Exercises for Lecture Course on Numerical Optimal Control (NOC)
Albert-Ludwigs-Universität Freiburg – Summer Term 2017

Exercise 0 – General Information and Environment Setup

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The course's aim is to give an introduction into numerical methods for the solution of optimal control problems in science and engineering. The focus is on both discrete time and continuous time optimal control in continuous state spaces. It is intended for a mixed audience of students from mathematics, physics, engineering and computer science.

1. **Organization of the Course**

   The course during the first two thirds of the semester is based on two pillars, lectures and exercises, accompanied by written material for self-study. Course language is English and all communication is made via the course homepage:

   `www.syscop.de/teaching/ss2017/numerical-optimal-control`.

   In the last third of the semester, some time slots are reserved for project work, for students of mathematics (additional 3 ECTS).

   Lectures: Lectures take place on Mondays and Wednesdays from 14:00 to 16:00 at Albertstrasse 23b, HS II. Their content will be recorded (voice and computer screen) and will be made available to the students afterwards. The first lecture is on Monday April 24, but the recordings begin only on Wednesday April 26.

   Exercises: The exercise sessions take place on Tuesdays 16:00 to 18:00. The location is Georges-Koehler-Allee 101, SR 01-009/13. Individual laptops with working installations of MATLAB and CasADi are required to work on the exercises. The computers in the reserved room will not be configured for use. Each Monday a new exercise sheet is distributed and some hints may be given. Students can then prepare themselves for the exercise session, where they can complete the tasks in teams of 1 to 4 people and show the results to the teaching assistants. In order to obtain points, the solutions will have to be shown to the teaching assistants within 8 days from the day the exercise sheet is handed out. This means that for every sheet you will have the chance to show your results at the two following exercise sessions. Groups that require more time or cannot make it to the exercise session may send their solutions by email (*andrea.zanelli@imtek.uni-freiburg.de*) until the following Wednesday at 12:00. Note that groups that complete the tasks during the exercise session *do not need to send a report by email.*

   Final Evaluation: The final grade of the lecture part of the course (6 ECTS) is based solely on a final written exam at the end of the semester. For students from the faculty of mathematics, the final course grade (9 ECTS) is a weighted sum of the final exam and the project. The final exam is a closed book exam. Only pencil, paper, a calculator and four single A4 pages of self-chosen formulas are allowed. In order to be eligible for the course, one has to have obtained a minimum of 50% of the total points in the exercise sheets that are distributed each week.

Projects: The project (3 ECTS), for students of mathematics (optional), consists in the formulation and implementation of a self-chosen optimization problem and numerical solution method, resulting in documented computer code, a project report, and a public presentation. Project work starts in the last third of the semester and participants can work either individually or in groups of up to three people.

2. **MATLAB and CasADi Installation**

   (a) MATLAB is an environment for numerical computing based on a proprietary language that allows one to easily manipulate matrices and visualize data which will be very helpful in prototyping the algorithms presented during the lectures of this course.

   The University of Freiburg offers a free-of-cost license to students and staff which can be obtained following the instructions at the link below:

   `www.rz.uni-freiburg.de/services/beschaffung/software/matlab-landeslizenz`.

   In order to be able to complete the exercises of this course, you will need a working installation of MATLAB. Follow the instructions at the provided link in order to install the software package.

   (b) CasADi is a symbolic framework for algorithmic differentiation and numerical optimization. In order to install CasADi, follow the instructions at the link below:

   `www.github.com/casadi/casadi/wiki/InstallationInstructions`.

   Download the binaries for your platform and, after having extracted them, add their location to MATLAB's path and save the changes made with the command `savepath`. In this way, the location of the binaries will be known even after restarting MATLAB. Finally, test your installation running a simple example as described at the provided link.