

A Course In Mathematical Biology Quantitative Modeling With Mathematical And Computational Monographs On Mathematical Modeling And Computation

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A Course in Mathematical Modeling - Douglas D. Mooney 2021-11-15

The emphasis of this book lies in the teaching of mathematical modeling rather than simply presenting models. To this end the book starts with the simple discrete exponential growth model as a building block, and successively refines it. This involves adding variable growth rates, multiple variables, fitting growth rates to data, including random elements, testing exactness of fit, using computer simulations and moving to a continuous setting. No advanced knowledge is assumed of the reader, making this book suitable for elementary modeling courses. The book can also be used to supplement courses in linear algebra, differential equations, probability theory and statistics.

Mathematical Modeling in Economics, Ecology and the Environment - N.V. Hritonenko 2013-04-17

The problems of interrelation between human economics and natural environment include scientific, technical, economic, demographic, social, political and other aspects that are studied by scientists of many specialities. One of the important aspects in scientific study of environmental and ecological problems is the development of mathematical and computer tools for rational management of economics and environment. This book introduces a wide range of mathematical models in economics, ecology and environmental sciences to a general mathematical audience with no in-depth experience in this specific area. Areas covered are: controlled economic growth and technological development, world dynamics, environmental impact, resource extraction, air and water pollution propagation, ecological population dynamics and exploitation. A variety of known models are considered, from classical ones (Cobb Douglass production function, Leontief input-output analysis, Solow models of economic dynamics, Verhulst-Pearl and Lotka-Volterra models of population dynamics, and others) to the models of world dynamics and the models of water contamination propagation used after Chernobyl nuclear catastrophe. Special attention is given to modelling of hierarchical regional economic-ecological interaction and technological change in the context of environmental impact. XIII XIV Construction of Mathematical Models ...

Mathematical Models and Their Analysis - Frederick Y. M. Wan 2018-03-20

A great deal can be learned through modeling and mathematical analysis about real-life phenomena, even before numerical simulations are used to accurately portray the specific configuration of a situation. Scientific computing also becomes more effective and efficient if it is preceded by some preliminary analysis. These important advantages of mathematical modeling are demonstrated by models of historical importance in an easily understandable way. The organization of Mathematical Models and Their Analysis groups models by the issues that need to be addressed about the phenomena. The new approach shows how mathematics effective for one modeled phenomenon can be used to analyze another unrelated problem. For instance, the mathematics of differential

equations useful in understanding the classical physics of planetary models, fluid motion, and heat conduction is also applicable to the seemingly unrelated phenomena of traffic flow and congestion, offshore sovereignty, and regulation of overfishing and deforestation. The formulation and in-depth analysis of these and other models on modern social issues, such as the management of exhaustible and renewable resources in response to consumption demands and economic growth, are of increasing concern to students and researchers of our time. The modeling of current social issues typically starts with a simple but meaningful model that may not capture all the important elements of the phenomenon. Predictions extracted from such a model may be informative but not compatible with all known observations; so the model may require improvements. The cycle of model formulation, analysis, interpretation, and assessment is made explicit for the modeler to repeat until a model is validated by consistency with all known facts.

Introduction to Mathematical Biology - S. I. Rubinow 2002

Developed from the author's course in mathematical biology at Cornell University, this volume is designed to cultivate in graduate biology students an awareness of and familiarity with applications of mathematical techniques and methods related to biology. This text explores five areas of mathematical biology, which are unified by their underlying mathematical structure. The first three subjects (cell growth, enzymatic reactions, and physiological tracers) are biological; the final two (biological fluid dynamics and diffusion) are biophysical. Introduced in an order of progressive mathematical complexity, the topics essentially follow a course in elementary differential equations, although linear algebra and graph theory are also touched upon. Free of mathematical jargon, the text requires only a knowledge of elementary calculus. A set of problems appears at the end of each chapter, with solutions at the end of the book. In addition to its value to biology students, this text will also prove useful to students with backgrounds in mathematics, physics, and engineering, who possess little knowledge of biology but nevertheless take an interest in the quantitative approach.

