Life Ma Nowak

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All of life is a game, and evolution by natural selection is no exception. The evolutionary game theory developed in this 2005 book provides the tools necessary for understanding many of nature's mysteries, including co-evolution, speciation, extinction and the major biological questions regarding fit of form and function, diversity, procession, and the distribution and abundance of life. Mathematics for the evolutionary game are developed based on Darwin's postulates leading to the concept of a fitness generating function (G-function). G-function is a tool that simplifies notation and plays an important role developing Darwinian dynamics that drive natural selection. Natural selection may result in special outcomes such as the evolutionarily stable strategy (ESS). An ESS maximum principle is formulated and its graphical representation as an adaptive landscape illuminates concepts such as adaptation, Fisher's Fundamental Theorem of Natural Selection, and the nature of life's evolutionary game. This self-contained introduction to the fast-growing field of Mathematical Biology is written for students with a mathematical background. It sets the subject in a historical context and guides the reader towards questions of current research interest. A broad range of topics is covered including: Population dynamics, Infectious diseases, Population genetics and evolution, Dispersal, Molecular and cellular biology, Pattern formation, and Cancer modelling. Particular attention is paid to situations where the simple assumptions of homogeneity made in early models break down and the process of mathematical modelling is seen in action. This 1982 book is an account of an alternative way of thinking about evolution and the theory of games. This text provides background and basic principles for bioinformatics research in an evolutionary context, with an emphasis on the link between gene and trait; this type of question arises in many industrial applications, e.g. biotechnology, pharmacology and drug discovery, and other applications based on genomics and proteomics. Less than 450 years ago, all European scholars believed that the Earth was at the centre of a Universe that was at most a few million miles in extent, and that the planets, sun, and stars all rotated around this centre. Less than 250 years ago, they believed that the Universe was createdessentially in its present state about 6000 years ago. Even less than 150 years ago, the view that living species were the result of special creation by God was still dominant. The recognition by Charles Darwin and Alfred Russel Wallace of the mechanism of evolution by natural selection has completely transformed our understanding of the living world, including our own origins. In this Very Short Introduction Brian and Deborah Charlesworth provide a clear and concise summary of the process of evolution by natural selection, and how natural selection gives rise to adaptations and eventually, over many generations, to new species. They introduce the central concepts of the field of evolutionary biology, as they have developed since Darwin and Wallace on the subject, over 140 years ago, and discuss some of the remaining questions regarding processes. They highlight the wide range of evidence for evolution, and the importance of an evolutionary understanding for instance in combating the rapid evolution of resistance by bacteria to antibiotics and of HIV to antiviral drugs. This reissue includes some key updates to the main text and a completely updated Further Reading section. ABOUT THE SERIES: The Very Short Introductions series from Oxford University Press contains hundreds of titles in almost every subject area. These pocket-sized books are the perfect way to get ahead in a new subject quickly. Our expert authors combine facts, analysis, perspective, new ideas, and enthusiasm to make interesting and challenging topics highly readable. This open access book chronicles the rise of a new scientific paradigm offering novel insights into the age-old enigmas of existence. Over 300 years ago, the human mind discovered the machine code of reality: mathematics. By utilizing abstract thought systems, humans began to decode the workings of the cosmos. From this understanding, the current scientific paradigm emerged, ultimately discovering the gift of technology. Today, however, our island of knowledge is
surrounded by ever longer shores of ignorance. Science appears to have hit a dead end when confronted with the nature of reality and consciousness. In this fascinating and accessible volume, James Glattfelder explores a radical paradigm shift uncovering the ontology of reality. It is found to be information-theoretic and participatory, yielding a computational and programmable universe. This volume is based on lectures delivered at the 2011 AMS Short Course on Evolutionary Game Dynamics, held January 4–5, 2011 in New Orleans, Louisiana. Evolutionary game theory studies basic types of social interactions in populations of players. It combines the strategic viewpoint of classical game theory (independent rational players trying to outguess each other) with population dynamics (successful strategies