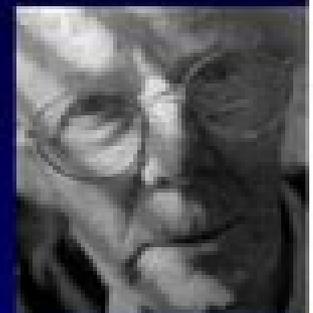


Evolutionary Dynamics



Martin Nowak
Harvard University

Dynamics Of Evolutionary Equations

Carmen Chicone, Yuri Latushkin



Dynamics Of Evolutionary Equations:

Dynamics of Evolutionary Equations George R. Sell, Yuncheng You, 2013-04-17 The theory and applications of infinite dimensional dynamical systems have attracted the attention of scientists for quite some time. Dynamical issues arise in equations that attempt to model phenomena that change with time. The infinite dimensional aspects occur when forces that describe the motion depend on spatial variables or on the history of the motion. In the case of spatially dependent problems the model equations are generally partial differential equations and problems that depend on the past give rise to differential delay equations. Because the nonlinearities occurring in these equations need not be small one needs good dynamical theories to understand the longtime behavior of solutions. Our basic objective in writing this book is to prepare an entree for scholars who are beginning their journey into the world of dynamical systems especially in infinite dimensional spaces. In order to accomplish this we start with the key concepts of a semiflow and a flow. As is well known the basic elements of dynamical systems such as the theory of attractors and other invariant sets have their origins here.

Dynamics of Evolutionary Equations George R. Sell, Yuncheng You, 2014-01-15

Evolutionary Dynamics Martin A. Nowak, 2006-09-29 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.

Dynamics of Evolutionary Equations Under Time Discretizations Hyeon Ohk Bae, 1996

Handbook of Differential Equations: Evolutionary Equations C.M. Dafermos, Eduard Feireisl, 2011-09-22 The material collected in this volume reflects the active present of this area of mathematics ranging from the abstract theory of gradient flows to stochastic representations of non linear parabolic PDE's. Articles will highlight the present as well as expected future

directions of development of the field with particular emphasis on applications. The article by Ambrosio and Savaré discusses the most recent development in the theory of gradient flow of probability measures. After an introduction reviewing the properties of the Wasserstein space and corresponding subdifferential calculus applications are given to evolutionary partial differential equations. The contribution of Herrero provides a description of some mathematical approaches developed to account for quantitative as well as qualitative aspects of chemotaxis. Particular attention is paid to the limits of cell scapability to measure external cues on the one hand and to provide an overall description of aggregation models for the slim mold *Dictyostelium discoideum* on the other. The chapter written by Masmoudi deals with a rather different topic: examples of singular limits in hydrodynamics. This is nowadays a well studied issue given the amount of new results based on the development of the existence theory for rather general systems of equations in hydrodynamics. The paper by DeLellis addresses the most recent results for the transport equations with regard to possible applications in the theory of hyperbolic systems of conservation laws. Emphasis is put on the development of the theory in the case when the governing field is only a BV function. The chapter by Rein represents a comprehensive survey of results on the Poisson-Vlasov system in astrophysics. The question of global stability of steady states is addressed in detail. The contribution of Sonar is devoted to different representations of non-linear parabolic equations in terms of Markov processes. After a brief introduction on the linear theory a class of non-linear equations is investigated with applications to stochastic control and differential games. The chapter written by Zuazua presents some of the recent progresses done on the problem of controllability of partial differential equations. The applications include the linear wave and heat equations, parabolic equations with coefficients of low regularity and some fluid-structure interaction models. Volume 1 focuses on the abstract theory of evolution. Volume 2 considers more concrete problems relating to specific applications. Volume 3 reflects the active present of this area of mathematics ranging from the abstract theory of gradient flows to stochastic representations of non-linear PDEs.

