**Thesis Topic**

**Fast approximate MPC with closed-loop guarantees using machine learning**

**Description:**
Model Predictive Control (MPC) is an optimization based control method that can handle general nonlinear systems and respect constraints on the state and input variables. The main challenges of applying MPC to complex systems is the successful online optimization under real time constraints. The key idea of this project is to exploit machine learning to compute offline an approximation of the MPC that is fast to evaluate online. The MPC is used to generate data offline, which is used to train an appropriate representation in a supervised learning setting (such as deep neural networks). Closed-loop properties of the learned controller can be guaranteed with a combination of robust MPC and suitable bounds on the approximation error.

The goal of this thesis is to extend this framework. Some of the following aspects can be investigated within this project:

- approximation bounds based on learning theory
- theoretical guarantees for deep reinforcement learning
- ‘clever’ learning based on structure of control law
- scalability to high-dimensional systems (e.g. underactuated humanoid robots)
- implementation on a robot or other platform

**Prerequisites:**
- Strong background in control theory and mathematics
- Programming skills: Matlab, optional: C/C++, python
- Optional: Machine learning, Model Predictive Control

**Supervisors:**

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**Area:**
Model Pred. Control  
Machine Learning  
Fast approximate MPC

**Properties:**
Type: MA  
10% literature  
60% theory  
30% simulation/experiment (flexible)

**Beginning:**
Any time

Weitere Informationen: [http://www.ist.uni-stuttgart.de/lehre/bama/index.html](http://www.ist.uni-stuttgart.de/lehre/bama/index.html)  
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