Optimal Control An Introduction

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Optimal Control An Introduction ***2023-12-15***

ODOM SPENCE

Optimal Control Theory Springer Science & Business Media

The theory of optimal control systems has grown and flourished since the 1960's. Many texts, written on varying levels of sophistication, have been published on the subject. Yet even those purportedly designed for beginners in the field are often riddled with complex theorems, and many treatments fail to include topics that are essential to a thorough grounding in the various aspects of and approaches to optimal control. Optimal Control Systems provides a comprehensive but accessible treatment of the subject with just the right degree of mathematical rigor to be complete but practical. It provides a solid bridge between "traditional" optimization using the calculus of variations and what is called "modern" optimal control. It also treats both continuous-time and discrete-time optimal control systems, giving students a firm grasp on both methods. Among this book's most outstanding features is a summary table that accompanies each topic or problem and includes a statement of the problem with a step-by-step solution. Students will also gain valuable experience in using industry-standard MATLAB and SIMULINK software, including the Control System and Symbolic Math Toolboxes. Diverse applications across fields from power engineering to medicine make a foundation in optimal control systems an essential part of an engineer's background. This clear, streamlined presentation is ideal for a graduate level course on control systems and as a quick reference for working engineers.

Optimal Control Systems
American Mathematical Soc.

From economics and business to the biological sciences to physics and engineering, professionals successfully use the powerful mathematical tool of optimal control to make management and strategy decisions. Optimal Control Applied to Biological Models thoroughly develops the mathematical aspects of optimal control theory and provides insight into the application of this theory to biological models. Focusing on mathematical concepts, the book first examines the most basic problem for continuous time ordinary differential equations (ODEs) before discussing more complicated problems, such as variations of the initial conditions, imposed bounds on the control, multiple states and controls, linear dependence on the control, and free terminal time. In addition, the authors introduce the optimal control of discrete systems and of partial differential equations (PDEs). Featuring a user-friendly interface, the book contains fourteen interactive sections of various applications, including immunology and epidemic disease models, management decisions in harvesting, and resource allocation models. It also develops the underlying numerical methods of the applications and includes the MATLAB® codes on which the applications are based. Requiring only basic knowledge of multivariable calculus, simple ODEs, and mathematical models, this text shows how to adjust controls in biological systems in order to achieve proper outcomes. *Optimal Control Theory for Applications* Springer Upper-level undergraduate text introduces aspects of optimal control theory:

dynamic programming, Pontryagin's minimum principle, and numerical techniques for trajectory optimization. Numerous figures, tables. Solution guide available upon request. 1970 edition.

An Introduction to Optimal Control CRC Press

The introduction of control theory in quantum mechanics has created a rich, new interdisciplinary scientific field, which is producing novel insight into important theoretical questions at the heart of quantum physics. Exploring this emerging subject, Introduction to Quantum Control and Dynamics presents the mathematical concepts and fundamental physics behind the analysis and control of quantum dynamics, emphasizing the application of Lie algebra and Lie group theory. To advantage students, instructors and practitioners, and since the field is highly interdisciplinary, this book presents an introduction with all the basic notions in the same place. The field has seen a large development in parallel with the neighboring fields of quantum information, computation and communication. The author has maintained an introductory level to encourage course use. After introducing the basics of quantum mechanics, the book derives a class of models for quantum control systems from fundamental physics. It examines the controllability and observability of quantum systems and the related problem of quantum state determination and measurement. The author also uses Lie group decompositions as tools to analyze dynamics and to design control algorithms. In addition, he describes various other control methods and discusses topics in quantum information theory that include entanglement and entanglement dynamics. Changes to the New Edition: New Chapter 4: Uncontrollable Systems and Dynamical Decomposition New section on quantum control landscapes A brief discussion of the experiments that earned the 2012 Nobel Prize in Physics Corrections and revised concepts are made to improve accuracy Armed with the basics of quantum control and dynamics, readers will invariably use this interdisciplinary knowledge in their mathematics, physics and engineering work.

