APPLIED OPTIMIZATION

William W. Hager and
Panos M. Pardalos

OPTIMAL CONTROL

Theory, Algorithms and Applications

Optimal Control Theory Algorithms And Applications

QUAN-FANG WANG

Optimal Control Theory Algorithms And Applications:

   Optimal Control William W. Hager,Panos M. Pardalos,2013-04-17 February 27 March 1 1997 the conference Optimal Control The ory Algorithms and Applications took place at the University of Florida hosted by the Center for Applied Optimization The conference brought together researchers from universities industry and government laborato ries in the United States Germany Italy France Canada and Sweden There were forty five invited talks including seven talks by students The conference was sponsored by the National Science Foundation and endorsed by the SIAM Activity Group on Control and Systems Theory the Mathe matical Programming Society the International Federation for Information Processing IFIP and the International Association for Mathematics and Computers in Simulation IMACS Since its inception in the 1940s and 1950s Optimal Control has been closely connected to industrial applications starting with aerospace The program for the Gainesville conference which reflected the rich cross disci plinary flavor of the field included aerospace applications as well as both novel and emerging applications to superconductors diffractive optics non linear optics structural analysis bioreactors corrosion detection acoustic flow process design in chemical engineering hydroelectric power plants sterilization of canned foods robotics and thermoelastic plates and shells The three days of the conference were organized around the three confer ence themes theory algorithms and applications This book is a collection of the papers presented at the Gainesville conference We would like to take this opportunity to thank the sponsors and participants of the conference the authors the referees and the publisher for making this volume possible   **Mathematical Control Theory** John B. Baillieul,J.C. Willems,2012-12-06 This volume on mathematical control theory contains high quality articles covering the broad range of this field The internationally renowned authors provide an overview of many different aspects of control theory offering a historical perspective while bringing the reader up to the very forefront of current research   *Symmetric Constrained Optimal Control* Claus Danielson,2014 This dissertation develops the theory of symmetry for constrained linear systems We use symmetry to design model predictive controllers for constrained linear systems with reduced complexity The dissertation is divided into three parts In the first part we review the relevant results from model predictive control and group theory In particular we present algorithms and data structures from computational group theory used to efficiently search groups In the second part we develop the theory of symmetry for constrained linear systems and model predictive control problems Symmetries of constrained linear systems are linear transformations that preserve the dynamics and constraints A symmetry of a model predictive control problem is a symmetry of the underlying constrained system that also preserves the cost We use a group theoretic formalism to derive properties of symmetric constrained linear systems and symmetric model predictive control problems We prove conditions under which the model predictive controller is symmetric and present a procedure for efficiently computing the symmetries of constrained linear systems and model predictive control problems Our method transforms the problem of finding generators for the symmetry group into a graph automorphism

