Numerical Methods for Bifurcations of Dynamical Equilibria

Willy J. F. Govaerts

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Christian Kuehn

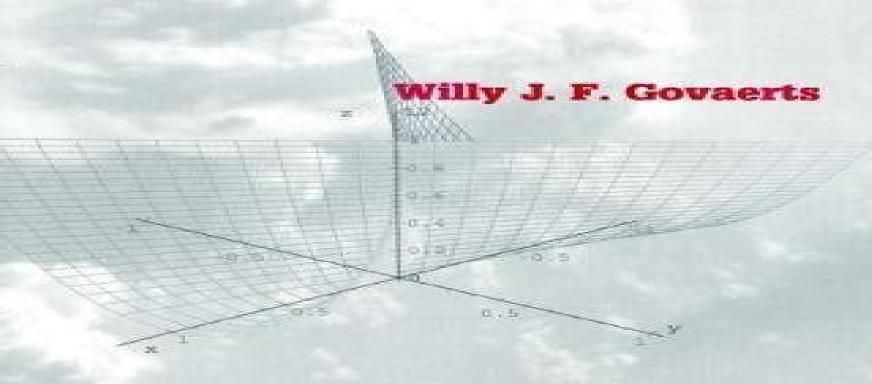**Numerical Methods For Bifurcations Of Dynamical Equilibria:**

Numerical Methods for Bifurcations of Dynamical Equilibria Willy J. F. Govaerts,2000-01-01 Dynamical systems arise in all fields of applied mathematics The author focuses on the description of numerical methods for the detection computation and continuation of equilibria and bifurcation points of equilibria of dynamical systems This subfield has the particular attraction of having links with the geometric theory of differential equations numerical analysis and linear algebra

Numerical methods for equilibrium bifurcations of dynamical systems Willy J. Govaerts,2000   Numerical Continuation Methods for Dynamical Systems Bernd Krauskopf,Hinke M. Osinga,Jorge Galan-Vioque,2007-11-06 Path following in combination with boundary value problem solvers has emerged as a continuing and strong influence in the development of dynamical systems theory and its application It is widely acknowledged that the software package AUTO developed by Eusebius J Doedel about thirty years ago and further expanded and developed ever since plays a central role in the brief history of numerical continuation This book has been compiled on the occasion of Sebius Doedel s 60th birthday Bringing together for the first time a large amount of material in a single accessible source it is hoped that the book will become the natural entry point for researchers in diverse disciplines who wish to learn what numerical continuation techniques can achieve The book opens with a foreword by Herbert B Keller and lecture notes by Sebius Doedel himself that introduce the basic concepts of numerical bifurcation analysis The other chapters by leading experts discuss continuation for various types of systems and objects and showcase examples of how numerical bifurcation analysis can be used in concrete applications Topics that are treated include interactive continuation tools higher dimensional continuation the computation of invariant manifolds and continuation techniques for slow fast systems for symmetric Hamiltonian systems for spatially extended systems and for systems with delay Three chapters review physical applications the dynamics of a SQUID global bifurcations in laser systems and dynamics and bifurcations in electronic circuits   Methods In Equivariant Bifurcations And Dynamical Systems Pascal Chossat,Reiner Lauterbach,2000-02-28 This invaluable book presents a comprehensive introduction to bifurcation theory in the presence of symmetry an applied mathematical topic which has developed considerably over the past twenty years and has been very successful in analysing and predicting pattern formation and other critical phenomena in most areas of science where nonlinear models are involved like fluid flow instabilities chemical waves elasticity and population dynamics The book has two aims One is to expound the mathematical methods of equivariant bifurcation theory Beyond the classical bifurcation tools such as center manifold and normal form reductions the presence of symmetry requires the introduction of the algebraic and geometric formalism of Lie group theory and transformation group methods For the first time all these methods in equivariant bifurcations are presented in a coherent and self consistent way in a book The other aim is to present the most recent ideas and results in this theory in relation to applications This includes bifurcations of relative equilibria and relative periodic orbits for compact and noncompact group actions heteroclinic cycles and forced

