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Book Reviews

1 Geometric Numerical Integration (Structure-Preserving Algorithms for Ordinary Differential Equations). Series: Springer Series in Computational Mathematics , Vol. 31. By Ernst Hairer, Christian Lubich and Gerhard Wanner, 2002, XIII, 515 pp. 119 figs. Hardcover ISBN: 3-540-43003-2

The scope of this book is the study of: (1) the numerical methods that preserve properties of Hamiltonian systems, (2) the numerical algorithms for the reversible systems, (3) the methods for the differential equations on manifolds and (4) the numerical methods for problems with highly oscillatory solutions.

In this book a complete and self-contained theory for symplectic and symmetric methods is presented and also the construction of the numerical methods is discussed. Using a backward error analysis (modified equations) combined with KAM theory, a study of the long-time behavior of the numerical solutions is presented.

Applications from physics and astronomy are also presented.

More specifically in Chapter I (Examples and Numerical Experiments) an introduction of some interesting examples of differential equations and an illustration of different types of qualitative behavior of numerical methods is presented.

In Chapter II (Numerical Integrators) a study of Runge-Kutta methods, collocation methods, partitioned Runge-Kutta and Nyström methods, composition and splitting methods is presented.

In Chapter III (Order Conditions, Trees and B-Series) a compact theory of the order conditions of the methods described in Chapter II is presented.

In Chapter IV (Conservation of First Integrals and Methods on Manifolds) an investigation of the conservation of invariants by numerical methods and a study of numerical methods for differential equations on manifolds is presented.

In Chapters V (Symmetric Integration and Reversibility) and VI (Symplectic Integration of Hamiltonian Systems) a study of symmetric and symplectic methods is presented.

In Chapter VII (Further Topics in Structure Preservation) an investigation of: (i) symmetric and symplectic methods for constrained Hamiltonian systems, (ii) Poison integrators for Hamiltonian problems with a non-standard structure matrix, (iii) volume-preserving algorithms for divergence-free differential equations that are not necessary Hamiltonian systems is presented.

In Chapter VIII (Structure-Preserving Implementation) the authors present implementation of geometric integrators.

In Chapter IX (Backward Error Analysis and Structure Preservation) a backward error analysis is presented.

In Chapter X (Hamiltonian Perturbation Theory and Symplectic Integrators) the authors study the behavior of symplectic integrators in the long-time integration.

In Chapter XI (Reversible Perturbation Theory and Symmetric Integrators) numerical illustration of symmetric methods to integrable and non-integrable systems is presented.

In Chapter XII (Dissipatively Perturbed Hamiltonian and Reversible Systems) the authors investigate the behavior of the numerical methods in their application to dissipative perturbations of integrable systems.

In Chapter XIII (Highly Oscillatory Differential Equations) an investigation of numerical algorithms for second-order differential equations with oscillatory solutions is presented.

In Chapter XIV (Dynamics of Multistep Methods) the authors study the behavior of multistep methods to long-time integration of Hamiltonian or reversible systems.

This book is a very good written book for numerical methods with constant coefficients applied to Hamiltonian or reversible systems. It can used from postgraduate students. This book can also be a very useful reference book for researchers on the construction of numerical methods for geometric numerical integration.

In summary this book is an excellent book on numerical algorithms for geometric numerical integration and I strongly recommended to all postgraduate students and also to researchers of numerical ordinary differential equations.

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Greece

2 Wavelets in Numerical Simulation (Problem Adapted Construction and Applications). Series: Lecture Notes in Computational Science and Engineering , Vol. 22. By Urban, Karsten, 2002, XV, 181 pp. 61 figs., Softcover ISBN: 3-540-43055-5

In this research monograph the authors present recent developments of wavelet concepts in the context of large scale numerical simulation.

The authors give a systematic way to use the wavelets as a numerical aid by adapting wavelet bases to the problem at hand. This way includes (i) the development of wavelets on general domains and (ii) the adaptation of wavelet bases to the particular structure of function spaces governing certain variational problems.

These advantages that makes wavelets an important aid in numerical analysis and simulation are clearly presented. The constructions and the developments are based on the above advantages.

More specifically in Chapter 1 (Wavelet Bases) the authors describe the general framework of wavelet bases and present some particular examples. They give a definition and important features in general setting. We note here that the discussion of the general framework is very important since this framework fits to various application which they will be considered later. After that they describe wavelet bases starting on the real line up to general domains.

In Chapter 2 (Wavelet Bases for $H(div)$ and $H(curl)$) the authors construct wavelet bases for the spaces $H(div)$ and $H(curl)$. We note here that the above spaces arise in the variational formulation of a variety of partial differential equations (for example Navier-Stokes equations and Maxwell's equations)

In Chapter 3 some applications of the wavelet bases described above are presented. More specifically two types of applications are presented. First wavelet bases are used in order to prove robustness and optimality of wavelet preconditioners in a Wavelet-Galerkin method for certain relevant problems (including Lamé equations, Maxwell's equations and Navier-Stokes equations).

