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BOOK REVIEWS

CHRISTOPH BÖRGERS, *Mathematics of Social Choice. Voting, Compensation, and Division*, SIAM, 2010 (Adriana-Ioana Lefter)

MICHAEL FIELD, MARTIN GOLUBITSKY, *Symmetry in Chaos. A search for pattern in mathematics, art, and nature,* 2nd edition, SIAM, 2009 (Adriana-Ioana Lefter)

MYOUNG AN, ANDRZEJ K. BRODZIK, RICHARD TOLIMIERI, *Ideal Sequence Design in Time-Frequency Space. Applications to Radar, Sonar, and Communication Systems,* Series: Applied and Numerical Harmonic Analysis, Birkhäuser, 2009 (Ionel-Dumitrel Ghiba)

ANDREW R. CONN, KATYA SCHEINBERG, LUIS N. VICENTE, *Introduction to Derivative-Free Optimization*, MPS-SIAM Series on Optimization, SIAM-MPS, 2009 (Adrian Zălinescu)

IGOR GRIVA, STEPHEN G. NASH, ARIELA SOFER, *Linear and Nonlinear Optimization*, 2nd edition, SIAM, 2009 (Adriana-Ioana Lefter)

BISWA NATH DATTA, *Numerical Linear Algebra and Applications*, 2nd edition, SIAM, 2010 (Adriana-Ioana Lefter)

JASON L. SPEYER, DAVID H. JACOBSON, *Primer on Optimal Control Theory*, SIAM, 2010 (Ionuţ Munteanu)

J.J. DUISTERMAAT, J.A.C. KOLK, *Distributions. Theory and Applications*, Cornerstones Series, Birkhäuser, 2010 (Ionuţ Munteanu)

JAN MODERSITSKI, *FAIR: Flexible Algorithms for Image Registration,* SIAM, 2009 (Adriana-Ioana Lefter)

DIANNE P. O'LEARY, *Scientific Computing with case studies,* SIAM, 2009 (Adriana-Ioana Lefter)

STEPHEN LYNCH, *Dynamical Systems with Applications using Maple,* 2nd edition, Birkhäuser, 2010 (Adriana-Ioana Lefter)

CHRISTOPH BÖRGERS, *Mathematics of Social Choice. Voting, Compensation, and Division*, SIAM, Philadelphia, 2010, xii+245 p., ISBN 978-0-898716-95-5.

This book is an introduction to election systems and fair division of resources, most of it accessible to readers without a high-level mathematical background. A wide range of examples illustrate the notions discussed in the text.

The content is divided into three independent parts. The first part (Chapters 1-12) deals with voting methods for selecting or ranking candidates. Chapters 1-8 present and analyze the advantages and disadvantages of several methods used for the selection of a single winner from a group of candidates, such as: the plurality method, the runoff and the instant runoff method, the method of pairwise comparison, the Smith method, Schulze's beatpath method. Chapters 9 and 10 provide examples of requirements that cannot be satisfied by any reasonable winner selection method, and present the Muller-Saterthwaite and Gibbard-Satterthwaite Theorems. Chapters 11 and 12 treat elections meant to rank a field of candidates. The relation between ranking and winner selection is discussed and a proof of Arrow's dictatorship theorem is given.

The second part (Chapters 13-15) deals with compensation problems wherein an indivisible item must be assigned to one of several people who are equally entitled to ownership of the item, with monetary compensation paid to the others. The notions of fairness, envy-freeness, Pareto-optimality, and equitability are introduced.

The third part (Chapters 16-26) discusses the problem of sharing a divisible object among several people. Chapter 16 revisits the notions of envy-freeness, Pareto-optimality, and equitability in the context of the "cake cutting" problem with two participants. Generalizations of this problem for three participants (Steinhaus' method) or for arbitrarily many participants (Kuhn's method) are examined in Chapters 17 and 19. Kuhn's method is related to Hall's marriage theorem, presented in Chapter 18. Chapter 20 describes Selfridge and Conway's method for envy-free cake division among three persons. The next six chapters consider the "cake cutting" problem for a "cake" consisting of finitely many homogenous pieces. Chapters 21-24 present the adjusted winner method of Brams and Taylor for two participants, and analyze the resolution of conflicts and the effect of dishonesty. Proportional allocation for two people is studied in Chapter 25, while in Chapter 26 one finds generalizations on the idea of adjusted winner method to the case of at least three participants.

Three appendices on sets, logic, and mathematical induction are added. Each chapter includes a list of exercises, their solutions being provided in the fourth appendix.

