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BOOK REVIEWS

RENÉ ESCALANTE, MARCOS RAYDAN, *Alternating Projection Methods*, Fundamentals of Algorithms Series, SIAM, Philadelphia, 2011, ix+127 p., ISBN: 978-1-611971-93-4.

The present book offers a concise but rigorous account of all algorithms based on the Method of Alternating Projection (MAP), a class of algorithms which is dedicated to the general problem of finding a point in the intersection of several sets in Hilbert spaces.

The book is divided into six chapters, the first two being introductory. Then, the authors present the MAP on subspaces (Chapter 3) and this discussion is subsequently extended to linear varieties (Chapter 4). The fifth chapter concerns the problem of finding the closest point in the intersection of convex sets to a given point, while the last chapter concentrates on two applications of MAP to matrix problems. Each chapter (except the first one) contains an extended section of comments and bibliographical references, as well as a problems section.

The book is useful to the mathematical, scientific and engineering communities as a pertinent presentation of several powerful results and algorithms, but it can be used as well as an up-to-date reference on its specific subject of research.

Marius Durea

LORENTZ T. BIEGLER, *Nonlinear Programming. Concepts, Algorithms, and Applications to Chemical Processes*, SIAM, Philadelphia, 2010, xvi + 399 p., ISBN 978-0-898717-02-0.

This book attempts at filling the gap between mathematical programming and engineering texts by treating modern nonlinear programming concepts and algorithms, along with their real-world applications (mainly to chemical process engineering). It shows which nonlinear programming methods are best suited for specific applications, how large-scale problems should be formulated and what features of these problems should be emphasized, and how the existing nonlinear programming methods can be extended to exploit specific structures of large-scale optimization models.

The methods discussed by the author are illustrated by examples and case studies. Each of the 11 chapters of the book ends with a summary, notes for further reading and a list of exercises.

Chapter 1 is an introduction to process optimization and presents the scope of optimization problems, a classification of optimization problems and some examples of applications of optimization and nonlinear programming in chemical engineering.

Chapter 2 studies the basic concepts and properties for nonlinear programming and gives the fundamentals of unconstrained optimization, while Chapter 3 deals with Newton and quasi-Newton methods for unconstrained optimization. Line search and trust region methods are presented as globalization strategies.

Chapter 4 discusses the fundamental concepts of constrained optimization. It presents and analyzes the Karush-Kuhn-Tucker conditions. Chapters 5 and 6 extend the Newton methods in Chapter 3 for nonlinear programs with equality and inequality constraints, respectively. Chapter 7 treats steady-state process optimization and presents the application of nonlinear programming methods to modular and equation-oriented simulation environments.

Chapter 8 deals with dynamic modeling and optimization in process systems. The author describes a general multiperiod problem formulation that applies to a wide range of applications and presents a hierarchy of optimality conditions, along with variational strategies to solve these problems. Chapter 9 discusses dynamic optimization methods with embedded differential-algebraic equation solvers, while Chapter 10 is devoted to simultaneous methods for dynamic optimization.

Chapter 11 studies some properties of mathematical programs with complementarity constraints and analyzes nonlinear programming-based solution strategies for these problems.

The volume is addressed to chemical engineers willing to apply nonlinear programming algorithms, but also to experts in mathematical optimization wanting to understand process engineering problems and to develop better approaches for solving them. Moreover, it could be a valuable textbook for graduate and advanced undergraduate students in engineering, applied mathematics or operations research. It may equally prove useful for practitioners in process optimization in the area of design and operations, or for researchers in process engineering and applied mathematics.

Adriana-Ioana Lefter

DAVID E. STEWART, *Dynamics with Inequalities. Impact and Hard Constraints*, SIAM, Philadelphia, 2011, xiii + 387 p., ISBN: 987-1-611970-70-8.

The book addresses, in a comprehensively manner, dynamics with inequalities. The author develops the theory and application of dynamical systems that incorporate hard inequality constraints as mechanical systems with impact, electrical circuits with diodes, social and economic systems that involve natural or imposed restrictions, which means that restrictions appear as natural models for many dynamic phenomena. The author discusses how finite- and infinite-dimensional problems are treated in a unified way in order to apply the theory for both ordinary differential equations and partial differential equations.

Hard constraints frequently occur in practical systems and their models; these hard constraints are often used in optimization, since optima are frequently found at these hard limits. In optimal control theory, this can be seen in the prevalence of “bang-bang” solutions – the “bang” represents a control at a hard limit. In spite of this, hard limits eschewed in most dynamical models. There are a number of reasons for this. One is the back of a suitable or “nice” theory for such systems, another is that the numerical methods do not handle this situation well, a third is that it is often not clear what should happen in a differential equation when a hard limit is reached.

Hard limits are natural models for many dynamic phenomena, and there are natural ways of creating “differential equations with hard constraints” which provide accurate models for many physical, biological, and economic systems. The models described in this book have roots in the optimization theory, and so we can find Lagrange multipliers and complementarity principles not only as methods to enable the reader to minimize functions subject to constraints, but also as ways for formulating dynamic models to systems with hard constraints.

A central idea of this work is the idea of *index*, which represents the number of differentiations between a hard constraint and the state variables of dynamic system. The higher the index, the more difficult is to solve it. This index is closely related to the index which is used in the area of *differential algebraic equations* (DAEs), which can be seen as differential equations with *equality constraints*.

Differential variational inequalities (DVIs) also form a focal point in this work. The connection with more abstract theories, such as differential inclusions, are fleshed out so that the reader can compare the properties and strengths of the two means of modeling such models.

The book *Dynamics with Inequalities: Impact and Hard Constraints* is stuctured into eight chapter and three Appendices. It starts with *Some Examples* and *Static Problems*. *Fomalisms* are analyzed and *Index Zero and Index One*, *Index two: Impact Problems* are studied. The final part is dedicated to *Numerical Methods* for the study of the considered problems and it ends with *Some basics of Functional Analysis, Convex and Nonsmooth Analysis* and *Differential Equations*, the last being an Annex.

This book is mathematically self-contained, so that it is accessible to engineers, economists, and others with a strong mathematical background. The material contained in this book involve considerable technical development, especially for problems involving partial differential equations. These techniques consider spaces of functions with infinite dimensions. Results which include, wherever possible, infinite-dimensional cases are given.

Eduard-Paul Rotenstein

NAIRA HOVAKIMYAN, CHENGYU CAO, *L_1 Adaptive Control Theory*. G*uaranteed Robustness with Fast Adaptation*, Advances in Design and Control (21), SIAM, 2010, xx + 320 p., ISBN: 978-0-898717-04-4.

Research in the field of adaptive flight control started with attempts to develop adaptive autopilots for supersonic aircraft in the mid 1950s. Since then, following the experiments, an adaptive control theory has been developed. The book *L_1 Adaptive Control Theory* presents a comprehensive overview of the recently developed L_1 adaptive control theory, including detailed proofs of the main results. Moreover, at the end of the book there are three appendices containing the mathematical support used throughout the text. This is because the book is intended for graduate students, researchers and aerospace, mechanical, chemical, industrial and electrical engineers interested in pursuing new directions in research and developing technology at reduced costs.

The key feature of the L_1 adaptive control theory is decoupling of adaption from robustness. The architectures of L_1 adaptive control theory have guaranteed transient performance and robustness in the presence of fast adaptation, without enforcing persistent excitation, applying gain-scheduling or resorting to high-gain feedback.

