RobotLib Examples using the Cart-Pole System

The Robot Locomotion Group

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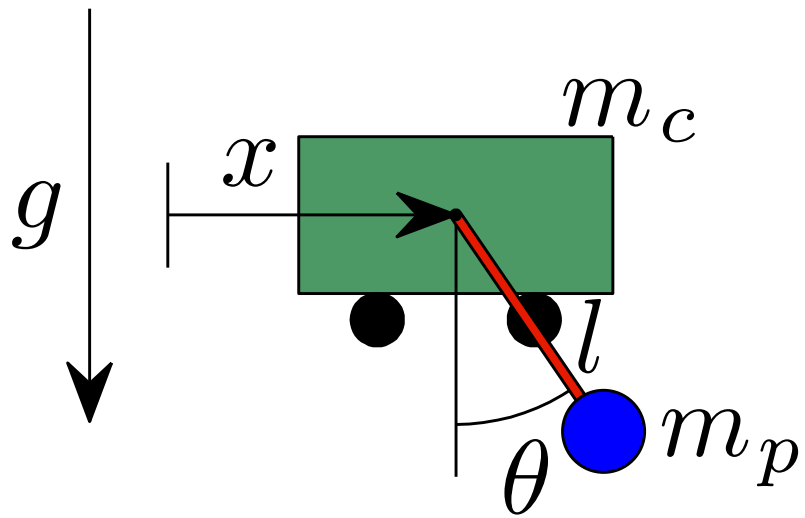
Dynamics (CartPolePlant)

Equations of motion:

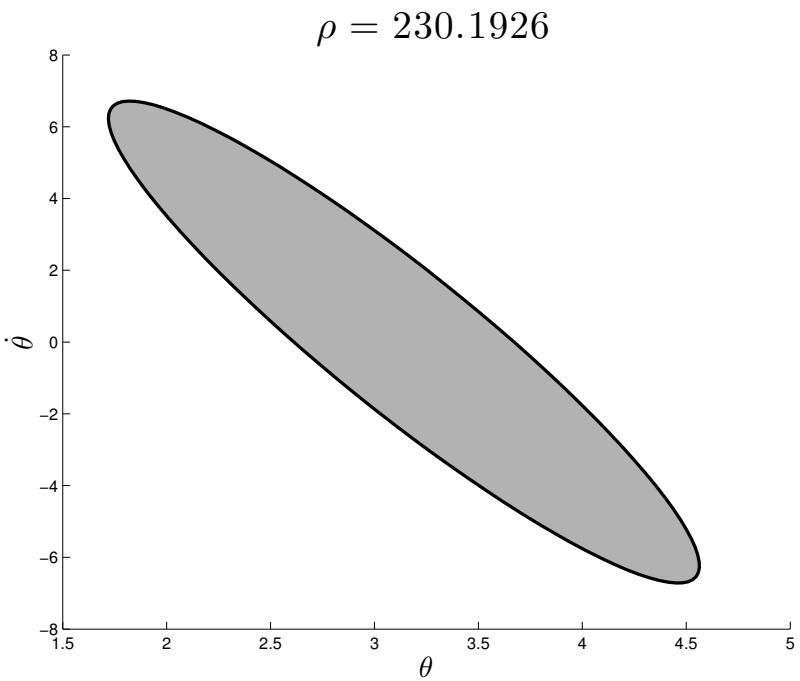
$$\ddot{x} = \frac{1}{m_c + m_p \sin^2\theta}\left[f + m_p \sin\theta(l\dot{\theta}^2 + g\cos\theta)\right]$$

$$\ddot{\theta} = \frac{1}{l(m_c + m_p \sin^2\theta)}\left[-f\cos\theta - m_p l\dot{\theta}^2\cos\theta\sin\theta - (m_c + m_p)g\sin\theta\right]$$



ROA for LQR Balancing Controller

$$Q = \text{diag}([1, 50, 1, 50]), \quad R = .1$$



Taylor approx via SOS

- According to a sample-base check, this appears to be tight (sampled ROA is 2% larger on average).
- Note that these controllers use a *lot* of control effort. Revisit when verification w/ saturations is implemented.

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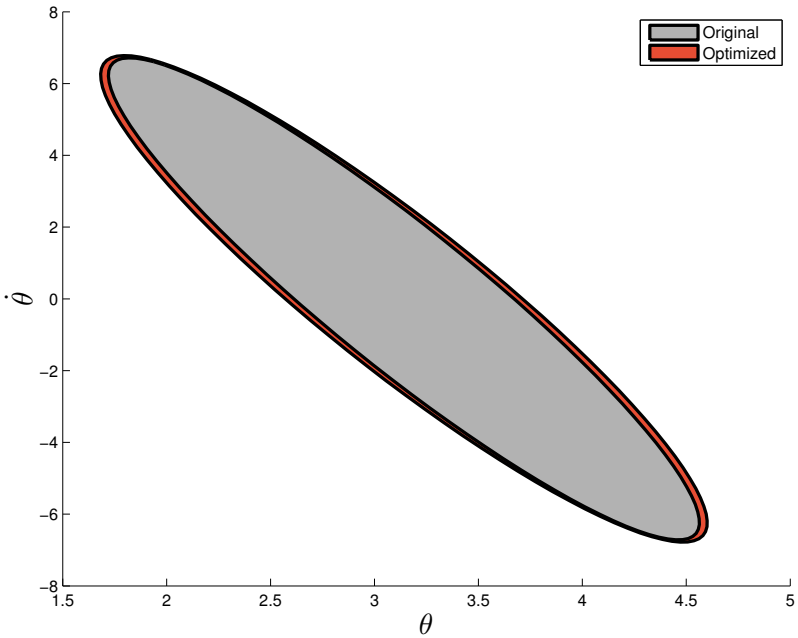

Taylor approx via SOS w/ searching over quadratic Lyapunov functions.

- According to a sample-base check, this appears to be tight (sampled ROA is 2% larger on average).
- Note that these controllers use a *lot* of control effort. Revisit when verification w/ saturations is implemented.
- Optimizing quadratic V doesn't help much.