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Proceedings of the third Multidisciplinary International Symposium on Positive Systems: Theory and Applications (POSTA 09) Valencia, Spain, September 2-4, 2009
Nonlinear Dynamics of Interacting Populations
Dynamical Systems and Population Persistence
Evolutionary Games and Population Dynamics

MARIANA STEIN

Applications of Dynamical Systems in Biology and Medicine Springer Why do organisms become extremely abundant one year and then seem to disappear a few years later? Why do population outbreaks in particular species happen more or less regularly in certain locations, but only irregularly (or never at all) in other locations? Complex population dynamics have fascinated biologists for decades. By bringing together mathematical models, statistical analyses, and field experiments, this book offers a comprehensive new synthesis of the theory of population oscillations. Peter Turchin first reviews the conceptual tools that ecologists use to investigate population oscillations, introducing population modeling and the statistical analysis of time series data. He then provides an in-depth discussion of several case studies--including the larch budmoth, southern pine beetle, red grouse, voles and lemmings, snowshoe hare, and ungulates--to develop a new analysis of the mechanisms that drive population oscillations in nature.

Through such work, the author argues, ecologists can develop general laws of population dynamics that will help turn ecology into a truly quantitative and predictive science. Complex Population Dynamics integrates theoretical and empirical studies into a major new synthesis of current knowledge about population dynamics. It is also a pioneering work that sets the course for ecology's future as a predictive science.

Complex Population Dynamics

Elsevier Inc. Chapters

This volume contains the proceedings of the "Third Multidisciplinary Symposium on Positive Systems: Theory and Applications (POSTA09)" held in Valencia, Spain, September 2–4, 2009. This is the only world congress whose main topic is focused on this field.

Differential Dynamical Systems, Revised Edition

American Mathematical Soc.

The aim of this book is to provide a well-structured and coherent overview of existing mathematical modeling approaches for biochemical reaction systems, investigating relations between both the conventional models and several types of deterministic-stochastic hybrid model recombinations. Another main objective is to illustrate and compare diverse numerical simulation schemes and their computational effort. Unlike related works, this book presents a broad scope in its applications, from offering a detailed introduction to hybrid approaches for the case of multiple population scales to discussing the setting of time-scale separation resulting from widely varying firing rates of reaction channels. Additionally, it also addresses modeling approaches for non well-mixed reaction-diffusion dynamics, including deterministic and stochastic PDEs and spatiotemporal master equations. Finally, by translating and incorporating complex theory to a level accessible to non-mathematicians, this book effectively bridges the gap between mathematical research in computational biology and its practical use in biological, biochemical, and biomedical systems.

Chapter 11. Top-Down Dynamical Modeling of Molecular Regulatory Networks

SIAM Presenting very recent results in a major research area, this book is addressed to experts and non-experts in the mathematical community alike. The applied issues range from crystallization and dendrite growth to quantum chaos, conveying their significance far into the neighboring disciplines of science.

A Theoretical/empirical Synthesis

Springer

This book contains a systematic study of ecological communities of two or three interacting populations. Starting from the Lotka-Volterra system, various regulating factors are considered, such as rates of birth and death, predation and competition. The different factors can have a stabilizing or a destabilizing effect on the community, and their interplay leads to increasingly complicated behavior. Studying and understanding this path to greater dynamical complexity of ecological systems constitutes the backbone of this book. On the mathematical side, the tool of choice is the qualitative theory of dynamical systems — most importantly bifurcation theory, which describes the dependence of a system on the parameters. This approach allows one to find general patterns of behavior that are expected to be observed in ecological models. Of special interest is the reaction of a

given model to disturbances of its present state, as well as to changes in the external conditions. This leads to the general idea of “dangerous boundaries” in the state and parameter space of an ecological system. The study of these boundaries allows one to analyze and predict qualitative and often sudden changes of the dynamics — a much-needed tool, given the increasing antropogenic load on the biosphere.As a spin-off from this approach, the book can be used as a guided tour of bifurcation theory from the viewpoint of application. The interested reader will find a wealth of intriguing examples of how known bifurcations occur in applications. The book can in fact be seen as bridging the gap between mathematical biology and bifurcation theory. Springer Science & Business Media
The book provides an introduction to deterministic (and some stochastic) modeling of spatiotemporal phenomena in ecology, epidemiology, and neural systems. A survey of the classical models in the fields with up to date applications is given. The book begins with detailed description of how spatial dynamics/diffusive processes influence the dynamics of biological populations. These