increase their frequencies). A substantial part of the appeal of evolutionary game theory comes from its highly diverse applications such as social dilemmas, the evolution of language, or mating behaviour in animals. Moreover, its methods are becoming increasingly popular in computer science, engineering, and control theory. They help to design and control multi-agent systems, often with a large number of agents (for instance, when routing drivers over highway networks or data packets over the Internet). While these fields have traditionally used a top down approach by directly controlling the behaviour of each agent in the system, attention has recently turned to an indirect approach allowing the agents to function independently while providing incentives that lead them to behave in the desired way. Instead of the traditional assumption of equilibrium behaviour, researchers opt increasingly for the evolutionary paradigm and consider the dynamics of behaviour in populations of agents employing simple, myopic decision rules. At a time of unprecedented expansion in the life sciences, evolution is the one theory that transcends all of biology. Any observation of a living system must ultimately be interpreted in the context of its evolution. Evolutionary change is the consequence of mutation and natural selection, which are two concepts that can be described by mathematical equations. Evolutionary Dynamics is concerned with these equations of life. In this book, Martin A. Nowak draws on the languages of biology and mathematics to outline the mathematical principles according to which life evolves. His work introduces readers to the powerful yet simple laws that govern the evolution of living systems, no matter how complicated they might seem. Evolution has become a mathematical theory, Nowak suggests, and any idea of an evolutionary process or mechanism should be studied in the context of the mathematical equations of evolutionary dynamics. His book presents a range of analytical tools that can be used to this end: fitness landscapes, mutation matrices, genomic sequence space, random drift, quasispecies, replicators, the Prisoner’s Dilemma, games in finite and infinite populations, evolutionary graph theory, games on grids, evolutionary kaleidoscopes, fractals, and spatial chaos. Nowak then shows how evolutionary dynamics applies to critical real-world problems, including the progression of viral diseases such as AIDS, the virulence of infectious agents, the unpredictable mutations that lead to cancer, the evolution of altruism, and even the evolution of human language. His book makes a clear and compelling case for understanding every living system—and everything that arises as a consequence of living systems—in terms of evolutionary dynamics. Covering the major topics of evolutionary game theory, Game-Theoretical Models in Biology presents both abstract and practical mathematical models of real biological situations. It discusses the static aspects of game theory in a mathematically rigorous way that is appealing to mathematicians. In addition, the authors explore many applications of game theory to biology, making the text useful to biologists as well. The book describes a wide range of topics in evolutionary games, including matrix games, replicator dynamics, the hawk–dove game, and the prisoner’s dilemma. It covers the evolutionarily stable strategy, a key concept in biological games, and offers in-depth details of the mathematical models. Most chapters illustrate how to use MATLAB® to solve various games. Important biological phenomena, such as the sex ratio of so many species being close to a half, the evolution of cooperative behavior, and the existence of adornments (for example, the peacock’s tail), have been explained using ideas underpinned by game theoretical modeling. Suitable for readers studying and working at the interface of mathematics and the life sciences, this book shows how evolutionary game theory is used in the modeling of these diverse biological phenomena. We have built a world that no longer fits our bodies. Our genes — selected through our evolution — and the many processes by which our development is tuned within the womb, limit our capacity to adapt to the modern urban lifestyle. There is a mismatch. We are seeing the impact of this mismatch in the explosion of diabetes, heart disease and obesity. But it also has consequences in earlier puberty and old age. Bringing together the latest scientific research in evolutionary biology, development, medicine, anthropology and ecology, Peter Gluckman and Mark Hanson, both leading medical scientists, argue that many of our problems as modern-day humans can be understood in terms of this fundamental and growing mismatch. It is an insight that we ignore at our peril. There are two main approaches towards the phenotypic analysis of frequency dependent natural selection. First, there is the approach of evolutionary game theory, which was introduced in 1973 by John Maynard Smith and George R. Price. In this theory, the dynamical process of natural selection is not modeled explicitly. Instead, the selective forces acting within a population are represented by a fitness function, which is then analysed according...
