

Real-Time PDE-Constrained Optimization



Edited by
Lorenz T. Biegler, Omar Ghattas,
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COMPUTATIONAL SCIENCE & ENGINEERING

Real Time Pde Constrained Optimization Computational Science And Engineering

**Thomas Carraro, Michael Geiger, Stefan
Körkel, Rolf Rannacher**



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Real-time PDE-constrained Optimization Lorenz T. Biegler, Omar Ghattas, Matthias Heinkenschloss, David Keyes, Bart van Bloemen Waanders, 2007-01-01 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 Audience 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 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

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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

Mathematical Modeling, Applied Analysis and Computational Methods Khursheed Alam, Ayub Khan, R. C. Singh, Yeliz Karaca, 2025-05-29 This volume presents a curated selection of papers presented at the International Conference on Applied and Industrial Mathematics ICAIM 2023 hosted by Sharda University in Greater Noida Uttar Pradesh India from 24-26 March 2023 It delves into diverse realms of mathematical modelling applied analyses computational methods and industrial mathematics Each chapter within this collection offers intriguing insights into tackling real world challenges through the lens of mathematical modelling and computational approaches The book traverses an array of compelling subjects from safeguarding secrets through specialized codes to optimizing solar energy utilization It illuminates how mathematics is potent in unravelling intricate problems such as understanding disease propagation or enhancing machine learning algorithms Through lucid explanations and engaging examples this volume is tailored for curious minds eager to delve into the marvels of mathematics from fresh perspectives

Multiple Shooting and Time Domain

Decomposition Methods Thomas Carraro, Michael Geiger, Stefan Körkel, Rolf Rannacher, 2015-10-26 This book offers a comprehensive collection of the most advanced numerical techniques for the efficient and effective solution of simulation and optimization problems governed by systems of time dependent differential equations The contributions present various approaches to time domain decomposition focusing on multiple shooting and parareal algorithms The range of topics covers theoretical analysis of the methods as well as their algorithmic formulation and guidelines for practical implementation Selected examples show that the discussed approaches are mandatory for the solution of challenging practical problems The practicability and efficiency of the presented methods is illustrated by several case studies from fluid dynamics data compression image processing and computational biology giving rise to possible new research topics This volume resulting from the workshop Multiple Shooting and Time Domain Decomposition Methods held in Heidelberg in May 2013 will be of great interest to applied mathematicians computer scientists and all scientists using mathematical methods Numerical

Models for Differential Problems Alfio Quarteroni, 2010-01-22 In this text we introduce the basic concepts for the numerical modelling of partial differential equations We consider the classical elliptic parabolic and hyperbolic linear equations but also the diffusion transport and Navier Stokes equations as well as equations representing conservation laws saddle point problems and optimal control problems Furthermore we provide numerous physical examples which underline such equations In particular we discuss the algorithmic and computer implementation aspects and provide a number of easy to use programs The text does not require any previous advanced mathematical knowledge of partial differential equations the absolutely essential concepts are reported in a preliminary chapter It is therefore suitable for students of bachelor and master courses in scientific disciplines and recommendable to those researchers in the academic and extra academic domain who want to approach this interesting branch of applied mathematics Simulation and Optimization in Process

Engineering Michael Bortz, Norbert Asprion, 2022-04-16 Simulation and Optimization in Process Engineering The Benefit of Mathematical Methods in Applications of the Process Industry brings together examples where the successful transfer of progress made in mathematical simulation and optimization has led to innovations in an industrial context that created substantial benefit Containing introductory accounts on scientific progress in the most relevant topics of process engineering substance properties simulation optimization optimal control and real time optimization the examples included illustrate how such scientific progress has been transferred to innovations that delivered a measurable impact covering details of the methods used and more With each chapter bringing together expertise from academia and industry this book is the first of its kind providing demonstratable insights Recent mathematical methods are transformed into industrially relevant innovations Covers recent progress in mathematical simulation and optimization in a process engineering context with chapters written by experts from both academia and industry Provides insight into challenges in industry aiming for a digitized world

German Success Stories in Industrial Mathematics Hans Georg Bock, Karl-Heinz Küfer, Peter Maass, Anja Milde, Volker

Schulz,2022-03-12 This book should illustrate the impact of collaborations between mathematics and industry It is both an initiative of and coordinated by the German Committee for Mathematical Modeling Simulation and Optimization KoMSO This publication aims at comparing the state of the art at the intersection of mathematics and industry as well as the demands for future development of science and technology in Germany and beyond Each contribution addresses the importance of mathematics in innovation by means of introducing a successful cooperation with an industrial partner in order to display the wide range of industrial sectors where the use of mathematics is the crucial factor for success but also show the variety of mathematical areas involved in these activities The success stories introduced in this volume will be supplemented by appropriate illustrations It is the goal of this publication to highlight cooperation between mathematics and industry as a two way technology and knowledge transfer providing industry with solutions and mathematics with new research topics and inspiring new methodologies

Advanced Reduced Order Methods and Applications in Computational Fluid Dynamics Gianluigi Rozza,Giovananni Stabile,Francesco Ballarin,2022-11-21 Reduced order modeling is an important growing field in computational science and engineering and this is the first book to address the subject in relation to computational fluid dynamics It focuses on complex parametrization of shapes for their optimization and includes recent developments in advanced topics such as turbulence stability of flows inverse problems optimization and flow control as well as applications This book will be of interest to researchers and graduate students in the field of reduced order modeling

Numerical Partial Differential Equations James H. Adler,Hans De Sterck,Scott MacLachlan,Luke Olsen,2025-03-26 This comprehensive textbook focuses on numerical methods for approximating solutions to partial differential equations PDEs The authors present a broad survey of these methods introducing readers to the central concepts of various families of discretizations and solution algorithms and laying the foundation needed to understand more advanced material The authors include over 100 well established definitions theorems corollaries and lemmas and summaries of and references to in depth treatments of more advanced mathematics when needed Numerical Partial Differential Equations is divided into four parts Part I covers basic background on PDEs and numerical methods Part II introduces the three main classes of numerical methods for PDEs that are the book's focus finite difference finite element and finite volume methods Part III discusses linear solvers and finite element and finite volume methods at a more advanced level Part IV presents further high level topics on discretizations and solvers This book is intended for advanced undergraduate first year graduate and advanced graduate students in applied math as well as students in science and engineering disciplines The book will also appeal to researchers in the field of scientific computing Chapters are designed to be stand alone allowing distinct paths through the text making it appropriate for both single semester and multi semester courses It is appropriate for courses covering topics ranging from numerical methods for PDEs to numerical linear algebra

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