Dimensionality Reduction for Robust Data-Enabled MPC

TECHNISCHE UNIVERSITÄT DARMSTADT

Master's Thesis

Model predictive control (MPC) is widely used for the optimal control of systems when constraints must be satisfied. At its core, MPC relies on the online solution of an optimal control problem, where it is assumed that a system model is available for predicting the system's future behavior.
In recent years, MPC formulations have been proposed that entirely rely on a system description based on measured input-output trajectories, without a prior identification step [1].

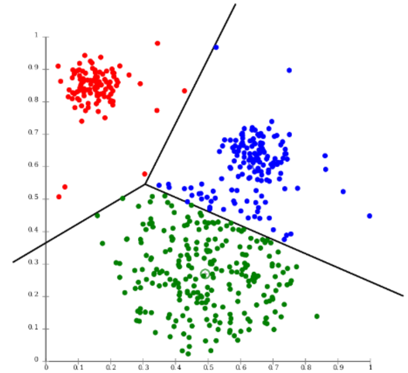
One of the drawbacks of MPC is the computational burden that comes from solving the optimal control problem. Therefore, dimensionality reduction techniques have been proposed to facilitate the online evaluation of the controller [2].

The main goal of this thesis is the implementation of a data-enabled MPC scheme and its combination with existing, clustering-based dimensionality reduction techniques for model-based MPC.

The thesis contains the following steps:

- Literature review on (i) data-enabled MPC and (ii) dimensionality reduction methods for model-based MPC
- Implementation of a reduced, data-enabled MPC controller
- Analysis of the controller's robustness against measurement noise
- Potential extensions are, e.g., the inclusion of closed-loop information in the subspace design or state-dependent subspace interpolation as done in [3] in a different context
- Evaluation and comparison of the results

Basic knowledge of control theory and optimization is required. Creativity is desirable. Please don't hesitate to contact me if you have any further questions!



https://de.wikipedia.org/wiki/Clusteranalyse

[1] J. Berberich, J. Köhler, M. A. Müller and F. Allgöwer, "Data-Driven Model Predictive Control With Stability and Robustness Guarantees," in *IEEE Transactions on Automatic Control*, vol. 66, no. 4, pp. 1702-1717, 2021

[2] A. Bemporad and G. Cimini, "Reduction of the number of variables in parametric constrained least-square problems," *arXiv preprint arXiv:2012.10423*, 2020

[3] D. Amsallem and C. Farhat, "Interpolation method for adapting reduced-order models and application to aeroelasticity." AIAA journal 46.7 (2008): 1803-1813.

M.Sc. Roland Schurig

Room: S3|10-508
Tel.: 06151 / 16-25184
E-Mail: roland.schurig@iat.tu-darmstadt.de
Home: ccps.tu-darmstadt.de/ccps