to the concept of an evolutionarily stable strategy or ESS. Later on, the static approach of evolutionary game theory has been complemented by a dynamic stability analysis of the replicator equations. Introduced by Peter D. Taylor and Leo B. Jonker in 1978, these equations specify a class of dynamical systems, which provide a simple dynamic description of a selection process. Usually, the investigation of the replicator dynamics centers around a stability analysis of their stationary solutions. Although evolutionary stability and dynamic stability both intend to characterize the long-term outcome of frequency dependent selection, these concepts differ considerably in the 'philosophies' on which they are based. It is therefore not too surprising that they often lead to quite different evolutionary predictions (see, e.g., Weissing 1983). The present paper intends to illustrate the incongruities between the two approaches towards a phenotypic theory of natural selection. A detailed game theoretical and dynamical analysis is given for a generic class of evolutionary normal form games. This text offers a systematic, rigorous, and unified presentation of evolutionary game theory, covering the core developments of the theory from its inception in biology in the 1970s through recent advances. Evolutionary game theory, which studies the behavior of large populations of strategically interacting agents, is used by economists to make predictions in settings where traditional assumptions about agents' rationality and knowledge may not be justified. Recently, computer scientists, transportation scientists, engineers, and control theorists have also turned to evolutionary game theory, seeking tools for modeling dynamics in multiagent systems. Population Games and Evolutionary Dynamics provides a point of entry into the field for researchers and students in all of these disciplines. The text first considers population games, which provide a simple, powerful model for studying strategic interactions among large numbers of anonymous agents. It then studies the dynamics of behavior in these games. By introducing a general model of myopic strategy revision by individual agents, the text provides foundations for two distinct approaches to aggregate behavior dynamics: the deterministic approach, based on differential equations, and the stochastic approach, based on Markov processes. Key results on local stability, global convergence, stochastic stability, and nonconvergence are developed in detail. Ten substantial appendixes present the mathematical tools needed to work in evolutionary game theory, offering a practical introduction to the methods of dynamic modeling. Accompanying the text are more than 200 color illustrations of the mathematics and theoretical results; many were created using the Dynamo software suite, which is freely available on the author's Web site. Readers are encouraged to use Dynamo to run quick numerical experiments and to create publishable figures for their own research. Draws on the languages of biology and mathematics to outline the mathematical principles according to which life evolves in an intriguing study that makes a clear and compelling case for understanding every living system in terms of evolutionary dynamics. An enthralling account of the arguments about altruism and sexual selection raging since Darwin's day. Metasolutions of Parabolic Equations in Population Dynamics explores the dynamics of a generalized prototype of semilinear parabolic logistic problem. Highlighting the author's advanced work in the field, it covers the latest developments in the theory of nonlinear parabolic problems. The book reveals how to mathematically determine if a species maintains, dwindles, or increases under certain circumstances. It explains how to predict the time evolution of species inhabiting regions governed by either logistic growth or exponential growth. The book studies the possibility that the species grows according to the Malthus law while it simultaneously inherits a limited growth in other regions. The first part of the book introduces large solutions and metasolutions in the context of population dynamics. In a self-contained way, the second part analyzes a series of very sharp optimal uniqueness results found by the author and his colleagues. The last part reinforces the evidence that metasolutions are also categorical imperatives to describe the dynamics of huge classes of spatially heterogeneous semilinear parabolic problems. Each chapter presents the mathematical formulation of the problem, the most important mathematical results available, and proofs of theorems where relevant. Thorough and accessible, this book presents the design principles of biological systems, and highlights the recurring circuit elements that make up biological networks. It provides a simple mathematical framework which can be used to understand and even design biological circuits. The text avoids specialist terms, focusing instead on several well-studied biological systems that concisely demonstrate key principles. An Introduction to Systems Biology: Design Principles of Biological Circuits builds a solid foundation for the intuitive understanding of general principles. It encourages the reader to ask why a system is designed in a particular way and then proceeds to answer with simplified models. This volume looks at social dilemmas where cooperative motivations are subverted and self-interest becomes self-defeating. Sigmund, a pioneer in evolutionary game theory, uses simple and well-known game theory models to examine the foundations of collective action and the effects of reciprocity and reputation. "In this accessible and well-written text, Martin Nowak and Robert May describe the emerging field of theoretical immunology. Using mathematical and computational models, the authors explore how populations of viruses and immune cells interact in various circumstances, and how infectious diseases spread within patients."--Page 4 de la
