Stochastic Processes In Cell Biology Interdiscipl

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Stochastic Models for Fractional Calculus Springer Science & Business Media
Biological Processes in Living Systems is the fourth and final volume of the Toward a Theoretical Biology series. It contains essays that deal in detail with particular biological processes: morphogenesis of pattern, the development of neuronal networks, evolutionary processes, and others. The main thrust of this volume brings relevance to the general underlying nature of living systems. Faced with trying to understand how the complexity of molecular microstates leads to the relative simplicity of phenome structures, Waddington-on behalf of his colleagues-stresses on the structure of language as a paradigm for a theory of general biology. This is language in an imperative mood: a set of symbols, organized by some form of generative grammar, making possible the conveyance of commands for action to produce effects on the surroundings of the emitting and the receiving entities. "Biology," he writes, "is concerned with algorithm and program." Among the contributions in this volume are: "The Riemann-Hugoniot Catastrophe and van der Waals Equation," David H. Fowler; "Differential Equations for the Heartbeat and Nerve Impulse," E. Christopher Zeeman; "Structuralism and Biology," Rene Thom; "The Concept of Positional Information and Pattern Formation," Lewis Wolpert; "Pattern Formation in Fibroblast Cultures," Tom Elsdale; "Form and Information," C. H. Waddington; "Organizational Principles for Theoretical Neurophysiology," Michael A. Arbib; "Stochastic Models of Neuroelectric Activity," Jack D. Cowan. Biological Processes in Living Systems is a pioneering volume by recognized leaders in an ever-growing field.
Principles of Computational Cell Biology Walter de Gruyter
Applied Stochastic Processes is a collection of papers dealing with stochastic processes, stochastic equations, and their applications in many fields of science. One paper discusses stochastic systems involving randomness in the system itself that can be a large dynamical multi-input, multi-output system. Examples of a large system are the national economy of a major country or when an acoustic wave is propagating as in the atmosphere, ocean, or sea. Another paper proves that only the average properties of the molecules of biology can be measured with precision in the test tube; and disputes a "simplistic" model of the cell as defined by a miniature Laplaces' universe. The paper notes that the way existing cells are constructed implies that quantum mechanical principles lead to certain questions (about simple experiments) having only statistical answers. Another paper addresses the detection of distributed, fluctuating targets in a reverberation limited, randomly time, and space varying transmission media. This approach is done by using the concepts of "random Green's functions" and the "stochastic Green's function." The collection will prove useful for cellular researchers, mathematicians, physicist, engineers, and academicians in the field of applied mathematics, statistics, and chemistry.
Stochastic Processes in Physics, Chemistry, and Biology Springer Nature
Biophysics is a new way of looking at living matter. It uses quantitative experimental and theoretical methods to open a new window for studying and understanding life processes. This textbook gives compact introductions to the basics of the field, including molecular cell biology and statistical physics. It then presents in-depth discussions of more advanced biophysics subjects, progressing to state-of-the-art experiments and their theoretical interpretations. The book is unique by offering a general introduction to biophysics, yet at the same time restricting itself to processes that occur inside the cell nucleus and that involve biopolymers (DNA, RNA, and proteins). This allows for an accessible read for beginners and a springboard for specialists who wish to continue their study in more detail.
Computational Cell Biology Routledge
Biological examples of branching processes from molecular and cellular biology are introduced in this volume, as well as from the fields of human evolution and medicine. It will interest scientists who work in quantitative modeling of biological systems, particularly probabilists, mathematical biologists, and others. 54 illustrations.
An Introduction to Stochastic Modeling Imperial College Press
Graph-structured data is ubiquitous throughout the natural and social sciences, from telecommunication networks to quantum chemistry. Building relational inductive biases into deep learning architectures is crucial for creating systems that can learn, reason, and generalize from this kind of data. Recent years have seen a surge in research on graph representation learning, including techniques for deep graph embeddings, generalizations of convolutional neural networks to graph-structured data, and neural message-passing approaches inspired by belief propagation. These advances in graph representation learning have led to new state-of-the-art results in numerous domains, including chemical synthesis, 3D vision, recommender systems, question answering, and social network analysis. This book provides a synthesis and overview of graph representation learning. It begins with a discussion of the goals of graph representation learning as well as key methodological foundations in graph theory and network analysis. Following this, the book introduces and reviews methods for learning node embeddings, including random-walk-based methods and applications to knowledge graphs. It then provides a technical synthesis and introduction to the highly successful graph neural network (GNN) formalism, which has become a dominant and fast-growing paradigm for deep learning with graph data. The book concludes with a synthesis of recent advancements in deep generative models for graphs—a nascent but quickly growing subset of graph representation learning.
Stochastic Processes in Cell Biology Springer Science & Business Media
A Top 25 CHOICE 2016 Title, and recipient of the CHOICE Outstanding Academic Title (OAT) Award. How much energy is released in ATP hydrolysis? How many mRNAs are in a cell? How genetically similar are two random people? What is faster, transcription or translation?Cell Biology by the Numbers explores these questions and dozens of others provid
Stochastic Approaches for Systems Biology Springer
Physical Biology of the Cell is a textbook for a first course in physical biology or biophysics for undergraduate or graduate students. It maps the huge and complex landscape of cell and molecular biology from the distinct perspective of physical biology. As a key organizing principle, the proximity of topics is based on the physical concepts that
Evolution Equations and Their Applications in Physical and Life Sciences Academic Press
The revised and expanded edition of this textbook presents the concepts and applications of random processes with the same illuminating simplicity as its first edition, but with the notable addition of substantial modern material on biological modeling. While still treating many important problems in fields such as engineering and mathematical physics, the book also focuses on the highly relevant topics of cancerous mutations, influenza evolution, drug resistance, and immune response. The models used elegantly apply various classical stochastic models presented earlier in the text, and exercises are included throughout to reinforce essential concepts. The second edition of Classical and Spatial Stochastic Processes is suitable as a textbook for courses in stochastic processes at the advanced-undergraduate and graduate levels, or as a self-study resource for researchers and practitioners in mathematics, engineering, physics, and mathematical biology. Reviews of the first edition: An appetizing textbook for a first course in stochastic processes. It guides the reader in a very clever manner from classical ideas to some of the most interesting modern results. ... All essential facts are presented with clear proofs, illustrated by beautiful examples. ... The book is well organized, has informative chapter summaries, and presents interesting exercises. The clear proofs

