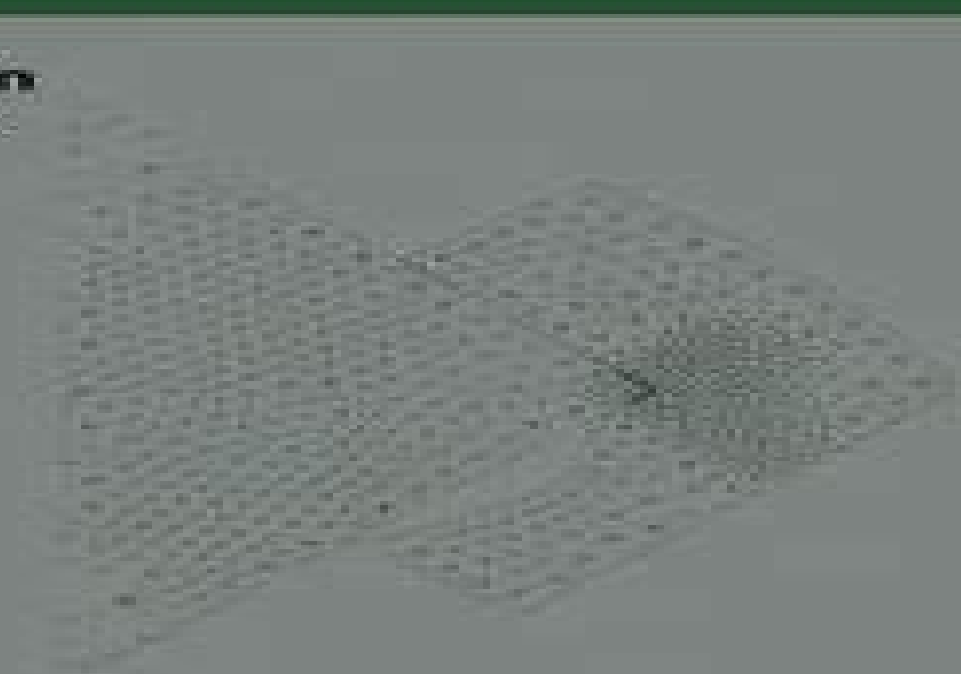


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Fast Solution of Discretized Optimization Problems

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Fast Solution Of Discretized Optimization Problems



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Ghattas, Matthias
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Fast Solution Of Discretized Optimization Problems:

Fast Solution of Discretized Optimization Problems Karl-Heinz Hoffmann, Ronald W. Hoppe, Volker Schulz, 2001-09-01 A collection of articles summarizing the state of knowledge in a large portion of modern homotopy theory This welcome reference for many new results and recent methods is addressed to all mathematicians interested in homotopy theory and in geometric aspects of group theory , **Real-Time PDE-Constrained Optimization** Lorenz T. Biegler, Omar Ghattas, Matthias Heinkenschloss, David Keyes, Bart van Bloemen Waanders, 2007-07-12 a timely contribution to a field of growing importance This carefully edited book presents a rich collection of chapters ranging from mathematical methodology to emerging applications I recommend it to students as a rigorous and comprehensive presentation of simulation based optimization and to researchers as an overview of recent advances and challenges in the field Jorge Nocedal Professor Northwestern University Many engineering and scientific problems in design control and parameter estimation can be formulated as optimization problems that are governed by partial differential equations PDEs The complexities of the PDEs and the requirement for rapid solution pose significant difficulties A particularly challenging class of PDE constrained optimization problems is characterized by the need for real time solution i e in time scales that are sufficiently rapid to support simulation based decision making Real Time PDE Constrained Optimization the first book devoted to real time optimization for systems governed by PDEs focuses on new formulations methods and algorithms needed to facilitate real time PDE constrained optimization In addition to presenting state of the art algorithms and formulations the text illustrates these algorithms with a diverse set of applications that includes problems in the areas of aerodynamics biology fluid dynamics medicine chemical processes homeland security and structural dynamics Despite difficulties there is a pressing need to capitalize on continuing advances in computing power to develop optimization methods that will replace simple rule based decision making with optimized decisions based on complex PDE simulations Audience The book is aimed at readers who have expertise in simulation and are interested in incorporating optimization into their simulations who have expertise in numerical optimization and are interested in adapting optimization methods to the class of infinite dimensional simulation problems or who have worked in offline optimization contexts and are interested in moving to online optimization Contents Preface Part I Concepts and Properties of Real Time Online Strategies Chapter 1 Constrained Optimal Feedback Control of Systems Governed by Large Differential Algebraic Equations Chapter 2 A Stabilizing Real Time Implementation of Nonlinear Model Predictive Control Chapter 3 Numerical Feedback Controller Design for PDE Systems Using Model Reduction Techniques and Case Studies Chapter 4 Least Squares Finite Element Method for Optimization and Control Problems Part II Fast PDE Constrained Optimization Solvers Chapter 5 Space Time Multigrid Methods for Solving Unsteady Optimal Control Problems Chapter 6 A Time Parallel Implicit Methodology for the Near Real Time Solution of Systems of Linear Oscillators Chapter 7 Generalized SQP Methods with Parareal Time Domain Decomposition for Time Dependent PDE Constrained