couverture.In this new edition of Evolution of the Social Contract, Brian Skyrms uses evolutionary game theory to analyze the genesis of social contracts and investigates social phenomena including justice, communication, altruism, and bargaining. Featuring new material on evolution and information transfer, and including recent developments in game theory and evolution literature, his book introduces and applies appropriate concepts of equilibrium and evolutionary dynamics, showing how key issues can be modeled as games and considering the ways in which evolution sometimes supports, and sometimes does not support, rational choice. He discusses topics including how bargaining with neighbors promotes sharing of resources, the diversity of behavior in ultimatum bargaining in small societies, the Prisoner's Dilemma, and an investigation into signaling games and the spontaneous emergence of meaningful communication. His book will be of great interest to readers in philosophy of science, social science, evolutionary biology, game and decision theory, and political theory.This volume is a collection of notes from lectures given at the 2008 Clay Mathematics Institute Summer School, held in Zürich, Switzerland. The lectures were designed for graduate students and mathematicians within five years of the Ph.D., and the main focus of the program was on recent progress in the theory of evolution equations. Such equations lie at the heart of many areas of mathematical physics and arise not only in situations with a manifest time evolution (such as linear and nonlinear wave and Schrödinger equations) but also in the high energy or semi-classical limits of elliptic problems. The three main courses focused primarily on microlocal analysis and spectral and scattering theory, the theory of the nonlinear Schrödinger wave equations, and evolution problems in general relativity. These major topics were supplemented by several mini-courses reporting on the derivation of effective evolution equations from microscopic quantum dynamics; on wave maps with and without symmetries; on quantum N-body scattering, diffraction of waves, and symmetric spaces; and on nonlinear Schrödinger equations at critical regularity. Although highly detailed treatments of some of these topics are now available in the published literature, in this collection the reader can learn the fundamental ideas and tools with a minimum of technical machinery. Moreover, the treatment in this volume emphasizes common themes and techniques in the field, including exact and approximate conservation laws, energy methods, and positive commutator arguments. Titles in this series are co-published with the Clay Mathematics Institute (Cambridge, MA).A groundbreaking argument for why alien life will evolve to be much like life here on Earth We are all familiar with the popular idea of strange alien life wildly different from life on earth inhabiting other planets. Maybe it's made of silicon! Maybe it has wheels! Or maybe it doesn't. In The Equations of Life, biologist Charles S. Cockell makes the forceful argument that the laws of physics narrowly constrain how life can evolve, making evolution's outcomes predictable. If we were to find on a distant planet something very much like a lady bug eating something like an aphid, we shouldn't be surprised. The forms of life are guided by a limited set of rules, and as a result, there is a narrow set of solutions to the challenges of existence. A remarkable scientific contribution breathing new life into Darwin's theory of evolution, The Equations of Life makes a radical argument about what life can--and can't--be.A First Course in Systems Biology is an introduction for advanced undergraduate and graduate students to the growing field of systems biology. Its main focus is the development of computational models and their applications to diverse biological systems. The book begins with the fundamentals of modeling, then reviews features of the molecular inventories that bring biological systems to life and discusses case studies that represent some of the frontiers in systems biology and synthetic biology. In this way, it provides the reader with a comprehensive background and access to methods for executing standard systems biology tasks, understanding the modern literature, and launching into specialized courses or projects that address biological questions using theoretical and computational means. New topics in this edition include: default modules for model design, limit cycles and chaos, parameter estimation in Excel, model representations of gene regulation through transcription factors, derivation of the Michaelis-Menten rate law from the original conceptual model, different types of inhibition, hysteresis, a model of differentiation, system adaptation to persistent signals, nonlinear nullclines, PBPK models, and elementary modes. The format is a combination of instructional text and references to primary literature, complemented by sets of small-scale exercises that enable hands-on experience, and large-scale, often open-ended questions for further reflection.Examines the importance of cooperation in human beings and in nature, arguing that this social tool is as an important aspect of evolution as mutation and natural selection. This book both summarizes the basic theory of evolutionary games and explains their developing applications, giving special attention to the 2-player, 2-strategy game. This game, usually termed a “2×2 game” in the jargon, has been deemed most important because it makes it possible to posit an archetype framework that can be extended to various applications for engineering, the social sciences, and even pure science fields spanning theoretical biology, physics, economics, politics, and information science. The 2×2 game is in fact one of the hottest issues in the field of statistical physics. The book first shows how the fundamental theory of the 2×2 game, based on so-called replicator dynamics, highlights its potential relation with nonlinear dynamical
