

The Delft Center for Systems and Control (DCSC) of Delft University of Technology, The Netherlands has three vacancies for 4-year **PhD positions** on

## **Integrated optimization-based and learning-based control of networks with hybrid dynamics**

### **Project description**

These 3 PhD projects are part of the European ERC Advanced Grant project CLariNet – a novel control paradigm for large-scale hybrid networks. The goal of CLariNet is to create a completely new paradigm for control of large-scale networks with hybrid dynamics by bridging the gap between optimization-based control and learning-based control. The breakthrough idea is to bridge that gap by using piecewise affine models and to unite the optimality of optimization-based control with the on-line tractability of learning-based control.

The 3 projects all have a strong fundamental flavor. In addition, applications for the case studies include multi-modal transportation networks and smart multi-energy networks.

### **Topic 1: Multi-agent integrated optimization-based and learning-based control for large-scale networks with hybrid dynamics**

In this PhD project we will develop integrated optimization-based and learning-based control methods for large-scale hybrid systems – in particular piecewise affine (PWA) systems. More specifically, the aim is to develop several innovative approaches to combine model predictive control (MPC) and reinforcement learning so as to merge the advantages of both approaches, and to embed them in a distributed/multi-agent control setting. The main challenge will be to determine efficient approaches to obtain coordination among the control agents.

### **Topic 2: Integrated optimization-based and learning-based control for constrained hybrid systems in the presence of uncertainty**

In this PhD project we will develop integrated optimization-based and learning-based control methods for hybrid systems – in particular piecewise affine (PWA) systems, in the presence of (stochastic) uncertainty and subject to input, output, and state constraints. The idea is to integrate scenario-based chance-constrained model predictive control (MPC) with learning-based control approaches. This also includes methods to efficiently obtain sets of representative scenarios that are rich enough so that performance guarantees can be given, and that be extracted in an efficient way from the huge amount of historical data that is available.

### **Topic 3: Performance analysis of integrated optimization-based and learning-based control for constrained hybrid systems**

In this PhD project we will analyze and prove formal properties of integrated optimization-based and learning-based control methods for piecewise affine (PWA) systems subject to input, output, and state constraints. We will consider issues such as stability, computational complexity, error bounds, formal or probabilistic performance guarantees, robustness, finite termination effects, safety, etc. We will also investigate and characterize the various trade-offs (e.g., between allowed computation time and control performance/constraint violations).

### **What do we ask?**

We are looking for a candidate with an MSc degree in systems and control, applied mathematics, computer science, electrical engineering, or a related field, and with a strong background or interest in

- distributed control, machine learning, and (distributed) optimization (for Topic 1);
- stochastic control and machine learning (for Topic 2);
- systems & control, machine learning, and formal analysis (for Topic 3).

The candidate is expected to work on the boundary of several research domains. A good command of the English language is required.

### **What do we offer?**

We offer the opportunity to do scientifically challenging research in a multi-disciplinary research group. The appointment will be for up to 4 years. The PhD student will also be able to participate in the research school DISC (<https://www.disc.tudelft.nl>). As an employee of the university you will receive a competitive salary starting of EUR 2443 gross per month in the first year and rising to a maximum of 3122 gross per month based on a full-time appointment, as well as excellent secondary benefits in accordance with the Collective Agreement (CAO) of the Association of Universities in the Netherlands (VSNU). Assistance with accommodation can be arranged.

### **How to apply?**

Are you interested in this vacancy? Please apply by June 5, 2022 via the application website and upload your letter of application along with a detailed curriculum vitae, an indication of which of the topic(s) you want to apply for, a motivation why the proposed research topic(s) interest you, a list of publications (if applicable), the abstract and/or summary of your MSc thesis, your BSc and MSc course program and the corresponding marks, names and addresses of two to three reference persons, and all other information that might be relevant to your application.

More information on this position can be obtained from Bart De Schutter (email: [b.deschutter\\_at\\_tudelft.nl](mailto:b.deschutter_at_tudelft.nl)).

The application deadline for the position is June 5, 2022. However, the position will stay open until a suitable candidate has been found.