Statistical estimation of instantaneous frequency estimation with drift

Zheng Zhao

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1 Background

Given a signal, estimating its instantaneous frequency is a fundamental research question in statistical signal processing. Traditional methods, such as Hilbert transform, least square, and short-time Fourier transform typically rely on strong model assumptions (e.g., linear frequency) or are limited by the uncertainty principle. Recently, Gaussian processes-based statistical methods have been developed to perform the estimation with much relaxed model assumptions. However, the method is not yet complete when encountering signal drift. In this project, we will work on the research question of estimating the fundamental frequency in the presence of signal drift.

2 Learning outcomes

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

- Gaussian processes, a class of probabilistic models widely used in machine learning.
- Markov models, a fundamental class of stochastic processes in statistics.
- 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.

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.
- The student has a research vision, and is willing to summarise the results as a research publication.

5 Contact

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