Worksheet 5

Issued: Fri 19. 12.
Due: Thu 8. 1.26

Assessed Assignments

H 5.1 · *Discrete Dynamic Programming of an Inverted Pendulum* *(20 points)*

Implement the numerical approach to dynamic programming (DP) ('Dynamic Programming' slide 8) for the linear-quadratic (LQ) regulator (LQR) problem discussed in Exercise 2.3. Assume a maximum time span of 2 seconds for the inverted pendulum controller to achieve its goal, that is, $\mathbf{x}(1.5) \approx 0$, penalise all states at $t_\mathrm{f} = 1.5$ with $300\ \phi^2(1.5)$, and define the admissible states and inputs to be $\mathcal{X} = [-1, 1] \times [-5, 4]$ and $\mathcal{U} = [-30, 2]$, respectively. Use $\Delta t = 0.05$, $\Delta u = 2$, $\Delta\phi = 0.1$, and $\Delta\dot{\phi} = 0.05$ for the sampling resolutions of time, inputs, and state parameters. For approximation, you can discretise the system dynamics according to the pattern $\mathbf{x}_{k+1} = \mathbf{x}_k + \dot{\mathbf{x}}_k \cdot \Delta t$.

H 5.2 · *Dynamic Programming of Two Heated Tanks* *(30 points)*

Consider again the system of two heated tanks (Exercises 2.2 and 3.2).

(a) Focus on one mode $\mathbf{l}_1$. In place of the LQR law, compute a tabular control law $\mathbf{u}$ using discrete dynamic programming (DDP) with value iteration ('Dynamic Programming' slide 9).

(b) Use your routine to compute both single-input/single-output (SISO)-controllers working exclusively and independently on their tanks, one at a time. Ensure that the tabular laws are defined for a sufficiently large state space.

(c) Implement the hybrid automaton (HA) jumps in your simulator to switch between the two controllers using an appropriate tolerance for the jump guards.