Dynamic Models in Biology

Stephen P. Ellner and
John Guckenheimer

Dynamic Models In Biological Sciences

Vadrevu Sree Hari Rao,Ponnada Raja Sekhara Rao

Dynamic Models In Biological Sciences:

Dynamic Models in Biology Stephen P. Ellner,John Guckenheimer,2011-09-19 From controlling disease outbreaks to predicting heart attacks dynamic models are increasingly crucial for understanding biological processes Many universities are starting undergraduate programs in computational biology to introduce students to this rapidly growing field In Dynamic Models in Biology the first text on dynamic models specifically written for undergraduate students in the biological sciences ecologist Stephen Ellner and mathematician John Guckenheimer teach students how to understand build and use dynamic models in biology Developed from a course taught by Ellner and Guckenheimer at Cornell University the book is organized around biological applications with mathematics and computing developed through case studies at the molecular cellular and population levels The authors cover both simple analytic models the sort usually found in mathematical biology texts and the complex computational models now used by both biologists and mathematicians Linked to a Web site with computer lab materials and exercises Dynamic Models in Biology is a major new introduction to dynamic models for students in the biological sciences mathematics and engineering *Dynamic Models and Control of Biological Systems* Vadrevu Sree Hari Rao,Ponnada Raja Sekhara Rao,2009-07-30 Mathematical Biology has grown at an astonishing rate and has established itself as a distinct discipline Mathematical modeling is now being applied in every major discipline in the biological sciences Though the field has become increasingly large and specialized this book remains important as a text that introduces some of the exciting problems which arise in the biological sciences and gives some indication of the wide spectrum of questions that modeling can address **Dynamical Models in Biology** Miklós Farkas,2001-06-15 Dynamic Models in Biology offers an introduction to modern mathematical biology This book provides a short introduction to modern mathematical methods in modeling dynamical phenomena and treats the broad topics of population dynamics epidemiology evolution immunology morphogenesis and pattern formation Primarily employing differential equations the author presents accessible descriptions of difficult mathematical models Recent mathematical results are included but the author s presentation gives intuitive meaning to all the main formulae Besides mathematicians who want to get acquainted with this relatively new field of applications this book is useful for physicians biologists agricultural engineers and environmentalists Key Topics Include Chaotic dynamics of populations The spread of sexually transmitted diseases Problems of the origin of life Models of immunology Formation of animal hide patterns The intuitive meaning of mathematical formulae explained with many figures Applying new mathematical results in modeling biological phenomena Miklos Farkas is a professor at Budapest University of Technology where he has researched and instructed mathematics for over thirty years He has taught at universities in the former Soviet Union Canada Australia Venezuela Nigeria India and Columbia Prof Farkas received the 1999 Bolyai Award of the Hungarian Academy of Science and the 2001 Albert Szentgyorgyi Award of the Hungarian Ministry of Education A down to earth introduction to the growing field of modern mathematical biology Also includes appendices which provide

