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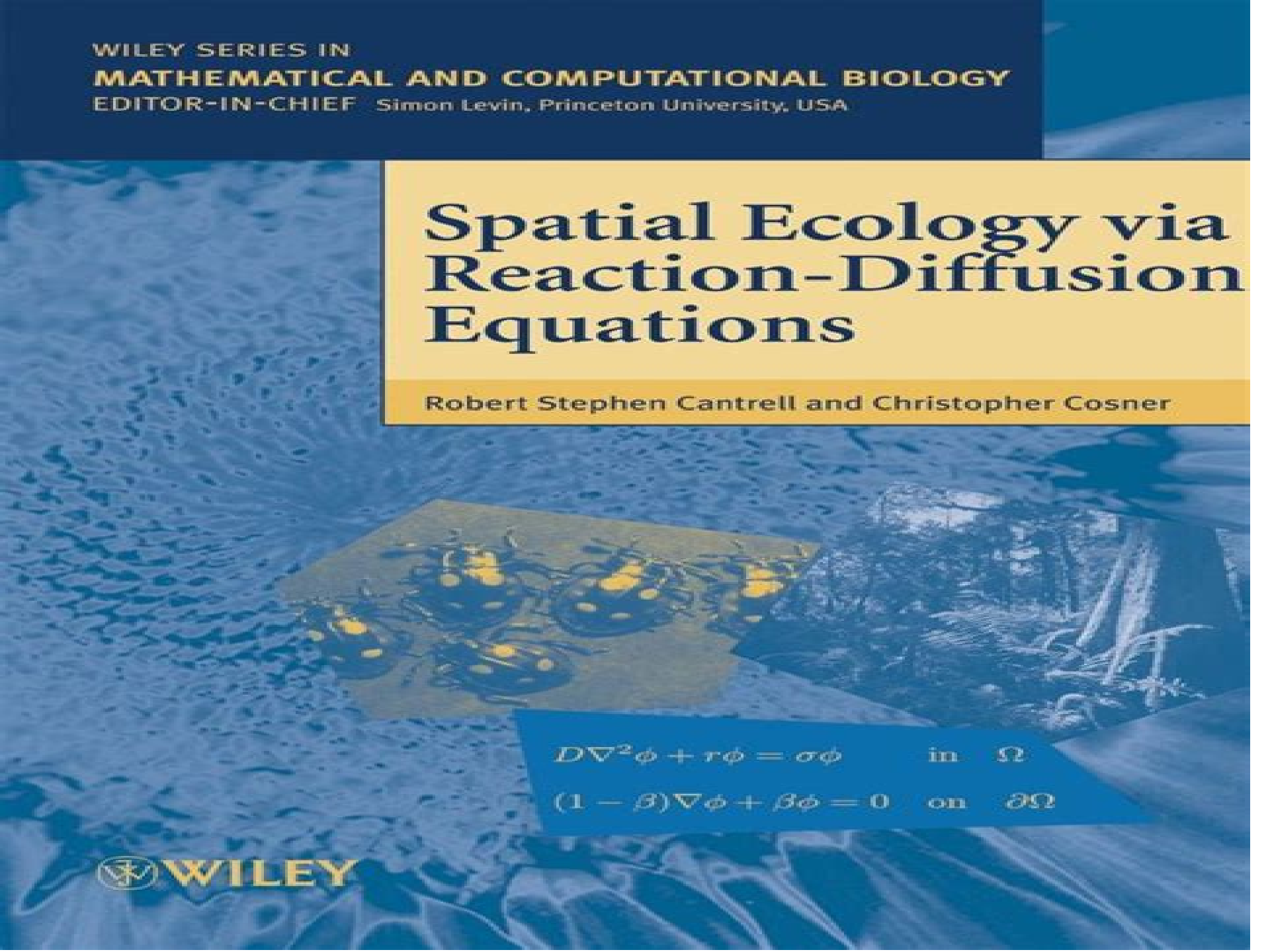
Spatial Ecology via Reaction-Diffusion Equations

Robert Stephen Cantrell and Christopher Cosner



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Spatial Ecology Via Reaction Diffusion Equations

Hal L. Smith,Horst R. Thieme

Spatial Ecology Via Reaction Diffusion Equations:

