

Approximation of Large-Scale Dynamical Systems



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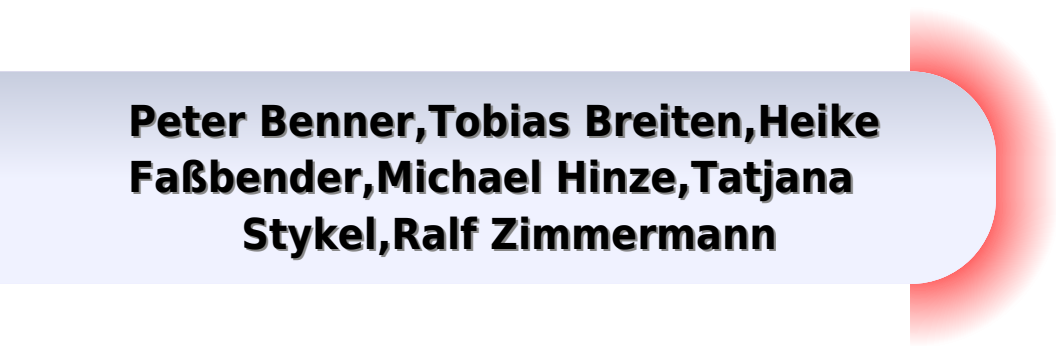


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Approximation Of Large Scale Dynamical Systems Advances In Design And Control

**Peter Benner, Tobias Breiten, Heike
Faßbender, Michael Hinze, Tatjana
Stykel, Ralf Zimmermann**



Approximation Of Large Scale Dynamical Systems Advances In Design And Control:

Approximation of Large-Scale Dynamical Systems Athanasios C. Antoulas, 2009-06-25 Mathematical models are used to simulate and sometimes control the behavior of physical and artificial processes such as the weather and very large scale integration VLSI circuits The increasing need for accuracy has led to the development of highly complex models However in the presence of limited computational accuracy and storage capabilities model reduction system approximation is often necessary Approximation of Large Scale Dynamical Systems provides a comprehensive picture of model reduction combining system theory with numerical linear algebra and computational considerations It addresses the issue of model reduction and the resulting trade offs between accuracy and complexity Special attention is given to numerical aspects simulation questions and practical applications

Efficient Modeling and Control of Large-Scale Systems Javad Mohammadpour, Karolos M. Grigoriadis, 2010-06-23 Complexity and dynamic order of controlled engineering systems is constantly increasing Complex large scale systems where large reflects the system s order and not necessarily its physical size appear in many engineering fields such as micro electromechanics manufacturing aerospace civil engineering and power engineering Modeling of these systems often result in very high order models imposing great challenges to the analysis design and control problems Efficient Modeling and Control of Large Scale Systems compiles state of the art contributions on recent analytical and computational methods for addressing model reduction performance analysis and feedback control design for such systems Also addressed at length are new theoretical developments novel computational approaches and illustrative applications to various fields along with An interdisciplinary focus emphasizing methods and approaches that can be commonly applied in various engineering fields Examinations of applications in various fields including micro electromechanical systems MEMS manufacturing processes power networks traffic control Efficient Modeling and Control of Large Scale Systems is an ideal volume for engineers and researchers working in the fields of control and dynamic systems

Dimension Reduction of Large-Scale Systems Peter Benner, Volker Mehrmann, Danny C. Sorensen, 2006-03-30 In the past decades model reduction has become an ubiquitous tool in analysis and simulation of dynamical systems control design circuit simulation structural dynamics CFD and many other disciplines dealing with complex physical models The aim of this book is to survey some of the most successful model reduction methods in tutorial style articles and to present benchmark problems from several application areas for testing and comparing existing and new algorithms As the discussed methods have often been developed in parallel in disconnected application areas the intention of the mini workshop in Oberwolfach and its proceedings is to make these ideas available to researchers and practitioners from all these different disciplines

