Doctoral Candidate 13 - Brain age estimation from multiparametric k-space data

Host Institution	Amsterdam UMC, The Netherlands
PhD enrolment	University of Amsterdam, The Netherlands
Primary Supervisor	Prof. Dr. Matthan Caan, Dept. of Biomedical Engineering & Physics
Subject area	Parameter estimation, DL for image reconstruction, quantitative imaging, brain age analysis

About this doctoral project and your tasks

Estimating brain age is a promising new method for characterising disease onset and progression in an early stage. You will be in the unique position to develop **methods for estimating brain age** directly from the source of MRI: k-space. You will do so using quantitative multi-parametric R1/R2*/QSM reconstruction using a **unified forward model in a neural network**, e.g., the Recurrent Inference Machine (*Zhang et al., Neuroimage 2022*), while **accounting for motion and B0-inhomogeneities** using reference navigators and self-consistency. You will use the publicly available AHEAD (Amsterdam ultra-high field adult lifespan database) dataset for experimentation. (Bayesian) uncertainty estimation will be included, by validation against established outcome measures: quantitative sharpness and interquartile range in relaxometry parameters, in and out of age distribution. You will use this information for brain age regression using age/sex as additional input, and generative models will be developed for training.

Your tasks will include:

- Develop a unified model for MRI reconstruction, quantification, and estimation of brain age
- Create a representative training set for supervised learning using generative modeling
- Explore self-supervised methods for training
- Train a motion correction network using available navigator data
- Apply the network to the AHEAD-database and identify cases with accelerated ageing
- Explore other applications of end-to-end learning in MRI

Foreseen secondments

For this project, we foresee secondments to:

- Dr. Ana-Maria Oros-Peusquens (2 months) at **Forschungszentrum Jülich** (Germany)
- Prof. Daniel Rueckert (2 months) at **Technische Universität München** (Germany)
- Dr. Bradley Macintosh (2 months) at **Oslo University Hospital** (Norway)
- Dr. Ole Gunnar Johansen (2 months) at **Nordic Imaging Lab** (Norway)

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