processes play a key role in understanding the outbreak and spread of pandemics which help us in designing the control strategies from the public health perspective. A brief discussion on the functional mechanism of the brain (single neuron models and network level) with classical models of neuronal dynamics in space and time is given. Relevant phenomena and existing modeling approaches in ecology, epidemiology and neuroscience are introduced, which provide examples of pattern formation in these models. The analysis of patterns enables us to study the dynamics of macroscopic and microscopic behaviour of underlying systems and travelling wave type patterns observed in dispersive systems. Moving on to virus dynamics, authors present a detailed analysis of different types models of infectious diseases including two models for influenza, five models for Ebola virus and seven models for Zika virus with diffusion and time delay. A Chapter is devoted for the study of Brain Dynamics (Neural systems in space and time). Significant advances made in modeling the reaction-diffusion systems are presented and spatiotemporal patterning in the systems is reviewed. Development of appropriate mathematical models and detailed analysis (such as linear stability, weakly nonlinear analysis, bifurcation analysis, control theory, numerical simulation) are presented. Key Features Covers the fundamental concepts and mathematical skills required to analyse reaction-diffusion models for biological populations. Concepts are introduced in such a way that readers with a basic knowledge of differential equations and numerical methods can understand the analysis. The results are also illustrated with figures. Focuses on mathematical modeling and numerical simulations using basic conceptual and classic models of population dynamics, Virus and Brain dynamics. Covers wide range of models using spatial and non-spatial approaches. Covers single, two and multispecies reaction-diffusion models from ecology and models from bio-chemistry. Models are analysed for stability of equilibrium points, Turing instability, Hopf bifurcation and pattern formations. Uses Mathematica for problem solving and MATLAB for pattern formations. Contains solved Examples and Problems in Exercises. The Book is suitable for advanced undergraduate, graduate and research students. For those who are working in the above areas, it provides information from most of the recent works. The text presents all the fundamental concepts and mathematical skills needed to build models and perform analyses. Mathematics for Ecology and Environmental Sciences Princeton University Press Chaos in Ecology is a convincing demonstration of chaos in a biological population. The book synthesizes an ecologically focused interdisciplinary blend of non-linear dynamics theory, statistics, and experimentation yielding results of uncommon clarity and rigor. Topics include fundamental issues that are of general and widespread importance to population biology and ecology. Detailed descriptions are included of the mathematical, statistical, and experimental steps they used to explore nonlinear dynamics in ecology. Beginning with a brief overview of chaos theory and its implications for ecology. The book continues by deriving and rigorously testing a mathematical model that is closely wedded to biological mechanisms of their research organism. Therefrom were generated a variety of predictions that are fundamental to chaos theory and experiments were designed and analyzed to test those predictions. Discussion of patterns in chaos and how they can be investigated using real data follows and book ends with a discussion of the salient lessons learned from this research program Book jacket.

Dynamical Systems with Applications Using Mathematica ® Springer This volume highlights problems from a range of biological and medical applications that can be interpreted as questions about system behavior or control. Topics include drug resistance in cancer and malaria, biological fluid dynamics, auto-regulation in the kidney, anti-coagulation therapy, evolutionary diversification and photo-transduction. Mathematical techniques used to describe and investigate these biological and medical problems include ordinary, partial and stochastic differentiation equations, hybrid discrete-continuous approaches, as well as 2 and 3D numerical simulation. *Dynamical Systems in Social Psychology* SIAM Differential equations are the basis for models of any physical systems that exhibit smooth change. This book combines much of the material found in a traditional course on ordinary differential equations with an introduction to the more modern theory of dynamical systems. Applications of this theory to physics, biology, chemistry, and engineering are shown through examples in such areas as population modeling, fluid dynamics, electronics, and mechanics.? Differential Dynamical Systems begins with coverage of linear systems, including matrix algebra; the focus then shifts to foundational material on nonlinear differential equations, making heavy use of the contraction-mapping theorem. Subsequent chapters deal specifically with dynamical systems concepts?flow, stability, invariant manifolds, the phase plane, bifurcation, chaos, and Hamiltonian dynamics. This new edition contains several important updates and revisions throughout the book. Throughout the book, the author includes exercises to help students develop an analytical and geometrical understanding of dynamics. Many of the exercises and examples are based on applications and some involve computation; an appendix offers simple codes written in Maple?, Mathematica?, and MATLAB? software to give students practice with computation applied to dynamical systems problems.

