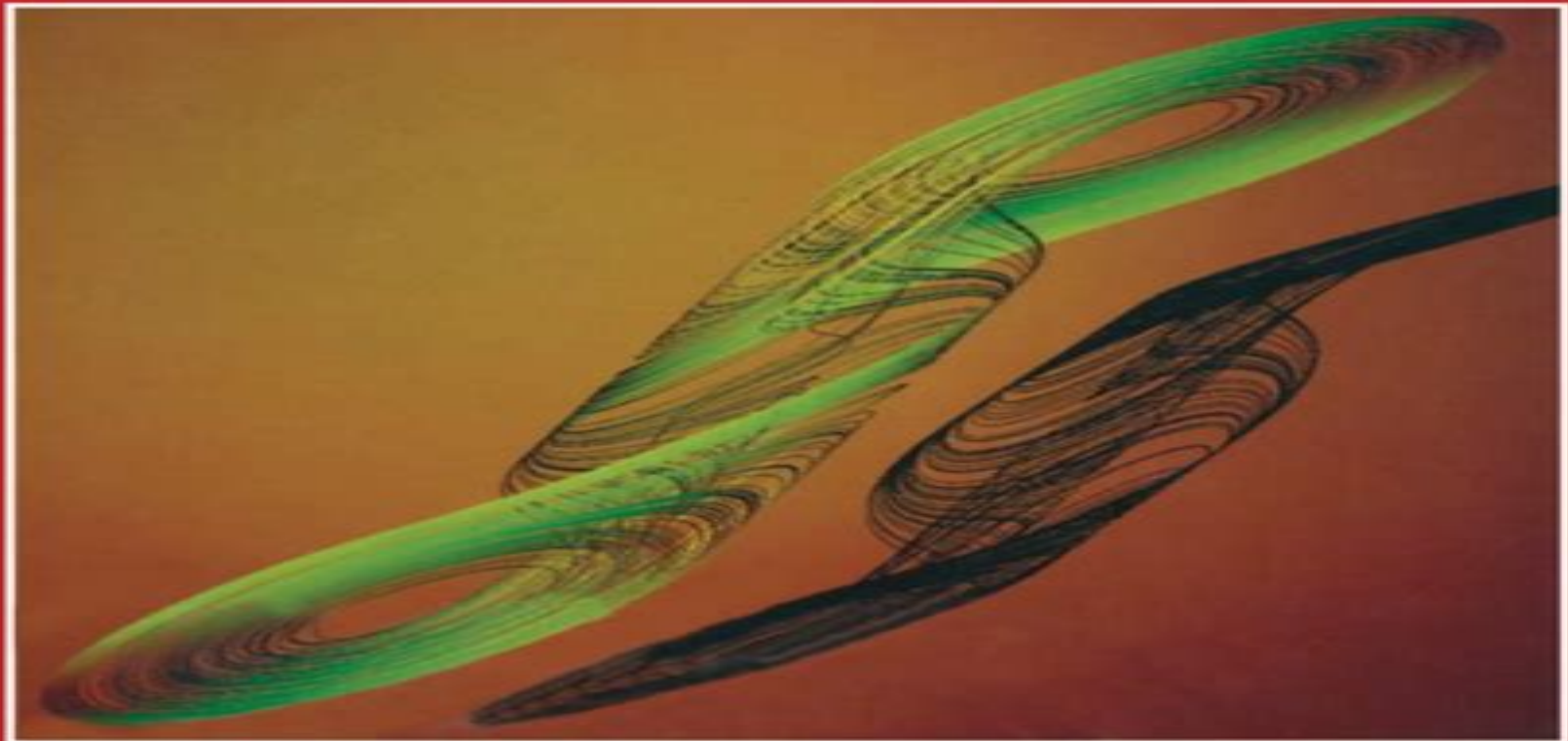


T.S. Parker and L.O. Chua

Practical Numerical Algorithms for Chaotic Systems



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Practical Numerical Algorithms For Chaotic Systems

Maciej J Ogorzalek



Practical Numerical Algorithms For Chaotic Systems:

Practical Numerical Algorithms for Chaotic Systems Thomas S. Parker, Leon Chua, 2012-12-06 One of the basic tenets of science is that deterministic systems are completely predictable given the initial condition and the equations describing a system the behavior of the system can be predicted for all time The discovery of chaotic systems has eliminated this viewpoint Simply put a chaotic system is a deterministic system that exhibits random behavior Though identified as a robust phenomenon only twenty years ago chaos has almost certainly been encountered by scientists and engineers many times during the last century only to be dismissed as physical noise Chaos is such a wide spread phenomenon that it has now been reported in virtually every scientific discipline astronomy biology biophysics chemistry engineering geology mathematics medicine meteorology plasmas physics and even the social sciences It is no coincidence that during the same two decades in which chaos has grown into an independent field of research computers have permeated society It is in fact the wide availability of inexpensive computing power that has spurred much of the research in chaotic dynamics The reason is simple the computer can calculate a solution of a nonlinear system This is no small feat Unlike linear systems where closed form solutions can be written in terms of the system's eigenvalues and eigenvectors few nonlinear systems and virtually no chaotic systems possess closed form solutions

Practical Numerical Algorithms for Chaotic Systems

Practical Numerical Algorithms for Chaotic Systems Thomas S Parker, Leon Chua, 1989-08-01

Construction of Arithmetical Meanings and Strategies Leslie Steffe, Paul Cobb, 1987-12-18 The studies presented in this book should be of interest to anybody concerned with the teaching of arithmetic to young children or with cognitive development in general The teaching experiment was carried out with half a dozen children entering first grade over two years in biweekly sessions Methodologically the authors research is original It is a longitudinal but not a naturalistic study since the experimenter teachers directed their interaction with each individual child with a view to his or her possible progress It is experimental in the sense that two groups of subjects were selected according to criteria derived from an earlier study Steffe von Glasersfeld Richards but unlike more rigid and shorter learning or training studies it does not include pre and posttests or predetermined procedures Theoretically the authors subscribe to Piaget's constructivism numbers are made by children not found as they may find some pretty rocks for example or accepted from adults as they may accept and use a toy The authors interpret changes in the children's counting behaviors in terms of constructivist concepts such as assimilation accommodation and reflective abstraction and certain excerpts from protocols provide on line examples of such processes at work They also subscribe to Vygotsky's proposal for teachers to utilize the zone of proximal development and to lead the child to what he can not yet do 1965 p 104

Practical numerical Algorithms for chaotic systems, 1989 *The Journal of Agricultural Economics Research*, 1991

Journal of Agricultural Economics Research, 1991

Chaos And Complexity In Nonlinear Electronic Circuits Maciej J Ogorzalek, 1997-09-16 The basic procedures for designing and analysing electronic systems are based largely on the assumptions of linear behavior of the

system Nonlinearities inherent in all real applications very often cause unexpected and even strange behavior This book presents an electronic engineer s perspective on chaos and complex behavior It starts from basic mathematical notions which enable understanding of the observed phenomena and guides the reader through the methodology and tools used in the laboratory and numerical experiments to interpretation and explanation of basic mechanisms On typical circuit examples it shows how the theoretical and empirical developments can be used in practice Attention is drawn to applications of chaotic circuits as noise generators and the possible use of synchronized chaotic systems in information transmission and encryption Chaos control is considered as a new emerging area where electronic equipment and chaos theory could turn vital in biomedical and engineering issues

Mixing H. Chaté,E. Villermanx,J.-M. Chomaz,2012-12-06 Mixing may be thought of as the operation by which a system evolves from one state of simplicity initial segregation to another state of simplicity complete uniformity Between these two extremes complex patterns emerge and die Questions naturally arise how can the geometry of complex patterns be characterised what is the time scale of the process what structures are involved in the flow This volume comprising the proceedings of the NATO ASI on Mixing attempts to address these questions from the approaches of geometry kinetics and structure The ASI which brought together diverse communities with a common interest in the problem of mixing now provides us with a comprehensive work on the problem of mixing

Optimization of Integer/Fractional Order Chaotic Systems by Metaheuristics and their Electronic Realization Esteban Tlelo-Cuautle,Luis Gerardo de la Fraga,Omar Guillén-Fernández,Alejandro Silva-Juárez,2021-05-09 Mathematicians have devised different chaotic systems that are modeled by integer or fractional order differential equations and whose mathematical models can generate chaos or hyperchaos The numerical methods to simulate those integer and fractional order chaotic systems are quite different and their exactness is responsible in the evaluation of characteristics like Lyapunov exponents Kaplan Yorke dimension and entropy One challenge is estimating the step size to run a numerical method It can be done analyzing the eigenvalues of self excited attractors while for hidden attractors it is difficult to evaluate the equilibrium points that are required to formulate the Jacobian matrices Time simulation of fractional order chaotic oscillators also requires estimating a memory length to achieve exact results and it is associated to memories in hardware design In this manner simulating chaotic hyperchaotic oscillators of integer fractional order and with self excited hidden attractors is quite important to evaluate their Lyapunov exponents Kaplan Yorke dimension and entropy Further to improve the dynamics of the oscillators their main characteristics can be optimized applying metaheuristics which basically consists of varying the values of the coefficients of a mathematical model The optimized models can then be implemented using commercially available amplifiers field programmable analog arrays FPAA field programmable gate arrays FPGA microcontrollers graphic processing units and even using nanometer technology of integrated circuits The book describes the application of different numerical methods to simulate integer fractional order chaotic systems These methods are used within optimization loops to

