Adaptive Control

Fall 2012

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Course Overview

- Introduction
- Parametric Models
- Parameter Identifications
- Model Reference Adaptive Control
- Adaptive Pole Placement Control
- Adaptive Control for Non-linear Systems

Adaptive Control Uok

Plamen Parvanov Angelov

Adaptive Control Uok:

Lessons from AlphaZero for Optimal, Model Predictive, and Adaptive Control Dimitri Bertsekas,2022-03-19 The purpose of this book is to propose and develop a new conceptual framework for approximate Dynamic Programming DP and Reinforcement Learning RL This framework centers around two algorithms which are designed largely independently of each other and operate in synergy through the powerful mechanism of Newton s method We call these the off line training and the on line play algorithms the names are borrowed from some of the major successes of RL involving games Primary examples are the recent 2017 AlphaZero program which plays chess and the similarly structured and earlier 1990s TD Gammon program which plays backgammon In these game contexts the off line training algorithm is the method used to teach the program how to evaluate positions and to generate good moves at any given position while the on line play algorithm is the method used to play in real time against human or computer opponents Both AlphaZero and TD Gammon were trained off line extensively using neural networks and an approximate version of the fundamental DP algorithm of policy iteration Yet the AlphaZero player that was obtained off line is not used directly during on line play it is too inaccurate due to approximation errors that are inherent in off line neural network training Instead a separate on line player is used to select moves based on multistep lookahead minimization and a terminal position evaluator that was trained using experience with the off line player The on line player performs a form of policy improvement which is not degraded by neural network approximations As a result it greatly improves the performance of the off line player Similarly TD Gammon performs on line a policy improvement step using one step or two step lookahead minimization which is not degraded by neural network approximations To this end it uses an off line neural network trained terminal position evaluator and importantly it also extends its on line lookahead by rollout simulation with the one step lookahead player that is based on the position evaluator Significantly the synergy between off line training and on line play also underlies Model Predictive Control MPC a major control system design methodology that has been extensively developed since the 1980s This synergy can be understood in terms of abstract models of infinite horizon DP and simple geometrical constructions and helps to explain the all important stability issues within the MPC context An additional benefit of policy improvement by approximation in value space not observed in the context of games which have stable rules and environment is that it works well with changing problem parameters and on line replanning similar to indirect adaptive control Here the Bellman equation is perturbed due to the parameter changes but approximation in value space still operates as a Newton step An essential requirement here is that a system model is estimated on line through some identification method and is used during the one step or multistep lookahead minimization process In this monograph we aim to provide insights often based on visualization which explain the beneficial effects of on line decision making on top of off line training In the process we will bring out the strong connections between the artificial intelligence view of RL and the control theory views of MPC and adaptive control Moreover we will show that in

addition to MPC and adaptive control our conceptual framework can be effectively integrated with other important methodologies such as multiagent systems and decentralized control discrete and Bayesian optimization and heuristic algorithms for discrete optimization One of our principal aims is to show through the algorithmic ideas of Newton s method and the unifying principles of abstract DP that the AlphaZero TD Gammon methodology of approximation in value space and rollout applies very broadly to deterministic and stochastic optimal control problems Newton s method here is used for the solution of Bellman s equation an operator equation that applies universally within DP with both discrete and continuous state and control spaces as well as finite and infinite horizon   *Applications of Neural Adaptive Control Technology* Jens Kalkkuhl,Rafal Zbikowski,1997 This book presents the results of the second workshop on Neural Adaptive Control Technology NACT II held on September 9 10 1996 in Berlin The workshop was organised in connection with a three year European Union funded Basic Research Project in the ESPRIT framework called NACT a collaboration between Daimler Benz Germany and the University of Glasgow Scotland The NACT project which began on 1 April 1994 is a study of the fundamental properties of neural network based adaptive control systems Where possible links with traditional adaptive control systems are exploited A major aim is to develop a systematic engineering procedure for designing neural controllers for nonlinear dynamic systems The techniques developed are being evaluated on concrete industrial problems from within the Daimler Benz group of companies The aim of the workshop was to bring together selected invited specialists in the fields of adaptive control nonlinear systems and neural networks The first workshop NACT I took place in Glasgow in May 1995 and was mainly devoted to theoretical issues of neural adaptive control Besides monitoring further development of theory the NACT II workshop was focused on industrial applications and software tools This context dictated the focus of the book and guided the editors in the choice of the papers and their subsequent reshaping into substantive book chapters Thus with the project having progressed into its applications stage emphasis is put on the transfer of theory of neural adaptive engineering into industrial practice The contributors are therefore both renowned academics and practitioners from major industrial users of neurocontrol   *Methods and Applications in Adaptive Control* H. Unbehauen,1980-07 An International Symposium on Adaptive Systems was held at the Department of Electrical Engineering of the Ruhr University Bochum during March 20 21 1980 The aim of this symposium was the discussion of the actual situation and the future development of adaptive systems The papers during the first day were concerned with methods in adaptive control and during the second day with applications The primary purpose was to bring together researchers and practicing engineers Theorists could learn from the relevant features of practical applications while engineers could learn what possibilities are offered by adaptive control theories especially how to apply specific theoretical methods All papers presented at this conference are published in this volume   *Mathematical Theory of Adaptive Control* Vladimir Grigor?evich Sragovich,2006 The theory of adaptive control is concerned with construction of strategies so that the controlled system behaves in a desirable way without assuming the

