

Research Project

Name of Institution and department: Technical University of Munich, Institute of
Neuroradiology

Link to website: <https://www.neurokopfzentrum.med.tum.de/neuroradiologie/>

City and Country of Institution: Munich, Germany

RESEARCH GROUP

Brief description of the research group and of its mission:

The research group at the Institute of Neuroradiology, Technical University of Munich, brings together expertise from medicine and computer science to advance magnetic resonance imaging (MRI) for the diagnosis and management of neurodegenerative disorders. The group is led by Prof. Dr. Dennis Hedderich and Dr. Benedikt Zott, PhD, and closely collaborates with Prof. Dr. Christian Wachinger (Professor of AI in Radiology, Computer Science) and Dr. Fabian Bongratz, reflecting a strong interdisciplinary integration of clinical neuroradiology and artificial intelligence.

Our research focuses on developing advanced MRI analysis methods that go beyond traditional normative modeling approaches. In particular, we design novel techniques that improve robustness across multi-site data and reduce site-specific biases, thereby enabling more reliable and generalizable imaging biomarkers. These methodological innovations are tightly coupled with clinical applications in well-characterized patient cohorts, with the aim of improving differential diagnosis and optimizing the clinical workup of neurodegenerative diseases.

In addition, we leverage image-derived brain phenotypes to predict individualized treatment response, including the benefits and potential side effects of emerging anti-amyloid therapies. By combining cutting-edge AI methods with clinical expertise, our mission is to enhance precision diagnostics and contribute to more personalized, data-driven decision-making in neurodegenerative disorders.

TITLE OF PROPOSED RESEARCH PROJECT

Improved Diagnosis of Neurodegenerative Disorders by Cross-Ethnic Application of Stochastic Cortical Self-Reconstruction (SCSR)

BACKGROUND

Stochastic Cortical Self-Reconstruction (SCSR) is an unsupervised, deep learning-based framework for individualized mapping of cortical thickness deviations from MRI. In contrast to conventional normative modeling approaches, which rely on demographic covariates and are often sensitive to site-specific effects, SCSR reconstructs a subject-specific healthy reference directly from the individual's cortical data by leveraging learned spatial relationships across the cortex.

A key advantage of SCSR is its improved generalizability across datasets and scanners. By operating directly on cortical thickness values and avoiding explicit modeling of site variables, SCSR is inherently less prone to site-specific biases, a well-known limitation of traditional normative models. This makes it particularly suitable for cross-cohort applications.

In this project, SCSR will be applied and evaluated on a Chinese cohort of healthy individuals and patients with neurodegenerative disorders, which has already been acquired by Prof. Yaou Liu, to assess cross-ethnic generalizability and clinical utility.

OBJECTIVES

- Evaluate the generalizability of SCSR models trained predominantly on Caucasian populations when applied to an independent Chinese cohort, including both healthy individuals and patients with neurodegenerative disorders.
- Identify and develop optimal strategies to mitigate site- and population-specific biases, thereby enhancing robustness and diagnostic accuracy.
- Assess the added clinical value of SCSR in the diagnostic workup of neurodegenerative disorders, with a particular focus on early detection and differential diagnosis (reader study).

APPLICANT'S DUTIES

- Retrain and apply the SCSR algorithm on external datasets, including comprehensive data curation and preprocessing.
- Generate SCSR-derived deviation maps and conduct a multi-reader study to evaluate their clinical interpretability and diagnostic utility.
- Perform statistical data analysis and contribute to the preparation of scientific manuscripts.

APPLICANT'S BENEFITS

- Participation on scientific outcomes of the project i.e. presentations to congresses or publications of papers
- Acquisition of hands-on expertise in the application, adaptation, and development of state-of-the-art neuroimaging methodologies.
- Engagement in an interdisciplinary and multicultural research environment, fostering international collaboration and long-term scientific partnerships.

- Project Leader: Prof. Dr. Dennis Hedderich
- Members: Prof. Dr. Christian Wachinger, Dr. Fabian Bongratz, Dr. Benedikt Zott, Taylor Barda (PhD student), Dr. Melissa Thalhammer, Yitong Li (PhD student), Alexandra Samoylova (PhD student)