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BOOK REVIEWS

M. DEHMER, F. EMMERT-STREIB, S. PICKL, A. HOLZINGER (Editors), *Big Data of Complex Networks*, Chapman & Hall/CRC Big Data Series, 1st Edition, August 2016, 332 pages, ISBN-10: 1498723616, ISBN-13: 978-1498723619

This volume, edited by four German and Austrian scientists, offers to computer scientists, statisticians, users of big data research results, and mathematicians an interesting mixture of research advances pertaining to the applications of big data and large networks in varied fields.

The volume is interdisciplinary and tackles issues such as visualization, computational biology, bioinformatics and genomics, text analysis, data protection, networks applications, and theoretical foundations in branches related to data structures, such as large graphs and large matrices.

While the chapters have diverse topics, the entire volume is well-focused along major lines in the duality: 'big data' and networks and graphs theory. The depth of the coverage of theoretical issues is impressive, without disturbing the primarily applicative aim of the book. The examples of big data come from several fields, allowing the reader to compare the approaches and the results across different domains. The chapters are authored by experienced scientists from China, Germany, Japan, Tunisia, and U.S.

The primary audience of the volume is composed of graduate students in computer science, mathematics, and statistics, and graduate students in disciplines that make use already of big data in networks, such as computational biology, marketing, and logistics. Also, all researchers involved in 'big data' analysis will find the book very useful and enticing.

Horia-Nicolai Teodorescu

C. B. SCHÖNLIEB, *Partial Differential Equation Methods for Image Inpainting,* Schonlieb, Cambridge University Press, 2015, 265 pages, ISBN-13: 978-1107001008, ISBN-10: 1107001005.

This book provides a very good overview on the use of partial differential equations (PDEs) for digital image reconstruction. The work is well-written and organized. It is composed of nine chapters and four appendixes.

In the first chapter, which represents the introduction, the author explains what a digital image and its restoration processes mean. Then, an introduction is made in the image inpainting domain, its applications and artistical origins being also described. The second chapter provides an overview of matematical models for inpainting. The variational and PDE-based image inpainting schemes are described in the first section. Some state-of-the-art inpainting models, such as Bertalmio algorithm, the Masnou and Morel interpolation, Mumford-Shah inpainting model, Total Variation (TV) Inpainting, CDD Inpainting and Euler Elastica Inpainting are briefly presented. Also, the chapter approaches structural *versus* textural inpainting, color image inpainting and video sequence interpolation.

The third chapter disscuses some important principles related to image completion. The Gesalt theory, which studies the laws of visual reconstruction, and Kanisza's Amodal Completion are described. The second-order diffusion-based interpolation models are presented in detail in the fourth chapter. An axiomatic approach to image reconstruction is described first. Then, Harmonic Inpainting model, TV Inpainting and Curvature Driven Diffusion (CDD) Inpainting are detailed.

Higher-order PDE inpainting models are approached in the fifth chapter. Curvature-based inpainting models, such as Euler's Elastica approach and its relaxations, are described first. Rigorous mathematical treatments are provided for these PDE variational frameworks, their well-posedness being investigated. The nonlinear fourth-order Cahn-Hilliard Inpainting and TV-H^{-1} Inpainting schemes are then presented. Mathematical investigations on the existence of unique and weak solutions are performed on these PDE-based models, many propositions and proofs related to their well-posedness being provided. Numerical solutions are also discussed.

The sixth chapter of the book describes image inpainting based on the generic transport model. Three PDE-based inpainting techniques based on transport dynamics are presented. The first method

inpaints the digital image by using transport along the level lines. The second reconstruction approach represents the interpolation model with coherence transport proposed by Bornemann and Marz. The last completion algorithm is a recent method called GuideFill, a fast artist-guided transport inpainting scheme. Numerical discussions are provided for all these transport-based models.

The Mumford-Shah Inpainting model is discussed in the seventh chapter. A robust mathematical investigation is performed on the well-posedness of this variational model, several theorems and proofs being provided. Then, the Mumford-Shah-Euler Inpainting scheme, representing a higher-order extension of this model by an Euler elastic regularisation on the edge set, is presented and investigated.

Inpainting mechanisms of transport and diffusion are discussed in the eighth chapter of this book. The author performs rigorous analyses on Euler's Elastica Inpainting, TV-H^{-1} Inpainting and LCIS Inpainting schemes. A natural decomposition of a flux field into its normal and tangent field is performed for each of them. Numerical results and method comparison are also provided.

