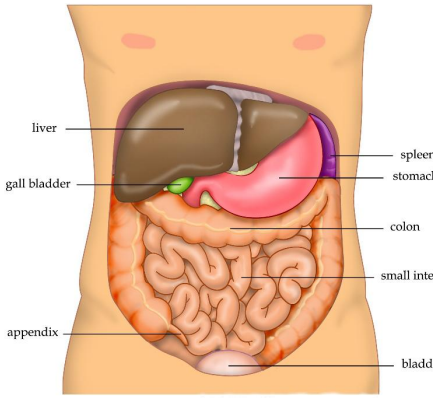
Master's Project 2023
Digital Health & Machine Learning
Prof. Dr. Christoph Lippert, *HPI*

Genome-wide association studies of abdominal MRI

Or: Finding genetic mutations that cause differences in abdominal organs

Abdominal MRI



Organs in the abdominal region

The UK Biobank imaging study[1] has been collecting Magnetic Resonance Imaging (MRI) data, including abdominal imaging, for a cohort of 50,000 study participants from the UK population. 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 organs that we observe in abdominal 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 of the retina and

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

cardiac MRI images. Due to its large size and the number of compactly packed organs in the abdominal region the approach will incorporate image segmentation to tease apart different organs. To this end, we will build on our collaborations with biomedical experts from the Max Delbrück Center for Molecular Medicine (MDC) and the Department for Radiology at the Icahn School of Medicine at Mount Sinai on image segmentation of different abdominal organs (liver and colon). In this Master project, we will extend this method to 3-D spatial images of the abdomen and apply it to find novel genetic mutations that code for human trait variation found in the UK Biobank.

What you will do

- Train deep neural network embeddings of 3D spatial MRI data
- Train and apply deep neural networks to segment the different organs in the abdominal region (liver, bowel, intestines)
- Perform a genome-wide association study of embedded MRI images and segmented organs
- Identify and conduct statistical tests based on the extracted data
- Collaborate with clinicians and biologists on an interdisciplinary research project
- Present your work to researchers

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).