Karlsruher Institut für Technologie

Fakultät für Informatik
Institut für Anthropomatik und Robotik (IAR)
Lehrstuhl für Intelligente Sensor-Aktor-Systeme (ISAS)
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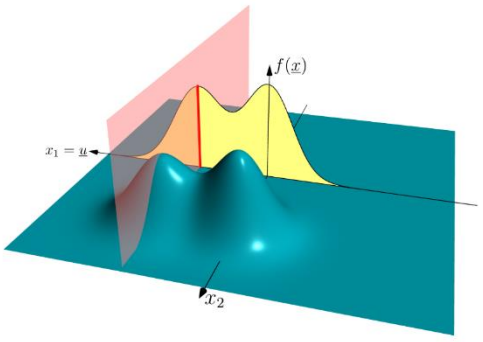
Intelligente ISAS Sensor-Aktor-Systeme

Bachelor/Master Thesis

Deterministic Sampling of High-Dimensional Probability Distributions Using Projections

Sampling from a probability distribution is a ubiquitous task in stochastic information processing. Samples are used in many applications like particle filters or Monte-Carlo integration. In the simplest case they are drawn randomly from a distribution. Deterministic samples on the other hand are optimally placed to represent a distribution, yielding Quasi-Monte-Carlo methods. These have been shown to have better convergence properties than using random samples.



Source: U. Hanebeck, Deterministic Sampling of Multivariate Densities based on Projected Cumulative Distributions, 2019

In one dimension it is straightforward to find deterministic samples by inverse transform sampling, but it is more difficult in higher dimensions. At ISAS a sampling method based on Projected Cumulative Distributions (PCDs) was developed, that transforms sampling from high-dimensional distributions to the one-dimensional case by projecting them onto one-dimensional subspaces using the so-called Radon transform.

This method has shown good results in tests for two dimensions. The goal of this thesis is to extend the method to more than two dimensions and includes the following tasks:

- Literature research on deterministic sampling and PCDs
- Extension of existing algorithms and determination of suitable projection subspaces
- Evaluation of the resulting sampling algorithm with an appropriate metric

Requirements
This topic is suited for students with a background in computer science, mathematics, electrical engineering, or other engineering majors. High motivation, reliability, and a methodical and independent approach to work are expected. Prior knowledge in stochastics, optimization, and the Julia language are advantageous.

Emphasis:

Theoretical Study	■■■■■■
Software Implementation	■■■■■■■■■■
Hardware Implementation	■

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