Tutorial:
Modeling and System Identification with the CRONE toolbox

Organizers:

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Abstract: This tutorial is intended to Researchers, Ph.D. and Master students, Engineers, who wish to utilize a user-friendly CRONE toolbox under Matlab, for their various applications of fractional derivatives in modeling and system identification.

Tutorial identification code:

Abstract of the tutorial and general schedule:

Fractional (or non-integer) differentiation has played an important role in various fields notably in signal and image processing and control theory. In these last fields, important considerations such as modeling, system identification and observability are now linked to long-range dependence phenomena. It is expected that such an open invited track attracts new researchers and developers that use fractional calculus in the areas of mathematics, physics, engineering and particularly in automatic control.

The latest developments for continuous-time modeling and system identification with fractional order models are proposed in the newest CRONE toolbox (version 2.0). Fully compatible with the latest Matlab® versions (since 2020a), it includes time-domain identification algorithms for estimating continuous-time models. Thanks to this new programming, the options arguments of the proposed functions have been simplified and updated. In order to help a new user, a tutorial has been completely revised as the CRONE demos command which allows handling the new options.
A Guided User Interface (GUI) is now available, as the CroneIdentification application so that a user, familiar with the Matlab SystemIdentification GUI, can easily handle the system identification methods for preprocessing data, defining a model structure and estimating as well the coefficients as the differentiation orders.

This tutorial prepares the audience with:

1. System modeling with the different classes (*frac_poly_exp, frac_tf, frac_lti*…)
2. Simulation of fractional order models
3. System Identification with fractional order model: coefficient and order estimations
4. *CroneIdentification* application

Description of the intended audience and the expected learning outcomes:

Graduate students, postdocs, engineers, and faculty members dealing with modeling of complex systems, health monitoring, system identification, prediction and predictive maintenance tasks.

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Program (half day):

Modeling of fractional order systems
System identification with fractional order models
CRONE toolbox presentation
CRONE toolbox: practical work
Applications system identification with fractional order models: global warming, wind turbulence modeling, heat transfers in lungs, battery, COVID-19 spreading, …

Expected learning outcomes:

1. Basic knowledge on fractional calculus
2. Basic knowledge on modeling dynamical fractional order systems
3. Basic knowledge on system identification with fractional order models
4. Basic knowledge on handling CRONE toolbox

Desired prerequisite knowledge of the audience:

1. Basic knowledge on signals and systems, automatic control, Laplace transform,
2. Optional: optimization, signal processing

Brief biographies:

Stéphane Victor graduated from Bordeaux INP/ENSEIRB-MATMECA and Ecole Polytechnique de Montréal engineering schools in 2006, and obtained his M.Sc. and Ph.D. degrees in Automatic control from Univ. Bordeaux in 2006 and 2010. He received his Accreditation to supervise research (HDR) from Univ. Bordeaux in 2022. He is currently Associate Professor and has joined the CRONE team of IMS laboratory at Univ. Bordeaux in 2006. His research interests are in the area of fractional differentiation and its applications in automatic control, system identification, thermal systems, autonomous vehicle, trajectory planning and motion planning with flatness. He is a member of two IFAC technical committees, namely 1.1 ‘‘Modelling, Identification and Signal Processing’’ and 2.2 ‘‘Linear Control Systems’’.