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systems. This analytical approach implies that there is a gap between theoretical and reality-based prognoses observed in social systems of humans as well as in those of animal species. The book explains that this perceived gap is the result of an underlying reciprocity mechanism called social viscosity. As a second major point, the book puts a sharp focus on network reciprocity, one of the five fundamental mechanisms for adding social viscosity to a system and one that has been a great concern for study by statistical physicists in the past decade. The book explains how network reciprocity works for emerging cooperation, and readers can clearly understand the existence of substantial mechanics when the term "network reciprocity" is used. In the latter part of the book, readers will find several interesting examples in which evolutionary game theory is applied. One such example is traffic flow analysis. Traffic flow is one of the subjects that fluid dynamics can deal with, although flowing objects do not comprise a pure fluid but, rather, are a set of many particles. Applying the framework of evolutionary games to realistic traffic flows, the book reveals that social dilemma structures lie behind traffic flow. Many animals, including humans, acquire valuable skills and knowledge by copying others. Scientists refer to this as social learning. It is one of the most exciting and rapidly developing areas of behavioral research and sits at the interface of many academic disciplines, including biology, experimental psychology, economics, and cognitive neuroscience. Social Learning provides a comprehensive, practical guide to the research methods of this important emerging field. William Hoppitt and Kevin Laland define the mechanisms thought to underlie social learning and demonstrate how to distinguish them experimentally in the laboratory. They present techniques for detecting and quantifying social learning in nature, including statistical modeling of the spatial distribution of behavior traits. They also describe the latest theory and empirical findings on social learning strategies, and introduce readers to mathematical methods and models used in the study of cultural evolution. This book is an indispensable tool for researchers and an essential primer for students. Provides a comprehensive, practical guide to social learning research. Combines theoretical and empirical approaches. Describes techniques for the laboratory and the field. Covers social learning mechanisms and strategies. Statistical modeling techniques for field data. Mathematical modeling of cultural evolution. And more. Genetic algorithms are playing an increasingly important role in studies of complex adaptive systems, ranging from adaptive agents in economic theory to the use of machine learning techniques in the design of complex devices such as aircraft turbines and integrated circuits. Adaptation in Natural and Artificial Systems is the book that initiated this field of study, presenting the theoretical foundations and exploring applications. In its most familiar form, adaptation is a biological process, whereby organisms evolve by rearranging genetic material to survive in environments confronting them. In this now classic work, Holland presents a mathematical model that allows for the nonlinearity of such complex interactions. He demonstrates the model's universality by applying it to economics, psychological, and artificial intelligence and then outlines the way in which this approach modifies the traditional views of mathematical genetics. Initially applying his concepts to simply defined artificial systems with limited numbers of parameters, Holland goes on to explore their use in the study of a wide range of complex, naturally occurring processes, concentrating on systems having multiple factors that interact in nonlinear ways. Along the way he accounts for major effects of coadaptation and coevolution: the emergence of building blocks, or schemata, that are recombined and passed on to succeeding generations to provide, innovations and improvements. Branching processes form one of the classical fields of applied probability and are still an active area of research. The field has by now grown so large and diverse that a complete and unified treatment is hardly possible anymore, let alone in one volume. So, our aim here has been to single out some of the more recent developments and to present them with sufficient background material to obtain a largely self-contained treatment intended to supplement previous monographs rather than to overlap them. The body of the text is divided into four parts, each of its own flavor. Part A is a short introduction, stressing examples and applications. In Part B we give a self-contained and up-to-date presentation of the classical limit theory of simple branching processes, viz. the Galton-Watson (Bienaymée-G-W) process and its continuous time analogue. Part C deals with the limit theory of Iłłar’kov branching processes with a general set of types under conditions tailored to (multigroup) branching diffusions on bounded domains, a setting which also covers the ordinary multitype case. Whereas the point of view in Parts A and B is quite pedagogical, the aim of Part C is to treat a large subfield to the highest degree of generality and completeness possible. The exposition there is at times quite technical. Have you ever wondered how birds flock or forest fires spread? For thousands of years people—from DaVinci to Einstein—have created models to help them better understand patterns and processes in the world around them. Computers make it easier for novices to build and explore their own models—and learn new scientific ideas in the process. Adventures in Modeling introduces you and your students to designing, creating, and investigating models in StarLogo. Computer modeling, the use of computer programs to simulate complex, dynamic systems or events (like population growth or environmental conservation), is...