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Kunisch, 2008-01-01 Lagrange multiplier theory provides a tool for the analysis of a general class of nonlinear variational problems and is the basis for developing efficient and powerful iterative methods for solving these problems This comprehensive monograph analyzes Lagrange multiplier theory and shows its impact on the development of numerical algorithms for problems posed in a function space setting The authors develop and analyze efficient algorithms for constrained optimization and convex optimization problems based on the augmented Lagrangian concept and cover such topics as sensitivity analysis convex optimization second order methods and shape sensitivity calculus General theory is applied to challenging problems in optimal control of partial differential equations image analysis mechanical contact and friction problems and American options for the Black Scholes model *Constrained Optimization and Optimal Control for*

Partial Differential Equations Günter Leugering, Sebastian Engell, Andreas Griewank, Michael Hinze, Rolf Rannacher, Volker Schulz, Michael Ulbrich, Stefan Ulbrich, 2012-01-03 This special volume focuses on optimization and control of processes governed by partial differential equations The contributors are mostly participants of the DFG priority program 1253

Optimization with PDE constraints which is active since 2006 The book is organized in sections which cover almost the entire spectrum of modern research in this emerging field Indeed even though the field of optimal control and optimization for PDE constrained problems has undergone a dramatic increase of interest during the last four decades a full theory for nonlinear problems is still lacking The contributions of this volume some of which have the character of survey articles therefore aim at creating and developing further new ideas for optimization control and corresponding numerical simulations of systems of possibly coupled nonlinear partial differential equations The research conducted within this unique network of groups in more than fifteen German universities focuses on novel methods of optimization control and identification for problems in infinite dimensional spaces shape and topology problems model reduction and adaptivity discretization concepts and important applications Besides the theoretical interest the most prominent question is about the effectiveness of model based numerical optimization methods for PDEs versus a black box approach that uses existing codes often heuristic based for optimization A Direct Method for Parabolic PDE Constrained Optimization Problems Andreas Potschka, 2013-11-29

Andreas Potschka discusses a direct multiple shooting method for dynamic optimization problems constrained by nonlinear possibly time periodic parabolic partial differential equations In contrast to indirect methods this approach automatically computes adjoint derivatives without requiring the user to formulate adjoint equations which can be time consuming and error prone The author describes and analyzes in detail a globalized inexact Sequential Quadratic Programming method that exploits the mathematical structures of this approach and problem class for fast numerical performance The book features applications including results for a real world chemical engineering separation problem Scalable Algorithms for Contact Problems Zdeněk Dostál, Tomáš Kozubek, Marie Sadowská, Vít Vondrák, 2023-10-28 This book presents a comprehensive treatment of recently developed scalable algorithms for solving multibody contact problems of linear elasticity The brand new feature of these algorithms is their theoretically supported numerical scalability i e asymptotically linear complexity and parallel scalability demonstrated in solving problems discretized by billions of degrees of freedom The theory covers solving multibody frictionless contact problems contact problems with possibly orthotropic Tresca s friction and transient contact problems In addition it also covers BEM discretization treating jumping coefficients floating bodies mortar non penetration conditions etc This second edition includes updated content including a new chapter on hybrid domain decomposition methods for huge contact problems Furthermore new sections describe the latest algorithm improvements e g the fast reconstruction of displacements the adaptive reorthogonalization of dual constraints and an updated chapter on parallel implementation Several chapters are extended to give an independent exposition of classical bounds on the spectrum of mass and dual stiffness matrices a benchmark for Coulomb orthotropic friction details of discretization etc The exposition is divided into four parts the first of which reviews auxiliary linear algebra optimization and analysis The most important algorithms and optimality results are presented in the third chapter The presentation includes continuous formulation discretization domain decomposition optimality results and numerical experiments The final part contains extensions to contact shape optimization plasticity and HPC implementation Graduate students and researchers in mechanical engineering computational engineering and applied mathematics will find this book of great value and interest *Online Optimization of Large Scale Systems* Martin Grötschel, Sven O. Krumke, Joerg Rambau, 2013-03-14 In its thousands of years of history mathematics has made an extraordinary career It started from rules for bookkeeping and computation of areas to become the language of science Its potential for decision support was fully recognized in the twentieth century only vitally aided by the evolution of computing and communication technology Mathematical optimization in particular has developed into a powerful machinery to help planners Whether costs are to be reduced profits to be maximized or scarce resources to be used wisely optimization methods are available to guide decision making Optimization is particularly strong if precise models of real phenomena and data of high quality are at hand often yielding reliable automated control and decision procedures But what if the models are soft and not all data are around Can mathematics help as well This book addresses such issues e g

