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Dynamic Systems Models

New Methods of Parameter and State Estimation

Springer

Dynamic Systems Models Parameter Estimation

Klaus Schittkowski

Dynamic Systems Models Parameter Estimation:

Modelling and Parameter Estimation of Dynamic Systems J.R. Raol,G. Girija,J. Singh,2004-08-13 This book presents a detailed examination of the estimation techniques and modeling problems The theory is furnished with several illustrations and computer programs to promote better understanding of system modeling and parameter estimation *Dynamic Systems Models* Josif A. Boguslavskiy,2016-03-22 This monograph is an exposition of a novel method for solving inverse problems a method of parameter estimation for time series data collected from simulations of real experiments These time series might be generated by measuring the dynamics of aircraft in flight by the function of a hidden Markov model used in bioinformatics or speech recognition or when analyzing the dynamics of asset pricing provided by the nonlinear models of financial mathematics Dynamic Systems Models demonstrates the use of algorithms based on polynomial approximation which have weaker requirements than already popular iterative methods Specifically they do not require a first approximation of a root vector and they allow non differentiable elements in the vector functions being approximated The text covers all the points necessary for the understanding and use of polynomial approximation from the mathematical fundamentals through algorithm development to the application of the method in for instance aeroplane flight dynamics or biological sequence analysis The technical material is illustrated by the use of worked examples and methods for training the algorithms are included Dynamic Systems Models provides researchers in aerospatial engineering bioinformatics and financial mathematics as well as computer scientists interested in any of these fields with a reliable and effective numerical method for nonlinear estimation and solving boundary problems when carrying out control design It will also be of interest to academic researchers studying inverse problems and their solution **Identification of Dynamic Systems** Rolf Isermann,Marco Münchhof,2010-11-22 Precise dynamic models of processes are required for many applications ranging from control engineering to the natural sciences and economics Frequently such precise models cannot be derived using theoretical considerations alone Therefore they must be determined experimentally This book treats the determination of dynamic models based on measurements taken at the process which is known as system identification or process identification Both offline and online methods are presented i e methods that post process the measured data as well as methods that provide models during the measurement The book is theory oriented and application oriented and most methods covered have been used successfully in practical applications for many different processes Illustrative examples in this book with real measured data range from hydraulic and electric actuators up to combustion engines Real experimental data is also provided on the Springer webpage allowing readers to gather their first experience with the methods presented in this book Among others the book covers the following subjects determination of the non parametric frequency response fast Fourier transform correlation analysis parameter estimation with a focus on the method of Least Squares and modifications identification of time variant processes identification in closed loop identification of continuous time processes

and subspace methods Some methods for nonlinear system identification are also considered such as the Extended Kalman filter and neural networks The different methods are compared by using a real three mass oscillator process a model of a drive train For many identification methods hints for the practical implementation and application are provided The book is intended to meet the needs of students and practicing engineers working in research and development design and manufacturing PARAMETER ESTIMATION IN DYNAMIC SYSTEMS. David Burke Bartus,1987 solution of model equations *Parameter Estimation in Nonlinear Dynamic Systems* W. J. H. Stortelder,1998 **Identification of Continuous-Time Systems** Allamaraju Subrahmanyam,Ganti Prasada Rao,2019-12-06 Models of dynamical systems are required for various purposes in the field of systems and control The models are handled either in discrete time DT or in continuous time CT Physical systems give rise to models only in CT because they are based on physical laws which are invariably in CT In system identification indirect methods provide DT models which are then converted into CT Methods of directly identifying CT models are preferred to the indirect methods for various reasons The direct methods involve a primary stage of signal processing followed by a secondary stage of parameter estimation In the primary stage the measured signals are processed by a general linear dynamic operation computational or realized through prefilters to preserve the system parameters in their native CT form and the literature is rich on this aspect In this book Identification of Continuous Time Systems Linear and Robust Parameter Estimation Allamaraju Subrahmanyam and Ganti Prasada Rao consider CT system models that are linear in their unknown parameters and propose robust methods of estimation This book complements the existing literature on the identification of CT systems by enhancing the secondary stage through linear and robust estimation In this book the authors provide an overview of CT system identification consider Markov parameter models and time moment models as simple linear in parameters models for CT system identification bring them into mainstream model parameterization via basis functions present a methodology to robustify the recursive least squares algorithm for parameter estimation of linear regression models suggest a simple off line error quantification scheme to show that it is possible to quantify error even in the absence of informative priors and indicate some directions for further research This modest volume is intended to be a useful addition to the literature on identifying CT systems **Dynamic Systems Biology Modeling and Simulation** Joseph DiStefano III,2015-01-10 Dynamic Systems Biology Modeling and Simuation consolidates and unifies classical and contemporary multiscale methodologies for mathematical modeling and computer simulation of dynamic biological systems from molecular cellular organ system on up to population levels The book pedagogy is developed as a well annotated systematic tutorial with clearly spelled out and unified nomenclature derived from the author s own modeling efforts publications and teaching over half a century Ambiguities in some concepts and tools are clarified and others are rendered more accessible and practical The latter include novel qualitative theory and methodologies for recognizing dynamical signatures in data using structural multicompartmental and network models and graph theory and

