Chair of Automatic Control

FAU

Announcement for Master/ Research project

Automated Robust Parameter Tuning of MPC Algorithms

Motivation

Bayesian Optimization (BO) is a commonly used method in black-box optimization, i.e. for automated tuning of controller parameters such as for model predictive control. Starting from an initial dataset, Gaussian processes are learned for the black-box models. During the optimization process further informative samples are learned and the Gaussian processes are adaptively refined.

Model predictive control (MPC) is widely used because it allows to consider non-linear state and input constraints. It is based on the solution of an optimal control problem on a receding horizon and the performance and computational time of the solution of the respective dynamic optimization problem depends on the settings of the optimization algorithm.

GRAMPC [1] is a toolbox for MPC that is based on gradient descent and Augmented Lagrangian methods. It has parameters such as the number of Newton iterations or the number of iterations of the Augmented Lagrangian algorithm that must be tuned for every new application. This is done manually by performing many simulations and experiments. The selected parameters must ensure good controller performances not only for nominal conditions but also for model errors or changing environmental conditions.

Task

The parameters of the GRAMPC algorithm shall be optimized in terms of computational time such that a given controller performance is still maintained. Bayesian optimization methods for nominal and robust optimization shall be used. The results shall be compared to manually tuned parameters.

Requirements

General interest in mathematics and control engineering, especially model predictive control. Knowledge in Gaussian processes and Bayesian optimization are beneficial but not mandatory.

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References

[1] Englert, T., Völz, A., Mesmer, F., Rhein, S., & Graichen, K. (2019). A software framework for embedded nonlinear model predictive control using a gradient-based augmented Lagrangian approach (GRAMPC). Optimization and Engineering, 20(3), 769-809.