Model Reduction of Complex Dynamical Systems Peter Benner, Tobias Breiten, Heike Faßbender, Michael Hinze, Tatjana Stykel, Ralf Zimmermann, 2021-08-26 This contributed volume presents some of the latest research related to model order reduction of complex dynamical systems with a focus on time dependent problems Chapters are written by leading

researchers and users of model order reduction techniques and are based on presentations given at the 2019 edition of the workshop series Model Reduction of Complex Dynamical Systems MODRED held at the University of Graz in Austria The topics considered can be divided into five categories system theoretic methods such as balanced truncation Hankel norm approximation and reduced basis methods data driven methods including Loewner matrix and pencil based approaches dynamic mode decomposition and kernel based methods surrogate modeling for design and optimization with special emphasis on control and data assimilation model reduction methods in applications such as control and network systems computational electromagnetics structural mechanics and fluid dynamics and model order reduction software packages and benchmarks This volume will be an ideal resource for graduate students and researchers in all areas of model reduction as well as those working in applied mathematics and theoretical informatics

Proceedings of International Joint Conference on Advances in Computational Intelligence Mohammad Shorif Uddin, Jagdish Chand Bansal, 2021-05-17 This book gathers outstanding research papers presented at the International Joint Conference on Advances in Computational Intelligence IJCACI 2020 organized by Daffodil International University DIU and Jahangirnagar University JU in Bangladesh and South Asian University SAU in India These proceedings present novel contributions in the areas of computational intelligence and offer valuable reference material for advanced research The topics covered include collective intelligence soft computing optimization cloud computing machine learning intelligent software robotics data science data security big data analytics and signal and natural language processing

Computational Methods for Approximation of Large-Scale Dynamical Systems Mohammad Monir Uddin, 2019-04-30 These days computer based simulation is considered the quintessential approach to exploring new ideas in the different disciplines of science engineering and technology SET To perform simulations a physical system needs to be modeled using mathematics these models are often represented by linear time invariant LTI continuous time CT systems Oftentimes these systems are subject to additional algebraic constraints leading to first or second order differential algebraic equations DAEs otherwise known as descriptor systems Such large scale systems generally lead to massive memory requirements and enormous computational complexity thus restricting frequent simulations which are required by many applications To resolve these complexities the higher dimensional system may be approximated by a substantially lower dimensional one through model order reduction MOR techniques

Computational Methods for Approximation of Large Scale Dynamical Systems discusses computational techniques for the MOR of large scale sparse LTI CT systems Although the book puts emphasis on the MOR of descriptor systems it begins by showing and comparing the various MOR techniques for standard systems The book also discusses the low rank alternating direction implicit LR ADI iteration and the issues related to solving the Lyapunov equation of large scale sparse LTI systems to compute the low rank Gramian factors which are important components for implementing the Gramian based MOR Although this book is primarily aimed at post graduate students and researchers of the various SET disciplines the basic

contents of this book can be supplemental to the advanced bachelor s level students as well It can also serve as an invaluable reference to researchers working in academics and industries alike Features Provides an up to date step by step guide for its readers Each chapter develops theories and provides necessary algorithms worked examples numerical experiments and related exercises With the combination of this book and its supplementary materials the reader gains a sound understanding of the topic The MATLAB codes for some selected algorithms are provided in the book The solutions to the exercise problems experiment data sets and a digital copy of the software are provided on the book s website The numerical experiments use real world data sets obtained from industries and research institutes

Applied Dynamic Programming for Optimization of Dynamical Systems Rush D. Robinett III, David G. Wilson, G. Richard Eisler, John E. Hurtado, 2005-01-01 Based on the results of over 10 years of research and development by the authors this book presents a broad cross section of dynamic programming DP techniques applied to the optimization of dynamical systems The main goal of the research effort was to develop a robust path planning trajectory optimization tool that did not require an initial guess The goal was partially met with a combination of DP and homotopy algorithms DP algorithms are presented here with a theoretical development and their successful application to variety of practical engineering problems is emphasized