analyzing structural and measurement data models for quantification feasibility The level is basic to intermediate with much emphasis on biomodeling from real biodata for use in real applications Introductory coverage of core mathematical concepts such as linear and nonlinear differential and difference equations Laplace transforms linear algebra probability statistics and stochastics topics The pertinent biology biochemistry biophysics or pharmacology for modeling are provided to support understanding the amalgam of math modeling with life sciences Strong emphasis on quantifying as well as building and analyzing biomodels includes methodology and computational tools for parameter identifiability and sensitivity analysis parameter estimation from real data model distinguishability and simplification and practical bioexperiment design and optimization Companion website provides solutions and program code for examples and exercises using Matlab Simulink VisSim SimBiology SAAMII AMIGO Copasi and SBML coded models A full set of PowerPoint slides are available from the author for teaching from his textbook He uses them to teach a 10 week quarter upper division course at UCLA which meets twice a week so there are 20 lectures They can easily be augmented or stretched for a 15 week semester course Importantly the slides are editable so they can be readily adapted to a lecturer s personal style and course content needs The lectures are based on excerpts from 12 of the first 13 chapters of DSBMS They are designed to highlight the key course material as a study guide and structure for students following the full text content The complete PowerPoint slide package 25 MB can be obtained by instructors or prospective instructors by emailing the author directly at joed cs ucla edu **Network Bioscience, 2nd Edition** Marco Pellegrini,Marco Antoniotti,Bud Mishra,2020-03-27 Network science has accelerated a deep and successful trend in research that influences a range of disciplines like mathematics graph theory physics statistics data science and computer science just to name a few and adapts the relevant techniques and insights to address relevant but disparate social biological technological questions We are now in an era of big biological data supported by cost effective high throughput genomic transcriptomic proteomic metabolomic data collection techniques that allow one to take snapshots of the cells molecular profiles in a systematic fashion Moreover recently also phenotypic data data on diseases symptoms patients etc are being collected at nation wide level thus giving us another source of highly related causal big data This wealth of data is usually modeled as networks aka binary relations graphs or webs of interactions including protein protein metabolic signaling and transcription regulatory interactions The network model is a key view point leading to the uncovering of mesoscale phenomena thus providing an essential bridge between the observable phenotypes and omics underlying mechanisms Moreover network analysis is a powerful hypothesis generation tool guiding the scientific cycle of data gathering data interpretation hypothesis generation and hypothesis testing A major challenge in contemporary research is the synthesis of deep insights coming from network science with the wealth of data often noisy contradictory incomplete and difficult to replicate so to answer meaningful biological questions in a quantifiable way using static and dynamic properties of biological networks Numerical Data Fitting in Dynamical Systems Klaus Schittkowski,2002-12-31 Real life

