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Mathematical Models in Quantitative MRI

Quantitative MRI is not a novelty, but it has inspired a lot of innovation in the last 10-15 years driven by two main needs: shorter scan times, improved accuracy and precision.
Quantitative MRI typically requires the acquisition of multiple images with different acquisition parameters and subsequent voxel-wise fitting to an appropriate signal model. A major challenge in the adoption of quantitative MRI protocols in clinical practice is the often long acquisition time required to obtain data for parameter estimation. Due to the long acquisition times, QMRI approaches are often acquired with a very few points with different acquisition parameters, in the extreme case only two images are acquired. This necessitates using simplifications in the signal model applied to extract the quantitative parameters, leading to reduced accuracy and reproducibility.
Instead of simplifying the signal model, one can utilize it as a prior knowledge in the reconstruction allowing fast acquisition while still acquiring sufficient number of images. Following this idea, multiple reconstruction approaches were developed for quantitative MRI that heavily rely on the mathematical modelling of the reconstruction problem. At the same time, the aim towards improved accuracy and reproducibility of quantitative MRI has also pushed the development of qMRI techniques using more complex signal models.
This lecture will provide an overview of the above mentioned techniques, starting from estimating a single parameter and extending to approaches for simultaneous multi-parameter mapping.

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