Realization and Model Reduction of Dynamical Systems Christopher Beattie, Peter Benner, Mark Embree, Serkan Gugercin, Sanda Lefteriu, 2022-06-09 This book celebrates Professor Thanos Antoulas s 70th birthday marking his fundamental contributions to systems and control theory especially model reduction and more recently data driven modeling and system identification Model reduction is a prominent research topic with wide ranging scientific and engineering applications

Numerical Methods for Optimal Control Problems Maurizio Falcone, Roberto Ferretti, Lars Grüne, William M. McEneaney, 2019-01-26 This work presents recent mathematical methods in the area of optimal control with a particular emphasis on the computational aspects and applications Optimal control theory concerns the determination of control strategies for complex dynamical systems in order to optimize some measure of their performance Started in the 60 s under the pressure of the space race between the US and the former USSR the field now has a far wider scope and embraces a variety of areas ranging from process control to traffic flow optimization renewable resources exploitation and management of financial markets These emerging applications require more and more efficient numerical methods for their solution a very difficult task due the huge number of variables The chapters of this volume give an up to date presentation of several recent methods in this area including fast dynamic programming algorithms model predictive control and max plus techniques This book is addressed to researchers graduate students and applied scientists working in the area of control problems differential games and their applications

Hierarchical Power Systems: Optimal Operation Using Grid Flexibilities Tim Aschenbruck, Jörg Dickert, Willem Esterhuizen, Bartosz Filipecki, Sara Grundel, Christoph Helmberg, Tobias K. S. Ritschel, Philipp Sauerteig, Stefan Streif, Andreas Wasserrab, Karl Worthmann, 2023-03-18 This book explains the power grid as a hierarchy made up of the transmission

distribution and microgrid levels Interfaces among these levels are explored to show how flexibility in power demand associated with residential batteries can be communicated through the entire grid to facilitate optimal power flow computations within the transmission grid To realize this approach the authors combine semi definite optimal power flow with model order reduction at the distribution level and with a new heuristic algorithm for stable power flow at the transmission level To demonstrate its use a numerical case study based on modified IEEE 9 bus and 33 bus systems for the transmission and distribution grid respectively is included This book shows how exploiting the flexibility on the residential level improves the performance of the power flow with the transmission grid

Nonlinear Control Under Nonconstant Delays Nikolaos Bekiaris-Liberis, Miroslav Krstic, 2013-09-25 The authors have developed a methodology for control of nonlinear systems in the presence of long delays with large and rapid variation in the actuation or sensing path or in the presence of long delays affecting the internal state of a system In addition to control synthesis they introduce tools to quantify the performance and the robustness properties of the designs provided in the book The book is based on the concept of predictor feedback and infinite dimensional backstepping transformation for linear systems and the authors guide the reader from the basic ideas of the concept with constant delays only on the input all the way through to nonlinear systems with state dependent delays on the input as well as on system states Readers will find the book useful because the authors provide elegant and systematic treatments of long standing problems in delay systems such as systems with state dependent delays that arise in many applications In addition the authors give all control designs by explicit formulae making the book especially useful for engineers who have faced delay related challenges and are concerned with actual implementations and they accompany all control designs with Lyapunov based analysis for establishing stability and performance guarantees

Reduced Order Methods for Modeling and Computational Reduction Alfio Quarteroni, Gianluigi Rozza, 2014-06-05 This monograph addresses the state of the art of reduced order methods for modeling and computational reduction of complex parametrized systems governed by ordinary and or partial differential equations with a special emphasis on real time computing techniques and applications in computational mechanics bioengineering and computer graphics Several topics are covered including design optimization and control theory in real time with applications in engineering data assimilation geometry registration and parameter estimation with special attention to real time computing in biomedical engineering and computational physics real time visualization of physics based simulations in computer science the treatment of high dimensional problems in state space physical space or parameter space the interactions between different model reduction and dimensionality reduction approaches the development of general error estimation frameworks which take into account both model and discretization effects This book is primarily addressed to computational scientists interested in computational reduction techniques for large scale differential problems

