

GEOMETRIC METHODS FOR DISCRETE DYNAMICAL SYSTEMS

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Geometric Methods For Discrete Dynamical Systems

R. Martini, E.M. de Jager



Geometric Methods For Discrete Dynamical Systems:

Geometric Methods for Discrete Dynamical Systems Robert W. Easton, 2023 **Geometric Methods for Discrete Dynamical Systems** Robert W. Easton, 1998-02-26 This book looks at dynamics as an iteration process where the output of a function is fed back as an input to determine the evolution of an initial state over time The theory examines errors which arise from round off in numerical simulations from the inexactness of mathematical models used to describe physical processes and from the effects of external controls The author provides an introduction accessible to beginning graduate students and emphasizing geometric aspects of the theory Conley s ideas about rough orbits and chain recurrence play a central role in the treatment The book will be a useful reference for mathematicians scientists and engineers studying this field and an ideal text for graduate courses in dynamical systems *Dynamical Systems* Jürgen Jost, 2005-11-24 Our aim is to introduce explain and discuss the fundamental problems ideas concepts results and methods of the theory of dynamical systems and to show how they can be used in specific examples We do not intend to give a comprehensive overview of the present state of research in the theory of dynamical systems nor a detailed historical account of its development We try to explain the important results often neglecting technical refinements 1 and usually we do not provide proofs One of the basic questions in studying dynamical systems i e systems that evolve in time is the construction of invariants that allow us to classify qualitative types of dynamical evolution to distinguish between qualitatively different dynamics and to study transitions between different types It is also important to find out when a certain dynamic behavior is stable under small perturbations as well as to understand the various scenarios of instability Finally an essential aspect of a dynamic evolution is the transformation of some given initial state into some final or asymptotic state as time proceeds The temporal evolution of a dynamical system may be continuous or discrete but it turns out that many of the concepts to be introduced are useful in either case *Lectures on Dynamical Systems* Eduard Zehnder, 2010 This book originated from an introductory lecture course on dynamical systems given by the author for advanced students in mathematics and physics at ETH Zurich The first part centers around unstable and chaotic phenomena caused by the occurrence of homoclinic points The existence of homoclinic points complicates the orbit structure considerably and gives rise to invariant hyperbolic sets nearby The orbit structure in such sets is analyzed by means of the shadowing lemma whose proof is based on the contraction principle This lemma is also used to prove S Smale s theorem about the embedding of Bernoulli systems near homoclinic orbits The chaotic behavior is illustrated in the simple mechanical model of a periodically perturbed mathematical pendulum The second part of the book is devoted to Hamiltonian systems The Hamiltonian formalism is developed in the elegant language of the exterior calculus The theorem of V Arnold and R Jost shows that the solutions of Hamiltonian systems which possess sufficiently many integrals of motion can be written down explicitly and for all times The existence proofs of global periodic orbits of Hamiltonian systems on symplectic manifolds are

based on a variational principle for the old action functional of classical mechanics The necessary tools from variational calculus are developed There is an intimate relation between the periodic orbits of Hamiltonian systems and a class of symplectic invariants called symplectic capacities From these symplectic invariants one derives surprising symplectic rigidity phenomena This allows a first glimpse of the fast developing new field of symplectic topology

Dynamical Systems Clark Robinson, 1998-11-17 Several distinctive aspects make Dynamical Systems unique including treating the subject from a mathematical perspective with the proofs of most of the results included providing a careful review of background materials introducing ideas through examples and at a level accessible to a beginning graduate student

Differential Geometric Methods in Mathematical Physics H.-D. Doebner, S. I. Andersson, H. R. Petry, 2006-11-14

Ergodic Theory, Analysis, and Efficient Simulation of Dynamical Systems Bernold Fiedler, 2012-12-06 This book summarizes and highlights progress in our understanding of Dynamical Systems during six years of the German Priority Research Program Ergodic Theory Analysis and Efficient Simulation of Dynamical Systems The program was funded by the Deutsche Forschungsgemeinschaft DFG and aimed at combining focussing and enhancing research efforts of active groups in the field by cooperation on a federal level The surveys in the book are addressed to experts and non experts in the mathematical community alike In addition they intend to convey the significance of the results for applications far into the neighboring disciplines of Science Three fundamental topics in Dynamical Systems are at the core of our research effort behavior for large time dimension measure and chaos Each of these topics is of course a highly complex problem area in itself and does not fit naturally into the deplorably traditional confines of any of the disciplines of ergodic theory analysis or numerical analysis alone The necessity of mathematical cooperation between these three disciplines is quite obvious when facing the formidable task of establishing a bidirectional transfer which bridges the gap between deep detailed theoretical insight and relevant specific applications Both analysis and numerical analysis play a key role when it comes to building that bridge Some steps of our joint bridging efforts are collected in this volume Neither our approach nor the presentations in this volume are monolithic

Mathematics of Complexity and Dynamical Systems Robert A. Meyers, 2011-10-05 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

