ETH Eidgenössische Technische Hochschule Zürich Swiss Federal Institute of Technology Zurich

Learning & Adaptive Systems

zh aw School of Engineering

Optimized Sampling and Reconstruction in NMR Spectroscopy

Nicolas Schmid
ZHAW /UZH

Mojmír Mutný
ETH

Andreas Krause
ETH

February 7, 2024

1 Motivation

A common problem in multi-dimensional NMR spectroscopy is long experiment times, from days to weeks, to acquire high-quality spectra. To reduce measurement time, reconstruction techniques from undersampled, i.e. non-uniformly sampled (NUS), data have been developed based on prior assumptions such as sparsity or learnt priors. Our project aims to improve NMR spectroscopy sampling and reconstruction by applying advanced compressed sensing techniques. We will be building upon the work of Bora et al. [Bora et al., 2017] and other subsequent studies [Jalal et al., 2021], [Ravula et al., 2023]. Recent developments in the field have shown promising results in robust and efficient data processing, particularly deep generative priors in MRI data reconstruction. We will adapt these methods to enhance NMR spectroscopy, focusing on optimizing NUS strategies for improved data acquisition and reconstruction accuracy.

2 Challenge

Adapting complex machine learning and compressed sensing techniques to the specific needs and constraints of NMR spectroscopy data presents a significant challenge. This includes addressing the unique characteristics of NMR data, effectively integrating generative models, and ensuring that the adapted methods can handle the high-dimensional and diverse nature of NMR datasets.

3 Background

We are seeking a student passionate about generative modelling and reconstruction algorithms, such as compressed sensing, and seeking real-world experience with state-of-the-art machine learning techniques that have a significant impact. In case of interest, don't hesitate to contact Nicolas Schmid at ZHAW `scdn@zhaw.ch`. This project is jointly supervised by ZHAW and ETH Zürich.

References

[Bora et al., 2017] Bora, A., Jalal, A., Price, E., and Dimakis, A. G. (2017). Compressed Sensing using Generative Models. In *Proceedings of the 34th International Conference on Machine Learning*.

[Jalal et al., 2021] Jalal, A., Arvinte, M., Daras, G., Price, E., Dimakis, A. G., and Tamir, J. (2021). Robust Compressed Sensing MRI with Deep Generative Priors. In *Advances in Neural Information Processing Systems*.

[Ravula et al., 2023] Ravula, S., Levac, B., Jalal, A., Tamir, J. I., and Dimakis, A. G. (2023). Optimizing Sampling Patterns for Compressed Sensing MRI with Diffusion Generative Models. arXiv:2306.03284 [cs, eess].