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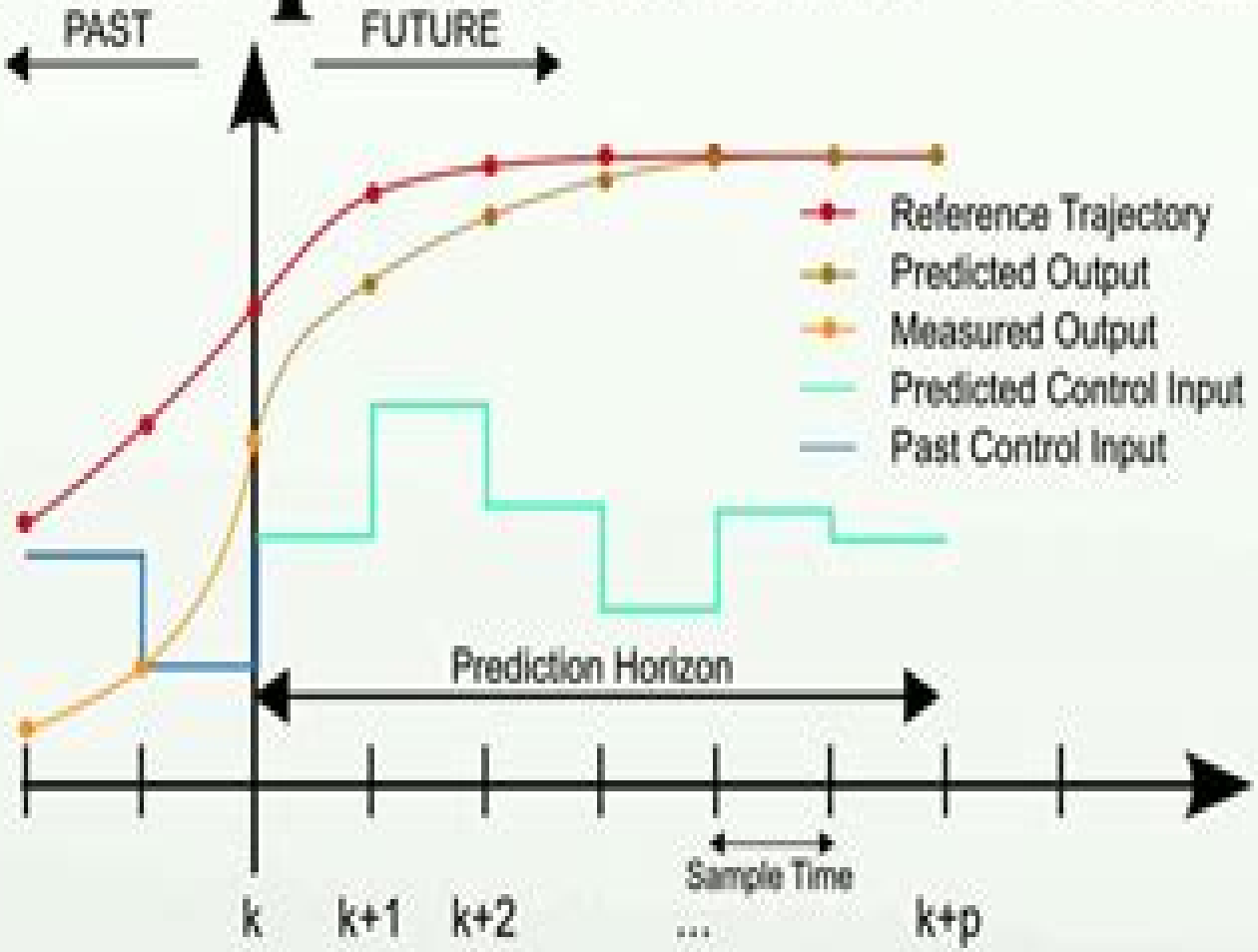