background material that goes beyond advanced calculus and linear algebra *Dynamical Models in Biology* Miklós Farkas,2001-06-06 Dynamic Models in Biology offers an introduction to modern mathematical biology This book provides a short introduction to modern mathematical methods in modeling dynamical phenomena and treats the broad topics of population dynamics epidemiology evolution immunology morphogenesis and pattern formation Primarily employing differential equations the author presents accessible descriptions of difficult mathematical models Recent mathematical results are included but the author s presentation gives intuitive meaning to all the main formulae Besides mathematicians who want to get acquainted with this relatively new field of applications this book is useful for physicians biologists agricultural engineers and environmentalists Key Topics Include Chaotic dynamics of populations The spread of sexually transmitted diseases Problems of the origin of life Models of immunology Formation of animal hide patterns The intuitive meaning of mathematical formulae explained with many figures Applying new mathematical results in modeling biological phenomena Miklos Farkas is a professor at Budapest University of Technology where he has researched and instructed mathematics for over thirty years He has taught at universities in the former Soviet Union Canada Australia Venezuela Nigeria India and Columbia Prof Farkas received the 1999 Bolyai Award of the Hungarian Academy of Science and the 2001 Albert Szentgyorgyi Award of the Hungarian Ministry of Education A down to earth introduction to the growing field of modern mathematical biology Also includes appendices which provide background material that goes beyond advanced calculus and linear algebra **Modeling Dynamic Biological Systems** Bruce Hannon,Matthias Ruth,2014-07-05 Many biologists and ecologists have developed models that find widespread use in theoretical investigations and in applications to organism behavior disease control population and metapopulation theory ecosystem dynamics and environmental management This book captures and extends the process of model development by concentrating on the dynamic aspects of these processes and by providing the tools such that virtually anyone with basic knowledge in the Life Sciences can develop meaningful dynamic models Examples of the systems modeled in the book range from models of cell development the beating heart the growth and spread of insects spatial competition and extinction to the spread and control of epidemics including the conditions for the development of chaos Key features easy to learn and easy to use software examples from many subdisciplines of biology covering models of cells organisms populations and metapopulations no prior computer or programming experience required Key benefits learn how to develop modeling skills and system thinking on your own rather than use models developed by others be able to easily run models under alternative assumptions and investigate the implications of these assumptions for the dynamics of the biological system being modeled develop skills to assess the dynamics of biological systems A Mathematical Treatment of Dynamical Models in Biological Science Kristína Smítalová,Štefan Šujan,1991 Providing a comprehensive introduction to mathematical modelling in biology and ecology this book presents numerous results and developments The basic mathematical facts on the theory of the dynamics of biological

communities are presented with emphasis placed on the quantitive aspects **Dynamical Models of Biology and Medicine** Yang Kuang,Meng Fan,Shengqiang Liu,2019-09-25 Mathematical and computational modeling approaches in biological and medical research are experiencing rapid growth globally This Special Issue Book intends to scratch the surface of this exciting phenomenon The subject areas covered involve general mathematical methods and their applications in biology and medicine with an emphasis on work related to mathematical and computational modeling of the complex dynamics observed in biological and medical research Fourteen rigorously reviewed papers were included in this Special Issue These papers cover several timely topics relating to classical population biology fundamental biology and modern medicine While the authors of these papers dealt with very different modeling questions they were all motivated by specific applications in biology and medicine and employed innovative mathematical and computational methods to study the complex dynamics of their models We hope that these papers detail case studies that will inspire many additional mathematical modeling efforts in biology and medicine **Modeling Dynamic Phenomena in Molecular and Cellular Biology** Lee A. Segel,1984-03-30 The dynamic development of various processes is a central problem of biology and indeed of all the sciences The mathematics describing that development is in general complicated because the models that are realistic are usually nonlinear Consequently many biologists may not notice a possible application of theory They may be unable to decide whether a particular model captures the essence of a system or to appreciate that analysis of a model can reveal important aspects of biological problems and may even describe in detail how a system works The aim of this textbook is to remedy the situation by adopting a general approach to model analysis and applying it several times to problems drawn primarily from molecular and cellular biology of gradually increasing biological and mathematical complexity Although material of considerable sophistication is included little mathematical background is required only some exposure to elementary calculus appendixes supply the necessary mathematics and the author concentrates on concepts rather than techniques He also emphasizes the role of computers in giving a full picture of model behavior and complementing more qualitative analysis Some problems suitable for computer analysis are also included This is a class tested textbook suitable for a one semester course for advanced undergraduate and beginning graduate students in biology or applied mathematics It can also be used as a source book for teachers and a reference for specialists *Levels of Organization in the Biological Sciences* Daniel S. Brooks,James DiFrisco,William C. Wimsatt,2021-08-24 Scientific philosophers examine the nature and significance of levels of organization a core structural principle in the biological sciences This volume examines the idea of levels of organization as a distinct object of investigation considering its merits as a core organizational principle for the scientific image of the natural world It approaches levels of organization roughly the idea that the natural world is segregated into part whole relationships of increasing spatiotemporal scale and complexity in terms of its roles in scientific reasoning as a dynamic open ended idea capable of performing multiple overlapping functions in distinct empirical settings The contributors scientific