The book is intended for students having only notions of elementary algebra, but it also contains sections that may prove useful for more advanced readers, interested in the applications of mathematics to social sciences.

Adriana – Ioana Lefter

MICHAEL FIELD, MARTIN GOLUBITSKY, *Symmetry in Chaos. A search for pattern in mathematics, art, and nature,* 2^{nd} edition, SIAM, Philadelphia, 2009, xiv+199 p., ISBN 978-0-898716-72-6.

The volume entitled *Symmetry in Chaos. A search for pattern in mathematics, art, and nature* explores the connections between art and mathematics. It mathematically explains the ideas of symmetry and chaos, and presents astonishing computer-generated images of symmetric chaos, and the ideas needed to create them.

The content is divided into 7 chapters. The first two chapters introduce the mathematical ideas of symmetry, chaos and determinism and explain how computer pictures are produced. In the third chapter, the authors make a comparison between pictures taken from nature (animals, flowers, etc.) or man-made decorative designs and remarkably similar designs produced on the computer using symmetric chaos methods. The fourth chapter analyses in more detail chaos and symmetry creation.

The many colourful computer pictures shown in the book are classified by the authors into three categories, namely symmetric icons, quilts and symmetric fractals. These images have been produced by three mathematically different methods, which are thoroughly described in chapters 5-7.

At the end of the book, one finds three appendices. The first one provides a list of the mappings and parameter values used to produce the pictures, while the last two, the technical ones, treat D_n and Z_n equivariants and planar lattices.

Adriana – Ioana Lefter

MYOUNG AN, ANDRZEJ K. BRODZIK, RICHARD TOLIMIERI, *Ideal Sequence Design in Time-Frequency Space. Applications to Radar, Sonar, and Communication Systems,* Series: Applied and Numerical Harmonic Analysis, Birkhäuser, Boston, 2009, xii+220 p. , ISBN: 978-0-8176-4737-7

The present volume is included in the Applied and Numerical Harmonic Analysis (ANHA) book series. The aims of ANHA are to provide the engineering, mathematical, and scientific communities with significant developments in harmonic analysis, ranging from abstract harmonic analysis to basic applications.

The topic of the book is the design of sequences with good correlation properties. The approach is based on the finite Zak transform, and the point of departure in the investigation is the discrete linear frequency modulated (FM) chirp. The mathematical developments are illustrated by numerous examples and by many tables, which compare the number and size of the signal sets satisfying good correlation properties of specified periodicity attainable by the methods of communication theory with those attainable by Zak space methods.

The work has sixteen chapters. The first one presents the book results. The second and the third chapters provide together a brief review on matrix algebra, tensor products and permutation groups. In Chapters 4 and 5, the main digital signal processing concepts, the finite Fourier transform and correlation are developed. Chapters 6 through 9 introduce the discrete chirp and the finite Zak transform, and state the main results on Zak space representations of chirp, including the Zak space correlation of chirps. Chapters 14 through 15 form the core of the book, as they develop the Zak space design framework of the ideal sequences. Chapter 10 characterizes the set *- permutations associated with ideal permutation sequences. Chapter 11 analyzes the properties of permutation sequences based on *-permutations and identifies several families of ideal sequences. Chapter 12 investigates the properties of modulation and derives the conditions for arbitrary sequences to satisfy the ideal correlation. In Chapter 13, the authors use results on permutation sequence pairs to develop design strategies for constructing collections of permutation sequences satisfying pairwise ideal correlations. Chapters 14 and 15 address several engineering issues pertinent to radar and sonar signal processing, and Chapter 16 outlines several outstanding time-frequency sequence design problems.

In conclusion, the book combines mathematical and engineering results to give complete descriptions of the considered problems.

The book was written to help the graduate students and researchers interested in radar, sonar and communications system, from equally mathematical and engineering perspectives.

Ionel-Dumitrel Ghiba

ANDREW R. CONN, KATYA SCHEINBERG, LUIS N. VICENTE, *Introduction to Derivative-Free Optimization*, MPS-SIAM Series on Optimization, SIAM-MPS, Philadelphia, 2009, ISBN 978-0-898716-68-9.

The absence of derivatives, often combined with the presence of noise or lack of smoothness, is a major challenge for optimization. The book here under review explains how sampling and model techniques are used in derivative-free methods and how these methods are designed to efficiently and rigorously solve optimization problems. Although readily accessible to readers with a modest background in computational mathematics, it is also intended to be of interest to researchers in the field.

