Exercises: Getting started with acados in Python
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This exercise showcases how to use acados with its Python interface to implement different MPC controllers efficiently for the CSTR system.

Important Resources

- https://docs.acados.org/

- Installation guide https://docs.acados.org/installation/

- Python Interface: Installation and documentation https://docs.acados.org/python_interface/

- acados problem formulation PDF: https://github.com/acados/acados/blob/master/docs/problem_formulation/problem_formulation_ocp_mex.pdf

- acados forum https://discourse.acados.org

Exercises

Due to the strict timing constraint, we provide the solution to this exercise sheet in this zip file: https://www.syscop.de/files/2022ss/phdcourse/cstr_acados_exercise.zip

Model and MPC task

- the nonlinear continuous stirred-tank reactor (CSTR) system from earlier Lecture 1, slide 34 and following

- the MPC simulation described in slide 77 and the following of Lecture 3

- Go through the file cstr_model.py to see how a dynamic model is formulated with acados

Solution

- Go through the file main.py to see how a closed loop simulation can be implemented with acados.

    - To simulate the plant, we use an acados integrator, i.e. AcadosSimSolver

    - The controller is implemented using the AcadosOcpSolver class

- Run the main file to get reproduce the plot from earlier, the result should look similar to Figure 1.

- Uncomment the lines that run the simulation with a controller that uses the Real-Time Iteration (RTI) scheme, to get a plot similar to Figure 2.
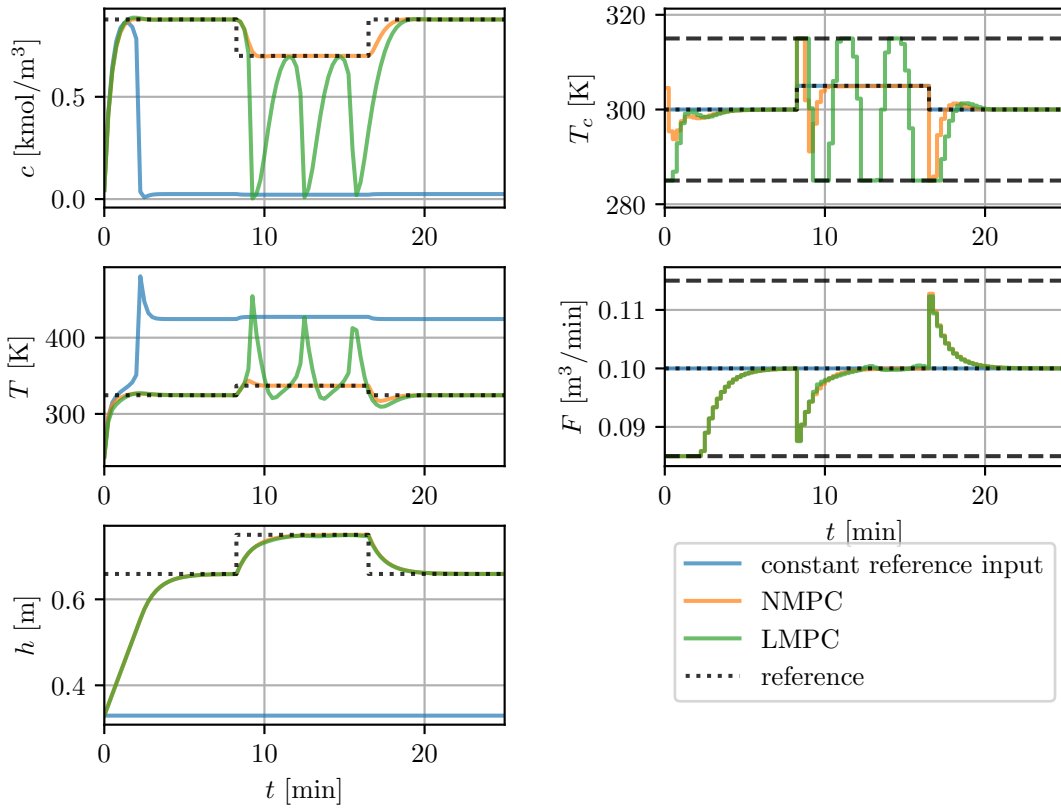
Figure 1: Uncontrolled, LMPC controlled and NMPC controlled trajectories for CSTR using `acados` and reproduces Figure 15 from Lecture 3.
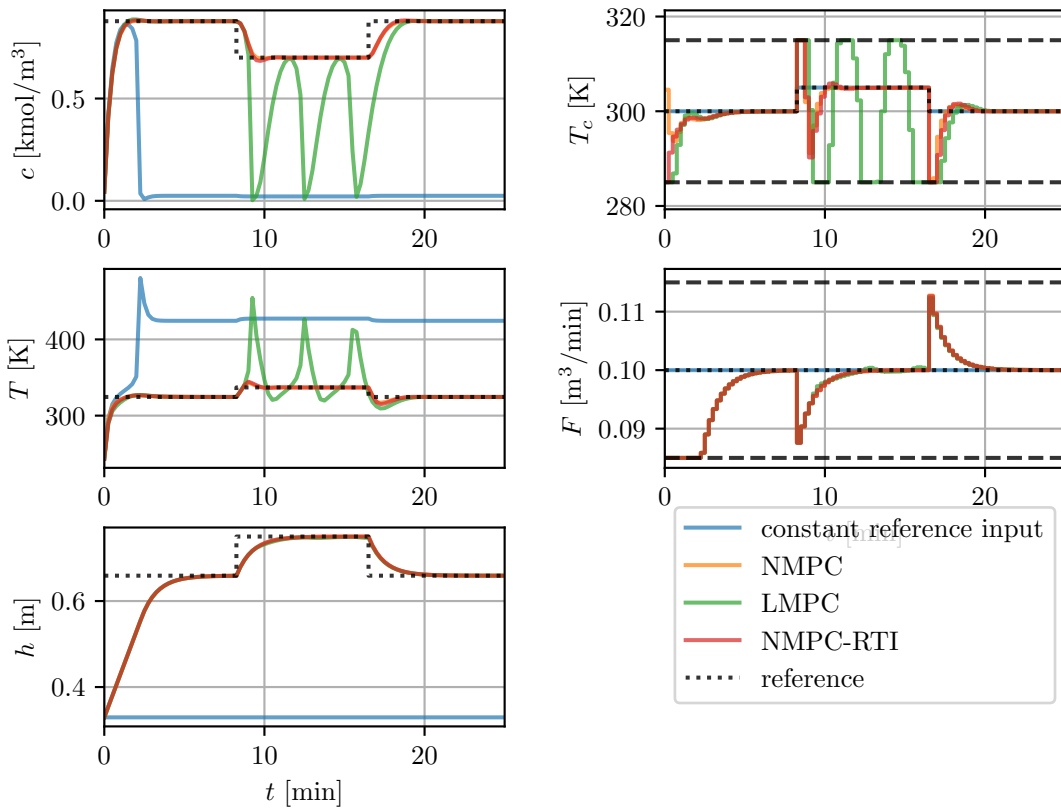