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Model Predictive Control

Steve Bailey

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Model Predictive Control Eduardo F. Camacho,Carlos Bordons Alba,2013-01-10 The second edition of Model Predictive Control provides a thorough introduction to theoretical and practical aspects of the most commonly used MPC strategies It bridges the gap between the powerful but often abstract techniques of control researchers and the more empirical approach of practitioners The book demonstrates that a powerful technique does not always require complex control algorithms Many new exercises and examples have also been added throughout Solutions available for download from the authors website save the tutor time and enable the student to follow results more closely even when the tutor isn t present **Nonlinear Model Predictive Control** Lars Grüne,Jürgen Pannek,2016-11-09 This book offers readers a thorough and rigorous introduction to nonlinear model predictive control NMPC for discrete time and sampled data systems NMPC schemes with and without stabilizing terminal constraints are detailed and intuitive examples illustrate the performance of different NMPC variants 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 An introduction to nonlinear optimal control algorithms yields essential insights into how the nonlinear optimization routine the core of any nonlinear model predictive controller works Accompanying software in MATLAB and C downloadable from extras springer com together with an explanatory appendix in the book itself enables readers to perform computer experiments exploring the possibilities and limitations of NMPC The second edition has been substantially rewritten edited and updated to reflect the significant advances that have been made since the publication of its predecessor including a new chapter on economic NMPC relaxing the assumption that the running cost penalizes the distance to a pre defined equilibrium a new chapter on distributed NMPC discussing methods which facilitate the control of large scale systems by splitting up the optimization into smaller subproblems an extended discussion of stability and performance using approximate updates rather than full optimization replacement of the pivotal sufficient condition for stability without stabilizing terminal conditions with a weaker alternative and inclusion of an alternative and much simpler proof in the analysis and further variations and extensions in response to suggestions from readers of the first edition Though primarily aimed at academic researchers and practitioners working in control and optimization the text is self contained featuring background material on infinite horizon optimal control and Lyapunov stability theory that also makes it accessible for graduate students in control engineering and applied mathematics *Model Predictive Control* Basil Kouvaritakis,Mark Cannon,2015-12-01 For the first time a textbook that brings together classical predictive control with treatment of up to date robust and stochastic techniques Model Predictive Control describes the development of tractable algorithms for uncertain stochastic constrained systems The starting point is classical predictive control and the appropriate formulation of performance objectives and constraints to provide guarantees of closed loop stability and performance Moving on to robust

