolas Juillet, Gilles Pags, Dai Taguchi, Alexis Devulder, Mátyás Barczy and Peter Kern, I. Bailleul, Jürgen Angst and Camille Tardif, Nicolas Privault, Anita Behme, Alexander Lindner and Makoto Maejima, Cédric Lecouvey and Kilian Raschel, Christophe Profeta and Thomas Simon, O. Khorunzhiy and Songzi Li, Franck Maunoury, Stéphane Laurent, Anna Aksamit and Libo Li, David Applebaum, and Wendelin Werner. "Written by two renowned experts in the field, the books under review contain a thorough and insightful treatment of the fundamental underpinnings of various aspects of stochastic processes as well as a wide range of applications. Providing clear exposition, deep mathematical results, and superb technical representation, they are masterpieces of the subject of stochastic analysis and nonlinear filtering....These books...will become classics." --SIAM REVIEW This text introduces upper division undergraduate/beginning graduate students in mathematics, finance, or economics, to the core topics of a beginning course in finance/financial engineering. Particular emphasis is placed on exploiting the power of the Monte Carlo method to illustrate and explore financial principles. Monte Carlo is the uniquely appropriate tool for modeling the random factors that drive financial markets and simulating their implications. The Monte Carlo method is introduced early and it is used in conjunction with the geometric Brownian motion model (GBM) to illustrate and analyze the topics covered in the remainder of the text. Placing focus on Monte Carlo methods allows for students to travel a short road from theory to practical applications. Coverage includes investment science, mean-variance portfolio theory, option pricing principles, exotic options, option trading strategies, jump diffusion and exponential Lévy alternative models, and the Kelly criterion for maximizing investment growth. Novel features: inclusion of both portfolio theory and contingent claim analysis in a single text pricing methodology for exotic options expectation analysis of option trading strategies pricing models that transcend the Black–Scholes framework optimizing investment allocations concepts thoroughly explored through numerous simulation exercises numerous worked examples and illustrations The mathematical background required is a year and one-half course in calculus, matrix algebra covering solutions of linear systems, and a knowledge of probability including expectation, densities and the normal distribution. A refresher for these topics is presented in the Appendices. The programming background needed is how to code branching, loops and subroutines in some mathematical or general purpose language. The mathematical background required is a year and one-half course in calculus, matrix algebra covering solutions of linear systems, and a knowledge of probability including expectation, densities and the normal distribution. A refresher for these topics is presented in the Appendices. The programming background needed is how to code branching, loops and subroutines in some mathematical or general purpose language. Also by the author: (with F. Mendivil) Explorations in Monte Carlo, ©2009, ISBN: 978-0-387-87836-2; (with J. Herod) Mathematical Biology: An Introduction with Maple and Matlab, Second edition, ©2009, ISBN: 978-0-387-70983-3. The decision to invest in oil field development is an extremely complex problem, even in the absence of uncertainty, due to the great number of technological alternatives that may be used, to the dynamic complexity of oil reservoirs - which involves mul- phase flows (oil, gas and water) in porous media with phase change, and to the c- plicated combinatorial optimization problem of choosing the optimal oil well network, that is, choosing the number and types of wells (horizontal, vertical, directional, m- tilateral) required for draining oil from a field with a view to maximizing its economic value. This problem becomes even more difficult when technical uncertainty and e- nomic uncertainty are considered. The former are uncertainties regarding the existence, volume and quality of a reservoir and may encourage an investment in information before the field is developed, in order to reduce these uncertainties and thus optimize the heavy investments required for developing the reservoir. The economic or market uncertainties are associated with the general movements of the economy, such as oil prices, gas demand, exchange rates, etc. , and may lead decision-makers to defer - vestments and wait for better market conditions. Choosing the optimal investment moment under uncertainty is a complex problem which traditionally involves dynamic programming tools and other techniques that are used by the real options theory. Tools for Computational Finance offers a clear explanation of computational issues arising in financial mathematics. The new third edition is thoroughly revised and significantly extended, including an extensive new section on analytic methods, focused mainly on interpolation approach and quadratic approximation. Other new material is devoted to risk-neutrality, early-exercise curves, multidimensional Black-Scholes models, the integral representation of options and the derivation of the Black-Scholes equation. New figures, more exercises, and expanded background material make this guide a real must-to-have for everyone working in the world of financial engineering. This book concentrates on some general facts and ideas of the theory of stochastic processes. The topics include the Wiener process, stationary processes, infinitely divisible processes, and Ito stochastic equations. Basics of discrete time martingales are also presented and then used in one