problems of the following type An elevator cannot know all transportation requests in advance In which order should it serve the passengers Wing profiles of aircrafts influence the fuel consumption Is it possible to continuously adapt the shape of a wing during the flight under rapidly changing conditions Robots are designed to accomplish specific tasks as efficiently as possible But what if a robot navigates in an unknown environment Energy demand changes quickly and is not easily predictable over time Some types of power plants can only react slowly

Relaxation in Optimization Theory and Variational Calculus Tomáš Roubíček, 2020-11-09 The relaxation method has enjoyed an intensive development during many decades and this new edition of this comprehensive text reflects in particular the main achievements in the past 20 years Moreover many further improvements and extensions are included both in the direction of optimal control and optimal design as well as in numerics and applications in materials science along with an updated treatment of the abstract parts of the theory

Fast Solution of Discretized Optimization Problems Karl-Heinz Hoffmann, Ronald H. W. Hoppe, Volker Schulz, 2001-01-01 This book contains a collection of articles summarizing the state of knowledge in a large portion of modern homotopy theory A call for articles was made on the occasion of an emphasis semester organized by the Centre de Recerca Matemàtica in Bellaterra Barcelona in 1998 The main topics treated in the book include abstract features of stable and unstable homotopy homotopical localizations p compact groups H spaces classifying spaces for proper actions cohomology of discrete groups K theory and other generalized cohomology theories configuration spaces and Lusternik Schnirelmann category The book is addressed to all mathematicians interested in homotopy theory and in geometric aspects of group theory New research directions in topology are highlighted Moreover this informative and educational book serves as a welcome reference for many new results and recent methods

Numerical Data Fitting in Dynamical Systems Klaus Schittkowski, 2013-06-05 Real life phenomena in engineering natural or medical sciences are often described by a mathematical model with the goal to analyze numerically the behaviour of the system Advantages of mathematical models are their cheap availability the possibility of studying extreme situations that cannot be handled by experiments or of simulating real systems during the design phase before constructing a first prototype Moreover they serve to verify decisions to avoid expensive and time consuming experimental tests to analyze understand and explain the behaviour of systems or to optimize design and production As soon as a mathematical model contains differential dependencies from an additional parameter typically the time we call it a dynamical model There are two key questions always arising in a practical environment 1 Is the mathematical model correct 2 How can I quantify model parameters that cannot be measured directly In principle both questions are easily answered as soon as some experimental data are available The idea is to compare measured data with predicted model function values and to minimize the differences over the whole parameter space We have to reject a model if we are unable to find a reasonably accurate fit To summarize parameter estimation or data fitting respectively is extremely important in all practical situations where a mathematical model and corresponding experimental data are available to describe the behaviour of a

dynamical system *Free Boundary Problems* Pierluigi Colli, Claudio Verdi, Augusto Visintin, 2012-12-06 Many phenomena of interest for applications are represented by differential equations which are defined in a domain whose boundary is a priori unknown and is accordingly named a free boundary A further quantitative condition is then provided in order to exclude indeterminacy Free boundary problems thus encompass a broad spectrum which is represented in this state of the art volume by a variety of contributions of researchers in mathematics and applied fields like physics biology and material sciences Special emphasis has been reserved for mathematical modelling and for the formulation of new problems

Computational Optimization of Systems Governed by Partial Differential Equations Alfio Borzi, Volker Schulz, 2012-01-26 This book provides a bridge between continuous optimization and PDE modelling and focuses on the numerical solution of the corresponding problems Intended for graduate students in PDE constrained optimization it is also suitable as an introduction for researchers in scientific computing or optimization Control of Coupled Partial Differential Equations Karl

Kunisch, Günter Leugering, Jürgen Sprekels, Fredi Tröltzsch, 2007-08-08 The international Conference on Optimal Control of Coupled Systems of partial Differential Equations was held at the Mathematisches Forschungsinstitut Oberwolfach from April 17 to 23 2005 The applications discussed during the conference includes the optimization and control of quantum mechanical systems **Control and Estimation of Distributed Parameter Systems** Wolfgang Desch, Franz Kappel, Karl

Kunisch, 2012-12-06 Consisting of 16 refereed original contributions this volume presents a diversified collection of recent results in control of distributed parameter systems Topics addressed include optimal control in fluid mechanics numerical methods for optimal control of partial differential equations modeling and control of shells level set methods mesh adaptation for parameter estimation problems shape optimization Advanced graduate students and researchers will find the book an excellent guide to the forefront of control and estimation of distributed parameter systems Optimal Control of Partial

Differential Equations Karl-Heinz Hoffmann, Günter Leugering, Fredi Tröltzsch, 2012-12-06 The application of PDE based control theory and the corresponding numerical algorithms to industrial problems have become increasingly important in recent years This volume offers a wide spectrum of aspects of the discipline and is of interest to mathematicians and scientists working in the field **Theory and Numerics of Differential Equations** James Blowey, John P. Coleman, Alan W.