The volume covers most of the relevant classes of algorithms from direct search to model-based approaches. It contains a comprehensive description of the sampling and modeling tools needed for derivative-free optimization, which allow the reader to better understand the convergent properties of the algorithms and identify their differences and similarities. *Introduction to Derivative-Free Optimization* also contains analysis of convergence for modified Nelder-Mead and implicit-filtering methods, as well as for model-based methods, such as wedge methods and methods based on minimum-norm Frobenius models.

The text is divided into 13 chapters; after the introductory one, the authors dedicate the first part of the book to *Sampling and Modeling*. The second chapter introduces the reader to positive spanning sets and bases, linear interpolation and regression models, simplex gradients, and discusses the importance of geometry. It also includes error bounds in the linear case. The next three chapters consider nonlinear polynomial interpolation models in a determined, regression and undetermined form, respectively. Chapter 6 is devoted to constructive ways to ensure that well-posedness holds and to material preparation on derivative-free models for use in model-based algorithms, such as the trust-region ones.

The second part of the book on *Frameworks and Algorithms* begins with Chapter 7, describing direct-search methods where sampling is guided by desirable sets of directions. The next chapter deals with direct-search methods based on simplexes and operations over simplexes, of which a classical example is the already mentioned Nelder-Mead method, for which the authors include a globally convergent variant. Chapter 9 is devoted to line-search methods based on simplex derivatives, establishing a connection with the implicit-filtering method. Chapter 10 presents trust-region-based methods, including the relationship with derivatives-based methods. The more practical aspects of derivative-free trust-region methods, with particular examples of modified versions of the existing methods, are covered in Chapter 11.

Finally, the third part of the book (Chapters 12 and 13) is concerned with some relevant topics not covered in full detail, as surrogate models built by other techniques, constrained derivative-free optimization, or extension to other classes of problems, in particular global optimization. The book ends with an appendix reviewing the existing software for derivative-free optimization.

The book is definitely challenging and, not incidentally, very useful to anyone with a background in calculus, linear algebra and numerical analysis. *Introduction to Derivative-Free Optimization* paves the way to an exciting and interesting research area for many years to come.

Adrian Zălinescu

IGOR GRIVA, STEPHEN G. NASH, ARIELA SOFER, *Linear and Nonlinear Optimization*, 2^{nd} edition, SIAM, Philadelphia, 2009, xxii+742 p., ISBN 978-0-898716-61-0.

This is the second, revised and updated edition of an introductory text in the theory, algorithms and practical applications of optimization. The authors carry out a unified approach on linear and nonlinear optimization, and incorporate up-to-date interior-point methods in linear and nonlinear optimization.

The book is conceived on a modular structure, in order to meet the varying needs of teachers, students and practitioners with different experience levels in this area. Each section ends with a set of exercises. In the notes concluding the chapters, appropriate references are suggested from a list of almost 300 titles.

The text is divided into four parts, the last three independent on each other.

The first part (Chapters 1-3) presents the basics of optimization. Chapter 1 contains simple examples of optimization models and of applications of optimization. Chapter 2 studies basic optimization topics, relevant to both linear and nonlinear problems, such as local and global optima, convexity, and the general form of an optimization algorithm. Also, the notions of rate of convergence, Taylor series, and Newton's method for nonlinear equations are treated. Chapter 3 treats the representation of linear constraints.

Part II (Chapters 4-10) deals with linear programming techniques. In Chapter 4, the correspondence between the geometric and the algebraic approach of linear programs is analysed. Chapters 5-7 describe the simplex and the dual simplex methods, and several ways to improve the simplex method. Chapter 8 is devoted to linear programming problems defined on networks and to the network simplex method. The computational efficiency of the simplex method is the subject of Chapter 9. Finally, Chapter 10 introduces the interior-point methods for linear programming.

The third part (Chapters 11-13) addresses unconstrained optimization problems. Chapter 11 studies Newton's method for minimization and globalization strategies, such as line search methods and trust-region methods. Chapter 12 analyses quasi-Newton methods, the steepest-descent method, as well as derivative-free methods. Low-storage methods, such as truncated-Newton methods, nonlinear conjugate-gradient methods, and limited-memory quasi-Newton methods are described in Chapter 13.

Part IV (Chapters14-16) presents nonlinear optimization tools. Thus, Chapter 14 deals with optimality conditions for constrained problems, in the cases of linear equality, linear inequality, or nonlinear constraints. Also, the duality theory for linear optimization is generalized for nonlinear problems. Chapter 15 studies feasible-point methods for constrained optimization problems; for nonlinear constraints, the sequential quadratic programming and reduced-gradient methods are presented. Chapter 16 is concerned with stabilized penalty and barrier methods, exact penalty methods, multiplier-based methods and nonlinear primal-dual methods.