L_1 Adaptive Control Theory. *Guaranteed Robustness with Fast Adaptation* contains not only complete mathematical proofs and the flight test results that have used this theory, but it also includes results not yet published in technical journals. Moreover, the software is available on a supplementary Web page.

Ionuţ Munteanu

KEITH DEVLIN, *Mathematics Education for a New Era. Video Games as a Medium for Learning*, A K Peters, Ltd., Natick, Massachusetts, 2011, xiii+203 p., ISBN: 978-1-56881-431-5.

The present book is addressed to mathematicians, mathematics educators and game designers. The content is based on empirical theories of learning, teaching and gaming. The book covers the current state of affairs and how games provide a great forum for math educations.

Costică Moroşanu

DAVID MUMFORD, AGNES DESOLNEUX, *Pattern Theory: The Stochastic Analysis of Real-World Signals*, A K Peters, Ltd., Natick, Massachusetts, 2010, xi+400 p., ISBN: 978-1-56881-579-4.

The book is an introduction to pattern theory. It presents some methods for analyzing all types of real-world signals: images, sounds, written texts, DNA or protein strings, spike trains in neurons, or weather. Authors seek for the patterns that occur in the real-world signals and try to develop stochastic models for them. The book is structured into seven chapters. The first chapter is introductory and each of the next chapters presents a type of signal analysis ordered according to its complexity. Each chapter begins with an example and ends with a set of exercises.

Chapter 0, presenting the basic type of patterns, is an answer to the question "What Is Pattern Theory?". It contains a brief introduction to the techniques of Bayesian probability theory. In this approach, first, a stochastic model is created, after which data analysis algorithms based on these models are used.

Chapter I is dedicated to simplest patterns, sequences of characters in text. Text is seen as a discrete-valued function in discrete time. In this case, the stochastic model is based on the table of occurrence frequencies of character substrings. For fixed length substrings, the n^{th} order Markov approximation of the full language of strings is build.

The second chapter studied sounds (music), a real-valued function of continuous time. The authors are interested in constructing a stochastic model for the signal, which represents air pressure as a function of time while music is being played. In this case, the pattern analysis is based on Gaussian distribution and Fourier analysis, while discontinuities are modeled using Poisson processes.

Chapter III is dedicated to bi-dimensional signals. In this case, the patterns are contours of various objects contained in images. Contours are random curves which are represented as a pair of random real-valued functions or as a random orientation function of arc length. In his case, the stochastic process is modeled as Brownian motion. The last section explains how grammars are used for assembling shapes and obtaining models for recognizing alphanumeric characters.

Chapter IV studies the recognition of objects in two-dimensional static images. In this case, the objects are distinguishable by color and / or texture. The authors describe the Gibbs fields and the $u+v$ models used in image segmentation, texture modeling through exponential models, texture segmentation. Some algorithms for image segmentation are also presented.

The goal of chapter V is to seek a stochastic model that incorporates the variables which affect the appearance of human faces: illumination, view angle, face expression, individual faces variations and partial occlusion of face.

The last chapter deals with natural scenes modeling. In this case, rotation, translation and scaling invariant instruments are required. Scenes modeling involve usage of mathematical instruments like image pyramids, wavelet decomposition, etc. The probability distribution constructed in this chapter allows image representation as a sum of independent “imagelets”.

This book will be of interest to mathematicians, engineers, researchers interested in image analysis and understanding.

Cristina Diana Niță

PER CHRISTIAN HANSEN, *Discrete Inverse Problems: Insight and Algorithms*, Fundamentals of Algorithms Series, SIAM, 2010, 225 p., ISBN: 978-0-898716-96-2.

This book offers a large perspective on the mathematical methods and algorithms that can be used to solve inverse problems, which insolve reconstruction of the original information from noisy data. What is remarkable is the fact that the methods presented in this book can be successfully applied to solve real world problems, such as barcode reading, 2D medical imaging, image deblurring and 2D gravity surveying. Also, because every chapter includes, besides theoretical notions, exercises for assessing the understanding of the presented ideas, the volume can be used as a course for undergraduate or graduate students.

The concepts presented in the book are introduced gradually, in eight chapters, starting with inverse problems definition (Chapter 1) and with the definition of the class of problems the book deals with (Chapter 2), continuing with detailed descriptions of methods for linear inverse problem discretizations (Chapter 3) and for regularizations of the input data (Chapter 4), as well as for choosing the regularization parameters (Chapter 5). The applicative part of the book, which is preceded by the introduction of iterative regularization methods (Chapter 6), presents detailed examples of how regularization methods can be used to solve common real-world problems (Chapter 7). Taking into account that, until now, all methods were exemplified on 1D and 2D problems, the final chapter of the book generalizes some of the previously presented concepts.

The first chapter defines inverse problems starting from a simple example of magnetization computation inside a volcano, motivating at the same time the necessity of studying the numerical treatment of inverse problems.

The second chapter introduces the Fredholm integral equation of the first type, which is the form of linear inverse problems here taken into consideration, as well as the singular value expansion (SVE) as a mathematical tool for analyzing these equations.

In view of their computational implementation, it is necessary the discretization of the inverse linear problems, which can be obtained by applying the quadrature and expansion methods detailed in Chapter 3. This chapter also presents the singular value decomposition (SVD) method, which is a powerful tool for analyzing the discrete form of inverse problems, as well as the different types of noise.

In the following chapter, there are presented methods of data regularization necessary for obtaining regularity in the computed solutions. The main methods to enforce this regularity are truncated SVD, which is a simple method, and Tikhonov's method, which is a more versatile regularization method.

As, for achieving better performances, both methods are using some parameters which require adjustments, Chapter 5 presents some automated techniques for their selection.

The methods of regularization presented until now are designed for problems permitting a mathematical computation of the SVD or Tikhonov solutions. For more complex inverse problems, iterative methods, such as Landweber and Cimmino iteration and ART, a.k.a Kaczmarz's method or other modern methods, are necessary.

Chapter 7 demonstrates the applicability of regularizing methods in solving several real world problems, which include barcode reading, image deblurring, tomography reconstruction from projections, as well as assessing the gravitational field by 2D ground surveing.

The last chapter extends the theoretical analysis of the regularizing methods by presenting the general forms of Tikhonov's and SVD methods.

The book is very useful for researchers in computer science, to develop image processing software and also for scientists in geology and medicine, to interpret the noisy data generated by technical equipment. The information in the book is presented in logical order and the details provided assure an easy understanding of the concepts.

Mircea Hulea

ALEXANDER SHAPIRO, DARNKA DENTCHEVA, ANDRZEJ RUSZCZYŃSKI, *Lectures on Stochastic Programming. Modeling and Theory*, SIAM, 2009, xv+436 p., ISBN 978-0-898716-87-0.

The aim of this book is to give a comprehensive presentation of theoretical foundations and recent advances in the area of stochastic programming. The main objective of this domain is to find optimal decisions in problems which involve uncertain data. These are modeled by stochastic models, which have already proved their adaptability and efficacity in diverse areas of science. The field of stochastic programming is rapidly developing, with contributions from several disciplines, including operations research, mathematics and probability. In its turn, it is applied in a wide variety of subjects, ranging from agriculture to financial planning and from industrial engineering to computer networks.

The book is organized into seven chapters, each one being refered to one or two primarily responsibles among the authors. The first chapter is based on modeling aspects of the theory. Within specific models, several basic concepts are introduced, such as recourse actions, probabilistic constraints and the nonanticipativity principle.

