A Data-driven Approach to Microstructural Imaging (ADAMI)

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The ability to study tissue microstructure in vivo and completely noninvasively using magnetic resonance imaging (MRI) has the potential to radically change how we detect, monitor, and treat diseases, in particular the many neurodegenerative diseases that affect our world's aging population. Unfortunately, MRI provides a very indirect measure of microstructure, and a variety of contributing factors complicates one-to-one association between the MRI measurements and the microscopic substrate. As a result, microstructural mapping is still a poorly understood and challenging inverse problem that often yields inconsistent and contradictory outcomes.

Funded by the European Research Council, the ADAMI project is shifting from the traditional model-driven approach to a data-driven methodology. Rather than relying on a single source of contrast, we exploit the versatility of MRI and use multiple, independent contrast mechanisms that provide the necessary information to distinguish reliably between microscopic substrates. Rather than relying on preconceived models and slow and unreliable model fitting routines, we use machine/deep learning to learn appropriate models and efficient and robust fitting routines directly from the data. Rather than performing a posteriori histological validation of these new microstructural models, we will acquire a priori histological data to directly inform this learning process, guaranteeing, for the first time, a close match between microstructural readouts obtained from MRI and invasive histology.

Through these innovations, ADAMI will advance the field of medical imaging by introducing a groundbreaking data-driven approach to microstructure imaging which will significantly impact the understanding, diagnosis, and monitoring of brain diseases and beyond.