The Fokker-Planck Equation for Gaussian Process-based Model Predictive Control

TECHNISCHE UNIVERSITÄT DARMSTADT

Proposal for a Master‘s Thesis Project

Model predictive control, an advanced, optimization-based and nowadays widely used control scheme has shown to benefit from employing machine learning approaches to generate and improve the underlying prediction model of the system. One such machine learning approach is Gaussian process (GP) regression, which predicts the system‘s future behavior in terms of Gaussian probability distributions. Besides a nominal prediction (the mean), one thus obtains simultaneously an uncertainty measure (the variance), which can be used for robust controller designs. However, along the controller‘s prediction horizon, the GP model has to be evaluated recursively, i.e., a probability distribution needs to be repeatedly propagated through it. This yields in general analytically intractable distributions that make it impossible to extract accurate uncertainty information therefrom. This is a main drawback of GP-MPC and motivates a rash of approaches to approximate those distributions.

In recent works, MPC has been used together with the so-called Fokker-Planck equation, a partial differential equation that describes the temporal evolution of probability density functions, to control ensembles whose elements are subject to stochastic dynamics. It is possible to interpret the output distribution of a GP model as such an ensemble of different realizations of the system. The scope of this master‘s thesis is to investigate if the Fokker-Planck approach can also be applied to GP-MPC in order to obtain exact uncertainty information along the prediction horizon.

The following prerequisites will be useful for the project:

Experience with / knowledge about:	Model predictive control, Gaussian process regression, partial and stochastic differential equations
Programming skills:	Matlab or Python
Language:	German or English

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