Mathematics for Biological Scientists - Mike Aitken 2009-09-30

Mathematics for Biological Scientists is a new undergraduate textbook which covers the mathematics necessary for biology students to understand, interpret and discuss biological questions. The book's twelve chapters are organized into four themes. The first theme covers the basic concepts of mathematics in biology, discussing the mathematics used in biological quantities, processes and structures. The second theme, calculus, extends the language of mathematics to describe change. The third theme is probability and statistics, where the uncertainty and variation encountered in real biological data is described. The fourth theme is explored briefly in the final chapter of the book, which is to show how the 'tools' developed in the first few chapters are used within biology to develop

models of biological processes. Mathematics for Biological Scientists fully integrates mathematics and biology with the use of colour illustrations and photographs to provide an engaging and informative approach to the subject of mathematics and statistics within biological science.

Mathematics in Population Biology - Horst R. Thieme 2018-06-05

An Introduction to Mathematical Modeling - Edward A. Bender 2012-05-23

Accessible text features over 100 reality-based examples pulled from the science, engineering, and operations research fields. Prerequisites: ordinary differential equations, continuous probability. Numerous references.

Includes 27 black-and-white figures. 1978 edition.

Mathematical Epidemiology - Fred Brauer 2008-04-30

Based on lecture notes of two summer schools with a mixed audience from mathematical sciences, epidemiology and public health, this volume offers a comprehensive introduction to basic ideas and techniques in modeling infectious diseases, for the comparison of strategies to plan for an anticipated epidemic or pandemic, and to deal with a disease outbreak in real time. It covers detailed case studies for diseases including pandemic influenza, West Nile virus, and childhood diseases. Models for other diseases including Severe Acute Respiratory Syndrome, fox rabies, and sexually transmitted infections are included as applications. Its chapters are coherent and complementary independent units. In order to accustom students to look at the current literature and to experience different perspectives, no attempt has been made to achieve united writing style or unified notation. Notes on some mathematical background (calculus, matrix algebra, differential equations, and probability) have been prepared and may be downloaded at the web site of the Centre for Disease Modeling (www.cdm.yorku.ca).

Mathematical Methods in Biology - J. David Logan 2009-08-17

A one-of-a-kind guide to using deterministic and probabilistic methods for solving problems in the biological sciences Highlighting the growing relevance of quantitative techniques in scientific research, **Mathematical Methods in Biology** provides an accessible presentation of the broad range of important mathematical methods for solving problems in the biological sciences. The book reveals the growing connections between mathematics and biology through clear explanations and specific, interesting problems from areas such as population dynamics, foraging theory, and life history theory. The authors begin with an introduction and review of mathematical tools that are employed in subsequent chapters, including biological modeling, calculus, differential equations, dimensionless variables, and descriptive statistics. The following chapters examine standard discrete and continuous models using matrix algebra as well as difference and differential equations. Finally, the book outlines probability, statistics, and stochastic methods as well as material on bootstrapping and stochastic differential equations, which is a unique approach that is not offered in other literature on the topic. In order to demonstrate the application of mathematical methods to the biological sciences, the authors provide focused examples from the field of theoretical ecology, which serve as an accessible context for study while also demonstrating mathematical skills that are applicable to many other areas in the life sciences. The book's algorithms are illustrated using MATLAB®, but can also be replicated using other software packages, including R, Mathematica®, and Maple; however, the text does not require any single computer algebra package. Each chapter contains numerous exercises and problems that range in difficulty, from the basic to more challenging, to assist readers with building their problem-solving skills. Selected solutions are included at the back of the book, and a related Web site features supplemental material for further study. Extensively class-tested to ensure an easy-to-follow format, **Mathematical Methods in Biology** is an excellent book for mathematics and biology courses at the upper-undergraduate and graduate levels. It also serves as a valuable reference for researchers and professionals working in the fields of biology, ecology, and biomathematics.