Spatial Ecology via Reaction-Diffusion Equations Robert Stephen Cantrell,Chris Cosner,2004-01-09 Many ecological phenomena may be modelled using apparently random processes involving space and possibly time Such phenomena are classified as spatial in their nature and include all aspects of pollution This book addresses the problem of modelling spatial effects in ecology and population dynamics using reaction diffusion models Rapidly expanding area of research for biologists and applied mathematicians Provides a unified and coherent account of methods developed to study spatial ecology via reaction diffusion models Provides the reader with the tools needed to construct and interpret models Offers specific applications of both the models and the methods Authors have played a dominant role in the field for years Essential reading for graduate students and researchers working with spatial modelling from mathematics statistics ecology geography and biology Introduction to Reaction-Diffusion Equations King-Yeung Lam,Yuan Lou,2022-12-01 This book introduces some basic mathematical tools in reaction diffusion models with applications to spatial ecology and evolutionary biology It is divided into four parts The first part is an introduction to the maximum principle the theory of principal eigenvalues for elliptic and periodic parabolic equations and systems and the theory of principal Floquet bundles The second part concerns the applications in spatial ecology We discuss the dynamics of a single species and two competing species as well as some recent progress on N competing species in bounded domains Some related results on stream populations and phytoplankton populations are also included We also discuss the spreading properties of a single species in an unbounded spatial domain as modeled by the Fisher KPP equation The third part concerns the applications in evolutionary biology We describe the basic notions of adaptive dynamics such as evolutionarily stable strategies and evolutionary branching points in the context of a competition model of stream populations We also discuss a class of selection mutation models describing a population structured along a continuous phenotypical trait The fourth part consists of several appendices which present a self contained treatment of some basic abstract theories in functional analysis and dynamical systems Topics include the Krein Rutman theorem for linear and nonlinear operators as well as some elements of monotone dynamical systems and abstract competition systems Most of the book is self contained and it is aimed at graduate students and researchers who are interested in the theory and applications of reaction diffusion equations Spatial Dynamics and Pattern Formation in Biological Populations Ranjit Kumar Upadhyay,Satteluri R. K. Iyengar,2021-02-24 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

Dispersal, Individual Movement and Spatial Ecology Mark A. Lewis,Philip K. Maini,Sergei V. Petrovskii,2013-03-21 Dispersal of plants and animals is one of the most fascinating subjects in ecology It has long been recognized as an important factor affecting ecosystem dynamics Dispersal is apparently a phenomenon of biological origin however because of its complexity it cannot be studied comprehensively by biological methods alone Deeper insights into dispersal properties and implications require interdisciplinary approaches involving biologists ecologists and mathematicians The purpose of this book is to provide a forum for researches with different backgrounds and expertise and to ensure further advances in the study of dispersal and spatial ecology This book is unique in its attempt to give an overview of dispersal studies across different spatial scales such as the scale of individual movement the population scale and the scale of communities and ecosystems It is written by top level experts in the field of dispersal modeling and covers a wide range of problems ranging from the identification of Levy walks in animal movement to the implications of dispersal on an evolutionary timescale **Theory of the Spread of Epidemics and Movement Ecology of Animals** V. M. (Nitant) Kenkre,Luca Giuggioli,2021-01-28 Powerful

