Master's Project: Accelerating MR-STAT Reconstructions Using Deep Learning

Location: University Medical Center Utrecht – Computational Imaging Group

Supervisors: Oscar van der Heide & Alessandro Sbrizzi

Project Summary:

Magnetic Resonance Spin TomogrAphy in Time-domain (MR-STAT) is a fast, multi-parametric MRI technique that reconstructs all parameters of interest from a single, short acquisition. In MR-STAT, the human body is modeled as a large dynamical system, probed in the time domain using standard radiofrequency coils. Since the underlying physics is well understood (Bloch equations and Faraday's law), image reconstruction is formulated as a **large-scale non-linear inverse problem solved directly from the acquired time-domain data**.

This approach removes the need for separate image formation and parameter estimation steps. Unlike conventional MRI protocols, which are notoriously long, MR-STAT acquisitions are **short (around 5 minutes)**, which is highly beneficial for both patients (due to reduced scan time) and hospitals (higher scanner throughput, more consistent results).

However, a key challenge in MR-STAT is the **long reconstruction time**. Using current state-of-the-art iterative methods, full 3D reconstructions take approximately **20 minutes**, which exceeds the actual scan time and hinders clinical adoption of the method.

The goal of this ambitious project is to accelerate MR-STAT reconstructions using deep learning, particularly through **physics-informed neural networks** such as **unrolled optimization schemes**, which emulate iterative solvers in a trainable framework. The student will explore literature, develop and implement computational models, and evaluate performance improvements over existing methods. Ideally, reconstruction times are reduced to be in the order of one minute to allow real-time feedback at the scanner console.

This project offers a unique opportunity to work at the intersection of medical imaging and AI within the Imaging and Oncology division at UMC Utrecht. You'll be part of a world-leading MRI research group with strong

international collaborations and an interdisciplinary research environment. Learn more at www.cig-utrecht.org.

Requirements:

- Background in (applied) mathematics, computer science, or biomedical engineering
- Interest in MRI, inverse problems, and deep learning
- Experience with Python, Matlab or Julia and machine learning libraries (e.g. PyTorch)

To apply:

Send your **CV** and **academic transcript (with course names and grades)** to:

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