problem These symmetries are used to design model predictive control algorithms with reduced complexity We also present two novel explicit model predictive control designs Both reduce memory requirements by discarding symmetrically redundant pieces of the control law The control law in the eliminated pieces can be reconstructed online using symmetry We show that storing the symmetries of the problem requires less memory than storing the controller pieces In the third part of this dissertation we apply our symmetry theory to the battery balancing problem We use symmetry to reduce the memory requirements for explicit model predictive controllers for seven battery balancing hardware designs proposed in the literature This application demonstrates that our symmetric controller designs can significantly reduce the memory requirements of explicit model predictive control In particular for four out of seven of the designs in our numerical study the number of pieces in the symmetric controller did not increase as the battery pack size was increased **Recent Advances in Model Predictive Control** Timm Faulwasser,Matthias A. Müller,Karl Worthmann,2021-04-17 This book focuses on distributed and economic Model Predictive Control MPC with applications in different fields MPC is one of the most successful advanced control methodologies due to the simplicity of the basic idea measure the current state predict and optimize the future behavior of the plant to determine an input signal and repeat this procedure ad infinitum and its capability to deal with constrained nonlinear multi input multi output systems While the basic idea is simple the rigorous analysis of the MPC closed loop can be quite involved Here distributed means that either the computation is distributed to meet real time requirements for very large scale systems or that distributed agents act autonomously while being coupled via the constraints and or the control objective In the latter case communication is necessary to maintain feasibility or to recover system wide optimal performance The term economic refers to general control tasks and thus goes beyond the typically predominant control objective of set point stabilization Here recently developed concepts like strict dissipativity of optimal control problems or turnpike properties play a crucial role The book collects research and survey articles on recent ideas and it provides perspectives on current trends in nonlinear model predictive control Indeed the book is the outcome of a series of six workshops funded by the German Research Foundation DFG involving early stage career scientists from different countries and from leading European industry stakeholders **Optimal Control of Dynamic Systems Driven by Vector Measures** N. U. Ahmed,Shian Wang,2021-09-13 This book is devoted to the development of optimal control theory for finite dimensional systems governed by deterministic and stochastic differential equations driven by vector measures The book deals with a broad class of controls including regular controls vector valued measurable functions relaxed controls measure valued functions and controls determined by vector measures where both fully and partially observed control problems are considered In the past few decades there have been remarkable advances in the field of systems and control theory thanks to the unprecedented interaction between mathematics and the physical and engineering sciences Recently optimal control theory for dynamic systems driven by vector measures has attracted increasing interest This book presents this theory for

dynamic systems governed by both ordinary and stochastic differential equations including extensive results on the existence of optimal controls and necessary conditions for optimality Computational algorithms are developed based on the optimality conditions with numerical results presented to demonstrate the applicability of the theoretical results developed in the book This book will be of interest to researchers in optimal control or applied functional analysis interested in applications of vector measures to control theory stochastic systems driven by vector measures and related topics In particular this self contained account can be a starting point for further advances in the theory and applications of dynamic systems driven and controlled by vector measures **Optimization And Optimal Control** Panos M Pardalos,Ider Tsevendorj,Rentsen Enkhbat,2003-09-25 This volume gives the latest advances in optimization and optimal control which are the main part of applied mathematics It covers various topics of optimization optimal control and operations research Nonsmooth Optimization: Analysis And Algorithms With Applications To Optimal Control Marko M Makela,Pekka Neittaanmaki,1992-05-07 This book is a self contained elementary study for nonsmooth analysis and optimization and their use in solution of nonsmooth optimal control problems The first part of the book is concerned with nonsmooth differential calculus containing necessary tools for nonsmooth optimization The second part is devoted to the methods of nonsmooth optimization and their development A proximal bundle method for nonsmooth nonconvex optimization subject to nonsmooth constraints is constructed In the last part nonsmooth optimization is applied to problems arising from optimal control of systems covered by partial differential equations Several practical problems like process control and optimal shape design problems are considered *PRACTICAL APPLICATION O OPTIMAL CONTROL THEORY* QUAN-FANG WANG,2011-11-11 **Optimal Control of Nonlinear Parabolic Systems** Pekka Neittaanmaki,D. Tiba,1994-02-08 This book discusses theoretical approaches to the study of optimal control problems governed by non linear evolutions including semi linear equations variational inequalities and systems with phase transitions It also provides algorithms for solving non linear parabolic systems and multiphase Stefan like systems SIAM Journal on Control and Optimization Society for Industrial and Applied Mathematics,2000 **Optimization and Optimal Control** Altannar Chinchuluun,Panos M. Pardalos,Rentsen Enkhbat,Ider Tseveendorj,2010-08-05 Optimization and optimal control are the main tools in decision making Because of their numerous applications in various disciplines research in these areas is accelerating at a rapid pace Optimization and Optimal Control Theory and Applications brings together the latest developments in these areas of research as well as presents applications of these results to a wide range of real world problems This volume can serve as a useful resource for researchers practitioners and advanced graduate students of mathematics and engineering working in research areas where results in optimization and optimal control can be applied Splitting Algorithms, Modern Operator Theory, and Applications Heinz H. Bauschke,Regina S. Burachik,D. Russell Luke,2019-11-06 This book brings together research articles and state of the art surveys in broad areas of optimization and numerical analysis with particular emphasis on algorithms The

