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B A C H E L O R T H E S I S / M A S T E R ' S T H E S I S
for
Student's name
Student ID 0815, Degree EI

Information Measures for Data Selection in Gaussian Process Learning Control

Problem description:

Autonomous robots such as self-driving cars and unmanned aerial vehicles require the ability to adapt to unseen and dynamically changing environments. Combining methods from machine learning and control theory allows to address this problem, while providing formal guarantees e.g. for safety. Gaussian process regression [2] is a commonly used learning technique due to its data efficiency and Bayesian treatment of uncertainty. Furthermore, probabilistic regression error bounds exist [3], which allow to design robust control strategies. Although there exist several information measures such as mutual information or relative entropy [1], which can be used to determine optimal training data sets for Gaussian process regression, it is not clear how this information theoretic optimality relates to resulting control performance.
Therefore, the goal of this thesis is the analysis and comparison of information measures for active learning with Gaussian processes. The focus of this analysis lies in effects on control theoretic properties such as stability and real-time computability of the measure for on-line learning.

Tasks:

- Literature research on information measures for Gaussian processes and their relationships
- Theoretical comparison of information measures regarding the effects on system theoretic properties
- Numerical evaluation of different information measures in active learning problems

Bibliography:

[1] Tansu Alpcan and Iman Shames. An Information-Based Learning Approach to Dual Control. *IEEE Transactions on Neural Networks and Learning Systems*, 26(11):2736–2748, 2015.
[2] Carl E. Rasmussen and Christopher K. I. Williams. *Gaussian processes for machine learning*. The MIT Press, 2006.
[3] Niranjan Srinivas, Andreas Krause, Sham M. Kakade, and Matthias W. Seeger. Information-theoretic regret bounds for Gaussian process optimization in the bandit setting. *IEEE Transactions on Information Theory*, 58(5):3250–3265, 2012.

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