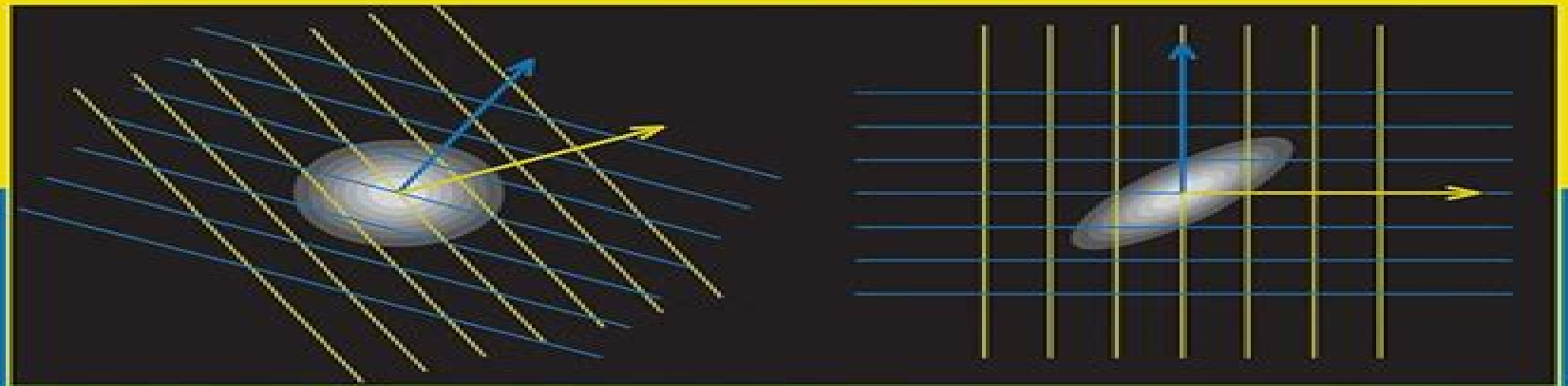


# EVOLUTIONARY THEORY

*Mathematical and Conceptual Foundations*



Sean H. Rice

# Mathematical Evolutionary Theory

**Josef Hofbauer, Karl Sigmund**



## **Mathematical Evolutionary Theory:**

*Mathematical Evolutionary Theory* Marcus Feldman, 2014-07-14 An international group of distinguished scientists presents an up to date survey of quantitative problems at the forefront of modern evolutionary theory Their articles illustrate results from the latest research in population and behavioral genetics molecular evolution and ecology Each author gives careful attention to the exposition of the models the logic of their analysis and the legitimacy of qualitative biological inferences The topics covered include stochastic models of finite populations and the sorts of diffusion approximations that are valid for their study models of migration kin selection geneculture coevolution sexual selection life history evolution the statistics of linkage disequilibrium and the molecular evolution of repeated DNA sequences and the HLA system in humans The fourteen contributions are presented in two sections Part I Stochastic and Deterministic Genetic Theory and Part II Behavior Ecology and Evolutionary Genetics Marcus W Feldman provides an introduction to each part The contributors are J G Bodmer W F Bodmer L L Cavalli Sforza F B Christiansen C Cockerham W J Ewens M W Feldman J H Gillespie R R Hudson N L Kaplan S Lessard U Liberman M E N Majerus P O Donald J Roughgarden S Tavar M K Uyenoyama G A Watterson and B Weir Originally published in 1989 The Princeton Legacy Library uses the latest print on demand technology to again make available previously out of print books from the distinguished backlist of Princeton University Press These editions preserve the original texts of these important books while presenting them in durable paperback and hardcover editions The goal of the Princeton Legacy Library is to vastly increase access to the rich scholarly heritage found in the thousands of books published by Princeton University Press since its founding in 1905

*Mathematical Evolutionary Theory* Marcus W. Feldman, Samuel Karlin, 1989 An international group of distinguished scientists presents an up to date survey of quantitative problems at the forefront of modern evolutionary theory Their articles illustrate results from the latest research in population and behavioral genetics molecular evolution and ecology Each author gives careful attention to the exposition of the models the logic of their analysis and the legitimacy of qualitative biological inferences The topics covered include stochastic models of finite populations and the sorts of diffusion approximations that are valid for their study models of migration kin selection geneculture coevolution sexual selection life history evolution the statistics of linkage disequilibrium and the molecular evolution of repeated DNA sequences and the HLA system in humans The fourteen contributions are presented in two sections Part I Stochastic and Deterministic Genetic Theory and Part II Behavior Ecology and Evolutionary Genetics Marcus W Feldman provides an introduction to each part The contributors are J G Bodmer W F Bodmer L L Cavalli Sforza F B Christiansen C Cockerham W J Ewens M W Feldman J H Gillespie R R Hudson N L Kaplan S Lessard U Liberman M E N Majerus P O Donald J Roughgarden S Tavar M K Uyenoyama G A Watterson and B Weir Originally published in 1989 The Princeton Legacy Library uses the latest print on demand technology to again make available previously out of print books from the distinguished backlist of Princeton University Press These paperback editions preserve the original texts of these

