Evolutionary Dynamics Exploring The Equations Of Life Ma Nowak

This work aims to foster the interdisciplinary dialogue between mathematicians and socio-economic scientists. Interaction among scholars and practitioners traditionally coming from different research areas is necessary more than ever in order to better understand many real-world problems we face today. On the one hand, mathematicians need economists and social scientists to better address the methodologies they design in a more realistic way; on the other hand, economists and social scientists need to be aware of sound mathematical modelling tools in order to understand and, ultimately, solve the complex problems they encounter in their research. With this goal in mind, this work is designed to take into account a multidisciplinary approach that will encourage the transfer of knowledge, ideas, and methodology from one discipline to the other. In particular, the work has three main themes: Demystifying and unravelling complex systems; Introducing models of individual behaviours in the social and economic sciences; Modelling socio-economic sciences as complex living systems. Specific tools examined in the work include a recently developed modelling approach using stochastic game theory within the framework of statistical mechanics and progressing up to modeling Darwinian evolution. Special attention is also devoted to social network theory as a fundamental instrument for the understanding of socio-economic systems.?

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.

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.

This contributed volume considers recent advances in dynamic games and their applications, based on presentations given at the 16th Symposium of the International Society of Dynamic Games, held July 9-12, 2014, in Amsterdam. Written by experts in their respective disciplines, these papers cover various aspects of dynamic game theory including differential games, evolutionary games, and stochastic games. They discuss theoretical developments, algorithmic methods, issues relating to lack of information, and applications in areas such as biological or economical competition, stability in communication networks, and maintenance decisions in an electricity market, just to name a few. Advances in Dynamic and Evolutionary Games presents state-of-the-art research in a wide spectrum of areas. As such, it serves as a testament to the vitality and growth of the field of dynamic games and their applications. It will be of interest to an interdisciplinary audience of

researchers, practitioners, and advanced graduate students.
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Familiar modes of problem solving may be efficient, but they often prevent us from discovering innovative solutions to more complex problems. To create meaningful change, we must train ourselves to discover previously unseen variables in day-to-day challenges. The Design of Insight is intended to be a personal problem-solving platform for decision makers and advisors who seek answers to critical business questions. It introduces an approach that uses multiple "problem-solving languages" to systematically expand our understanding of problem framing and high quality problem solving. Useful as a critical thinking approach or a think-out-loud document for strategic teams, this brief is a resource for enriching and implementing thoughtful management practices.

This book presents recent developments and results found by participants of the Third International Conference on the Dynamics of Information Systems, which took place at the University of Florida, Gainesville FL, USA on February 16-18, 2011. The purpose of this conference was to bring together scientists and engineers from industry, government, and universities to exchange knowledge and results in a broad range of topics relevant to the theory and practice of the

dynamics of information systems. Dynamics of Information plays an increasingly critical role in our society. The influence of information on social, biological, genetic, and military systems must be better understood to achieve large advances in the capability and understanding of these systems. Applications are widespread and include: research in evolutionary theory, optimization of information workflow, military applications, climate networks, collision work, and much more. Dynamics of Information plays an increasingly critical role in our society. The influence of information on social, biological, genetic, and military systems must be better understood to achieve large advances in the capability and understanding of these systems. Applications are widespread and include: research in evolutionary theory, optimization of information workflow, military applications, climate networks, collision work, and much more.

Evolution and complexity characterize both biological and artificial life – by direct modeling of biological processes and the creation of populations of interacting entities from which complex behaviors can emerge and evolve. This edited book includes invited chapters from leading scientists in the fields of artificial life, complex systems, and evolutionary computing. The contributions identify both fundamental theoretical issues and state-of-the-art real-world applications. The book is intended for researchers and graduate students in the related domains.

Volume Two of an award-winning professor's introduction to essential concepts of calculus and mathematical modeling for students in the biosciences This is the second of a two-part series exploring essential concepts of calculus in the context of biological systems. Building on the essential ideas and theories of basic calculus taught in Mathematical Models in the

Biosciences I, this book focuses on epidemiological models, mathematical foundations of virus and antiviral dynamics, ion channel models and cardiac arrhythmias, vector calculus and applications, and evolutionary models of disease. It also develops differential equations and stochastic models of many biomedical processes, as well as virus dynamics, the Clancy-Rudy model to determine the genetic basis of cardiac arrhythmias, and a sketch of some systems biology. Based on the author's calculus class at Yale, the book makes concepts of calculus less abstract and more relatable for science majors and premedical students.