To make the book self-contained, some appendices on the fundamentals of linear algebra and calculus and an appendix with software suggestions are added.

The book is a useful textbook for advanced undergraduate and graduate students, but also a valuable tool for researchers and practitioners in science or engineering, interested in modern algorithms of optimization.

Adriana – Ioana Lefter

BISWA NATH DATTA, *Numerical Linear Algebra and Applications*, 2nd edition, SIAM, Philadelphia, 2010, xxiv+530 p., ISBN 978-0-898716-85-6.

This is the second edition, entirely revised, updated and improved, of a very well received textbook on computational linear algebra. Unlike other textbooks, the theoretical results are illustrated by many applications in various science and engineering areas.

The material is divided into 13 chapters. Each one opens with the statement of the background material needed, and ends with a summary of the important concepts herein developed, suggestions for further reading, and numerous exercises, theoretical or MATLAB- and MATCOM- based. The MATLAB toolkit MATCOM contains implementations of the major algorithms in the text and enables the reader to compare different algorithms for the same problem. Solutions to selected exercises are provided on the book's webpage.

Chapter 1 introduces the fundamental linear algebra problems, and discusses their importance and the computational difficulties to be expected while solving them. Chapter 2 reviews the linear algebra concepts necessary in the book: vectors, matrices and special matrices, vector and matrix norms, and singular value decomposition. Chapter 3 discusses floating point numbers and errors in computation. Chapter 4 deals with the stability of algorithms, conditioning of problems and perturbation analysis, and the effects of conditioning and stability on the accuracy of the solution.

Chapter 5 describes the Gaussian elimination process and the LU factorization of a matrix, while Chapter 6 uses this method for numerically solving a linear algebric system. Chapter 7 is devoted to QR factorization of matrices, projections using QR factorization, and singular value decomposition of matrices. Chapter 8 presents the least-squares problem. Chapter 9 treats numerical matrix eigenvalue problems, while Chapter 10 discusses computational algorithms for the symmetric eigenvalue problem and singular value decomposition. Chapter 11 analyses generalized and quadratic eigenvalue problems. Chapter 12 is an overview of iterative methods for large and sparse problems; Krylov subspace methods are here detailed.

Finally, Chapter 13 provides a list of key terms in numerical linear algebra, for quick reference.

This very readable book, ideal for self-study, is a valuable reference to undergraduate and graduate students in applied and computational mathematics, computer science, financial mathematics, and electrical and mechanical engineering, but also to researchers in real sciences, engineers and industrial mathematicians.

Adriana – Ioana Lefter

JASON L. SPEYER, DAVID H. JACOBSON, *Primer on Optimal Control Theory*, SIAM, Philadelphia, 2010, xiv+307 p., ISBN: 978-0-898716-94-8 .

The textbook *Primer on Optimal Control Theory* makes optimal control theory accessible to a large class of engineers and scientists who are not mathematicians, although they have a basic mathematical background, but who need to understand and to value the sophisticated material associated with optimal control theory.

The optimal control theory can be applied to many physical, economic, biomedical, manufacturing and engineering processes whose behavior can be often influenced by altering certain parameters or controls, to optimize some desired property or output.

Providing a rigorous introduction to the analysis of these processes and the best modes of control and operation with them, presenting the important concepts of weak and strong control variations leading to local necessary conditions, the global sufficiency of Hamilton-Jacobi-Bellman theory, and offering lots of interesting examples and exercises, this book will enable applied mathematicians, engineers, scientists, biomedical researchers and economists to understand and implement optimal control theory at a level of sufficient generality and applicability for most practical purposes. This textbook is a start in proceeding to higher mathematical concepts and advanced systems formulations and analyses.

Ionuţ Munteanu

J.J. DUISTERMAAT, J.A.C. KOLK, *Distributions. Theory and Applications*, Cornerstones Series, Birkhäuser, Boston, 2010, xvi+445 p., ISBN: 978-0-8176-4672-1.

The theory of distributions is a powerful tool used in mathematical analysis which generalizes the notion of function. This textbook, *"Distributions: Theory and Applications"*, is an application-oriented introduction to the theory of distributions, well-written and requiring only a minimal mathematical background. So, it is perfect for young undergraduate students in mathematics, theoretical physics and engineering who will find this textbook a welcome introduction to the subject. The work may also serve as an excellent self-study guide for researchers who use distributions in various fields.

