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Consisting of 23 refereed contributions, this volume offers a broad and diverse view of current research in control and estimation of partial differential equations. Topics addressed include, but are not limited to - control and stability of hyperbolic systems related to elasticity, linear and nonlinear; - control and identification of nonlinear parabolic systems; - exact and approximate controllability, and observability; - Pontryagin's maximum principle and dynamic programming in PDE; and - numerics pertinent to optimal and suboptimal control problems. This volume is primarily geared toward control theorists seeking information on the latest developments in their area of expertise. It may also serve as a stimulating reader to any researcher who wants to gain an impression of activities at the forefront of a vigorously expanding area in applied mathematics. The multilevel projection method is a new formalism that provides a framework for the development of multilevel algorithms in a very general setting. This methodology guides the choices of all the major multilevel processes, including relaxation and coarsening, and it applies directly to global or locally-refined discretizations. This book was developed from lectures at the CBMS-NSF Regional Conference on Multigrid and Multilevel Adaptive Methods for Partial Differential Equations in June 1991, and is a supplement to Multilevel Adaptive Methods for Partial Differential Equations, also written by Stephen F. McCormick. Today’s scientific and engineering community has a good grasp on how to model fluid flows at macro and molecular scales, with well-developed theory and supporting technologies. Between these two extremes lies the nano/meso scale (i.e. in the range of 50nm-500nm) where fluid flow models continue to be problematic. Continuum models used at macro scales assume a negligible influence from molecular interactions, while molecular models do not predict flow well at nano/meso dimensions. The solution, and the subject of this book, is to use elements from both to capture correctly the proper physics (from the molecular scale) and provide a description in terms of useful fluid properties (as characterized on the continuum scale). Fluid Properties at Nano/Meso Scale is based on the authors’ past five years’ research that has yielded new innovations in fluid simulation strategies at the nano/meso scale. The authors approach this subject in a straightforward and easy to understand format, providing a first step into the subject for researchers at all levels. They present new tools that allow the numerical computation of fluid properties from first principles, enabling the reader to begin to model successfully fluids at nano/meso scale. It is hoped that these first steps will engender the further development and advancement of simulation techniques at this scale, and keep engineering simulation

at the cutting edge of technology. Presents internationally leading developments in the field of fluid properties at nano/meso scale Provides the reader with the first steps to fluid modelling at nano/meso-scales as well as state-of-the-art applications Includes innovative and new simulation techniques along with a detailed examination of existing numerical methods A unified treatment of fluid mechanics, analysis and numerical analysis appropriate for first year graduate students. This unique volume presents reviews of research in several important areas of applications of mathematical concepts to science and technology, for example applications of inverse problems and wavelets to real world systems. The book provides a comprehensive overview of current research of several outstanding scholars engaged in diverse fields such as complexity theory, vertex coupling in quantum graphs, mixing of substances by turbulence, network dynamics and architecture, processes with rate OCo independent hysteresis, numerical analysis of Hamilton Jacobi OCo Bellman equations, simulations of complex stochastic differential equations, optimal flow control, shape optimal flow control, shape optimization and aircraft designing, mathematics of brain, nanotechnology and DNA structure and mathematical models of environmental problems. The volume also contains contributory talks based on current researches of comparatively young researchers participating in the conference. Advances in Structural Optimization presents the techniques for a wide set of applications, ranging from the problems of size and shape optimization (historically the first to be studied) to topology and material optimization. Structural models are considered that use both discrete and finite elements. Structural materials can be classical or new. Emerging methods are also addressed, such as automatic differentiation, intelligent structures optimization, integration of structural optimization in concurrent engineering environments, and multidisciplinary optimization. For researchers and designers in industries such as aerospace, automotive, mechanical, civil, nuclear, naval and offshore. A reference book for advanced undergraduate or graduate courses on structural optimization and optimum design. This is the Proceedings of the Ninth International Conference on Management Science and Engineering Management (ICMSEM) held from July 21-23, 2015 at Karlsruhe, Germany. The goals of the conference are to foster international research collaborations in Management Science and Engineering Management as well as to provide a forum to present current findings. These proceedings cover various areas in management science and engineering management. It focuses on the identification of management science problems in engineering and innovatively using management theory and methods to solve engineering problems effectively. It also establishes a new management theory and methods based on experience of new management issues in engineering. Readers interested in the fields of management science and