Book reviews

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BOOK REVIEWS

Omri Rand, Vladimir Rovenski: ANALYTICAL METHODS IN ANISOTROPIC ELASTICITY WITH SYMBOLIC COMPUTATIONAL TOOLS. Birkhäuser, Boston, 2005, xviii+451 pages, CD-ROM included, softcover, ISBN 0-8176-4272-2, EUR 84.–.

It might seem old-fashioned to write a book about analytical techniques in elasticity when numerical methods are blossoming and a plethora of numerical software is ready to solve problems whose complexity was beyond analysts' dreams two or three decades ago.

Yet, Rand and Rovenski successfully present comprehensive foundations of anisotropic elasticity theory, mathematical techniques for solving anisotropic elasticity problems analytically, a number of nontrivial applications, and relevant MAPLE codes.

In my opinion, the authors have shown that analytical methods are and will be firmly niched in techniques used to solve particular sorts of problems arising in applications of elasticity theory. At least three arguments can be advanced to support this conviction. First, analytical methods offer deep insight into the behavior of mathematical models of elastic bodies. Second, in special instances and in combination with modern computer algebra software, analytical methods can promptly deliver a solution to a problem that, if solved numerically, would need more labor. Third, analytically solved problems can serve as benchmarks in verification and validation of numerical methods and numerical software.

The book is rich in content. Chapter 1 presents the fundamentals of elasticity theory such as strain, stress, compatibility equations, energy theorems, Euler's equations, coordinate systems, and more. The core of Chapter 2 is the generalized Hooke's law and its particular forms related to materials that are generally anisotropic, monoclinic, orthotropic, tetragonal, cubic, or isotropic. Plane deformation models are treated in Chapter 3, namely plane strain, plane stress, plane shear, a coupled plane problem, and plates under bending. In Chapter 4, these problems are formulated in a unified way as two-dimensional boundary value problems, and various methodologies leading to a polynomial solution are presented and discussed. If the domain of the boundary value problem is simply shaped, take an ellipse, for instance, then the exact solution can be obtained in this way. Otherwise, at least an approximate polynomial solution is found.

Unlike the above-mentioned chapters, which are oriented towards general elasticity theory and general models, the rest of the book deals with anisotropic beams that are analyzed by the tools assembled and sharpened in Chapters 1 to 4. The analyses include: beams of general anisotropy; homogeneous, uncoupled (at the structural level) monoclinic beams; nonhomogeneous beams; solid coupled monoclinic beams (demonstrating the bending-twist coupling, for instance); and thin-walled coupled monoclinic beams with either open or closed cross-sections. At relevant places, special attention is paid to laminated beams.

To derive complex formulae, so abundant in the book, the authors resorted to MAPLE, a computer algebra software package. Moreover, to illustrate the presented theory and examples, the book includes a CD-ROM that stores dozens of MAPLE programs as `mws` and `html` files. The reader can either activate the former files with MAPLE, or view the latter files with a web browser. The viewing is passive; it permits only reading MAPLE codes and outputs inclusive of MAPLE color plots. These plots, however, are included in the book as gray-scale figures.

For those who have MAPLE 8, 9, or a later version available, activating the MAPLE worksheets opens the opportunity to see and repeat the deduction of formulae that are printed in the book, to modify input parameters, and to solve particular elastic body problems within pre-programmed types of problems. It is also possible to play with graphical outputs, and to easily perform complex tasks—take, for example, coordinate system dependent transformations of operators, equations, or matrices.

The authors point out that the worksheets are written mainly for demonstration and illustration of specific cases and analytical techniques. The programs are not intended as a software package. Knowing this, the reader should not be surprised that the presented MAPLE code is only formally book-independent. In fact, the worksheets often ask for a parallel use of the book because the code itself is austere, with only brief and scarce comments.

I ran a dozen programs. The majority worked well, but a syntax error message appeared twice (in Program P.2.7 and Program P.7.3).

The book balances between a textbook and a reference book. The pace of the exposition seems to be rather demanding, but the amount of information is huge and rewarding. Mathematical skills in calculus are assumed. An acquaintance with linear elasticity theory is not necessary, but desirable.

I believe the readership of the book will include those who pursue advanced analytical models of anisotropic elastic bodies as students, lecturers, and scientists in the solid-mechanics-oriented part of the academic world, or as engineers, designers, and analysts in industrial and research companies.