Von Karman Evolution Equations Igor Chueshov, Irena Lasiecka, 2010-04-08

In the study of mathematical models that arise in the context of concrete applications the following two questions are of fundamental importance: i) well-posedness of the model including existence and uniqueness of solutions and ii) qualitative properties of solutions. A positive answer to the first question is of prime interest on purely mathematical grounds; also provides an important test of the viability of the model as a description of a given physical phenomenon. An answer or insight to the second question provides a wealth of information about the model, hence about the process it describes. Of particular interest are questions related to long-time behavior of solutions. Such an evolution property cannot be verified empirically; thus any a priori information about the long-time asymptotics can be used in predicting an ultimate long-time response and dynamical behavior of solutions. In recent years this set of investigations has attracted a great deal of attention. Consequent efforts have then resulted in the creation and infusion of new methods and new tools that have been responsible for carrying out a successful analysis of long-time behavior.

of several classes of nonlinear PDEs

Effective Evolution Equations from Quantum Dynamics Niels

Benedikter, Marcello Porta, Benjamin Schlein, 2015-11-04 These notes investigate the time evolution of quantum systems and in particular the rigorous derivation of effective equations approximating the many body Schrödinger dynamics in certain physically interesting regimes The focus is primarily on the derivation of time dependent effective theories non equilibrium question approximating many body quantum dynamics The book is divided into seven sections the first of which briefly reviews the main properties of many body quantum systems and their time evolution Section 2 introduces the mean field regime for bosonic systems and explains how the many body dynamics can be approximated in this limit using the Hartree equation Section 3 presents a method based on the use of coherent states for rigorously proving the convergence towards the Hartree dynamics while the fluctuations around the Hartree equation are considered in Section 4 Section 5 focuses on a discussion of a more subtle regime in which the many body evolution can be approximated by means of the nonlinear Gross Pitaevskii equation Section 6 addresses fermionic systems characterized by antisymmetric wave functions here the fermionic mean field regime is naturally linked with a semiclassical regime and it is proven that the evolution of approximate Slater determinants can be approximated using the nonlinear Hartree Fock equation In closing Section 7 reexamines the same fermionic mean field regime but with a focus on mixed quasi free initial data approximating thermal states at positive temperature

Attractors of Evolution Equations A.V. Babin, M.I. Vishik, 1992-03-09

Problems ideas and notions from the theory of finite dimensional dynamical systems have penetrated deeply into the theory of infinite dimensional systems and partial differential equations From the standpoint of the theory of the dynamical systems many scientists have investigated the evolutionary equations of mathematical physics Such equations include the Navier Stokes system magneto hydrodynamics equations reaction diffusion equations and damped semilinear wave equations Due to the recent efforts of many mathematicians it has been established that the attractor of the Navier Stokes system which attracts in an appropriate functional space as $t \rightarrow \infty$ all trajectories of this system is a compact finite dimensional in the sense of Hausdorff set Upper and lower bounds in terms of the Reynolds number for the dimension of the attractor were found These results for the Navier Stokes system have stimulated investigations of attractors of other equations of mathematical physics For certain problems in particular for reaction diffusion systems and nonlinear damped wave equations mathematicians have established the existence of the attractors and their basic properties furthermore they proved that as $t \rightarrow \infty$ an infinite dimensional dynamics described by these equations and systems uniformly approaches a finite dimensional dynamics on the attractor U which in the case being considered is the union of smooth manifolds This book is devoted to these and several other topics related to the behaviour as $t \rightarrow \infty$ of solutions for evolutionary equations

Dynamical Systems and Evolution Equations John A.

Walker, 2012-12-27 This book grew out of a nine month course first given during 1976-77 in the Division of Engineering Mechanics University of Texas Austin and repeated during 1977-78 in the Department of Engineering Sciences and Applied

Mathematics Northwestern University Most of the students were in their second year of graduate study and all were familiar with Fourier series Lebesgue integration Hilbert space and ordinary differential equations in finite dimensional space This book is primarily an exposition of certain methods of topological dynamics that have been found to be very useful in the analysis of physical systems but appear to be well known only to specialists The purpose of the book is twofold to present the material in such a way that the applications oriented reader will be encouraged to apply these methods in the study of those physical systems of personal interest and to make the coverage sufficient to render the current research literature intelligible preparing the more mathematically inclined reader for research in this particular area of applied mathematics We present only that portion of the theory which seems most useful in applications to physical systems Adopting the view that the world is deterministic we consider our basic problem to be predicting the future for a given physical system This prediction is to be based on a known equation of evolution describing the forward time behavior of the system but it is to be made without explicitly solving the equation