The applications of the PDE-based image inpainting domain are presented in the last chapter. The first one, inpainting of medieval frescoes is performed by using Cahn-Hilliard and TV-H^{-1} inpainting models. The second application is the inpainting of roads in satellite images, the third represents sinogram inpainting for limited angle tomography and the last one is inpainting for 3D conversion. The appendices of the volume contain exercises involving PDEs, mathematical preliminaries, the Matlab implementations of the algorithms and image credits.

To conclude, this book approaches a very interesting subject, provides many image processing techniques and mathematical models and treatments, and addresses an important audience, including professionals of digital image processing and mathematics.

Tudor Barbu

D. A. SIMOVICI, *Linear Algebra Tools for Data Mining*, World Scientific Publishing Company, 2012, 880 pages, ISBN: 978-981-4383-49-3 (Tudor Barbu)

This book describes the foundations of linear algebra ideas and methods applied to data mining and the related domains, since linear algebra has gained increasing importance in data mining and pattern recognition fields. It represents a comprehensive volume, very well organized in two parts and 16 chapters.

The former part of this work describes the linear algebra theory, while the latter presents the applications of linear algebra. The mathematical theory presented in the chapters of the first part includes modules and linear spaces, the matrix theory, determinants, norms on linear spaces, inner product spaces, convexity, eingenvalues, similiarity and spectra and singular values. Numerous definitions, theorems and mathematical demonstrations related to these algebric notions are provided in these chapters. Since MATLAB represents the main programming tool used in this work for linear algebra computations, its instructions related to the matrix theory are described in a special chapter of the first part.

Linear algebra has many important applications in scientific domains like the graph theory, tolopogy, data mining and pattern classification, having a very strong impact upon these domains. The fields are approached in the chapters of the second part of this book, which present graphs, data sample matrices, least squares approximations and dimensionality reduction techniques (like LDA and PCA) used by data mining, and clustering approaches, such as the K-means algorithm and spectral clustering, used in the pattern recognition area.

Full mathematical justifications are provided by the author for describing these linear algebra applications. The theoretical results are accompanied by MATLAB implementations of the algorithms. Besides these robust MATLAB computations, all chapters of the book contain hundreds of exercises and supplements.

This self-contained book provides a solid mathematical background which is immediately relevant to data mining and pattern recognition. The practical and theoretical results here described

can be succesfully applied in other scientific areas related to pattern classification and data mining, such as image processing and analysis, and computer vision. Therefore, this book successfully addresses an important audience, including graduate students and professional researchers interested in all such mathematical and engineering topics.

Tudor Barbu

T. F. COLEMAN, W. XU, *Automatic Differentiation in MATLAB Using ADMAT with Applications*, Software, Environments and Tools Series, SIAM, Philadelphia, 2016, XI + 105 p., ISBN 978-1-611974-35-5.

This book is focused on automatic differentiation (AD) and ADMAT, a toolbox developed for MATLAB to help users compute first and second derivates and related structures in an efficient, accurate and automatic way. Many areas of scientific computing need calculation of partial derivatives, *e.g.* determining the gradient of a differentiable function of n variables, *i.e.* the sharpest ascent of a function, optimization of multidimensional functions, nonlinear regression and multidimensional zero-finding. The authors consider AD as the best available technology for obtaining derivatives, making critical assessments on other existing possibilities: finite differencing, hand coding or symbolic differentiation. Also, ways to dramatically improve the space and time efficiency of AD are indicated throughout the book. AD history begins when Newton and Leibniz applied derivative computation in differential equations instead of symbolic formulae. In 1950, compilers where developed to compute derivatives by the chain rule. Since 1990, AD has become interesting as a practical tool in scientific computing.

The book is organized into a preface, nine chapters and two appendixes. The ADMAT 2.0 toolbox can be found at www.siam.org/books/se27. Chapter 1 introduces fundamental notions of automatic differentiation and illustrates them with simple straightforward examples using ADMAT. Related to this chapter are the two appendixes, one regarding installation of ADMAT on Linux and Windows computers, and the other detailing the AD as a chain rule-based technique for calculating derivatives and its two modes of application: forward and reverse. AD is presented through a matrix view and the practical examples provided concern first derivatives (Jacobian, gradient) and second derivatives (Hessian matrix) computation.