Explorations of Mathematical Models in Biology with MATLAB - Mazen Shahin 2013-12-24

Explore and analyze the solutions of mathematical models from diverse disciplines As biology increasingly depends on data, algorithms, and models, it has become necessary to use a computing language, such as the user-friendly MATLAB, to focus more on building and analyzing models as opposed to configuring tedious calculations.

Explorations of Mathematical Models in Biology with MATLAB provides an introduction to model creation using MATLAB, followed by the translation, analysis, interpretation, and observation of the models. With an integrated and interdisciplinary approach that embeds mathematical modeling into biological applications, the book illustrates numerous applications of mathematical techniques within biology, ecology, and environmental sciences. Featuring a quantitative, computational, and mathematical approach, the book includes: Examples of real-world applications, such as population dynamics, genetics, drug administration, interacting species, and the spread of contagious diseases, to showcase the relevancy and wide applicability of abstract mathematical techniques Discussion of various mathematical concepts, such as Markov chains, matrix algebra, eigenvalues, eigenvectors, first-order linear difference equations, and nonlinear first-order difference equations Coverage of difference equations to model a wide range of real-life discrete time situations in diverse areas as well as discussions on matrices to model linear problems Solutions to selected exercises and additional MATLAB codes *Explorations of Mathematical Models in Biology with MATLAB* is an ideal textbook for upper-undergraduate courses in mathematical models in biology, theoretical ecology, bioeconomics, forensic science, applied mathematics, and environmental science. The book is also an excellent reference for biologists, ecologists, mathematicians, biomathematicians, and environmental and resource economists.

Computational Cell Biology - Christopher P. Fall 2007-06-04

This textbook provides an introduction to dynamic modeling in molecular cell biology, taking a computational and intuitive approach. Detailed illustrations, examples, and exercises are included throughout the text. Appendices containing mathematical and computational techniques are provided as a reference tool.

A Course in Mathematical Biology - Gerda de Vries 2006-07-01

This is the only book that teaches all aspects of modern mathematical modeling and that is specifically designed to introduce undergraduate students to problem solving in the context of biology. Included is an integrated package of theoretical modeling and analysis tools, computational modeling techniques, and parameter estimation and model validation methods, with a focus on integrating analytical and computational tools in the modeling of biological processes. Divided into three parts, it covers basic analytical modeling techniques; introduces computational tools used in the modeling of biological problems; and includes various problems from epidemiology, ecology, and physiology. All chapters include realistic biological examples, including many exercises related to biological questions. In addition, 25 open-ended research projects are provided, suitable for students. An accompanying Web site contains solutions and a tutorial for the implementation of the computational modeling techniques. Calculations can be done in modern computing languages such as Maple, Mathematica, and MATLAB?.

Epidemic Modelling - D. J. Daley 2001-05-28

This is a general introduction to the mathematical modelling of diseases.

A Biologist's Guide to Mathematical Modeling in Ecology and Evolution - Sarah P. Otto 2011-09-19

Thirty years ago, biologists could get by with a rudimentary grasp of mathematics and modeling. Not so today. In seeking to answer fundamental questions about how biological systems function and change over time, the modern biologist is as likely to rely on sophisticated mathematical and computer-based models as traditional fieldwork. In this book, Sarah Otto and Troy Day provide biology students with the tools necessary to both interpret models and to build their own. The book starts at an elementary level of mathematical modeling, assuming that the reader has had high school mathematics and first-year calculus. Otto and Day then gradually build in depth and complexity,

from classic models in ecology and evolution to more intricate class-structured and probabilistic models. The authors provide primers with instructive exercises to introduce readers to the more advanced subjects of linear algebra and probability theory. Through examples, they describe how models have been used to understand such topics as the spread of HIV, chaos, the age structure of a country, speciation, and extinction. Ecologists and evolutionary biologists today need enough mathematical training to be able to assess the power and limits of biological models and to develop theories and models themselves. This innovative book will be an indispensable guide to the world of mathematical models for the next generation of biologists. A how-to guide for developing new mathematical models in biology Provides step-by-step recipes for constructing and analyzing models Interesting biological applications Explores classical models in ecology and evolution Questions at the end of every chapter Primers cover important mathematical topics Exercises with answers Appendixes summarize useful rules Labs and advanced material available

Applied Mathematical Models in Human Physiology - Johnny T. Ottesen 2004-01-01

This book introduces mathematicians to real applications from physiology. Using mathematics to analyze physiological systems, the authors focus on models reflecting current research in cardiovascular and pulmonary physiology. In particular, they present models describing blood flow in the heart and the cardiovascular system, as well as the transport of oxygen and carbon dioxide through the respiratory system and a model for baroreceptor regulation.

