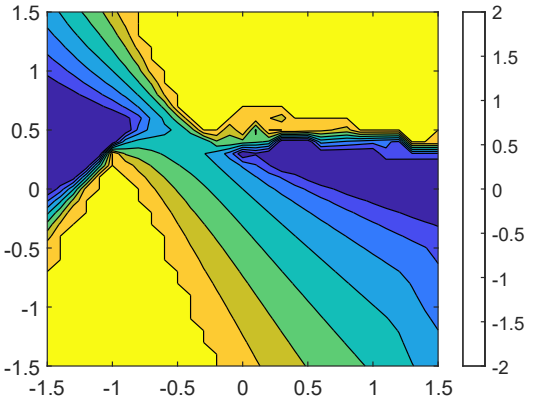
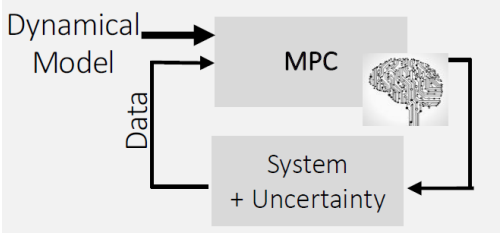
Approximating Model Predictive Controllers using Neural Networks and Gaussian Processes

TECHNISCHE UNIVERSITÄT DARMSTADT

Projectseminar (4 students, homeoffice possible)

Model Predictive Control (MPC) is an advanced control method that can naturally handle nonlinear systems subject to constraints. Furthermore, there exists a strong theoretical backbone to guarantee stability and constraint satisfaction. However, for MPC we must solve an optimal control problem each time we want to apply a new control input. Consequently, MPC is often out of reach for real-time application. In order to avoid solving an optimal control problem online, we can shift the computational load to offline computations. The goal of this project is to approximate the model predictive controller using neural networks and Gaussian processes. To this end, the OCP is solved offline for sufficiently many initial conditions to generate data for training the neural network or Gaussian process. The focus of this project is to compare both methods by means of computational demand and performance for different example problems. The final report must be written in English. Meetings during the project can be in English or German.





Requirements:

- Must: Python and Matlab, CasADi, English
  Beneficial: MPC or Optimal Control, experience with Gaussian processes and neural networks (plus related programming tools/libraries)

Your tasks will be:

- Literature review on methods to approximate a model predictive control law
- Illustrate advantages, disadvantages and limitations in suitably chosen example problems
- Investigate how network pruning or sparse Gaussian processes can speed up online computations
- Evaluate, compare and present the results

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CCPS Control and Cyber-Physical Systems