Timothy J. Barth
Herman Deconinck (Eds.)

Error Estimation
and Adaptive
Discretization Methods
in Computational
Fluid Dynamics

Springer

Error Estimation And Adaptive Discretization Methods In Computational Fluid Dynamics

Jochen Garcke,Michael Griebel

Error Estimation And Adaptive Discretization Methods In Computational Fluid Dynamics:

Error Estimation and Adaptive Discretization Methods in Computational Fluid Dynamics Timothy J. Barth,Herman Deconinck,2013-04-17 As computational fluid dynamics CFD is applied to ever more demanding fluid flow problems the ability to compute numerical fluid flow solutions to a user specified tolerance as well as the ability to quantify the accuracy of an existing numerical solution are seen as essential ingredients in robust numerical simulation Although the task of accurate error estimation for the nonlinear equations of CFD seems a daunting problem considerable effort has centered on this challenge in recent years with notable progress being made by the use of advanced error estimation techniques and adaptive discretization methods To address this important topic a special course wasjointly organized by the NATO Research and Technology Office RTO the von Karman Insti tute for Fluid Dynamics and the NASA Ames Research Center The NATO RTO sponsored course entitled Error Estimation and Solution Adaptive Discretization in CFD was held September 10 14 2002 at the NASA Ames Research Center and October 15 19 2002 at the von Karman Institute in Belgium During the special course a series of comprehensive lectures by leading experts discussed recent advances and technical progress in the area of numerical error estimation and adaptive discretization methods with spe cific emphasis on computational fluid dynamics The lecture notes provided in this volume are derived from the special course material The volume con sists of 6 articles prepared by the special course lecturers **2023 Asia-Pacific International Symposium on Aerospace Technology (APISAT 2023) Proceedings** Song Fu,2024-07-04 This book is a compilation of peer reviewed papers from the 2023 Asia Pacific International Symposium on Aerospace Technology APISAT2023 The symposium is a common endeavour among the four national aerospace societies in China Australia Korea and Japan namely Chinese Society of Aeronautics and Astronautics CSAA Royal Aeronautical Society Australian Division RAeS Australian Division Japan Society for Aeronautical and Space Sciences JSASS and Korean Society for Aeronautical and Space Sciences KSAS APISAT is an annual event initiated in 2009 It aims to provide the opportunity to Asia Pacific nations for the researchers of universities and academic institutes and for the industry engineers to discuss the current and future advanced topics in aeronautical and space engineering This is the volume II of the proceedings Finite Difference Computing with PDEs Hans Petter Langtangen,Svein Linge,2017-06-21 This book is open access under a CC BY 4 0 license This easy to read book introduces the basics of solving partial differential equations by means of finite difference methods Unlike many of the traditional academic works on the topic this book was written for practitioners Accordingly it especially addresses the construction of finite difference schemes formulation and implementation of algorithms verification of implementations analyses of physical behavior as implied by the numerical solutions and how to apply the methods and software to solve problems in the fields of physics and biology *A Primer on Scientific Programming with Python* Hans Petter Langtangen,2016-07-28 The book serves as a first introduction to computer programming of scientific applications using the high level Python language The exposition is example and problem oriented

where the applications are taken from mathematics numerical calculus statistics physics biology and finance The book teaches Matlab style and procedural programming as well as object oriented programming High school mathematics is a required background and it is advantageous to study classical and numerical one variable calculus in parallel with reading this book Besides learning how to program computers the reader will also learn how to solve mathematical problems arising in various branches of science and engineering with the aid of numerical methods and programming By blending programming mathematics and scientific applications the book lays a solid foundation for practicing computational science From the reviews Langtangen does an excellent job of introducing programming as a set of skills in problem solving He guides the reader into thinking properly about producing program logic and data structures for modeling real world problems using objects and functions and embracing the object oriented paradigm Summing Up Highly recommended F H Wild III Choice Vol 47 8 April 2010 Those of us who have learned scientific programming in Python on the streets could be a little jealous of students who have the opportunity to take a course out of Langtangen s Primer John D Cook The Mathematical Association of America September 2011 This book goes through Python in particular and programming in general via tasks that scientists will likely perform It contains valuable information for students new to scientific computing and would be the perfect bridge between an introduction to programming and an advanced course on numerical methods or computational science Alex Small IEEE CiSE Vol 14 2 March April 2012 This fourth edition is a wonderful inclusive textbook that covers pretty much everything one needs to know to go from zero to fairly sophisticated scientific programming in Python Joan Horvath Computing Reviews March 2015   Finite Difference Computing with Exponential Decay Models Hans Petter Langtangen,2016-06-10 This text provides a very simple initial introduction to the complete scientific computing pipeline models discretization algorithms programming verification and visualization The pedagogical strategy is to use one case study an ordinary differential equation describing exponential decay processes to illustrate fundamental concepts in mathematics and computer science The book is easy to read and only requires a command of one variable calculus and some very basic knowledge about computer programming Contrary to similar texts on numerical methods and programming this text has a much stronger focus on implementation and teaches testing and software engineering in particular   **Numerical Mathematics and Advanced Applications - ENUMATH 2013** Assyr Abdulle,Simone Deparis,Daniel Kressner,Fabio Nobile,Marco Picasso,2014-11-25 This book gathers a selection of invited and contributed lectures from the European Conference on Numerical Mathematics and Advanced Applications ENUMATH held in Lausanne Switzerland August 26 30 2013 It provides an overview of recent developments in numerical analysis computational mathematics and applications from leading experts in the field New results on finite element methods multiscale methods numerical linear algebra and discretization techniques for fluid mechanics and optics are presented As such the book offers a valuable resource for a wide range of readers looking for a state of the art overview of advanced techniques algorithms and results in numerical

