TEMPO Summer School on

Numerical Optimal Control and Embedded Optimization

University of Freiburg, July 27 – August 7, 2015

Room 1098, Ground Floor Kollegiengebäude 1 (KG1), Platz der Universität 3, 79098 Freiburg

Welcome to Freiburg and to the Summer School!

The aim of this intensive two week course is to give both theoretical background and hands-on practical knowledge with computational tools for optimal control and embedded optimization.

The course covers all topics relevant for the formulation and practical solution of optimal control problems (OCP) with a focus on embedded optimization algorithms. It starts with an introduction into convex optimization with a particular focus on solution algorithms for quadratic programming (QP) problems arising in optimal control and embedded optimization. We also treat methods for general nonlinear optimal control problems such as direct transcription methods (multiple shooting and collocation) and dynamic programming, and methods tailored to model predictive control (MPC) such as explicit MPC, code generated MPC solvers, online active set methods, sparsity exploitation and fast gradient methods. We are 62 participants from 13 countries with a teaching and organizing team of 15 people. We look forward to an inspiring week together!

The Organizers

Public Transportation

Public transportation in Freiburg is all run by VAG (Freiburger Verkehrs AG). The tram, bus, and subway system all have the same tickets. A one-way ticket within the city costs 2,20 €. A cheaper option if you are planning on taking multiple trips is to buy 2x4-FahrtenKarte. This costs 15,90 € and gives you 2 tickets with 4 rides possible on each. You must punch the Fahrtenkarte in the machine once you board the vehicle. Transfers are allowed on the same ticket within a one hour period. Tickets can be bought on buses, or at ticket machines around the city.

Internet

You can access the internet via eduroam or ask us for temporary login details. (For the second option you need to download a VPN from the following website: https://www.rz.uni-freiburg.de/services/netztel/wlan-vpn/vpn-clients?set_language=en)

Eating out

During the course most of us have lunch at the university cafeteria Mensa Rempartstraße (Rempartstraße 18, 79098 Freiburg). Here you can obtain a Mensa Card for a deposit of 7 Euros. You can top up this card with cash and use it to pay for your meal. At the end of your stay you can return the card to receive your deposit back as well as any rest amount of money that is still on your card.

For Thursday 30th July we have reserved some places in the beer garden of the Feierling in Freiburg (Gerberau 46, 79098 Freiburg). This gives you an opportunity to socialize, have a drink or some food together. Since the reservation is for the outside area of the restaurant, we have to hope that the weather holds up. Should it rain, the reservation will be cancelled.

Contact information

Should you encounter any problems please feel free to contact Rien (+49 157 525 93144) or Christine (+49 176 988 34570)

Systems Control and Optimization Laboratory / Lehrstuhl für Systemtheorie
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Course Program

TEMPO Summer School on Numerical Optimal Control and Embedded Optimization, First Week from July 27-31, 2015							
	Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
9:00	Introduction: Systems, Control and Optimization	Nonlinear Simulation and Optimization	Convex Optimization and Sparsity	Alexander Domahidi: Interior Point Methods	Newton Type Optimization	**Black Forest Hike**	
10:30	**Coffee Break**	**Coffee Break**	**Coffee Break**	**Coffee Break**	**Coffee Break**		
11:00	Exercise 1 Linear-Quadratic Regulator	Exercise 3 Newton's Method	Exercise 5 YALMIP	Exercise 7 FORCES	Exercise 9 Gauss-Newton		
12:30	**Lunch Break**	**Lunch Break**	**Lunch Break**	**Lunch Break**	**Lunch Break**		
13:30	Optimal Control Overview	Direct Optimal Control	Joachim Ferreau: qpOASES	Alexander Domahidi: Interior Point Methods	Real-Time Iterations and ACADO		
15:00	**Coffee Break**	**Coffee Break**	**Coffee Break**	**Coffee Break**	**Coffee Break**		
15:30	Exercise 2 Dynamic Programming	Exercise 4 Shooting Methods	Exercise 6 qpOASES for MPC	Exercise 8 ECOS	Exercise 10 ACADO Code Generation		
17:00	**Break**	**Break**	**Break**	**Break**	**Break**		
17:20	Review Session	Review Session	Review Session	Review Session	Review Session		
18:00	**End**	**End**	**End**	**End**	**End**		
	18:30 Reception**		18:00 Guided City Tour	18:30 Dinner Reservation (self-payment)*			

* Location: Feierling outside area (beer garden), Gerberau 46, 79098 Freiburg

TEMPO Summer School on Numerical Optimal Control and Embedded Optimization, Second Week from August 3-7, 2015					
	Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
9:00	Exam	Alternating Direction Method of Multipliers	Block Condensing for qpDUNES	Project Work	Project Presentations
10:30	**Coffee Break**	**Coffee Break**	**Coffee Break**	**Coffee Break**	**Coffee Break**
11:00	Explicit MPC	Exercise 12 ADMM	Project Work	Project Work	Project Presentations
12:30	**Lunch Break**	**Lunch Break**	**Lunch Break**	**Lunch Break**	Project Presentations
13:30	Explicit MPC	Project Work	Project Work	Project Work	**End**
15:00	**Coffee Break**	**Coffee Break**	**Coffee Break**	**Coffee Break**	
15:30	Exercise 11 Explicit MPC	Project Work	H. G. Bock Efficient Methods for Inverse Optimal Control Problems	Project Work	
17:00	**Break**	**Break**	**Break**	**Break**	
17:20	Review Session and Project Commitments	Systems Control and Optimization Lab Tour	Project Work	Project Work	
18:00	**End**	**End**	**End**	**End**	
			18:30 Dinner**		

** Location: Peterhofkeller, Niemensstr. 10, 79098 Freiburg

List of Organizers and Teachers

Name	Institution
Prof. Dr. Dr. h.c. mult. Hans Georg Bock	Heidelberg University, Germany
Prof. Dr. Moritz Diehl	University of Freiburg, Germany
Dr. Alexander Domahidi	Embotech, Switzerland
Dr. Joachim Ferreau	ABB, Switzerland
Jean Hours	EPFL, Switzerland
Prof. Dr. Colin Jones	EPFL, Switzerland
Milan Korda	EPFL, Switzerland
Dimitris Kouzoupis	University of Freiburg, Germany
Dr. Michal Kvasnica	Slovak University, Slovakia
Adeleh Mohammadi	KU Leuven, Belgium
Christine Paasch	University of Freiburg, Germany
Rien Quirynen	University of Freiburg, Germany
Georgios Stathopoulos	EPFL, Switzerland
Pu Ye	EPFL, Switzerland
Mario Zanon	University of Freiburg, Germany