# Discretization Of Processes Stochastic Modelling And Applied Probability

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Abstract. This chapter develops discretization schemes for stochastic differential equations and their applications to the probabilistic numerical resolution of deterministic parabolic partial differential equations. It starts with some important properties of Itô’s Brownian stochastic calculus, and the existence and uniqueness theorem for stochastic differential equations with Lipschitz coefficients.

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This monograph by two leading experts in the field of stochastic processes will certainly become a standard reference when statistical questions in semimartingale models need to be investigated. The text is very well written and is without doubt a must have for scientists interested in applications of advanced stochastic process models.” (H. M. Mai, Zentralblatt MATH, Vol. 1259, 2013)

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In mathematics, the Ornstein–Uhlenbeck process is a stochastic process with applications in financial mathematics and the physical sciences. Its original application in physics was as a model for the velocity of a massive Brownian particle under the influence of friction. It is named after Leonard Ornstein and George Eugene Uhlenbeck.. The Ornstein–Uhlenbeck process is a stationary Gauss ...

**Ornstein–Uhlenbeck process - Wikipedia**

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Stochastic Modelling Central Limit Theorem (CLT), when possible The case of stochastic processes, and even stochastic dynamical systems, is of course more difficult, since often one is no 31 Discretization Schemes 63 32 Semimartingales with p-SummableJumps Sim.DiffProc: A Package for Simulation of Diffusion ...

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**Discretization of Processes | Jean Jacod | Springer**

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In applications, and especially in mathematical finance, random time-dependent events are often modeled as stochastic processes. Assumptions are made about the structure of such processes, and serious researchers will want to justify those assumptions through the use of data. As statisticians are wont to say, “In God we trust; all others must bring data.” This book establishes the theory of how to go about estimating not just scalar parameters about a proposed model, but also the underlying structure of the model itself. Classic statistical tools are used: the law of large numbers, and the central limit theorem. Researchers have recently developed creative and original methods to use these tools in sophisticated (but highly technical) ways to reveal new details about the underlying structure. For the first time in book form, the authors present these latest techniques, based on research from the last 10 years. They include new findings. This book will be of special interest to researchers, combining the theory of mathematical finance with its investigation using market data, and it will also prove to be useful in a broad range of applications, such as to mathematical biology, chemical engineering, and physics.

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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.

Covering formulation, algorithms, and structural results, and linking theory to real-world applications in controlled sensing (including social learning, adaptive radars and sequential detection), this book focuses on the conceptual foundations of partially observed Markov decision processes (POMDPs). It emphasizes structural results in stochastic dynamic programming, enabling graduate students and researchers in engineering, operations research, and economics to understand the underlying unifying themes without getting weighed down by mathematical technicalities. Bringing together research from across the literature, the book provides an introduction to nonlinear filtering followed by a systematic development of stochastic dynamic programming, lattice programming and reinforcement learning for POMDPs. Questions addressed in the book include: when does a POMDP have a threshold optimal policy? When are myopic policies optimal? How do local and global decision makers interact in adaptive decision making in multi-agent social learning where there is herding and data incest? And how can sophisticated radars and sensors adapt their sensing in real time?

There is an ever increasing need for modelling complex processes reliably. Computational modelling techniques, such as CFD and MD may be used as tools to study specific systems, but their emergence has not decreased the need for generic, analytical process models. Multiphase and multicomponent systems, and high-intensity processes displaying a highly complex behaviour are becoming omnipresent in the processing industry. This book discusses an elegant, but little-known technique for formulating process models in process technology: stochastic process modelling. The technique is based on computing the probability distribution for a single particle's position in the process vessel, and/or the particle's properties, as a function of time, rather than - as is traditionally done - basing the model on the formulation and solution of differential conservation equations. Using this technique can greatly simplify the formulation of a model, and even make modelling possible for processes so complex that the traditional method is impracticable. Stochastic modelling has sporadically been used in various branches of process technology under various names and guises.

This book gives, as the first, an overview of this work, and shows how these techniques are similar in nature, and make use of the same basic mathematical tools and techniques. The book also demonstrates how stochastic modelling may be implemented by describing example cases, and shows how a stochastic model may be formulated for a case, which cannot be described by formulating and solving differential balance equations. Introduction to stochastic process modelling as an alternative modelling technique Shows how stochastic modelling may be succesful where the traditional technique fails Overview of stochastic modelling in process technology in the research literature Illustration of the principle by a wide range of practical examples In-depth and self-contained discussions Points the way to both mathematical and technological research in a new, rewarding field

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 proceedings book discusses state-of-the-art research on uncertainty quantification in mechanical engineering, including statistical data concerning the entries and parameters of a system to produce statistical data on the outputs of the system. It is based on papers presented at Uncertainties 2020, a workshop organized on behalf of the Scientific Committee on Uncertainty in Mechanics (Mécanique et Incertain) of the AFM (French Society of Mechanical Sciences), the Scientific Committee on Stochastic Modeling and Uncertainty Quantification of the ABCM (Brazilian Society of Mechanical Sciences) and the SBMAC (Brazilian Society of Applied Mathematics).

The field of applied probability has changed profoundly in the past twenty years. The development of computational methods has greatly contributed to a better understanding of the theory. A First Course in Stochastic Models provides a self-contained introduction to the theory and applications of stochastic models. Emphasis is placed on establishing the theoretical foundations of the subject, thereby providing a framework in which the applications can be understood. Without this solid basis in theory no applications can be solved. Provides an introduction to the use of stochastic models through an integrated presentation of theory, algorithms and applications. Incorporates recent developments in computational probability. Includes a wide range of examples that illustrate the models and make the methods of solution clear. Features an abundance of motivating exercises that help the student learn how to apply the theory. Accessible to anyone with a basic knowledge of probability. A First Course in Stochastic Models is suitable for senior undergraduate and graduate students from computer science, engineering, statistics, operations resear ch, and any other discipline where stochastic modelling takes place. It stands out amongst other textbooks on the subject because of its integrated presentation of theory, algorithms and applications.

Stochastic Modeling of Scientific Data combines stochastic modeling and statistical inference in a variety of standard and less common models, such as point processes, Markov random fields and hidden Markov models in a clear, thoughtful and succinct manner. The distinguishing feature of this work is that, in addition to probability theory, it contains statistical aspects of model fitting and a variety of data sets that are either analyzed in the text or used as exercises. Markov chain Monte Carlo methods are introduced for evaluating likelihoods in complicated models and the forward backward algorithm for analyzing hidden Markov models is presented. The strength of this text lies in the use of informal language that makes the topic more accessible to non-mathematicians. The combinations of hard science topics with stochastic processes and their statistical inference puts it in a new category of probability textbooks. The numerous examples and exercises are drawn from astronomy, geology, genetics, hydrology, neurophysiology and physics.

This book constitutes the refereed proceedings of the 23rd International Conference on Analytical and Stochastic Modelling Techniques and Applications, ASMTA 2016, held in Cardiff, UK, in August 2016. The 21 full papers presented in this book were carefully reviewed and selected from 30 submissions. The papers discuss the latest developments in analytical, numerical and simulation algorithms for stochastic systems, including Markov processes, queueing networks, stochastic Petri nets, process algebras, game theory, etc.