The next two chapters deal with the theory of two- and multi-stage stochastic programming problems, where the properties of the models are analysed. Optimality conditions and duality theory are developed in a quite general framework, but the authors are still able to derive results without applying methods of functional analysis, due to the specific properties of these problems.

Chapter 4 is devoted to stochastic optimization problems with probabilistic (chance) constraints, which appear naturally in many applications. Again, the approach is accomplished in the framework of optimality theory and duality by addressing notions of generalized convexity, differentiability and approximations of probability functions.

The motivation standing behind Chapter 5 is to solve stochastic programming problems by Monte Carlo sampling techniques. The main analytical tool is provided by the notion of statistical inference, in which the expected value of the optimization problem is replaced by its sample average approximation. In Chapter 6, the authors investigate stochastic programming from the viewpoint of risk averse optimization.

Chapter 7 collects some background material required for understanding the notions used in the other parts of the book. Some of the results are reffered to literature, while technical less-known results are given with proofs.

The book is recommended to researchers working on the theory and applications of optimization, as well as to students with basic knowledge on linear programming, elementary analysis and probability. Written in an accessible and rigorous form, this book will undoubtedly stimulate other researchers to apply stochastic programming models and to undertake further studies in this fascinating and rapidly developing area.

Adrian Zălinescu

LARS-ERIK ANDERSSON, NEIL F. STEWART, *Introduction to the Mathematics of Subdivision Surfaces*, SIAM, Philadelphia, 2010, xxiv+ 356p., ISBN 978-0-898716-97-9.

This volume is intended to introduce the essential mathematics underlying subdivision surfaces, in a manner accessible both to graduate students in computer science and to researchers with a similar or stronger mathematical background. It provides a unified view of the field and prepares the reader to easily approach more advanced literature. Moreover, the text itself provides suggestions of further reading for the topics not covered here.

The book is divided into seven chapters. It also contains an appendix and some explanative notes. Each chapter ends with additional comments, exercises and even projects. On an associated Web page, one may find course materials, including solutions to the exercises.

Chapter 1 presents an overview of the field and the plan of the book. It also clarifies some notions often left unclear in literature, such as the difference between a logical mesh and a polyhedral mesh, or the existence of various kinds of subdivision matrices (used in the description and analysis of subdivision methods). The standard subdivision methods are organized into a simple and unambiguous hierarchy based on the class of spline surfaces they generate. The graduate presentation of the methods in Chapters 2-4 follows this scheme.

Chapter 2 is about B-spline surfaces. Definition and recursion formulas for scalar univariate uniform B-spline functions and uniform B-spline curves are provided, and the Lane-Riesenfeld algorithm is introduced. The presentation of uniform B-splines is based on centered basis functions. The chapter also treats tensor-product surfaces, B-spline methods for finite meshes and some further results for univariate B-splines, such as differentiation, partition of unity or linear independence.

Chapter 3 deals with box-spline surfaces, both uncentered and centered. Box-spline methods, such as Loop, Midedge, and 4-8 subdivision, are described.

Chapter 4 studies generalized-spline surfaces. After discussing general-subdivision-polynomial methods (including $\sqrt{3}$-subdivision, the Modified Butterfly or the Kobbelt method) and their variants, the authors analyze the existence and construction of a nodal function corresponding to a given subdivision polynomial, then describe how the support of a nodal function is related to the coefficient set of the subdivision polynomial and give conditions on the subdivision polynomial that characterize affine invariance. Finally, a certain two-dimensional manifold associated with a given locally planar logical mesh is introduced. This manifold is viewed as a global parametric domain for the subdivision surface, and it is used to define the generalized nodal splines by means of the Nodal-Function Computation principle.

Chapter 5 treats convergence and smoothness. It contains very precise and general results on the convergence of the box-spline subdivision methods, some elementary results of convergence and smoothness for general subdivision polynomials, an analysis of the convergence and smoothness for the nonregular case (exemplified on the Catmull-Clark method), and also conditions for single sheetedness.

Chapter 6 deals with the evaluation and estimation of surfaces. The use of evaluation stencils and tangent stencils for nonregular points and for subdivision-polynomial methods is discussed. Then, the methods of de Boor and Stam to evaluate the nodal functions for any parameter value are presented. The chapter also contains a detailed study of precision sets, and the degree of polynomial reproduction, a presentation of the Wu-Peters method for finding tight bounding envelopes for the surface, and a brief discussion of adaptive subdivision.

Chapter 7 treats shape control for primal and dual methods.

The appendix resumes three equivalent formulations of the Catmull-Clark method and then gives details on the Fourier transform, the Fourier series, and certain proofs that had been omitted in the main text.

Adriana-Ioana Lefter

THOMAS BANCHOFF, STEPHEN LOVEET, *Differential Geometry of Curves and Surfaces*, A K Peters, Ltd., 2010, xvi+332 p., ISBN 978-1-56881-456-8.

The geometry of curves and surfaces, although a classical subject, is an essential theme in the curricula of the students from several domains: mathematics, physics, engineering. Therefore, any new textbook is welcome, if putting forward some new perspectives.

The present book contains a undergraduated text introducing the fundamentals of differential geometry of curves and surfaces in the usual three-dimensional Euclidean space.

The text focuses first on plane curves studied from both local and global points of view. The same method is used for space curves: their local properties are the subject of Chapter 3, while Chapter 4 is devoted to global properties. There follows the original part of this monograph, announced in the first paragraph. The relationships with the modern theories of knots and links are carefully analysed, in an excellent text for every beginner in these fascinating worlds.

The next four chapters are devoted to the geometry of surfaces and all classical and important subjects are detailed, with large classes of examples.

Another important contribution of the present book to the family of textbooks for students consists in computer graphics that illustrate many concepts and theorems introduced in the text. All applet materials are available online at the site: http://www.akpeters.com/DiffGeo.

As a conclusion, we strongly recommend this book to all lovers of classical differential geometry, especially to beginners.

Mircea Crâşmăreanu

FIORALBA CAKONI, DAVID COLTON, PETER MONK, *The Linear Sampling Method in Inverse Electromagnetic Scattering,* CBMS-NSF Regional Conference Series in Applied Mathematics, SIAM, Philadelphia, 2011, x+138 p., ISBN: 978-0-898719-39-0.

The book is structured into six chapters and describes the linear sampling method in inverse scattering problems for electromagnetic waves, which is very important in applied mathematics.

Qualitative methods in inverse scattering theory avoid the problems inherent when using weak scattering approximations (for example, radar is based on weak scattering approximations) or nonlinear optimization techniques and generally recover less information than the two methods.

The first chapter presents inverse scattering in two dimensions case; the former gives a brief description of several classical methods, the latter introduces a linear sampling method (LSM) – a relatively rapid method, because it requires very limited data and involves only the solution of linear ill-posed problems but needs many input data. Two-dimensional examples to show that LSM provide useful information are present.

The second chapter deals some basic results for the solutions of time-harmonic Maxwell's equations.

Chapter three is concerned with an inverse electromagnetic obstacle problem, namely how to determine the shape of a perfect conductor or the shape and surface impedance λ of an imperfect conductor, when knowledge about the far field pattern of the scattered wave is available. The LSM for solving the inverse electromagnetic problem for obstacles and a few numerical examples in three dimensions case are also presented.

Chapter four describes more recent results obtained when using LSM for a penetrable scatter and including uniqueness theory. The role played by the interior transmission problem to resolve the scattering problem for penetrable scatter is studied. Another section is dedicated to the solution of inverse problem for anisotropic inhomogeneous medium.