philosophers with longstanding ties to the biological sciences discuss topics including the philosophical and scientific contexts for an inquiry into levels whether the concept can actually deliver on its organizational promises the role of levels in the development and evolution of complex systems conditional independence and downward causation and the extension of the concept into the sociocultural realm Taken together the contributions embrace the diverse usages of the term as aspects of the big picture of levels of organization Contributors Jan Baedke Robert W Batterman Daniel S Brooks James DiFrisco Markus I Eronen Carl Gillett Sara Green James Griesemer Alan C Love Angela Potochnik Thomas Reydon Ilya T mkin Jon Umerez William C Wimsatt James Woodward **Spatial Dynamics Models In The Life Sciences And The Role Of Feedback In Robust Developments** Frederic Y M Wan,2022-12-28 Basic mathematical techniques for partial differential equations PDE with applications to the life sciences form an integral part of the core curriculum for programs in mathematical biology Yet students in such a program with an undergraduate training in biology are typically deficient in any exposure to PDE This volume starts with simple first order PDE and progresses through higher order equations and systems but with interesting applications even at the level of a single first order PDE with constant coefficients Similar to the two previous volumes by the author another unique feature of the book is highlighting the scientific theme s of interest for the biological phenomena being modelled and analysed In addition to temporal evolution of a biological phenomenon its limiting equilibrium states and their stability the possibility of locational variations leads to a study of additional themes such as signal and wave propagation spatial patterning and robustness The requirement that biological developments are relatively insensitive to sustained environmental changes provides an opportunity to examine the issue of feedback and robustness not encountered in the previous two volumes of this series **Dynamical System Models in the Life Sciences and Their Underlying Scientific Issues** Frederic Y. M. Wan,2018 Broadly speaking there are two general approaches to teaching mathematical modeling 1 The case study approach focusing on different specific modeling problems familiar to the particular author and 2 The methods approach teaching some useful mathematical techniques accessible to the targeted student cohort with different models introduced to illustrate the application of the methods taught The goal and approach of this new text differ from these two conventional approaches in that its emphasis is on the scientific issues that prompt the mathematical modeling and analysis of a particular phenomenon For example in the study of a fish population we may be interested in the growth and evolution of the population whether the natural growth or harvested population reaches a steady state equilibrium or periodically changing population in a particular environment is a steady state stable or unstable with respect to a small perturbation from the equilibrium state whether a small change in the environment would lead to a catastrophic change etc Each of these scientific issues requires the introduction of a different kind of model and a different set of mathematical tools to extract information about the same biological organisms or phenomena Volume I of this three volume set limits its scope to phenomena and scientific issues that can be modeled by ordinary differential equations ODE that

govern the evolution of the phenomena with time The scientific issues involved include evolution equilibrium stability bifurcation feedback optimization and control Scientific issues such as signal and wave propagation diffusion and shock formation pertaining to phenomena involving spatial dynamics are to be modeled by partial differential equations PDE and will be treated in Volume II Scientific issues involving randomness and uncertainty are deferred to Volume III

