Simulation And Inference For Stochastic Differential Equations With R Examples 1st Edition

Presents inference and simulation of stochastic process in the field of model calibration for financial times series modelled by continuous time processes and numerical option pricing. Introduces the bases of probability theory and goes on to explain how to model financial times series with continuous models, how to calibrate them from discrete data and further covers option pricing with one or more underlying assets based on these models. Analysis and implementation of models goes beyond the standard Black and Scholes framework and includes Markov switching models, Lévy models and other models with jumps (e.g. the telegraph process); Topics other than option pricing include: volatility and covariation estimation, change point analysis, asymptotic expansion and classification of financial time series from a statistical viewpoint. The book features problems with solutions and examples. All the examples and R code are available as an additional R package, therefore all the examples can be reproduced.

An overview of the techniques and practices involved in simulation-based inference.

Degradation of components and structures is a major threat to the safety and reliability of large engineering systems, such as the railway networks or the nuclear power plants. Periodic inspection and maintenance are thus required to ensure that the system is in good condition for continued service. A key element for the optimal inspection and maintenance is to accurately model and forecast the degradation progress, such that inspection and preventive maintenance can be scheduled accordingly. In recently years, probabilistic models based on stochastic process have become increasingly popular in degradation modelling, due to their flexibility in modelling both the temporal and sample uncertainties of the degradation. However, because of the often complex structure of stochastic degradation models, accurate estimate of the model parameters can be quite difficult, especially when the inspection data are noisy or incomplete. Not considering the effect of uncertain inspection data is likely to result in biased parameter estimates and therefore erroneous predictions of future degradation. The main objective of the thesis is to develop formal methods for the parameter estimation of stochastic degradation models using uncertain inspection data. Three typical stochastic models are considered. They are the random rate model, the gamma process model and the Poisson process model, among which the random rate model and the gamma process model are used to model the flaw growth, and the Poisson process model is used to model the flaw generation. Likelihood functions of the three stochastic models given noisy or incomplete inspection data are derived, from which maximum likelihood estimates can be obtained. The thesis also investigates Bayesian inference of the stochastic degradation models. The most notable advantage of Bayesian inference over classical point estimates is its ability to incorporate background information in the estimation process, which is especially useful when inspection data are scarce. A major obstacle for accurate parameter inference of stochastic models from uncertain inspection data is the computational difficulties of the likelihood evaluation, as it often involves calculation of high dimensional integrals or large number of convolutions. To overcome the computational difficulties, a number of numerical methods are developed in the thesis. For example, for the gamma process model subject to sizing error, an efficient maximum likelihood method is developed using the Genz's transform and quasi-Monte Carlo simulation. A Markov Chain Monte Carlo simulation with sizing error as auxiliary variables is developed for the Poisson flaw generation model, A sequential Bayesian updating using approximate Bayesian computation and weighted samples is also developed for Bayesian inference of the gamma process subject to sizing error. Examples on the degradation of nuclear power plant components are presented to illustrate the use of the stochastic degradation models using practical uncertain inspection data. It is shown from the examples that the proposed methods are very effective in terms of accuracy and computational efficiency.

Bayesian analysis of complex models based on stochastic processes has in recent years become a growing area. This book provides a unified treatment of Bayesian analysis of models based on stochastic processes, covering the main classes of stochastic processing including modeling, computational, inference, forecasting, decision making and important applied models. Key features: Explores Bayesian analysis of models based on stochastic processes, providing a unified treatment. Provides a thorough introduction for research students. Computational tools to deal with complex problems are illustrated along with real life case studies Looks at inference, prediction and decision making. Researchers, graduate and advanced undergraduate students interested in stochastic processes in fields such as statistics, operations research (OR), engineering, finance, economics, computer science and Bayesian analysis will benefit from reading this book. With numerous applications included, practitioners of OR, stochastic modelling and applied statistics will also find this book useful.