Craig, 2013-03-09 The Ninth EPSRC Numerical Analysis Summer School was held at the University of Durham UK from the 10th to the 21st of July 2000 This was the first of these schools to be held in Durham having previously been hosted initially by the University of Lancaster and latterly by the University of Leicester The purpose of the summer school was to present high quality instructional courses on topics at the forefront of numerical analysis research to postgraduate students Eminent figures in numerical analysis presented lectures and provided high quality lecture notes At the time of writing it is now more than two years since we first contacted the guest speakers and during that period they have given significant portions of their time to making the summer school and this volume a success We would like to thank all six of them for the care which

they took in the preparation and delivery of their lectures The speakers were Christine Bernardi Petter Bjørstad Carsten Carstensen Peter Kloeden Ralf Kornhuber and Anders Szepessy This volume presents written contributions from five of the six speakers In all cases except one these contributions are more comprehensive versions of the lectures which were distributed to participants during the meeting Peter Kloeden's contribution is intended to be complementary to his lecture course and numerous references are given therein to sources of the lecture material

Trends in PDE Constrained Optimization Günter Leugering, Peter Benner, Sebastian Engell, Andreas Griewank, Helmut Harbrecht, Michael Hinze, Rolf Rannacher, Stefan Ulbrich, 2014-12-22 Optimization problems subject to constraints governed by partial differential equations PDEs are among the most challenging problems in the context of industrial economical and medical applications Almost the entire range of problems in this field of research was studied and further explored as part of the Deutsche Forschungsgemeinschaft DFG priority program 1253 on Optimization with Partial Differential Equations from 2006 to 2013 The investigations were motivated by the fascinating potential applications and challenging mathematical problems that arise in the field of PDE constrained optimization New analytic and algorithmic paradigms have been developed implemented and validated in the context of real world applications In this special volume contributions from more than fifteen German universities combine the results of this interdisciplinary program with a focus on applied mathematics The book is divided into five sections on Constrained Optimization Identification and Control Shape and Topology Optimization Adaptivity and Model Reduction Discretization Concepts and Analysis and Applications Peer reviewed research articles present the most recent results in the field of PDE constrained optimization and control problems Informative survey articles give an overview of topics that set sustainable trends for future research This makes this special volume interesting not only for mathematicians but also for engineers and for natural and medical scientists working on processes that can be modeled by PDEs

Modeling, Simulation, and Optimization of Integrated Circuits K. Antreich, R. Bulirsch, A. Gilg, P. Rentrop, 2012-12-06 In November 2001 the Mathematical Research Center at Oberwolfach Germany hosted the third Conference on Mathematical Models and Numerical Simulation in Electronic Industry It brought together researchers in mathematics electrical engineering and scientists working in industry The contributions to this volume try to bridge the gap between basic and applied mathematics research in electrical engineering and the needs of industry

Optimal Control of Partial Differential Equations Fredi Tröltzsch, 2024-03-21 Optimal control theory is concerned with finding control functions that minimize cost functions for systems described by differential equations The methods have found widespread applications in aeronautics mechanical engineering the life sciences and many other disciplines This book focuses on optimal control problems where the state equation is an elliptic or parabolic partial differential equation Included are topics such as the existence of optimal solutions necessary optimality conditions and adjoint equations second order sufficient conditions and main principles of selected numerical techniques It also contains a survey on the Karush Kuhn Tucker theory of nonlinear

programming in Banach spaces The exposition begins with control problems with linear equations quadratic cost functions and control constraints To make the book self contained basic facts on weak solutions of elliptic and parabolic equations are introduced Principles of functional analysis are introduced and explained as they are needed Many simple examples illustrate the theory and its hidden difficulties This start to the book makes it fairly self contained and suitable for advanced undergraduates or beginning graduate students Advanced control problems for nonlinear partial differential equations are also discussed As prerequisites results on boundedness and continuity of solutions to semilinear elliptic and parabolic equations are addressed These topics are not yet readily available in books on PDEs making the exposition also interesting for researchers Alongside the main theme of the analysis of problems of optimal control Tr ltzsch also discusses numerical techniques The exposition is confined to brief introductions into the basic ideas in order to give the reader an impression of how the theory can be realized numerically After reading this book the reader will be familiar with the main principles of the numerical analysis of PDE constrained optimization

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