engineering management will benefit from the latest cutting-edge innovations and research advances presented in these proceedings and will find new ideas and research directions. A total number of 132 papers from 15 countries are selected for the proceedings by the conference scientific committee through rigorous referee review. The selected papers in the first volume are focused on Intelligent System and Management Science covering areas of Intelligent Systems, Logistics Engineering, Information Technology and Risk Management. The selected papers in the second volume are focused on Computing and Engineering Management covering areas of Computing Methodology, Project Management, Industrial Engineering and Decision Making Systems. This book highlights new developments in the wide and growing field of partial differential equations (PDE)-constrained optimization. Optimization problems where the dynamics evolve according to a system of PDEs arise in science, engineering, and economic applications and they can take the form of inverse problems, optimal control problems or optimal design problems. This book covers new theoretical, computational as well as implementation aspects for PDE-constrained optimization problems under uncertainty, in shape optimization, and in feedback control, and it illustrates the new developments on representative problems from a variety of applications. One of the main ways by which we can understand complex processes is to create computerised numerical simulation models of them. Modern simulation tools are not used only by experts, however, and reliability has therefore become an important issue, meaning that it is not sufficient for a simulation package merely to print out some numbers, claiming them to be the desired results. An estimate of the associated error is also

needed. The errors may derive from many sources: errors in the model, errors in discretization, rounding errors, etc. Unfortunately, this situation does not obtain for current packages and there is a great deal of room for improvement. Only if the error can be estimated is it possible to do something to reduce it. The contributions in this book cover many aspects of the subject, the main topics being error estimates and error control in numerical linear algebra algorithms (closely related to the concept of condition numbers), interval arithmetic and adaptivity for continuous models. The concept of Floer homology was one of the most striking developments in differential geometry. It yields rigorously defined invariants which can be viewed as homology groups of infinite-dimensional cycles. The ideas led to great advances in the areas of low-dimensional topology and symplectic geometry and are intimately related to developments in Quantum Field Theory. The first half of this book gives a thorough account of Floer's construction in the context of gauge theory over 3 and 4-dimensional manifolds. The second half works out some further technical developments of the theory, and the final chapter outlines some research developments for the future - including a discussion of the appearance of modular forms in the theory. The scope of the material in this book means that it will appeal to graduate students as well as those on the frontiers of the subject. This book collects papers presented at the International Conference on Mathematical Modelling and Computational Intelligence Techniques (ICMMCIT) 2021, held at the Department of Mathematics, The Gandhigram Rural Institute (Deemed to be University), Gandhigram, Tamil Nadu, India, from 10–12 February 2021. Significant contributions from renowned researchers from fields of applied analysis, mathematical modelling and computing techniques have been received for this conference. Chapters emphasize on the research of computational nature focusing on new algorithms, their analysis and numerical results, as well as applications in physical, biological, social, and behavioural sciences. The accepted papers are organized in topical sections as mathematical modelling, image processing, control theory, graphs and networks, and inventory control. This text presents a comprehensive mathematical theory for elliptic, parabolic, and hyperbolic differential equations. It compares finite element and finite difference methods and illustrates applications of generalized difference methods to elastic bodies, electromagnetic fields, underground water pollution, and coupled sound-heat flows. A balanced guide to the essential techniques for solving elliptic partial differential equations Numerical Analysis of Partial Differential Equations provides a comprehensive, self-contained treatment of the quantitative methods used to solve elliptic partial differential equations (PDEs), with a focus on the efficiency as well as the error of the presented methods. The author utilizes coverage of theoretical PDEs, along with the nu merical solution of linear systems and various examples and exercises, to supply readers with an introduction to the essential concepts in the numerical analysis of PDEs. The book presents the three main discretization methods of elliptic PDEs: finite difference, finite elements, and spectral methods. Each topic has its own devoted chapters and is discussed alongside additional key topics, including: The mathematical theory of elliptic PDEs Numerical linear algebra Time-dependent PDEs Multigrid and domain decomposition PDEs posed on infinite domains The book concludes with a discussion of the methods for nonlinear problems, such as Newton's method, and addresses the importance of hands-on work to facilitate learning. Each chapter concludes with a set of exercises, including theoretical and programming problems, that allows readers to test their understanding of the presented theories and techniques. In addition, the book discusses important nonlinear problems in many fields of science and engineering, providing information as to how they can serve as computing projects across various disciplines. Requiring only a preliminary understanding of analysis, Numerical Analysis of Partial Differential Equations is suitable for courses on numerical PDEs at the upper-undergraduate and graduate levels. The book is also appropriate for students majoring in the mathematical sciences and engineering. As in previous editions, the focus in INTERMEDIATE ALGEBRA remains on the Aufmann Interactive Method (AIM). Students are encouraged to be active participants in the classroom and in their own studies as they work through the How To examples and the paired Examples and You Try It problems. Student engagement is crucial to success. Presenting students with worked examples, and then providing them with the opportunity to immediately solve