Jan Chleboun, Praha

S. Argyros, S. Todorcevic: RAMSEY METHODS IN ANALYSIS. Birkhäuser, Basel, 2005, 263 pages, EUR 38.–.

In the 90's, a number of long-standing open problems in Banach space theory has been solved. The avalanche was triggered by a paper of Schlumprecht, which contained a modification of a well-known example of Tsirelson. Further adjustments of the construction, due independently to Gowers and Maurey, lead to the example of a Banach space which contains no unconditional basic sequence. In fact, their example is hereditarily indecomposable (HI), which means that it does not contain a nontrivial complemented subspace. The strategy of the proof lies, roughly speaking, in finding sets in the space, which have a large distance to each other, but at the same time contain points of every infinite dimensional subspace. This property creates a link to other open problems, notable the distortion problem and to the stabilization of Lipschitz functions defined on the unit sphere of a Banach space.

A prominent role in these and further investigations is played by combinatorial arguments, of the Ramsey type, the main topic of the book under review. The book is divided into two parts, written by the respective authors. In the first part, Argyros gives a thorough exposition of (mostly) his own results, and the results of his students. Various types of Tsirelson spaces are defined and investigated, from the point of view of hereditarily indecomposability, or more generally the closely related properties of bounded operators on the space. The theory has numerous surprising applications. For example, it is shown that the classical ℓ_p spaces, which abound in complemented subspaces, are in fact quotients of some HI spaces. A construction of a nonseparable HI space is also sketched. This part of the book is closer to the classical Banach space theory in its spirit and arguments.

The style and approach of the second part is clearly combinatorial and Ramsey theoretic, betraying the original field of Todorcevic. We are taking a tour of the main applications of the combinatorial method throughout Banach space theory. This includes the classical results on spreading models, Rosenthal's results on ℓ_1, unconditional basic subsequences of characteristic functions, Maurey-Rosenthal's theorem, and finally we arrive at the recent

Gowers dichotomy, according to which every Schauder basis contains a block subsequence which is either unconditional or spans a HI space. Many very recent developments are also included.

Both authors made a clear and successful effort to write an accessible text, in spite of the technical difficulty of the material, and did a valuable service to the Banach space community.

There is some overlap with recent surveys in the Handbook of the Geometry of Banach Spaces, and the book Analysis and Logic by Henson, Kechris and Odell, but the presented material includes more recent results, and offers interesting and coherent points of view.

I strongly recommend this book to all young researchers and senior graduate students in the field.

Petr Hájek, Praha

Carl Rohwer: NONLINEAR SMOOTHING AND MULTIRESOLUTION ANALYSIS. Birkhäuser, Basel, 2005, xiv+137 pages, hardcover, ISBN 3-7643-7229-X, CHF 128.–/EUR 78.–.

Although the title indicates a rather broad subject, the author focuses mainly on a particular class of nonlinear mappings, namely on *LULU*-operators, also known as *LULU*-smoothers or min-max filters. The author deserves credit for his step-by-step approach that introduces the reader into the *LULU*-operators. The book, however, could have been better if it had been proofread more carefully. In any case, its strengths outweigh its weaknesses.

The cornerstones of the *LULU*-operators are two simple mappings: for a given sequence $x \in X$, where X is the space of bi-infinite sequences of real numbers, new respective sequences y and z are defined through the mapping $\overset{n}{\bigvee}$ as $y_i = \Bigl(\overset{n}{\bigvee} x\Bigr)_i = \max\{x_i, x_{i+1}, \ldots, x_{i+n}\}$ and the mapping $\overset{n}{\bigwedge}$ as $z_i = \Bigl(\overset{n}{\bigwedge} x\Bigr)_i = \min\{x_{i-n}, \ldots, x_i\}$. It is obvious from the definition that $\overset{n}{\bigvee}$ swallows local downward pulses and $\overset{n}{\bigwedge}$ swallows local upward pulses, where that locality is n-dependent. Next, the operators $L_n = \overset{n}{\bigvee}\overset{n}{\bigwedge}$ and $U_n = \overset{n}{\bigwedge}\overset{n}{\bigvee}$ are introduced. Their compositions L_nU_n and U_nL_n give rise to the class of *LULU*-operators. Due to their swallowing features, the *LULU*-operators can smooth signals contaminated with impulsive noise, reveal trends in signals, or create envelopes of signals.

