Doctoral Candidate 16 - Quantitative phenotyping via the generative modelling of quantitative MRI data

Host Institution	King's College London, United Kingdom
PhD enrolment	King's College London, United Kingdom
Primary Supervisor	Prof. Dr. Jorge Cardoso, Artificial Medical Intelligence Group
Subject area	Advanced ML for medical applications; Scientific Computing, Image Processing and Image Acquisition

About this doctoral project and your tasks

MRI imaging can be highly heterogeneous in how it is acquired. Even though MRI physics parameters and associated acquisition sequences are key determinants of the appearance and contrast of the acquired qualitative images, downstream AI models (generative, segmentation, clustering, etc) do not take these into consideration, resulting in poor generalisability and in non-quantitative biomarkers. This project aims to build **generative models of brain MRI imaging data** that are physics aware, able to deal with multiple modalities and resolutions, and invariant to the physics of acquisition. Rather than relying on quantitative data, which is often limited in terms of volume and variability, these models will be made self-supervised, with non-quantitative MRI data used to augment the model with large phenotype and appearance variability. Training models with non-quantitative acquisitions will also allow for the disentangling image content (i.e., the underlying phenotype) and style (i.e., the physics of acquisition).

Ultimately, this generative model will **map data from a non-quantitative acquisition to a set of harmonised quantitative maps (qMRI**). This will not only allow for non-quantitative images to be generated from qMRI data using Bloch equation models (or their static approximations), but also allow for the creation of downstream physics-invariant biomarker extraction networks (segmentation, classification, etc).

Your tasks will include:

- Develop **physics-inspired AI models**
- Contribute towards **MONAI Generative Models open-source toolkit**
- **Train advanced AI models** on very large datasets
- Work with hospital staff to collect large datasets providing the necessary **generalisability**
- **Validate** the work against qMRI ground truths

Foreseen secondments

For this project, we foresee secondments to:

- Prof. dr. Matthan Caan (3 months) at **Amsterdam UMC (**The Netherlands)
- Prof. dr. Marleen Verhoye (2 months) at **University of Antwerp** (Belgium)
- Dr. Thanh Vân Phan (3 months) at **Icometrix** (Belgium)

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