

# Model Predictive Control and Reinforcement Learning

– Welcome and introduction –

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Armin Nurkanović, Dirk Reinhardt

Fall School on Model Predictive Control and Reinforcement Learning  
Freiburg, 7-16 October 2026

universität freiburg



NTNU

Norwegian University of  
Science and Technology

## Lecturers



**Joschka  
Bödecker**

University of Freiburg



**Moritz  
Diehl**

University of Freiburg



**Sebastien  
Gros**

NTNU Trondheim



**Armin  
Nurkanović**

University of Freiburg



**Dirk  
Reinhardt**

CorPower Ocean

## Organizers



**Leonard  
Fichtner**

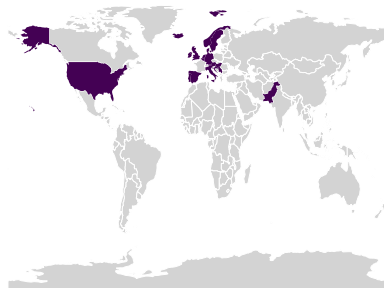
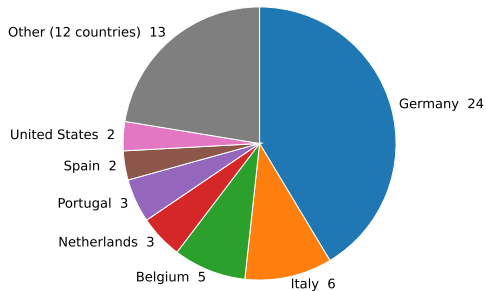
University of Freiburg



**Jasper  
Hoffmann**

University of Freiburg

# The Participants



59 registered participants with affiliations in 19 countries, 24 of them in Germany.



## Week 1: Introduction to MPC and RL

- ▶ Dynamic systems, simulation, numerical optimization
- ▶ MDPs, dynamic programming, LQR
- ▶ Monte Carlo, TD, Q-learning, function approximation, actor-critic

## Week 2: Topics in MPCRL

- ▶ Real-time NMPC, differentiable programming
- ▶ Synthesis of MPC and RL, why does it work?
- ▶ Safety, stability, sensitivities, open questions, diffusion

## Lectures and exercises

- ▶ Every day two lectures and two hands-on sessions
- ▶ Exercises in Python with `casadi`, `torch`, `acados` and `leap-c`

## Projects

- ▶ Brainstorming from Thursday 8 October
- ▶ Kick-off Wednesday 14 October, then project work and research shorts
- ▶ Presentations on Friday 16 October