similar problems, helps them build their confidence and eventually master the concepts. Simplicity is key in the organization of this edition, as in all other editions. All lessons, exercise sets, tests, and supplements are organized around a carefully constructed hierarchy of objectives. Each exercise mirrors a preceding objective, which helps to reinforce key concepts and promote skill building. This clear, objective-based approach allows students to organize their thoughts around the content, and supports instructors as they work to design syllabi, lesson plans, and other administrative documents. New features like Focus on Success, Apply the Concept, and Concept Check add an increased emphasis on study skills and conceptual understanding to strengthen the foundation of student success. The Ninth Edition also features a new design, enhancing the Aufmann Interactive Method and making the pages easier for both students and instructors to follow. Available with InfoTrac Student Collections http://gocengage.com/infotrac. Important Notice: Media content referenced within the product description or the product text may not be available in the ebook version. This corrected third printing retains the authors'main emphasis on ordinary differential equations. It is most appropriate for upper level undergraduate and graduate students in the fields of mathematics, engineering, and applied mathematics, as well as the life sciences, physics and economics. The authors have taken the view that a differential equations theory defines functions; the object of the theory is to understand the behaviour of these functions. The tools the authors use include qualitative and numerical methods besides the traditional analytic methods, and the companion software, MacMath, is designed to bring these notions to life. the conference participants. We also thank M. Koleva for the help in putting together the book. Numerical Methods for Partial Differential Equations: An Introduction Vitoriano Ruas, Sorbonne Universités, UPMC - Université Paris 6, France A comprehensive overview of techniques for the computational solution of PDE's Numerical Methods for Partial Differential Equations: An Introduction covers the three most popular methods for solving partial differential equations: the finite difference method, the finite element method and the finite volume method. The book combines clear descriptions of the three methods, their reliability, and practical implementation aspects. Justifications for why numerical methods for the main classes of PDE's work or not, or how well they work, are supplied and exemplified. Aimed primarily at students of Engineering, Mathematics, Computer Science, Physics and Chemistry among others this book offers a substantial insight into the principles numerical methods in this class of problems are based upon. The book can also be used as a reference for research work on numerical methods for PDE’s. Key features: A balanced emphasis is given to both practical considerations and a rigorous mathematical treatment The reliability analyses for the three methods are carried out in a unified framework and in a structured and visible manner, for the basic types of PDE's Special attention is given to low order methods, as practitioner's overwhelming default options for everyday use New techniques are employed to derive known results, thereby simplifying their proof Supplementary material is available from a companion website. The volume will consist of about 40 articles written by some very influential mathematicians of our time and will expose the latest achievements in the broad area of nonlinear analysis and its various interdisciplinary applications. This volume is the Proceedings of the Workshop on Analytical and Computational Methods for Convection-Dominated and Singularly Perturbed Problems, which took place in Lozenetz, Bulgaria, 27-31 August 1998. The workshop attracted about 50 participants from 12 countries. The volume includes 13 invited lectures and 19 contributed papers presented at the workshop and thus gives an overview of the latest developments in both the theory and applications of advanced numerical methods to problems having boundary and interior layers. There was an emphasis on experiences from the numerical analysis of such problems and on theoretical developments. The aim of the workshop was to provide an opportunity for scientists from the East and the West, who develop robust methods for singularly perturbed and related problems and also who apply these methods to real-life problems, to discuss recent achievements in this area and to exchange ideas with a view of possible research co-operation. The description of many interesting phenomena in science and engineering leads to infinite-dimensional minimization or evolution problems that define nonlinear partial differential equations. While the development and analysis of numerical methods for linear