"Taken together, the body of information contained in this book provides readers with a bird's-eye view of different aspects of exciting work at the convergence of disciplines that will ultimately lead to a future where we understand how immunity is regulated, and how we can harness this knowledge toward practical ends that reduce human suffering. I commend the editors for putting this volume together." –Arup K. Chakraborty, Robert T. Haslam Professor of Chemical Engineering, and Professor of Physics, Chemistry, and Biological Engineering, Massachusetts Institute of Technology, Cambridge, USA New experimental techniques in immunology have produced large and complex data sets that require quantitative modeling for analysis. This book provides a complete overview of computational immunology, from basic concepts to mathematical modeling at the single molecule, cellular, organism, and population levels. It showcases modern mechanistic models and their use in making predictions, designing experiments, and elucidating underlying biochemical processes. It begins with an introduction to data analysis, approximations, and assumptions used in model building. Core chapters address models and methods for studying immune responses, with fundamental concepts clearly defined. Readers from immunology, quantitative biology, and applied physics will benefit from the following: Fundamental principles of computational immunology and modern quantitative methods for studying immune response at the single molecule, cellular, organism, and population levels. An overview of basic concepts in modeling and data analysis. Coverage of topics where mechanistic modeling has contributed substantially to current understanding. Discussion of genetic diversity of the immune system, cell signaling in the immune system, immune response at the cell population scale, and ecology of host-pathogen interactions.

The YUIMA package is the first comprehensive R framework based on S4 classes and methods which allows for the simulation of stochastic differential equations driven by Wiener process, Lévy processes or fractional Brownian motion, as well as CARMA, COGARCH, and Point processes. The package performs various central statistical analyses such as quasi maximum likelihood estimation, adaptive Bayes estimation, structural change point analysis, hypotheses testing, asynchronous covariance estimation, lead-lag estimation, LASSO model selection, and so on. YUIMA also supports stochastic numerical analysis by fast computation of the expected value of functionals of stochastic processes through automatic asymptotic expansion by means of the Malliavin calculus. All models can be multidimensional, multiparametric or non parametric.The book explains briefly the underlying theory for simulation and inference of several classes of stochastic processes and then presents both simulation experiments and applications to real data. Although these processes have been originally proposed in physics and more recently in finance, they are becoming popular also in biology due to the fact the time course experimental data are now available. The YUIMA package, available on CRAN, can be freely downloaded and this companion book will make the user able to start his or her analysis from the first page.

This is a volume consisting of selected papers that were presented at the 3rd St. Petersburg Workshop on Simulation held at St. Petersburg, Russia, during June 28-July 3, 1998. The Workshop is a regular international event devoted to mathematical problems of simulation and applied statistics organized by the Department of Stochastic Simulation at St. Petersburg State University in cooperation with INFORMS College on Simulation (USA). Its main purpose is to exchange ideas between researchers from Russia and from the West as well as from other coun tries throughout the World. The 1st Workshop was held during May 24-28, 1994, and the 2nd workshop was held during June 18-21, 1996. The selected proceedings of the 2nd Workshop was published as a special issue of the Journal of Statistical Planning and Inference.

Russian mathematical tradition has been formed by such genius as Tchebysh eff, Markov and Kolmogorov whose ideas have formed the basis for contempo rary probabilistic models. However, for many decades now, Russian scholars have been isolated from their colleagues in the West and as a result their mathe matical contributions have not been widely known. One of the primary reasons for these workshops is to bring the contributions of Russian scholars into lime light and we sincerely hope that this volume helps in this specific purpose.