The book is organized as follows. After introducing the motivations and goals, the author presents basic definitions and theorems. Then, the *LULU*-operator theory is developed step by step with consideration given to smoothing, approximation, variation reduction, and shape preservation. A multiresolution analysis of sequences follows, in which the *LULU*-approach shows some advantages over wavelet analysis. It is also proved that *LULU*-based decompositions of sequences are consistent; that is, the output components are preserved if the operator is repeatedly applied. Focus is placed on the effectiveness, effectivity, and stability of the operators, as well as on the comparison of the *LULU*-smoothers with linear smoothers. Attention is also paid to random noise. The last chapter is brief, a mere two and a half pages long, and consists of a list of conclusions, comments, and the author's thoughts.

As regards the *LULU*-operators, no preliminary knowledge is assumed. In chapters that are not restricted to the *LULU*-theory, some familiarity is expected with wavelet analysis, linear smoothers, median smoothers, and random noise, because these subjects are only briefly introduced. However, even readers who are not familiar with these topics may profit from the examples, observations, and conclusions presented in a graphical or narrative manner.

I regret to say that the book shows some lack of proofreading. The symbols L_n and U_n are introduced on page 13. They become Ln and Un on page 14, and are used as such till page 49, where they suddenly restore their original appearance.

Wrong numbers are often given in references to theorems: Theorem 5.1 (p. 17) should be Theorem 2.11; Theorem 5.2 (p. 17) should be Theorem 2.12; Theorem 2.5 (p. 26) should be Theorem 3.5; Theorem 1 (p. 66), Theorem 4 (p. 67, p. 99), Theorem 6 (p. 100), Theorem 7 (p. 99), and Theorem 8 (p. 104) do not exist in the numeral-dot-numeral numbering scheme used by the author.

Bibliographical references are numbered, but the author sometimes refers only to the reference author surname. The reader can only assume that Mallows (p. 78), mentioned in connection with the axioms of a smoother, refers to the unique reference [14] Mallows in the list of references. It is not clear whether or not the Wild on p. 121 is included into the list of references as [32], or into the list of further literature as [22]. Additionally, Wild [52] (p. 63) cannot be found in any of the two parts of references.

Other typographical errors can also be encountered. Take, for instance, $\mu(N)$ instead of the correct $\mu(P)$ (Lemma on p. 45), α instead of the correct $|\alpha|$ (p. 52, the proof of Theorem 6.1), switching from φ to ϕ and back (p. 73), misplaced closing parenthesis (p. 106, Example 1); wrong sub- and superscripts also occur.

The reader's understanding is sometimes hampered by a tacit assumption as in the example on page 29 that is valid if (tacitly) $a \geqslant 1$, or by an undefined symbol, take, for example, symbols C_n and F_n in Figure 6.1 on page 60 that are not defined till page 64.

Nevertheless, despite these somewhat annoying flaws, this book will be appreciated by scientists, engineers, and undergraduates interested in signal- and image processing, multiresolution analysis, digital filtering, or mathematical morphology. The $LULU$-operator theory is built up from scratch, illustrated by examples, and compared with other, more common approaches to signal smoothing and decomposition. Moreover, the nature of the $LULU$-smoothers makes their algorithmization easy and opens the door for numerical experiments with real data sets. The book provides valuable inspiration in this respect, too.

Jan Chleboun, Praha

G. Grätzer: THE CONGRUENCES OF A FINITE LATTICE, A PROOF-BY-PICTURE APPROACH. Birkhäuser, Basel 2006, 282 pages, 110 illus., EUR 52.–.

This is a book by the leading expert in lattice theory George Grätzer. To describe a homomorphism from a given lattice it does not suffice to use ideals, one has to use congruences. The lattice of all congruences is a natural structure that one can use to study the given lattice. Grätzer's book focuses on the representation problem, which is in a sense a reverse process: for a given distributive lattice K to find a lattice L such that the congruence lattice is isomorphic to K. The book presents a number of results about representation of finite distributive lattices. Finite lattices can be presented by their Hasse diagrams, which makes this field very suitable for a "proof-by-picture approach".

The book is suitable for students starting with universal algebra. It contains a lot of problems that do not need much background to understand. I regret that the author decided to cover only his own results and those he coauthored. Thus the book covers some older results about the problem of representation of infinite algebraic distributive lattices, but the new exciting results are mentioned only briefly.

Pavel Pudlák, Praha