are concentrated at the ends of the chapters making it easy to find the results. The style is a good balance of mathematical rigorosity and user-friendly explanation. —Biometric Journal This small book is well-written and well-organized. ... Only simple results are treated ... but at the same time many ideas needed for more complicated cases are hidden and in fact very close. The second part is a really elementary introduction to the area of spatial processes. ... All sections are easily readable and it is rather tentative for the reviewer to learn them more deeply by organizing a course based on this book. The reader can be really surprised seeing how simple the lectures on these complicated topics can be. At the same time such important questions as phase transitions and their properties for some models and the estimates for certain critical values are discussed rigorously. ... This is indeed a first course on stochastic processes and also a masterful introduction to some modern chapters of the theory. —Zentralblatt Math

Probabilistic Cellular Automata Springer Nature

This is a book about the physical processes in reacting complex molecules, particularly biomolecules. In the past decade scientists from different fields such as medicine, biology, chemistry and physics have collected a huge amount of data about the structure, dynamics and functioning of biomolecules. Great progress has been achieved in exploring the structure of complex molecules. However, there is still a lack of understanding of the dynamics and functioning of biological macromolecules. In particular this refers to enzymes, which are the basic molecular machines working in living systems. This book contributes to the exploration of the physical mechanisms of these processes, focusing on critical aspects such as the role of nonlinear excitations and of stochastic effects. An extensive range of original results has been obtained in the last few years by the authors, and these results are presented together with a comprehensive survey of the state of the art in the field. Contents: Introduction to the Reaction Theory and Cluster Dynamics of Enzymes (W Ebeling, A Netrebko & Yu Romanovsky); Tools of Stochastic Dynamics (L Schimansky-Geier & P Talkner); Motion of Test Particles in a 2-D Potential Landscape (O A Chichigina, A V Netrebko & N V Netrebko); Microscopic Simulations of Activation and Dissociation (W Ebeling, V Yu Podlipchuk, M G Sapeshinsky & A A Valuev); Excitations on Rings of Molecules (A Chetverikov, W Ebeling, M Jenssen & Yu Romanovsky); Fermi Resonance and Kramers Problem in 2-D Force Field (S V Kroo, A V Netrebko, Yu M Romanovsky & L Schimansky-Geier); Molecular Scissors. Cluster Model of Acetylcholinesterase (A Yu Chikishev, S V Kroo, A V Netrebko, N V Netrebko & Yu Romanovsky); Dynamics of Proton Transfer in the Active Site of Chymotrypsin (A Yu Chikishev, B A Grishanin & E V Shuvalova); On the Damping of Cluster Oscillations in Protein Molecules (A Yu Chikishev, A V Netrebko & Yu M Romanovsky); Protein Dynamics and New Approaches to the Molecular Mechanisms of Protein Functioning (K V Shaitan). Readership: Researchers and graduate students in physics, biophysics, molecular biology and the life sciences; experts on nonlinear dynamics and the stochastic process in molecular systems and biomolecules.