An Introduction To Chaotic Dynamical Systems

Dynamical Systems in Population Biology

Why do organisms become extremely abundant one year and then seem to disappear a few years later? Why do population outbreaks in particular species happen more or less regularly in certain locations, but only irregularly (or never at all) in other locations? Complex population dynamics have fascinated biologists for decades. By bringing together mathematical models, statistical analyses, and field experiments, this book offers a comprehensiv e new synthesis of the theory of population oscillations. Peter Turchin first reviews the conceptual tools that ecologists use to investigate population oscillations, introducing population modeling and the statistical analysis of time series data. He then provides an in-depth discussion of several case studies--including the larch budmoth, southern pine beetle, red grouse, voles and lemmings, snowshoe hare, and ungulates--to develop a new analysis of the mechanisms that drive population oscillations in nature. Through such work, the author argues, ecologists can develop general laws of population dynamics that will help turn ecology into a truly quantitative and predictive science. Complex Population Dynamics integrates theoretical and empirical studies into a major new synthesis of current knowledge about population dynamics. It is also a pioneering work that sets the course for ecology's future as a predictive science.

Dynamic Systems Biology Modeling and Simulation

Princeton University Press

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 Systems for Biological Modeling
Springer Science & Business Media
This volume discusses the rich and interesting properties of dynamical systems that appear in ecology and environmental sciences. It provides a fascinating survey of the theory of dynamical systems in ecology and environmental science. Each chapter introduces students and scholars to the state-of-the-art in an exciting area, presents new results, and inspires future contributions to mathematical modeling in ecology and environmental sciences.

Differential Equations and Applications in Ecology, Epidemics, and Population Problems
Academic Press
This textbook is an introduction to dynamical systems and its applications to evolutionary game theory, mathematical ecology, and population

genetics. This first English edition is a translation from the authors' successful German edition which has already made an enormous impact on the teaching and study of mathematical biology. The book's main theme is to discuss the solution of differential equations that arise from examples in evolutionary biology. Topics covered include the Hardy–Weinberg law, the Lotka–Volterra equations for ecological models, genetic evolution, aspects of sociobiology, and mutation and recombination. There are numerous examples and exercises throughout and the reader is led up to some of the most recent developments in the field. Thus the book will make an ideal introduction to the subject for graduate students in mathematics and biology coming to the subject for the first time. Research workers in evolutionary theory will also find much of interest here in the application of powerful mathematical techniques to the subject.

The Dynamics of Biological Systems Springer Nature Taking more of a qualitative rather than computational approach, this text presents the techniques required to undertake basic modelling of biological systems through the development and analysis of dynamical systems. It includes many different types of applications from population biology and epidemiology.

Complex Population Dynamics

Chapman and Hall/CRC

This book provides an introduction to the theory of dynamical systems with the aid of the Mathematica ® computer algebra package. The book has a very hands-on approach and takes the reader from basic theory to recently published research material. Emphasized throughout are numerous applications to biology, chemical kinetics, economics, electronics, epidemiology, nonlinear optics, mechanics, population dynamics, and neural networks. Theorems and proofs are kept to a minimum. The first section deals with continuous systems using ordinary differential equations, while the second part is devoted to the study of discrete dynamical systems.

mathematical population dynamics

Springer Nature

This book summarizes and highlights progress in Dynamical Systems achieved during six years of the German Priority Research Program "Ergotic Theory, Analysis, and Efficient Simulation of Dynamical Systems", funded by the Deutsche Forschungsgemeinschaft (DFG). The three fundamental topics of large time behavior, dimension, and measure are tackled with by a rich circle of uncompromisingly rigorous mathematical concepts. The range of applied issues comprises such diverse areas as crystallization and dendrite growth, the dynamo effect, efficient simulation of biomolecules, fluid dynamics and reacting flows, mechanical problems involving friction, population biology, the spread of infectious diseases, and quantum chaos. The surveys in the book are addressed to experts and non-experts in the mathematical community alike. In addition they intend to convey the significance of the results for applications fair into the neighboring disciplines of Science.

