

Instantaneous frequency estimation with Markov chain Monte Carlo

Zheng Zhao

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1 Background

Estimating the fundamental instantaneous frequency is an important problem in statistical signal processing. Over the decades, various types of methods have been developed to solve this problem. In this project we focus on full-Bayesian estimators for instantaneous frequencies. However, current methods for the estimation are statistically biased. **Therefore, in this project we will propose a new class of estimators based on Markov chain Monte Carlo for statistically exact estimations.**

2 Learning outcomes

You will substantially learn new theoretical knowledge across the domains of statistics, machine learning, and signal processing, as well as practical skills:

- Markov chain Monte Carlo and sequential Monte Carlo, a class of estimation methods widely used in statistics and machine learning.
- Frequency modulation, a fundamental problem in signal processing.
- JAX, a Python library for high-performance and differentiable computation.

3 Reading list

Zheng Zhao, Simo Särkkä, Jens Sjölund, and Thomas B. Schön. Probabilistic estimation of instantaneous frequencies of chirp signals. *IEEE Transactions on Signal Processing*, 71:461–476, 2023.

Christian A. Naesseth, Fredrik Lindsten, and Thomas B. Schön. Elements of sequential Monte Carlo. *Foundations and Trends in Machine Learning*, 12(3): 307-392, 2019.

4 Eligibility requirements

- It is not necessary for the candidate to have any knowledge of frequency estimation. The supervisor will help you to start. However, a strong background in statistical machine learning is a mandate. In particular, the candidate is motivated to learn Markov chain Monte Carlo.
- The student has a research vision, and is willing to summarise the results as a research publication.

5 Contact

Zheng Zhao (email: zheng.zhao@liu.se, website: <https://zz.zabemon.com/>), assistant professor at STIMA.