mathematics and scientific computing   *Building Bridges: Connections and Challenges in Modern Approaches to Numerical Partial Differential Equations* Gabriel R. Barrenechea,Franco Brezzi,Andrea Cangiani,Emmanuil H. Georgoulis,2016-10-03 This volume contains contributed survey papers from the main speakers at the LMS EPSRC Symposium Building bridges connections and challenges in modern approaches to numerical partial differential equations This meeting took place in July 8 16 2014 and its main purpose was to gather specialists in emerging areas of numerical PDEs and explore the connections between the different approaches The type of contributions ranges from the theoretical foundations of these new techniques to the applications of them to new general frameworks and unified approaches that can cover one or more than one of these emerging techniques   *Numerical Mathematics and Advanced Applications ENUMATH 2019* Fred J. Vermolen,Cornelis Vuik,2021-04-30 This book gathers outstanding papers presented at the European Conference on Numerical Mathematics and Advanced Applications ENUMATH 2019 The conference was organized by Delft University of Technology and was held in Egmond aan Zee the Netherlands from September 30 to October 4 2019 Leading experts in the field presented the latest results and ideas regarding the design implementation and analysis of numerical algorithms as well as their applications to relevant societal problems ENUMATH is a series of conferences held every two years to provide a forum for discussing basic aspects and new trends in numerical mathematics and scientific and industrial applications all examined at the highest level of international expertise The first ENUMATH was held in Paris in 1995 with successive installments at various sites across Europe including Heidelberg 1997 Jyvaskyla 1999 lschia Porto 2001 Prague 2003 Santiago de Compostela 2005 Graz 2007 Uppsala 2009 Leicester 2011 Lausanne 2013 Ankara 2015 and Bergen 2017   Numerical Geometry, Grid Generation and Scientific Computing Vladimir A. Garanzha,Lennard Kamenski,Hang Si,2021-09-25 The focus of these conference proceedings is on research development and applications in the fields of numerical geometry scientific computing and numerical simulation particularly in mesh generation and related problems In addition this year s special focus is on Delaunay triangulations and their applications celebrating the 130th birthday of Boris Delaunay In terms of content the book strikes a balance between engineering algorithms and mathematical foundations It presents an overview of recent advances in numerical geometry grid generation and adaptation in terms of mathematical foundations algorithm and software development and applications The specific topics covered include quasi conformal and quasi isometric mappings hyperelastic deformations multidimensional generalisations of the equidistribution principle discrete differential geometry spatial and metric encodings Voronoi Delaunay theory for tilings and partitions duality in mathematical programming and numerical geometry mesh based optimisation and optimal control methods Further aspects examined include iterative solvers for variational problems and algorithm and software development The applications of the methods discussed are multidisciplinary and include problems from mathematics physics biology chemistry material science and engineering   *High Order Nonlinear Numerical Schemes for Evolutionary PDEs* Rémi Abgrall,Héloïse Beaugendre,Pietro Marco