Chapter five approaches the inverse electromagnetic scattering problem of determining the shape of a thin object, with data on the incident time-harmonic electromagnetic plane wave and the electric far field pattern of the scattered wave at a fixed frequency. In this chapter, the goal is to establish the validity of LSM for solving the inverse scattering problem for thin objects. This class of problems can be mathematically modeled by a boundary value problem for an open surface. Thickness of the object is small compared to the wavelength and other characteristic dimensions.

Chapter six is dedicated the inverse scattering problem for obstacles situated in a homogeneous background. In most applications, the target is embedded in an inhomogeneous background and the material properties of the target are generally unknown. It is difficult to distinguish the scattered field, due to the target from the scattered fields formed by the earth, the antenna, and, in particular, the air-earth interface. That is why, instead of the traditional methods of imaging, such as the use of weak scattering approximations and nonlinear optimization techniques, linear sampling method (LSM) is used because it has the advantage of imaging of buried objects. It is a linear method that does not ignore multiple scattering effects and determines the shape of a target without requiring any the knowledge of the target's physical properties.

This book will be of interest to mathematicians, physicists or engineers who want to research the inverse electromagnetic scattering theory and it can also serve as an excellent resource for researchers and graduate students studying inverse problems.

Cristina Diana Niță

C.T. KELLEY, *Implicit Filtering*, Software, Environments, and Tools Series, SIAM, Philadelphia, 2011, XIV + 170 p., ISBN 978-1-611971-89-7.

The book, addressing students, scientists and engineers, is an introduction to implicit filtering, that is a derivative-free optimization method. Implicit filtering is used in applications in electrical, civil, and mechanical engineering.

Unlike methods that use interpolation to reconstruct the function and its higher derivatives, implicit filtering builds upon coordinate search and then interpolates to get an approximation of the gradient. Implicit filtering is a hybrid of a projected quasi-Newton or Gauss-Newton algorithm for bound constrained optimization and least square problems, and a deterministic grid-based search algorithm. The gradients for the quasi-Newton method and the Jacobians for the Gauss-Newton iteration are approximated with finite differences, and the difference increment varies as optimization progress. The author describes the algorithm, its convergence theory, and imfil.m, a new MATLAB implementation of the implicit filtering method. The latest version of the software can be downloaded from http://www.siam.org/books/se23/.

The book is structured into four parts, with ten chapters. Chapter 1 includes a brief introduction, Chapters 2, 6, and 8 serve as the stand alone users' guide to imfil.m. Chapter 3 introduces the concepts and notations needed to follow the algorithmic and theoretical development in Chapters 4 and 5. Chapter 4 is an overview of the algorithms in imfil.m. The convergence theory for imfil.m is developed in Chapter 5. In the last part of the book, the author shows how imfil.m can be applied to a few problems: harmonic oscillator, hydraulic capture problem, water resources policy. To conclude with, this is a valuable and useful book of Applied Mathematics, including MATLAB programs.

Ana-Maria Moşneagu

RICHARD EVAN SCHWARTZ, *Mostly Surfaces*, Student Mathematical Library, 60, AMS, 2011, xiv+314 p., ISBN 978-0-8218-5368-9.

The present book is a excellent course concerning the fundamentals of geometry and topology of surfaces in the usual three-dimensional Euclidean space.

The text discusses the notion of surface from several points of view: topological (as metric spaces), geometrical (as two-dimensional Riemannian manifolds), as support space for a very interesting complex analysis (Riemannian surfaces), as support space for billiards, and so on. A lot of classical results are put together in order to give a complete image of a fabulous geometrical (more precisely, mathematical) object, namely a surface: the Pythagorean Theorem, Pick's Theorem, Hadamard's Theorem, the Liouville Theorem, Riemann Mapping Theorem, the Small Picard Theorem, Gauss-Bonnet Theorem, Banach-Tarski Theorem, and so on, and so on. There are several pictures, probable drawn by the author, such as the cover illustration, for which might be necessary an explanation in a future Edition.

The contents is divided into six Parts, preceded by Chapter 1, entitled *Book Overview*. The titles of these parts are as follows: *Surfaces and Topology*, *Surfaces and Geometry*, *Surfaces and Complex Analysis*, *Flat Cone Surfaces*, *The Totality of Surfaces*, *Dessert*. This enumeration shows that the present book is a perfect companion for the usual textbooks in differential geometry of surfaces, usually devoted to other tools like *mean* and *Gaussian* curvature, asymptotics, umbilical points, and so on. The Bibliography is concise, indicating technical books for the continuing one possible subject. Also, the index is very ample.

Since the book is intended for beginners, I find very interesting the following words from Preface: "My general view of mathematics is that most of the complicated things we learn have their origins in very simple examples and phenomena. A good way to master a body of mathematics is to first understand all the sources that lead to it. In this book, the *square torus* is one of the key simple examples. A great deal of the theory of surfaces is a kind of elaboration of phenomena one encounters when studying the square torus." Truly, several constructions, like *gluing* and *loops*, are nicely explained on the torus.

As a conclusion, we strongly recommend this book to all lovers of the geometry and topology of surfaces, especially to beginners.

Mircea Crâşmăreanu

ILYA SHMULEVICH, EDWARD R. DOUGHERTY, *Probabilistic Boolean Networks. The Modeling and Control of Gene Regulatory Networks*, SIAM (Society for Industrial and Applied Mathematics), Philadelphia, 2010, xiii + 267 p., ISBN: 978-0-898716-92-4.

This book offers a large perspective on the possibility of estimating biological cell evolution using mathematical models, such as the Probabilistic Boolean Networks. Quite remarkable is the fact that this type of networks is able to model genetic regulation of living cells and can help in developing some efficient tools for slowing down the evolution of diseases like cancer. Also, by structural intervention in Probabilistic Boolean Networks, it is possible to obtain a network behavior which models an anti-aging therapy.

The concepts presented in the book are introduced gradually, in six chapters, starting with the presentation of Boolean Networks properties (Chapter 1) and the description of the structure and dynamics of the Probabilistic Boolean Networks (Chapter 2), and continuing with the inference of the model structure (Chapter 3). The normal evolution of the probabilistic neural networks can be altered on long-term by structural intervention (Chapter 4), or on short-term, by external control (Chapter 5). Finally, Chapter 6 presents some notions on the asynchronous updating of the Probabilistic Boolean Networks states.

The first chapter presents an introduction into the Boolean Networks, describing the networks properties and dynamics, the Boolean Models of biological networks and the main advantage of discretization of biological systems.

In the second chapter, the complexity of the basic Boolean Networks model is increased by replacing the binary transition matrix with state dependent multivariate conditional probabilities, introducing in this way the definition of Probabilistic Neural Networks.

The problem of model structure inference is detailed in the following chapter together with some inferential tools, such as the coefficient of determination and data consistency requirements. Also, an example of inference of Probabilistic Boolean Networks from time series data is presented.

To increase the probability for the network to evolve desirable steady states, and also to avoid the possibility of obtaining undesired states, the long-run evolution of the network can be altered. Chapter 4 presents a method to achieve some changes in the regulatory rules of the system, which is known as a structural intervention. An example of intervention in the biological systems is the inhibition of aging mechanisms by using an estrogen.

In the next chapter it is introduced the concept of external control which alters temporarily the behavior of the system. Considering this, the intervention *via* one-time gene perturbation consists in flipping one or more genes values at current moment. In this chapter, there are introduced notions such as finite and infinite horizon control, as well as reinforced learning.