Physical Biology of the Cell World Scientific

This volume reviews the theory and simulation methods of stochastic kinetics by integrating historical and recent perspectives, presents applications, mostly in the context of systems biology and also in combustion theory. In recent years, due to the development in experimental techniques, such as optical imaging, single cell analysis, and fluorescence spectroscopy, biochemical kinetic data inside single living cells have increasingly been available. The emergence of systems biology brought renaissance in the application of stochastic kinetic methods.

Markov Processes for Stochastic Modeling World Scientific

The theory of stochastic processes originally grew out of efforts to describe Brownian motion quantitatively. Today it provides a huge arsenal of methods suitable for analyzing the influence of noise on a wide range of systems. The credit for acquiring all the deep insights and powerful methods is due ma- ly to a handful of physicists and mathematicians: Einstein, Smoluchowski, Langevin, Wiener, Stratonovich, etc. Hence it is no surprise that until - cently the bulk of basic and applied stochastic research was devoted to purely mathematical and physical questions. However, in the last decade we have witnessed an enormous growth of results achieved in other sciences - especially chemistry and biology - based on applying methods of stochastic processes. One reason for this stochastics boom may be that the realization that noise plays a constructive rather than the expected deteriorating role has spread to communities beyond physics. Besides their aesthetic appeal these noise-induced, noise-supported or noise-enhanced effects sometimes offer an explanation for so far open pr- lems (information transmission in the nervous system and information p- cessing in the brain, processes at the cell level, enzymatic reactions, etc.). They may also pave the way to novel technological applications (noise-- hanced reaction rates, noise-induced transport and separation on the na- scale, etc.). Key words to be mentioned in this context are stochastic r- onance, Brownian motors or ratchets, and noise-supported phenomena in excitable systems.

Control Theory and Systems Biology John Wiley & Sons

This book develops the theory of continuous and discrete stochastic processes within the context of cell biology. In the second edition the material has been significantly expanded, particularly within the context of nonequilibrium and self-organizing systems. Given the amount of additional material, the book has been divided into two volumes, with volume I mainly covering molecular processes and volume II focusing on cellular processes. A wide range of biological topics are covered in the new edition, including stochastic ion channels and excitable systems, molecular motors, stochastic gene networks, genetic switches and oscillators, epigenetics, normal and anomalous diffusion in complex cellular environments, stochastically-gated diffusion, active intracellular transport, signal transduction, cell sensing, bacterial chemotaxis, intracellular pattern formation, cell polarization, cell mechanics, biological polymers and membranes, nuclear structure and dynamics, biological condensates, molecular aggregation and nucleation, cellular length control, cell mitosis, cell motility, cell adhesion, cytoneme-based morphogenesis, bacterial growth, and quorum sensing. The book also provides a pedagogical introduction to the theory of stochastic and nonequilibrium processes – Fokker Planck equations, stochastic differential equations, stochastic calculus, master equations and jump Markov processes, birth-death processes, Poisson processes, first passage time problems, stochastic hybrid systems, queuing and renewal theory, narrow capture and escape, extreme statistics, search processes and stochastic resetting, exclusion processes, WKB methods, large deviation theory, path integrals, martingales and branching processes, numerical methods, linear response theory, phase separation, fluctuation-dissipation theorems, age-structured models, and statistical field theory. This text is primarily aimed at graduate students and researchers working in mathematical biology, statistical and biological physicists, and applied mathematicians interested in stochastic modeling. Applied probabilists should also find it of interest. It provides significant background material in applied mathematics and statistical physics, and introduces concepts in stochastic and nonequilibrium 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 Dynamics of Reacting Biomolecules CRC Press

This volume presents a collection of lectures on linear partial differntial equations and semigroups, nonlinear equations, stochastic evolutionary processes, and evolution problems from physics, engineering and mathematical biology. The contributions come from the 6th International Conference on Evolution Equations and Their Applications in Physical and Life Sciences, held in Bad Herrenalb, Germany.

Quantitative Fundamentals of Molecular and Cellular Bioengineering Springer

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 process – Fokker Planck equations, stochastic differential equations, master equations and jump Markov processes, diffusion approximations and the system size expansion, first passage time problems, stochastic hybrid systems, reaction-diffusion equations, exclusion processes, WKB methods, martingales and branching processes, 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 Models In The Life Sciences And Their Methods Of Analysis Springer

Computational cell biology courses are increasingly obligatory for biology students around the world but of course also a must for mathematics and informatics students specializing in bioinformatics. This book, now in its second edition is geared towards both audiences. The author, Volkhard Helms, has, in addition to extensive teaching experience, a strong background in biology and informatics and knows exactly what the key points are in making the book accessible for students while still conveying in depth knowledge of the subject.About 50% of new content has been added for the new edition. Much more room is now given to statistical methods, and several new chapters address protein-DNA interactions, epigenetic modifications, and microRNAs.