An Introduction to Modeling Neuronal Dynamics - Christoph Börgers 2017-04-17

This book is intended as a text for a one-semester course on Mathematical and Computational Neuroscience for upper-level undergraduate and beginning graduate students of mathematics, the natural sciences, engineering, or computer science. An undergraduate introduction to differential equations is more than enough mathematical background. Only a slim, high school-level background in physics is assumed, and none in biology. Topics include models of individual nerve cells and their dynamics, models of networks of neurons coupled by synapses and gap junctions, origins and functions of population rhythms in neuronal networks, and models of synaptic plasticity. An extensive online collection of Matlab programs generating the figures accompanies the book.

Modelling for Field Biologists and Other Interesting People - Hanna Kokko 2007-06-28

Students of evolutionary and behavioural ecology are often unfamiliar with mathematical techniques, though much of biology relies on mathematics. Evolutionary ideas are often complex, meaning that the logic of hypotheses proposed should not only be tested empirically but also mathematically. There are numerous different modelling tools used by ecologists, ranging from population genetic 'bookkeeping', to game theory and individual-based computer simulations. Due to the many different modelling options available, it is often difficult to know where to start. Hanna Kokko has designed this 2007 book to help with these decisions. Each method described is illustrated with one or two biologically interesting examples that have been chosen to help overcome fears of many biologists when faced with mathematical work, whilst also providing the programming code (Matlab) for each problem. Aimed primarily at students of evolutionary and behavioural ecology, this book will be of interest to any biologist interested in mathematical modelling.

Undergraduate Mathematics for the Life Sciences - Glenn Ledder 2013

There is a gap between the extensive mathematics background that is beneficial to biologists and the minimal mathematics background biology students acquire in their courses. The result is an undergraduate education in biology with very little quantitative content. New mathematics courses must be devised with the needs of biology students in mind. In this volume, authors from a variety of institutions address some of the problems involved in reforming mathematics curricula for biology students. The problems are sorted into three themes: Models, Processes, and Directions. It is difficult for mathematicians to generate curriculum ideas for the training of biologists

so a number of the curriculum models that have been introduced at various institutions comprise the Models section. Processes deals with taking that great course and making sure it is institutionalized in both the biology department (as a requirement) and in the mathematics department (as a course that will live on even if the creator of the course is no longer on the faculty). Directions looks to the future, with each paper laying out a case for pedagogical developments that the authors would like to see.

[Mathematics for the Life Sciences](#) - Erin N. Bodine 2014-08-17

An accessible undergraduate textbook on the essential math concepts used in the life sciences The life sciences deal with a vast array of problems at different spatial, temporal, and organizational scales. The mathematics necessary to describe, model, and analyze these problems is similarly diverse, incorporating quantitative techniques that are rarely taught in standard undergraduate courses. This textbook provides an accessible introduction to these critical mathematical concepts, linking them to biological observation and theory while also presenting the computational tools needed to address problems not readily investigated using mathematics alone. Proven in the classroom and requiring only a background in high school math, Mathematics for the Life Sciences doesn't just focus on calculus as do most other textbooks on the subject. It covers deterministic methods and those that incorporate uncertainty, problems in discrete and continuous time, probability, graphing and data analysis, matrix modeling, difference equations, differential equations, and much more. The book uses MATLAB throughout, explaining how to use it, write code, and connect models to data in examples chosen from across the life sciences. Provides undergraduate life science students with a succinct overview of major mathematical concepts that are essential for modern biology Covers all the major quantitative concepts that national reports have identified as the ideal components of an entry-level course for life science students Provides good background for the MCAT, which now includes data-based and statistical reasoning Explicitly links data and math modeling Includes end-of-chapter homework problems, end-of-unit student projects, and select answers to homework problems Uses MATLAB throughout, and MATLAB m-files with an R supplement are available online Prepares students to read with comprehension the growing quantitative literature across the life sciences A solutions manual for professors and an illustration package is available