Optimal Control for Chemical Engineers CRC Press

This best-selling text focuses on the analysis and design of complicated dynamics systems. CHOICE called it “a high-level, concise book that could well be used as a reference by engineers, applied mathematicians, and undergraduates. The format is good, the presentation clear, the diagrams instructive, the examples and problems helpful...References and a multiple-choice examination are included.”

State Estimation and Optimal Control with Orthogonal Functions Springer Science &

Business Media
The published material represents the outgrowth of teaching analytical optimization to aerospace engineering graduate students. To make the material available to the widest audience, the prerequisites are limited to calculus and differential equations. It is also a book about the mathematical aspects of optimal control theory. It was developed in an engineering environment from material learned by the author while applying it to the solution of engineering problems. One goal of the book is to help engineering graduate students learn the fundamentals which are needed to apply the methods to engineering problems. The examples are from geometry and elementary dynamical systems so that they can be understood by all engineering students. Another goal of this text is to unify optimization by using the differential of calculus to create the Taylor series expansions needed to derive the optimality conditions of optimal control theory.

Introduction to optimal control theory

Routledge
In this book, we study theoretical and practical aspects of computing methods for mathematical modelling of nonlinear systems. A number of computing techniques are considered, such as methods of operator approximation with any given accuracy; operator interpolation techniques including a non-Lagrange interpolation; methods of system representation subject to constraints

associated with concepts of causality, memory and stationarity; methods of system representation with an accuracy that is the best within a given class of models; methods of covariance matrix estimation; methods for low-rank matrix approximations; hybrid methods based on a combination of iterative procedures and best operator approximation; and methods for information compression and filtering under condition that a filter model should satisfy restrictions associated with causality and different types of memory. As a result, the book represents a blend of new methods in general computational analysis, and specific, but also generic, techniques for study of systems theory ant its particular branches, such as optimal filtering and information compression. - Best operator approximation, - Non-Lagrange interpolation, - Generic Karhunen-Loeve transform - Generalised low-rank matrix approximation - Optimal data compression - Optimal nonlinear filtering

Optimal Control Theory

CRC Press

Focusing on applications to science and engineering, this book presents the results of the ITN-FP7 SADCO network's innovative research in optimization and control in the following interconnected topics: optimality conditions in optimal control, dynamic programming approaches to optimal feedback synthesis and reachability analysis, and

computational developments in model predictive control. The novelty of the book resides in the fact that it has been developed by early career researchers, providing a good balance between clarity and scientific rigor. Each chapter features an introduction addressed to PhD students and some original contributions aimed at specialist researchers. Requiring only a graduate mathematical background, the book is self-contained. It will be of particular interest to graduate and advanced undergraduate students, industrial practitioners and to senior scientists wishing to update their knowledge.
Applications to Management Science and Economics Springer Science & Business Media Optimal control theory is a technique being used increasingly by academic economists to study problems involving optimal decisions in a multi-period framework. This textbook is designed to make the difficult subject of optimal control theory easily accessible to economists while at the same time maintaining rigour. Economic intuitions are emphasized, and examples and problem sets covering a wide range of applications in economics are provided to assist in the learning process. Theorems are clearly stated and their proofs are carefully explained. The development of the text is gradual and fully integrated, beginning with simple formulations and progressing to advanced