Introduction to Stochastic Calculus with Applications Cambridge University Press

This book develops the theory of continuous and discrete stochastic processes within the context of cell biology. In the second edition the material has been significantly expanded, particularly within the context of nonequilibrium and self-organizing systems. Given the amount of additional material, the book has been divided into two volumes, with volume I mainly covering molecular processes and volume II focusing on cellular processes. A wide range of biological topics are covered in the new edition, including stochastic ion channels and excitable systems, molecular motors, stochastic gene networks, genetic switches and oscillators, epigenetics, normal and anomalous diffusion in complex cellular environments, stochastically-gated diffusion, active intracellular transport, signal transduction, cell sensing, bacterial chemotaxis, intracellular pattern formation, cell polarization, cell mechanics, biological polymers and membranes, nuclear structure and dynamics, biological condensates, molecular aggregation and nucleation, cellular length control, cell mitosis, cell motility, cell adhesion, cytoneme-based morphogenesis, bacterial growth, and quorum sensing. The book also provides a pedagogical introduction to the theory of stochastic and nonequilibrium processes – Fokker Planck equations, stochastic differential equations, stochastic calculus, master equations and jump Markov processes, birth-death processes, Poisson processes, first passage time problems, stochastic hybrid systems, queuing and renewal theory, narrow capture and escape, extreme statistics, search processes and stochastic resetting, exclusion processes, WKB methods, large deviation theory, path integrals, martingales and branching processes, numerical methods, linear response theory, phase separation, fluctuation-dissipation theorems, age-structured models, and statistical field theory. This text is primarily aimed at graduate students and researchers working in mathematical biology, statistical and biological physicists, and applied mathematicians interested in stochastic modeling. Applied probabilists should also find it of interest. It provides significant background material in applied mathematics and statistical physics, and introduces concepts in stochastic and nonequilibrium 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.

Classical and Spatial Stochastic Processes Springer Science & Business Media

A survey of how engineering techniques from control and systems theory can be used to help biologists understand the behavior of cellular systems.

Stochastic Processes in Cell Biology MIT Press

The objective of this book is to introduce the elements of stochastic processes in a rather concise manner where we present the two most important parts — Markov chains and stochastic analysis. The readers are led directly to the core of the main topics to be treated in the context. Further details and additional materials are left to a section containing abundant exercises for further reading and studying.In the part on Markov chains, the focus is on the ergodicity. By using the minimal nonnegative solution method, we deal with the recurrence and various types of ergodicity. This is done step by step, from finite state spaces to denumerable state spaces, and from discrete time to continuous time. The methods of proofs adopt modern techniques, such as coupling and duality methods. Some very new results are included, such as the estimate of the spectral gap. The structure and proofs in the first part are rather different from other existing textbooks on Markov chains.In the part on stochastic analysis, we cover the martingale theory and Brownian motions, the stochastic integral and stochastic differential equations with emphasis on one dimension, and the multidimensional stochastic integral and stochastic equation based on semimartingales. We introduce three important topics here: the Feynman-Kac formula, random time transform and Girsanov transform. As an essential application of the probability theory in classical mathematics, we also deal with the famous Brunn-Minkowski inequality in convex geometry.This book also features modern probability theory that is used in different fields, such as MCMC, or even deterministic areas: convex geometry and number theory. It provides a new and direct routine for students going through the classical Markov chains to the modern stochastic analysis.

Introduction To Stochastic Processes Springer

This book is a lucid, straightforward introduction to the concepts and techniques of statistical physics that students of biology, biochemistry, and biophysics must know. It provides a sound basis for understanding random motions of molecules, subcellular particles, or cells, or of processes that depend on such motion or are markedly affected by it. Readers do not need to understand thermodynamics in order to acquire a knowledge of the physics involved in diffusion, sedimentation, electrophoresis, chromatography, and cell motility--subjects that become lively and immediate when the author discusses them in terms of random walks of individual particles.

Biophysics for Beginners Academic Press

In the 17th century, Descartes put forth the metaphor of the machine to explain the functioning of living beings. In the 18th century, La Mettrie extended the metaphor to man. The clock was then used as the paradigm of the machine. In the 20th century, this metaphor still held but the clock was replaced by a computer. Nowadays, the organism is viewed as a robot obeying signals emanating from a computer program controlled by genetic information. This book shows that such a conception leads to contradictions not only in the theory of biology but also in its experimental research program, thereby impeding its development. The analysis of this problem is based on the most recent experimental data obtained in molecular biology as well as the history and philosophy of biology. It shows that the machine theory did not succeed in breaking with Aristotle's finalism. The book presents a new approach to biological systems based on cellular Darwinism. Genes are ruled by probabilistic mechanisms allowing cells to differentiate stochastically. Embryo development is not governed by a determinist genetic program but by natural selection occurring among cell populations inside the organism. This theory has considerable philosophical consequences. Man may be a machine but he is a random one.