Advances in molecular biology, remote sensing, systems biology, bioinformatics, non-linear science, the physics of complex systems and other fields have rendered a great amount of data that remain to be integrated into models and theories that are capable of accounting for the complexity of ecological systems and the evolutionary dynamics of life. It is thus necessary to provide a solid basis to discuss and reflect on these and other challenges both at the local and global scales. This volume aims to delineate an integrative and interdisciplinary view that suggests new avenues in research and teaching, critically discusses the scope of the diverse methods in the study of complex systems, and points at key open questions. Finally, this book will provide students and specialists with a collection of high quality open access essays that will contribute to integrate Ecology, Evolution and Complexity in the context of basic research and in the field of Sustainability Sciences.

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.

This book constitutes the thoroughly refereed proceedings of the 25th International Conference on Computer Aided Verification, CAV 2013 held in St. Petersburg, Russia in July 2013. The 54 regular and 16 tool papers presented were carefully selected from 209 submissions. The papers are organized in topical sections on biology, concurrency, hardware, hybrid

systems, interpolation, loops and termination, new domains, probability and statistics, SAT and SMZ, security, shape analysis, synthesis, and time.

This book discusses the recent advances in natural computation, fuzzy systems and knowledge discovery. Presenting selected, peer-reviewed papers from the 15th International Conference on Natural Computation, Fuzzy Systems and Knowledge Discovery (ICNC-FSKD 2019), held in Kunming, China, from 20 to 22 July 2019, it is a useful resource for researchers, including professors and graduate students, as well as R&D staff in industry.

Evolutionary game theorists have devoted a great deal of effort to answering questions related to cooperation. They typically combine game theory with coupled nonlinear differential equations to create an evolutionary dynamic system. Indeed, cooperation, where individuals pay costs to benefit others, is a cornerstone of human civilization. The most common mathematical model used to study evolutionary dynamic systems is the replicator equation: a payoff matrix is defined such that strategies with a payoff above average are more and more prevalent over time while strategies with a payoff below average are less prevalent. Interestingly, many of the dynamics studied using the replicator equation have applications inside and outside the field of of biology, including the dynamics of sociological systems, the evolution of language, fashion, autocatalytic chemical networks, behavioral dynamics, and multi-agent decision making in social networks. Nonetheless, some non-trivial questions have not yet been explored. In our work, we explore the long term nonlinear dynamics of evolutionary

dynamical systems with the replicator equation in which agents are allowed to mutate into each other using various graph-theoretic mutation patterns. Additionally, we introduce a minimal mathematical model to investigate which processes or strategies are favored by natural selection in a competitive environment where different levels of resources are available and agents have a choice between making long term rational decisions or quick and effortless decisions that focus on the present.

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.

This book presents a wide range of research on these cross-cutting topics. The workshop out of which they came brought together physicists and computer scientists, on the one hand, and molecular, developmental, and macro-evolutionary biologists, on the other. The dialogue that emerges from the collection as a whole sheds new light on the richness and difficulty of evolutionary dynamics."--BOOK JACKET.

This book presents an introduction to Evolutionary Game Theory (EGT) which is an emerging field in the area of complex systems attracting the attention of researchers from disparate scientific communities. EGT allows one to represent and study several complex phenomena, such as the emergence of cooperation in social systems, the role of conformity in shaping the equilibrium of a population, and the dynamics in biological and ecological

systems.Since EGT models belong to the area of complex systems, statistical physics constitutes a fundamental ingredient for investigating their behavior. At the same time, the complexity of some EGT models, such as those realized by means of agent-based methods, often require the implementation of numerical simulations. Therefore, beyond providing an introduction to EGT, this book gives a brief overview of the main statistical physics tools (such as phase transitions and the Ising model) and computational strategies for simulating evolutionary games (such as Monte Carlo algorithms on lattices). This book will appeal to students and researchers in this burgeoning field of complex systems.