topics such as control parameters, jumps in state variables, and bounded state space. For greater economy and elegance, optimal control theory is introduced directly, without recourse to the calculus of variations. The connection with the latter and with dynamic programming is explained in a separate chapter. A second purpose of the book is to draw the parallel between optimal control theory and static optimization. Chapter 1 provides an extensive treatment of constrained and unconstrained maximization, with emphasis on economic insight and applications. Starting from basic concepts, it derives and explains important results, including the envelope theorem and the method of comparative statics. This chapter may be used for a course in static optimization. The book is largely self-contained. No previous knowledge of differential equations is required. **Linear Quadratic Methods** Springer Science & Business Media The lectures gathered in this volume present some of the different aspects of Mathematical Control Theory. Adopting the point of view of Geometric Control Theory and of Nonlinear Control Theory, the lectures focus on some aspects of the Optimization and Control of nonlinear, not necessarily smooth, dynamical systems. Specifically, three of the five lectures discuss respectively: logic-based switching control, sliding mode control and the input to the state stability paradigm for the control and stability of nonlinear systems. The remaining two lectures are devoted to Optimal Control: one investigates the connections between Optimal Control Theory, Dynamical Systems and Differential Geometry, while the second presents a very general version, in a non-smooth context, of the Pontryagin Maximum Principle. The arguments of the whole volume are self-contained and are directed to everyone working in Control Theory. They offer a sound presentation of the methods employed in the control and optimization of nonlinear dynamical systems.

Introduction to Optimal Control Oxford University Press

This paper is intended for the beginner. It is not a state of-the-art paper for research workers in the field of control theory. Its purpose is to introduce the reader to some of the problems and results in control theory, to illustrate the application of these re sults, and to provide a guide for his further reading on this subject. I have tried to motivate the results with examples, especial ly with one canonical, simple example described in §3. Many results, such as the maximum principle, have long and difficult proofs. I have omitted these proofs. In general I have included only the proofs which are either (1) not too difficult or (2) fairly enlightening as to the nature of the result. I have, however, usually attempted to draw the strongest conclusion from a given proof. For example, many existing proofs in control theory for compact targets and uniqueness of solutions also hold for closed targets and non-uniqueness. Finally, at the end of each section I have given references to generalizations and origins of the results discussed in that section. I make no claim of completeness in the references, however, as I have often been content merely to refer the reader either to an exposition or to a paper which has an extensive bibliography. IV These 1ecture notes are revisions of notes I used for aseries of nine 1ectures on contro1 theory at the International Summer Schoo1 on Mathematica1 Systems and Economics held in Varenna, Ita1y, June 1967.

Applied Optimal Control
Cambridge University Press
This best-selling text focuses on the analysis and design of complicated dynamics systems. CHOICE called it ""a high-level, concise book that could well be used as a reference by engineers, applied mathematicians, and undergraduates. The format is good, the presentation clear, the diagrams instructive, the examples and problems helpful...References and a multiple-choice examination are included.

Continuous Time Dynamical Systems
Elsevier
The performance of a process -- for example, how an aircraft consumes fuel -- can be enhanced when the most effective controls and operating points for the process are

determined. This holds true for many physical, economic, biomedical, manufacturing, and engineering processes whose behavior can often be influenced by altering certain parameters or controls to optimize some desired property or output.

Optimal Control: Novel Directions and Applications CRC Press This new 4th edition offers an introduction to optimal control theory and its diverse applications in management science and economics. It introduces students to the concept of the maximum principle in continuous (as well as discrete) time by combining dynamic programming and Kuhn-Tucker theory. While some mathematical background is needed, the emphasis of the book is not on mathematical rigor, but on modeling realistic situations encountered in business and economics. It applies optimal control theory to the functional areas of management including finance, production and marketing, as well as the economics of growth and of natural resources. In addition, it features material on stochastic Nash and Stackelberg differential games and an adverse selection model in the principal-agent framework. Exercises are included in each chapter, while the answers to selected exercises help deepen readers' understanding of the material covered. Also included are appendices of supplementary material on the solution of differential equations, the calculus of variations and its ties to the maximum principle, and special topics including the Kalman filter, certainty equivalence, singular control, a global saddle point theorem, Sethi-Skiba points, and distributed parameter systems. Optimal control methods are used to determine optimal ways to control a dynamic system. The theoretical work in this field serves as the foundation for the book, in which the author applies it to business management problems developed from his own research and classroom instruction. The new edition has been refined and updated, making it a valuable resource for graduate courses on applied optimal control theory, but also for financial and industrial engineers, economists, and operational researchers interested in applying dynamic optimization in their fields.