symmetry breaking perturbations Although not all recent contributions could be included and a choice had to be made a rather complete description of these new developments is provided At the end of every chapter exercises are offered to the reader   Handbook of Dynamical Systems B. Fiedler,2002-02-21 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 namejust a few are ubiquitous dynamical concepts throughout the articles   **Elements of Applied Bifurcation Theory** Yuri Kuznetsov,2013-03-09 The years that have passed since the publication of the first edition of this book proved that the basic principles used to select and present the material made sense The idea was to write a simple text that could serve as a seri ous introduction to the subject Of course the meaning of simplicity varies from person to person and from country to country The word introduction contains even more ambiguity To start reading this book only a moder ate knowledge of linear algebra and calculus is required Other preliminaries qualified as elementary in modern mathematics are explicitly formulated in the book These include the Fredholm Alternative for linear systems and the multidimensional Implicit Function Theorem Using these very limited tools a framewo k of notions results and methods is gradually built that allows one to read and possibly write scientific papers on bifurcations of nonlinear dynamical systems Among other things progress in the sciences means that mathematical results and methods that once were new become standard and routinely used by the research and development community Hopefully this edition of the book will contribute to this process The book s structure has been kept intact Most of the changes introduced reflect recent theoretical and software developments in which the author was involved Important changes in the third edition can be summarized as follows A new section devoted to the fold flip bifurcation for maps has appeared in Chapter 9   *Computational Science - ICCS 2003. Part 1.* Peter Sloot,2003-05-22 The four volume set LNCS 2657 LNCS 2658 LNCS 2659 and LNCS 2660 constitutes the refereed proceedings of the Third International Conference on Computational Science ICCS 2003 held concurrently in Melbourne Australia and in St Petersburg Russia in June 2003 The

four volumes present more than 460 reviewed contributed and invited papers and span the whole range of computational science from foundational issues in computer science and algorithmic mathematics to advanced applications in virtually all application fields making use of computational techniques These proceedings give a unique account of recent results in the field *Modeling And Computations In Dynamical Systems: In Commemoration Of The 100th Anniversary Of The Birth Of John Von Neumann* Eusebius Doedel,Gabor Domokos,Ioannis Kevrekidis,2006-03-10 The Hungarian born mathematical genius John von Neumann was undoubtedly one of the greatest and most influential scientific minds of the 20th century Von Neumann made fundamental contributions to Computing and he had a keen interest in Dynamical Systems specifically Hydrodynamic Turbulence This book offering a state of the art collection of papers in computational dynamical systems is dedicated to the memory of von Neumann Including contributions from J E Marsden P J Holmes M Shub A Iserles M Dellnitz and J Guckenheimer this book offers a unique combination of theoretical and applied research in areas such as geometric integration neural networks linear programming dynamical astronomy chemical reaction models structural and fluid mechanics The contents of this book was also published as a special issue of the International Journal of Bifurcation and Chaos March 2005 **Nonlinear Structures & Systems, Vol. 1** Matthew R.W. Brake,Ludovic Renson,Robert J. Kuether,Paolo Tiso,2025-08-07 Nonlinear Structures Systems Volume 1 Proceedings of the 42nd IMAC A Conference and Exposition on Structural Dynamics 2024 the first volume of ten from the Conference brings together contributions to this important area of research and engineering The collection presents early findings and case studies on fundamental and applied aspects of Nonlinear Dynamics including papers on Experimental Nonlinear Dynamics Jointed Structures Identification Mechanics Dynamics Nonlinear Damping Nonlinear Modeling and Simulation Nonlinear Reduced Order Modeling Nonlinearity and System Identification **Numerical Bifurcation Analysis for Reaction-Diffusion Equations** Zhen Mei,2013-03-09 Reaction diffusion equations are typical mathematical models in biology chemistry and physics These equations often depend on various parame ters e g temperature catalyst and diffusion rate etc Moreover they form normally a nonlinear dissipative system coupled by reaction among differ ent substances The number and stability of solutions of a reaction diffusion system may change abruptly with variation of the control parameters Cor respondingly we see formation of patterns in the system for example an onset of convection and waves in the chemical reactions This kind of phe nomena is called bifurcation Nonlinearity in the system makes bifurcation take place constantly in reaction diffusion processes Bifurcation in turn in duces uncertainty in outcome of reactions Thus analyzing bifurcations is essential for understanding mechanism of pattern formation and nonlinear dynamics of a reaction diffusion process However an analytical bifurcation analysis is possible only for exceptional cases This book is devoted to nu merical analysis of bifurcation problems in reaction diffusion equations The aim is to pursue a systematic investigation of generic bifurcations and mode interactions of a dass of reaction diffusion equations This is realized with a combination of three mathematical approaches numerical methods for con