The most important feature of this book is that it relates the distributions to linear partial differential equations and Fourier analysis problems found in mechanics, optics, quantum mechanics, quantum field theory and signal analysis. The applicative character of this book makes it more interesting.

Numerous examples, exercises, hints and solutions guiding the reader throughout the text, original proofs which may be difficult to locate elsewhere for many well-known results, systematic use of pullback and pushforward, the transparent treatment of the Fourier transform and the new proof of the Kernel Theorem, applied to derive numerous important results, make from this textbook a perfect reading for everyone who wants to study distributions without getting bored.

Ionuţ Munteanu

JAN MODERSITSKI, *FAIR: Flexible Algorithms for Image Registration,* SIAM, Philadelphia, 2009, xxi+189 p., ISBN 978-0-898716-90-0.

This book intends to provide a unified mathematical approach to image registration, offering insight into its concepts and practical tools. Registration is viewed completely from an optimization perspective.

An additional web page freely permits downloading of the PDF version of the book and of the MATLAB-based package FAIR, used for the examples and results given in the text. FAIR also enables the reader to combine its building blocks to study his own applications and to integrate further features. Apart from the exercises, each chapter ends with a list of FAIR tutorials related to its subject.

Chapter 1 presents the scope and aims of the book and a brief outline. Moreover, it contains a list of some 50 books one may consult before entering the domain and a list of links to open source registration software; other 150 titles of registration-specific literature are mentioned at the end of the book.

The main FAIR concepts are introduced in Chapter 2. Chapter 3 discusses linear, spline and multiscale spline image interpolation for 1D or higher-dimensional data, as well as the discrete multilevel approach. Chapter 4 analyses parametric transformations, presenting a general model, including important classes, such as rigid, affine, and spline-based transformations. Chapter 5 covers landmark-based registration techniques, Chapter 6 deals with parametric image registration for intensity-based distance measures, Chapter 7 presents a general framework for distance measures, while L^2-norm-based regularization is discussed in Chapter 8. Chapter 9 covers numerical schemes for solving the nonparametric image registration problem.

The final chapter offers an outlook on the material presented in the first nine chapters and points out topics not covered in the book.

The book is intended for mathematicians interested in image registration, computer scientists and engineers willing to understand the numerical schemes behind the techniques, for medical imaging professionals, but it may also be used as a course text at advanced graduate level.

Adriana – Ioana Lefter

DIANNE P. O'LEARY, *Scientific Computing with case studies,* SIAM, Philadelphia, 2009, xvi+383 p., ISBN 978-0-898716-66-5.

The volume under review explains how to choose and use basic numerical algorithms for designing algorithms able to solve a wide variety of problems, such as linear and nonlinear equations, differential equations, optimization problems, and eigenvalue problems. It covers not only standard problems, but also important variants such as sparse systems, differential-algebraic equations, constrained optimization, Monte Carlo simulations, and parametric studies, with emphasis on stability and error analysis. The MATLAB programming language is used for examples and illustrations.

The volume is divided into seven parts, containing expository material, as well as 19 case studies. Each part opens with explanations, accompanied by appropriate titles in the bibliography, on the background required for understanding the respective unit. All chapters end with indications on further reading. For each part, the author provides a checklist showing what the reader should be able to do after working through that unit. A Web site provides solutions to most of the challenges offered throughout the book and also supplies relevant MATLAB codes, derivations, and supplementary notes and slides.

The first part (Chapters 1-4) presents some preliminaries on mathematical modelling, errors, hardware, and software. Chapter 1 analyses the sources of error, how errors propagate into calculations, and how to measure and bound errors, Chapter 2 covers sensitivity analysis, Chapter 3 focuses on memory management and estimation of memory parameters, while Chapter 4 describes the principles behind writing and documenting an algorithm.

Part II (Chapters 5-8) refers to dense matrix computations. After presenting Basic Linear Algebra Subroutines (BLAS), Chapter 5 discusses various matrix decompositions and their uses. Three case studies, on image deblurring, updating and downdating matrix factorizations and the direction of arrival of signals problem exemplify the subject.

Part III (Chapters 9-15) deals with optimization and data fitting. It includes a presentation of numerical methods for unconstrained and constrained optimization problems, as well as five case studies on the data clustering problem, on fitting a model to data using nonlinear least squares (featuring the special case of solving separable least squares problems), and on blind deconvolution in spectroscopy.