discussion also focuses on advances in monotone operator theory and other topics from variational analysis and nonsmooth optimization especially as they pertain to algorithms and concrete implementable methods The theory of monotone operators is a central framework for understanding and analyzing splitting algorithms Topics discussed in the volume were presented at the interdisciplinary workshop titled Splitting Algorithms Modern Operator Theory and Applications held in Oaxaca Mexico in September 2017 Dedicated to Jonathan M Borwein one of the most versatile mathematicians in contemporary history this compilation brings theory together with applications in novel and insightful ways   **Optimal Control Theory** Suresh P. Sethi,Gerald L. Thompson,2000-07-31 Optimal control methods are used to determine optimal ways to control a dynamic system The theoretical work in this field serves as a foundation for the book which the authors have applied to business management problems developed from their research and classroom instruction Sethi and Thompson have provided management science and economics communities with a thoroughly revised edition of their classic text on Optimal Control Theory The new edition has been completely refined with careful attention to the text and graphic material presentation Chapters cover a range of topics including finance production and inventory problems marketing problems machine maintenance and replacement problems of optimal consumption of natural resources and applications of control theory to economics The book contains new results that were not available when the first edition was published as well as an expansion of the material on stochastic optimal control theory   *Nonlinear Model Predictive Control* Lars Grüne,Jürgen Pannek,2011-04-11 Nonlinear Model Predictive Control is a thorough and rigorous introduction to nonlinear model predictive control NMPC for discrete time and sampled data systems NMPC is interpreted as an approximation of infinite horizon optimal control so that important properties like closed loop stability inverse optimality and suboptimality can be derived in a uniform manner These results are complemented by discussions of feasibility and robustness NMPC schemes with and without stabilizing terminal constraints are detailed and intuitive examples illustrate the performance of different NMPC variants An introduction to nonlinear optimal control algorithms gives insight into how the nonlinear optimisation routine the core of any NMPC controller works An appendix covering NMPC software and accompanying software in MATLAB and C downloadable from www springer com ISBN enables readers to perform computer experiments exploring the possibilities and limitations of NMPC   *Optimal Control of Distributed Systems* A. V. Fursikov,2000 This volume presents the analysis of optimal control problems for systems described by partial differential equations The book offers simple and clear exposition of main results in this area The methods proposed by the author cover cases where the controlled system corresponds to well posed or ill posed boundary value problems which can be linear or nonlinear The uniqueness problem for the solution of nonlinear optimal control problems is analysed in various settings Solutions of several previously unsolved problems are given In addition general methods are applied to the study of two problems connected with optimal control of fluid flows described by the Navier Stokes equations   **Nonsmooth Optimization** Marko M. Mäkelä,1990   <u>Reinforcement</u>