partial differential equations is nearly complete, only few results are available in the case of nonlinear equations. This monograph devises numerical methods for nonlinear model problems arising in the mathematical description of phase transitions, large bending problems, image processing, and inelastic material behavior. For each of these problems the underlying mathematical model is discussed, the essential analytical properties are explained, and the proposed numerical method is rigorously analyzed. The practicality of the algorithms is illustrated by means of short implementations. This volume contains the texts of the four series of lectures presented by B.Cockburn, C.Johnson, C.W. Shu and E.Tadmor at a C.I.M.E. Summer School. It is aimed at providing a comprehensive and up-to-date presentation of numerical methods which are nowadays used to solve nonlinear partial differential equations of hyperbolic type, developing shock discontinuities. The most effective methodologies in the framework of finite elements, finite differences, finite volumes spectral methods and kinetic methods, are addressed, in particular high-order shock capturing techniques, discontinuous Galerkin methods, adaptive techniques based upon a-posteriori error analysis. This book examines incentives at work to see how and how well coordination is achieved by motivating individual decision makers. Technology is becoming more and more integrated in mathematics teaching and the use of technology is explicitly demanded by the curricula. Technology can be for example integrated while conceptualizing parameters of quadratic functions. In this thesis three technical visualizations (classic function plotter, drag mode, and sliders) for the manipulation of parameters of quadratic functions shall be compared with an access without the possibility of technical visualization. For this purpose, a Guided Discovery environment was developed, which was conducted in an intervention study with 14 classes of grade 9 (N=383). Different strengths and weaknesses of the individual visualizations in favor of the dynamic visualizations by drag mode and slider are shown. Also, different potentials and constraints of the use of technology are visible, for example the students use the technology to test their own hypotheses that were generated through the use of technology. The author Lisa Göbel completed her dissertation as a research assistant under Prof. Dr. Bärbel Barzel in the Mathematics Education department at the University of Duisburg-Essen. Her interests include functional thinking and the use of technology in mathematics teaching. This book offers a comprehensive presentation of some of the most successful and popular domain decomposition preconditioners for finite and spectral element approximations of partial differential equations. It places strong emphasis on both algorithmic and mathematical aspects. It covers in detail important methods such as FETI and balancing Neumann-Neumann methods and algorithms for spectral element methods. xxx Rediscovering Mathematics is aimed at a general audience and addresses the question of how best to teach and study mathematics. The book attempts to bring the exciting and dynamic world of mathematics to a non-technical audience. With so much focus today on how best to educate the new generation and make mathematics less rote and more interactive, this book is an eye-opening experience for many people who suffered with dull math teachers and curricula. Rediscovering Mathematics is an eclectic collection of mathematical topics and puzzles aimed at talented youngsters and inquisitive adults who want to expand their view of mathematics. By focusing on problem solving, and discouraging rote memorization, the book shows how to learn and teach mathematics through investigation, experimentation, and discovery. Rediscovering Mathematics is also an excellent text for training math teachers at all levels. Topics range in difficulty and cover a wide range of historical periods, with some examples demonstrating how to uncover mathematics in everyday life, including: number theory and its application to secure communication over the Internet, the algebraic and combinatorial work of a medieval mathematician Rabbi, and applications of probability to sports, casinos, and gambling. Rediscovering Mathematics provides a fresh view of mathematics for those who already like the subject, and offers a second chance for those who think they don't. This three-volume set LNAI 8724, 8725 and 8726 constitutes the refereed proceedings of the European Conference on Machine Learning and Knowledge Discovery in Databases: ECML PKDD 2014, held in Nancy, France, in September 2014. The 115 revised research papers presented together with 13 demo track papers, 10 nectar track papers, 8 PhD track papers, and 9 invited talks were carefully reviewed and selected from 550

submissions. The papers cover the latest high-quality interdisciplinary research results in all areas related to machine learning and knowledge discovery in databases. The book presents an overview of the state of research of advanced finite element technologies. Besides the mathematical analysis, the finite element development and their engineering applications are shown to the reader. The authors give a survey of the methods and technologies concerning efficiency, robustness and performance aspects. The book covers the topics of mathematical foundations for variational approaches and the mathematical understanding of the analytical requirements of modern finite element methods. Special attention is paid to finite deformations, adaptive strategies, incompressible, isotropic or anisotropic material behavior and the mathematical and numerical treatment of the well-known locking phenomenon. Beyond that new results for the introduced approaches are presented especially for challenging nonlinear problems. Over the past two decades, the theoretical interests of mathematics educators have changed substantially—as any brief look at the titles and abstracts of articles shows. Largely through the work of Paul Cobb and his various collaborators, mathematics educators came to be attuned to the intricate relationship between individual and the social configuration of which she or he is part. That is, this body of work, running alongside