This monograph aims to lay the groundwork for the design of a unified mathematical approach to the modeling and analysis of large, complex systems composed of interacting living things. Drawing on twenty years of research in various scientific fields, it explores how mathematical kinetic theory and evolutionary game theory can be used to understand the complex interplay between mathematical sciences and the dynamics of living systems. The authors hope this will contribute to the development of new tools and strategies, if not a new mathematical theory. The first chapter discusses the main features of living systems and outlines a strategy for their modeling. The following chapters then explore some of the methods needed to potentially achieve this in practice. Chapter Two provides a brief introduction to the mathematical kinetic theory of classical particles, with special emphasis on the Boltzmann equation; the

Enskog equation, mean field models, and Monte Carlo methods are also briefly covered. Chapter Three uses concepts from evolutionary game theory to derive mathematical structures that are able to capture the complexity features of interactions within living systems. The book then shifts to exploring the relevant applications of these methods that can potentially be used to derive specific, usable models. The modeling of social systems in various contexts is the subject of Chapter Five, and an overview of modeling crowd dynamics is given in Chapter Six, demonstrating how this approach can be used to model the dynamics of multicellular systems. The final chapter considers some additional applications before presenting an overview of open problems. The authors then offer their own speculations on the conceptual paths that may lead to a mathematical theory of living systems hoping to motivate future research activity in the field. A truly unique contribution to the existing literature, A Quest Toward a Mathematical Theory of Living Systems is an important book that will no doubt have a significant influence on the future directions of the field. It will be of interest to mathematical biologists, systems biologists, biophysicists, and other researchers working on understanding the complexities of living systems.

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.

This field of research examines how embodied and situated agents, such as robots, evolve language and thus communicate with each other. This book is a comprehensive survey of the research in this emerging field. The contributions explain the theoretical and methodological foundations of the field, and then illustrate the scientific and technological potentials and promising research directions. The book also provides descriptions of research experiments and related open software and hardware tools, allowing the reader to gain a practical knowledge of the topic. The book will be of interest to scientists and undergraduate and graduate students in the areas of cognition, artificial life, artificial intelligence and linguistics.

Countless medical researchers over the past century have been occupied by the search for a cure of cancer. So far, they have developed and implemented a wide range of treatment techniques, including surgery, chemo- and radiotherapy, antiangiogenic drugs, small molecule inhibitors, and oncolytic viruses. However, patterns of these treatments' effectiveness remain largely unclear, and a better understanding of how cancer therapies work has become a key research goal. Cancer Treatment in Silico provides the first in-depth study of approaching this understanding by modeling cancer treatments, both mathematically and through computer simulations. The main goal of this book is to help expose students and researchers to in silico methods of studying cancer. It is intended for both the applied mathematics and experimental oncology communities, as mathematical models are playing an increasingly important role to

supplement laboratory biology in the fight against cancer. Written at a level that generally requires little technical background, the work will be a valuable resource for scientists and students alike.

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Complex Social Networks is a newly emerging (hot) topic with applications in a variety of domains, such as communication networks, engineering networks, social networks, and biological networks. In the last decade, there has been an explosive growth of research on complex real-world networks, a theme that is becoming pervasive in many disciplines, ranging from mathematics and computer science to the social and biological sciences. Optimization of complex communication networks requires a deep understanding of the interplay between the dynamics of the physical network and the information dynamics within the network. Although there are a few books addressing social networks or complex networks, none of them has specially focused on the optimization perspective of studying these networks. This book provides the basic theory of complex networks with several new mathematical approaches and optimization techniques to design and analyze dynamic complex networks. A wide range of applications and optimization problems derived from research areas such as cellular and molecular chemistry, operations research, brain physiology, epidemiology, and ecology.

Mathematics of Complexity and Dynamical Systems is an authoritative reference to the basic tools and concepts of complexity, systems theory, and dynamical

systems from the perspective of pure and applied mathematics. Complex systems are systems that comprise many interacting parts with the ability to generate a new quality of collective behavior through self-organization, e.g. the spontaneous formation of temporal, spatial or functional structures. These systems are often characterized by extreme sensitivity to initial conditions as well as emergent behavior that are not readily predictable or even completely deterministic. The more than 100 entries in this wide-ranging, single source work provide a comprehensive explication of the theory and applications of mathematical complexity, covering ergodic theory, fractals and multifractals, dynamical systems, perturbation theory, solitons, systems and control theory, and related topics. Mathematics of Complexity and Dynamical Systems is an essential reference for all those interested in mathematical complexity, from undergraduate and graduate students up through professional researchers.

