TECHNISCHE UNIVERSITÄT MÜNCHEN
LEHRSTUHL FÜR STEUERUNGS- UND REGELUNGSTECHNIK
UNIV.-PROF. DONGHEUI LEE

10 June 2016

M A S T E R ' S T H E S I S
for
Yuchao Yin
Student ID 03656508, Degree EI

Model-based Reinforcement Learning using a simplified robot model

Problem description:

The goal of Reinforcement learning (RL) is to make an agent able to autonomously learn how to perform a certain task. The ability of learning tasks by self-practice is appealing for robotics, and several RL approaches have been proposed in the past decade [1]. When applied to robotics, a RL algorithm has to face three main problems: *i)* control policies are, in general, continuous functions of the robot state, *ii)* the state space of the robot can be quite big (e.g. humanoid robots), *iii)* it is tedious and time consuming to perform thousands of rollouts on a real robotic platform. Aforementioned problems can be partially alleviated via control policy parameterization and model-based RL approaches adoptions. Among the other model-based RL approaches, the Probabilistic Inference for Learning Control (PILCO) [2, 3] has been proved to require few real rollouts to find the optimal control policy. PILCO learns a model of the robot from sensory data and iteratively improves the model and the policy until the task is satisfied. A limitation of PILCO is that it has to explore as much as possible the robot state space to learn a reliable model. This is usually achieved by randomly initializing the control policy during the first rollout, which can generate unpredictable behaviors in multi degrees-of-freedom robotic platforms.

In this Master's thesis work the student has to investigate the possibility of using a simplified dynamical model of the robot for model-based reinforcement learning. Eventual inaccuracies of the simplified model will be corrected by an additive term, learned from sensory data.

Tasks:

- Literature overview on model-free and model-based Reinforcement learning
- Model-based RL algorithm implementation
- Comparison with state-of-the-art approaches and experimental evaluation

Bibliography:

[1] J. Kober, J. A. Bagnell and J. Peters. Reinforcement Learning in Robotics: A Survey in *The International Journal of Robotics Research*, 2013.
[2] M. P. Deisenroth and C. E. Rasmussen. PILCO: A Model-based and Data-Efficient Approach to Policy Search, in *International Conference on Machine Learning*, 2011.
[3] M. P. Deisenroth, D. Fox and C. E. Rasmussen. Gaussian Processes for Data-Efficient Learning in Robotics and Control, in *Transactions on Pattern Analysis and Machine Intelligence*, 2015.

Supervisor:	M. Sc. Matteo Saveriano
Start:	20.06.2016
Intermediate Report:	xx.09.2016
Delivery:	xx.12.2016

(D. Lee)
Univ.-Professor