more traditional constructivist and psychological approaches, showed that what happens at the collective level in a classroom both constrains and affords opportunities for what individuals do (their practices). Increasingly, researchers focused on the mediational role of sociomathematical norms and how these emerged from the enacted lessons. A second major shift in mathematical theorizing occurred during the past decade: there is an increasing focus on the embodied and bodily manifestation of mathematical knowing (e.g., Lakoff & Núñez, 2000). Mathematics educators now working from this perspective have come to their position from quite different bodies of literatures: for some, linguistic concerns and mathematics as material praxis lay at the origin for their concerns; others came to their position through the literature on the situated nature of cognition; and yet another line of thinking emerged from the work on embodiment that Humberto Maturana and Francisco Varela advanced. Whatever the historical origins of their thinking, mathematics educators taking an embodiment perspective presuppose that it is of little use to think of mathematical knowing in terms of transcendental concepts somehow recorded in the brain, but rather, that we need to conceptual knowing as mediated by the human body, which, because of its senses, is at the origin of sense. One of the question seldom asked is how the two perspectives, one that focuses on the bodily, embodied nature of mathematical cognition and the other that focuses on its social nature, can be thought together. This edited volume situates itself at the intersection of theoretical and focal concerns of both of these lines of work. In all chapters, the current culture both at the classroom and at the societal level comes to be expressed and provides opportunities for expressing oneself in particular ways; and these expressions always are bodily expressions of body-minds. As a collective, the chapters focus on mathematical knowledge as an aspect or attribute of mathematical performance; that is, mathematical knowing is in the doing rather than attributable to some mental substrate structured in particular ways as conceived by conceptual change theorists or traditional cognitive psychologists. The collection as a whole shows readers important aspects of mathematical cognition that are produced and observable at the interface between the body (both human and those of [inherently material] inscriptions) and culture. Drawing on cultural-historical activity theory, the editor develops an integrative perspective that serves as a background to a narrative that runs through and pulls together the book into an integrated whole. This book is a tutorial written by researchers and developers behind the FEniCS Project and explores an advanced, expressive approach to the development of mathematical software. The presentation spans mathematical background, software design and the use of FEniCS in applications. Theoretical aspects are complemented with computer code which is available as free/open source software. The book begins with a special introductory tutorial for beginners. Following are chapters in Part I addressing fundamental aspects of the approach to automating the creation of finite element solvers. Chapters in Part II address the design and implementation of the FEnicS software. Chapters in Part III present the application of FEniCS to a wide range of applications, including fluid flow, solid mechanics, electromagnetics and geophysics.

This book elucidates how Finite Element methods look like from the perspective of Green's functions, and shows new insights into the mathematical theory of Finite Elements. Practically, this new view on Finite Elements enables the reader to better assess solutions of standard programs and to find better model of a given problem. The book systematically introduces the basic concepts how Finite Elements fulfill the strategy of Green's functions and how approximating of Green's functions. It discusses in detail the discretization error and shows that are coherent with the strategy of "goal oriented refinement". The book also gives much attention to the dependencies of FE solutions from the parameter set of the model. This book provides a solid introduction to the foundation and the application of the finite element method in structural analysis. It offers new theoretical insight and practical advice. This second edition contains additional sections on sensitivity analysis, on retrofitting structures, on the Generalized FEM (X-FEM) and on model adaptivity. An additional chapter treats the boundary element method, and related software is available at www.winfem.de. This book presents a systematic exposition of the main ideas and methods in treating inverse problems for PDEs arising in basic mathematical models, though it makes no claim to being exhaustive. Mathematical models of most physical phenomena are governed by initial and boundary value problems for PDEs, and inverse problems governed by these equations arise naturally in nearly all branches of science and engineering. The book's content, especially in the Introduction and Part I, is self-contained and is intended to also be accessible for beginning graduate students, whose mathematical background includes only basic courses in advanced calculus, PDEs and functional analysis. Further, the book can be used as the backbone for a lecture course on inverse and ill-posed problems for partial differential equations. In turn, the second part of the book consists of six nearly-independent chapters. The choice of these chapters was motivated by the fact that the inverse coefficient and source problems considered here are based on the basic and commonly used mathematical models governed by PDEs. These chapters describe not only these inverse problems, but also main inversion methods and techniques. Since the most distinctive features of any inverse problems related to PDEs are hidden in the properties