complete knowledge of the system The models considered in this comprehensive book are of Markovian type Both partial observation and partial information cases are analyzed While the book focuses on discrete time models continuous time ones are considered in the final chapter The book provides a novel perspective by summarizing results on adaptive control obtained in the Soviet Union which are not well known in the West Comments on the interplay between the Russian and Western methods are also included   Adaptive Control, Filtering, and Signal Processing K.J. Aström,G.C. Goodwin,P.R. Kumar,2012-12-06 The area of adaptive systems which encompasses recursive identification adaptive control filtering and signal processing has been one of the most active areas of the past decade Since adaptive controllers are fundamentally nonlinear controllers which are applied to nominally linear possibly stochastic and time varying systems their theoretical analysis is usually very difficult Nevertheless over the past decade much fundamental progress has been made on some key questions concerning their stability convergence performance and robustness Moreover adaptive controllers have been successfully employed in numerous practical applications and have even entered the marketplace   **Neural Adaptive Control Technology** Rafa? ?bikowski,Kenneth J. Hunt,1996 This book is an outgrowth of the workshop on Neural Adaptive Control Technology NACT I held in 1995 in Glasgow Selected workshop participants were asked to substantially expand and revise their contributions to make them into full papers The workshop was organised in connection with a three year European Union funded Basic Research Project in the ESPRIT framework called NACT a collaboration between Daimler Benz Germany and the University of Glasgow Scotland A major aim of the NACT project is to develop a systematic engineering procedure for designing neural controllers for nonlinear dynamic systems The techniques developed are being evaluated on concrete industrial problems from Daimler Benz In the book emphasis is put on development of sound theory of neural adaptive control for nonlinear control systems but firmly anchored in the engineering context of industrial practice Therefore the contributors are both renowned academics and practitioners from major industrial users of neurocontrol   *Intelligent Optimal Adaptive Control for Mechatronic Systems* Marcin Szuster,Zenon Hendzel,2017-12-28 The book deals with intelligent control of mobile robots presenting the state of the art in the field and introducing new control algorithms developed and tested by the authors It also discusses the use of artificial intelligent methods like neural networks and neuraldynamic programming including globalised dual heuristic dynamic programming for controlling wheeled robots and robotic manipulators and compares them to classical control methods   Adaptive Systems in Control and Signal Processing 1986 K.J. Aström,B. Wittenmark,2016-07-21 This second IFAC workshop discusses the variety and applications of adaptive systems in control and signal processing The various approaches to adaptive control systems are covered and their stability and adaptability analyzed The volume also includes papers taken from two poster sessions to give a concise and comprehensive overview treatment of this increasingly important field   **Optimal Control** Mr. Rohit Manglik,2024-07-15 EduGorilla Publication is a trusted name in the education sector committed to empowering learners with high quality study

materials and resources Specializing in competitive exams and academic support EduGorilla provides comprehensive and well structured content tailored to meet the needs of students across various streams and levels **Advances In Intelligent Control** C J Harris,1994-03-11 Advances in intelligent Control is a collection of essays covering the latest research in the field Based on a special issue of The International Journal of Control the book is arranged in two parts Part one contains recent contributions of artificial neural networks to modelling and control Part two concerns itself primarily with aspects of fuzzy logic in intelligent control guidance and estimation although some of the contributions either make direct equivalence relationships to neural networks or use hybrid methods where a neural network is used to develop the fuzzy rule base