Evolutionary Equations with Applications in Natural Sciences Jacek Banasiak, Mustapha Mokhtar-Kharroubi, 2014-11-07 With the unifying theme of abstract evolutionary equations both linear and nonlinear in a complex environment the book presents a multidisciplinary blend of topics spanning the fields of theoretical and applied functional analysis partial differential equations probability theory and numerical analysis applied to various models coming from theoretical physics biology engineering and complexity theory Truly unique features of the book are the first simultaneous presentation of two complementary approaches to fragmentation and coagulation problems by weak compactness methods and by using semigroup techniques comprehensive exposition of probabilistic methods of analysis of long term dynamics of dynamical systems semigroup analysis of biological problems and cutting edge pattern formation theory The book will appeal to postgraduate students and researchers specializing in applications of mathematics to problems arising in natural sciences and engineering

Nonlinear Dynamics and Evolutionary Economics Richard Hollis Day, Ping Chen, 1993 Advances in physics computers and mathematics have made it possible to illustrate an astonishing array of potential behavior that can occur when nonlinear interactions are present As Prigogine explains from a physicist's perspective the fundamental role of instability and bounded rationality provide more precise understanding for evolution and changes This volume considers these developments from various fields in the context of economic science The work starts with a general non mathematical discussion introducing the major themes nonlinearity dynamical systems and evolution in economic processes The work continues with nonlinear analysis of macroeconomic growth and fluctuations It describes analyses of economic adaptation learning and self organization The volume also scrutinizes a specific market equities using nonlinear analysis controlled experiments and statistical inference when nonlinearity plays an essential role in data generation The volume closes with an historical reflection by Richard Goodwin and a roundtable discussion on basic issues and new challenges in nonlinear economic dynamics

Mathematical Models in Environmental Policy Analysis Leon

Aganesovich Petrosiān, V. V. Zakharov, 1997 Presents mathematical ideas and models that can be used to facilitate rational environmental policy making Describes classical models for biological community performance ecological system stability and population dynamics presents air pollution models and methods for solving emission problems and highlights major results of the application of *Evolution Semigroups in Dynamical Systems and Differential Equations* Carmen Chicone, Yuri Latushkin, 1999 The main theme of the book is the spectral theory for evolution operators and evolution semigroups a subject tracing its origins to the classical results of J Mather on hyperbolic dynamical systems and J Howland on nonautonomous Cauchy problems The authors use a wide range of methods and offer a unique presentation The authors give a unifying approach for a study of infinite dimensional nonautonomous problems which is based on the consistent use of evolution semigroups This unifying idea connects various questions in stability of semigroups infinite dimensional hyperbolic linear skew product flows translation Banach algebras transfer operators stability radii in control theory Lyapunov exponents magneto dynamics and hydro dynamics Thus the book is much broader in scope than existing books on asymptotic behavior of semigroups Included is a solid collection of examples from different areas of analysis PDEs and dynamical systems This is the first monograph where the spectral theory of infinite dimensional linear skew product flows is described together with its connection to the multiplicative ergodic theorem the same technique is used to study evolution semigroups kinematic dynamos and Ruelle operators the theory of stability radii an important concept in control theory is also presented Examples are included and non traditional applications are provided **Handbook of Dynamical Systems** B. Fiedler, 2002 This handbook is volume II in a series collecting mathematical state of the art surveys in the field of dynamical systems Much of this field has developed from interactions with other areas of science and this volume shows how concepts of dynamical systems further the understanding of mathematical issues that arise in applications Although modeling issues are addressed the central theme is the mathematically rigorous investigation of the resulting differential equations and their dynamic behavior However the authors and editors have made an effort to ensure readability on a non technical level for mathematicians from other fields and for other scientists and engineers The eighteen surveys collected here do not aspire to encyclopedic completeness but present selected paradigms The surveys are grouped into those emphasizing finite dimensional methods numerics topological methods and partial differential equations Application areas include the dynamics of neural networks fluid flows nonlinear optics and many others While the survey articles can be read independently they deeply share recurrent themes from dynamical systems Attractors bifurcations center manifolds dimension reduction ergodicity homoclinicity hyperbolicity invariant and inertial manifolds normal forms recurrence shift dynamics stability to name just a few are ubiquitous dynamical concepts throughout the articles **Evolutionary Dynamic Equations** Akram Ben Aissa, Khaled Zennir, 2025-08-04 The book discusses the stability observability and controllability of nonlinear systems of PDEs such as Wave Heat Euler Bernoulli beam Petrovsky Kirchhoff equations and more Methods based on the theory of