Figure 2: Uncontrolled, LMPC controlled and NMPC controlled trajectories for CSTR using `acados` and reproduces Figure 15 from Lecture 3.

Integrator experiment

- We want to compare the discretization accuracy and computation time of different integration schemes, using a trajectory of the CSTR model controlled by an NMPC controller.
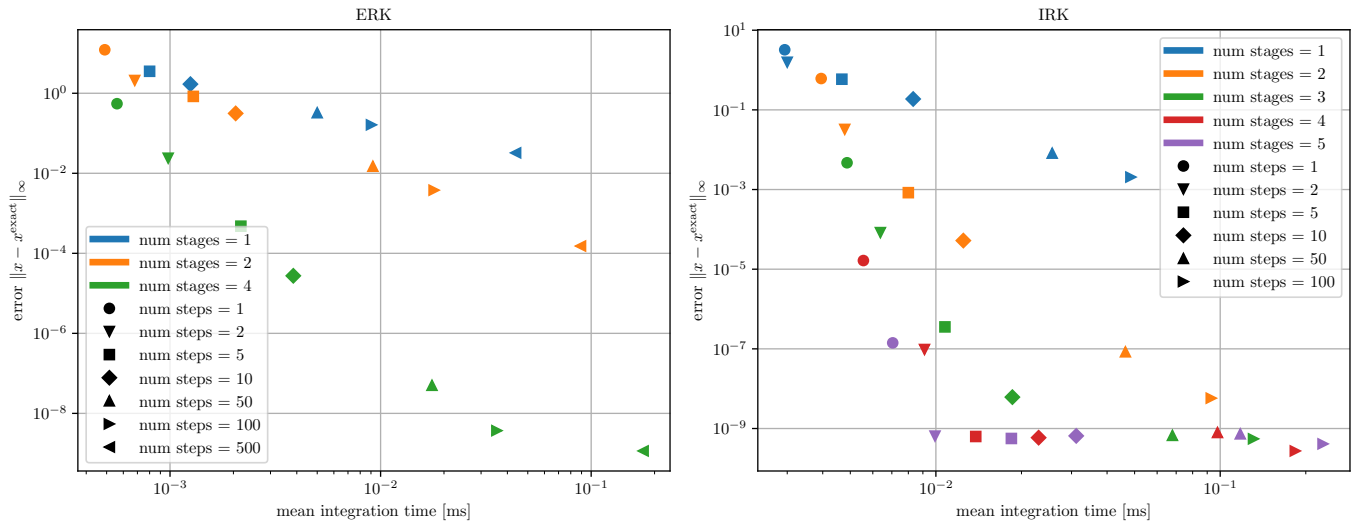
- Run the `integrator_experiment.py`.

- The results are shown in Figure 3.

Figure 3: Results of the integrator experiment.