maximize positive Lyapunov exponents Kaplan Yorke dimension and entropy Single and multi objective optimization approaches applying metaheuristics are described as well as their tuning techniques to generate feasible solutions that are suitable for electronic implementation The book details several applications of chaotic oscillators such as in random bit number generators cryptography secure communications robotics and Internet of Things

Nonlinear Dynamics in Economics and Social Sciences Franco Gori, Lucio Geronazzo, Marcello Galeotti, 2012-12-06 This volume constitutes the Proceedings of the Nonlinear Dynamics in Economics and Social Sciences Meeting held at the Certosa di Pontignano Siena on May 27-30 1991 The Meeting was organized by the National Group Modelli Nonlineari in Economia e Dinamiche Complesse of the Italian Ministry of University and Scientific Research MURST The aim of the Conference which followed a previous analogous initiative taking place in the very same Certosa on January 1988 was the one of offering a come together opportunity to economists interested in a new mathematical approach to the modelling of economical processes through the use of more advanced analytical techniques and mathematicians acting in the field of global dynamical systems theory and applications A basic underlying idea drove the organizers the necessity of focusing on the use that recent methods and results as those commonly referred to the overpopularized label of Chaotic Dynamics did find in the social sciences domain and thus to check their actual relevance in the research program of modelling economic phenomena in order to individuate and stress promising perspectives as well as to curb excessive hopes and criticize not infrequent cases where research reduces to mechanical ad hoc applications of a la mode techniques In a word we felt the need of looking about the state of the arts in non linear systems theory applications to economics and social processes hence the title of the workshop and the volume

Applied Mathematical Modeling Douglas R. Shier, K.T. Wallenius, 1999-11-11 The practice of modeling is best learned by those armed with fundamental methodologies and exposed to a wide variety of modeling experience Ideally this experience could be obtained by working on actual modeling problems But time constraints often make this difficult Applied Mathematical Modeling provides a collection of models illustrating the power and richness of the mathematical sciences in supplying insight into the operation of important real world systems It fills a gap within modeling texts focusing on applications across a broad range of disciplines The first part of the book discusses the general components of the modeling process and highlights the potential of modeling in practice These chapters discuss the general components of the modeling process and the evolutionary nature of successful model building The second part provides a rich compendium of case studies each one complete with examples exercises and projects In keeping with the multidimensional nature of the models presented the chapters in the second part are listed in alphabetical order by the contributor's last name Unlike most mathematical books in which you must master the concepts of early chapters to prepare for subsequent material you may start with any chapter Begin with cryptology if that catches your fancy or go directly to bursty traffic if that is your cup of tea Applied Mathematical Modeling serves as a handbook of in depth case studies that span the mathematical sciences

building upon a modest mathematical background Readers in other applied disciplines will benefit from seeing how selected mathematical modeling philosophies and techniques can be brought to bear on problems in their disciplines The models address actual situations studied in chemistry physics demography economics civil engineering environmental engineering industrial engineering telecommunications and other areas

Fundamentals of the New Artificial Intelligence Toshinori Munakata, 2008-01-01 The book covers the most essential and widely employed material in each area particularly the material important for real world applications Our goal is not to cover every latest progress in the fields nor to discuss every detail of various techniques that have been developed New sections subsections added in this edition are Simulated Annealing Section 3 7 Boltzmann Machines Section 3 8 and Extended Fuzzy if then Rules Tables Sub section 5 5 3 Also numerous changes and typographical corrections have been made throughout the manuscript The Preface to the first edition follows General scope of the book Artificial intelligence AI as a field has undergone rapid growth in diversification and practicality For the past few decades the repertoire of AI techniques has evolved and expanded Scores of newer fields have been added to the traditional symbolic AI Symbolic AI covers areas such as knowledge based systems logical reasoning symbolic machine learning search techniques and natural language processing The newer fields include neural networks genetic algorithms or evolutionary computing fuzzy systems rough set theory and chaotic systems