The only complete guide to all aspects and uses of simulation-from the international leaders in the field There has never been a single definitive source of key information on all facets of discrete-event simulation and its applications to major industries. The Handbook of Simulation brings together the contributions of leading academics, practitioners, and software developers to offer authoritative coverage of the principles, techniques, and uses of discrete-event simulation. Comprehensive in scope and thorough in approach, the Handbook is the one reference on discrete-event simulation that every industrial engineer, management scientist, computer scientist, operations manager, or operations researcher involved in problem-solving should own, with an in-depth examination of: * Simulation methodology, from experimental design to data analysis and more * Recent advances, such as object-oriented simulation, on-line simulation, and parallel and distributed simulation * Applications across a full range of manufacturing and service industries * Guidelines for successful simulations and sound simulation project management * Simulation software and simulation industry vendors

Recent years have seen an explosion in new kinds of data on infectious diseases, including data on social contacts, whole genome sequences of pathogens, biomarkers for susceptibility to infection, serological panel data, and surveillance data. The Handbook of Infectious Disease Data Analysis provides an overview of many key statistical methods that have been developed in response to such new data streams and the associated ability to address key scientific and epidemiological questions. A unique feature of the Handbook is the wide range of topics covered. Key features Contributors include many leading researchers in the field Divided into four main sections: Basic concepts, Analysis of Outbreak Data, Analysis of Seroprevalence Data, Analysis of Surveillance Data Numerous case studies and examples throughout Provides both introductory material and key reference material

Explores computer-intensive probability and statistics for ecosystem management decision making Simulation is an accessible way to explain probability and stochastic model behavior to beginners. This book introduces probability and statistics to future and practicing ecosystem managers by providing a comprehensive treatment of these two areas. The author presents a self-contained introduction for individuals involved in monitoring, assessing, and managing ecosystems and features intuitive, simulation-based explanations of probabilistic and statistical concepts. Mathematical programming details are provided for estimating ecosystem model parameters with Minimum Distance, a robust and computer-intensive method. The majority of examples illustrate how probability and statistics can be applied to ecosystem management challenges. There are over 50 exercises – making this book suitable for a lecture course in a natural resource and/or wildlife management department, or as the main text in a program of self-study. Key features: Reviews different approaches to wildlife and ecosystem management and inference. Uses simulation as an accessible way to explain probability and stochastic model behavior to beginners. Covers material from basic probability through to hierarchical Bayesian models and spatial/ spatio-temporal statistical inference. Provides detailed instructions for using R, along with complete R programs to recreate the output of the many examples presented. Provides an introduction to Geographic Information Systems (GIS) along with examples from Quantum GIS, a free GIS software package. A companion website featuring all R code and data used throughout the book. Solutions to all exercises are presented along with an online intelligent tutoring system that supports readers who are using the book for self-study.

Based on a loss function approach, this comprehensive reference reviews the most recent advances in financial and actuarial modeling, providing a strong statistical background for advanced methods in pension plan structuring, risk estimation, and modeling of investment and options pricing. An authoritative tool supplying every conceptual model and technique required by the modern financial investigator, Financial and Actuarial Statistics offers an analysis of American options models, mortality adjustment factors for increased risk individuals, time trend regression adjustments for mortality tables, and simulation approaches for stochastic models.

This volume features original contributions and invited review articles on mathematical statistics, statistical simulation and experimental design. The selected peer-reviewed contributions originate from the 8th International Workshop on Simulation held in Vienna in 2015. The book is intended for mathematical statisticians, Ph.D. students and statisticians working in medicine, engineering, pharmacy, psychology, agriculture and other related fields. The International Workshops on Simulation are devoted to statistical techniques in stochastic simulation, data collection, design of scientific experiments and studies representing broad areas of interest. The first 6 workshops took place in St. Petersburg, Russia, in 1994 – 2009 and the 7th workshop was held in Rimini, Italy, in 2013.

Information technologies have changed people’s lives to a great extent, and now it is almost impossible to imagine any activity that does not depend on computers in some way. Since the invention of first computer systems, people have been trying to avail computers in order to solve complex problems in various areas. Traditional methods of calculation have been replaced by computer programs that have the ability to predict the behavior of structures under different loading conditions. There are eight chapters in this book that deal with: optimal control of thermal pollution emitted by power plants, finite difference solution of conjugate heat transfer in double pipe with trapezoidal fins, photovoltaic system integrated into the buildings, possibilities of modeling Petri nets and their extensions, etc.

