Project 2 –
NUMN26/FMNN05: Simulation Tools

Robert Klöfkorn

This is part II of the overall course project.
In this part, we consider constrained ordinary differential equations, so-called DAEs and investigate the effect of index reduction considering the squeezer example described in the lecture.
Please describe you observation in report form. It should include

- a description of the problem considered,
- a description of your tests, i.e. what is tested and why ...,
- a description of your test cases in such a way so that they are reproducible, and
- your own interpretation of the results.

Consider the tasks listed below as suggestions for experiments. You are free to design others as long as they lead to a statement.
This assignment has 8 tasks.

Task 1

Read the mathematical description of the squeezer in publication [2] (see also the literature list on the course's home page).

Task 2

Download the file squeezer.py from the course's project page. Modify it, so that it fits to Assimulo's problem class.

Task 3

In Reference [2], Eq. (7.7) a possible choice of consistent initial conditions is given. Try to construct these initial values by using Newton's method or a corresponding Scipy method in the way as described in Ref [2], p. 535.

Task 4

The code squeezer.py describes the equations of motion in residual form. The constraints are given as index-3 constraints. Write a corresponding function squeezer2, which is based on index-2 constraints, i.e. constraints on velocity level.

Task 5

Simulate with Assimulo/IDA both problem formulations until $t_f = 0.03$ sec . In case of simulation problems, you might want to exclude the algebraic variables (λ and if needed even the velocity components, see below.) from the error test by using the method attribute algvar.
The tolerances, in particular atol, control the error test as well as the convergence test for the Newton iteration. Define atol as a vector and set the components corresonding to algebraic variables to something big (e.g. 1.e5).

If this does not remove convergence failures do the same with the velocity components.

Task 6

Plot the solution and compare in particular the Lagrange multipliers.

Task 7

Evaluate the run time statistics.

Task 8

Test even an explicit Runge-Kutta method from Assimulo on the index 1 problem as described in [2].

Don't hesitate to ask for help in case you run into problems.

Lycka till!