Karlsruhe Institute of Technology

Department of Informatics
Institute for Anthropomatics und Robotics (IAR)
Chair for Intelligent Sensor-Actuator-Systems (ISAS)
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Intelligent ISAS Sensor-Actuator-Systems

Bachelor/Master Thesis

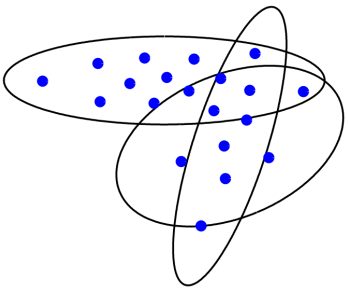
Gaussian Mixture Sample Reduction

Sampling from the **Gaussian mixture (GM)** density is a ubiquituous problem. Alongside the **random samples** (iid, independent identically distributed), there are **deterministic samples**, where sample positions are chosen as homogeneously as possible, yielding superior convergence properties. State of art deterministic sampling methods for GMs are however too slow for real-time application. Instead, low-quality samples (that can be generated fast) can easily be **reduced to fewer high-quality samples**. GMs play an important role in state estimation and control, representing multimodal estimates, and in machine learning, representing clusters.

Task 1: Implement different ways of fast low-quality GM sampling and combine them with different methods of sample reduction, respectively.

Task 2: Perform a comprehensive evaluation. Find out, for example, how many reference samples should be used.

Task 3: Publish a repository that can be used by other researchers in the future who need high-quality GM samples.



What to do
- Understand and check mathematical derivations
- Implement in Julia
- Optimize and publish the repository

Reference: Hanebeck, *Optimal Reduction of Multivariate Dirac Mixture Densities*; Frisch, Hanebeck, *The Generalized Fibonacci Grid as Low-Discrepancy Point Set for Optimal Deterministic Gaussian Sampling*.

Requirements:
Students with a background in computer science, mathematics, electrical engineering, or other engineering majors. Pre-knowledge in Julia is welcome. Strong self-motivation, reliability, mathematical skills, and critical mind are expected.

Emphasis:

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

We offer:
- excellent support and advice
- highend infrastructure
- contact to industry and research partners

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