In contrast with the first five chapters, where the states updating process was synchronous with time, the last chapter presents briefly the previously introduced concepts for asynchronous networks.

The book is very useful for scientists from medical fields, in finding solutions for treating fatal diseases like cancer, or to prevent aging. Also, the book addresses biologists who analyze the behavior and evolution of living cells. The information in the book is presented in logical order and the details are sufficient for easy understanding of the concepts.

Mircea Hulea

SIMON BRENDLE, *Ricci Flow and the Sphere Theorem*, Graduate Studies in Mathematics, 111, AMS, 2010, viii+176 p., ISBN 978-0-8218-4938-5.

The present book contains an introduction in the main topics of the theory called *Ricci flow*. This evolution equation was introduced in a (classical by now) paper by Richard Hamilton following an earlier work of Eells and Sampson on the harmonic map heat flow. More precisely, using this Ricci flow, Hamilton proved that every compact three-dimensional manifold with positive Ricci curvature is diffeomorphic to a spherical space form. Since then, the Ricci flow was used to resolve longstanding open problems in Riemannian geometry, for example the famous Poincaré Conjecture concerning three-dimensional topology.

The text focuses on the converge theory for the Ricci flow in any dimension greater than three and its applications to a very important geometric result, namely Differentiable Sphere Theorem, obtained by the author in collaboration with Richard Schoen. An important remark here is that, although the results have all appeared in various research papers, the author have made a substantial effort to simplify the proofs as well as the techniques.

The monograph contains 9 Chapters, two Appendices and a very interesting Section with 16 Problems. The Bibliography has 87 titles and includes the famous Perelman's preprints from arXiv.

An important subject of the book consists in the study of evolution for some main objects, especially curvature tensors, under the Ricci flow. The most impressive part for the present Referee was Chapter 4, which describes completely the Ricci flow for the two-dimensional sphere.

Together with other books on the same theme, namely the Ricci flow, the book under review completes a suggestive puzzle about the real world.

Mircea Crâşmăreanu

JOHN T. BETTS, *Practical Methods for Optimal Control and Estimation Using Nonlinear Programming*, 2nd edition, SIAM, Philadelphia, 2010, xiv+ 434p., ISBN 978-0-898716-88-7.

This is the second edition, incorporating a lot of new material, of a well received work, which proposes a unified approach to solving optimal estimation and control problems. Apart from the theoretical background, the book provides many examples, most of them drawn from the author's experience in the aerospace industry. Examples have been solved using the SOCS software, which John T. Betts coauthors with Bill Huffman.

The methods used to solve differential equations and those used in function optimization are intimately related. Throughout the text, the interaction between optimization and integration is emphasized. The content is divided into 7 chapters, as follows.

Chapter 1 presents the nonlinear programming concepts for small dense applications. Newton-based methods, as well as common difficulties that can be encountered in practice are discussed. Chapter 2 focuses on the techniques specific to both large and sparse problems. After discussing the calculation of Jacobian and Hessian information in this particular case, it describes a sparse QP algorithm and its extension to the sparse nonlinear least squares problem, and a sparse interior-point barrier algorithm. Chapter 3 deals with the numerical solution of differential and differential-algebraic equations, while Chapter 4 presents some methods for solving optimal control problems, and Chapter 5 studies parameter estimation problems.

The various concepts and techniques described in the first half of the book are illustrated in Chapters 6 and 7 by real world examples, such as: construction of the reentry trajectory for the space shuttle; the minimum time to climb for an airplane; models of low-thrust orbit transfer and of two-burn orbit transfer; range maximization of a hang glider; abort landing in the presence of a windshear; space station attitude control; reorientation of an asymmetric rigid body; an example describing the motion of an industrial robot; Andrew's squeezer mechanism; a kinematic chain problem; the motion of a free-flying robot equipped with a propulsion system; a kinetic model of the batch reactor; the Delta III launch vehicle; a two-strain tuberculosis model; a model for tumor anti-angiogenesis. Examples of "advanced applications", that require solving sequences of optimal control and/or optimization subproblems, are also provided: examples of optimal lunar swingby transfers to four different mission orbits; a case of multiple-pass aero-assisted orbit transfer; examples in enzyme kinetics, immunology and engineering, modeled by delay differential equations; in-flight dynamic optimization of wing trailing edge surface positions.

The volume ends with an Epilogue, containing some remarks of the author, and with an appendix offering a brief overview of the SOCS library.

This book is intended for scientists interested in optimal control, working in aerospace industry, chemical process control, mathematical biology, robotics and multibody simulation, or electrical, mechanical and structural engineering. It can also prove valuable as a textbook for graduate courses on optimal control methods.

Adriana-Ioana Lefter

STEPHEN LOVEET, *Differential Geometry of Manifolds*, A K Peters, Ltd., 2010, xiv+422 p., ISBN 978-1-56881-457-5.

This text is the second in a pair of books intended to initiate the reader in the fascinating world of differential geometry. The first book in the series, *Differential Geometry of Curves and Surfaces*, authored by Thomas F. Banchoff and Stephen T. Lovett, was published by the same Editorial House.

The present book contains a graduated text introducing the fundamentals of differential geometry of manifolds, which is the foundation of some modern physical theories.

The text focuses first on *Analysis of Multivariable Functions* and *Coordinates, Frames and Tensor Notation* (the first two chapters) before moving onto the subject in chapter 3. Global analysis is treated in this general framework of manifolds by means of all classical powerful tools: vector bundles, vector fields (as sections in the tangent bundle), differential forms, integration theory.

The next 100 pages are devoted to the most frequently used manifolds, namely the Riemannian ones, and to their applications. More precisely, the last chapter includes four physical theories based on manifolds: Hamiltonian mechanics; Electromagnetism; String theory; General Relativity.

The book ends with three useful Appendices (Point Set Theory; Calculus of Variations; Multilinear Algebra), a list of References including 57 titles and a complete Index.

A large number of exercises, that develop key aspects of the theory and add several interesting examples, are provided at the end of each chapter (and Appendices A and C).

The exposition is clear, concise and lively, so that the book can be used to cover a semester's worth of material for a first graduate course in geometry of manifolds.

Mircea Crâşmăreanu

MARK S. GOCHENBACH, *Partial Differential Equations. Analytical and Numerical Methods*, 2nd edition, SIAM, 2010, xviii + 654 p., ISBN 978-0-898719-35-2.

Partial differential equations (PDEs) are essential for modeling many physical phenomena. *Partial Differential Equations. Analytical and Numerical Methods* is the second edition of a successful undergraduate textbook, which introduces students to the topic by a unique approach that emphasizes the modern finite element method, alongside the classical method of Fourier analysis.

This second edition continues to emphasize Fourier series and finite element methods, which were the primary scope of the first edition. Aditional issues now treated can be summarized as follows: broader coverage of PDE methods and applications, with new chapters on the method of characteristics, Sturm-Liouville problems, and Green's functions, as well as a new section on the finite difference method for the wave equation; explicit use of the language and results of linear algebra; examples and exercises analyzing realistic experiments (with correct physical parameters and units). Emphasis is put on the mathematical software, which must form a part of the arsenal of both students and professional mathematicians.

Partial Differential Equations. Analytical and Numerical Methods is written for undergraduate courses usually titled Introduction to Partial Differential Equations or Fourier Series and Boundary Value Problems. The clear presentation, the numerous examples and numerical computations entitles it as a very good tool for undergraduate students to understand and to feel how PDEs work.

