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PhD Thesis: Microscopic Image Classification and Segmentation using Machine Learning Algorithms and Deep Neural Networks

Project title: Towards Improvement of Automated Organ, Tissue and Nuclei Classification and Segmentation in Microscopic Images Using Deep Learning Approaches

Project description:

Quantitative image analysis of microscopic images has become an essential tool for diagnoses and prognosis as well as treatment decisions in numerous diseases and is also essential in basic research. While analysis by human experts was and still is the standard method, it is time consuming, expensive and might not be reliable due to intra- and inter-observer variability. Because of aforementioned reasons, the need for fully or semi-automatic methods for microscopic image analysis has emerged. In order to extract meaningful biomedical information from the digital microscopic images, there is a need for robust and accurate segmentation and classification algorithms. Although many computer-

assisted approaches have been proposed in the literature in order to segment and classify medical images, their level of accuracy is not comparable with manual segmentation, when applied for microscopic images due to certain challenges of those images including complex clinical representations, limited quantities of available public dataset and the extremely large size of singular images. With advent of deep convolutional neural network (CNN) for segmenting and classifying natural images with excellent performance, there is a growing trend to adapt them to be used for medical images and also for microscopic images.

This thesis is part of the “CaSR-Biomedicine” EU project funded by the Marie Sklodowska-Curie Actions of the European Union's Horizon 2020 programme. It includes 13 beneficiaries and 14 ESRs, who aim at a better understanding of the Calcium-sensing receptor (CaSR), its implication in a variety of diseases and new treatment possibilities. In the context of the project, quantitative image analysis, provided by project partner TissueGnostics GmbH (TG), will be one of the core methods used. This thesis, perfomed by early stage researcher at TG (ESR_{TG}) aims at applying deep CNNs for segmentation and classification of nuclei, cells and organ structures in microscopic images provided by several project partners with minimum pre- and post- processing steps. In the frame of this work, we will implement, train and validate segmentation and classification algorithms based on deep learning (DL) for mouse parathyroid gland detection and segmentation, mouse colon cancer tumor analysis and mouse airway analysis. In order to investigate the generalization power of the implemented algorithms, they shall be tested on at least two public available microscopic datasets. Results will be compared to state-of-the-art algorithms. In order to implement these algorithms, a number of well-established CNNs will be exploited and adapted for microscopic image analysis. Upon successful implementation of the algorithms, they shall be integrated to TG´s software product for image analysis, StrataQuest^{TM} to be applied on a wide range of microscopic images in the future.