This 3rd edition of the successful Elements of Applied Stochastic Processes improves on the last edition by condensing the material and organising it into a more teachable format. It provides more in-depth coverage of Markov chains and simple Markov process and gives added emphasis to statistical inference in stochastic processes. Integration of theory and application offers improved teachability Provides a comprehensive introduction to stationary processes and time series analysis Integrates a broad set of applications into the text Utilizes a wealth of examples from research papers and monographs

The Handbook of Simulation Optimization presents an overview of the state of the art of simulation optimization, providing a survey of the most well-established approaches for optimizing stochastic simulation models and a sampling of recent research advances in theory and methodology. Leading contributors cover such topics as discrete optimization via simulation, ranking and selection, efficient simulation budget allocation, random search methods, response surface methodology, stochastic gradient estimation, stochastic approximation, sample average approximation, stochastic constraints, variance reduction techniques, model-based stochastic search methods and Markov decision processes. This single volume should serve as a reference for those already in the field and as a means for those new to the field for understanding and applying the main approaches. The intended audience includes researchers, practitioners and graduate students in the business/engineering fields of operations research, management science, operations management and stochastic control, as well as in economics/finance and computer science.

This book introduces the fundamental concepts of inverse heat transfer solutions and their applications for solving problems in convective, conductive, radiative, and multi-physics problems. Inverse Heat Transfer: Fundamentals and Applications, Second Edition includes techniques within the Bayesian framework of statistics for the solution of inverse problems. By modernizing the classic work of the late Professor M. Necati Özisik and adding new examples and problems, this new edition provides a powerful tool for instructors, researchers, and graduate students studying thermal-fluid systems and heat transfer. FEATURES Introduces the fundamental concepts of inverse heat transfer Presents in systematic fashion the basic steps of powerful inverse solution techniques Develops inverse techniques of parameter estimation, function estimation, and state estimation Applies these inverse techniques to the solution of practical inverse heat transfer problems Shows inverse techniques for conduction, convection, radiation, and multi-physics phenomena M. Necati Özisik (1923–2008) retired in 1998 as Professor Emeritus of North Carolina State University's Mechanical and Aerospace Engineering Department. Helcio R. B. Orlande is a Professor of Mechanical Engineering at the Federal University of Rio de Janeiro (UFRJ), where he was the Department Head from 2006 to 2007.

Systems studied in environmental science, due to their structure and the heterogeneity of the entities composing them, often exhibit complex dynamics that can only be captured by hybrid modeling approaches. While several concurrent definitions of "hybrid modeling" can be found in the literature, it is defined here broadly as the approach consisting in coupling existing modelling paradigms to achieve a more accurate or efficient representation of systems. The need for hybrid models generally arises from the necessity to overcome the limitation of a single modeling technique in terms of structural flexibility, capabilities, or computational efficiency. This book brings together experts in the field of hybrid modelling to demonstrate how this approach can address the challenge of representing the complexity of natural systems. Chapters cover applied examples as well as modeling methodology.

This book presents a systematic approach to understanding and applying the principles of hydrology and hydroclimatology, examining the interactions among different components of the water cycle. It takes a fresh look at the fundamentals and challenges in hydrologic and hydroclimatic systems as well as climate change. The author describes the application of nontraditional data sets and new investigation techniques to water-related problems. He also examines long lead forecasting and simulation, time series analysis, and risk and uncertainty in hydrologic design.