Chapter 2 shows how AD can deliver directly the Jacobian-matrix product or the Hessian-matrix product without prior determination of Jacobian or Hessian matrices. The case of sparse Jacobian or Hessian matrices is considered, and details on when to use the AD forward or reverse mode are presented. Bi-partitioning related to Jacobian matrices and the graph theory is approached, along with a bi-coloring technique. Then examples are given on how to partition Jacobian matrices with the MNCO algorithm and how to compute with the help of ADMAT a sparse Jacobian-matrix and a sparse Hessian-matrix.

In Chapter 3 more examples of using automatic differentiation produced by the ADMAT toolbox are given, in relation with the MATLAB Optimization toolbox, which uses the finite difference method to estimate Jacobian or Hessian matrices by default. The authors show how to configure MATLAB functions so that the Jacobian or Hessian matrices can be computed by ADMAT. Examples consider the nonlinear equation solver *fsolve*, the nonlinear least squares solver *Isqnonlin*, multidimensional nonlinear minimization solvers *fmincon* and *fminuc*, a quasi-Newton computation with gradients determined by ADMAT and a sensitivity problem.

Chapter 4 shows how efficient spars techniques can be effectively applied to dense but structured problems for AD determination of Jacobians or Hessians. The general situation is first presented, along with computing gradients, a mixed strategy for computing Jacobian matrices and an example on using ADMAT for the structured problems. Then structured Hessian computation is considered with two algorithms and three examples.

Chapter 5 deals with the Newton step and how to apply structured computation with ADMAT for solving nonlinear equations and minimization problems (by two detailed examples).

Chapter 6 shows how to use ADMAT when users include C or FORTRAN MEX interface functions in MATLAB routines.

In Chapter 7 the inverse optimization problems are considered, stating that these type of issues exhibit a structure and so are prone to be efficiently solved with ADMAT. Details are given in several examples, one of them from computational finance, regarding the implied volatility surface problem for option pricing.

Chapter 8 presents several templates for structural problems included in the ADMAT-ST collection: the Jacobian template JACOBIANST, the gradient template GRADIENTST and the Hessian template HESSIANST.

The book concludes with Chapter 9, presenting some future developments of ADMAT, like the possibility to use 3D data structures or the possibility to integrate the automatic differentiation technology with graphics processor unit computing.

Adrian Ciobanu

V.T. KUMAR, M.R. KESSLER (Editors), *Green Biorenewable Biocomposites. From Knowledge to Industrial Applications.* CRC Press, Taylor & Francis Group, Apple Academic Press, ISBN 978-1-77188-032-9, 2015, 547 pages, 17 chapters.

In recent decades, most of the environmental concerns related to soil, water, air pollution with undegradable plastic waste led to intensified efforts of research and industry to elaborate various administrative regulations and management solutions for overcoming such problems. An efficient solution is considered the replacement of undegradable synthetic materials with environmentally friendly ones, based mainly on renewable resources. Among these materials, both bio-based polymers and green renewable biocomposites attracted much interest, due to their good physico-chemical properties which can be tailored by varying their composition, associated with biodegradability, low toxicity, low emission of gases – known as responsible for global warming.

This book is organized into 17 chapters, each of them giving an extensive review on the existing knowledge in the field, including preparation at laboratory or industrial scale, properties, performance and applications. Among the types of biocomposites described in the book mention should be made of: spider silk biocomposites, hydroxyapatite-based implants, liquid crystal and cellulose derivatives, lignocellulosics-, epoxy-, polyphenols-, wood-, cellulosic fibres- or other natural fibres-containing composites, etc. Some chapters are devoted to problems related to processing of natural fibres reinforced composites as injection molding, using of compatibilizers and coupling agents, etc.

Industrial developments of such materials include biocomposites as sound absorbers, for industrial noise control, benzophenone absorption or as fire resistant materials, etc. Applications of biocomposites as biomaterials and in food packaging are also detailed, being described as very promising alternatives to improve life quality.

Stress is laid on one of the most studied research trends for obtaining and characterizing advanced bio- and bionano-composite materials, developed technologies and the applied solutions in industry and environment protection.

The contributors to the book are well-known experts in their area of research and development, which adds value to the book.

This volume is addressed to both researchers from different disciplines and students, educators and technologists.

Cornelia Vasile