analytical tools from statistical physics guided by field observations are applied to spread of epidemics and movement ecology Quantitative Ecology and Evolutionary Biology Otso Ovaskainen,Henrik Johan de Knegt,Maria del Mar Delgado,2016-09-01 This novel interdisciplinary text achieves an integration of empirical data and theory with the aid of mathematical models and statistical methods The emphasis throughout is on spatial ecology and evolution especially on the interplay between environmental heterogeneity and biological processes The book provides a coherent theme by interlinking the modelling approaches used for different subfields of spatial ecology movement ecology population ecology community ecology and genetics and evolutionary ecology each being represented by a separate chapter Each chapter starts by describing the concept of each modelling approach in its biological context goes on to present the relevant mathematical models and statistical methods and ends with a discussion of the benefits and limitations of each approach The concepts and techniques discussed throughout the book are illustrated throughout with the help of empirical examples This is an advanced text suitable for any biologist interested in the integration of empirical data and theory in spatial ecology evolution through the use of quantitative statistical methods and mathematical models The book will also be of relevance and use as a textbook for graduate level courses in spatial ecology ecological modelling theoretical ecology and statistical ecology Spatial Simulation David O'Sullivan,George L. W. Perry,2013-09-10 A ground up approach to explaining dynamic spatial modelling for an interdisciplinary audience Across broad areas of the environmental and social sciences simulation models are an important way to study systems inaccessible to scientific experimental and observational methods and also an essential complement to those more conventional approaches The contemporary research literature is teeming with abstract simulation models whose presentation is mathematically demanding and requires a high level of knowledge of quantitative and computational methods and approaches Furthermore simulation models designed to represent specific systems and phenomena are often complicated and as a result difficult to reconstruct from their descriptions in the literature This book aims to provide a practical and accessible account of dynamic spatial modelling while also equipping readers with a sound conceptual foundation in the subject and a useful introduction to the wide ranging literature Spatial Simulation Exploring Pattern and Process is organised around the idea that a small number of spatial processes underlie the wide variety of dynamic spatial models Its central focus on three building blocks of dynamic spatial models forces of attraction and segregation individual mobile entities and processes of spread guides the reader to an understanding of the basis of many of the complicated models found in the research literature The three building block models are presented in their simplest form and are progressively elaborated and related to real world process that can be represented using them Introductory chapters cover essential background topics particularly the relationships between pattern process and spatiotemporal scale Additional chapters consider how time and space can be represented in more complicated models and methods for the analysis and evaluation of models Finally the three building block models are woven together in a more elaborate example to show how a

complicated model can be assembled from relatively simple components To aid understanding more than 50 specific models described in the book are available online at patternandprocess org for exploration in the freely available Netlogo platform This book encourages readers to develop intuition for the abstract types of model that are likely to be appropriate for application in any specific context Spatial Simulation Exploring Pattern and Process will be of interest to undergraduate and graduate students taking courses in environmental social ecological and geographical disciplines Researchers and professionals who require a non specialist introduction will also find this book an invaluable guide to dynamic spatial simulation **Handbook of Differential Equations: Stationary Partial Differential Equations** Michel Chipot,Pavol Quittner,2004-07-06 The book could be a good companion for any graduate student in partial differential equations or in applied mathematics Each chapter brings indeed new ideas and new techniques which can be used in these fields The differents chapters can be read independently and are of great pedagogical value The advanced researcher will find along the book the most recent achievements in various fields Independent chapters Most recent advances in each fields Hight didactic quality Self contained Excellence of the contributors Wide range of topics **Applications of Chaos and Nonlinear Dynamics in Science and Engineering - Vol. 4** Santo Banerjee,Lamberto Rondoni,2015-05-04 Chaos and nonlinear dynamics initially developed as a new emergent field with its foundation in physics and applied mathematics The highly generic interdisciplinary quality of the insights gained in the last few decades has spawned myriad applications in almost all branches of science and technology and even well beyond Wherever quantitative modeling and analysis of complex nonlinear phenomena is required chaos theory and its methods can play a key role his fourth volume concentrates on reviewing further relevant contemporary applications of chaotic and nonlinear dynamics as they apply to the various cuttingedge branches of science and engineering This encompasses but is not limited to topics such as synchronization in complex networks and chaotic circuits time series analysis ecological and biological patterns stochastic control theory and vibrations in mechanical systems Featuring contributions from active and leading research groups this collection is ideal both as a reference and as a recipe book full of tried and tested successful engineering applications *New Trends in the Applications of Differential Equations in Sciences* Angela Slavova,2025-06-16 This volume compiles selected papers focusing on the applications of differential equations across various scientific domains presented at the International Conference New Trends in the Applications of Differential Equations in Sciences NTADES which took place in Saints Constantine and Helena Bulgaria in July 2024 The book is organized around several key themes including applications in mathematical physics mathematical biology financial mathematics fractional analysis numerical methods and neuroscience The covered applications encompass diverse topics such as mechanics neural networks in insurance credit portfolios predator prey systems with fractional derivatives recent findings regarding COVID 19 epidemic waves memristive cellular nonlinear networks and more By promoting fundamental research in mathematics this book aims to develop new methods and