Mathematics for Neuroscientists - Fabrizio Gabbiani 2017-03-21

Mathematics for Neuroscientists, Second Edition, presents a comprehensive introduction to mathematical and computational methods used in neuroscience to describe and model neural components of the brain from ion channels to single neurons, neural networks and their relation to behavior. The book contains more than 200 figures generated using Matlab code available to the student and scholar. Mathematical concepts are introduced hand in hand with neuroscience, emphasizing the connection between experimental results and theory. Fully revised material and corrected text Additional chapters on extracellular potentials, motion detection and neurovascular coupling Revised selection of exercises with solutions More than 200 Matlab scripts reproducing the figures as well as a selection of equivalent Python scripts

Mathematical Models in Biology - Leah Edelstein-Keshet 1988-01-01

Mathematical Models in Biology is an introductory book for readers interested in biological applications of mathematics and modeling in biology. A favorite in the mathematical biology community, it shows how relatively simple mathematics can be applied to a variety of models to draw interesting conclusions. Connections are made between diverse biological examples linked by common mathematical themes. A variety of discrete and continuous ordinary and partial differential equation models are explored. Although great advances have taken place in many of the topics covered, the simple lessons contained in this book are still important and informative. Audience: the book does not assume too much background knowledge--essentially some calculus and high-school algebra. It was originally written with third- and fourth-year undergraduate mathematical-biology majors in

mind; however, it was picked up by beginning graduate students as well as researchers in math (and some in biology) who wanted to learn about this field.

Mathematical Modeling in Systems Biology - Brian P. Ingalls 2022-06-07

An introduction to the mathematical concepts and techniques needed for the construction and analysis of models in molecular systems biology. Systems techniques are integral to current research in molecular cell biology, and system-level investigations are often accompanied by mathematical models. These models serve as working hypotheses: they help us to understand and predict the behavior of complex systems. This book offers an introduction to mathematical concepts and techniques needed for the construction and interpretation of models in molecular systems biology. It is accessible to upper-level undergraduate or graduate students in life science or engineering who have some familiarity with calculus, and will be a useful reference for researchers at all levels. The first four chapters cover the basics of mathematical modeling in molecular systems biology. The last four chapters address specific biological domains, treating modeling of metabolic networks, of signal transduction pathways, of gene regulatory networks, and of electrophysiology and neuronal action potentials. Chapters 3–8 end with optional sections that address more specialized modeling topics. Exercises, solvable with pen-and-paper calculations, appear throughout the text to encourage interaction with the mathematical techniques. More involved end-of-chapter problem sets require computational software. Appendixes provide a review of basic concepts of molecular biology, additional mathematical background material, and tutorials for two computational software packages (XPPAUT and MATLAB) that can be used for model simulation and analysis.

Elements of Mathematical Ecology - Mark Kot 2001-07-19

Elements of Mathematical Ecology provides an introduction to classical and modern mathematical models, methods, and issues in population ecology. The first part of the book is devoted to simple, unstructured population models that ignore much of the variability found in natural populations for the sake of tractability. Topics covered include density dependence, bifurcations, demographic stochasticity, time delays, population interactions (predation, competition, and mutualism), and the application of optimal control theory to the management of renewable resources. The second part of this book is devoted to structured population models, covering spatially-structured population models (with a focus on reaction-diffusion models), age-structured models, and two-sex models. Suitable for upper level students and beginning researchers in ecology, mathematical biology and applied mathematics, the volume includes numerous clear line diagrams that clarify the mathematics, relevant problems throughout the text that aid understanding, and supplementary mathematical and historical material that enrich the main text.