This is the first book designed to introduce Bayesian inference procedures for stochastic processes. There are clear advantages to the Bayesian approach (including the optimal use of prior information). Initially, the book begins with a brief review of Bayesian inference and uses many examples relevant to the analysis of stochastic processes, including the four major types, namely those with discrete time and discrete state space and continuous time and continuous state space. The elements necessary to understanding stochastic processes are then introduced, followed by chapters devoted to the Bayesian analysis of such processes. It is important that a chapter devoted to the fundamental concepts in stochastic processes is included. Bayesian

inference (estimation, testing hypotheses, and prediction) for discrete time Markov chains, for Markov jump processes, for normal processes (e.g. Brownian motion and the Ornstein–Uhlenbeck process), for traditional time series, and, lastly, for point and spatial processes are described in detail. Heavy emphasis is placed on many examples taken from biology and other scientific disciplines. In order analyses of stochastic processes, it will use R and WinBUGS. Features: Uses the Bayesian approach to make statistical Inferences about stochastic processes The R package is used to simulate realizations from different types of processes Based on realizations from stochastic processes, the WinBUGS package will provide the Bayesian analysis (estimation, testing hypotheses, and prediction) for the unknown parameters of stochastic processes To illustrate the Bayesian inference, many examples taken from biology, economics, and astronomy will reinforce the basic concepts of the subject A practical approach is implemented by considering realistic examples of interest to the scientific community WinBUGS and R code are provided in the text, allowing the reader to easily verify the results of the inferential procedures found in the many examples of the book Readers with a good background in two areas, probability theory and statistical inference, should be able to master the essential ideas of this book.
Bridging the gap between research and application, Markov Chain Monte Carlo: Stochastic Simulation for Bayesian Inference provides a concise, and integrated account of Markov chain Monte Carlo (MCMC) for performing Bayesian inference. This volume, which was developed from a short course taught by the author at a meeting of Brazilian statisticians and probabilists, retains the didactic character of the original course text. The self-contained text units make MCMC accessible to scientists in other disciplines as well as statisticians. It describes each component of the theory in detail and outlines related software, which is of particular benefit to applied scientists.

Since the first edition of Stochastic Modelling for Systems Biology, there have been many interesting developments in the use of "likelihood-free" methods of Bayesian inference for complex stochastic models. Having been thoroughly updated to reflect this, this third edition covers everything necessary for a good appreciation of stochastic kinetic modelling of biological networks in the systems biology context. New methods and applications are included in the book, and the use of R for practical illustration of the algorithms has been greatly extended. There is a brand new chapter on spatially extended systems, and the statistical inference chapter has also been extended with new methods, including approximate Bayesian computation (ABC). Stochastic Modelling for Systems Biology, Third Edition is now supplemented by an additional software library, written in Scala, described in a new appendix to the book. New in the Third Edition New chapter on spatially extended systems, covering the spatial Gillespie algorithm for reaction diffusion master equation models in 1- and 2-d, along with fast approximations based on the spatial chemical Langevin equation Significantly expanded chapter on inference for stochastic kinetic models from data, covering ABC, including ABC-SMC Updated R package, including code relating to all of the new material New R package for parsing SBML models into simulatable stochastic Petri net models New open-source software library, written in Scala, replicating most of the functionality of the R packages in a fast, compiled, strongly typed, functional language Keeping with the spirit of earlier editions, all of the new theory is presented in a very informal and intuitive manner, keeping the text as accessible as possible to the widest possible readership. An effective introduction to the area of stochastic modelling in computational systems biology, this new edition adds additional detail and computational methods that will provide a stronger foundation for the development of more advanced courses in stochastic biological modelling.

