Ph.D. in Information Technology
Thesis Defenses

February 14, 2023
at 15:00
Room Conferenze "Emilio Gatti"

Fabio BONASSI – XXXV Cycle

RECONCILING DEEP LEARNING AND CONTROL THEORY: RECURRENT NEURAL NETWORKS FOR MODEL-BASED CONTROL DESIGN

Supervisor: Prof. **Riccardo Scattolini**

Abstract:

In this dissertation, we investigate the use of recurrent neural networks for the identification and model-based control of nonlinear dynamical systems. To this end, we first show how recurrent neural network models can be used for system identification procedures. To ensure their safety and robustness against input perturbations, their stability properties, such as Input-to-State Stability (ISS) and Incremental Input-to-State Stability (δISS), are investigated, and a methodology for training networks that provenly enjoy these properties is devised. Based on these stable models, control laws, such as Nonlinear Model Predictive Control and Internal Model Control, are then proposed, showing that a suitable design of these controllers allows to guarantee desirable closed-loop stability properties.

Lorenzo Jr SABUG – XXXV Cycle

ON DATA-DRIVEN OPTIMIZATION IN THE DESIGN AND CONTROL OF AUTONOMOUS SYSTEM

Supervisor: Prof. **Lorenzo Fagiano**

Abstract:

We present a new framework for data-driven optimization called the Set Membership Global Optimization (SMGO), geared towards problems where the optimization objective and constraints cannot be explicitly expressed mathematically, and should be evaluated by performing expensive experiments and/or simulations. Taking a Lipschitz continuity assumption, a Set Membership-based model is built from the data set. In choosing a candidate point for sampling, SMGO automatically trades off between exploitation of the current best feasible data point, and exploration around the search space to acquire more information about the shape of the pertinent hidden functions. We investigate the theoretical convergence properties of SMGO, as well as its practical implementation concerns, including a novel approach for treating time-varying problems. The effectiveness of the proposed method is verified and validated in the context of a benchmark test, in comparison with other state-of-the-art methods. Lastly, we present SMGO's performance in solving challenging practical optimization problems with real-life experiments.

PhD Committee
Prof. **Simone Garatti,** DEIB - Politecnico di Milano
Prof. **Eric Kerrigan**, Imperial College London
Prof. **Lalo Magni**, Universita' degli Studi di Pavia