

March 9, 2016

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

Risk-Sensitive Cooperative Dynamic Movement Primitives using Gaussian Processes

Problem description:

Cooperative Dynamic Movement Primitives (DMPs) provide a flexible encoding for goal-directed and periodic movements demonstrated by humans. They can therefore be applied in various tasks like human-robot or robot-robot cooperative object manipulation. [2]

Gaussian Processes (GPs) are a non-parametric regression model which recently gained high attention in the Machine Learning community as well as in robotics. It is fully described by a mean and variance function and can be considered as a distribution over functions. When learning a trajectory for a robotic movement from multiple demonstrations, the GP provides during execution not only a desired position but also an estimate about the confidence of that value. [1]

The goal of this thesis is to explore the potential of combining GPs with cooperative DMPs. This hasn't been tried before and is promising as it mimics human behavior in a team when performing cooperative tasks: More knowledgeable team members dominate in the decision-making process and contribute more than uncertain and less confident team members.

Tasks:

- Familiarization with concepts of Cooperative DMPs and Gaussian Processes
- Generate and implement concept for risk-sensitive cooperative DMPs with GPs
- Experimental validation and comparison with existing approaches AND/OR
- Analytical/theoretical analysis of with respect to control engineering properties

Bibliography:

- [1] CE. Rasmussen and CKI. Williams. *Gaussian Processes for Machine Learning*. Adaptive Computation and Machine Learning. MIT Press, Cambridge, MA, USA, January 2006.
- [2] Jonas Umlauf, Dominik Sieber, and Sandra Hirche. Dynamic Movement Primitives for cooperative manipulation and synchronized motions. In *Robotics and Automation (ICRA), 2014 IEEE International Conference on*, pages 766–771. IEEE, May 2014.

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Start:	XX.XX.XXXX
Intermediate Report:	XX.XX.XXXX
Delivery:	XX.XX.XXXX

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