Stochastic processes are widely used for model building in the social, physical, engineering and life sciences as well as in financial economics. In model building, statistical inference for stochastic processes is of great importance from both a theoretical and an applications point of view. This book deals with Fractional Diffusion Processes and statistical inference for such stochastic processes. The main focus of the book is to consider parametric and nonparametric inference problems for fractional diffusion processes when a complete path of the process over a finite interval is observable. Key features: Introduces self-similar processes, fractional Brownian motion and stochastic integration with respect to fractional Brownian motion. Provides a comprehensive review of statistical inference for processes driven by fractional Brownian motion for modelling long range dependence. Presents a study of parametric and nonparametric inference problems for the fractional diffusion process. Discusses the fractional Brownian sheet and infinite dimensional fractional Brownian motion. Includes recent results and developments in the area of statistical inference of fractional diffusion processes. Researchers and students working on the statistics of fractional diffusion processes and applied mathematicians and statisticians involved in stochastic process modelling will benefit from this book.

This book is a comprehensive treatment of inference for hidden Markov models, including both algorithms and statistical theory. Topics range from filtering and smoothing of the hidden Markov chain to parameter estimation, Bayesian methods and estimation of the number of states. In a unified way the book covers both models with finite state spaces and models with continuous state spaces (also called state-space models) requiring approximate simulation-based algorithms that are also described in detail. Many examples illustrate the algorithms and theory. This book builds on recent developments to present a self-contained view.

Piecewise-deterministic Markov processes form a class of stochastic models with a sizeable scope of applications: biology, insurance, neuroscience, networks, finance... Such processes are defined by a deterministic motion punctuated by random jumps at random times, and offer simple yet challenging models to study. Nevertheless, the issue of statistical estimation of the parameters ruling the jump mechanism is far from trivial. Responding to new developments in the field as well as to current research interests and needs, Statistical inference for piecewise-deterministic Markov processes offers a detailed and comprehensive survey of state-of-the-art results. It covers a wide range of general processes as well as applied models. The present book also dwells on statistics in the context of Markov chains, since piecewise-deterministic Markov processes are characterized by an embedded Markov chain corresponding to the position of the process right after the jumps.

This book provides a comprehensive assessment of the latest simulation techniques, and examines the three main areas of econometric inference where the use of simulation methods has been successful; Bayesian inference, classical inference, and the solution and stochastic simulation of dynamic econometric models, in particular general equilibrium models.

While there have been few theoretical contributions on the Markov Chain Monte Carlo (MCMC) methods in the past decade, current understanding and application of MCMC to the solution of inference problems has increased by leaps and bounds. Incorporating changes in theory and highlighting new applications, Markov Chain Monte Carlo: Stochastic Simulation for Bayesian Inference, Second Edition presents a concise, accessible, and comprehensive introduction to the methods of this valuable simulation technique. The second edition includes access to an internet site that provides the code, written in R and WinBUGS, used in many of the previously existing and new examples and exercises. More importantly, the self-explanatory nature of the codes will enable modification of the inputs to the codes and variation on many directions will be available for further exploration. Major changes from the previous edition: · More examples with discussion of computational details in chapters on Gibbs sampling and Metropolis-Hastings algorithms · Recent developments in MCMC, including reversible jump, slice sampling, bridge sampling, path sampling, multiple-try, and delayed rejection · Discussion of computation using both R and WinBUGS · Additional exercises and selected solutions within the text, with all data sets and software available for download from the Web · Sections on spatial models and model adequacy The self-contained text units make MCMC accessible to scientists in other disciplines as well as statisticians. The book will appeal to everyone working with MCMC techniques, especially research and graduate statisticians and biostatisticians, and scientists handling data and formulating models. The book has been substantially reinforced as a first reading of material on MCMC and, consequently, as a textbook for modern Bayesian computation and Bayesian inference courses.

This book is a comprehensive guide to simulation methods with explicit recommendations of methods and algorithms. It covers both the technical aspects of the subject, such as the generation of random numbers, non-uniform random variates and stochastic processes, and the use of simulation.

