Optimal Control And The Calculus Of Variations By Enid R Pinch

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CLARA HUGHES

Optimal Control Theory Birkhäuser
Optimal control is a modern development of the calculus of variations and classical optimization theory. For that reason, this introduction to the theory of optimal control starts by considering the problem of minimizing a function of many variables. It moves through an exposition of the calculus of variations, to the optimal control of systems governed by ordinary differential equations. This approach should enable students to see the essential unity of important areas of mathematics, and also allow optimal control and the Pontryagin maximum principle to be placed in a proper context. A good knowledge of analysis, algebra, and methods is assumed. All the theorems are carefully proved, and there are many worked examples and exercises. Although this book is written for the advanced undergraduate mathematician, engineers and scientists who regularly rely on mathematics will also find it a useful text.
Variational Calculus with Elementary Convexity World Scientific
The calculus of variations is a classical area of mathematical analysis yet its myriad applications in science and technology continue to keep it an active area of research. Encompassing two volumes, this set brings together leading experts who focus on critical point theory, differential equations, and the variational aspects of optimal control. The books cover monotonicity, nonlinear optimization, the impossible pilot wave, the Lavrentiev phenomenon, and elliptic problems.
Control Theory and Optimization I CRC Press
The calculus of variations is used to find functions that optimize quantities expressed in terms of integrals. Optimal control theory seeks to find functions that minimize cost integrals for systems described by differential equations. This book is an introduction to both the classical theory of the calculus of variations and the more modern developments of optimal control theory

from the perspective of an applied mathematician. It focuses on understanding concepts and how to apply them. The range of potential applications is broad: the calculus of variations and optimal control theory have been widely used in numerous ways in biology, criminology, economics, engineering, finance, management science, and physics. Applications described in this book include cancer chemotherapy, navigational control, and renewable resource harvesting. The prerequisites for the book are modest: the standard calculus sequence, a first course on ordinary differential equations, and some facility with the use of mathematical software. It is suitable for an undergraduate or beginning graduate course, or for self study. It provides excellent preparation for more advanced books and courses on the calculus of variations and optimal control theory.

Calculus of Variations and Optimal Control Springer Science & Business Media

The calculus of variations, whose origins can be traced to the works of Aristotle and Zenodoros, is now Ii vast repository supplying fundamental tools of exploration not only to the mathematician, but-as evidenced by current literature-also to those in most branches of science in which mathematics is applied. (Indeed, the macroscopic statements afforded by variational principles may provide the only valid mathematical formulation of many physical laws.) As such, it retains the spirit of natural philosophy common to most mathematical investigations prior to this century. How ever, it is a discipline in which a single symbol (b) has at times been assigned almost mystical powers of operation and discernment, not readily subsumed into the formal structures of modern mathematics. And it is a field for which it is generally supposed that most questions motivating interest in the subject will probably not be answerable at the introductory level of their formulation. In earlier articles,1,2 it was shown through several examples that a complete characterization of the solution of optimization problems may be available by elementary methods, and it is the purpose of this work to explore further the convexity which underlay these individual successes in the context of a full introductory treatment of the theory of the variational calculus. The required convexity is that determined through Gateaux variations, which can be defined in any real linear space and which provide an unambiguous foundation for the theory.

Primer on Optimal Control Theory

Optimal Control and the Calculus of Variations

This book introduces a variety of problem statements in classical optimal control, in optimal estimation and filtering, and in optimal control problems with non-scalar-valued performance criteria. Many example problems are solved completely in the body of the text. All chapter-end exercises are sketched in the appendix. The theoretical part of the book is based on the calculus of variations, so the exposition is very transparent and requires little mathematical rigor.

Optimal Control of Differential Equations 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

Calculus of Variations and Optimal Control Theory American Mathematical Soc.

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.