Ionuţ Munteanu

JIANKE YANG, *Nonlinear Waves in Integrable and Nonintegrable Systems*, SIAM, Philadelphia, 2010, xxvi+ 430p., ISBN 978-0-898717-05-1.

Unlike other books in this area, *Nonlinear Waves in Integrable and Nonintegrable Systems* treats nonlinear waves from integrable to nonintegrable equations, from analysis to efficient numerics, and from theory to experiments. The author has intended to make its content self-contained. The calculations are detailed and carefully explained.

The material is organized into 7 chapters.

The first chapter presents the derivation of nonlinear wave equations, such as the nonlinear Schrödinger equation for weakly nonlinear wave packets, the generalized nonlinear Schrödinger equation for light beam propagation, and other nonlinear wave equations in physical systems.

Chapter 2 studies the integrable theory for the nonlinear Schrödinger equation using the Riemann-Hilbert formulation. The author covers the inverse scattering transform method, the infinite number of conservation laws, eigenvalues and eigenfunctions of the Zakharov-Shabat system, and the connection between squared eigenfunctions and the linearized integrable equations. Theories for integrable equations with high-order scattering operators are discussed in the third chapter.

Chapter 4 deals with soliton perturbation theories and applications, treating the direct soliton perturbation theory for the nonlinear Schrödinger equation, higher-order effects on optical solitons, weak interactions of nonlinear Schrödinger equation solitons, and the soliton perturbation theory for the complex modified Korteweg-de Vries equation.

Chapter 5 develops theories for nonintegrable equations. It discusses the Vakhitov-Kolokov stability criterion and its generalization, the exponential asymptotics technique for nonlocal waves, the dynamics of embedded solitons. Fractal scattering in collisions and in weak interactions of solitary waves, transverse instability of solitary waves, and wave collapse in the two-dimensional nonlinear Schrödinger equation are also presented.

Chapter 6 analyses nonlinear wave phenomena in periodic media. One- and two-dimensional gap solitons bifurcated from block bands and their stability, as well as one- and two-dimensional gap solitons not bifurcated from block bands are presented. This chapter features the analytical theories and experiments in optics and Bose-Einstein condensates.

Chapter 7 treats the numerical methods for nonlinear wave equations, namely, numerical methods for evolution simulations, for computations of solitary waves, and for linear-stability eigenvalues of solitary waves. A large number of simple and efficient MATLAB® codes for various types of nonlinear wave computations are provided; these codes can be also found on the book's associated Web page.

The volume is a valuable resource for graduate students and researchers working in applied mathematics, engineering, or in physical domains where nonlinear wave phenomena arise (such as nonlinear optics, Bose-Einstein condensates, and fluid dynamics).

Adriana-Ioana Lefter

PATSY WANG-IVERSON, ROBERT J. LANG, MARK YIM (Editors), *Origami 5:Fifth International Meeting of Origami, Science, Mathematics, and Education,* CRC Press; Taylor & Francis Group, 2011, xiv + 646 p., ISBN: 978-1-56881-714-9.

The book comprises the articles presented at the *Fifth International Meeting of Origami, Science, Mathematics, and Education*. The purpose of this book is to explore the connections between origami, mathematics, science, engineering, technology, education, and other academic research fields.

The book is well-written, very well-organized and pretty comprehensible. It is composed of four chapters containing articles which investigate interesting origami - related topics. Each article is elaborated in a clear and concise style.

The first chapter of the book, entitled *Origami History, Art and Design*, is composed of eleven works which provide origami history information and artists' descriptions of their processes. Thus, a very interesting origami history aspect is investigated in the first article, where its author, Koshiro Hatori, identifies the origins of origami in both West and East. Another interesting aspect of the origami domain discussed in this chapter is the surprising role of origami in the creation of the American flag. Some other papers of the chapter are oriented on origami art and design. Various robust mathematical tools for origami design are proposed by their authors. Let us mention here the curved folding models, polygon-based construction algorithms, illumination origami models and twirl design approaches. Numerous novelty elements are brought by these described techniques.

The second chapter of *Origami 5* is focused on origami in education. Its eight articles are quite successful in investigating the role of origami in the educational systems of various countries. The authors examine rigorously how origami could be successfully used in some important education domains, such as geometry teaching or for enhancing spatial skills of college students.

The third chapter of this book is entitled *Origami Science, Engineering and Technology* and contains ten articles. These works try to demonstrate how an art form like origami could have a powerful impact on today society through its numerous science and technology applications. The authors propose novel origami cylinder patterning techniques, design approaches for rigid folding, structural engineering methods, software algorithms for origami construction and origami-inspired devices.

The last chapter of the book, entitled *Mathematics of Origami* and composed of eighteen papers, focuses on origami mathematics. Some novel mathematical design algorithms are proposed in this chapter. First, an analysis of the design of knots folded from strips of papers is performed, after which patterns for folding arbitrary 3D shapes composed of cubes are provided. Other papers consider algorithms for rotationally symmetric solids and for the design of generally planar structures.

Some articles are devoted to the mathematical underpinnings of origami design. Interesting geometric constructions based on origami are proposed in several papers of the chapter. The flat-foldability area is also investigated in this chapter, satisfactory results being obtained. Thus, a combinatorial definition of 1D flat-folding is proposed by Hidefumi Kawasaki, and flat vertex fold sequences are also investigated. An important result is described in the last paper, where its authors prove that the circle/river packing-based origami design problem is NP-hard.

Given the important and interesting topic investigated in this book, the numerous novel techniques and models provided here, the experienced scientists contributing to it, the numerous possible applications of the described approaches, and its clear and concise writing style, we consider that *Origami 5* represent a valuable scientific work and a major step in the development of the origami-related research areas. Also, this book is addressing a large audience, including professionals of various scientific and humanities domains.

Tudor Barbu

MICHEL C.DELFOUR, J.-P. ZOLESIO, *Shapes and Geometries: Metrics, Analysis, Differential Calculus, and Optimization*, 2nd edition, SIAM, 2011, xxiii + 622 p., ISBN: 978-0-898719-36-9.

Many important problems in science and engineering involve geometry as a modeling, design or control variable. This book presents the theoretical foundation to shape optimization, where geometry is seen as a variable.

The introductory chapter presents some generic examples in which the shape or the geometry is the modeling, control, or optimization variable, subsequently used to illustrate the many ways such problems can be formulated.

Chapters 2, 3 and 4 contain a classical description of sets and domains from the point of view of differential geometry. Chapter 2 describes nonempty subsets of the finite-dimensional Euclidean space characterized by smoothness or properties of their boundary. In chapter 3, quotient groups of transformations and their associated complete Courant metrics are constructed. Chapter 4 gives the general equivalences between transformations and flows of velocity fields for unconstrained and constrained families of domains.

Chapters 5, 6 and 7 give a function analytic description of sets and domains *via* the set-parameterized characteristic functions, distance functions and oriented distance functions. In chapter 5, the Abelian group structure on measurable characteristic functions, the Lebesgue measurable characteristic functions and finite perimeter sets properties are presented. Chapter 6 studies the Hausdorff complementary metric topologies, the properties of distance functions, approximations of distance functions, convex sets properties and several compactness theorems under global and local conditions on the Hessian matrix of the distance function. In Chapter 7, the authors studied the oriented distance functions and their role in the description of the geometric properties and smoothness of domains and their boundary.

Chapter 8 deals with shape continuity and optimization problems. Some examples, like the Transmission Problem, Homogeneous Dirichlet Boundary Value Problem and Homogeneous Neumann Boundary Value Problem are provided and discussed.