Nonlinear and Optimal Control Systems CRC Press

An Introduction to Applied Optimal Control

Optimal Control and Estimation SIAM

Geared toward advanced undergraduate and graduate engineering students, this text introduces the theory and applications of optimal control. It serves as a bridge to the technical literature, enabling students to evaluate the implications of theoretical control work, and to judge the merits of papers on the subject. Rather than presenting an exhaustive treatise, Optimal Control offers a detailed introduction that fosters careful thinking and disciplined intuition. It develops the basic mathematical background, with a coherent formulation of the control problem and discussions of the necessary conditions for optimality based on the maximum principle of Pontryagin. In-depth examinations cover applications of the theory to minimum time, minimum fuel, and to quadratic criteria problems. The structure, properties, and engineering realizations of several optimal feedback control systems also receive attention. Special features include numerous specific problems, carried through to engineering realization in block diagram form. The text treats almost all current examples of control problems that permit analytic solutions, and its unified approach makes frequent use of geometric ideas to encourage students' intuition.

An Introduction Springer Science & Business Media This textbook offers a concise yet rigorous introduction to calculus of variations and optimal control theory, and is a self-contained resource for graduate students in engineering, applied mathematics, and related subjects. Designed specifically for a one-semester course, the book begins with calculus of variations, preparing the ground for optimal control. It then gives a complete proof of the maximum principle and covers key topics such as the Hamilton-Jacobi-Bellman theory of dynamic programming and linear-quadratic optimal control. Calculus of Variations and Optimal Control Theory also traces the historical development of the subject and features numerous exercises, notes and references at the end of each chapter, and suggestions for further study. Offers a concise yet rigorous introduction Requires limited background in control theory or advanced mathematics Provides a complete proof of the maximum principle Uses consistent notation in the exposition of classical and modern topics Traces the historical development of the subject Solutions manual (available only to teachers) Leading universities that have adopted this book include: University of Illinois at Urbana-Champaign ECE 553: Optimum Control Systems Georgia Institute of Technology ECE 6553: Optimal Control and Optimization University of Pennsylvania ESE 680: Optimal Control Theory University of Notre Dame EE 60565: Optimal Control

Optimal Control Theory and Static Optimization in Economics John Wiley & Sons

Designed for one-semester introductory senior-or graduate-level course, the authors provide the student with an introduction of analysis techniques used in the design of nonlinear and optimal feedback control systems. There is special emphasis on the fundamental topics of stability, controllability, and optimality, and on the corresponding geometry associated with these topics. Each chapter contains several examples and a variety of exercises. *Primer on Optimal Control Theory* CRC Press Numerous examples highlight this treatment of the use of linear quadratic Gaussian methods for control system design. It explores linear optimal control theory from an engineering viewpoint, with illustrations of practical applications. Key topics include loop-recovery techniques, frequency shaping, and controller reduction. Numerous examples and complete solutions. 1990 edition. Optimal Control of Partial Differential Equations Springer Science & Business Media A NEW EDITION OF THE CLASSIC TEXT ON OPTIMAL CONTROL THEORY As a superb introductory text and an indispensable reference, this new edition of Optimal Control will serve the needs of both the professional engineer and the advanced student in mechanical, electrical, and aerospace engineering. Its coverage encompasses all the fundamental topics as well as the major changes that have occurred in recent years. An abundance of computer simulations using MATLAB and relevant Toolboxes is included to give the reader the actual experience of applying the theory to real-world situations. Major topics covered include: Static Optimization Optimal Control of Discrete-Time Systems Optimal Control of Continuous-Time Systems The Tracking

Problem and Other LQR Extensions Final-Time-Free and Constrained Input Control Dynamic Programming Optimal Control for Polynomial Systems Output Feedback and Structured Control Robustness and Multivariable Frequency-Domain Techniques Differential Games Reinforcement Learning and Optimal Adaptive Control