PhD thesis
on
Gray box model learning with convex relaxation

We have a vacancy for a PhD student (3 years) in a joint research project between the LIAS laboratory (Université de Poitiers) and the System Identification and Control (SIC) group in Politecnico di Torino.

Keywords: dynamical model learning, numerical optimization, convex relaxation, linear algebra

Project description

Model learning (or system identification) consists in accurately estimate the parameters of dynamical models (used, e.g., to mimic the behavior of complex systems) from experimentally collected data and some prior information. Model structures encountered in system identification are often divided into three classes: white (model structure entirely based on physical equations), black (mathematical model structure with no relation with the physical equations) and gray-box models. In this project, a specific attention is paid to gray-box models, i.e., models whose structure is partially governed by some prior physical knowledge and/or first principles. Accurately estimating the parameters of a gray-box linear time-invariant state-space representation is a challenging problem especially if the number of unknowns exceeds ten, due to the fact that the model equations typically depend nonlinearly on physical parameters to be estimated. Standard nonlinear (local) optimization-based procedures often fail because the initial guesses are not in the domain of attraction of the user-defined cost function global minimum. The main goal of this project is to overcome such issues by combining linear algebra and convex-relaxation based set membership solutions which have proved their efficiency in several applied data driven modeling problems in the recent years. The activity will be developed in the context of a collaboration between the Department of Control and Computer Engineering of Politecnico di Torino and the Laboratory of Computer Science and Automatic Control for Systems of Poitiers University. In a nutshell, the proposed research project is focused on combining the theoretical results and numerical algorithms developed by both research groups for proposing novel effective approaches for gray-box model learning able to overcome limitation of the methods already available in the literature.

The possibly involved industries/companies are Fiat Chrysler Automobile and Fiat Research Center, which have collaborated with the Department of Control and Computer Engineering of Politecnico di Torino continuously in the last decade, which will be involved in the application of the derived algorithms to different modeling, identification and control problems arising in the automotive fields.

Supervision team

This PhD project will be supervised both by academic partners.
The project will be supervised by G. Mercère (Associate Professor at the University of Poitiers) and D. Regruto (Associate Professor at Politecnico di Torino). Their expertise covers the different control engineering aspects present in this research project (data-based modeling, numerical optimization, convex relaxation, linear algebra). *The PhD student will be registered at the Graduate School of Poitiers University and of Politecnico di Torino (co-tutelle).*

**Appointment**

This challenging job is based on a fixed-term appointment for a period of three years (preferred starting date: November 2020) during which the PhD candidate will be able to gain both academic and industrial experience.

**Candidate requirements**

Applicants should have an MSc degree in engineering from a good-quality engineering school. They should possess a strong background and interest in mathematics and, ideally, in system identification and advanced control. They should have excellent analytical and problem solving skills and, preferably, well-developed programming skills. Applicants should have a good knowledge of Matlab. The candidate should have excellent oral and written communication skills in English.

**Application procedure**

If you are interested by this challenging project, please contact G. Mercère ([guillaume.mercere@univ-poitiers.fr](mailto:guillaume.mercere@univ-poitiers.fr)) and D. Regruto ([diego.regruto@polito.it](mailto:diego.regruto@polito.it)) by email with subject "gray box model learning with convex relaxation", attaching an academic CV, a cover letter, a pdf of your diplomas and transcript of course work and grades, a recommendation letter from your MSc thesis’ supervisor, a certificate of proficiency in English, as well as any other document which can enrich the application.