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B A C H E L O R T H E S I S / M A S T E R T H E S I S
for
N.N.
Student ID XXXXXXX, Degree XX-XX

Learning Stochastic Stable Systems

Problem description:

Robots interacting with humans face the difficulty to react to unseen events in their environment which occurs in many real-world applications. One approach is to make the robot acquire skills autonomously from observation and generalization. This idea initiated research at the intersection between machine learning and control and lead to significant results.
An open remaining challenge is to guarantee desired behaviour of such self-learning robots, such as stability or good tracking performance [3]. First approaches, in [2] and [1] have shown promising results, but are not using the full potential of the underlying machine learning techniques by employing deterministic models. Therefore, this work aims to learn stable dynamics from observations based on probabilistic models. It enables robots to generate guaranteed converging trajectory by choosing from a distribution of trajectories. Additionally, knowledge about the similarity to the observation can be used for the riskquantification of movements.

Tasks:

- Literature review on stochastic stability and learning of stable dynamics
- Developing of a learning scheme for stable stochastic models
- Simulate and evaluate trajectory generation based on stochastic dynamics

Bibliography:

[1] S Mohammad Khansari-Zadeh and Aude Billard. Learning control lyapunov function to ensure stability of dynamical system-based robot reaching motions. *Robotics and Autonomous Systems*, 62(6):752–765, 2014.
[2] Seyed Mohammad Khansari-Zadeh and Aude Billard. Learning stable nonlinear dynamical systems with gaussian mixture models. *IEEE Transactions on Robotics*, 27(5):943–957, 2011.
[3] Harold Joseph Kushner. *Introduction to stochastic control*. Holt, Rinehart and Winston New York, 1971.

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