Applied and Computational Measurable Dynamics Erik M. Bollt, Naratip Santitissadeekorn, 2013-12-03 Until recently measurable dynamics has been held as a highly theoretical mathematical topic with few generally known obvious links for practitioners in areas of applied mathematics However the advent of high speed computers rapidly developing algorithms and new numerical methods has allowed for a tremendous amount of progress and sophistication in efforts to represent the notion of a transfer operator discretely but to high resolution This book connects many concepts in dynamical systems with mathematical tools from areas such as graph theory and ergodic theory The authors introduce practical tools for applications related to measurable dynamical systems coherent structures and transport problems The new and fast developing computational tools discussed throughout the book allow for detailed analysis of real world problems that are simply beyond the reach of traditional methods

Differential Dynamical Systems, Revised Edition James D. Meiss, 2017-01-24

Differential equations are the basis for models of any physical systems that exhibit smooth change This book combines much of the material found in a traditional course on ordinary differential equations with an introduction to the more modern theory of dynamical systems Applications of this theory to physics biology chemistry and engineering are shown through examples in such areas as population modeling fluid dynamics electronics and mechanics *Differential Dynamical Systems* begins with coverage of linear systems including matrix algebra the focus then shifts to foundational material on nonlinear differential equations making heavy use of the contraction mapping theorem Subsequent chapters deal specifically with dynamical systems concepts flow stability invariant manifolds the phase plane bifurcation chaos and Hamiltonian dynamics This new edition contains several important updates and revisions throughout the book Throughout the book the author includes exercises to help students develop an analytical and geometrical understanding of dynamics Many of the exercises and examples are based on applications and some involve computation an appendix offers simple codes written in Maple Mathematica and MATLAB software to give students practice with computation applied to dynamical systems problems

Differential and Difference Equations with Applications Sandra Pinelas, John R. Graef, Stefan Hilger, Peter Kloeden, Christos Schinas, 2020-10-21 This edited volume gathers selected peer reviewed contributions presented at the fourth International Conference on Differential Markov models time scales non linear difference equations multi scale modeling and myriad applications

2-D Quadratic Maps and 3-D ODE Systems Elhadj Zeraoulia, Julien C. Sprott, 2010

This book is based on research on the rigorous proof of chaos and bifurcations in 2 D quadratic maps especially the invertible case such as the Hénon map and in 3 D ODE s especially piecewise linear systems such as the Chua s circuit In addition the book covers some recent works in the field of general 2 D quadratic maps especially their classification into equivalence classes and finding regions for chaos hyperchaos and non chaos in the space of bifurcation parameters Following the main introduction to the rigorous tools used to prove chaos and bifurcations in the two representative systems is the study of the

invertible case of the 2 D quadratic map where previous works are oriented toward non mapping 2 D quadratic maps are then classified into 30 maps with well known formulas Two proofs on the regions for chaos hyperchaos and non chaos in the space of the bifurcation parameters are presented using a technique based on the second derivative test and bounds for Lyapunov exponents Also included is the proof of chaos in the piecewise linear Chua's system using two methods the first of which is based on the construction of Poincaré map and the second is based on a computer assisted proof Finally a rigorous analysis is provided on the bifurcational phenomena in the piecewise linear Chua's system using both an analytical 2 D mapping and a 1 D approximated Poincaré mapping in addition to other analytical methods Electromagnetic Waveguides and Transmission Lines F. Olyslager, 1999-05-27 This monograph deals with the theoretical aspects of the circuit modelling of high frequency electromagnetic structures using the Lorentz reciprocity theorem This is the first book to cover the generalization from closed structures to open boundary waveguides and circuit structures The author has developed a new way to represent a general waveguide by transmission lines and was awarded the Microwave Prize of the IEEE for this work The first part of the book discusses the construction of transmission line models for waveguide structures Then the incidence of external electromagnetic waves on high frequency structures is studied and finally the concepts derived in the earlier parts of the book are generalized to reciprocal and non reciprocal anisotropic bi isotropic and bianisotropic materials

Difference Equations and Discrete Dynamical Systems with Applications Martin Bohner, Stefan Siegmund, Roman Šimon Hilscher, Petr Stehlík, 2020-02-10 This book presents the proceedings of the 24th International Conference on Difference Equations and Applications which was held at the Technical University in Dresden Germany in May 2018 under the auspices of the International Society of Difference Equations ISDE The conference brought together leading researchers working in the respective fields to discuss the latest developments and to promote international cooperation on the theory and applications of difference equations This book appeals to researchers and scientists working in the fields of difference equations and discrete dynamical systems and their applications *Engineering Rheology* Roger I. Tanner, 2000-03-02 This book sets out to provide a guide with examples for those who wish to make predictions about the mechanical and thermal behaviour of non Newtonian materials in engineering and processing technology After an introductory survey of the field and a review of basic continuum mechanics the radical differences between elongational and shear behaviour are shown Two chapters one based on a continuum approach and the other using microstructural approaches lead to useful mathematical descriptions of materials for engineering applications As examples of nearly viscometric and nearly elongational flows there is a discussion of lubrication and related shearing flows and fibre spinning and film blowing respectively A long chapter is devoted to the important new field of computational rheology and this is followed by chapters on stability and turbulence and the all important temperature effects in flow This new edition contains much new material not available in book form elsewhere for example wall slip suspension rheology computational rheology and new results in stability theory *Robust*