Optimal Networked Control Systems with MATLAB Jagannathan Sarangapani,Hao Xu,2018-09-03 Optimal Networked Control Systems with MATLAB discusses optimal controller design in discrete time for networked control systems NCS The authors apply several powerful modern control techniques in discrete time to the design of intelligent controllers for such NCS Detailed derivations rigorous stability proofs computer simulation examples and downloadable MATLAB codes are included for each case The book begins by providing background on NCS networked imperfections dynamical systems stability theory and stochastic optimal adaptive controllers in discrete time for linear and nonlinear systems It lays the foundation for reinforcement learning based optimal adaptive controller use for finite and infinite horizons The text then Introduces quantization effects for linear and nonlinear NCS describing the design of stochastic adaptive controllers for a class of linear and nonlinear systems Presents two player zero sum game theoretic formulation for linear systems in input output form enclosed by a communication network Addresses the stochastic optimal control of nonlinear NCS by using neuro dynamic programming Explores stochastic optimal design for nonlinear two player zero sum games under communication constraints Treats an event sampled distributed NCS to minimize transmission of state and control signals within the feedback loop via the communication network Covers distributed joint optimal network scheduling and control design for wireless NCS as well as the effect of network protocols on the wireless NCS controller design An ideal reference for graduate students university researchers and practicing engineers Optimal Networked Control Systems with MATLAB instills a solid understanding of neural network controllers and how to build them *Stochastic Systems* P. R. Kumar,Pravin Varaiya,2015-12-15 Since its origins in the 1940s the subject of decision making under uncertainty has grown into a diversified area with application in several branches of engineering and in those areas of the social sciences concerned with policy analysis and prescription These approaches required a computing capacity too expensive for the time until the ability to collect and process huge quantities of data engendered an explosion of work in the area This book provides succinct and rigorous treatment of the foundations of stochastic control a unified approach to filtering estimation prediction and stochastic and adaptive control and the conceptual framework necessary to understand current trends in stochastic control data mining machine learning and robotics **European Control Conference 1995** ,1995-09-05 Proceedings of the

European Control Conference 1995 Rome Italy 5 8 September 1995 **Optimal Control** Frank L. Lewis,Draguna Vrabie,Vassilis L. Syrmos,2012-03-20 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 **Computer-Aided Transit Scheduling** Joachim R. Daduna,Isabel Branco,Jose M.P. Paixao,2012-12-06 This proceedings volume consists of papers presented at the Sixth International Workshop on Computer Aided Scheduling of Public Transpon which was held at the Fund lio Calouste Gulbenkian in Lisbon from July 6th to 9th 1993 In the tradition of alternating Workshops between North America and Europe Chicago 1975 Leeds 1980 Montreal 1983 Hamburg 1987 and again Montreal 1990 the European city of Lisbon was selected as the venue for the Workshop in 1993 As in earlier Workshops the central theme dealt with vehicle and duty scheduling problems and the employment of operations research based software systems for operational planning in public transport However as was initiated in Hamburg in 1987 the scope of this Workshop was broadened to include topics in related fields This fundamental alteration was an inevitable consequence of the growing demand over the last decade for solutions to the complete planning process in public transport through integrated systems Therefore the program of this workshop included sections which dealt with scheduling problems and computerized systems for operational planning as well as sections on network planning and data management Stochastic Theory and Control Bozenna Pasik-Duncan,2002-07-24 This volume contains almost all of the papers that were presented at the Workshop on Stochastic Theory and Control that was held at the Univ sity of Kansas 18 20 October 2001 This three day event gathered a group of leading scholars in the eld of stochastic theory and control to discuss leading edge topics of stochastic control which include risk sensitive control adaptive control mathematics of nance estimation identi cation optimal control nonlinear ltering stochastic di erential equations stochastic p tial di erential equations and stochastic theory and its applications The workshop provided an opportunity for many stochastic control researchers to network and discuss cutting edge technologies and applications teaching and future directions of stochastic control Furthermore the workshop focused on promoting control theory in particular stochastic control and it promoted collaborative initiatives in stochastic theory and control and stochastic c trol education The lecture on Adaptation of Real Time Seizure Detection

