Data-driven Model Predictive Control for Nonlinear MIMO process

TECHNISCHE UNIVERSITÄT DARMSTADT

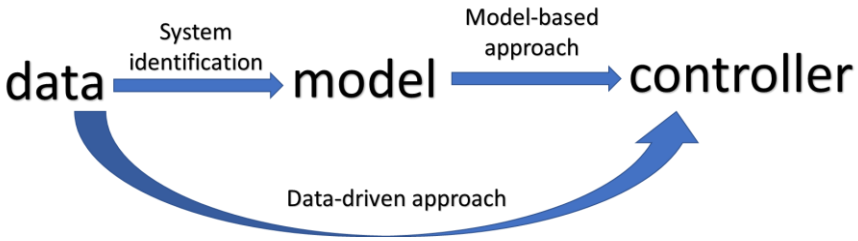
Proposal for a Master's Thesis Project

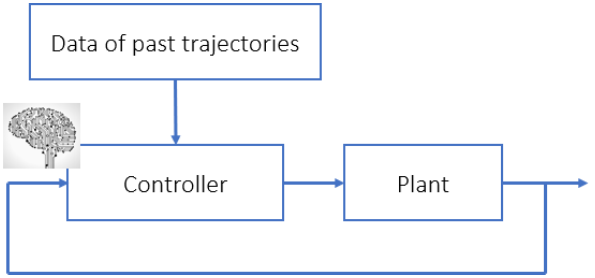
There has been an increasing attention on controller design methods based on data (data-driven approach) instead of the model-based methods in recent years.

It is shown in [1] that the whole set of trajectories that a linear system can generate can be represented by a finite set of its past trajectories, if such past trajectories come from sufficiently excited dynamics. Therefore, instead of requiring a prior identification step, we can directly uses the data measured from the past trajectories to design the controller for the system. There are several works following this idea, which have been proposed in [2] and [3], as well as attempts to extend the framework to the case of nonlinear systems.

In this project, the student needs to investigate the data-driven approach by using Willems' lemma and extend the results to design a data-driven Model Predictive Control (MPC) for nonlinear MIMO process. The control object is suggested to be a boiler-turbine unit.

The project is theoretical and done in simulation only. The student should have sufficient knowledge on MPC. The student should also be familiar with Matlab. The language for discussion and writing is preferably English. For more information, feel free to contact via email.





[1] Jan C. Willems, Paolo Rapisarda, Ivan Markovsky, Bart L.M. De Moor, "A note on persistency of excitation," Systems & Control Letters, vol. 54, no 4, pp. 325-329, 2005.

[2] C. De Persis and P. Tesi, "Formulas for Data-Driven Control: Stabilization, Optimality, and Robustness," in IEEE Trans. Automat. Cont, vol. 65, no. 3, pp. 909-924, 2020.

[3] J. Berberich, J. Köhler, M. A. Müller and F. Allgöwer, "Data-Driven Model Predictive Control With Stability and Robustness Guarantees," in IEEE Trans. Automat. Contr, vol. 66, no. 4, pp. 1702-1717, 2021.

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CCPS Control and Cyber-Physical Systems