Physical Models of Living Systems - Philip Nelson 2015-03-06

Written for intermediate-level undergraduates pursuing any science or engineering major, Physical Models of Living Systems helps students develop many of the competencies that form the basis of the new MCAT2015. The only prerequisite is first-year physics. With the more advanced "Track-2" sections at the end of each chapter, the book can be used in graduate-level courses as well.

Mathematical Methods of Population Biology - Frank C. Hoppensteadt 1982-02-26

An introduction to mathematical methods used in the study of population phenomena including models of total population and population age structure, models of random population events presented in terms of Markov chains, and methods used to uncover qualitative behavior of more complicated difference equations.

Mathematics in Industry - Angela Slavova 2015-09-18

In this book, a wide range of problems concerning recent achievements in the field of industrial and applied mathematics are presented. It provides new ideas and research for scientists developing and studying mathematical methods and algorithms, and researchers applying them for solving real-life problems. The importance of the computing infrastructure is unquestionable for the development of modern science. The main focus of the book is

the application of mathematics to industry and science. It promotes basic research in mathematics leading to new methods and techniques useful to industry and science. The volume also considers strategy-making integration between scientists of applied mathematics and those working in applied informatics, which has potential for long-lasting integration and co-operation. The integration role is regarded here as a tool for consolidation and reinforcement of the research, education and training, and for the transfer of scientific and management knowledge. This volume operates as a medium for the exchange of information and ideas between mathematicians and other technical and scientific personnel. The book will be essential for the promotion of interdisciplinary collaboration between applied mathematics and science, engineering and technology. The main topics examined in this volume are: numerical methods and algorithms; control systems and applications; partial differential equations and real-life applications; the high performance of scientific computing; linear algebra applications; neurosciences; algorithms in industrial mathematics; equations of mathematical physics; and industrial applications of mechanics.

Mathematical Methods in Image Reconstruction - Frank Natterer 2001-01-01

This book provides readers with a superior understanding of the mathematical principles behind imaging.

Mathematical Models in Biology - Elizabeth S. Allman 2004

This introductory textbook on mathematical biology focuses on discrete models across a variety of biological subdisciplines. Biological topics treated include linear and non-linear models of populations, Markov models of molecular evolution, phylogenetic tree construction, genetics, and infectious disease models. The coverage of models of molecular evolution and phylogenetic tree construction from DNA sequence data is unique among books at this level. Computer investigations with MATLAB are incorporated throughout, in both exercises and more extensive projects, to give readers hands-on experience with the mathematical models developed. MATLAB programs accompany the text. Mathematical tools, such as matrix algebra, eigenvector analysis, and basic probability, are motivated by biological models and given self-contained developments, so that mathematical prerequisites are minimal.

An Introduction to Continuous-Time Stochastic Processes - Vincenzo Capasso 2008-01-03

This concisely written book is a rigorous and self-contained introduction to the theory of continuous-time stochastic processes. Balancing theory and applications, the authors use stochastic methods and concrete examples to model real-world problems from engineering, biomathematics, biotechnology, and finance. Suitable as a textbook for graduate or advanced undergraduate courses, the work may also be used for self-study or as a reference. The book will be of interest to students, pure and applied mathematicians, and researchers or practitioners in mathematical finance, biomathematics, physics, and engineering.

How to Write and Illustrate a Scientific Paper - Björn Gustavii 2008-02-28

This second edition of How to Write and Illustrate a Scientific Paper will help both first-time writers and more experienced authors, in all biological and medical disciplines, to present their results effectively. Whilst retaining the easy-to-read and well-structured approach of the previous edition, it has been broadened to include comprehensive advice on writing compilation theses for doctoral degrees, and a detailed description of preparing case reports. Illustrations, particularly graphs, are discussed in detail, with poor examples redrawn for comparison. The reader is offered advice on how to present the paper, where and how to submit the manuscript, and finally, how to correct the proofs. Examples of both good and bad writing, selected from actual journal articles, illustrate the author's advice - which has been developed through his extensive teaching experience - in this accessible and informative guide.