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**Mathematical and Statistical Developments of Evolutionary Theory** S. Lessard, 2012-12-06

Mathematical and statistical approaches to evolutionary theory are numerous The NATO Advanced Study Institute ASI held at the Universite de Montreal Montreal August 3 21 1987 was an opportunity to review most of the classical approaches and to study the more recent developments The participation of theoretical biologists and geneticists as well as applied mathematicians and statisticians made possible exchanges of ideas between students and scholars having different views on the subject These Proceedings contain the lecture notes of seven 7 of the eleven 11 series of lectures that were given ESS Evolutionarily Stable Strategy theory is considered from many perspectives from a game theoretic approach to understanding behavior and evolution W G S Hines and a systematic classification of properties and patterns of ESS s C Cannings to particular applications of the differential geometry of the Shahshahani metric E Akin Extensions of ESS theory to sexual populations and finite populations not to mention games between relatives are presented W G S Hines Special attention is given to the classical game called the War of Attrition but with  $n$  players and random rewards C Cannings The Shahshahani metric is also used to show the occurrence of cycling in the two locus two allele model E Akin Various inference problems in population genetics are addressed Procedures to detect and measure selection components and polymorphism in particular the Wahlund effect at one or several loci from mother offspring combinations in natural populations are discussed at length F B Christiansen

Mathematical Evolutionary Theory Marcus W. Feldman,

**The Role of Mathematics in**

**Evolutionary Theory** Jun Otsuka, 2019-10-17 The central role of mathematical modeling in modern evolutionary theory has raised a concern as to why and how abstract formulae can say anything about empirical phenomena of evolution This Element introduces existing philosophical approaches to this problem and proposes a new account according to which evolutionary models are based on causal and not just mathematical assumptions The novel account features causal models both as the Humean uniform nature underlying evolutionary induction and as the organizing framework that integrates mathematical and empirical assumptions into a cohesive network of beliefs that functions together to achieve epistemic goals of evolutionary biology

The Mathematical Theory of Selection, Recombination, and Mutation R. Bürger, 2000-11-02

It is close to being a masterpiece could well be the classic presentation of the area Warren J Ewens University of Pennsylvania USA Population genetics is concerned with the study of the genetic ecological and evolutionary factors that influence and change the genetic composition of populations The emphasis here is on models that have a direct bearing on evolutionary quantitative genetics Applications concerning the maintenance of genetic variation in quantitative traits and their dynamics under selection are treated in detail Provides a unified self contained and in depth study of the theory of multilocus systems Introduces the basic population genetic models Explores the dynamical and equilibrium properties of the distribution of

quantitative traits under selection Summarizes important results from more demanding sections in a comprehensible way Employs a clear and logical presentation style Following an introduction to elementary population genetics and discussion of the general theory of selection at two or more loci the author considers a number of mutation selection models and derives the dynamical equations for polygenic traits under general selective regimes The final chapters are concerned with the maintenance of quantitative genetic variation the response to directional selection the evolutionary role of deleterious mutations and other topics Graduate students and researchers in population genetics evolutionary theory and biomathematics will benefit from the in depth coverage This text will make an excellent reference volume for the fields of quantitative genetics population and theoretical biology

**Mathematical Models of Social Evolution** Richard McElreath, Robert Boyd, 2008-09-15 Over the last several decades mathematical models have become central to the study of social evolution both in biology and the social sciences But students in these disciplines often seriously lack the tools to understand them A primer on behavioral modeling that includes both mathematics and evolutionary theory Mathematical Models of Social Evolution aims to make the student and professional researcher in biology and the social sciences fully conversant in the language of the field Teaching biological concepts from which models can be developed Richard McElreath and Robert Boyd introduce readers to many of the typical mathematical tools that are used to analyze evolutionary models and end each chapter with a set of problems that draw upon these techniques Mathematical Models of Social Evolution equips behaviorists and evolutionary biologists with the mathematical knowledge to truly understand the models on which their research depends Ultimately McElreath and Boyd's goal is to impart the fundamental concepts that underlie modern biological understandings of the evolution of behavior so that readers will be able to more fully appreciate journal articles and scientific literature and start building models of their own

