

Model Predictive Control and Reinforcement Learning – Project Instructions –

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Time Table



Week 1 at Faculty of Engineering (HS 0-26 - Buil. 101)				Week 2 at Historical University (HS 1015 - Buil. KG I)				
	Wed 4-Oct	Thu 5-Oct	Fri 6-Oct	Mon 9-Oct	Tue 10-Oct	Wed 11-Oct	Thu 12-Oct	Fri 13-Oct
09:00-10:30	Welcome + <i>Lecture 1</i> Dynamic Systems and Simulation (MD)	<i>Lecture 3</i> Dynamic Programming and LQR (MD)	<i>Lecture 5</i> Monte Carlo RL, Temporal Difference and Q-Learning (JB)	Motivation + <i>Lecture 7</i> Real-Time Algorithms for NMPC (MD)	<i>Lecture 9</i> Policy gradient and Actor-Critic methods (JB)	<i>Lecture 11</i> Introduction MPC and RL Framework (SG)	<i>Lecture 13</i> When to use RL in MPC? (SG)	Past project presentations + Project work
10:30-11:00	Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break
11:00-12:20	<i>Exercise 1</i> Dynamic Systems and Simulation	<i>Exercise 3</i> Dynamic Programming and Optimal Control	<i>Exercise 5</i> Q-learning	<i>Exercise 7</i> NMPC (Acados)	<i>Exercise 9</i> Policy Gradient	<i>Exercise 11</i> MPC-based value functions, policies, and their sensitivities	<i>Exercise 12</i> RL with MPC as function approximators	Project work / Project presentations
12:20-12:30		<i>Project Brainstorming</i>	<i>Project Brainstorming</i>	<i>Project Brainstorming</i>	<i>Project Brainstorming</i>			
12:30-14:00	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch
14:00-15:30	<i>Lecture 2</i> Numerical Optimization (MD)	<i>Lecture 4</i> Deep Learning (JB)	<i>Lecture 6</i> RL with Function Approximation (JB)	<i>Lecture 8</i> Transformers (JH)	<i>Lecture 10</i> MPPI (HH)	<i>Lecture 12</i> Safety and Stability in MPCRL (SG)	Q & A Session + Project work	Project presentations
15:30-16:00	Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break
16:00-17:30	<i>Exercise 2</i> Numerical Optimization	<i>Exercise 4</i> PyTorch	<i>Exercise 6</i> DQN	<i>Exercise 8</i> Transformer in practice (forecasting)	<i>Exercise 10</i> MPPI	Project brainstorming and kick-off	Project work	
		Break		Break	From 17 to 18: Short Research Announcements	Break		
19:00-		Social Gathering		Aperitif at Waldsee		Workshop Dinner		



- ▶ Projects can be either application- or algorithm-oriented.
 - ▶ For **application-based projects** you formulate and solve a self chosen optimal control or reinforcement learning problem. The focus should be on the mathematical description of your problem (the modeling), its numerical solution and the interpretation of the results.
 - ▶ For **algorithm-based projects**, you choose a scheme for the solution of optimal control problems or a reinforcement learning algorithm. The focus is then on the implementation of the scheme and an investigation of its performance, using several test problems/benchmarks. They should illustrate the properties of the algorithm, but need not necessarily have a real-world interpretation.
- ▶ The project can be done in groups of up to three students.
- ▶ To register your team please fill out the following form:
<https://cloud.syscop.de/apps/forms/z7eqp3xTWLkA65Kf>



- ▶ On Friday, there will be an opportunity for projects to present their preliminary results.
- ▶ If you think a project should be spotlighted you can make a suggestion to the organizers.
- ▶ Please make suggestions in time such that we can notice potential presenters early enough!
- ▶ Presentations should be 5-10 minutes long.
- ▶ For the presentation, you should send the tutors a pdf.



- ▶ The report must be a new and self-written document and may not contain any copy of other text or figures. The report must be solely written by the author(s).
- ▶ The report must include a short, interesting title, the name(s) of the author(s) and an abstract. The content should be clearly structured in sections. It should start with an introduction and conclude with a short summary and critical discussion of the results.
- ▶ The report should contain at least one (selfmade) sketch of the modeled system or implemented algorithm.
- ▶ The report must cite all external sources as references at the end and other people's contributions must be acknowledged. Using other people's ideas and help is allowed, even encouraged. But not citing or acknowledging them properly is fraud.
- ▶ The report should be **4 to 5 pages**.
- ▶ We strongly recommend using LaTeX. You can consider using the official IEEE template for conferences that can be downloaded here:
www.ieee.org/conferences_events/conferences/publishing/templates.html
- ▶ Please send your report as pdfs to both tutors, Andrea and Jasper, until **November 17**.



- ▶ To get ECTS for this course you need to take part of the exercises (Studienleistung) and do the project report (Prüfungsleistung).
- ▶ Please register your team until the evening of October 12 by using the following link:
<https://mattermost.syscop.de/general/p1/w5j6ac6xhfnj8j4m66mj7t6ioa>.
- ▶ The use of tools like ChatGPT are allowed under the following guidelines by IEEE:
<https://t.ly/T04g5>.