Machine learning for Systems & Control
5SC27

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Week 8 Model Internalization-Based RL

M. Schoukens, R. Tóth, G. Beintema

Introduction

This exercise on model internalization using PILCO can be solve using

- Matlab PILCO toolbox available at `http://mlg.eng.cam.ac.uk/pilco/`

To get a hang of PILCO I recommend carefully reading the lecture, the first chapter of the PILCO manual `http://mlg.eng.cam.ac.uk/pilco/release/pilcodocV0.9.pdf` and for further reading the original PILCO paper `http://www.doc.ic.ac.uk/~mpd37/publications/pami_final_w_appendix.pdf`.

There is also a python version available at `https://github.com/nrontsis/PILCO` but it works less well than the MATLAB version.

Installation PILCO MATLAB

1. Download the PILCO toolbox from the website
2. Add the PILCO toolbox to your path ("addpath(genpath('the pilco directory'))")
3. **Optional** Run an example from scenarios folder.

Afterwards check out the examples in the pilcoV09/scenarios directory.

Exercise 1: The Cart-Pole Problem

The objective is to learn a policy (state feedback control map) that can swing up a pendulum attached to a cart and keep the cart around its original position. The cart has mass m_1 and the attached pendulum has mass m_2 and length l, swinging freely in the plane. The pendulum angle θ_2 is measured anti-clockwise from hanging down. The cart can move horizontally with

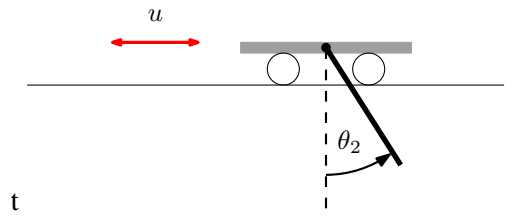

Figure 1: Cart-pole system.

an applied external force u and affected by viscous friction b between the cart and the ground. The parameters of the system are: $m_1 = 0.5$ kg, $m_2 = 0.5$ kg, $l = 0.6$ m and $b = 0.1$ N/m/s.

Use the PILCO toolbox to solve the problem. An example script has been prepared with extensive documentation to demonstrate how this can be achieved, see `Sol_1.m`. Observe how many episodes are required (compared to the previous model free Q-learning) to swing up the pendulum.

I also included a python implementation using `https://github.com/nrontsis/PILCO` which does not work as well as the matlab implementation but it might be interesting to see (if you want to run the python version you will need to install tensorflow 2.4).