Chapter 9 presents a modern version of shape calculus: definitions and the main properties of first-order shape semi-derivatives and shape functional derivatives, extended definitions and structure theorems to second-order derivatives.

Chapter 10 concentrates on two generic problems encountered in shape optimization: compliance problems, where the shape functional is itself the minimum of a domain-dependent energy functional, and shape functionals that can be expressed as the saddle point of some appropriate Lagrangian.

A rich bibliography and index, and a list of notations completes a book written in a mathematical language that will attract mathematicians, advanced engineers and scientists interested in this field.

Silviu Bejinariu

JOHN STILLWELL, *Roads to Infinity. The Mathematics of Truth and Poof*, A K Peters Ltd., Natick, Massachusetts, 2010, xi + 203 p., ISBN: 978-1-56881-466-7.

The book explores some consequences of accepting the notion of infinity, emphasizing the role of infinity in the development of modern mathematics. The reader is introduced gradually into various levels of infinity, starting from the cardinal of natural numbers, to various ordinal cardinals. Along the famous theories and results of well-recognized mathematicians, like Cantor, Peano, Dedekind, Gödel, Turing and others, the author gives particular attention to the undervalued contributions of Emil Post and Gerhard Gentzen, for a better understanding of infinity.

Each chapter of the book contains some historical notes related to the notions under discussion. These notes are particularly interesting for anyone who wishes to follow the development of a mathematical idea in time, from the moment of its first appearance till nowadays. The level of understanding of this work is accessible to anyone having high-school training in mathematics, although some technical parts may necessitate higher level of understanding maths.

The book consists of seven chapters; it starts with a short preface and it ends with an adequate bibliographical list. The first chapter is dedicated to the diagonal argument introduced by Georg Cantor, which proved for the first time the existence of uncountable sets. In Stillwell's opinion, the diagonal argument, although heavily criticized by some mathematicians, provides the very first road to infinity. References to this argument and its consequences will appear many times in the following chapters. The first chapter also contains some of the paradoxes related to the set theory and it ends with the Zermelo-Fraenkel axiomatic system. The second chapter deals with ordinals which, in author's view, are the second "road to infinity". This chapter presents the normal forms of Cantor and discusses the continuum hypothesis from a historical perspective. The chapter ends with historical background on the ordinals. The third chapter introduces notions related to formal languages. Concepts like computability and proof are discussed here, as well as their formalizations. Based on Cantor's diagonal argument, it is proved that any formal theory for Arithmetic is incomplete. Thus, one can find true sentences in axioms' language that cannot be derived from the axioms. The Chapter also contains various incompleteness theorems (Gödel and Post) together with their historical background. The forth chapter contains a short introduction to Mathematical Logic and related historical notes. The Peano Arithmetic is the main subject of the fifth chapter. The connections between the consistency of this theory to the transfinite induction (induction using ordinals) are also discussed. The sixth chapter presents examples of natural unprovable sentences, these are sentences that cannot be proved using Peano's axiomatic system. The first example is a generalization of Goodstein theorem, which is shown to prove the consistency of the Peano axiomatic system. Other examples discussed here are: one from combinatorics (Ramsey theory) and two from the graph theory (the Kruskal theorem and the minor graph theorem, which Stillwell calls to be the hardest theorem in graph theory). Like all other chapters, this one ends with some historical notes on the subject. The last chapter of this book is thought to be like an epilogue. It explores the influences of the various levels of infinity on the understanding of real numbers. The author's conclusion is that a better understanding of finite objects depends on a very good understanding of infinity.

Iulian Stoleriu

BENNETT CHOW, SUN-CHIN CHU, DAVID GLICKENSTEIN, CRISTINE GUENTHER, JAMES ISENBERG, TOM IVEY, DAN KNOPF, PENG LU, FENG LUO, LEI NI, *The Ricci flow: Techniques and Applications. Part III: Geometric-Analytic Aspects*, Mathematical Surveys and Monographs, 163, AMS, 2011, xx+520 p., ISBN 978-0-8218-4661-2.

The present book continues a series of the same authors dedicated to *The Ricci flow: Techniques and Applications*, issued in 2007 and 2008 respectively. The titles of this series are very interesting, indeed; if the first is *Geometric Aspects* and the second is *Analytic Aspects*, then the third is *Geometric-Analytic Aspects*. This means that some of the tools discussed in the previous two volumes are put together for a better understanding of this fascinating subject called *Ricci flow*. Also, some of the techniques are up-dated in order to gives new results. Let us remark that, in fact, this a fourth book authored by Bennett Chow and some of his collaborators, as well as that in the last time there is an explosion of books dedicated to this subject, all edited by famous publications houses: AMS, Springer, London Mathematical Society.

The text contains Chapters 17-26 and Appendices G-J. The complexity of the present subject explains the great number of authors (10; an amazing fact for a mathematical book) as well as the numbers of volumes, all with a great amounts of pages. The Bibliography, very impressive, includes 198 of titles, a great part of them being published in the last two or three years, along with a number of preprints from arXiv like the famous Perelman papers, requiring major efforts for their understanding. Also, there are cited some lectures dedicated to this subjects from personal web pages.

By using a literary expression we can say that the contents are very *hard* and we enumerate only some techniques used herein: the Perelman Entropy, picking methods, singularities, Ricci solitons, heat kernels (three Chapters have these key words), convex functions on Riemannian manifolds, metric geometry, pseudolocality, and so on. As in the previous volumes, there are some very interesting Exercises in each Chapter, some of them solved in the last Appendix. Let us point out that all Chapters and Appendices (excepting J) end with *Notes and commentary*, very useful for a beginner.

Since the subject is at the core of modern mathematics, this book will become a classic in the future.

Mircea Crâşmăreanu

CHARLES F. VAN LOAN, K.-Y. DAISY FAN, *Insight through Computing. A MATLAB Introduction to Computational Science and Engineering*, SIAM, 2010, xviii + 434 p., ISBN: 978-0-898716-91-7 .

The present book is an introduction to MATLAB programming and to the computational methods from science and engineering.

Each chapter begins with the enunciation of a problem and finishes with proposed problems. The solutions are carefully derived. Every section includes a working script and a few MATLAB functions. The book contains around 120 MATLAB scripts and functions, all of them being available electronically on the Web at: www.siam.org/books/ot117 .

The volume is structured into fifteen chapters. The first chapter presents a program that computes the extent to which the surface area of a sphere increases if its radius increases slightly. The problem of finding the minimum value of a quadratic on an interval is also considered. In the second chapter, the authors compute π-approximations, using two ideas. The third chapter continues with the theme of approximation and studies the approximation of the golden ration. Chapter 4 discusses the boundary between continuous mathematics and digital computing. Chapter 5 starts by developing a function for computing square roots, based on a rectangle averaging process. Then, the authors consider the problem of computing the perimeter of an ellipse. In the sixth chapter, the authors show how to estimate π by simulating a random dart-throwing game whose expected score relates to the area of a circular target. Next, they examine a random walk. Chapter 7 considers problems which involve functions of two variables. Chapter 8 is about the works with arrays. The search problem is considered in Chapter 9. Two basic methods are considered: linear search and binary search. Chapter 10 starts with the problem of computing the diameter of a point set, after which the problem that involves rectangle intersection is considered and pairs of optimization problems are solved. The eleventh chapter considers a pair of file-processing computations. Applications and more advanced examples appear in Chapters 12, 13 and 15.

Briefly, the book combines computational and mathematical numerical and geometrical methods to give complete descriptions of the considered problems.

