

Data-driven control

Dates and time

12-10-2026

19-10-2026

26-10-2026

02-11-2026

From 10.15-12.30 hrs

Course location

Cursus- en vergadercentrum Domstad, Utrecht

ECTS

3 ECTS if the homework is completed successfully

1 ECTS for auditing the entire course

Lecturers

Dr. Henk van Waarde, University of Groningen

Prof. Kanat Camlibel, University of Groningen

Dr. Valentina Breschi, TU Eindhoven

Course description

Controllers for dynamical systems are often designed on the basis of a mathematical model of the to-be-controlled system. However, obtaining a model can be a tedious process, for example because the complexity of the system prevents first-principles modelling. In the absence of a reliable model, data-driven approaches are a viable alternative to their model-based counterparts. It is challenging, however, to ensure that data-driven methods come with the same stability and performance guarantees that are traditionally associated with model-based control. This course provides a comprehensive introduction to the principles and methods of data-driven control. Students will delve into various methods, such as data-driven stabilisation, regulation and predictive control, as well as their theoretical underpinnings like persistency of excitation, the fundamental lemma, and matrix versions of Yakubovich' S-lemma. The homework exercises will provide a deepening of the theory developed in class, as well as simulations that aim at applying data-driven control techniques.

Contents

Lecture 1 - Introduction to data-driven control:

1. Historical perspective
2. Data informativity framework
3. Data-driven analysis of stability, stabilizability and controllability
4. Data-driven stabilization and linear quadratic regulation

Lecture 2 - Robustness to noise:

1. Noise models and quadratic matrix inequalities
2. Matrix S-lemmas
3. Data-driven quadratic stabilization with noisy data

Lecture 3 - Advanced topics:

1. Data-driven optimal control with noisy data
2. Data-driven dissipativity analysis
3. Data-driven control with noisy input-output data

Lecture 4 - Data-driven predictive control:

1. Data-driven predictive control: the deterministic setting
2. Towards a stochastic setting: handling noise with regularization
3. Properties and guarantees
4. Data-driven predictive control in a stochastic setting

Course materials

We will use the book “Data-based linear systems and control theory”, available online via [this website](#). Additional lecture notes and slides will be distributed during the course.

Prerequisites

The course is theoretical in nature and requires a good command of linear algebra and linear systems theory, including state-space models, controllability and observability, and stabilisation.

Homework assignments

There are two homework sets, which will be distributed via the course platform.