predictive control the text explains how similar guarantees may be obtained for cases in which the model describing the system dynamics is subject to additive disturbances and parametric uncertainties Open and closed loop optimization are considered and the state of the art in computationally tractable methods based on uncertainty tubes presented for systems with additive model uncertainty Finally the tube framework is also applied to model predictive control problems involving hard or probabilistic constraints for the cases of multiplicative and stochastic model uncertainty The book provides extensive use of illustrative examples sample problems and discussion of novel control applications such as resource allocation for sustainable development and turbine blade control for maximized power capture with simultaneously reduced risk of turbulence induced damage Graduate students pursuing courses in model predictive control or more generally in advanced or process control and senior undergraduates in need of a specialized treatment will find Model Predictive Control an invaluable guide to the state of the art in this important subject For the instructor it provides an authoritative resource for the construction of courses *Predictive Control for Linear and Hybrid Systems* Francesco Borrelli,Alberto Bemporad,Manfred Morari,2017-06-22 Model Predictive Control MPC the dominant advanced control approach in industry over the past twenty five years is presented comprehensively in this unique book With a simple unified approach and with attention to real time implementation it covers predictive control theory including the stability feasibility and robustness of MPC controllers The theory of explicit MPC where the nonlinear optimal feedback controller can be calculated efficiently is presented in the context of linear systems with linear constraints switched linear systems and more generally linear hybrid systems Drawing upon years of practical experience and using numerous examples and illustrative applications the authors discuss the techniques required to design predictive control laws including algorithms for polyhedral manipulations mathematical and multiparametric programming and how to validate the theoretical properties and to implement predictive control policies The most important algorithms feature in an accompanying free online MATLAB toolbox which allows easy access to sample solutions Predictive Control for Linear and Hybrid Systems is an ideal reference for graduate postgraduate and advanced control practitioners interested in theory and or implementation aspects of predictive control **Model Predictive Control** James Blake Rawlings,David Q. Mayne,Moritz Diehl,2017 *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 **Practical Design and Application of Model Predictive Control** Nassim Khaled,Bibin Pattel,2018-05-04 Practical Design and Application of Model Predictive Control is a self learning resource on how to design tune and deploy an MPC using MATLAB and Simulink This reference is one of the most detailed publications on how to design and tune MPC controllers Examples presented range from double Mass spring system ship heading and speed control robustness analysis through Monte Carlo simulations photovoltaic optimal control and energy management of power split and air handling control Readers will also learn how to embed the designed MPC controller in a real time platform such as Arduino The selected problems are nonlinear and challenging and thus serve as an excellent experimental dynamic system to show the reader the capability of MPC The step by step solutions of the problems are thoroughly documented to allow the reader to easily replicate the results Furthermore the MATLAB and Simulink codes for the solutions are available for free download Readers can connect with the authors through the dedicated website which includes additional free resources at www practicalmpc com Illustrates how to design tune and deploy MPC for projects in a quick manner Demonstrates a variety of applications that are solved using MATLAB and Simulink Bridges the gap in providing a number of realistic problems with very hands on training Provides MATLAB and Simulink code solutions This includes nonlinear plant models that the reader can use for other projects and research work Presents application problems with solutions to help reinforce the information learned Model Predictive Control Corrine Wade,2015 Although industrial processes are inherently nonlinear many contributions for controller design for those plants are based on the assumption of a linear model of the system However in some cases it is difficult to represent a given process using a linear model Model Predictive Control MPC is an optimal control approach which can effectively deal with constraints and multivariable processes in industries Because of its advantages MPC has been widely applied in automotive and process control communities This book discusses the theory practices and future challenges of model predictive control **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 *Model Predictive Control* Carlos Bordons Alba,2012-12-06 In recent years Model Predictive Control MPC schemes have established themselves as the preferred control strategy for a large number of processes Their ability to handle constraints and multivariable processes and their intuitive way of posing the pro cess control problem in the time domain are two reasons for their popularity This volume by authors of international repute provides an extensive review concerning the theoretical and practical aspects of predictive controllers It describes the most commonly used MPC strategies especially Generalised Predictive Control GPC showing both their theoretical properties and their practical implementation issues Topics such as multivariable MPC constraint handling stability and robustness properties are thoroughly analysed in this text *Advanced Model Predictive Control* Tao Zheng,2011-07-05 Model Predictive Control MPC refers to a class of control algorithms in which a dynamic process model is used to predict and optimize process performance From lower request of modeling accuracy and robustness to complicated process plants MPC has been widely accepted in many practical fields As the guide for researchers and engineers all over the world concerned with the latest developments of MPC the purpose of Advanced Model Predictive Control is to show the readers the recent achievements in this area The first part of this exciting book will help you comprehend the frontiers in theoretical research of MPC such as Fast MPC Nonlinear MPC Distributed MPC Multi Dimensional MPC and Fuzzy Neural MPC In the second part several excellent applications of MPC in modern industry are proposed and efficient commercial software for MPC is introduced Because of its special industrial origin we believe that MPC will remain energetic in the future *Modern Predictive Control* Ding Baocang,2018-10-03 Modern Predictive Control explains how MPC differs from other control methods in its implementation of a control action Most importantly MPC provides the flexibility to act while optimizing which is essential to the solution of many engineering problems in complex plants where exact modeling is impossible The superiority of MPC is in its numerical solution Usually MPC is employed to solve a finite horizon optimal control problem at each sampling instant and obtain control actions for both the present time and a future period However only the current control move is applied to the plant This complete step by step exploration of various approaches to MPC Introduces basic concepts of systems modeling and predictive control detailing development from classical MPC to synthesis approaches Explores use of Model Algorithmic Control MAC Dynamic Matrix Control DMC Generalized Predictive Control GPC and Two Step Model Predictive Control Identifies important general approaches to synthesis Discusses open loop and closed loop optimization in synthesis approaches Covers output feedback synthesis approaches with and without a finite switching horizon This book gives researchers a variety of models for use with one and two step control The author clearly explains the variations between predictive control methods and the root of these differences to illustrate that there is no one ideal MPC