A Course in Mathematical Biology - Gerda de Vries 2006-07-01

This is the only book that teaches all aspects of modern mathematical modeling and that is specifically designed to introduce undergraduate students to problem solving in the context of biology. Included is an integrated package of

theoretical modeling and analysis tools, computational modeling techniques, and parameter estimation and model validation methods, with a focus on integrating analytical and computational tools in the modeling of biological processes. Divided into three parts, it covers basic analytical modeling techniques; introduces computational tools used in the modeling of biological problems; and includes various problems from epidemiology, ecology, and physiology. All chapters include realistic biological examples, including many exercises related to biological questions. In addition, 25 open-ended research projects are provided, suitable for students. An accompanying Web site contains solutions and a tutorial for the implementation of the computational modeling techniques. Calculations can be done in modern computing languages such as Maple, Mathematica, and MATLAB?

Methods and Models in Mathematical Biology - Johannes Müller 2015-08-13

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

Essential Mathematical Biology - Nicholas F. Britton 2012-12-06

This self-contained introduction to the fast-growing field of Mathematical Biology is written for students with a mathematical background. It sets the subject in a historical context and guides the reader towards questions of current research interest. A broad range of topics is covered including: Population dynamics, Infectious diseases, Population genetics and evolution, Dispersal, Molecular and cellular biology, Pattern formation, and Cancer modelling. Particular attention is paid to situations where the simple assumptions of homogeneity made in early models break down and the process of mathematical modelling is seen in action.

Algebraic and Discrete Mathematical Methods for Modern Biology - Raina Robeva 2015-05-09

Written by experts in both mathematics and biology, Algebraic and Discrete Mathematical Methods for Modern Biology offers a bridge between math and biology, providing a framework for simulating, analyzing, predicting, and modulating the behavior of complex biological systems. Each chapter begins with a question from modern biology, followed by the description of certain mathematical methods and theory appropriate in the search of answers. Every topic provides a fast-track pathway through the problem by presenting the biological foundation, covering the relevant mathematical theory, and highlighting connections between them. Many of the projects and exercises embedded in each chapter utilize specialized software, providing students with much-needed familiarity and experience with computing applications, critical components of the "modern biology" skill set. This book is appropriate for mathematics courses such as finite mathematics, discrete structures, linear algebra, abstract/modern algebra, graph theory, probability, bioinformatics, statistics, biostatistics, and modeling, as well as for biology courses such as genetics, cell and molecular biology, biochemistry, ecology, and evolution. Examines significant questions in modern biology and their mathematical treatments Presents important mathematical concepts and tools in the context of essential biology Features material of interest to students in both mathematics and biology Presents chapters in modular format so coverage need not follow the Table of Contents Introduces projects appropriate for undergraduate research Utilizes freely accessible software for visualization, simulation, and analysis in modern biology Requires no calculus as a prerequisite Provides a complete Solutions Manual Features a companion website with supplementary resources

Systems Biology of Cell Signaling - James E. Ferrell 2021-09-28

How can we understand the complexity of genes, RNAs, and proteins and the associated regulatory networks?

One approach is to look for recurring types of dynamical behavior. Mathematical models prove to be useful, especially models coming from theories of biochemical reactions such as ordinary differential equation models. Clever, careful experiments test these models and their basis in specific theories. This textbook aims to provide advanced students with the tools and insights needed to carry out studies of signal transduction drawing on modeling, theory, and experimentation. Early chapters summarize the basic building blocks of signaling systems: binding/dissociation, synthesis/destruction, and activation/inactivation. Subsequent chapters introduce various basic circuit devices: amplifiers, stabilizers, pulse generators, switches, stochastic spike generators, and oscillators. All chapters consistently use approaches and concepts from chemical kinetics and nonlinear dynamics, including rate-balance analysis, phase plane analysis, nullclines, linear stability analysis, stable nodes, saddles, unstable nodes, stable and unstable spirals, and bifurcations. This textbook seeks to provide quantitatively inclined biologists and biologically inclined physicists with the tools and insights needed to apply modeling and theory to interesting biological processes. Key Features: · Full-color illustration program with diagrams to help illuminate the concepts · Enables the reader to apply modeling and theory to the biological processes · Further Reading for each chapter · High-quality figures available for instructors to download