Congedo,Cécile Dobrzynski,Vincent Perrier,Mario Ricchiuto,2014-05-19 This book collects papers presented during the European Workshop on High Order Nonlinear Numerical Methods for Evolutionary PDEs HONOM 2013 that was held at INRIA Bordeaux Sud Ouest Talence France in March 2013 The central topic is high order methods for compressible fluid dynamics In the workshop and in this proceedings greater emphasis is placed on the numerical than the theoretical aspects of this scientific field The range of topics is broad extending through algorithm design accuracy large scale computing complex geometries discontinuous Galerkin finite element methods Lagrangian hydrodynamics finite difference methods and applications and uncertainty quantification These techniques find practical applications in such fields as fluid mechanics magnetohydrodynamics nonlinear solid mechanics and others for which genuinely nonlinear methods are needed *Sparse Grids and Applications* Jochen Garcke,Michael Griebel,2012-10-13 In the recent decade there has been a growing interest in the numerical treatment of high dimensional problems It is well known that classical numerical discretization schemes fail in more than three or four dimensions due to the curse of dimensionality The technique of sparse grids helps overcome this problem to some extent under suitable regularity assumptions This discretization approach is obtained from a multi scale basis by a tensor product construction and subsequent truncation of the resulting multiresolution series expansion This volume of LNCSE is a collection of the papers from the proceedings of the workshop on sparse grids and its applications held in Bonn in May 2011 The selected articles present recent advances in the mathematical understanding and analysis of sparse grid discretization Aspects arising from applications are given particular attention *Recent Advances in Algorithmic Differentiation* Shaun Forth,Paul Hovland,Eric Phipps,Jean Utke,Andrea Walther,2012-07-30 The proceedings represent the state of knowledge in the area of algorithmic differentiation AD The 31 contributed papers presented at the AD2012 conference cover the application of AD to many areas in science and engineering as well as aspects of AD theory and its implementation in tools For all papers the referees selected from the program committee and the greater community as well as the editors have emphasized accessibility of the presented ideas also to non AD experts In the AD tools arena new implementations are introduced covering for example Java and graphical modeling environments or join the set of existing tools for Fortran New developments in AD algorithms target the efficiency of matrix operation derivatives detection and exploitation of sparsity partial separability the treatment of nonsmooth functions and other high level mathematical aspects of the numerical computations to be differentiated Applications stem from the Earth sciences nuclear engineering fluid dynamics and chemistry to name just a few In many cases the applications in a given area of science or engineering share characteristics that require specific approaches to enable AD capabilities or provide an opportunity for efficiency gains in the derivative computation The description of these characteristics and of the techniques for successfully using AD should make the proceedings a valuable source of information for users of AD tools **Frontiers and Challenges in Warm Dense Matter** Frank Graziani,Michael P. Desjarlais,Ronald Redmer,Samuel B. Trickey,2014-04-28 Warm Dense Matter WDM

occupies a loosely defined region of phase space intermediate between solid liquid gas and plasma and typically shares characteristics of two or more of these phases WDM is generally associated with the combination of strongly coupled ions and moderately degenerate electrons and careful attention to quantum physics and electronic structure is essential The lack of a small perturbation parameter greatly limits approximate attempts at its accurate description Since WDM resides at the intersection of solid state and high energy density physics many high energy density physics HEDP experiments pass through this difficult region of phase space Thus understanding and modeling WDM is key to the success of experiments on diverse facilities These include the National Ignition Campaign centered on the National Ignition Facility NIF pulsed power driven experiments on the Z machine ion beam driven WDM experiments on the NDCX II and fundamental WDM research at the Linear Coherent Light Source LCLS Warm Dense Matter is also ubiquitous in planetary science and astrophysics particularly with respect to unresolved questions concerning the structure and age of the gas giants the nature of exosolar planets and the cosmochronology of white dwarf stars In this book we explore established and promising approaches to the modeling of WDM foundational issues concerning the correct theoretical description of WDM and the challenging practical issues of numerically modeling strongly coupled systems with many degrees of freedom **Finite and Boundary Element Tearing and Interconnecting Solvers for Multiscale Problems** Clemens Pechstein,2012-12-14 Tearing and interconnecting methods such as FETI FETI DP BETI etc are among the most successful domain decomposition solvers for partial differential equations The purpose of this book is to give a detailed and self contained presentation of these methods including the corresponding algorithms as well as a rigorous convergence theory In particular two issues are addressed that have not been covered in any monograph yet the coupling of finite and boundary elements within the tearing and interconnecting framework including exterior problems and the case of highly varying multiscale coefficients not resolved by the subdomain partitioning In this context the book offers a detailed view to an active and up to date area of research **Principal Manifolds for Data Visualization and Dimension Reduction** Alexander N. Gorban,Balázs Kégl,Donald C. Wunsch,Andrei Zinovyev,2007-09-11 In 1901 Karl Pearson invented Principal Component Analysis PCA Since then PCA serves as a prototype for many other tools of data analysis visualization and dimension reduction Independent Component Analysis ICA Multidimensional Scaling MDS Nonlinear PCA NLPCA Self Organizing Maps SOM etc The book starts with the quote of the classical Pearson definition of PCA and includes reviews of various methods NLPCA ICA MDS embedding and clustering algorithms principal manifolds and SOM New approaches to NLPCA principal manifolds branching principal components and topology preserving mappings are described as well Presentation of algorithms is supplemented by case studies from engineering to astronomy but mostly of biological data analysis of microarray and metabolite data The volume ends with a tutorial PCA and K means decipher genome The book is meant to be useful for practitioners in applied data analysis in life sciences engineering physics and chemistry it will also be valuable to PhD students and researchers in computer sciences

