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BACHELOR THESIS  
for  
N.N.  
Student ID XXXXXXXX, Degree XX-XX

## Path Integral Control for Gaussian Processes

### Problem description:

Research at the intersection of machine learning and control made impressive advances over the past years. Data-driven identification using Gaussian processes have been successfully employed in various control task [2]. However, taking the stochastic nature of these dynamic models into account remains challenging.

In this thesis, we aim to investigate a control approach, called path integral control [3], which solves the stochastic optimal control problem for nonlinear control affine system. Through the transformation of the value function it casts the optimal control problem into the estimation of an integral, which can efficiently be solved with sampling techniques [1].

The goal of this thesis is to evaluate the potential of path integral control for Gaussian process state space models. Based on a literature research for both topics, the theoretical approach must be formulated. The thesis should evaluate theoretically and empirically the potential of the combination of the two techniques.

### Tasks:

- Literature research on Gaussian processes and path integral control.
- Design of the theoretical approach.
- Implementation and evaluation of the proposed concept.

### Bibliography:

- [1] W Keith Hastings. Monte Carlo sampling methods using Markov chains and their applications. *Biometrika*, 57(1):97–109, 1970.
- [2] Carl Edward Rasmussen and Christopher KI Williams. *Gaussian Processes for Machine Learning*. MIT Press, Cambridge, MA, USA, January 2006.
- [3] Evangelos Theodorou, Jonas Buchli, and Stefan Schaal. A generalized path integral control approach to reinforcement learning. *Journal of Machine Learning Research*, 11(Nov):3137–3181, 2010.

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