PhD Student Position

Distributed Optimal Control for Complex Systems

Context and Objectives:

The wide deployment of connected and controllable assets at the individual scale incurs new challenges in the operation and management of legacy systems in which they are integrated. Thus, many infrastructures can be considered as *system of systems or complex systems in short*. In such frameworks, decisions taken at the individual level may have a significant impact on the overall system's behaviour. It is especially true for all the networked environments such as energy infrastructures or transportation. As an example, the push for small scale renewable based generation endanger the operations of the macroscopic electrical grid with additional uncertainty and variability. Flexibility shall then be leveraged at the individual scale with an appropriate coordination that ultimately ensures the global balance between the supply and demand of energy.

The objective of this project is the implementation of a methodology for distributed control in such complex systems. Mathematically, an equilibrium shall be reached at the global system scale while taking into account individual objectives and potential constraints. A specific attention will be paid to the information and coordination signals exchanged between the different stakeholders. The developed methods will highly rely on distributed optimization, game theory and iterative processes.
At the individual system scale, we will adapt a Hybrid-AI based optimization methodology for local decision making. In the DesCartes program, Hybrid-AI represents a modelling and decision-making framework that combines physics-based first principal models with data-driven AI based residual models to accurately model the underlying system dynamics. In our project, we will adapt this Hybrid-AI framework to develop an optimal decision-making methodology for the local scale. These decisions will then be integrated at the global system scale using a target cascading approach, to achieve optimal distributed control.

Expected Profile and Skills :

- Applicants should hold a MsC in Applied Mathematics or Computer Science
- Knowledge and strong interest in optimal control and/or optimisation and/or Machine Learning will be appreciated.
- Simulation/modelling and development tools – Matlab, Python, Java, C, etc; Mathematical Language Programming and experience in optimization solvers would be a plus – GAMS, Julia, YALMIP, CPLEX, GUROBI, GLPK, among others.
- Strong analytical and communication skills, ability to present clearly and concisely. Good writing and oral skills for efficient communication in international conferences and publications in scientific journals.
- Ability to work in an international environment, learn from experienced researchers and transfer knowledge.

Working Conditions :

The successful candidate will be enrolled for a 3 years, full-time PhD, hosted at G2ELab, Grenoble, France and CNRS@CREATE, Singapore. The candidate will receive a dual PhD degree, jointly with Nanyang Technological University (NTU), Singapore.