of the corresponding solutions to direct problems, special attention is paid to the investigation of these properties. This richly illustrated book introduces the subject of optimization to a broad audience with a balanced treatment of theory, models and algorithms. Through numerous examples from statistical learning, operations research, engineering, finance and economics, the text explains how to formulate and justify models while accounting for real-world considerations such as data uncertainty. It goes beyond the classical topics of linear, nonlinear and convex programming and deals with nonconvex and nonsmooth problems as well as games, generalized equations and stochastic optimization. The book teaches theoretical aspects in the context of concrete problems, which makes it an accessible onramp to variational analysis, integral functions and approximation theory. More than 100 exercises and 200 fully developed examples illustrate the application of the concepts. Readers should have some foundation in differential calculus and linear algebra. Exposure to real analysis would be helpful but is not prerequisite. The papers in this volume were selected for presentation at the 19th International Meshing Roundtable (IMR), held October 3–6, 2010 in Chattanooga, Tennessee, USA. The conference was started by Sandia National Laboratories in 1992 as a small meeting of organizations striving to establish a common focus for research and development in the field of mesh generation. Now after 19 consecutive years, the International Meshing Roundtable has become recognized as an international focal point annually attended by researchers and developers from dozens of co- tries around the world. The 19th International Meshing Roundtable consists of technical presentations from contributed papers, research notes, keynote and invited talks, short course presentations, and a poster session and competition. The Program Committee would like to express its appreciation to all who participate to make the IMR a successful and enriching experience. The papers in these proceedings were selected by the Program Committee from among numerous submissions. Based on input from peer reviews, the committee selected these papers for their perceived quality, originality, and appropriateness to the theme of the International Meshing Roundtable. We would like to thank all who submitted papers. We would also like to thank the colleagues who provided reviews of the submitted papers. The names of

the reviewers are acknowledged in the following pages. We extend special thanks to Jacqueline Hunter for her time and effort to make the 19th IMR another outstanding conference. Assumptions about how people form expectations for the future shape the properties of any dynamic economic model. To make economic decisions in an uncertain environment people must forecast such variables as future rates of inflation, tax rates, governme. This book is a collection of lecture notes for the LIASFMA Shanghai Summer School on 'One-dimensional Hyperbolic Conservation Laws and Their Applications' which was held during August 16 to August 27, 2015 at Shanghai Jiao Tong University, Shanghai, China. This summer school is one of the activities promoted by Sino-French International Associate Laboratory in Applied Mathematics (LIASFMA in short). LIASFMA was established jointly by eight institutions in China and France in 2014, which is aimed at providing a platform for some of the leading French and Chinese mathematicians to conduct in-depth researches, extensive exchanges, and student training in the field of applied mathematics. This summer school has the privilege of being the first summer school of the newly established LIASFMA, which makes it significant. The purpose of this book is to introduce and study numerical methods basic and advanced ones for scientific computing. This last refers to the implementation of appropriate approaches to the treatment of a scientific problem arising from physics (meteorology, pollution, etc.) or of engineering (mechanics of structures, mechanics of fluids, treatment signal, etc.). Each chapter of this book recalls the essence of the different methods resolution and presents several applications in the field of engineering as well as programs developed under Matlab software. This book introduces readers to one of the first methods developed for the numerical treatment of boundary value problems on polygonal and polyhedral meshes, which it subsequently analyzes and applies in various scenarios. The BEM-based finite element approaches employs implicitly defined trial functions, which are treated locally by means of boundary integral equations. A detailed construction of high-order approximation spaces is discussed and applied to uniform, adaptive and anisotropic polytopal meshes. The main benefits of these general discretizations are the flexible handling they offer for meshes, and their natural incorporation of hanging nodes. This can especially be seen in adaptive finite element strategies and when anisotropic meshes are used. Moreover, this approach allows for problem-adapted approximation spaces as presented for convection-dominated diffusion equations. All theoretical results and considerations discussed in the book are verified and illustrated by several numerical examples and experiments. Given its scope, the book will be of interest to mathematicians in the field of boundary value problems, engineers with a (mathematical) background in finite element methods, and advanced graduate students. Computing application to materials science is one of the fastest-growing research areas. This book introduces the concepts and methodologies related to the modeling of the complex phenomena occurring in materials processing. It is intended for undergraduate and graduate students in materials science and engineering, mechanical engineering and physics, and for engineering professionals or researchers.

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