**Evolutionary Theory** Sean H. Rice, 2004 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

**Mathematical Population Genetics 1** Warren J. Ewens, 2004-01-09 This is the first of a planned two volume work discussing the mathematical aspects of population genetics with an emphasis on evolutionary theory This volume draws heavily from the author's 1979 classic but it has been revised and expanded to include recent topics which follow naturally from the treatment in the earlier edition such as the theory of molecular population genetics

*Evolutionstheorie und Dynamische Systeme* Josef Hofbauer, Karl Sigmund, 1988 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

**Mathematical Population Genetics And Evolution Of Bacterial Cooperation** Volker Hosel, Christina Kuttler, Johannes Muller, 2020-03-13 Social life of bacteria is in the focus of recent research Bacteria are simple enough to be accessible by science but still complex enough to show cooperation division of labor bet hedging cross talk and synchronized activities and a rich variety of social traits A central question of evolutionary theory is the explanation why this social life did develop and why these systems are evolutionary stable This book introduces the reader into the theory of evolution covering classical models and as well as recent developments The theory developed is used to represent the up to date understanding of social bacteria This book will be useful for students and lecturers interested in mathematical evolutionary theory as well as for researchers as a reference

The Mathematics of Darwin's Legacy Fabio A. C. Chalub, José Francisco Rodrigues, 2011-06-24 The book presents a general overview of mathematical models in the context of evolution It covers a wide range of topics such as population genetics population dynamics speciation adaptive dynamics game theory kin selection and stochastic processes Written by leading scientists working at the interface between evolutionary biology and mathematics the book is the outcome of a conference commemorating Charles Darwin's 200th birthday and the 150th anniversary of the first publication of his book On the origin of species Its chapters vary in format between general introductory and state of the art research texts in biomathematics in this way addressing both students and researchers in mathematics biology and related fields Mathematicians looking for new problems as well as biologists looking for rigorous description of population dynamics will find this book fundamental

Proving Darwin

Gregory Chaitin, 2013-02-26 Groundbreaking mathematician Gregory Chaitin gives us the first book to posit that we can prove how Darwin's theory of evolution works on a mathematical level. For years it has been received wisdom among most scientists that just as Darwin claimed all of the Earth's life forms evolved by blind chance. But does Darwin's theory function on a purely mathematical level? Has there been enough time for evolution to produce the remarkable biological diversity we see around us? It's a question no one has yet answered; in fact, no one has attempted to answer it until now. In this illuminating and provocative book, Gregory Chaitin elucidates the mathematical scheme he's developed that can explain life itself and examines the works of mathematical pioneers John von Neumann and Alan Turing through the lens of biology. Fascinating and thought provoking, *Proving Darwin* makes clear how biology may have found its greatest ally in mathematics.

**Mathematical Population Genetics 1** Warren J. Ewens, 2012-10-01 Population genetics occupies a central role in a number of important biological and social undertakings. It is fundamental to our understanding of evolutionary processes of plant and animal breeding programs and of various diseases of particular importance to mankind. This is the first of a planned two volume work discussing the mathematical aspects of population genetics with an emphasis on the evolutionary theory. This first volume draws heavily from the author's classic 1979 edition which appeared originally in Springer's Biomathematics series. It has been revised and expanded to include recent topics which follow naturally from the treatment in the earlier edition, e.g. the theory of molecular population genetics. This book will appeal to graduate students and researchers in mathematical biology and other mathematically trained scientists looking to enter the field of population genetics. **A Biologist's Guide to Mathematical Modeling in Ecology and Evolution** Sarah P. Otto, Troy Day, 2011-09-19 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 Structure and Confirmation of Evolutionary Theory** Elisabeth A. Lloyd, 2021-01-12 Traditionally a scientific theory is viewed as based on universal laws of nature that serve as axioms for logical deduction In analyzing the logical structure of evolutionary biology Elisabeth Lloyd argues that the semantic account is more appropriate and powerful This book will be of interest to biologists and philosophers alike