a powerful learning tool that is finding a rapidly growing audience among teachers in middle and high school science and mathematics classes, especially since the NCTM Standards 2000 advocates its use in the curriculum. This valuable resource: Provides educators with a rich and accessible introduction to the use of computer modeling in the classroom using the popular StarLogo computer programming language; Takes readers step-by-step through the process of using computer models to simulate complex relationships; Shows how and why computer modeling can lead to powerful and enduring learning outcomes for all students. Provides explicit links between various state and national math and science content standards and the use of computer models, to enable educators to see how this work may enhance standards-based instruction; As computer use gains in currency and value in the middle and high school classroom, Adventures in Modeling will give teachers and students a very effective way to build curiosity and boost learning outcomes in a standards-based curriculum. The first complete overview of evolutionary computing, the collective name for a range of problem-solving techniques based on principles of biological evolution, such as natural selection and genetic inheritance. The text is aimed directly at lecturers and graduate and undergraduate students. It is also meant for those who wish to apply evolutionary computing to a particular problem or within a given application area. The book contains quick-reference information on the current state-of-the-art in a wide range of related topics, so it is of interest not just to evolutionary computing specialists but to researchers working in other fields. This book highlights cutting-edge research in the field of network science, offering scientists, researchers, students and practitioners a unique update on the latest advances in theory and a multitude of applications. It presents the peer-reviewed proceedings of the VI International Conference on Complex Networks and their Applications (COMPLEX NETWORKS 2017), which took place in Lyon on November 29 - December 1, 2017. The carefully selected papers cover a wide range of theoretical topics such as network models and measures; community structure, network dynamics; diffusion, epidemics and spreading processes; resilience and control as well as all the main network applications, including social and political networks; networks in finance and economics; biological and ecological networks and technological networks. Evolutionary Theory is for graduate students, researchers, and advanced undergraduates who want an understanding of the mathematical and biological reasoning that underlies evolutionary theory. The book covers all of the major theoretical approaches used to study the mechanics of evolution, including classical one- and two-locus models, diffusion theory, coalescent theory, quantitative genetics, and game theory. There are also chapters on theoretical approaches to the evolution of development and on multilevel selection theory. Each subject is illustrated by focusing on those results that have the greatest power to influence the way that we think about how evolution works. These major results are developed in detail, with many accompanying illustrations, showing exactly how they are derived and how the mathematics relates to the biological insights that they yield. In this way, the reader learns something of the actual machinery of different branches of theory while gaining a deeper understanding of the evolutionary process. Roughly half of the book focuses on gene-based models, the other half being concerned with general phenotype-based theory. Throughout, emphasis is placed on the fundamental relationships between the different branches of theory, illustrating how all of these branches are united by a few basic, universal, principles. The only mathematical background assumed is basic calculus. More advanced mathematical methods are explained, with the help of an extensive appendix, when they are needed. Evolution, Games, and God explores how cooperation and altruism, alongside mutation and natural selection, play a critical role in evolution, from microbes to human societies. Inheriting a tendency to cooperate and self-sacrifice on behalf of others may be as beneficial to a population's survival as the self-preserving instincts of individuals. Ecology and Evolution of Cancer is a timely work outlining ideas that not only represent a substantial and original contribution to the fields of evolution, ecology, and cancer, but also goes beyond by connecting the interfaces of these disciplines. This work engages the expertise of a multidisciplinary research team to collate and review the latest knowledge and developments in this exciting research field. The evolutionary perspective of cancer has gained significant international recognition and interest, which is fully understandable given that somatic cellular selection and evolution are elegant explanations for carcinogenesis. Cancer is now generally accepted to be an evolutionary and ecological process with complex interactions between tumor cells and their environment sharing many similarities with organismal evolution. As a critical contribution to this field of research the book is important and relevant for the applications of evolutionary biology to understand the origin of cancers, to control neoplastic progression, and to prevent therapeutic failures. Covers all aspects of the evolution of cancer, appealing to researchers seeking to understand its origins and effects of treatments on its progression, as well as to lecturers in evolutionary medicine. Functions as both an introduction to cancer and evolution and a review of the current research on this burgeoning, exciting field, presented by an international group of leading editors and contributors. Improves understanding of the origin and the evolution of cancer, aiding efforts to determine how this disease interferes with
