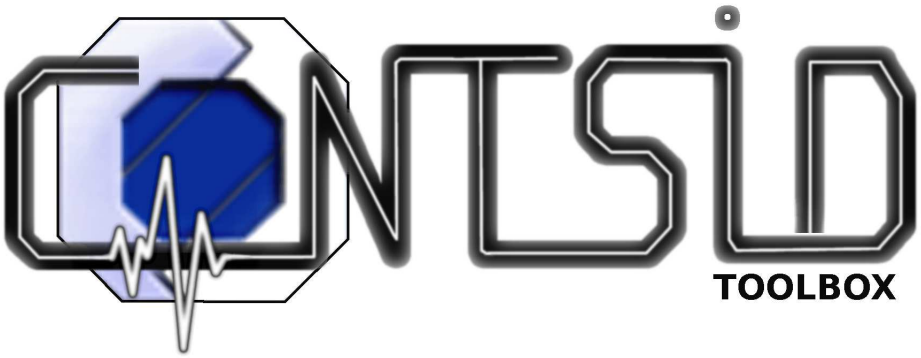
Short Course

on

Continuous-time System Identification. Theory and Practice



Instructors:

Hugues Garnier & Marion Gilson

Research Center for Automatic Control of Nancy
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Overview

This course teaches the theory and practice of building mathematical continuous-time models based on measured sampled data, a topic also known as Continuous-time System Identification.

The course includes relevant theory and background, but focuses mainly on practical approaches and solutions. All aspects of continuous-time system identification are included: experiment design, data handling, model formulation, model parameter estimation, model validation, and applications.

First the focus is to introduce the participants how to identify good continuous-time models for linear dynamic systems. The course offers an in-depth survey of reliable instrumental variable (IV) estimation techniques to identify the parameters of continuous-time transfer function models. The course will take the participants from the basic IV estimator up to powerful and recent developments for handling more difficult situations (such as nonlinear model identification) which is the scope of the second part of the course.

The course includes instruction in the use of a MATLAB® toolbox called CONTSID (CONtinuous-Time System IDentification), which is composed of a wide variety of tools developed at the Research Center for Automatic Control of Nancy for system identification problems.

The course also includes practical computer exercice experience, allowing participants to become familiar with the use of the CONTSID software on real data and to interpret the results.

Who should attend?

The course will be useful to engineers or control system designers and anyone who needs to identify high fidelity mathematical models based on measured data, or understand how it can be done efficiently and accurately.

This course is also appropriate to advanced Master and PhD students with a solid background in control theory or researchers from both industry or university.

Course outline

- Day 1
  - Morning session
    - Theme 1 (2 hours): Overview and advantages of continuous-time approaches for black-box linear transfer function model identification. Traditional SVF-based estimators - Optimal Instrumental Variable (IV) estimators. Model structure selection and model validation. The CONTSID toolbox - a guided tour
    - Theme 2 (2 hours): Extensions of IV methods to handle more advanced situations. Frequency domain data. Irregularly sampled data. Simple process models with delay. Box-Jenkins models for colored measurement noise. MISO systems. Linear Time-Varying (LTV) systems via recursive identification.
  - Afternoon session
    - Computer exercise 1 (2 hours): Hands on identification of continuous-time linear model identification. Experience on model order selection and real data.
    - Computer exercise 2 (2 hours): Hands on more advanced methods and recursive identification.

- Day 2
  - Morning session
    - Theme 3 (2 hours): More on linear continuous-time models. Closed-loop system identification. Optimal instrumental variable (IV) estimators. Two-stage IV-based approach.
    - Theme 4 (2 hours): Non-linear continuous-time model identification. Instrumental variable methods for block-oriented and Linear Parameter Varying (LPV) system identification.
  - Afternoon session
    - Computer exercise 4 (2 hours): Hands on identification of closed-loop model identification.
    - Computer exercise 4 (2 hours): Hands on identification of Hammerstein and LPV model identification.

Instructors

Marion Gilson and Hugues Garnier, both Professor at University of Lorraine, France will be the instructors for the course.