This MPDI book comprises a number of selected contributions to a Special Issue devoted to the modeling and simulation of living systems based on developments in kinetic mathematical tools. The focus is on a fascinating research field which cannot be tackled by the approach of the so-called hard sciences—specifically mathematics—without the invention of new methods in view of a new mathematical theory. The contents proposed by eight contributions witness the growing interest of scientists this field. The first contribution is an editorial paper which presents the motivations for studying the mathematics and physics of living systems within the framework an interdisciplinary approach, where mathematics and physics interact with specific fields of the class of

systems object of modeling and simulations. The different contributions refer to economy, collective learning, cell motion, vehicular traffic, crowd dynamics, and social swarms. The key problem towards modeling consists in capturing the complexity features of living systems. All articles refer to large systems of interaction living entities and follow, towards modeling, a common rationale which consists firstly in representing the system by a probability distribution over the microscopic state of the said entities, secondly, in deriving a general mathematical structure deemed to provide the conceptual basis for the derivation of models and, finally, in implementing the said structure by models of interactions at the microscopic scale. Therefore, the modeling approach transfers the dynamics at the low scale to collective behaviors. Interactions are modeled by theoretical tools of stochastic game theory. Overall, the interested reader will find, in the contents, a forward look comprising various research perspectives and issues, followed by hints on to tackle these.

A theoretical study dealing chiefly with matters of definition and clarification of terms and concepts involved in using Darwinian notions to model social phenomena.

The central aim of this accessible book is to show how the gene's-eye view differs from the traditional organismal account of evolution, trace its historical origins, clarify typical misunderstandings and, by using examples from contemporary experimental work, show why so many evolutionary biologists still consider it an indispensable heuristic.

With contributions from a team of leading experts, this volume provides a comprehensive survey of recent achievements in our scientific understanding of evolution. The questions it asks concern the beginnings of the universe, the origin of life and the chances of its arising at all, the role of contingency,

and the search for universal features in the plethora of evolutionary phenomena. Rather than oversimplified or premature answers, the chapters provide a clear picture of how these essential problems are being tackled, enabling the reader to understand current thinking and open questions. The tools employed stem from a range of disciplines including mathematics, physics, biochemistry and cell biology. Self-organization as an overarching concept is demonstrated in the most diverse areas: from galaxy formation in the universe to spindle and aster formation in the cell. Chemical master equations, population dynamics, and evolutionary game theory are presented as suitable frameworks for understanding the universal mechanisms and organizational principles observed in a wide range of living units, ranging from cells to societies. This book will provide engaging reading and food for thought for all those seeking a deeper understanding of the science of evolution.

This book contains a collection of the papers accepted in the 18th Asia Pacific Symposium on Intelligent and Evolutionary Systems (IES 2014), which was held in Singapore from 10-12th November 2014. The papers contained in this book demonstrate notable intelligent systems with good analytical and/or empirical results.

The Microeconomics of Complex Economies uses game theory, modeling approaches, formal techniques, and computer simulations to teach useful, accessible approaches to real modern economies. It covers topics of information and innovation, including national and regional systems of innovation; clustered and networked firms; and open-source/open-innovation production and use. Its final chapter on policy perspectives and decisions confirms the value of the toolset. Written so chapters can be used independently, the book includes an introduction to computer simulation and pedagogical supplements. Its formal, accessible treatment of

complexity goes beyond the scopes of neoclassical and mainstream economics. The highly interdependent economy of the 21st century demands a reconsideration of economic theories. Describes the usefulness of complex heterodox economics Emphasizes divergences and convergences with neoclassical economic theories and perspectives Fits easily into courses on intermediate microeconomics, industrial organization, and games through self-contained chapters

The two-volume set LNAI 5777 and LNAI 5778 constitutes the thoroughly refereed post-conference proceedings of the 10th European Conference, ECAl 2009, held in Budapest, Hungary, in September 2009. The 141 revised full papers presented were carefully reviewed and selected from161 submissions. The papers are organized in topical sections on evolutionary developmental biology and hardware, evolutionary robotics, protocells and prebiotic chemistry, systems biology, artificial chemistry and neuroscience, group selection, ecosystems and evolution, algorithms and evolutionary computation, philosophy and arts, optimization, action, and agent connectivity, and swarm intelligence.