biotic interactions that govern ecosystems Highlights research that intends to apply evolutionary principles to help predict emergence and metastatic progression with the aim of improving therapiesIntroduces current evolutionary game theory—where ideas from evolutionary biology and rationalistic economics meet—emphasizing the links between static and dynamic approaches and noncooperative game theory. This text introduces current evolutionary game theory—where ideas from evolutionary biology and rationalistic economics meet—emphasizing the links between static and dynamic approaches and noncooperative game theory. Much of the text is devoted to the key concepts of evolutionary stability and replicator dynamics. The former highlights the role of mutations and the latter the mechanisms of selection. Moreover, set-valued static and dynamic stability concepts, as well as processes of social evolution, are discussed. Separate background chapters are devoted to noncooperative game theory and the theory of ordinary differential equations. There are examples throughout as well as individual chapter summaries. Because evolutionary game theory is a fast-moving field that is itself branching out and rapidly evolving, Jörgen Weibull has judiciously focused on clarifying and explaining core elements of the theory in an up-to-date, comprehensive, and self-contained treatment. The result is a text for second-year graduate students in economic theory, other social sciences, and evolutionary biology. The book goes beyond filling the gap between texts by Maynard-Smith and Hofbauer and Sigmund that are currently being used in the field. Evolutionary Game Theory will also serve as an introduction for those embarking on research in this area as well as a reference for those already familiar with the field. Weibull provides an overview of the developments that have taken place in this branch of game theory, discusses the mathematical tools needed to understand the area, describes both the motivation and intuition for the concepts involved, and explains why and how it is relevant to economics. The world’s most revered and eloquent interpreter of evolutionary ideas offers here a work of explanatory force unprecedented in our time—a landmark publication, both for its historical sweep and for its scientific vision. With characteristic attention to detail, Stephen Jay Gould first describes the content and discusses the history and origins of the three core commitments of classical Darwinism: that natural selection works on organisms, not genes or species; that it is almost exclusively the mechanism of adaptive evolutionary change; and that these changes are incremental, not drastic. Next, he examines the three critiques that currently challenge this classic Darwinian edifice: that selection operates on multiple levels, from the gene to the group; that evolution proceeds by a variety of mechanisms, not just natural selection; and that causes operating at broader scales, including catastrophes, have figured prominently in the course of evolution. Then, in a stunning tour de force that will likely stimulate discussion and debate for decades, Gould proposes his own system for integrating these classical commitments and contemporary critique into a new structure of evolutionary thought. In 2001 the Library of Congress named Stephen Jay Gould one of America’s eighty-three Living Legends—people who embody the “quintessentially American ideal of individual creativity, conviction, dedication, and exuberance.” Each of these qualities finds full expression in this peerless work, the likes of which the scientific world has not seen—and may not see again—for well over a century. Thirty years ago, biologists could get by with a rudimentary grasp of mathematics and modeling. Not so today. In seeking to answer fundamental questions about how biological systems function and change over time, the modern biologist is as likely to rely on sophisticated mathematical and computer-based models as traditional fieldwork. In this book, Sarah Otto and Troy Day provide biology students with the tools necessary to both interpret models and to build their own. The book starts at an elementary level of mathematical modeling, assuming that the reader has had high school mathematics and first-year calculus. Otto and Day then gradually build in depth and complexity, from classic models in ecology and evolution to more intricate class-structured and probabilistic models. The authors provide primers with instructive exercises to introduce readers to the more advanced subjects of linear algebra and probability theory. Through examples, they describe how models have been used to understand such topics as the spread of HIV, chaos, the