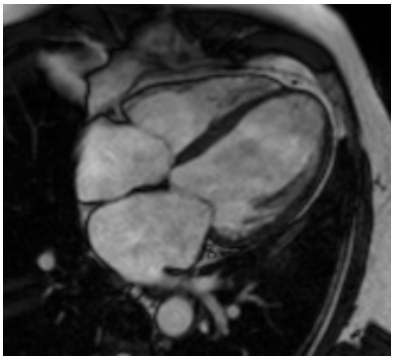
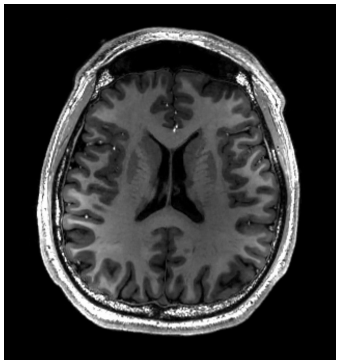
Master's Project 2022/23
Digital Health & Machine Learning
Prof. Dr. Christoph Lippert, *HPI*

Genome-wide association studies of MRI imaging phenotypes

Or: Finding genetic mutations that cause visible differences in medical images



Cardiac MRI



Brain MRI

Abdominal MRI

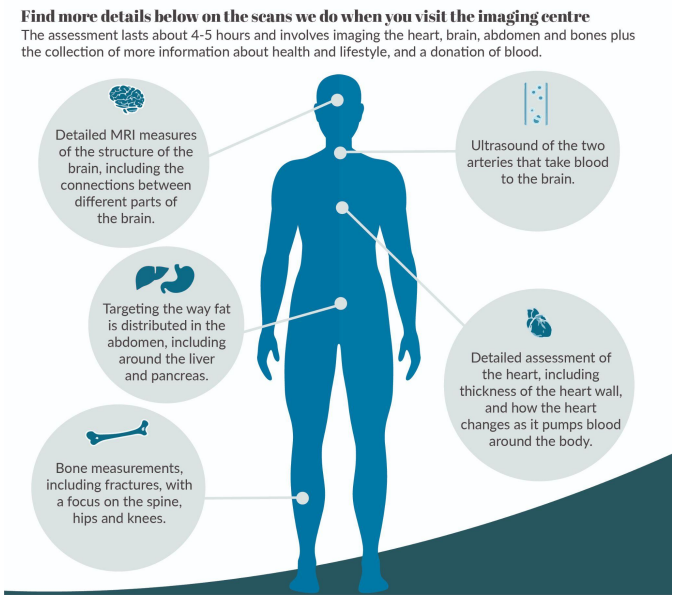
The UK Biobank imaging study[1] has been collecting Magnetic Resonance Imaging data for the whole body of a cohort of 50,000 study participants from the UK population (see examples above and data overview on the next page). This data is accompanied with a variety of relevant health data, detailed information about the sociodemographics, lifestyle and the health of the participants, including their DNA sequences.

The goal of this Master project will be to leverage this data to find dependencies between common genetic mutations in the participants' DNA sequences and the variation that we observe in the images. To this end, you will build on recent work by the Digital Health & Machine learning group that allows testing for associations between images and genetics (Kirchler et al., 2022, Taleb et al., 2022). So far, this method has been applied to 2-D images. In this Master project, we will extend this method to 3-D spatial images and MRI videos (e.g., functional MRI and cardiac cine-MRI) and apply it to find novel genetic mutations that code for human trait variation found in the UK Biobank.

[1] https://www.ukbiobank.ac.uk/enable-your-research/about-our-data/imaging-data

What you will do

- Train deep neural network embeddings of spatial data (2.5D and 3D MRI)
- Perform a genome-wide association study of embedded MRI images
- Identify and conduct statistical tests based on the extracted data
- Present your work to researchers



Data overview, UK Biobank Imaging study

What you will learn

- How to plan and conduct a complex deep learning (DL) project on medical images
- How to handle large amounts of genetic data
- How DL works in the field and how to overcome its challenges
- Development processes in a team with outside collaborators

What you should bring with you

- Software engineering skills
- Hands-on experience in Deep Learning and an interest in automated image processing
- Project management and soft skills
- High motivation and commitment
- Enthusiasm for working alongside researchers in a cutting-edge research project

References

Kirchler, M., Konigorski, S., Norden, M., Meltendorf, C., Kloft, M., Schurmann, C., & Lippert, C. *transferGWAS: GWAS of images using deep transfer learning*. OUP Bioinformatics.

Taleb, A., Kirchler, M., Monti, R., & Lippert, C. (2022). *ContIG: Self-supervised Multimodal Contrastive Learning for Medical Imaging with Genetics*. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 20908-20921).

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