techniques that can effectively address real life challenges through the application of differential equations Cross Diffusion Systems Dung Le,2022-10-24 The introduction of cross diffusivity opens many questions in the theory of reactiondiffusion systems This book will be the first to investigate such problems presenting new findings for researchers interested in studying parabolic and elliptic systems where classical methods are not applicable In addition The Gagliardo Nirenberg inequality involving BMO norms is improved and new techniques are covered that will be of interest This book also provides many open problems suitable for interested Ph D students *Advanced Computing in Industrial Mathematics* Krassimir Georgiev,Michail Todorov,Ivan Georgiev,2018-09-27 This book gathers the peer reviewed proceedings of the 12th Annual Meeting of the Bulgarian Section of the Society for Industrial and Applied Mathematics BGSIAM 17 held in Sofia Bulgaria in December 2017 The general theme of BGSIAM 17 was industrial and applied mathematics with a particular focus on high performance computing numerical methods and algorithms analysis of partial differential equations and their applications mathematical biology control and uncertain systems stochastic models molecular dynamics neural networks genetic algorithms metaheuristics for optimization problems generalized nets and Big Data Topics in Numerical Partial Differential Equations and Scientific Computing Susanne C. Brenner,2016-08-26 Numerical partial differential equations PDEs are an important part of numerical simulation the third component of the modern methodology for science and engineering besides the traditional theory and experiment This volume contains papers that originated with the collaborative research of the teams that participated in the IMA Workshop for Women in Applied Mathematics Numerical Partial Differential Equations and Scientific Computing in August 2014 **Dynamical Systems and Population Persistence** Hal L. Smith,Horst R. Thieme,2011 Providing a self contained treatment of persistence theory that is accessible to graduate students this monograph includes chapters on 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 Waves And Stability In Continuous Media - Proceedings Of The 14th Conference On Wascom 2007 Roberto Monaco,Salvatore Rionero,Tommaso Ruggeri,Natale Mangabari,2008-04-17 This volume is the fifth in a series of proceedings which started in 1999 The contributions include the latest results on the theory of wave propagation extended thermodynamics and the stability of the solutions to partial differential equations Proceedings, "WASCOM 2007" Natale Manganaro,Roberto Monaco,Salvatore Rionero,2008 This volume is the fifth in a series of proceedings which started in 1999 The contributions include the latest results on the theory of wave propagation extended thermodynamics and the stability of the solutions to partial differential equations Sample Chapter s Chapter 1 Reciprocal Transformations and Integrable Hamiltonian Hydrodynamic Type Systems 334 KB Contents Quantitative Estimates for the Large Time Behavior of a Reaction Diffusion Equation with Rational Reaction Term M Bisi et al Linearized Euler s Variational Equations in Lagrangian Coordinates G Boillat Restabilizing Forcing for a Diffusive Prey Predator Model B Buonomo Fluid Dynamical Features of the Weak KAM

Theory F Cardin Ricci Flow Deformation of Cosmological Initial Data Sets M Carfora Fuchsian Partial Differential Equations Y Choquet Bruhat Analytic Structure of the Four Wave Mixing Model in Photoreactive Material R Conte A Note about Waves in Dissipative and Dispersive Solids M Destrade Exponential and Algebraic Relaxation in Kinetic Models for Wealth Distribution B Dring et al Solitary Waves in Dispersive Materials J Engelbrecht et al A GinzburgOCoLandau Model for the Ice Water and Liquid Vapor Phase Transitions M Fabrizio Stability Considerations for Reaction Diffusion Systems J N Flavin A Mechanical Model for Liquid Nanolayers H Gouin A Particle Method for a Lotka Volterra System with Nonlinear Cross and Self Diffusion M Groppi Transport Properties of Chemically Reacting Gas Mixtures G M Kremer Navier Stokes in Aperture Domains Existence with Bounded Flux and Qualitative Properties P Maremonti On Two Pulse Interaction in a Class of Model Elastic Materials A Mentrelli et al On a Particle Size Segregation Equation C Mineo Problems of Stability and Waves in Biological Systems G Mulone Multiple Cold and Hot Second Sound Shocks in HE II A Muracchini Differential Equations and Lie Symmetries F Oliveri et al Bifurcation Analysis of Equilibria in Competitive Logistic Networks with Adaptation A Raimondi Poiseuille Flow of a Fluid Overlying a Porous Media B Straughan Analysis of Heat Conduction Phenomena in a One Dimensional Hard Point Gas by Extended Thermodynamics S Tanigushi et al On Waves in Weakly Nonlinear Poroelastic Materials Modeling Impacts of Meteorites K Wilmanski et al and other papers Readership Researchers in mathematics physics chemistry and engineering **Partial Differential Equations in Action** Sandro Salsa,Gianmaria Verzini,2022-12-08 This work is an updated version of a book evolved from courses offered on partial differential equations PDEs over the last several years at the Politecnico di Milano These courses had a twofold purpose on the one hand to teach students to appreciate the interplay between theory and modeling in problems arising in the applied sciences and on the other to provide them with a solid theoretical background for numerical methods such as finite elements Accordingly this textbook is divided into two parts The first part chapters 2 to 5 is more elementary in nature and focuses on developing and studying basic problems from the macro areas of diffusion propagation and transport waves and vibrations In the second part chapters 6 to 10 concentrate on the development of Hilbert spaces methods for the variational formulation and the analysis of mainly linear boundary and initial boundary value problems while Chapter 11 deals with vector valued conservation laws extending the theory developed in Chapter 4 The main differences with respect to the previous editions are a new section on reaction diffusion models for population dynamics in a heterogeneous environment several new exercises in almost all chapters a general restyling and a reordering of the last chapters The book is intended as an advanced undergraduate or first year graduate course for students from various disciplines including applied mathematics physics and engineering *An Introduction to Computational Systems Biology* Karthik Raman,2021-05-30 This book delivers a comprehensive and insightful account of applying mathematical modelling approaches to very large biological systems and networks a fundamental aspect of computational systems biology The book covers key modelling paradigms in detail while at the same time retaining a