Uncertainty in Mechanical Engineering Peter F. Pelz, Peter Groche, 2021-05-26 This open access book reports on methods and technologies to describe

evaluate and control uncertainty in mechanical engineering applications It brings together contributions by engineers mathematicians and legal experts offering a multidisciplinary perspective on the main issues affecting uncertainty throughout the complete system lifetime which includes process and product planning development production and usage The book is based on the proceedings of the 4th International Conference on Uncertainty in Mechanical Engineering ICUME 2021 organized by the Collaborative Research Center CRC 805 of the TU Darmstadt and held online on June 7 8 2021 All in all it offers a timely resource for researchers graduate students and practitioners in the field of mechanical engineering production engineering and engineering optimization Applied Stochastic Processes and Control for Jump-Diffusions Floyd B. Hanson, 2007-01-01 This self contained practical entry level text integrates the basic principles of applied mathematics applied probability and computational science for a clear presentation of stochastic processes and control for jump diffusions in continuous time The author covers the important problem of controlling these systems and through the use of a jump calculus construction discusses the strong role of discontinuous and nonsmooth properties versus random properties in stochastic systems *Shapes and Geometries* M. C. Delfour, J.-P. Zolesio, 2011-01-01 Presents the latest groundbreaking theoretical foundation to shape optimization in a form accessible to mathematicians scientists and engineers

Reduced-Order Modeling (ROM) for Simulation and Optimization Winfried Keiper, Anja Milde, Stefan Volkwein, 2018-04-11 This edited monograph collects research contributions and addresses the advancement of efficient numerical procedures in the area of model order reduction MOR for simulation optimization and control The topical scope includes but is not limited to new out of the box algorithmic solutions for scientific computing e g reduced basis methods for industrial problems and MOR approaches for electrochemical processes The target audience comprises research experts and practitioners in the field of simulation optimization and control but the book may also be beneficial for graduate students alike **Control Perspectives on Numerical Algorithms and Matrix Problems** Amit Bhaya, Eugenius

Kaszkurewicz, 2006-01-01 Control Perspectives on Numerical Algorithms and Matrix Problems organizes the analysis and design of iterative numerical methods from a control perspective The authors discuss a variety of applications including iterative methods for linear and nonlinear systems of equations neural networks for linear and quadratic programming problems support vector machines integration and shooting methods for ordinary differential equations matrix preconditioning matrix stability and polynomial zero finding This book opens up a new field of interdisciplinary research that should lead to insights in the areas of both control and numerical analysis and shows that a wide range of applications can be approached from and benefit from a control perspective Boundary Control of PDEs Miroslav Krstic, Andrey Smyshlyaev, 2008-09-25 A clear and concise introduction to backstepping an elegant new approach to boundary control of partial differential equations PDEs *Lagrange Multiplier Approach to Variational Problems and Applications* Kazufumi Ito, Karl 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

Scientific Computing in Electrical Engineering
Andreas Bartel,Markus Clemens,Michael Günther,E. Jan W. ter Maten,2016-05-09 This book is a collection of selected papers presented at the 10th International Conference on Scientific Computing in Electrical Engineering SCEE held in Wuppertal Germany in 2014 The book is divided into five parts reflecting the main directions of SCEE 2014 1 Device Modeling Electric Circuits and Simulation 2 Computational Electromagnetics 3 Coupled Problems 4 Model Order Reduction and 5 Uncertainty Quantification Each part starts with a general introduction followed by the actual papers The aim of the SCEE 2014 conference was to bring together scientists from academia and industry mathematicians electrical engineers computer scientists and physicists with the goal of fostering intensive discussions on industrially relevant mathematical problems with an emphasis on the modeling and numerical simulation of electronic circuits and devices electromagnetic fields and coupled problems The methodological focus was on model order reduction and uncertainty quantification this book will appeal to mathematicians and electrical engineers it offers a valuable starting point for developers of algorithms programs who want learn about recent advances in other fields as well open problems coming from industry moreover be use representatives industry with an interest new program tools mathematical methods

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