Optimal Control Theory Springer Science & Business Media

When the Tyrian princess Dido landed on the North African shore of the Mediterranean sea she was welcomed by a local chieftain. He offered her all the land that she could enclose between the shoreline and a rope of knotted cowhide. While the legend does not tell us, we may assume that Princess Dido arrived at the correct solution by stretching the rope into the shape of a circular arc and thereby maximized the area of the land upon which she was to found Carthage. This story of the founding of Carthage is

apocryphal. Nonetheless it is probably the first account of a problem of the kind that inspired an entire mathematical discipline, the calculus of variations and its extensions such as the theory of optimal control. This book is intended to present an introductory treatment of the calculus of variations in Part I and of optimal control theory in Part II. The discussion in Part I is restricted to the simplest problem of the calculus of variations. The topic is entirely classical; all of the basic theory had been developed before the turn of the century. Consequently the material comes from many sources; however, those most useful to me have been the books of Oskar Bolza and of George M. Ewing. Part II is devoted to the elementary aspects of the modern extension of the calculus of variations, the theory of optimal control of dynamical systems.

Calculus of Variations, Optimal Control Theory and Numerical Methods Springer Science & Business Media

This monograph is an introduction to optimal control theory for systems governed by vector ordinary differential equations. It is not intended as a state-of-the-art handbook for researchers. We have tried to keep two types of reader in mind: (1) mathematicians, graduate students, and advanced undergraduates in mathematics who want a concise introduction to a field which contains nontrivial interesting applications of mathematics (for example, weak convergence, convexity, and the theory of ordinary differential equations); (2) economists, applied scientists, and engineers who want to understand some of the mathematical foundations. of optimal control theory. In general, we have emphasized motivation and explanation, avoiding the "definition-axiom-theorem-proof" approach. We make use of a large number of examples, especially one simple canonical example which we carry through the entire book. In proving theorems, we often just prove the simplest case, then state the more general results which can be proved. Many of the more difficult topics are discussed in the "Notes" sections at the end of chapters and several major proofs are in the Appendices. We feel that a solid understanding of basic facts is best attained by at first avoiding excessive generality. We have not tried to give an exhaustive list of references, preferring to refer the reader to existing books or papers with extensive bibliographies. References are given by author's name and the year of publication, e.g., Waltman [1974].

The Calculus of Variations and Functional Analysis Springer Science & Business Media

An introduction to the variational methods used to formulate and solve mathematical and physical problems, allowing the reader an insight into the systematic use of elementary (partial) convexity of differentiable functions in Euclidian space. By helping students directly characterize the solutions for many minimization problems, the text serves as a prelude to the field theory for sufficiency, laying as it does the groundwork for further explorations in mathematics, physics, mechanical and electrical engineering, as well as computer science.

Constrained Optimization In The Calculus Of Variations and Optimal Control Theory Springer Science & Business Media

A new Chelsea classic now back in print!

