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M A S T E R T H E S I S
for
N.N.
Student ID XXXXXXX, Degree XX-XX

Data-Driven Approaches to Model Predictive Control

Problem description:

Recently, there has been a great interest in the integration of machine learning algorithms into control and impressive results have been achieved. Typically, supervised learning and regression is used for identification of the dynamical system before designing a suitable controller. However, incorporating other techniques from machine learning is also promising for the design of the controller itself.
More particular, Bayesian optimization has shown to be successful for iterative learning control in [2] due to a proper trade-off between exploration and exploitation. However, it is limited to design a local controller since it uses a linearization and compensates for modeling errors by updating the cost function. Therefore, a generalization to a global control scheme seems promising.
This works aims to apply Bayesian optimization in the context of nonlinear model predictive control [1] using Gaussian processes [3]. The focus is set on stability of the controller by choosing proper control Lyapunov functions as the terminal cost and adaptation of the cost function.

Tasks:

- Literature review on iterative learning and model predictive control
- Design of an model predictive controller scheme using Bayesian optimization
- Analyze theoretical properties and practical implications of the approach based on simulation

Bibliography:

[1] F. Allgöwer and A. Zheng. *Nonlinear model predictive control*, volume 26. Birkhäuser, 2012.
[2] A. Marco, P. Hennig, J. Bohg, S. Schaal, and S. Trimpe. Automatic lqr tuning based on gaussian process global optimization. In *International Conference on Robotics and Automation (ICRA)*, pages 270–277. IEEE, IEEE, 2016.
[3] C. E. Rasmussen and C. K. Williams. *Gaussian Processes for Machine Learning*. MIT Press, Cambridge, MA, USA, Jan. 2006.

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