Automated Mercuri Grading of Muscles in Magnetic Resonance Imaging

Background Myopathies are neuromuscular diseases (NMDs) that progressively cause a weakness of skeletal muscle over time by replacing muscular tissue with fatty tissue. This so-called fatty infiltration of muscles serves as a biomarker for disease severity. Often, magnetic resonance (MR) imaging is clinically used to visually assess such morphological changes of the muscles. To more precisely assess and also longitudinally track the fatty infiltration, a semi-quantitative grading according to the Mercuri scale is traditionally employed in the clinics [1], see Figure 1. This grading is known to be tedious and time-consuming producing considerable workload on physicians. We think that deep learning-based methods are a promising prospect for computer-assisted Mercuri grading.

Aim The student will investigate the use of deep learning methods for fully-automated Mercuri grading of skeletal muscles in MR images of the thigh and leg.

Materials and Methods The method will be developed and evaluated on T1-weighted MR images of the human thigh and leg from patients (n=120) affected by various NMDs. The MR images origin from two centres, the Inselspital in Bern and the Institute of Myology in Paris, and come with a clinical reference Mercuri grading. A supervised convolutional neural network (e.g., AlexNet [2]) will be implemented to fully-automatically grade the muscles in the MR images. The student will evaluate the implemented method on the provided images and write, if the results are convincing, a scientific journal publication.

Environment The student will actively collaborate with members of the Support Center of Advanced Neuroimaging (SCAN) and the Department of Neurology at the Inselspital, broadening his/her experience on different areas of applied research. Further, as this project is a collaboration with the NMR laboratory of the Institute of Myology in Paris, the student will also engage with an external team during the thesis. The output of the project will be integrated into the clinical workflow at the Inselspital and the Institute of Myology.

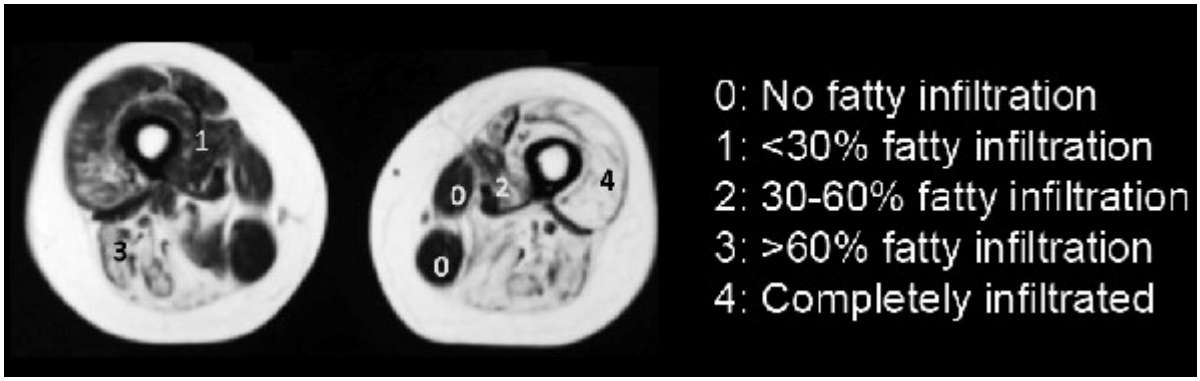

Fig. 1: T1-weighted MR image of the thigh with fatty infiltrated muscles and their Mercuri grading.

Nature of the Thesis
Image analysis & Machine learning: 60 %
Experiments & Evaluation: 40 %

Requirements
Interest in machine learning, especially deep learning
Programming knowledge in Python (or equivalent)

Supervisors
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Institutes
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References
[1] Mercuri et al. (2002) A short protocol for muscle MRI in children with muscular dystrophies. Eur J Paediatr Neurol. 6:305–7. doi: 10.1053/ejpn.2002.0617
[2] Krizhevsky et al. (2012) ImageNet Classification with Deep Convolutional Neural Networks. NIPS 25. 1097–1105.

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