The book is addressed to undergraduate students and researchers interested in computer science or mathematics.

Ionel-Dumitrel Ghiba

WEI-MING NI, *The Mathematics of Diffusion*, CBMS-NSF Regional Conference Series in Applied Mathematics, Vol. 82, SIAM, Philadelphia, 2011, 128 p., ISBN: 978-161197-19-65.

Diffusion has been used extensively in many disciplines in science to model a wide variety of phenomena. Therefore lots of works treat this subject. One of this works is the book entitled *The Mathematics of Diffusion*. A number of models are here included, such as the Gierer-Meinhardt system, Lengyel-Epstein model, Lotka-Voltera competition-diffusion system, and others, illustrate the behind mathematics, and also to make reading more interesting. It can be noticed the pronounced didactic character of this work, because this book is an expanded version of the lectures delivered by the author at Tulane University. Chapers 1 and 2 present fundamental notions about difussion equations with both Dirichlet and Neumann boundary conditions, and also questions of stabilization of solutions, including the rate of convergence. Therefore, the volume represents a good tool for the young researchers and students interested in elliptic or parabolic equations and in mathematical biology, which are at the begining of their research in this field.

Chapter 3 is dedicated to the analysis of steady state solutions. It is known the important role played by the steady state in the dynamics of solutions to parabolic equations. It should be mentioned that the results are presented rather from the dynamical systems point of view, than from the functional analysis point of view. The author studies the relation between the „shape" of the steady states and its stability property.

The next chapter explores the interactions between diffusion and spatial heterogeneity, according to the theory developed by Cantrell, Cosner and Lou and others in mathematical ecology. As a main example, it is considered the Lotka-Volttera competition-diffusion system, where the interaction between diffusion and spatial heterogeneity create different interesting phenomena.

It should be also mentioned that this book contains lots of important open problems for readers to investigate.

Ionuţ Munteanu

CIRO D'APICE, SIMONE GÖTTLICH, MICHAEL HERTY, BENEDETTO PICCOLI, *Modeling, Simulation, and Optimization of Supply Chains. A Continuous Approach*, SIAM, Philadelphia, 2010, 216 p., ISBN: 978-0-898717-00-6.

The purpose of this book is to present a survey of various modeling techniques in the theory of supply chains and to obtain and study the corresponding mathematical models, as well as optimization problems associated with them.

Chapters 1–3 are introductory to the theory of queing models and to the mathematical tools needed in the modeling process, namely systems of conservation laws.

Chapters 4–5, forming the core of the book, discuss three directions in the theory, that is: models based on ordinary differential equations, partial differential equations models, as well as continuum-discrete models.

The last two chapters consider optimal control problems associated with supply networks, optimality conditions, simulation and computational aspects.

The book may be useful to graduate students and researchers and may also be used as a support to a graduate level course.

Cătălin Lefter

ARNULF JENTZEN, PETER E. KLOEDEN, *Taylor Approximations for Stochastic Partial Differential Equations,* CBMS-NSF Regional Conference Series in Applied Mathematics, vol. 83, SIAM, Philadelphia, 2011, 234 p., ISBN: 987-1-611972-00-9.

This book gives a comprehensive presentation of numerical approximation of stochastic partial differential equations (SPDEs) via Taylor expansions for their solutions as the basis for deriving higher order numerical schemes. More specifically, it deals with stochastic evolution equations of the parabolic or hyperbolic type, thus combining methods and ideas encountered in the numerical area of both deterministic PDEs and finite dimensional stochastic ordinary differential equations (SODEs); of course, the difficulties are also inherited and many more appear due to the infinite dimensional nature of the driving noise processes.

The text is divided into two parts plus an Appendix. The first part is devoted to the study of numerical schemes for random ordinary differential equations (RODEs) and SODEs. Besides recalling the classic results on the convergence of stochastic Taylor expansions (breakthrough started with the Milstein scheme), the three chapters of this part also include recent developments, especially on numerical methods for SODEs with non-standard assumptions.

However, the interest of the authors is best shown in the second part, which deals with the infinite-dimensional counterpart based on their recent work. The fifth chapter familiarizes the reader with the concept of parabolic SPDEs, by introducing various types of solutions and giving results concerning their existence, uniqueness, and regularity. The proof of the main result is presented in the Appendix. In the next chapter the authors gather known results concerning numerical methods for SPDEs, with special attention for the exponential Euler scheme.

While in the finite-dimensional case, the stochastic Taylor schemes are based on an iterated application of the Itô formula, there is no such Itô formula for the solutions of SPDEs in Hilbert or Banach spaces. To overcome this problem, robust Taylor expansions are constructed for mild solutions of SPDEs with additive noise; this is the subject of the seventh chapter. The multiplicative noise case is treated in the following one, the approach being more demanding technically, but essentially the same.

The book is a rich source of information for the reader interested in using and further developing numerical methods for SPDEs. Written in a rigorous way, while maintaining an attractive style, it is also suitable as source material for graduate courses.

Adrian Zălinescu

FLORIN GORUNESCU, *Data Mining. Concepts, Models and Techniques,* Intelligent Systems Reference Library, Vol. 12, Springer-Verlag, 2011, 368 p., ISBN: 978-3-642-19720-8.

The book presents a large overview of data mining, including information on the fundamental concepts, the main techniques used in this domain, related examples, and methods for the evaluation of the performance of the classification, highlighting the usefulness and the applicability of this new branch of computer science.

The author aims to provide a structured collection of knowledge in a manner easy to understand and useful for the readers. He organized the book in six chapters that introduce step by step the main aspects of data mining.

The first and the second chapters clarify issues regarding the meaning of the “data mining” term, the problems that may be solved with data mining, the main applications, and about types of datasets and attributes.

Chapter 3 details the main topics of the exploratory data analysis, namely descriptive statistics, examination of distributions, analysis of correlation, data visualization, advanced linear and additive models, multivariate exploratory techniques, respectively anomaly detection.

An overview of classification and decision trees and of data mining techniques and models are presented in the Chapters 4 and 5. Chapter 4 includes the main steps in building and applying classification and decision trees in real-life problems, practical issues and advantages of using decision trees. The fifth chapter deals with Bayesian and rule-based classifiers, artificial neural networks for classification, *k*-nearest neighbors method, methods based on rough sets, clustering algorithms and genetic algorithms (not restricted to data mining applications). The last chapter is dedicated to the methods for the evaluation of the classification performance.

The strong aspects of the book are the presentation of both theoretical and practical aspects of the data mining concepts, the use of examples of application of the described techniques in various domains, the richness of drawings and pictures that clarify the examples, and the pseudocode sections that the readers can use to kick-start their own applications. The large number of references provides a significant coverage of the discussed topics. All these make the information easy to read and understand.

The book addresses a large range of researchers from different fields that are interested in the fundamentals of data mining and in applying data mining techniques in their projects. The way that the concepts and methods are described and the clarity of the presentation make the readers to be more interested in testing the exposed techniques in their own research. The book is also useful for students and PhD-students that want to learn about data-mining or to improve their knowledge in this domain.

The volume has a comprehensive set of references. Out of the more than 400 titles quoted, about 30 belong to the author, showing that the volume is a monograph written by a researcher well known to the scientific community.

Concluding, the volume is a useful and comprehensive text that sums up numerous recent techniques in the field, while the information in this book is well and rigorously presented. It is undoubtedly a valuable addition to the literature in the data mining domain.

Alina Hulea, Horia-Nicolai Teodorescu