Praise for the First Edition ". . . an excellent textbook . . . well organized and neatly written." —Mathematical Reviews ". . . amazingly interesting . . ." —Technometrics Thoroughly updated to showcase the interrelationships between probability, statistics, and stochastic processes, Probability, Statistics, and Stochastic Processes, Second Edition prepares readers to collect, analyze, and characterize data in their chosen fields. Beginning with three chapters that develop probability theory and introduce the axioms of probability, random variables, and joint distributions, the book goes on to present limit theorems and simulation. The authors combine a rigorous, calculus-based development of theory with an intuitive approach that appeals to readers' sense of reason and logic. Including more than 400 examples that help illustrate concepts and theory, the Second Edition features new material on statistical inference and a wealth of newly added topics, including: Consistency of point estimators Large sample theory Bootstrap simulation Multiple hypothesis testing Fisher's exact test and Kolmogorov-Smirnov test Martingales, renewal processes, and Brownian motion One-way analysis of variance and the general linear model Extensively class-tested to ensure an accessible presentation, Probability, Statistics, and Stochastic Processes, Second Edition is an excellent book for courses on probability and statistics at the upper-undergraduate level. The book is also an ideal resource for scientists and engineers in the fields of statistics, mathematics, industrial management, and engineering.

One out of every two men over eigthy suffers from carcinoma of the prostate.It is discovered incidentally in many patients with an alleged benign prostatic hyperplasia. In treating patients, the authors make clear that primary radical prostatectomy is preferred over transurethral resection due to the lower complication rate.

This book constitutes the proceedings of the 12th International Conference on Computational Methods in Systems Biology, CMSB 2014, held in Manchester, UK, in November 2014. The 16 regular papers presented together with 6 poster papers were carefully reviewed and selected from 31 regular and 18 poster submissions. The papers are organized in topical sections on formalisms for modeling biological processes, model inference from experimental data, frameworks for model verification, validation, and analysis of biological systems, models and their biological applications, computational approaches for synthetic biology, and flash posters.

This book covers a highly relevant and timely topic that is of wide interest, especially in finance, engineering and computational biology. The introductory material on simulation and stochastic differential equation is very accessible and will prove popular with many readers. While there are several recent texts available that cover stochastic differential equations, the concentration here on inference makes this book stand out. No other direct competitors are known to date. With an emphasis on the practical implementation of the simulation and estimation methods presented, the text will be useful to practitioners and students with minimal mathematical background. What’s more, because of the many R programs, the information here is appropriate for many mathematically well educated practitioners, too.

With the advent of DNA and protein sequencing, X-ray crystallography, and other methods of analysis, researchers interested in biological questions have been presented with a wealth of data to parse and interpret. Additionally, some hypotheses, such as those pertaining to the origin of life, are difficult to test experimentally using real molecules and/or systems. Computational and statistical models have therefore become essential tools to understanding the natural world. Such models can be applied to questions ranging from the origin of life on Earth to the spread of infectious diseases. This work provides background and descriptions of novel computational methods pertaining to: (a) a simulation study of sets of catalytic molecules that carry a minimal amount of genetic information for replication, (b) a new substitution method for phylogenetic inference on the aminoacyl-tRNA synthetase enzymes, which are responsible for attaching amino acids to tRNA molecules and are thereby instrumental to the functioning of the genetic code, and (c) the development, testing, and implementation of, and results generated by, a new model for joint phylogenetic and epidemiological inference from the sequences of rapidly evolving, infectious agents, and the comparison of two of these types of models with differing ways of describing branching processes.