applied mathematics and statistics   Sparse Grid Quadrature in High Dimensions with Applications in Finance and Insurance Markus Holtz,2010-10-22 This book deals with the numerical analysis and efficient numerical treatment of high dimensional integrals using sparse grids and other dimension wise integration techniques with applications to finance and insurance The book focuses on providing insights into the interplay between coordinate transformations effective dimensions and the convergence behaviour of sparse grid methods The techniques derivations and algorithms are illustrated by many examples figures and code segments Numerical experiments with applications from finance and insurance show that the approaches presented in this book can be faster and more accurate than quasi Monte Carlo methods even for integrands with hundreds of dimensions   Advanced Computing Michael Bader,Hans-Joachim Bungartz,Tobias Weinzierl,2013-09-26 This proceedings volume collects review articles that summarize research conducted at the Munich Centre of Advanced Computing MAC from 2008 to 2012 The articles address the increasing gap between what should be possible in Computational Science and Engineering due to recent advances in algorithms hardware and networks and what can actually be achieved in practice they also examine novel computing architectures where computation itself is a multifaceted process with hardware awareness or ubiquitous parallelism due to many core systems being just two of the challenges faced Topics cover both the methodological aspects of advanced computing algorithms parallel computing data exploration software engineering and cutting edge applications from the fields of chemistry the geosciences civil and mechanical engineering etc reflecting the highly interdisciplinary nature of the Munich Centre of Advanced Computing   *Programming for Computations - Python* Svein Linge,Hans Petter Langtangen,2019-10-30 This book is published open access under a CC BY 4 0 license This book presents computer programming as a key method for solving mathematical problems This second edition of the well received book has been extensively revised All code is now written in Python version 3 6 no longer version 2 7 In addition the two first chapters of the previous edition have been extended and split up into five new chapters thus expanding the introduction to programming from 50 to 150 pages Throughout the book the explanations provided are now more detailed previous examples have been modified and new sections examples and exercises have been added Also a number of small errors have been corrected The book was inspired by the Springer book TCSE 6 A Primer on Scientific Programming with Python by Langtangen but the style employed is more accessible and concise in keeping with the needs of engineering students The book outlines the shortest possible path from no previous experience with programming to a set of skills that allows students to write simple programs for solving common mathematical problems with numerical methods in the context of engineering and science courses The emphasis is on generic algorithms clean program design the use of functions and automatic tests for verification   **Isogeometric Analysis and Applications 2014** Bert Jüttler,Bernd Simeon,2015-12-21 Isogeometric Analysis is a groundbreaking computational approach that promises the possibility of integrating the finite element method into conventional spline based CAD design tools It thus bridges the gap between numerical analysis and

geometry and moreover it allows to tackle new cutting edge applications at the frontiers of research in science and engineering This proceedings volume contains a selection of outstanding research papers presented at the second International Workshop on Isogeometric Analysis and Applications held at Annweiler Germany in April 2014

Optimization with PDE Constraints Ronald Hoppe,2014-09-11 This book on PDE Constrained Optimization contains contributions on the mathematical analysis and numerical solution of constrained optimal control and optimization problems where a partial differential equation PDE or a system of PDEs appears as an essential part of the constraints The appropriate treatment of such problems requires a fundamental understanding of the subtle interplay between optimization in function spaces and numerical discretization techniques and relies on advanced methodologies from the theory of PDEs and numerical analysis as well as scientific computing The contributions reflect the work of the European Science Foundation Networking Programme Optimization with PDEs OPTPDE

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