phenomena in engineering natural or medical sciences are often described by a mathematical model with the goal to analyze numerically the behaviour of the system Advantages of mathematical models are their cheap availability the possibility of studying extreme situations that cannot be handled by experiments or of simulating real systems during the design phase before constructing a first prototype Moreover they serve to verify decisions to avoid expensive and time consuming experimental tests to analyze understand and explain the behaviour of systems or to optimize design and production As soon as a mathematical model contains differential dependencies from an additional parameter typically the time we call it a dynamical model There are two key questions always arising in a practical environment 1 Is the mathematical model correct 2 How can I quantify model parameters that cannot be measured directly In principle both questions are easily answered as soon as some experimental data are available The idea is to compare measured data with predicted model function values and to minimize the differences over the whole parameter space We have to reject a model if we are unable to find a reasonably accurate fit To summarize parameter estimation or data fitting respectively is extremely important in all practical situations where a mathematical model and corresponding experimental data are available to describe the behaviour of a dynamical system **Simulation of Dynamic Systems with MATLAB® and Simulink®** Harold Klee,Randal Allen,2018-02-02 Continuous system simulation is an increasingly important tool for optimizing the performance of real world systems The book presents an integrated treatment of continuous simulation with all the background and essential prerequisites in one setting It features updated chapters and two new sections on Black Swan and the Stochastic Information Packet SIP and Stochastic Library Units with Relationships Preserved SLURP Standard The new edition includes basic concepts mathematical tools and the common principles of various simulation models for different phenomena as well as an abundance of case studies real world examples homework problems and equations to develop a practical understanding of concepts **Nonlinear System Identification — Input-Output Modeling Approach** Robert Haber,L. Keviczky,2012-12-22 The subject of the book is to present the modeling parameter estimation and other aspects of the identification of nonlinear dynamic systems The treatment is restricted to the input output modeling approach Because of the widespread usage of digital computers discrete time methods are preferred Time domain parameter estimation methods are dealt with in detail frequency domain and power spectrum procedures are described shortly The theory is presented from the engineering point of view and a large number of examples of case studies on the modeling and identifications of real processes illustrate the methods Almost all processes are nonlinear if they are considered not merely in a small vicinity of the working point To exploit industrial equipment as much as possible mathematical models are needed which describe the global nonlinear behavior of the process If the process is unknown or if the describing equations are too complex the structure and the parameters can be determined experimentally which is the task of identification The book is divided into seven chapters dealing with the following topics 1 Nonlinear dynamic process models 2 Test signals for identification 3

Parameter estimation methods 4 Nonlinearity test methods 5 Structure identification 6 Model validity tests 7 Case studies on identification of real processes Chapter I summarizes the different model descriptions of nonlinear dynamical systems

Dynamic Data-driven Simulation: Real-time Data For Dynamic System Analysis And Prediction Xiaolin Hu,2023-03-21 This comprehensive book systematically introduces Dynamic Data Driven Simulation DDDS as a new simulation paradigm that makes real time data and simulation model work together to enable simulation based prediction analysis The text is significantly dedicated to introducing data assimilation as an enabling technique for DDDS While data assimilation has been studied in other science fields e g meteorology oceanography it is a new topic for the modeling and simulation community This unique reference text bridges the two study areas of data assimilation and modelling and simulation which have been developed largely independently from each other *Multi-level Dynamical Parameter Estimation: Hypothesis Testing with Dynamical Systems* Henry S Harrison,2017 The practice of dynamical modeling of perception action behavior has lagged behind the proliferation of the dynamical perspective Two methodological roadblocks to dynamical modeling are discussed First parameter selection is difficult with current tools Second it is unclear what role models have in the larger scientific project beyond their use as descriptions or proofs of concept In this dissertation a new parameter selection method is developed to address these issues Multi Level Dynamical Parameter Estimation MLDPE Like its precursor DPE MLDPE uses an extended Luenberger observer to stabilize the synchronization manifold in combined model data space MLDPE also embeds a regression model into the parameter selection process allowing for parameter values to vary systematically as a function of both fixed and random effects In this way it allows for parameter dynamics to be used as dependent variables in experimental research The method is tested with three experiments In Experiment 1 a model of steering dynamics was fit to data while allowing preferred walking speed to vary by participant In this case the limitations of local search were encountered due to non smooth functions in the model equations Experiments 2 and 3 demonstrated the use of fixed effects in MLDPE using data collected in a driving simulator with a braking task Experiment 2 showed that changing the context of the task from a race to a safety test produced predictable changes in parameter values Experiment 3 tested the effects of distraction on braking replicating previous results and describing them in terms of parameter dynamics Thus MLDPE is able to select parameters using multiple observations of a system unlike previous methods Additionally it is able to detect changes in dynamics across these observations This method allows dynamical models to be used in a traditional experimental research program Possible applications and limitations of the method are discussed **Control and Dynamic Systems V30: Advances in Algorithms and Computational Techniques in Dynamic System Control Part 3 of 3** C.T. Leonides,2012-12-02 Control and Dynamic Systems Advances in Theory in Applications Volume 30 Advances in Algorithms and Computational Techniques in Dynamic Systems Control Part 3 of 3 discusses developments in algorithms and computational techniques for control and dynamic systems This volume begins with the issue of decision making or optimal