Cambridge University Press

“Each chapter contains a well-written

introduction and notes. They include the author's deep insights on the subject matter and provide historical comments and guidance to related literature. This book may well become an important milestone in the literature of optimal control." —Mathematical Reviews
“Thanks to a great effort to be self-contained, [this book] renders accessibly the subject to a wide audience. Therefore, it is recommended to all researchers and professionals interested in Optimal Control and its engineering and economic applications. It can serve as an excellent textbook for graduate courses in Optimal Control (with special emphasis on Nonsmooth Analysis)." —Automatica
Control and Optimal Control Theories with Applications Taylor & Francis US
Functional analysis owes much of its early impetus to problems that arise in the calculus of variations. In turn, the methods developed there have been applied to optimal control, an area that also requires new tools, such as nonsmooth analysis. This self-contained textbook gives a complete course on all these topics. It is written by a leading specialist who is also a noted expositor. This book provides a thorough introduction to functional analysis and includes many novel elements as well as the standard topics. A short course on nonsmooth analysis and geometry completes the first half of the book whilst the second half concerns the calculus of variations and optimal control. The author provides a comprehensive course on these subjects, from their inception through to the present. A notable feature is the inclusion of recent, unifying developments on regularity, multiplier rules, and the Pontryagin maximum principle, which appear here for the first time in a textbook. Other major themes include existence and Hamilton-Jacobi methods. The many substantial examples, and the more than three hundred exercises, treat such topics as viscosity solutions, nonsmooth Lagrangians, the logarithmic Sobolev inequality, periodic trajectories, and systems theory. They also touch lightly upon several fields of application: mechanics, economics, resources, finance, control engineering. Functional Analysis, Calculus of Variations and Optimal Control is intended to support several different courses at the first-year or second-year graduate level, on functional analysis, on the calculus of variations and optimal control, or on some combination. For this reason, it has been organized with customization in mind. The text also has considerable value as a reference. Besides its advanced results in the calculus of variations and optimal control, its polished presentation of certain other topics (for example convex analysis, measurable selections, metric regularity, and nonsmooth analysis) will be appreciated by researchers in these and related fields.
Turnpike Properties in the Calculus of Variations and Optimal Control Springer Science & Business Media
The calculus of variations is a classical area of mathematical analysis-300 years old-yet its myriad applications in science and technology continue to hold great interest and keep it an active area of research. These two volumes contain the referenced proceedings of the international conference on Calculus of Variations and Related Topics held at the Technion-Israel Institute of Technology in March 1998. The conference commemorated 300 years of work in the field and brought together many of its

leading experts. The papers in the first volume focus on critical point theory and differential equations. The other volume deals with variational aspects of optimal control. Together they provide a unique opportunity to review the state-of-the-art of the calculus of variations, as presented by an international panel of masters in the field.

A Concise Introduction Oxford University Press

* A comprehensive and systematic exposition of the properties of semiconcave functions and their various applications, particularly to optimal control problems, by leading experts in the field * A central role in the present work is reserved for the study of singularities * Graduate students and researchers in optimal control, the calculus of variations, and PDEs will find this book useful as a reference work on modern dynamic programming for nonlinear control systems

Optimal Control CRC Press

Since its initial publication, this text has defined courses in dynamic optimization taught to economics and management science students. The two-part treatment covers the calculus of variations and optimal control. 1998 edition.

Optimal Control and the Calculus of Variations Springer Science & Business Media

The calculus of variations is a classical area of mathematical analysis-300 years old-yet its myriad applications in science and technology continue to hold great interest and keep it an active area of research. These two volumes contain the refereed proceedings of the international conference on Calculus of Variations and Related Topics held at the Technion-Israel Institute of Technology in March 1998. The conference commemorated 300 years of work in the field and brought together many of its leading experts. The papers in the first volume focus on critical point theory and differential equations. The other volume deals with variational aspects of optimal control. Together they provide a unique opportunity to review the state-of-the-art of the calculus of variations, as presented by an international panel of masters in the field.

Optimal Control Systems CRC Press

This book is devoted to the recent progress on the turnpike theory. The turnpike property was discovered by Paul A. Samuelson, who applied it to problems in mathematical economics in 1949. These properties were studied for optimal trajectories of models of economic dynamics determined by convex processes. In this monograph the author, a leading expert in modern turnpike theory, presents a number of results concerning the turnpike properties in the calculus of variations and optimal control which were obtained in the last ten years. These results show that the turnpike properties form a general phenomenon which holds for various classes of variational problems and optimal control problems. The book should help to correct the misapprehension that turnpike properties are only special features of some narrow classes of convex problems of mathematical economics. Audience This book is intended for mathematicians interested in optimal control, calculus of variations, game theory and mathematical economics.

An Introduction Horwood Publishing

Optimal Control and the Calculus of VariationsOxford University Press

An Introduction Waveland Press

In this text, Dr. Chiang introduces students to the most important methods

of dynamic optimization used in economics. The classical calculus of variations, optimal control theory, and dynamic programming in its discrete form are explained in the usual Chiang fashion, with patience and thoroughness. The economic examples, selected from both classical and recent literature, serve not only to illustrate applications of the mathematical methods, but also to provide a useful glimpse of the development of thinking in several areas of economics.