In the second type of examples the wavelets are used in order to extract quantities from numerical simulation.

This is an excellent monograph on wavelets in numerical simulation. I strongly recommend this book to researchers and graduate students of sciences and engineering which in their research use numerical simulation.

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3 Multimedia Tools for Communicating Mathematics. Series: Mathematics and Visualization. Borwein, J.; Morales, M.H.; Polthier, K.; Rodrigues, J.F. (Eds.), 2002, VIII, 314 pp. 114 figs., 46 in color, with CD-ROM., Hardcover ISBN: 3-540-42450-4

This book on multimedia tools for communicating mathematics is a selection of presentations which took place at an international workshop organized by the Centro de Matematica e Aplicacoes Fundamentais at the University of Lisbon, in November 2000, with the collaboration of the Sonderforschungsbereich 288 at the University of Technology in Berlin, and of the Centre for Experimental and Constructive Mathematics at Simon Fraser University in Burnaby, Canada.

The aim of Multimedia Tools for Communicating Mathematics (MTCM 2000) workshop was (1) the scientific methods and algorithms inside multimedia tools (2) the presentation of an overview of the range of present multimedia projects, their limitations and the underlying mathematical problems.

In this book the participants present some of the tools and methods currently being used to create new procedures of making enhanced interactive presentations and multimedia courses.

The contributions presented in the book are:

- Computer Animated Mathematics Videotapes (by Tom M. Apostol)
- A Virtual Reconstruction of a Virtual Exhibit (by Thomas F. Bancho. and Davide P. Cervone)
- An Intuitive Approach to Elementary Mathematics on the Web (by Bruce Bauslaugh, Richard Cannings, Claude La.amme, and W. Keith Nicholson)
- OpenMath Technology for Interactive Mathematical Documents (By Olga Caprotti, Arjeh M. Cohen, Hans Cuypers, and Hans Sterk)
- The StageTools Package for Creating Geometry for the Web (By Davide P. Cervone)
- Communicating and Learning Mathematics with Hypervideo (By Teresa Chambel and Nuno Guimarães)
- Collaboration in a Multimedia Laboratory (By Éliane Cousquer)
- JDvi A Way to Put Interactive TeX on the Web (By Tim Hoffmann)
- Visual Calculus Development and Tools (By Lawrence S. Husch)
- EG-Models A New Journal for Digital Geometry Models (By Michael Joswig and Konrad Polthier)

- The Future of Mathematical Software (By Ulrich H. Kortenkamp)
- A Dynamic Setup for Elementary Geometry (By Ulrich H. Kortenkamp and Jürgen Richter-Gebert)
- Dynamic Geometry on WWW (By Gilles Kuntz)
- Minimalistic Tools for Mathematical Multimedia (By Erich Neuwirth)
- Publication of Interactive Visualizations with JavaView (By Konrad Polthier, Samy Khadem, Eike Preu, and Ulrich Reitebuch)
- The Solver Learning Environment for Solving Mathematical Word Problems: Pupils Discussions (By Heli Ruokamo)
- Interactive Knot Theory with KnotPlot (By Robert G. Scharein and Kellogg S. Booth)
- Developing Gato and CATBox with Python: Teaching Graph Algorithms through Visualization and Experimentation (By Alexander Schliep and Winfried Hochstättler
- Rescalable Real-Time Interactive Computer Animations (By John M. Sullivan)

The discussion in the workshop (which was co-chaired by J.F. Rodrigues) has been divided into four main topics:

- Business models for multimedia tools (R. Fitzgerald and J. Borwein)
- New online services to provide mathematical knowledge (T. Banchoff)
- New mathematical algorithms and data structures for online mathematics (K. Polthier) and
- Multimedia tools of the future (J. Richter-Gebert)

The summaries are:

- While journals and books are the current sources for mathematical knowledge, new online sources have appeared and hint at what is on the horizon (for example, Neil Sloanes server of integer sequences etc)
- The diversity of multimedia tools for the doing of mathematics will grow substantially in the near future and will help substantially the way that mathematicians do mathematics.
- It is well known that new tools, new mathematical algorithms and data structures are needed for doing mathematics online. This need will be dramatically increased in the near future.

This is an excellent book on tools and algorithms which are used to create new ways of making interactive presentations and multimedia courses. This is also an excellent up-to-date reference book on multimedia tools available for mathematics and related subjects. I strongly recommend this book to mathematicians and computer scientists in multimedia design and software engineering.

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