Advanced Model Predictive Control — Fall 2022
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Programming Exercise 6

Stochastic Learning-Based MPC

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Exercise

Implement the following exercises in the Matlab code provided on Moodle.

1. **Graded.** Given the ellipsoidal set $\Omega = \{\theta \,|\, (\theta - \mu_\theta)^\top \Sigma_\theta^{-1} (\theta - \mu_\theta) \leq \tilde{p}\}$, compute a polytope, which is aligned with the coordinate frame and overapproximates Ω, i.e., the outer box approximation of Ω. Use the formula derived in Recitation 11.

2. **Graded.** Combine the parametric and additive uncertainties, i.e., $(A_1\theta_1 + A_2\theta_2)x_k$ and w_k, and compute a polytopic set $\tilde{\mathcal{W}}$ containing both.

3. **Not Graded.** Using the provided constraint tightening RMPC, solve the MPC problem for the initial state to obtain an open-loop plan. Then, simulate the system with randomly drawn parameters and observe the behavior. Are we robust? If not, which parameter choices violate the constraints?

4. **Graded.** Implement the Kalman filter update equations in the `KF.m` class using the following dynamics:

$$\begin{aligned} \theta(k+1) &= \theta(k) + w_\theta(k), & w_\theta(k) &\sim \mathcal{N}(0, \Sigma^\theta) \text{ i.i.d.} \\ x(k+1) &= \Phi(x(k), u(k))\theta(k) + w(k), & w(k) &\sim \mathcal{N}(0, \Sigma^w) \text{ i.i.d..} \end{aligned}$$