Compute inner-approximation of ROA (region of attraction) for systems with neural network-based controller

TECHNISCHE UNIVERSITÄT DARMSTADT

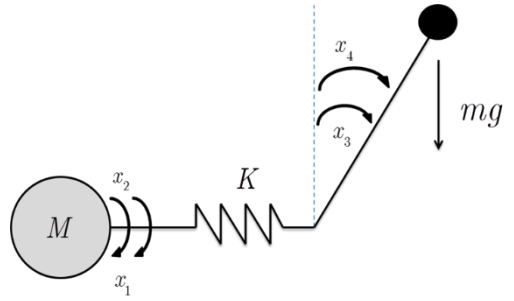
Proposal for a Master's Thesis Project

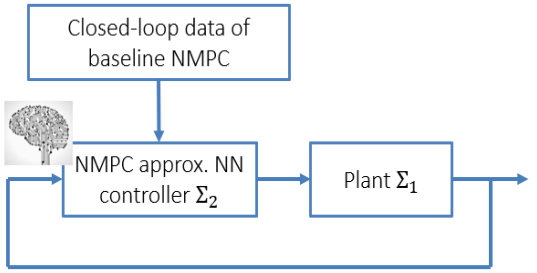
Safety guarantees for control systems with machine learning components are crucial but often challenging to achieve.

Due to computational and economical cost reduction, we may want to learn an available baseline controller by a neural network and use the neural network (NN) as the controller. The existing baseline controller has desirable closed-loop performance but may not provide provable properties such as stability. In order to guarantee safety for the closed-loop system with NN-based controller, we can use the robust control theoretic tools to derive a framework for providing nominal stability guarantees.

In this project, the plant is the flexible robotic arm where the nominal mathematical model is given. First, the student designs a Model Predictive Control (MPC) baseline controller (by using available toolbox such as HiLo-MPC). Then, the NN-based controller is trained by using the data generated by this baseline controller. The information of weight matrices of the NN is used to compute the ROA (safety region) for the closed-loop system by using robust control theory in form of LMIs (Linear Matrix Inequalities).

The project is theoretical and done in simulation only. The student should have sufficient knowledge on MPC and basic understand of feedforward neural network. The knowledge of LMI is a plus, but not compulsory. The student should also be familiar with Matlab and Python. The language for discussion and writing is preferably English. For more information, feel free to contact via email.





M.Sc. Hoang Hai Nguyen

E-Mail: hoang.nguyen@ovgu.de

CCPS Control and Cyber-Physical Systems