tinuation of solution curves and for detection and computation of bifurcation points effective low dimensional modeling of bifurcation scenario and long time dynamics of reaction diffusion equations analysis of bifurcation sce nario mode interactions and impact of boundary conditions   Bifurcation Analysis of Fluid Flows Henk A. Dijkstra,Fred W. Wubs,2023-08-24 A guide to computing bifurcation diagrams for fluid flows including relevant code with broad applicability to industrial environmental astrophysical flows   **Parallel Computational Technologies** Leonid Sokolinsky,Mikhail Zymbler,2017-10-01 This book constitutes the refereed proceedings of the 11th International Conference on Parallel Computational Technologies PCT 2017 held in Kazan Russia in April 2017 The 24 revised full papers presented were carefully reviewed and selected from 167 submissions The papers are organized in topical sections on high performance architectures tools and technologies parallel numerical algorithms supercomputer simulation   *Focus on Combustion Research* Sung Z. Jiang,2006 Combustion or burning is an exothermic reaction between a substance and a gas to release heat Combustion normally occurs in oxygen often in the form of gaseous O_2 to form oxides However combustion can also take place in other gases like chlorine The products of such reactions usually include water H_2O as well as carbon monoxide CO or carbon dioxide CO_2 or both Other by products such as partially reacted fuel and elemental carbon C may generate visible smoke and soot This book presents leading research from around the world in this frontal field   Nonlinear Targeted Energy Transfer in Mechanical and Structural Systems Alexander F. Vakakis,Oleg V. Gendelman,Lawrence A. Bergman,D. Michael McFarland,Gaëtan Kerschen,Young Sup Lee,2008-12-24 This monograph evolved over a period of nine years from a series of papers and presentations addressing the subject of passive vibration control of mechanical s tems subjected to broadband transient inputs The unifying theme is Targeted ergy Transfer TET which represents a new and unique approach to the passive control problem in which a strongly nonlinear fully passive local attachment the Nonlinear Energy Sink NES is employed to drastically alter the dynamics of the primary system to which it is attached The intrinsic capacity of the properly signed NES to promote rapid localization of externally applied narrowband bration or broadband shock energy to itself where it can be captured and dis pated provides a powerful strategy for vibration control and the opens the pos bility for a wide range of applications of TET such as vibration and shock i lation passive energy harvesting aeroelastic instability utter suppression se mic mitigation vortex shedding control enhanced reliability designs for ex ple in power grids and others The monograph is intended to provide a thorough explanation of the analytical computational and experimental methods needed to formulate and study TET in mechanical and structural systems Several prac cal engineering applications are examined in detail and experimental veri cation and validation of the theoretical predictions are provided as well The authors also suggest a number of possible future applications where application of TET seems promising The authors are indebted to a number of sponsoring agencies   **Algorithms in Algebraic Geometry** Alicia Dickenstein,Frank-Olaf Schreyer,Andrew J. Sommese,2010-07-10 In the last decade there has been a burgeoning of activity in the design and implementation of