control in the natural environment It then discusses large scale systems composed of multiple sensors algorithms for systems with multiplicative noise stochastic differential games Markovian targets low cost microcomputer and true digital control systems and algorithms for the design of teleoperated systems This book is an important reference for practitioners in the field who want a comprehensive source of techniques with significant applied implications *Modeling, Identification and Simulation of Dynamical Systems* P. P. J. van den Bosch,A. C. van der Klauw,2020-12-17 This book gives an in depth introduction to the areas of modeling identification simulation and optimization These scientific topics play an increasingly dominant part in many engineering areas such as electrotechnology mechanical engineering aerospace and physics This book represents a unique and concise treatment of the mutual interactions among these topics Techniques for solving general nonlinear optimization problems as they arise in identification and many synthesis and design methods are detailed The main points in deriving mathematical models via prior knowledge concerning the physics describing a system are emphasized Several chapters discuss the identification of black box models Simulation is introduced as a numerical tool for calculating time responses of almost any mathematical model The last chapter covers optimization a generally applicable tool for formulating and solving many engineering problems **Identification and System Parameter Estimation** ,1989

Nonlinear Dynamics and Entropy of Complex Systems with Hidden and Self-excited Attractors Christos Volos,Sajad Jafari,Jacques Kengne,Jesus M. Munoz-Pacheco,Karthikeyan Rajagopal,2019-05-03 In recent years entropy has been used as a measure of the degree of chaos in dynamical systems Thus it is important to study entropy in nonlinear systems Moreover there has been increasing interest in the last few years regarding the novel classification of nonlinear dynamical systems including two kinds of attractors self excited attractors and hidden attractors The localization of self excited attractors by applying a standard computational procedure is straightforward In systems with hidden attractors however a specific computational procedure must be developed since equilibrium points do not help in the localization of hidden attractors Some examples of this kind of system are chaotic dynamical systems with no equilibrium points with only stable equilibria curves of equilibria and surfaces of equilibria and with non hyperbolic equilibria There is evidence that hidden attractors play a vital role in various fields ranging from phase locked loops oscillators describing convective fluid motion drilling systems information theory cryptography and multilevel DC DC converters This Special Issue is a collection of the latest scientific trends on the advanced topics of dynamics entropy fractional order calculus and applications in complex systems with self excited attractors and hidden attractors *Numerical Data Fitting in Dynamical Systems* Klaus Schittkowski,2002-12-31 Real life phenomena in engineering natural or medical sciences are often described by a mathematical model with the goal to analyze numerically the behaviour of the system Advantages of mathematical models are their cheap availability the possibility of studying extreme situations that cannot be handled by experiments or of simulating real systems during the design phase before constructing a first prototype Moreover they serve to verify decisions

to avoid expensive and time consuming experimental tests to analyze understand and explain the behaviour of systems or to optimize design and production As soon as a mathematical model contains differential dependencies from an additional parameter typically the time we call it a dynamical model There are two key questions always arising in a practical environment 1 Is the mathematical model correct 2 How can I quantify model parameters that cannot be measured directly In principle both questions are easily answered as soon as some experimental data are available The idea is to compare measured data with predicted model function values and to minimize the differences over the whole parameter space We have to reject a model if we are unable to find a reasonably accurate fit To summarize parameter estimation or data fitting respectively is extremely important in all practical situations where a mathematical model and corresponding experimental data are available to describe the behaviour of a dynamical system **Dynamic Modeling, Parameter Estimation, and Uncertainty Analysis in R** Daniel Kaschek,Wolfgang Mader,Mirjam Fehling-Kaschek,Marcus Rosenblatt,Jens Timmer,2019 Abstract In a wide variety of research fields dynamic modeling is employed as an instrument to learn and understand complex systems The differential equations involved in this process are usually non linear and depend on many parameters whose values determine the characteristics of the emergent system The inverse problem i e the inference or estimation of parameter values from observed data is of interest from two points of view First the existence point of view dealing with the question whether the system is able to reproduce the observed dynamics for any parameter values Second the identifiability point of view investigating invariance of the prediction under change of parameter values as well as the quantification of parameter uncertainty In this paper we present the R package dMod providing a framework for dealing with the inverse problem in dynamic systems modeled by ordinary differential equations The uniqueness of the approach taken by dMod is to provide and propagate accurate derivatives computed from symbolic expressions wherever possible This derivative information highly supports the convergence of optimization routines and enhances their numerical stability a requirement for the applicability of sophisticated uncertainty analysis methods Computational efficiency is achieved by automatic generation and execution of C code The framework is object oriented S3 and provides a variety of functions to set up ordinary differential equation models observation functions and parameter transformations for multi conditional parameter estimation The key elements of the framework and the methodology implemented in dMod are highlighted by an application on a three compartment transporter model Identification and System Parameter Estimation Rolf Isermann,1980

Dynamic Systems Models Parameter Estimation Book Review: Unveiling the Power of Words

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