**Fundamentals of Mathematical Evolutionary Genetics** Yuri M. Svirezhev, V.P. Passekov, 2012-12-06 One service mathematics has rendered the Et moi si j'avais su comment en revenir human race It has put common sense back je riy serais point aile Jules Verne where it belongs on the topmost shelf next to the dusty canister labelled discarded non The series is divergent therefore we may be sense able to do something with it Eric T Bell O Heavieside Mathematics is a tool for thought A highly necessary tool in a world where both feedback and non linearities abound Similarly all kinds of parts of mathematics serve as tools for other parts and for other sciences Applying a simple rewriting rule to the quote on the right above one finds such statements as One service topology has rendered mathematical physics o One service logic has rendered computer science o One service category theory has rendered mathematics All arguably true And all statements obtainable this way form part of the raison d'être of this series

Evolutionary Genetics R. S. Singh, Costas B. Krimbas, 2000-03-28 This book brings out the central role of evolutionary genetics in all aspects of its connection to evolutionary biology

**Evolutionary Theory and Processes: Modern Horizons** Eviatar Nevo, 2004-01-31 Evolution is the most profound of human ideas integrating all natural phenomena cosmic biological and cultural into a continuous universal change This volume deals with evolutionary observations experiments and theories contributing to a deeper understanding of the evolutionary process th honoring the 75 birthday of Eviatar Eibi Nevo I first met Eibi in 1966 when he was a Fellow in the Museum of Comparative Zoology at Harvard University and working mostly on cricket frog vocalization and speciation in the United States His unique discovery of pipid fossil frogs in the Israeli Early Cretaceous central Negev is possibly the largest world collection of ancient fossil frogs Our acquaintance developed into mutual friendship and admiration Since then our long lasting friendship has included a visit to Israel enabling me to follow Eibi's major scientific achievements in particular his founding of the Institute of Evolution in the University of Haifa and now the pending establishment of the International Graduate School of Evolution The research program of Eibi Nevo in collaboration with numerous colleagues and students in Israel and across the world encompasses diverse perspectives of evolutionary biology and biodiversity of genes populations species and ecosystems integrating modern and classical evolutionary approaches molecular and organismal They deal with model organisms in all forms from bacteria through plants fungi animals and humans conducted over local regional and global scales

Introduction to Mathematical Oncology Yang Kuang, John D. Nagy, Steffen E. Eikenberry, 2018-09-03 Introduction to Mathematical Oncology presents biologically well

motivated and mathematically tractable models that facilitate both a deep understanding of cancer biology and better cancer treatment designs. It covers the medical and biological background of the diseases, modeling issues, and existing methods and their limitations. The authors introduce mathematical and programming tools along with analytical and numerical studies of the models. They also develop new mathematical tools and look to future improvements on dynamical models. After introducing the general theory of medicine and exploring how mathematics can be essential in its understanding, the text describes well-known practical and insightful mathematical models of avascular tumor growth and mathematically tractable treatment models based on ordinary differential equations. It continues the topic of avascular tumor growth in the context of partial differential equation models by incorporating the spatial structure and physiological structure such as cell size. The book then focuses on the recent active multi-scale modeling efforts on prostate cancer growth and treatment dynamics. It also examines more mechanistically formulated models, including cell quota-based population growth models with applications to real tumors and validation using clinical data. The remainder of the text presents abundant additional historical biological and medical background materials for advanced and specific treatment modeling efforts. Extensively classroom tested in undergraduate and graduate courses, this self-contained book allows instructors to emphasize specific topics relevant to clinical cancer biology and treatment. It can be used in a variety of ways, including a single semester undergraduate course, a more ambitious graduate course, or a full year sequence on mathematical oncology.

## Unveiling the Power of Verbal Beauty: An Mental Sojourn through **Mathematical Evolutionary Theory**

In a global inundated with screens and the cacophony of instantaneous transmission, the profound power and mental resonance of verbal beauty frequently disappear into obscurity, eclipsed by the regular onslaught of sound and distractions. Yet, located within the lyrical pages of **Mathematical Evolutionary Theory**, a captivating function of fictional elegance that impulses with organic feelings, lies an wonderful trip waiting to be embarked upon. Published by way of a virtuoso wordsmith, that mesmerizing opus courses readers on an emotional odyssey, delicately revealing the latent potential and profound impact stuck within the complicated web of language. Within the heart-wrenching expanse with this evocative evaluation, we shall embark upon an introspective exploration of the book is key themes, dissect their fascinating publishing type, and immerse ourselves in the indelible impact it leaves upon the depths of readers souls.

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