Control of Complex Systems Aleksandar Zecevic, Dragoslav D. Siljak, 2010-01-08 Control of Complex Systems Structural Constraints and Uncertainty focuses on control design under information structure constraints with a particular emphasis on large scale systems The complexity of such systems poses serious computational challenges and severely restricts the types of feedback laws that can be used in practice This book systematically addresses the main issues and provides a number of applications that illustrate potential design methods most which use Linear Matrix Inequalities LMIs which have become a popular design tool over the past two decades Authors Aleksandar I Zecevic and Dragoslav D Siljak use their years of experience in the control field to also Address the issues of large scale systems as they relate to robust control and linear matrix inequalities Discuss a new approach to applying standard LMI techniques to large scale systems combining graphic theoretic decomposition techniques with appropriate low rank numerical approximations and dramatically reducing the computational effort Providing numerous examples and a wide variety of applications ranging from electric power systems and nonlinear circuits to mechanical problems and dynamic Boolean networks Control of Complex Systems Structural Constraints and Uncertainty will appeal to practicing engineers researchers and students working in control design and other related areas

Membrane Transport and Renal Physiology Harold E. Layton, Alan M. Weinstein, 2002-08-06 The papers in this volume arose out of the workshop Membrane Transport and Renal Physiology which was conducted as part of the IMA 1998 1999 program year Mathematics in Biology The workshop brought together physiologists biophysicists and applied mathematicians who share a common interest in solute and water transport in biological systems especially in the integrated

function of the kidney Solute and water transport through cells involves fluxes across two cell membranes usually via specialized proteins that are integral membrane components By means of mathematical representations transport fluxes can be related to transmembrane solute concentrations and electrochemical driving forces At the next level of functional integration these representations can serve as key components for models of renal transcellular transport Ultimately simulations can be developed for transport dependent aspects of overall renal function Workshop topics included solute fluxes through ion channels cotransporters and metabolically driven ion pumps transport across fiber matrix and capillary membranes coordinated transport by renal epithelia the urine concentrating mechanism and intra renal hemodynamic control This volume will be of interest to biological and mathematical scientists who would like a view of recent mathematical efforts to represent membrane transport and its role in renal function

Applied Mathematics for Restructured Electric Power Systems Joe H. Chow, Felix F. Wu, James A. Momoh, 2004-11-09 Applied Mathematics for Restructured Electric Power Systems Optimization Control and Computational Intelligence consists of chapters based on work presented at a National Science Foundation workshop organized in November 2003 The theme of the workshop was the use of applied mathematics to solve challenging power system problems The areas included control optimization and computational intelligence In addition to the introductory chapter this book includes 12 chapters written by renowned experts in their respected fields Each chapter follows a three part format 1 a description of an important power system problem or problems 2 the current practice and or particular research approaches and 3 future research directions Collectively the technical areas discussed are voltage and oscillatory stability power system security margins hierarchical and decentralized control stability monitoring embedded optimization neural network control with adaptive critic architecture control tuning using genetic algorithms and load forecasting and component prediction This volume is intended for power systems researchers and professionals charged with solving electric and power system problems

Circuits and Systems Tutorials Chris Toumazou, Nick Battersby, Sonia Porta, 1995-12-11 Available for the first time in paperback this ground breaking industry textbook is heralded as a first in its state of the art coverage of the most important areas emerging in circuits and systems It is compiled from course material used in a suite of one day tutorials on circuits and systems designed expressly for engineers and research scientists who want to explore subjects outside but related to their immediate fields Authored by 50 circuits and systems experts this volume fosters a fundamental and authoritative understanding of each subject

Attractors, Bifurcations, and Chaos Tönü Puu, 2013-04-17 The present book relies on various editions of my earlier book Nonlinear Economic Dynamics first published in 1989 in the Springer series Lecture Notes in Economics and Mathematical Systems and republished in three more successively revised and expanded editions as a Springer monograph in 1991 1993 and 1997 The first three editions were focused on applications The last was considerably different by including some chapters with mathematical background material ordinary differential equations and iterated maps so as to make the book more self contained and suitable as a

textbook for economics students of dynamical systems To the same pedagogical purpose the number of illustrations were expanded The author also prepared some of the software used in producing the illustrations for use by the readers on the PC by making the programs interactive and providing them with a user interface Simulations are essential when dealing with nonlinear systems where closed form solutions do not exist Even theoretical science then becomes experimental The software prepared for that book can still be acquired directly from the author at the address tonu puu econ umu se The present book has been so much changed that I felt it reasonable to give it a new title There are two new mathematics chapters on partial differential equations and on catastrophe theory making the mathematical background material fairly complete There is also an account of the recently emergent method of critical lines and absorbing areas for non invertible maps added to the chapter on maps