way or another throughout the book. Another common feature of the main body of the book is using stochastic integration with respect to random orthogonal measures. In particular, it is used forspectral representation of trajectories of stationary processes and for proving that Gaussian stationary processes with rational spectral densities are components of solutions to stochastic equations. In the case of infinitely divisible processes, stochastic integration allows for obtaining arepresentation of trajectories through jump measures. The Ito stochastic integral is also introduced as a particular case of stochastic integrals with respect to random orthogonal measures. Although it is not possible to cover even a noticeable portion of the topics listed above in a short book, it is hoped that after having followed the material presented here, the reader will have acquired a good understanding of what kind of results are available and what kind of techniques are used toobtain them. With more than 100 problems included, the book can serve as a text for an introductory course on stochastic processes or for independent study. Other works by this author published by the AMS include, Lectures on Elliptic and Parabolic Equations in Holder Spaces and Introduction to the Theoryof Diffusion Processes. 'Pattern Theory' provides a comprehensice & accessible overview of the modern challenges in signal, data & pattern analysis in speech recognition, computational linguistics, image analysis & computer vision. Aimed at graduate students the text includes numerous exercises & an extensive bibliography. This text presents a complete and detailed development of the analysis, design and characterization of non-linear systems using the Volterra and Wiener theories, as well as gate functions, thus yielding new insights and a better comprehension of the subject. The Volterra and Wiener theories are useful in the study of systems in biological, mechanical, and electrical fields. Versatile solutions to routing network flows in unpredictable circumstances, presenting both mathematical tools and applications. Our increasingly integrated world relies on networks both physical and virtual to transfer goods and information. The Internet is a network of networks that connects people around the world in a real-time manner, but it can be disrupted by massive data flows, diverse traffic patterns, inadequate infrastructure, and even natural disasters and political conflict. Similar challenges exist for transportation and energy distribution networks. There is an urgent need for intelligent and adaptable routing of network flows, and a rich literature has evolved that treats “oblivious network design.” This book offers novel computational schemes for efficiently solving routing problems in unpredictable circumstances and proposes some real world applications for them. The versatile routing schemes mathematically guarantee long-term efficiency and are most appropriate for networks with non-deterministic (or oblivious) current and past states. After an introduction to network design and the importance of routing problems, the book presents mathematical tools needed to construct versatile routing schemes, emphasizing the role of linked hierarchical data structures, both top-down and bottom-up. It then describes two important applications of versatile routing schemes: a secure model for congestion-free content-centric networks (which will play a key role in the future of the Internet) and a novel approach for the distribution of green power resources on a smart electricity grid. Beginning with the concept of random processes and Brownian motion and building on the theory and research directions in a self-contained manner, this book provides an introduction to stochastic analysis for graduate students, researchers and applied scientists interested in stochastic processes and their applications. This is a new volume of the Séminaire de Probabilités which is now in its 43rd year. Following the tradition, this volume contains about 20 original research and survey articles on topics related to stochastic analysis. It contains an advanced course of J. Picard on the representation formulae for fractional Brownian motion. The regular chapters cover a wide range of themes, such as stochastic calculus and stochastic differential equations, stochastic differential geometry, filtrations, analysis on Wiener space, random matrices and free probability, as well as mathematical finance. Some of the contributions were presented at the Journées de Probabilités held in Poitiers in June 2009. Nothing provided The theory of probability is a powerful tool that helps electrical and computer engineers to explain, model, analyze, and design the technology they develop. The text begins at the advanced undergraduate level, assuming only a modest knowledge of probability, and progresses through more complex topics mastered at graduate level. The first five chapters cover the basics of probability and both discrete and continuous random variables. The later chapters have a more specialized coverage, including random vectors, Gaussian random vectors, random processes, Markov Chains, and convergence. Describing tools and results that are used extensively in the field, this is more than a textbook; it is also a reference for researchers working in communications, signal processing, and computer network traffic analysis. With over 300 worked examples, some 800 homework problems, and sections for exam preparation, this is an essential companion for advanced undergraduate and graduate students. Further resources for this title, including solutions (for Instructors only), are available online at www.cambridge.org/9780521864701. Ideal