Algorithm was videotaped by the PBS Participants of the workshop have been involved in contributing to the documentary being lmed by PBS which highlights the extraordinary work on Math Medicine and the Mind Discovering Tre ments for Epilepsy that examines the e orts of the multidisciplinary team on which several of the participants of the workshop have been working for many years to solve one of the world s most dramatic neurological conditions Invited high school teachers of Math and Science were among the part ipants of this professional meeting **Handbook On Computational Intelligence (In 2 Volumes)** Plamen Parvanov Angelov,2016-03-18 With the Internet the proliferation of Big Data and autonomous systems mankind has entered into an era of digital obesity In this century computational intelligence such as thinking machines have been brought forth to process complex human problems in a wide scope of areas from social sciences economics and biology medicine and social networks to cyber security The Handbook of Computational Intelligence in two volumes prompts readers to look at these problems from a non traditional angle It takes a step by step approach supported by case studies to explore the issues that have arisen in the process The Handbook covers many classic paradigms as well as recent achievements and future promising developments to solve some of these very complex problems Volume one explores the subjects of fuzzy logic and systems artificial neural networks and learning systems Volume two delves into evolutionary computation hybrid systems as well as the applications of computational intelligence in decision making the process industry robotics and autonomous systems This work is a one stop shop for beginners as well as an inspirational source for more advanced researchers It is a useful resource for lecturers and learners alike **A Course in Reinforcement Learning: 2nd Edition** Dimitri Bertsekas,2024-12-20 This is the 2nd edition of the textbook used at the author s ASU research oriented course on Reinforcement Learning RL offered in each of the last six years Its purpose is to give an overview of the RL methodology particularly as it relates to problems of optimal and suboptimal decision and control as well as discrete optimization While in this book mathematical proofs are deemphasized there is considerable related analysis which supports the conclusions and can be found in the author s recent RL and DP books These books also contain additional material on off line training of neural networks on the use of policy gradient methods for approximation in policy space and on aggregation

Adaptive Systems in Control and Signal Processing 1983 I. D. Landau,M. Tomizuka,D. M. Auslander,2014-06-28 Adaptive Systems in Control and Signal Processing 1983 is a compendium of papers presented at the International Federation of Automatic Control in San Francisco on June 20 22 1983 One paper addresses the results through comparative alternative algorithms in adaptive control of linear time invariant and time varying systems Another paper presents a method in computer simulation of a wide range of stable plants to achieve an alternative approach in designing an adaptive control system The book also compares the stability and the sensitivity approach involving the design of model reference adaptive systems The authors involved explain that the sensitivity concept determines the dynamic speed of adaptation while the stability concept focuses on finding a linear compensator for any deviant signal One paper proposes an indirect adaptive

control algorithm for MIMO square full rank minimum phase systems while another paper discusses the application of the discrete time multivariable adaptive control system to non minimum phase plants with an unknown dead time This book can prove valuable to engineers and researchers of electrical computer and mechanical engineering It can also be helpful for technicians and students dealing with automatic control and telecontrol   Output Feedback Reinforcement Learning Control for Linear Systems Syed Ali Asad Rizvi,Zongli Lin,2022-11-29 This monograph explores the analysis and design of model free optimal control systems based on reinforcement learning RL theory presenting new methods that overcome recent challenges faced by RL New developments in the design of sensor data efficient RL algorithms are demonstrated that not only reduce the requirement of sensors by means of output feedback but also ensure optimality and stability guarantees A variety of practical challenges are considered including disturbance rejection control constraints and communication delays Ideas from game theory are incorporated to solve output feedback disturbance rejection problems and the concepts of low gain feedback control are employed to develop RL controllers that achieve global stability under control constraints Output Feedback Reinforcement Learning Control for Linear Systems will be a valuable reference for graduate students control theorists working on optimal control systems engineers and applied mathematicians

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