

Dynamic Programming and Optimal Control

Dimitri P. Bertsekas



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Dynamic Programming and Optimal Control Dimitri Bertsekas, 2012-10-23 This is the leading and most up to date textbook on the far ranging algorithmic methodology of Dynamic Programming which can be used for optimal control Markovian decision problems planning and sequential decision making under uncertainty and discrete combinatorial optimization The treatment focuses on basic unifying themes and conceptual foundations It illustrates the versatility power and generality of the method with many examples and applications from engineering operations research and other fields It also addresses extensively the practical application of the methodology possibly through the use of approximations and provides an extensive treatment of the far reaching methodology of Neuro Dynamic Programming Reinforcement Learning Among its special features the book 1 provides a unifying framework for sequential decision making 2 treats simultaneously deterministic and stochastic control problems popular in modern control theory and Markovian decision popular in operations research 3 develops the theory of deterministic optimal control problems including the Pontryagin Minimum Principle 4 introduces recent suboptimal control and simulation based approximation techniques neuro dynamic programming which allow the practical application of dynamic programming to complex problems that involve the dual curse of large dimension and lack of an accurate mathematical model 5 provides a comprehensive treatment of infinite horizon problems in the second volume and an introductory treatment in the first volume

Reinforcement Learning and Optimal Control 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

Modern Control System Theory M. Gopal,1993 About the book The book provides an integrated treatment of continuous time and discrete time systems for two courses at postgraduate level or one course at undergraduate and one course at postgraduate level It covers mainly two areas of modern control theory namely system theory and multivariable and optimal control The coverage of the former is quite exhaustive while that of latter is adequate with significant provision of the necessary topics that enables a research student to comprehend various technical papers The stress is on interdisciplinary nature of the subject Practical control problems from various engineering disciplines have been drawn to illustrate the potential concepts Most of the theoretical results have been presented in a manner suitable for digital computer programming along with the necessary algorithms for numerical computations

Dynamic programming and optimal control,vol. 2 Dimitri P. Bertsekas,2000 *Proceedings of the International Conference on Control and Information 1995* Wing Shing Wong,1995-06-22

Reinforcement Learning-Enabled Intelligent Energy Management for Hybrid Electric Vehicles Teng Liu,2022-06-01 Powertrain electrification fuel decarbonization and energy diversification are techniques that are spreading all over the world leading to cleaner and more efficient vehicles Hybrid electric vehicles HEVs are considered a promising technology today to address growing air pollution and energy deprivation To realize these gains and still maintain good performance it is critical for HEVs to have sophisticated energy management systems Supervised by

such a system HEVs could operate in different modes such as full electric mode and power split mode Hence researching and constructing advanced energy management strategies EMSs is important for HEVs performance There are a few books about rule and optimization based approaches for formulating energy management systems Most of them concern traditional techniques and their efforts focus on searching for optimal control policies offline There is still much room to introduce learning enabled energy management systems founded in artificial intelligence and their real time evaluation and application In this book a series hybrid electric vehicle was considered as the powertrain model to describe and analyze a reinforcement learning RL enabled intelligent energy management system The proposed system can not only integrate predictive road information but also achieve online learning and updating Detailed powertrain modeling predictive algorithms and online updating technology are involved and evaluation and verification of the presented energy management system is conducted and executed

Encyclopedia of Optimization Christodoulos A. Floudas, Panos M. Pardalos, 2008-09-04 The goal of the Encyclopedia of Optimization is to introduce the reader to a complete set of topics that show the spectrum of research the richness of ideas and the breadth of applications that has come from this field The second edition builds on the success of the former edition with more than 150 completely new entries designed to ensure that the reference addresses recent areas where optimization theories and techniques have advanced Particularly heavy attention resulted in health science and transportation with entries such as Algorithms for Genomics Optimization and Radiotherapy Treatment Design and Crew Scheduling

Optimization Elijah Polak, 2012-12-06 This book deals with optimality conditions algorithms and discretization techniques for nonlinear programming semi infinite optimization and optimal control problems The unifying thread in the presentation consists of an abstract theory within which optimality conditions are expressed in the form of zeros of optimality junctions algorithms are characterized by point to set iteration maps and all the numerical approximations required in the solution of semi infinite optimization and optimal control problems are treated within the context of consistent approximations and algorithm implementation techniques Traditionally necessary optimality conditions for optimization problems are presented in Lagrange F John or Karush Kuhn Tucker multiplier forms with gradients used for smooth problems and subgradients for nonsmooth problems We present these classical optimality conditions and show that they are satisfied at a point if and only if this point is a zero of an upper semicontinuous optimality junction The use of optimality functions has several advantages First optimality functions can be used in an abstract study of optimization algorithms Second many optimization algorithms can be shown to use search directions that are obtained in evaluating optimality functions thus establishing a clear relationship between optimality conditions and algorithms Third establishing optimality conditions for highly complex problems such as optimal control problems with control and trajectory constraints is much easier in terms of optimality functions than in the classical manner In addition the relationship between optimality conditions for finite dimensional problems and semi infinite optimization and optimal control problems becomes transparent

Journal

of Dynamic Systems, Measurement, and Control ,1999 Analysis and Design of Hybrid Systems 2006 Christos
 Cassandras,Alessandro Giua,Carla Seatzu,Janan Zaytoon,2006-11-21 This volume contains the proceedings of Analysis and
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 Italy on June 7 9 2006 ADHS is a series of triennial meetings that aims to bring together researchers and practitioners with a
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 Optimal Control Analysis of Nuclear Reactors Richard John Hermsen,1963 **Numerical Optimisation of Dynamic
 Systems** Laurence Charles Ward Dixon,G. P. Szegö,1980 *Progress in System and Robot Analysis and Control Design*
 Spyros G. Tzafestas,1999-05-14 The fields of control and robotics are now at an advanced level of maturity both in theory and
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 contains a well balanced collection of over fifty papers focusing on analysis and design problems The current trends and
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 and legged robots virtual reality in robotics The book brings together important original results derived from a variety of
 academic and engineering environments Also it serves as a timely reference volume for the researcher and practitioner
 Modern Control Theory Julius T. Tou,1964 *IRE Transactions on Automatic Control* ,1961 **Annals of Economic
 and Social Measurement** ,1976 Region V IEEE Conference Digest ,1976 Distributed Parameter Systems Tanehiro
 Futagami,S. G. Tzafestas,Yoshifumi Sunahara,1989

Whispering the Strategies of Language: An Psychological Journey through **Dynamic Programming Optimal Control Vol**

In a digitally-driven world where monitors reign great and quick conversation drowns out the subtleties of language, the profound secrets and mental subtleties concealed within words usually get unheard. Yet, located within the pages of **Dynamic Programming Optimal Control Vol** a fascinating fictional prize pulsating with fresh feelings, lies an extraordinary journey waiting to be undertaken. Composed by a skilled wordsmith, that charming opus encourages viewers on an introspective journey, softly unraveling the veiled truths and profound impact resonating within ab muscles fabric of every word. Within the psychological depths of this touching evaluation, we shall embark upon a genuine exploration of the book is primary subjects, dissect its interesting publishing design, and yield to the effective resonance it evokes deep within the recesses of readers hearts.

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