Chua's Circuit: A Paradigm For Chaos Rabinder N Madan,1993-11-20 For uninitiated researchers engineers and scientists interested in a quick entry into the subject of chaos this book offers a timely collection of 55 carefully selected papers covering almost every aspect of this subject Because Chua's circuit is endowed with virtually every bifurcation phenomena reported in the extensive literature on chaos and because it is the only chaotic system which can be easily built by a novice simulated in a personal computer and tractable mathematically it has become a paradigm for chaos and a vehicle for illustrating this ubiquitous phenomenon Its supreme simplicity and robustness has made it the circuit of choice for generating chaotic signals for practical applications In addition to the 48 illuminating papers drawn from a recent two part Special Issue March and June 1993 of the Journal of Circuits Systems and Computers devoted exclusively to Chua's circuit several highly illustrative tutorials and incisive state of the art reviews on the latest experimental computational and analytical investigations on chaos are also included To enhance its pedagogical value a diskette containing a user friendly software and data base on many basic chaotic phenomena is attached to the book as well as a gallery of stunningly colorful strange attractors Beginning with an elementary freshman level physics introduction on experimental chaos the book presents a step by step guided tour with papers of increasing complexity which covers almost every conceivable aspects of bifurcation and chaos The second half of the book contains many original materials contributed by world renowned authorities on chaos including L P Shil'nikov A N Sharkovsky M Misiurewicz A I Mees R Lozi L O Chua and V S Afraimovich The scope of topics covered is quite comprehensive including at least one paper on each of the following topics routes to chaos 1 D maps universality self similarity 2 parameter renormalization group analysis piecewise linear dynamics slow fast dynamics conformal analysis symmetry breaking strange attractors basins of attraction geometric invariants time series reconstruction Lyapunov exponents bispectral analysis homoclinic bifurcation stochastic resonance synchronization and control of chaos as well as several novel applications of chaos including secure communications visual sensing neural networks dry turbulence nonlinear waves and music

Soft Computing Luigi Fortuna,Gianguido Rizzotto,Mario Lavorgna,Giuseppe Nunnari,Maria Gabriella Xibilia,Riccardo Caponetto,2012-12-06 In the last decade new artificial

intelligence methods for the modelling and control of complex systems namely neural networks fuzzy logic and probabilistic reasoning have drawn the interest of researchers and engineers Recently the advantages achievable by using combinations of these methods which have independent origin and evolution have been pointed out generating a new paradigm which is now termed soft computing This new methodology subsumes the capabilities of neural networks for modelling non linear systems and for solving classification problems the power of fuzzy logic to represent approximate or heuristic reasoning and the large capabilities of evolutionary computation for problem optimisation The book presents a clear understanding of a new type of computation system the cellular neural network CNN which has been successfully applied to the solution of many heavy computation problems mainly in the fields of image processing and complex partial differential equations CNNs computation based systems represent new opportunities for improving the soft computation toolbox The application of soft computing to complex systems and in particular to chaotic systems with the generation of chaotic dynamics by using CNN is also described These aspects are of particular interest owing to their growing interest for research and application purposes Specific topics covered in the text include fuzzy logic control and neural networks artificial neural networks and their application in the modelling and control of dynamical systems evolutionary optimisation algorithms complex dynamics and cellular neural networks applications in urban traffic noise monitoring robot control and rapid thermal process systems

Dynamical Chaos Vadim Semenovich Anishchenko, 1995 In this book bifurcational mechanisms of the development structure and properties of chaotic attractors are investigated by numerical and physical experiments based on the methods of the modern theory of nonlinear oscillations The typical bifurcations of regular and chaotic attractors which are due to parameter variations are analyzed Regularities of the transition to chaos via the collapse of quasiperiodic oscillations with two and three frequencies are investigated in detail The book deals with the problems of chaotic synchronization interaction of attractors and the phenomenon of stochastic resonance The problems of fluctuation influence on the bifurcations and properties of chaotic attractors are investigated more closely All principal problems are investigated by the comparison of theoretical and numerical results and data from physical experiments

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