and that one should remain open to selecting the best possible model in each unique circumstance *Model-Based Predictive Control* J.A. Rossiter,2003-06-27 Model Predictive Control MPC has become a widely used methodology across all engineering disciplines yet there are few books which study this approach Until now no book has addressed in detail all key issues in the field including apriori stability and robust stability results Engineers and MPC researchers now have a volume that provides a complete overview of the theory and practice of MPC as it relates to process and control engineering Model Based Predictive Control A Practical Approach analyzes predictive control from its base mathematical foundation but delivers the subject matter in a readable intuitive style The author writes in layman s terms avoiding jargon and using a style that relies upon personal insight into practical applications This detailed introduction to predictive control introduces basic MPC concepts and demonstrates how they are applied in the design and control of systems experiments and industrial processes The text outlines how to model provide robustness handle constraints ensure feasibility and guarantee stability It also details options in regard to algorithms models and complexity vs performance issues Model Predictive Control Eduardo F. Camacho,Carlos Bordons,José M. Maestre,2026-01-01 Model Predictive Control MPC the classic textbook for students and practitioners seeking deep understanding of advanced control systems is now revised updated and reorganized in a streamlined third edition The authors renowned researchers in the field cover an extensive range of topics that embraces the basic and the advanced the theoretical and the applied The book offers advanced undergraduate and graduate students an accessible step by step approach that enables them progressively to grasp and apply the concepts they are studying For instructors this is an invaluable curriculum resource packed with examples and case studies The text features material on commercial MPC convolution models transfer functions state space models and constraints advanced topics robust and stochastic MPC and MPC for nonlinear hybrid large scale and distributed systems and applications a series of case studies in solar energy generation hospital stock control a pilot microgrid and copper processing along with exercises to help readers assess their progress many with full or partial solutions in a solutions manual downloadable by adopting instructors MATLAB programs to assist with the design aspects of the book and with reproducing some of the examples are available for readers to download Model Predictive Control third edition s distinctive strength is its real world relevance It is an essential tool for future engineers its focus on practical implementation bridging the gap between academic theory and industrial practice and supplemented by exploration of optimization and algorithm related aspects of MPC ensures a holistic treatment of the subject

Nonlinear Model Predictive Control Frank Allgöwer,Alex Zheng,2012-12-06 During the past decade model predictive control MPC also referred to as receding horizon control or moving horizon control has become the preferred control strategy for quite a number of industrial processes There have been many significant advances in this area over the past years one of the most important ones being its extension to nonlinear systems This book gives an up to date assessment of the current state of the art in the new field of nonlinear model predictive control NMPC The main topic areas that appear to

