Diffusion-weighted magnetic resonance imaging Quality Enhancement for Automated Probabilistic Tractography

Project Management and Software Development for Medical Applications

General Info

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Project Abstract

The project consists in applying the XTRACT framework to an in-house dataset of diffusion weighted images of the brain in order to analyze the white matter structure.

Background and Motivation

Tractography techniques applied to diffusion-weighted magnetic resonance imaging (DWI) [1] are the only non-invasive way to infer white matter structure of the human brain in vivo. A novel tool, called XTRACT [2], allows for automatically obtaining 42 major tracts of the brain. Those tracts reflected the known anatomy in a high quality DWI dataset from the Human Connectome Project (HCP) [3]. For practical reasons, such high-quality dataset is still not always achievable. Therefore, a comprehensive evaluation of XTRACT reproducibility and accuracy in a simpler (more realistic or clinically feasible) dataset is highly beneficial.

In a previous work, the XTRACT framework was applied to a dataset from Klinikum Rechts der Isar in order to determine how it performs in modest quality data. In addition, several CNNs were trained (on a small portion of the in-house dataset) to denoise the images in such a way that they resemble those images acquired in better quality.

Student's Tasks Description.

The student will run the pretrained CNNs in all subjects of the in-house dataset and evaluate how well the networks generalize to this unseen data. The student will apply the XTRACT framework to the new and denoised images (as predicted by the CNN), with the aim to show the contribution of the CNNs towards improved reconstructed tracts. The tract obtained on the in-house dataset using XTRACT will be compared to the ones presented in the original paper [2]. Further improvements to the networks will be discussed and evaluated after the implementation of a first satisfactory baseline.

Technical Prerequisites

The student should have experience in Python programming and in standard image processing methods. Theoretical and/or practical knowledge of Deep Learning and Pytorch [4] programming are beneficial.

The project will be carried out on-site at the Department of Nuclear Medicine at Klinikum Rechts der Isar, with monthly meetings with the clinical partners.

References

[1] Baliyan V, Das CJ, Sharma R, Gupta AK. Diffusion weighted imaging: Technique and applications. World J Radiol. 2016;8(9):785-798. doi:10.4329/wjr.v8.i9.785

[2] S. Warrington, K. L. Bryant, A. A. Khrapitchev, J. Sallet, M. Charquero-Ballester, G. Douaud, S. Jbabdi, R. B. Mars, S. N. Sotiropoulos, XTRACT - Standardised protocols for automated tractography in the human and macaque brain, NeuroImage, Volume 217, 2020,

[3] http://www.humanconnectomeproject.org

[4] https://pytorch.org

Please send the completed proposal to ardit.ramadani@tum.de, lennart.bastian@tum.de and tianyu.song@tum.de. Please note that this proposal will be evaluated by the BMC coordinators and will be assigned to a student only in case of acceptance.