Stochastic geometry involves the study of random geometric structures, and blends geometric, probabilistic, and statistical methods to provide powerful techniques for modeling and analysis. Recent developments in computational statistical analysis, particularly Markov chain Monte Carlo, have enormously extended the range of feasible applications. Stochastic Geometry: Likelihood and Computation provides a coordinated collection of chapters on important aspects of the rapidly developing field of stochastic geometry, including: o a "crash-course" introduction to key stochastic geometry themes o considerations of geometric sampling bias issues o tesselations o shape o random sets o image analysis o spectacular advances in likelihood-based inference now available to stochastic geometry through the techniques of Markov chain Monte Carlo

This Handbook is a collection of chapters on key issues in the design and analysis of computer simulation experiments on models of stochastic systems. The chapters are tightly focused and written by experts in each area. For the purpose of this volume “simulation refers to the analysis of stochastic processes through the generation of sample paths (realization) of the processes. Attention focuses on design and analysis issues and the goal of this volume is to survey the concepts, principles, tools and techniques that underlie the theory and practice of stochastic simulation design and analysis. Emphasis is placed on the ideas and methods that are likely to remain an intrinsic part of the foundation of the field for the foreseeable future. The chapters provide up-to-date references for both the simulation researcher and the advanced simulation user, but they do not constitute an introductory level ‘how to’ guide. Computer scientists, financial analysts, industrial engineers, management scientists, operations researchers and many other professionals use stochastic simulation to design, understand and improve communications, financial, manufacturing, logistics, and service systems. A theme that runs throughout these diverse applications is the need to evaluate system performance in the face of uncertainty, including uncertainty in user load, interest rates, demand for product, availability of goods, cost of transportation and equipment failures. * Tightly focused chapters written by experts * Surveys concepts, principles, tools, and techniques that underlie the theory and practice of stochastic simulation design and analysis * Provides an up-to-date reference for both simulation researchers and advanced simulation users

This book is devoted to a number of stochastic models that display scale invariance. It primarily focuses on three issues: probabilistic properties, statistical estimation and simulation of the processes considered. It will be of interest to probability specialists, who will find here an uncomplicated presentation of statistics tools and to those statisticians who wants to tackle the most recent theories in probability in order to develop Central Limit Theorems in this context; both groups will also benefit from the section on simulation. Algorithms are described in great detail, with a focus on procedures that is not usually found in mathematical treatises. The models studied are fractional Brownian motions and processes that derive from them through stochastic differential equations. Concerning the proofs of the limit theorems, the “Fourth Moment Theorem” is systematically used, as it produces rapid and helpful proofs that can serve as models for the future. Readers will also find elegant and new proofs for almost sure convergence. The use of diffusion models driven by fractional noise has been popular for more than two decades now. This popularity is due both to the mathematics itself and to its fields of application. With regard to the latter, fractional models are useful for modeling real-life events such as value assets in financial markets, chaos in quantum physics, river flows through time, irregular images, weather events and contaminant diffusio n problems.

System Biology encompasses the knowledge from diverse fields such as Molecular Biology, Immunology, Genetics, Computational Biology, Mathematical Biology, etc. not only to address key questions that are not answerable by individual fields alone, but also to help in our understanding of the complexities of biological systems. Whole genome expression studies have provided us the means of studying the expression of thousands of genes under a particular condition and this technique had been widely used to find out the role of key macromolecules that are involved in biological signaling pathways. However, making sense of the underlying complexity is only possible if we interconnect various signaling pathways into human and computer readable network maps. These maps can then be used to classify and study individual components involved in a particular phenomenon. Apart from transcriptomics, several individual gene studies have resulted in adding to our knowledge of key components that are involved in a signaling pathway. It therefore becomes imperative to take into account

of these studies also, while constructing our network maps to highlight the interconnectedness of the entire signaling pathways and the role of that particular individual protein in the pathway. This collection of articles will contain a collection of pioneering work done by scientists working in regulatory signaling networks and the use of large scale gene expression and omics data. The distinctive features of this book would be: Act a single source of information to understand the various components of different signaling network (roadmap of biochemical pathways, the nature of a molecule of interest in a particular pathway, etc.), Serve as a platform to highlight the key findings in this highly volatile and evolving field, and Provide answers to various techniques both related to microarray and cell signaling to the readers.
Simulation and Inference for Stochastic Processes with YUIMAA Comprehensive R Framework for SDEs and Other Stochastic ProcessesSpringer