Chaos and Its Applications Elhadj Zeraoulia, Julien C. Sprott, 2012 Robust chaos is defined by the absence of periodic windows and coexisting attractors in some neighborhoods in the parameter space of a dynamical system This unique book explores the definition sources and roles of robust chaos The book is written in a reasonably self contained manner and aims to provide students and researchers with the necessary understanding of the subject Most of the known results experiments and conjectures about chaos in general and about robust chaos in particular are collected here in a pedagogical form Many examples of dynamical systems ranging from purely mathematical to natural and social processes displaying robust chaos are discussed in detail At the end of each chapter is a set of exercises and open problems more than 260 in the whole book intended to reinforce the ideas and provide additional experiences for both readers and researchers in nonlinear science in general and chaos theory in particular

Geometric Techniques in Gauge Theories R. Martini, E.M. de Jager, 2006-11-14

Boolean Systems Serban E. Vlad, 2023-01-06 The Boolean functions may be iterated either asynchronously when their coordinates are computed independently of each other or synchronously when their coordinates are computed at the same time In *Boolean Systems Topics in Asynchronicity* a book addressed to mathematicians and computer scientists interested in Boolean systems and their use in modelling author Serban E Vlad presents a consistent and original mathematical theory of the discrete time Boolean asynchronous systems The purpose of the book is to set forth the concepts of such a theory resulting from the synchronous Boolean system theory and mostly from the synchronous real system theory by analogy and to indicate the way in which known synchronous deterministic concepts generate new asynchronous nondeterministic concepts The reader will be introduced to the dependence on the initial conditions periodicity path connectedness topological transitivity and chaos A property of major importance is invariance which is present in five versions In relation to it the reader will study the maximal invariant subsets the minimal invariant supersets the minimal invariant subsets connectedness separation the basins of attraction and attractors The stability of the systems and their time reversal symmetry end the topics that refer to the systems without input The rest of the book is concerned with input systems The most consistent chapters of this part of the book refer to the fundamental operating mode and to the combinational systems systems without feedback The chapter Wires Gates and Flip Flops presents a variety of applications The first appendix addresses the issue of continuous time and the second one sketches the important theory of Daizhan Cheng which is put in relation to asynchronicity The third appendix is a bridge between asynchronicity and the symbolic dynamics of Douglas Lind and Brian Marcus Presents a consistent and original theory of the discrete time Boolean asynchronous systems which are useful for mathematicians and computer scientists interested in Boolean Networks dynamical systems and modeling Studies the flows and equations of evolution nullclines dependence on initial conditions periodicity path connectedness topological transitivity chaos nonwandering points invariance connectedness and separation as well as the basins of attraction attractors stability and time reversal symmetry Explains the fundamental operating mode of the input systems and the combinational systems

systems without feedback Includes a chapter of applications of the Boolean systems and their modeling techniques Makes use of the unbounded delay model of computation of the Boolean functions **Encyclopedia of Nonlinear Science** Alwyn Scott, 2006-05-17 In 438 alphabetically arranged essays this work provides a useful overview of the core mathematical background for nonlinear science as well as its applications to key problems in ecology and biological systems chemical reaction diffusion problems geophysics economics electrical and mechanical oscillations in engineering systems lasers and nonlinear optics fluid mechanics and turbulence and condensed matter physics among others **Boolean Functions** Serban E. Vlad, 2019-02-12 The essential guide showing how the unbounded delay model of computation of the Boolean functions may be used in the analysis of the Boolean networks Boolean Functions Topics in Asynchronicity contains the most current research in several issues of asynchronous Boolean systems In this framework asynchronicity means that the functions which model the digital circuits from electronics iterate their coordinates independently on each other and the author a noted expert in the field includes a formal mathematical description of these systems Filled with helpful definitions and illustrative examples the book covers a range of topics such as morphisms antimorphisms invariant sets path connected sets attractors Further it studies race freedom called here the technical condition of proper operation together with some of its generalized and strengthened versions and also time reversal borrowed from physics and also from dynamical systems together with the symmetry that it generates This book Presents up to date research in the field of Boolean networks Includes the information needed to understand the construction of an asynchronous Boolean systems theory and contains proofs Employs use of the language of algebraic topology and homological algebra Written for mathematicians and computer scientists interested in the theory and applications of Boolean functions dynamical systems and circuits Boolean Functions Topics in Asynchronicity is an authoritative guide indicating a way of using the unbounded delay model of computation of the Boolean functions in the analysis of the Boolean networks

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