

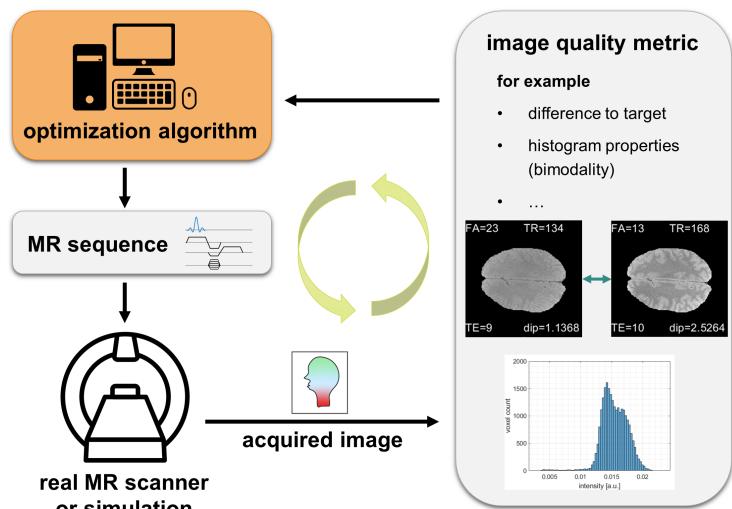
# Master's Thesis:

## Model-Free Optimization of MRI Sequences for Brain Tissue Contrast

### Overview

MRI can generate a variety of tissue contrasts depending on the chosen pulse sequence and its timing. Traditionally, these sequences are designed manually, based on human knowledge and simplified models. Recent work, formulates **sequence design as a supervised learning problem** based either on backpropagation in a differentiable physics simulation (MRzero) [1] or on an automatic, model-free optimization that runs directly on a real MR scanner (MR-double-zero) [2].

**Goal:** Explore these methods for optimizing brain tissue contrast (i.e., gray versus white matter) and to identify suitable cost functions for the perspective of real scanner-based optimization.



### Specific tasks

- Literature review, familiarize with the MRzero and MR-double-zero framework
- Set up an image contrast simulation based on MRzero
- Investigate cost functions for tissue contrast optimization
- Perform numerical optimizations
- Proof-of-concept validation at the MR scanner
- Documentation and illustration of the results

### Recommended Knowledge

- Programming in Python
- Basics of MRI
- ideally: basics of machine learning and optimization

### Literature

1. Loktyushin et al. *MRzero - Automated discovery of MRI sequences using supervised learning*. Magnetic Resonance in Medicine. 2021;86(2):709-724. doi:10.1002/mrm.28727
2. Glang et al. *MR-double-zero – proof-of-concept for a framework to autonomously discover MRI contrasts*. Journal of Magnetic Resonance. May 2022:107237. doi:10.1016/j.jmr.2022.107237

### Contact

Felix Glang

[glang@tugraz.at](mailto:glang@tugraz.at)

Feel free to get in touch without obligation, and we can discuss the project and see if it's a good fit for you.