**Micro exam:** Friday 16 October, 9:00–9:30

| Week 1 - Introduction to MPC and RL<br>Faculty of Engineering (HS 00 026 - Buil. 101) |                                                                                             |                                                                                  |                                                        | Week 2 - Topics in MPCRL<br>Historical University (HS 1015 - Buil. KG I) |                                                                     |                                                                       |                                                                                                         |                                            |
|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|--------------------------------------------------------|--------------------------------------------------------------------------|---------------------------------------------------------------------|-----------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|--------------------------------------------|
|                                                                                       | Wed 7-Oct                                                                                   | Thu 8-Oct                                                                        | Fri 9-Oct                                              | Mon 12-Oct                                                               | Tue 13-Oct                                                          | Wed 14-Oct                                                            | Thu 15-Oct                                                                                              | Fri 16-Oct                                 |
| 09:00<br>-<br>10:30                                                                   | Welcome +<br>Lecture 1<br>Dynamic<br>Systems and<br>Simulation (AN)                         | Lecture 3<br>MDPs, Dynamic<br>Programming<br>and LQR (JH)                        | Lecture 5<br>RL with Function<br>Approximation<br>(JB) | Lecture 7 Real-<br>Time Algorithms<br>for NMPC (MD)                      | Lecture 9<br>Synthesis of<br>MPCRL<br>(DR)                          | Lecture 11<br>Safety, Stability,<br>Role of the model<br>(SG)         | Lecture 13<br>Sensitivities of<br>model-based<br>policy<br>optimization and<br>its applications<br>(SG) | Micro Exam<br>9:00 - 9:30                  |
|                                                                                       |                                                                                             |                                                                                  |                                                        |                                                                          |                                                                     |                                                                       |                                                                                                         | Podium<br>Discussion                       |
|                                                                                       | Break                                                                                       | Break                                                                            | Break                                                  | Coffee Break                                                             | Coffee Break                                                        | Coffee Break                                                          | Coffee Break                                                                                            | Coffee Break                               |
| 11:00<br>-<br>12:30                                                                   | Exercise 1<br>Dynamic<br>Systems and<br>Simulation with<br>casadi                           | Exercise 3<br>Value Iteration<br>and LQR                                         | Exercise 5<br>DQN with torch                           | Exercise 7<br>Designing an<br>OCP with<br>acados                         | Exercise 9<br>MPC-SAC with<br>leap-c                                | Project Kick-off                                                      | Project Work                                                                                            | Project Work /<br>Project<br>Presentations |
|                                                                                       |                                                                                             |                                                                                  |                                                        |                                                                          |                                                                     |                                                                       |                                                                                                         |                                            |
|                                                                                       | Lunch                                                                                       | Lunch                                                                            | Lunch                                                  | Lunch                                                                    | Lunch                                                               | Lunch                                                                 | Lunch                                                                                                   | Lunch                                      |
| 14:00<br>-<br>15:30                                                                   | Lecture 2<br>Numerical<br>Optimization<br>(AN) @KG I                                        | Lecture 4<br>Monte Carlo RL,<br>Temporal<br>Difference and<br>Q-Learning<br>(JH) | Lecture 6<br>Actor-Critic<br>Methods<br>(JB)           | Lecture 8<br>Differentiable<br>Programming<br>(MD)                       | Lecture 10<br>RLMPC: Why<br>does it work<br>(fundamentals)?<br>(SG) | Lecture 12<br>RLMPC: Open<br>Questions &<br>Future Directions<br>(SG) | Lecture 14<br>Tutorial on<br>Diffusion<br>(JH)                                                          | Project<br>Presentations                   |
|                                                                                       |                                                                                             |                                                                                  |                                                        |                                                                          |                                                                     |                                                                       |                                                                                                         |                                            |
|                                                                                       | Break                                                                                       | Break                                                                            | Break                                                  | Coffee Break                                                             | Coffee Break                                                        | Coffee Break                                                          | Coffee Break                                                                                            |                                            |
| 16:00<br>-<br>17:30                                                                   | Instead of<br>Exercise 2: <a href="#">Talk<br/>by Richard D.<br/>Braatz (MIT)<br/>@KG I</a> | Exercise 4<br>Q-learning                                                         | Exercise 6<br>DDPG with<br>torch                       | Exercise 8<br>Differentiable<br>MPC with<br>acados                       | Exercise 10<br>Imitation<br>Learning with<br>leap-c                 | Project Work                                                          | Project Work                                                                                            |                                            |
|                                                                                       |                                                                                             |                                                                                  |                                                        |                                                                          |                                                                     |                                                                       |                                                                                                         |                                            |
|                                                                                       | Apero                                                                                       | Project<br>Brainstorming                                                         | Project<br>Brainstorming                               | Project<br>Brainstorming                                                 | Project<br>Brainstorming                                            | Research<br>Shorts                                                    | Research<br>Shorts                                                                                      |                                            |
|                                                                                       |                                                                                             |                                                                                  |                                                        | Break                                                                    |                                                                     | Break                                                                 |                                                                                                         |                                            |
| 19:00<br>-<br>?:?                                                                     | Note: Location<br>from 2pm is KG I<br>(as week 2)                                           |                                                                                  |                                                        | Aperitif Waldsee                                                         |                                                                     | Workshop Dinner                                                       |                                                                                                         |                                            |

## Where

- ▶ Wed 7 Oct, morning: Building 101, HS 00 026 (Georges-Köhler-Allee)
- ▶ Wed 14:00 onwards and all of week 2: KG I, HS 1015 (Platz der Universität 3)

## Social

- ▶ Aperero after the talk on Wednesday
- ▶ Aperitif at Waldsee on Monday of week 2
- ▶ Workshop dinner (Restaurant Hirschen) on Wednesday of week 2

## Exercises

- ▶ Bring your laptop
- ▶ marimo notebooks, released session by session
- ▶ Repository: [github.com/mpcrl-school/mpcrl26-exercises](https://github.com/mpcrl-school/mpcrl26-exercises)
- ▶ Setup: local Python (uv sync) or the VS Code dev container, see the README

## Everything else

- ▶ WiFi: ask Jasper
- ▶ Signal group: ask other participants or look in the welcome mail
- ▶ Questions: [mpcrl@cs.uni-freiburg.de](mailto:mpcrl@cs.uni-freiburg.de)

Everyone gets a **Mensa card** with **20 EUR** prepaid credit. Where to top it up:

**Week 1: Mensa Flugplatz**  
(Technical Faculty campus)

- ▶ Top-up only at the information desk on the **second floor**

**Week 2: Mensa Rempartstraße**  
(city center)

- ▶ Top-up at the machines or at the information desk

Other lunch options: see the school webpage.