<u>Learning and Optimal Control</u> Dimitri Bertsekas,2019-07-01 This book considers large and challenging multistage decision problems which can be solved in principle by dynamic programming DP but their exact solution is computationally intractable We discuss solution methods that rely on approximations to produce suboptimal policies with adequate performance These methods are collectively known by several essentially equivalent names reinforcement learning approximate dynamic programming neuro dynamic programming They have been at the forefront of research for the last 25 years and they underlie among others the recent impressive successes of self learning in the context of games such as chess and Go Our subject has benefited greatly from the interplay of ideas from optimal control and from artificial intelligence as it relates to reinforcement learning and simulation based neural network methods One of the aims of the book is to explore the common boundary between these two fields and to form a bridge that is accessible by workers with background in either field Another aim is to organize coherently the broad mosaic of methods that have proved successful in practice while having a solid theoretical and or logical foundation This may help researchers and practitioners to find their way through the maze of competing ideas that constitute the current state of the art This book relates to several of our other books Neuro Dynamic Programming Athena Scientific 1996 Dynamic Programming and Optimal Control 4th edition Athena Scientific 2017 Abstract Dynamic Programming 2nd edition Athena Scientific 2018 and Nonlinear Programming Athena Scientific 2016 However the mathematical style of this book is somewhat different While we provide a rigorous albeit short mathematical account of the theory of finite and infinite horizon dynamic programming and some fundamental approximation methods we rely more on intuitive explanations and less on proof based insights Moreover our mathematical requirements are quite modest calculus a minimal use of matrix vector algebra and elementary probability mathematically complicated arguments involving laws of large numbers and stochastic convergence are bypassed in favor of intuitive explanations The book illustrates the methodology with many examples and illustrations and uses a gradual expository approach which proceeds along four directions a From exact DP to approximate DP We first discuss exact DP algorithms explain why they may be difficult to implement and then use them as the basis for approximations b From finite horizon to infinite horizon problems We first discuss finite horizon exact and approximate DP methodologies which are intuitive and mathematically simple and then progress to infinite horizon problems c From deterministic to stochastic models We often discuss separately deterministic and stochastic problems since deterministic problems are simpler and offer special advantages for some of our methods d From model based to model free implementations We first discuss model based implementations and then we identify schemes that can be appropriately modified to work with a simulator The book is related and supplemented by the companion research monograph Rollout Policy Iteration and Distributed Reinforcement Learning Athena Scientific 2020 which focuses more closely on several topics related to rollout approximate policy iteration multiagent problems discrete and Bayesian optimization and distributed computation which are either discussed in less detail or not covered at all in the

present book The author s website contains class notes and a series of videolectures and slides from a 2021 course at ASU which address a selection of topics from both books **Model Predictive Control - Theory and Applications** Constantin Voloşencu,2023-07-12 The book presents some recent specialized theoretical and practical works in the field of process control based on the model predictive control MPC method It includes seven chapters that present studies on the application of MPC in various technical processes such as the atmospheric plasma spray process permanent magnet synchronous motors monitoring of the pose of a walking person monitoring of the heat treatment process of raw materials discrete event processes control of passenger vehicles and natural gas sweetening processes Chapters include examples and case studies from researchers in the field This volume provides readers with new solutions and answers to questions related to the emerging applications of MPC and their implementation **Algebraic and Geometric Methods in Nonlinear Control Theory** M. Fliess,Michiel Hazewinkel,2012-12-06 Approach your problems from the right end It isn t that they can t see the solution It is and begin with the answers Then one day that they can t see the problem perhaps you will find the final question G K Chesterton The Scandal of Father The Hermit Clad in Crane Feathers in R Brown The pointof a Pin van GuIik s The Chinese Maze Murders Growing specialization and diversification have brought a host of monographs and textbooks on increasingly specialized topics However the tree of knowledge of mathematics and related fields does not grow only by putting forth new branches It also happens quite often in fact that branches which were thought to be completely disparate are suddenly seen to be related Further the kind and level of sophistication of mathematics applied in various sciences has changed drastically in recent years measure theory is used non trivially in regional and theoretical economics algebraic geometry interacts with physics ihe Minkowsky lemma coding theory and the structure of water meet one another in packing and covering theory quantum fields crystal defects and mathematical programming profit from homotopy theory Lie algebras are relevant to filtering and prediction and electrical engineering can use Stein spaces And in addition to this there are such new emerging subdisciplines as experimental mathematics CFD completely integrable systems chaos synergetics and large scale order which are almost impossible to fit into the existing classification schemes They draw upon widely different sections of mathematics **Applications of Optimal Control Theory to Computer Controller Design** William S. Widnall,1968

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