simplicity that will appeal to those from less quantitative fields Key Features A hands on approach to modelling Covers a broad spectrum of modelling from static networks to dynamic models and constraint based models Thoughtful exercises to test and enable understanding of concepts State of the art chapters on exciting new developments like community modelling and biological circuit design Emphasis on coding and software tools for systems biology Companion website featuring lecture videos figure slides codes supplementary exercises further reading and appendices https ramanlab github io SysBioBook An Introduction to Computational Systems Biology Systems Level Modelling of Cellular Networks is highly multi disciplinary and will appeal to biologists engineers computer scientists mathematicians and others *Theoretical Ecology* Kevin S. McCann,Gabriel Gellner,2020-05-11 Theoretical Ecology concepts and applications continues the authoritative and established sequence of theoretical ecology books initiated by Robert M May which helped pave the way for ecology to become a more robust theoretical science encouraging the modern biologist to better understand the mathematics behind their theories This latest instalment builds on the legacy of its predecessors with a completely new set of contributions Rather than placing emphasis on the historical ideas in theoretical ecology the Editors have encouraged each contribution to synthesize historical theoretical ideas within modern frameworks that have emerged in the last 10 20 years e g bridging population interactions to whole food webs describe novel theory that has emerged in the last 20 years from historical empirical areas e g macro ecology and finally to cover the rapidly expanding area of theoretical ecological applications e g disease theory and global change theory The result is a forward looking synthesis that will help guide the field through a further decade of discovery and development It is written for upper level undergraduate students graduate students and researchers seeking synthesis and the state of the art in growing areas of interest in theoretical ecology genetics evolutionary ecology and mathematical biology **Nonlinear Systems Of Partial Differential Equations: Applications To Life And Physical Sciences** Anthony W Leung,2009-08-28 The book presents the theory of diffusion reaction equations starting from the Volterra Lotka systems developed in the eighties for Dirichlet boundary conditions It uses the analysis of applicable systems of partial differential equations as a starting point for studying upper lower solutions bifurcation degree theory and other nonlinear methods It also illustrates the use of semigroup stability theorems and W2ptheory Introductory explanations are included in the appendices for non expert readers The first chapter covers a wide range of steady state and stability results involving prey predator competing and cooperating species under strong or weak interactions Many diagrams are included to easily understand the description of the range of parameters for coexistence The book provides a comprehensive presentation of topics developed by numerous researchers Large complex systems are introduced for modern research in ecology medicine and engineering Chapter 3 combines the theories of earlier chapters with the optimal control of systems involving resource management and fission reactors This is the first book to present such topics at research level Chapter 4 considers persistence cross diffusion and boundary induced blow up etc The book also covers traveling or systems

of waves coupled Navier Stokes and Maxwell systems and fluid equations of plasma display These should be of interest to life and physical scientists

Whispering the Techniques of Language: An Psychological Quest through **Spatial Ecology Via Reaction Diffusion Equations**

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