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.
Evolutionary algorithms (EAs) are metaheuristics that learn from natural collective behavior and are applied to solve optimization problems in domains such as scheduling, engineering, bioinformatics, and finance. Such applications demand acceptable solutions with high-speed execution using finite computational resources. Therefore, there have been many attempts to develop platforms for running parallel EAs using multicore machines, massively parallel cluster machines, or grid computing environments. Recent advances in general-purpose computing on graphics processing units (GPGPU) have opened up this possibility for parallel EAs, and this is the first book dedicated to this exciting development. The three chapters of Part I are tutorials, representing a comprehensive introduction to the approach, explaining the characteristics of the hardware used, and presenting a representative project to develop a platform for automatic parallelization of evolutionary computing (EC) on GPGPUs. The 10 chapters in Part II focus on how to consider key EC approaches in the light of this advanced computational technique, in particular addressing generic local search, tabu search, genetic algorithms, differential evolution, swarm optimization, ant colony optimization, systolic genetic search, genetic programming, and multiobjective optimization. The 6 chapters in Part III present successful results from real-world problems in data mining, bioinformatics, drug discovery, crystallography, artificial chemistries, and sudoku. Although the parallelism of EAs is suited to the single-instruction multiple-data (SIMD)-based GPU, there are many issues to be resolved in design and implementation, and a key feature of the contributions is the practical engineering advice offered. This book will be of value to researchers, practitioners, and graduate students in the areas of evolutionary computation and scientific

computing.

This book constitutes the refereed proceedings of the 7th International Workshop on Internet and Network Economics, WINE 2011, held in Singapore, in December 2011. The 31 revised full papers and 5 revised short papers presented together with the abstracts of 3 papers about work in progress were carefully reviewed and selected from 100 submissions. The papers are organized in topical sections on algorithmic game theory, algorithmic mechanism design, computational advertising, computational social choice, convergence and learning in games, economics aspects of security and privacy, information and attention economics, network games and social networks.

There are many examples of cooperation in Nature: cells cooperate to form tissues, organs cooperate to form living organisms, and individuals cooperate to raise their offspring or to hunt. However, why cooperation emerges and survives in hostile environments, when defecting would be a much more profitable short-term strategy, is a question that still remains open. During the past few years, several explanations have been proposed, including kin and group selection, punishment and reputation mechanisms, or network reciprocity. This last one will be the center of the present study. The thesis explores the interface between the underlying structure of a given population and the outcome of the cooperative dynamics taking place on top of it, (namely, the Prisoner's Dilemma Game). The first part of this work analyzes the case of a static system, where the pattern of connections is fixed, so it does not evolve over time. The second part develops two models for growing topologies, where the growth and the dynamics are entangled.

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The future of oncology seems to lie in Molecular Medicine (MM). MM is a new science based on three pillars. Two of

them are evident in its very name and are well known: medical science and molecular biology. However, there is a general unawareness that MM is firmly based on a third, and equally important, pillar: Systems Biomedicine. Currently, this term denotes multilevel, hierarchical models integrating key factors at the molecular, cellular, tissue, through phenotype levels, analyzed to reveal the global behavior of the biological process under consideration. It becomes increasingly evident that the tools to construct such complex models include, not only bioinformatics and modern applied statistics, as is unanimously agreed, but also other interdisciplinary fields of science, notably, Mathematical Oncology, Systems Biology and Theoretical Biophysics.

In the spring of 2011, a diverse group of scientists gathered at Cornell University to discuss their research into the nature and origin of biological information. This symposium brought together experts in information theory, computer science, numerical simulation, thermodynamics, evolutionary theory, whole organism biology, developmental biology, molecular biology, genetics, physics, biophysics, mathematics, and linguistics. This volume presents new research by those invited to speak at the conference. The contributors to this volume use their wide-ranging expertise in the area of biological information to bring fresh insights into the many explanatory difficulties associated with biological information. These authors raise major challenges to the conventional scientific wisdom, which attempts to explain all biological information exclusively in terms of the standard mutation/selection paradigm. Several clear themes emerged from these research papers: 1) Information is indispensable to our understanding of what life is; 2) Biological information is more than the material structures that embody it; 3) Conventional chemical and evolutionary mechanisms seem insufficient to fully explain the labyrinth of information that is

life. By exploring new perspectives on biological information, this volume seeks to expand, encourage, and enrich research into the nature and origin of biological information.

Evolutionary DynamicsExploring the Equations of LifeHarvard University Press

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.