for courses aiming to give examples of the wide variety of empirical phenomena for which stochastic processes provide mathematical models. It introduces the methods of probability model building and provides the reader with mathematically sound techniques as well as the ability to further study the theory of stochastic processes. Probability Methods for Approximations in Stochastic Control and for Elliptic Equations This book presents a cogent description of the main methodologies used in derivatives pricing. Starting with a summary of the elements of Stochastic Calculus, Quantitative Methods in Derivatives Pricing develops the fundamental tools of financial engineering, such as scenario generation, simulation for European instruments, simulation for American instruments, and finite differences in an intuitive and practical manner, with an abundance of practical examples and case studies. Intended primarily as an introductory graduate textbook in computational finance, this book will also serve as a reference for practitioners seeking basic information on alternative pricing methodologies. Domingo Tavella is President of Octanti Associates, a consulting firm in risk management and financial systems design. He is the founder and chief editor of the Journal of Computational Finance and has pioneered the application of advanced numerical techniques in pricing and risk analysis in the financial and insurance industries. Tavella coauthored Pricing Financial Instruments: The Finite Difference Method. He holds a PhD in aeronautical engineering from Stanford University and an MBA in finance from the University of California at Berkeley. A framework for financial market modeling, the benchmark approach extends beyond standard risk neutral pricing theory. It permits a unified treatment of portfolio optimization, derivative pricing, integrated risk management and insurance risk modeling. This book presents the necessary mathematical tools, followed by a thorough introduction to financial modeling under the benchmark approach, explaining various quantitative methods for the fair pricing and hedging of derivatives. This eagerly awaited textbook covers everything the graduate student in probability wants to know about Brownian motion, as well as the latest research in the area. Starting with the construction of Brownian motion, the book then proceeds to sample path properties like continuity and nowhere differentiability. Notions of fractal dimension are introduced early and are used throughout the book to describe fine properties of Brownian paths. The relation of Brownian motion and random walk is explored from several viewpoints, including a development of the theory of Brownian local times from random walk embeddings. Stochastic integration is introduced as a tool and an accessible treatment of the potential theory of Brownian motion clears the path for an extensive treatment of intersections of Brownian paths. An investigation of exceptional points on the Brownian path and an appendix on SLE processes, by Oded Schramm and Wendelin Werner, lead directly to recent research themes. Provides a comprehensive theory of the approximations of quantile processes in light of recent advances, as well as some of their statistical applications. Now in its second edition, this book gives a systematic and self-contained presentation of basic results on stochastic evolution equations in infinite dimensional, typically Hilbert and Banach, spaces. In the first part the authors give a self-contained exposition of the basic properties of probability measure on separable Banach and Hilbert spaces, as required later; they assume a reasonable background in probability theory and finite dimensional stochastic processes. The second part is devoted to the existence and uniqueness of solutions of a general stochastic evolution equation, and the third concerns the qualitative properties of those solutions. Appendices gather together background results from analysis that are otherwise hard to find under one roof. This revised edition includes two brand new chapters surveying recent developments in the area and an even more comprehensive bibliography, making this book an essential and up-to-date resource for all those working in stochastic differential equations. These lectures concentrate on (nonlinear) stochastic partial differential equations (SPDE) of evolutionary type. There are three approaches to analyze SPDE: the "martingale measure approach", the "mild solution approach" and the "variational approach". The purpose of these notes is to give a concise and as self-contained as possible an introduction to the "variational approach". A large part of necessary background material is included in appendices. This volume provides a unified mathematical introduction to stationary time series models and to continuous time stationary stochastic processes. The analysis of these stationary models is carried out in time domain and in frequency domain. It begins with a practical discussion on stationarity, by which practical methods for obtaining stationary data are described. The presented topics are illustrated by numerous examples. Readers will find the following covered in a comprehensive manner:At the end, some selected topics such as stationary random fields, simulation of Gaussian stationary processes, time series for planar directions, large deviations approximations and results of information theory are presented. A detailed appendix containing complementary materials will assist the reader with many technical aspects of the book. This monograph presents a modern treatment of (1) stochastic differential equations and (2) diffusion and jump-diffusion processes. The