algorithms for algebraic geometric computation The workshop on Algorithms in Algebraic Geometry that was held in the framework of the IMA Annual Program Year in Applications of Algebraic Geometry by the Institute for Mathematics and Its Applications on September 2006 is one tangible indication of the interest This volume of articles captures some of the spirit of the IMA workshop   PDE Dynamics Christian Kuehn,2019-04-10 This book provides an overview of the myriad methods for applying dynamical systems techniques to PDEs and highlights the impact of PDE methods on dynamical systems Also included are many nonlinear evolution equations which have been benchmark models across the sciences and examples and techniques to strengthen preparation for research PDE Dynamics An Introduction is intended for senior undergraduate students beginning graduate students and researchers in applied mathematics theoretical physics and adjacent disciplines Structured as a textbook or seminar reference it can be used in courses titled Dynamics of PDEs PDEs 2 Dynamical Systems 2 Evolution Equations or Infinite Dimensional Dynamics   **Dynamics of the Chemostat** Abdelhamid Ajbar,Khalid Alhumaizi,2011-08-09 A ubiquitous tool in mathematical biology and chemical engineering the chemostat often produces instabilities that pose safety hazards and adversely affect the optimization of bioreactive systems Singularity theory and bifurcation diagrams together offer a useful framework for addressing these issues Based on the authors extensive work in this   Multiple Time Scale Dynamics Christian Kuehn,2015-02-25 This book provides an introduction to dynamical systems with multiple time scales The approach it takes is to provide an overview of key areas particularly topics that are less available in the introductory form The broad range of topics included makes it accessible for students and researchers new to the field to gain a quick and thorough overview The first of its kind this book merges a wide variety of different mathematical techniques into a more unified framework The book is highly illustrated with many examples and exercises and an extensive bibliography The target audience of this book are senior undergraduates graduate students as well as researchers interested in using the multiple time scale dynamics theory in nonlinear science either from a theoretical or a mathematical modeling perspective   **Current Trends in Dynamical Systems in Biology and Natural Sciences** Maira Aguiar,Carlos Braumann,Bob W. Kooi,Andrea Pugliese,Nico Stollenwerk,Ezio Venturino,2020-05-06 This book disseminates the latest results and envisages new challenges in the application of mathematics to various practical situations in biology epidemiology and ecology It comprises a collection of the main results presented at the Ninth Edition of the International Workshop Dynamical Systems Applied to Biology and Natural Sciences DSABNS held from 7 to 9 February 2018 at the Department of Mathematics University of Turin Italy While the principal focus is ecology and epidemiology the coverage extends even to waste recycling and a genetic application The topics covered in the 12 peer reviewed contributions involve such diverse mathematical tools as ordinary and partial differential equations delay equations stochastic equations control and sensitivity analysis The book is intended to help both in disseminating the latest results and in envisaging new challenges in the application of mathematics to various practical situations in biology epidemiology and ecology   Numerical

Bifurcation Analysis of Maps Yuri A. Kuznetsov,Hil G. E. Meijer,2019-03-28 This book combines a comprehensive state of the art analysis of bifurcations of discrete time dynamical systems with concrete instruction on implementations and example applications in the free MATLAB software MatContM developed by the authors While self contained and suitable for independent study the book is also written with users in mind and is an invaluable reference for practitioners Part I focuses on theory providing a systematic presentation of bifurcations of fixed points and cycles of finite dimensional maps up to and including cases with two control parameters Several complementary methods including Lyapunov exponents invariant manifolds and homoclinic structures and parts of chaos theory are presented Part II introduces MatContM through step by step tutorials on how to use the general numerical methods described in Part I for simple dynamical models defined by one and two dimensional maps Further examples in Part III show how MatContM can be used to analyze more complicated models from modern engineering ecology and economics

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