Part IV (Chapters 16-19) discusses some basic statistical principles under-lying the Monte Carlo methods, and proposes three case studies. In the first one, the Monte Carlo methods are used for the minimization of nonconvex functions, for discrete optimization, and for counting. The second case study is on estimating multidimensional integrals, while the last one presents a stochastic model for the spread of an epidemic.

Part V (Chapters 20-23) covers ordinary differential equations. Chapter 20 reviews some algorithms for solving initial value problems and boundary value problems for ordinary differential equations, as well as differential-algebraic equations. Chapter 21 shows that, in the case of large size populations, a differential equations model of the spread of an epidemic is more practical. To exemplify the stability and control of ordinary differential equations, the following case study presents a model for the motion of a robot arm. The third case study concerns finite differences and finite element methods for boundary value problems.

Part VI (Chapters 24-26) deals with nonlinear equations and continuation methods, applied in two case studies to a truss problem and to the determination of some parameters related to the life cycle of a flour beetle.

Part VII (Chapters 27-32) analyses direct and iterative methods for sparse matrices computations, with application to partial differential equations. The four case studies discuss elastoplastic torsion, the exploitation of structure in some problems to obtain fast solvers, eigenvalue problems for differential equations and, finally, multigrid methods.

The volume is a valuable textbook for courses in numerical analysis, scientific computing, and computational science for advanced undergraduate and early graduate students. It may be also used as a reference and tool for self-study by researchers in real sciences whose work involves numerical computing.

Adriana – Ioana Lefter

STEPHEN LYNCH, *Dynamical Systems with Applications using Maple,* 2nd edition, Birkhäuser, Boston, 2010, xviii+509 p., ISBN 978-0-8176-4389-8.

This is the second edition of a book published in 2001. Since, meanwhile, Maple has evolved from Maple V into Maple 13, this new edition has been updated and expanded. It provides more applications, examples, and exercises, two new chapters on neural networks and simulation, and new sections on perturbation methods, normal forms, Gröbner bases, and chaos synchronization.

The book offers an introduction to the theory of dynamical systems with the aid of the Maple algebraic manipulation package. Both continuous and discrete dynamical systems are analysed, emphasis being put on real world applications. Each chapter ends with a list of Maple worksheet files and a number of exercises, the answers to which are revealed in the final chapter. Bibliographical recommendations are given in all chapters and a list of references to textbooks and research papers is also provided at the end of the work.

After presenting a tutorial guide to Maple in the opening chapter, in Chapters 1-10 the author treats continuous dynamical systems using ordinary differential equations. More precisely, Chapter 1 reviews the basic methods for solving ordinary differential equations, with applications to chemical kinetics and electric circuits. Chapters 2 and 3 present the theory behind the construction of phase plane portraits for two-dimensional systems and apply this theory to modeling of the interacting species. The theory of planar limit cycles is introduced in Chapter 4. The fifth chapter treats Hamiltonian systems, Lyapunov functions and stability, while Chapter 6 studies the bifurcation theory. Chapter 7 introduces the concept of chaos and gives examples of tridimensional autonomous systems. Chapter 8 is concerned with Poincaré maps and nonautonomous systems in the plane, while Chapter 9 treats local and global bifurcations. In Chapter 10, the second part of Hilbert's sixteenth problem is stated and the main related results are reviewed by Poincaré compactification. Also, global and local results for Liénard type systems are given.

The next five chapters deal with discrete dynamical systems. Chapter 11 analyses linear discrete dynamical systems. The Leslie model used to investigate the population of a single species split into different age classes is here presented. Chapter 12 treats nonlinear discrete dynamical systems and Chapter 13 deals with complex iterative maps and introduces Julia sets and the Mandelbrot set. In Chapter 14, electromagnetic waves and optical resonators are studied, whereas Chapter 15 is devoted to fractals and multifractals.

The following three chapters study chaos control and synchronization, neural networks, and simulation of dynamical systems usins Simulink and MapleSim.

Chapter 19 contains examination-type questions used by the author over many years, while Chapter 20 gathers solutions to the exercises provided in the previous chapters.

The material is not over-theoretical, as it is intended to be intelligible to readers with a general mathematical background, such as undergraduate courses in linear algebra, real and complex analysis, calculus, and ordinary differential equations and, optionally, minimum of knowledge on a computer language.

The book is addressed to senior undergraduate and graduate students, and scientists from various branches of applied mathematics, natural sciences, and engineering.

Adriana – Ioana Lefter