simultaneous treatment of diffusion processes and jump processes in this book is unique: Each chapter starts from continuous processes and then proceeds to processes with jumps.In the first part of the book, it is shown that solutions of stochastic differential equations define stochastic flows of diffeomorphisms. Then, the relation between stochastic flows and heat equations is discussed. The latter part investigates fundamental solutions of these heat equations (heat kernels) through the study of the Malliavin calculus. The author obtains smooth densities for transition functions of various types of diffusions and jump-diffusions and shows that these density functions are fundamental solutions for various types of heat equations and backward heat equations. Thus, in this book fundamental solutions for heat equations and backward heat equations are constructed independently of the theory of partial differential equations.Researchers and graduate student in probability theory will find this book very useful. A thorough introduction to probabilistic numerics showing how to build more flexible, efficient, or customised algorithms for computation. Collective monograph The numerical analysis of stochastic differential equations (SDEs) differs significantly from that of ordinary differential equations. This book provides an easily accessible introduction to SDEs, their applications and the numerical methods to solve such equations. From the reviews: "The authors draw upon their own research and experiences in obviously many disciplines... considerable time has obviously been spent writing this in the simplest language possible." --ZAMP This book explains mathematical theories of a collection of stochastic partial differential equations and their dynamical behaviors. Based on probability and stochastic process, the authors discuss stochastic integrals, Ito formula and Ornstein-Uhlenbeck processes, and introduce theoretical framework for random attractors. With rigorous mathematical deduction, the book is an essential reference to mathematicians and physicists in nonlinear science. Contents: Preliminaries The stochastic integral and Itô formula OU processes and SDEs Random attractors Applications Bibliography Index This book lays the foundations for a theory on almost periodic stochastic processes and their applications to various stochastic differential equations, functional differential equations with delay, partial differential equations, and difference equations. It is in part a sequel of authors recent work on almost periodic stochastic difference and differential equations and has the particularity to be the first book that is entirely devoted to almost periodic random processes and their applications. The topics treated in it range from existence, uniqueness, and stability of solutions for abstract stochastic difference and differential equations. Expanding on the first edition of An Introduction to Continuous-Time Stochastic Processes, this concisely written book is a rigorous and self-contained introduction to the theory of continuous-time stochastic processes. A balance of theory and applications, the work features concrete examples of modeling real-world problems from biology, medicine, industrial applications, finance, and insurance using stochastic methods. No previous knowledge of stochastic processes is required. Comprehensive monograph by two leading international experts; includes applications to statistical and fluid mechanics and to finance. This book demonstrates the power of neural networks in learning complex behavior from the underlying financial time series data. The results presented also show how neural networks can successfully be applied to volatility modeling, option pricing, and value-at-risk modeling. These features mean that they can be applied to market-risk problems to overcome classic problems associated with statistical models. This book arises out of the need for Quantum Mechanics (QM) to be part of the common education of mathematics students. Rather than starting from the Dirac–Von Neumann axioms, the book offers a short presentation of the mathematical structure of QM using the C–-algebraic structure of the observable based on the operational definition of measurements and the duality between states and observables. The description of states and observables as Hilbert space vectors and operators is then derived from the GNS and Gelfand-Naimark Theorems. For finite degrees of freedom, the Weyl algebra codifies the experimental limitations on the measurements of position and momentum (Heisenberg uncertainty relations) and Schroedinger QM follows from the von Neumann uniqueness theorem. The existence problem of the dynamics is related to the self-adjointness of the differential operator describing the Hamiltonian and solved by the Rellich–Kato theorems. Examples are discussed which include the explanation of the discreteness of the atomic spectra. Because of the increasing interest in the relation between QM and stochastic processes, a final chapter is devoted to the functional integral approach (Feynman–Kac formula), the formulation in terms of ground state correlations (Wightman functions) and their analytic continuation to imaginary time (Euclidean QM). The quantum particle on a circle as an example of the interplay between topology and functional integral is also discussed in detail.

This book is intended to give atmospheric scientists a basic understanding of the physical and mathematical foundations of stochastic Lagrangian models of turbulent diffusion. It presents the reader with the historical context of the topic, and it provides definitions, criteria and applications for stochastic diffusion.