Marion Gilson received the M.S. degree in Control Engineering and Signal Processing in 1997, the Ph.D. degree in Automatic Control in 2000, and the Habilitation á Diriger des Recherches from Henri Poincaré University in Nancy, France in 2010.
She has been with the Research Center for Automatic Control of Nancy, at the University of Lorraine since 1997, where she is currently a full Professor. She is an associate Editor for Control Engineering Practice. In the last two decades, she has held visiting positions at different universities including Delft University of Technology (several months in 2003, 2005, 2008) and the University of Newcastle, Australia in 2012.

Hugues Garnier is Professor at the University of Lorraine in France. In 1995 he received a Ph.D. in Automatic Control from the Henri Poincaré University in Nancy, France.
He is a member of the Editorial Board of International Journal of Control. In the last two decades, he has held visiting positions at different universities including U.K., Australia and the U.S.A. In 1993, he visited the Industrial Control Centre at the University of Strathclyde in Glasgow, Scotland. In 2004, he visited the Centre for Complex Dynamic Systems and Control, University of Newcastle, Australia. In 2006 and 2007, he has held short term visiting positions at the Royal Melbourne Institute of Technology. In 2013, he visited the Department of Mechanical & Aerospace Engineering, University of California, San Diego (UCSD), USA.

Marion Gilson and Hugues Garnier's main research interest is related to the analysis and modelling of stochastic dynamical systems. This includes time series analysis and prediction, parameter estimation and system identification. They use system identification techniques to develop models to simulate, monitor, predict and control a variety of dynamical systems.

Frequently Asked Questions

What is the title of the course?

Continuous-time System Identification - Theory and Practice

What is System Identification?

System Identification is building a mathematical model that mimics the behavior of a physical system, based on measured data.
It is an interactive and systematic way of modeling system behavior by estimating dynamic models on the basis of experimental input/output data. Due to inherent experiment based nature of his research, the techniques can be applied to a wide variety of dynamical systems and include problems such as dynamic modeling for control, health monitoring or fault detection.

How long does the course last?

The course can be tailored to 1, 2, or 3 days, 8 hours per day. As the course length increases, the material is covered more completely and at a slower pace.

Who are the instructors?

Professors Marion Gilson and Hugues Garnier, both from University of Lorraine, France, are the instructors for the course. Their works include over 20 years of research and technical consulting in the areas of data-driven dynamic system identification.
Both have taught classes and given technical lectures for over 20 years, and have plenty of real-life stories that illustrate "lessons learned" and "best practices", gained from many years of practical experience.
They are the authors of CONTSID, a software toolbox written in MATLAB® and used at many organizations worldwide to solve system identification problems. CONTSID is the software package used for the practical hands-on work in the course.

What exactly does the course cover?

This course teaches the theory and practice of building mathematical continuous-time models based on measured data.
It includes relevant theory and background, but focuses mainly on practical approaches and solutions.
All aspects of system identification are included: experiment design, data handling, formulating the model, estimating model parameters, model validation techniques, and practical uses of modeling results.
Course notes and a practical hands-on book with an accompanying MATLAB® software toolbox are the materials for the course.
The software includes a wide variety of tools developed at the Research Center for Automatic Control of Nancy to solve system identification problems. The course also includes practical hands-on experience, to allow participants to become familiar with the use of the software on real data and to properly interpret results.

Are there any computer requirements for the course?

There are no computer requirements for the course. Software associated with the course is called CONtinuous-Time System IDentification (CONTSID) toolbox. CONTSID is a collection of more than 200 MATLAB® programs that perform various tasks associated with continuous-time system identification from sampled.
The CONTSID toolbox has successfully used to solve real-world problems. Participants are invited to take their own computer with MATLAB® installed (the MATLAB® Control and System Identification toolboxes are required) and bring their own data and modeling problems to class. This is very highly recommended, but not required. Real-world data sets included in CONTSID are used for the practical examples in class. The course will include substantial hands-on learning using CONTSID.

What materials are provided to the participants?

Each participant receives a hard copy of all class notes and exercises along with a copy of the latest version of the CONTSID software.
More information on CONTSID can be found at http://www.cran.univ-lorraine.fr/contsid/.

Who should I contact about the course scheduling and cost?

Prof. Hugues Garnier
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http://w3.cran.univ-lorraine.fr/perso/hugues.garnier/HGPerso-eng.html

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