be of central importance for NMPC are covered namely receding horizon control theory modeling for NMPC computational aspects of on line optimization and application issues The book consists of selected papers presented at the International Symposium on Nonlinear Model Predictive Control Assessment and Future Directions which took place from June 3 to 5 1998 in Ascona Switzerland The book is geared towards researchers and practitioners in the area of control engineering and control theory It is also suited for postgraduate students as the book contains several overview articles that give a tutorial introduction into the various aspects of nonlinear model predictive control including systems theory computations modeling and applications **Economic Nonlinear Model Predictive Control** Timm Faulwasser,Lars Grüne,Matthias A. Müller,2018-01-12 In recent years Economic Model Predictive Control EMPC has received considerable attention of many research groups The present tutorial survey summarizes state of the art approaches in EMPC In this context EMPC is to be understood as receding horizon optimal control with a stage cost that does not simply penalize the distance to a desired equilibrium but encodes more sophisticated economic objectives This survey provides a comprehensive overview of EMPC stability results with and without terminal constraints with and without dissipativity assumptions with averaged constraints formulations with multiple objectives and generalized terminal constraints as well as Lyapunov based approaches Model Predictive Control in the Process Industry Eduardo F. Camacho,Carlos A. Bordons,2012-12-06 Model Predictive Control is an important technique used in the process control industries It has developed considerably in the last few years because it is the most general way of posing the process control problem in the time domain The Model Predictive Control formulation integrates optimal control stochastic control control of processes with dead time multivariable control and future references The finite control horizon makes it possible to handle constraints and non linear processes in general which are frequently found in industry Focusing on implementation issues for Model Predictive Controllers in industry it fills the gap between the empirical way practitioners use control algorithms and the sometimes abstractly formulated techniques developed by researchers The text is firmly based on material from lectures given to senior undergraduate and graduate students and articles written by the authors Explicit Nonlinear Model Predictive Control Alexandra Grancharova,Tor Arne Johansen,2012-03-22 Nonlinear Model Predictive Control NMPC has become the accepted methodology to solve complex control problems related to process industries The main motivation behind explicit NMPC is that an explicit state feedback law avoids the need for executing a numerical optimization algorithm in real time The benefits of an explicit solution in addition to the efficient on line computations include also verifiability of the implementation and the possibility to design embedded control systems with low software and hardware complexity This book considers the multi parametric Nonlinear Programming mp NLP approaches to explicit approximate NMPC of constrained nonlinear systems developed by the authors as well as their applications to various NMPC problem formulations and several case studies The following types of nonlinear systems are considered resulting in different NMPC problem formulations Nonlinear systems described by first principles

models and nonlinear systems described by black box models Nonlinear systems with continuous control inputs and nonlinear systems with quantized control inputs Nonlinear systems without uncertainty and nonlinear systems with uncertainties polyhedral description of uncertainty and stochastic description of uncertainty Nonlinear systems consisting of interconnected nonlinear sub systems The proposed mp NLP approaches are illustrated with applications to several case studies which are taken from diverse areas such as automotive mechatronics compressor control combustion plant control reactor control pH maintaining system control cart and spring system control and diving computers *Assessment and Future Directions of Nonlinear Model Predictive Control* Rolf Findeisen,Frank Allgöwer,Lorenz Biegler,2007-09-08 Thepastthree decadeshaveseenrapiddevelopmentin the areaofmodelpred tive control with respect to both theoretical and application aspects Over these 30 years model predictive control for linear systems has been widely applied especially in the area of process control However today s applications often require driving the process over a wide region and close to the boundaries of erability while satisfying constraints and achieving near optimal performance Consequently the application of linear control methods does not always lead to satisfactory performance and here nonlinear methods must be employed This is one of the reasons why nonlinear model predictive control NMPC has joyed signi cant attention over the past years with a number of recent advances on both the theoretical and application frontier Additionally the widespread availability and steadily increasing power of today s computers as well as the development of specially tailored numerical solution methods for NMPC bring thepracticalapplicabilityofNMPCwithinreachevenforveryfastsystems This has led to a series of new exciting developments along with new challenges in the area of NMPC **Model Predictive Control Handbook** Steve Bailey,2015-02-09 This book provides elucidative information regarding Model Predictive Control MPC Model predictive control is that part of control algorithms in which a progressive method structure is utilized to foretell and improve process work Also it can be viewed as an expression demonstrating a typical restrain scheme that replicates the human thinking capability most efficiently Nearly 50 years after its origin it is vastly being welcomed in lot of spheres of engineering and is proving to be very advantageous The book focuses on the latest developments in the field of MPC in practice and theory and structured in a way to provide in depth knowledge to the practitioners and discoverers who want to gain information about the perimeters of MPC research The book deals with the limits of MPC in theory and provides enough examples to enable us to understand them It also portrays the practical usage of MPC in recent engineering spheres As analytical and structural technology is growing rapidly MPC will remain at the forefront even in the future

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