age structure of a country, speciation, and extinction. Ecologists and evolutionary biologists today need enough mathematical training to be able to assess the power and limits of biological models and to develop theories and models themselves. This innovative book will be an indispensable guide to the world of mathematical models for the next generation of biologists. A how-to guide for developing new mathematical models in biology Provides step-by-step recipes for constructing and analyzing models Interesting biological applications Explores classical models in ecology and evolution Questions at the end of every chapter Primers cover important mathematical topics Exercises with answers Appendixes summarize useful rules Labs and advanced material available The book aims to provide an introduction to mathematical models that describe the dynamics of tumor growth and the evolution of tumor cells. It can be used as a textbook for advanced undergraduate or graduate courses, and also serves as a reference book for researchers. The book has a strong evolutionary component and reflects the viewpoint that cancer can be understood rationally through a combination of mathematical and biological tools. It can be used both by mathematicians and biologists. Mathematically, the book starts
with relatively simple ordinary differential equation models, and subsequently explores more complex stochastic and spatial models. Biologically, the book starts with explorations of the basic dynamics of tumor growth, including competitive interactions among cells, and subsequently moves on to the evolutionary dynamics of cancer cells, including scenarios of cancer initiation, progression, and treatment. The book finishes with a discussion of advanced topics, which describe how some of the mathematical concepts can be used to gain insights into a variety of questions, such as epigenetics, telomeres, gene therapy, and social interactions of cancer cells. Contents: Teaching Guide Cancer and Somatic Evolution Mathematical Modeling of Tumorogenesis Basic Growth Dynamics and Deterministic Models: Single Species Growth Two-Species Competition Dynamics Competition Between Genetically Stable and Unstable Cells Chromosomal Instability and Tumor Growth Angiogenesis Inhibitors, Promoters, and Spatial Growth Evolutionary Dynamics and Stochastic Models: Evolutionary Dynamics of Tumor Initiation Through Oncogenes: The Gain-of-Function Model Evolutionary Dynamics of Tumor Initiation Through Tumor-Suppressor Genes: The Loss-of-Function Model and Stochastic Tunneling Microsatellite and Chromosomal Instability in Sporadic and Familial Colorectal Cancers Evolutionary Dynamics in Hierarchical Populations Spatial Evolutionary Dynamics of Tumor Initiation Complex Tumor Dynamics in Space Stochastic Modeling of Cellular Growth, Treatment, and Resistance Generation Evolutionary Dynamics of Drug Resistance in Chronic Myeloid Leukemia Advanced Topics: Evolutionary Dynamics of Stem-Cell Driven Tumor Growth Tumor Growth Kinetics and Disease Progression Epigenetic Changes and the Rate of DNA Methylation Telomeres and Cancer Protection Gene Therapy and Oncolytic Virus Therapy Immune Responses, Tumor Growth, and Therapies Towards Higher Complexities: Social Interactions Readership: Researchers in mathematical biology, mathematical modeling, biology, mathematical oncology. Keywords: Mathematical Oncology; Dynamics; Evolution; Evolutionary Dynamics; Cancer; Mathematical Models; Somatic Evolution; Teaching Key Features: Both a reference book for the topic, and provides material for undergraduate and graduate courses Tries to bridge the divide between mathematicians and biologists, which is also reflected in the backgrounds of the two authors Shows how mathematical concepts can be translated into experimentally and clinically useful insights Rooted in evolutionary biology, the book handles this very complex phenomenon in an intuitive and mathematically elegant way Contains problems and research projects for each topic 10 pages of figures in color A famed political scientist's classic argument for a more cooperative world We assume that, in a world ruled by natural selection, selfishness pays. So why cooperate? In The Evolution of Cooperation, political scientist Robert Axelrod seeks to answer this question. In 1980, he organized the famed Computer Prisoners Dilemma Tournament, which sought to find the optimal strategy for survival in a particular game. Over and over, the simplest strategy, a cooperative program called Tit for Tat, shut out the competition. In other words, cooperation, not unfettered competition, turns out to be our best chance for survival. A vital book for leaders and decision makers, The Evolution of Cooperation reveals how cooperative principles help us think better about everything from military strategy, to political elections, to family dynamics. Evolution, Games, and God explores how cooperation and altruism, alongside mutation and natural selection, play a critical role in evolution, from microbes to human societies. Inheriting a tendency to cooperate and self-sacrifice on behalf of others may be as beneficial to a population's survival as the self-preserving instincts of individuals. The extraordinary role of viruses in evolution and how this is revolutionising biology and medicine. Copyright code: 61f771892132f4faba8c2dd59626fcd6b