Mathematical Methods in Medical and Biological Sciences Harendra Singh,Hari M Srivastava,2024-11-05 Mathematical Methods in Medical and Biological Sciences presents mathematical methods for computational models arising in the medical and biological sciences The book presents several real life medical and biological models such as infectious and non infectious diseases that can be modeled mathematically to accomplish profound research in virtual environments when the cost of laboratory expenses is relatively high It focuses on mathematical techniques that provide global solutions for models arising in medical and biological sciences by considering their long term benefits In addition the book provides leading edge developments and insights for a range of applications including epidemiological modeling of pandemic dynamics viral infection developments cancer developments blood oxygen dynamics HIV infection spread reaction diffusion models polio infection spread and chaos modeling with fractional order derivatives Presents the mathematical treatment of a wide range of real life medical and biological models including both infectious and non infectious diseases Provides in depth analysis of the spread of Covid 19 polio and HIV including discussion of computational methods and applications Includes computational modeling methods along with their practical applications providing the basis for further exploration and research in epidemiology and applied biomedical sciences **Systems Biology for Signaling Networks** Sangdun Choi,2010-08-09 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 Dynamic Models of Biodiversity Pattern and Process Susan E. Cameron,2008 Dynamic Models of Energy, Robotic, and Biological Systems José De Jesús Rubio,Alejandro Zacarias,Jaime Pacheco,2025-05-08 **Modeling Biological Systems** James W. Haefner,2012-12-06 This book is intended as a text for a first course on creating and analyzing computer simulation models of biological systems The expected audience for this book are students wishing to use dynamic models to interpret real data mueh as they would use standard statistical techniques It is meant to provide both the essential principles as well as the details and equa tions applicable to a few particular systems and subdisciplines Biological systems however encompass a vast diverse array of topics and problems This book discusses only a select number of these that I have found to be useful and interesting to biologists just beginning their appreciation of computer simulation The examples chosen span classical mathematical models of well studied systems to state of the art topics such as cellular automata and artificial life I have stressed the relationship between the models and the biology over mathematical analysis in order to give the reader a sense that mathematical models really are useful to biologists In this light I have sought examples that address fundamental and I think interesting biological questions Almost all of the models are directly COIIl pared to quantitative data to provide at least a partial demonstration that some biological models can accurately predict **Dynamic Systems Biology Modeling and Simulation** Joseph DiStefano III,2015-01-10 Dynamic Systems Biology Modeling and Simuation consolidates and unifies classical and contemporary multiscale methodologies for mathematical modeling and computer simulation of dynamic biological systems from molecular cellular organ system on up to population levels The book pedagogy is developed as a well annotated systematic tutorial with clearly spelled out and unified nomenclature derived from the author s own modeling efforts publications and teaching over half a century Ambiguities in some concepts and tools are clarified and others are rendered more accessible and practical The latter include novel qualitative theory and methodologies for recognizing dynamical signatures in data using structural multicompartmental and network models and graph theory and analyzing structural and measurement data models for quantification feasibility The level is basic to intermediate with much emphasis on biomodeling from real biodata for use in real applications Introductory coverage of core mathematical concepts such as linear and nonlinear differential and difference equations Laplace transforms linear algebra probability statistics and stochastics topics The pertinent biology biochemistry biophysics or pharmacology for modeling are provided to support understanding the amalgam of math modeling with life sciences Strong emphasis on quantifying as well as building and analyzing biomodels includes methodology and computational tools for parameter identifiability and sensitivity analysis parameter estimation from real data model distinguishability and simplification and practical bioexperiment design and

optimization Companion website provides solutions and program code for examples and exercises using Matlab Simulink VisSim SimBiology SAAMII AMIGO Copasi and SBML coded models A full set of PowerPoint slides are available from the author for teaching from his textbook He uses them to teach a 10 week quarter upper division course at UCLA which meets twice a week so there are 20 lectures They can easily be augmented or stretched for a 15 week semester course Importantly the slides are editable so they can be readily adapted to a lecturer s personal style and course content needs The lectures are based on excerpts from 12 of the first 13 chapters of DSBMS They are designed to highlight the key course material as a study guide and structure for students following the full text content The complete PowerPoint slide package 25 MB can be obtained by instructors or prospective instructors by emailing the author directly at joed cs ucla edu **Mathematics and Computers in Biomedical Applications** Jerome Eisenfeld,Charles DeLisi,1985 **Fiftieth Anniversary, 1912-1962** Institute of Radio Engineers,1962 Self-Modifying Systems in Biology and Cognitive Science G. Kampis,1991-04-30 The theme of this book is the self generation of information by the self modification of systems The author explains why biological and cognitive processes exhibit identity changes in the mathematical and logical sense This concept is the basis of a new organizational principle which utilizes shifts of the internal semantic relations in systems There are mathematical discussions of various classes of systems Turing machines input output systems synergetic systems non linear dynamics etc which are contrasted with the author s new principle The most important implications of this include a new conception on the nature of information and which also provides a new and coherent conceptual view of a wide class of natural systems This book merits the attention of all philosophers and scientists concerned with the way we create reality in our mathematical representations of the world and the connection those representations have with the way things really are

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