Dynamical Systems and Their Applications in Biology Cambridge University Press

Population dynamics is an important subject in mathematical biology. A central problem is to study the long-term behavior of modeling systems. Most of these systems are governed by various evolutionary equations such as difference, ordinary, functional, and partial differential equations (see, e. g. , [165, 142, 218, 119, 55]). As we know, interactive populations often live in a fluctuating environment. For example, physical environmental conditions such as temperature and humidity and the availability of food, water, and other resources usually vary in time with seasonal or daily variations. Therefore, more realistic models should be nonautonomous systems. In particular, if the data in a model are periodic functions of time with commensurate period, a periodic system arises; if these periodic functions have different (minimal) periods, we get an almost periodic system. The existing reference books, from the dynamical systems point of view, mainly focus on autonomous biological systems. The book of Hess [106J is an excellent reference for periodic parabolic boundary value problems with applications to population dynamics. Since the publication of this book there have been extensive investigations on periodic, asymptotically periodic, almost periodic, and even general nonautonomous biological systems, which in turn have motivated further development of the theory of dynamical systems. In order to explain the dynamical systems approach to periodic population problems, let us consider, as an illustration, two species periodic competitive systems dUI dt = !I(t,Ul,U2), (0.

An Introduction to Dynamical Systems for Biological Modeling

CRC Press This volume is based on the proceedings of the International Workshop on Dynamical Systems and their Applications in Biology held at the Canadian Coast Guard College on Cape Breton Island (Nova Scotia, Canada). It presents a broad picture of the current research surrounding applications of dynamical systems in biology, particularly in population biology. The book contains 19 papers and includes articles on the qualitative and/or numerical analysis of models involving ordinary, partial, functional, and stochastic differential equations. Applications include epidemiology, population dynamics, and physiology. The material is suitable for graduate students and research mathematicians interested in ordinary differential equations and

their applications in biology. Also available by Ruan, Wolkowicz, and Wu is Differential Equations with Applications to Biology, Volume 21 in the AMS series Fields Institute Communications.
Dynamical Models in Biology Academic Press Differential Equations and Applications in Ecology, Epidemics, and Population Problems is composed of papers and abstracts presented at the 1981 research conference on Differential Equations and Applications to Ecology, Epidemics, and Population Problems held at Harvey Mudd College. The reported researches consist of mathematics that is either a direct outgrowth from questions in population biology and biomathematics, or applicable to such questions. The content of this volume are collected in four groups. The first group addresses aspects of population dynamics that involve the interaction between spatial and temporal effects. The second group covers other questions in population dynamics and some other areas of biomathematics. The third group deals with topics in differential and functional differential equations that are continuing to find important applications in

mathematical biology. The last group comprises of work on various aspects of differential equations and dynamical systems, not essentially motivated by biological applications. This book is valuable to students and researchers in theoretical biology and biomathematics, as well as to those interested in modern applications of differential equations.

Modeling Dynamic Biological Systems American Mathematical Soc.

The book presents nine mini-courses from a summer school, Dynamics of Biological Systems, held at the University of Alberta in 2016, as part of the prestigious seminar series: Séminaire de Mathématiques Supérieures (SMS). It includes new and significant contributions in the field of Dynamical Systems and their applications in Biology, Ecology, and Medicine. The chapters of this book cover a wide range of mathematical methods and biological applications. They - explain the process of mathematical modelling of biological systems with many examples, - introduce advanced methods from dynamical systems theory, - present many examples of the use of mathematical modelling to gain biological insight - discuss innovative methods for the analysis of biological processes, - contain extensive lists of references, which allow interested readers to continue the research on their own. Integrating the theory of dynamical systems with biological modelling, the book will appeal to researchers and graduate students in Applied Mathematics and Life Sciences.

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