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Dynamical Systems in Population Biology

Second Edition



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Dynamical Systems In Population Biology

Xiao-Qiang Zhao



Dynamical Systems In Population Biology:

Dynamical Systems in Population Biology Xiao-Qiang Zhao, 2013-06-05 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 [106] 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.

Dynamical Systems and Population Persistence Hal L. Smith, Horst R. Thieme, 2011 The mathematical theory of persistence answers questions such as which species in a mathematical model of interacting species will survive over the long term. It applies to infinite dimensional as well as to finite dimensional dynamical systems and to discrete time as well as to continuous time semiflows. This monograph provides a self-contained treatment of persistence theory that is accessible to graduate students. The key results for deterministic autonomous systems are proved in full detail, such as the acyclicity theorem and the tripartition of a global compact attractor. Suitable conditions are given for persistence to imply strong persistence, even for nonautonomous semiflows, and time heterogeneous persistence results are developed using so-called average Lyapunov functions. Applications play a large role in the monograph from the beginning. These include ODE models such as an SEIRS infectious disease in a meta population and discrete time nonlinear matrix models of demographic dynamics. Entire chapters are devoted to infinite dimensional examples including an SI epidemic model with variable infectivity, microbial growth in a tubular bioreactor and an age structured model of cells growing in a chemostat.

Competition Models in Population Biology Paul Waltman, 1983-01-01 This book uses fundamental ideas in dynamical systems to answer questions of a biologic nature, in particular questions about the behavior of populations given a relatively few hypotheses about the nature of their growth and interaction. The principal subject treated is that of coexistence under certain parameter ranges, while asymptotic methods are used to show competitive exclusion in other parameter ranges. Finally, some problems in genetics are posed and analyzed as problems in nonlinear

ordinary differential equations Dynamical Systems and Their Applications in Biology Shigui Ruan, Gail Susan Kohl Wolkowicz, Jianhong Wu, 2003 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 **Population Dynamics:**

Algebraic And Probabilistic Approach Utkir A Rozikov, 2020-04-22 A population is a summation of all the organisms of the same group or species which live in a particular geographical area and have the capability of interbreeding The main mathematical problem for a given population is to carefully examine the evolution time dependent dynamics of the population The mathematical methods used in the study of this problem are based on probability theory stochastic processes dynamical systems nonlinear differential and difference equations and non associative algebras A state of a population is a distribution of probabilities of the different types of organisms in every generation Type partition is called differentiation for example sex differentiation which defines a bisexual population This book systematically describes the recently developed theory of bisexual population and mainly contains results obtained since 2010 The book presents algebraic and probabilistic approaches in the theory of population dynamics It also includes several dynamical systems of biological models such as dynamics generated by Markov processes of cubic stochastic matrices dynamics of sex linked population dynamical systems generated by a gonosomal evolution operator dynamical system and an evolution algebra of mosquito population and ocean ecosystems The main aim of this book is to facilitate the reader s in depth understanding by giving a systematic review of the theory of population dynamics which has wide applications in biology mathematics medicine and physics Dynamical Systems and Their Applications in Biology Shigui Ruan, Gail Susan Kohl Wolkowicz, Jianhong Wu, Fields Institute for Research in Mathematical Sciences, 2003-01-01 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

Current Trends in Dynamical Systems in Biology and Natural Sciences Maira Aguiar, Carlos Braumann, Bob W. Kooi, Andrea Pugliese, Nico Stollenwerk, Ezio Venturino, 2020-05-06 This book disseminates the latest results and envisages new challenges in the application of mathematics to various practical situations in biology epidemiology and ecology It comprises a collection of the main results presented at the Ninth Edition of the International Workshop Dynamical Systems Applied to Biology and Natural Sciences DSABNS held from 7 to 9 February 2018 at the Department of Mathematics University of Turin Italy While the principal focus is ecology and epidemiology the coverage extends even to waste recycling and a genetic application The topics covered in the 12 peer reviewed contributions involve such diverse mathematical tools as ordinary and partial differential equations delay equations stochastic equations control and sensitivity analysis The book is intended to help both in disseminating the latest results and in envisaging new challenges in the application of mathematics to various practical situations in biology epidemiology and ecology

