SSY281 - Model Predictive Control
Micro-Assignment MA11 - Alternative formulations of MPC

Lucas Rath - **Group 09**

Question 1 *Consider the following Hankel matrix and find a representation of (A, B, C) when the system as one input and one output.* $H = [0\ 0.5;\ 0.5\ 1]$

$$H = \begin{bmatrix} 0 & 0.5 \\ 0.5 & 1 \end{bmatrix} = \begin{bmatrix} CB & CAB \\ CAB & CA^2B \end{bmatrix} \tag{1}$$

Lets say that the system consists of two states. Therefore $A \in \mathbb{R}^{2\times 2}, B \in \mathbb{R}^{2\times 1}, C \in \mathbb{R}^{1\times 2}$. Since we have only three linear-independent equations, we might have 3 variables to determine. Therefore, we propose before-hand B and C and find and A symmetric matrix. Solving this in Matlab leads to:

$$B = \begin{bmatrix} 1 \\ 0 \end{bmatrix} \quad C = \begin{bmatrix} 1 & 0 \end{bmatrix} \quad \Rightarrow \quad A = \begin{bmatrix} 2 & 0.5 \\ 0.5 & 0 \end{bmatrix} \tag{2}$$

Question 2 *In a RH controller, what is the effect of a short control horizon, i.e. small M, on the complexity of the method? How does this effect the existence of a feasible solution?*

The size of M determines the number of variables we need to optimize every time-step. The larger M, the more computation we need. On the other hand, as we increase M, the feasible set $\mathcal{X}_N$ becomes bigger.

Question 3 *Qualitatively compare Predictive Functional Control (PFC) against RH controller in terms of complexity and optimality.*

The number of parameters of the basis function in PFC determines the complexity of the optimization problem to be solved. Therefore, we might end-up with a few number of parameters, which are however able to define the input u over the whole prediction horizon.