Deep Learning Imitation Controller design: State/Output feedback Controllers, integrated Observers
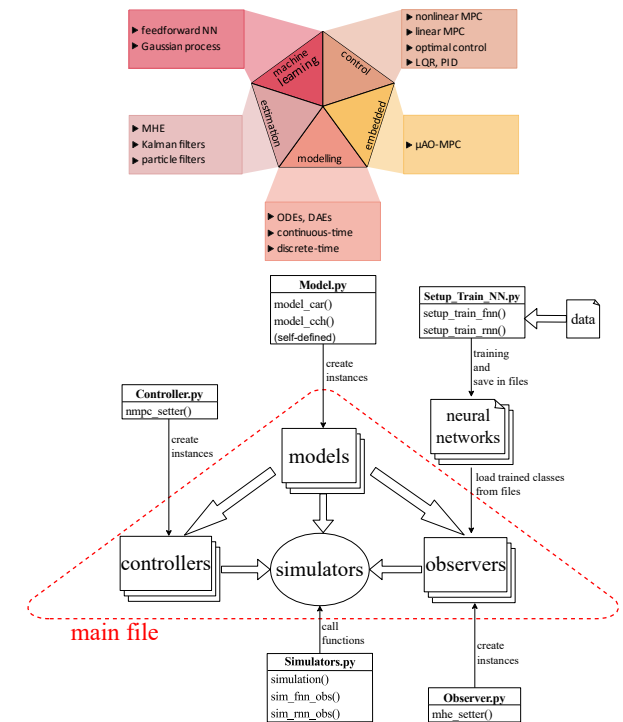
TECHNISCHE UNIVERSITÄT DARMSTADT

Project Seminar (2-4 students, Homeoffice/In presence)

Surge in popularity of Deep Learning methods has been observed in many fields of engineering, including control engineering. While it promises a universal approach at approximating any mapping due to model agnosticism, deriving a well performed controller with Deep Learning is a challenging task.

The problem is further complicated when the available output measurements do not cover all model states. In classical control theory approaches this is handled in one of two ways. We can design an output feedback controller, that determines control action solely using measurement information. Alternatively, we can introduce an observer, whose role is to estimate system states first, and then pass them on to the standard state feedback controller.

The current seminar project aims to compare these approaches in case when the controllers and observers will be derived from (simulated) measurement data using Neural Networks. The students will consider a system, for which not all states are measured, but all are observable. They then will compare various designs of the closed-loop controllers for this system: an output feedback controller that uses a moving window of past measurements in the form of a Feed-forward Neural Network (FNN), an output feedback controller as a Recurrent Neural Network, a dedicated observer followed by a state feedback controller, or a hybrid output feedback controller, that uses the model states as its latent space.

The preferred language for this project is English. Programming experience with Python is required. Experience with PyTorch and CasADi toolboxes are beneficial. If you have questions, feel free to contact us.

[1] https://github.com/hilo-mpc/hilo-mpc
[2] https://www.sciencedirect.com/science/article/abs/pii/S0098135421000442

M.Sc. Johannes Pohlodek
Dr.-Ing. Anton Savchenko
Tel.:   06151 / 16-25190
E-Mail: johannes.pohlodek@iat.tu-darmstadt.de
          anton.savchenko@iat.tu-darmstadt.de
Web: https://www.ccps.tu-darmstadt.de/ccps/

CCPS Control and Cyber-Physical Systems