Dynamical Systems for Biological Modeling Fred Brauer, Christopher Kribs, 2015-12-23 Dynamical Systems for Biological Modeling An Introduction prepares both biology and mathematics students with the understanding and techniques necessary to undertake basic modeling of biological systems It achieves this through the development and analysis of dynamical systems The approach emphasizes qualitative ideas rather than explicit computation

Mathematics for Ecology and Environmental Sciences Yasuhiro Takeuchi, Yoh Iwasa, Kazunori Sato, 2007-01-19 Dynamical systems theory in mathematical biology has attracted much attention from many scientific directions The purpose of this volume is to discuss the many rich and interesting properties of dynamical systems that appear in ecology and environmental sciences The main topics include population dynamics with dispersal nonlinear discrete population dynamics structured population models mathematical models in evolutionary ecology stochastic spatial models in ecology game dynamics and the chemostat model Each chapter will serve to introduce students and scholars to the state of the art in an exciting area to present important new results and to inspire future contributions to mathematical modeling in ecology and environmental sciences

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mathematical population dynamics Ovide Arino, 2020-12-18 This book is an outcome of the Second International Conference on Mathematical Population Dynamics It is intended for mathematicians statisticians biologists and medical researchers who are interested in recent advances in analyzing changes in populations of genes cells and tumors

Topological Dynamics of Random Dynamical Systems Nguyen Dinh Cong, 1997 This book is the first systematic treatment of the theory of topological dynamics of random dynamical systems A

relatively new field the theory of random dynamical systems unites and develops the classical deterministic theory of dynamical systems and probability theory finding numerous applications in disciplines ranging from physics and biology to engineering finance and economics This book presents in detail the solutions to the most fundamental problems of topological dynamics linearization of nonlinear smooth systems classification and structural stability of linear hyperbolic systems Employing the tools and methods of algebraic ergodic theory the theory presented in the book has surprisingly beautiful results showing the richness of random dynamical systems as well as giving a gentle generalization of the classical deterministic theory

Positive Dynamical Systems in Discrete Time Ulrich Krause, 2015-03-10 This book provides a systematic rigorous and self contained treatment of positive dynamical systems A dynamical system is positive when all relevant variables of a system are nonnegative in a natural way This is in biology demography or economics where the levels of populations or prices of goods are positive The principle also finds application in electrical engineering physics and computer sciences The author has greatly expanded the field of positive systems in surprising ways Prof Dr David G Luenberger Stanford University USA

Handbook of Differential Equations: Ordinary Differential Equations A. Canada, P. Drabek, A. Fonda, 2006-08-21 This handbook is the third volume in a series of volumes devoted to self contained and up to date surveys in the theory of ordinary differential equations written by leading researchers in the area All contributors have made an additional effort to achieve readability for mathematicians and scientists from other related fields so that the chapters have been made accessible to a wide audience These ideas faithfully reflect the spirit of this multi volume and hopefully it becomes a very useful tool for research learning and teaching This volume consists of seven chapters covering a variety of problems in ordinary differential equations Both pure mathematical research and real world applications are reflected by the contributions to this volume Covers a variety of problems in ordinary differential equations Pure mathematical and real world applications Written for mathematicians and scientists of many related fields

Ordinary Differential Equations With Applications (2nd Edition) Sze-bi Hsu, 2013-06-07 During the past three decades the development of nonlinear analysis dynamical systems and their applications to science and engineering has stimulated renewed enthusiasm for the theory of Ordinary Differential Equations ODE This useful book which is based on the lecture notes of a well received graduate course emphasizes both theory and applications taking numerous examples from physics and biology to illustrate the application of ODE theory and techniques Written in a straightforward and easily accessible style this volume presents dynamical systems in the spirit of nonlinear analysis to readers at a graduate level and serves both as a textbook and as a valuable resource for researchers This new edition contains corrections and suggestions from the various readers and users A new chapter on Monotone Dynamical Systems is added to take into account the new developments in ordinary differential equations and dynamical systems