classical weak functions analysis and movements in Sobolev spaces are used to analyze nonlinear systems of evolutionary partial differential equations With the unifying theme of evolutionary dynamic equations both linear and nonlinear in more complex environments with different approaches the book presents a multidisciplinary blend of topics spanning the fields of PDEs applied to various models coming from theoretical physics biology engineering and natural sciences This comprehensive book is prepared for a diverse audience interested in applied mathematics With its broad applicability this book aims to foster interdisciplinary collaboration and facilitate a deeper understanding of complex phenomenon concepts practically in electromagnetic waves the acoustic model for seismic waves waves in blood vessels wind drag on space the linear shallow water equations sound waves in liquids and gases non elastic effects in the string

Introduction to the Theory of Complex Systems Stefan Thurner, Rudolf Hanel, Peter Klimek, 2018-09-05 This book is a comprehensive introduction to quantitative approaches to complex adaptive systems Practically all areas of life on this planet are constantly confronted with complex systems be it ecosystems societies traffic financial markets opinion formation and spreading or the internet and social media Complex systems are systems composed of many elements that interact strongly with each other which makes them extremely rich dynamical systems showing a huge range of phenomena Properties of complex systems that are of particular importance are their efficiency robustness resilience and proneness to collapse The quantitative tools and concepts needed to understand the co evolutionary nature of networked systems and their properties are challenging The book gives a self contained introduction to these concepts so that the reader will be equipped with a toolset that allows them to engage in the science of complex systems Topics covered include random processes of path dependent processes co evolutionary dynamics dynamics of networks the theory of scaling and approaches from statistical mechanics and information theory The book extends beyond the early classical literature in the field of complex systems and summarizes the methodological progress made over the past 20 years in a clear structured and comprehensive way

Nonlinearity, 2009

Evolutionary Game Theory Jörgen W. Weibull, 1997 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 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 J rgen 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

Topological Approximation Methods for Evolutionary Problems of Nonlinear Hydrodynamics Viktor Grigor'evich Zviagin, Victor G. Zvyagin, Dmitry A. Vorotnikov, 2008 The authors present functional analytical methods for solving a class of partial differential equations The results have important applications to the numerical treatment of rheology specific examples are the behaviour of blood or print colours and to other applications in fluid mechanics A class of methods for solving problems in hydrodynamics is presented

Evolutionary Games and Population Dynamics Josef Hofbauer, Karl Sigmund, 1998-05-28 Every form of behaviour is shaped by trial and error Such stepwise adaptation can occur through individual learning or through natural selection the basis of evolution Since the work of Maynard Smith and others it has been realised how game theory can model this process Evolutionary game theory replaces the static solutions of classical game theory by a dynamical approach centred not on the concept of rational players but on the population dynamics of behavioural programmes In this book the authors investigate the nonlinear dynamics of the self regulation of social and economic behaviour and of the closely related interactions between species in ecological communities Replicator equations describe how successful strategies spread and thereby create new conditions which can alter the basis of their success i e to enable us to understand the strategic and genetic foundations of the endless chronicle of invasions and extinctions which punctuate evolution In short evolutionary game theory describes when to escalate a conflict how to elicit cooperation why to expect a balance of the sexes and how to understand natural selection in mathematical terms

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