Mathematical Models in Population Biology and Epidemiology - Fred Brauer 2013-03-09

The goal of this book is to search for a balance between simple and analyzable models and unsolvable models which are capable of addressing important questions on population biology. Part I focusses on single species simple models including those which have been used to predict the growth of human and animal population in the past. Single population models are, in some sense, the building blocks of more realistic models -- the subject of Part II. Their role is fundamental to the study of ecological and demographic processes including the role of population structure and spatial heterogeneity -- the subject of Part III. This book, which will include both examples and exercises, is of use to practitioners, graduate students, and scientists working in the field.

Quantifying Life - Dmitry A. Kondrashov 2016-08-04

Since the time of Isaac Newton, physicists have used mathematics to describe the behavior of matter of all sizes, from subatomic particles to galaxies. In the past three decades, as advances in molecular biology have produced an avalanche of data, computational and mathematical techniques have also become necessary tools in the arsenal of biologists. But while quantitative approaches are now providing fundamental insights into biological systems, the college curriculum for biologists has not caught up, and most biology majors are never exposed to the computational and probabilistic mathematical approaches that dominate in biological research. With *Quantifying Life*, Dmitry A. Kondrashov offers an accessible introduction to the breadth of mathematical modeling used in biology today. Assuming only a foundation in high school mathematics, *Quantifying Life* takes an innovative computational approach to developing mathematical skills and intuition. Through lessons illustrated with copious examples, mathematical and programming exercises, literature discussion questions, and computational projects of various degrees of difficulty, students build and analyze models based on current research papers and learn to implement them in the R programming language. This interplay of mathematical ideas, systematically developed programming skills, and a broad selection of biological research topics makes *Quantifying Life* an invaluable guide for seasoned life scientists and the next generation of biologists alike.

Mathematical Biology - Ronald W. Shonkwiler 2009-08-04

This text presents mathematical biology as a field with a unity of its own, rather than only the intrusion of one science into another. The book focuses on problems of contemporary interest, such as cancer, genetics, and the rapidly growing field of genomics.

Mathematical Biology - James D. Murray 2007-06-12

Mathematical Biology is a richly illustrated textbook in an exciting and fast growing field. Providing an in-depth

look at the practical use of math modeling, it features exercises throughout that are drawn from a variety of bioscientific disciplines - population biology, developmental biology, physiology, epidemiology, and evolution, among others. It maintains a consistent level throughout so that graduate students can use it to gain a foothold into this dynamic research area.

Exploring Mathematical Modeling in Biology Through Case Studies and Experimental Activities - Rebecca Sanft
2020-04-15

Exploring Mathematical Modeling in Biology through Case Studies and Experimental Activities provides supporting materials for courses taken by students majoring in mathematics, computer science or in the life sciences. The book's cases and lab exercises focus on hypothesis testing and model development in the context of real data. The supporting mathematical, coding and biological background permit readers to explore a problem, understand assumptions, and the meaning of their results. The experiential components provide hands-on learning

both in the lab and on the computer. As a beginning text in modeling, readers will learn to value the approach and apply competencies in other settings. Included case studies focus on building a model to solve a particular biological problem from concept and translation into a mathematical form, to validating the parameters, testing the quality of the model and finally interpreting the outcome in biological terms. The book also shows how particular mathematical approaches are adapted to a variety of problems at multiple biological scales. Finally, the labs bring the biological problems and the practical issues of collecting data to actually test the model and/or adapting the mathematics to the data that can be collected. Presents a single volume on mathematics and biological examples, with data and wet lab experiences suitable for non-experts. Contains three real-world biological case studies and one wet lab for application of the mathematical models. Includes R code templates throughout the text, which are also available through an online repository, along with the necessary data files to complete all projects and labs.