Integrodifference Equations in Spatial Ecology Frithjof Lutscher, 2019-10-30 This book is the first thorough introduction to and comprehensive treatment of the theory and

applications of integrodifference equations in spatial ecology Integrodifference equations are discrete time continuous space dynamical systems describing the spatio temporal dynamics of one or more populations The book contains step by step model construction explicitly solvable models abstract theory and numerical recipes for integrodifference equations The theory in the book is motivated and illustrated by many examples from conservation biology biological invasions pattern formation and other areas In this way the book conveys the more general message that bringing mathematical approaches and ecological questions together can generate novel insights into applications and fruitful challenges that spur future theoretical developments The book is suitable for graduate students and experienced researchers in mathematical ecology alike

Dynamical Systems Lamberto Cesari, Jack K. Hale, Joseph P. LaSalle, 2014-05-10 *Dynamical Systems* An International Symposium Volume 1 contains the proceedings of the International Symposium on Dynamical Systems held at Brown University in Providence Rhode Island on August 12-16 1974 The symposium provided a forum for reviewing the theory of dynamical systems in relation to ordinary and functional differential equations as well as the influence of this approach and the techniques of ordinary differential equations on research concerning certain types of partial differential equations and evolutionary equations in general Comprised of 29 chapters this volume begins with an introduction to some aspects of the qualitative theory of differential equations followed by a discussion on the Lefschetz fixed point formula Nonlinear oscillations in the frame of alternative methods are then examined along with topology and nonlinear boundary value problems Subsequent chapters focus on bifurcation theory evolution governed by accretive operators topological dynamics and its relation to integral equations and non autonomous systems and non controllability of linear time invariant systems using multiple one dimensional linear delay feedbacks The book concludes with a description of sufficient conditions for a relaxed optimal control problem This monograph will be of interest to students and practitioners in the field of applied mathematics

Nonlinear Structures & Systems, Volume 1 Matthew R.W. Brake, Ludovic Renson, Robert J. Kuether, Paolo Tiso, 2025-08-07 *Nonlinear Structures Systems Volume 1* Proceedings of the 41st IMAC A Conference and Exposition on Structural Dynamics 2023 the first volume of ten from the Conference brings together contributions to this important area of research and engineering The collection presents early findings and case studies on fundamental and applied aspects of Nonlinear Dynamics including papers on Experimental Nonlinear Dynamics Jointed Structures Identification Mechanics Dynamics Nonlinear Damping Nonlinear Modeling and Simulation Nonlinear Reduced Order Modeling Nonlinearity and System Identification

Ordinary Differential Equations With Applications (Third Edition) Sze-bi Hsu, Kuo-chang Chen, 2022-12-02 Written in a straightforward and easily accessible style this volume is suitable as a textbook for advanced undergraduate or first year graduate students in mathematics physical sciences and engineering The aim is to provide students with a strong background in the theories of Ordinary Differential Equations Dynamical Systems and Boundary Value Problems including regular and singular perturbations It is also a valuable resource for researchers This volume presents an

abundance of examples in physical and biological sciences and engineering to illustrate the applications of the theorems in the text Readers are introduced to some important theorems in Nonlinear Analysis for example Brouwer fixed point theorem and fundamental theorem of algebras A chapter on Monotone Dynamical Systems takes care of the new developments in Ordinary Differential Equations and Dynamical Systems In this third edition an introduction to Hamiltonian Systems is included to enhance and complete its coverage on Ordinary Differential Equations with applications in Mathematical Biology and Classical Mechanics

Nonlinear Dynamics of Interacting Populations A. D. Bazykin, Aleksandr Iosifovich Khibnik, Bernd Krauskopf, 1998 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

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