AI-based analysis of multiplex microscopy images of cancer tissue for improved immunotherapy understanding

Master project proposal, Image Analysis and Machine Learning, VT2023

MIDA - Methods for Image Data Analysis - group, Dept. of Information Technology

Background:
Immunotherapy is a life-saving option for advanced cancer patients, however only a minority responds well to it. Prediction of individual patients' response to immunotherapy is very difficult, and requires advanced analysis methods. Immunity is closely related to the complex interaction of a multitude of cells in the spatial context of the surrounding tissue. Multiplex imaging enables to capture and differentiate cell types that play a role in immuno-response (Fig. 1).

Aim:
The goal of the project is to evaluate performance of contemporary deep-learning based image analysis methods on predicting survival of lung cancer patients and to try to gain knowledge of properties of the tumor micro-environment relevant for patient survival. Ultimately, the results of the project will contribute to the development of better cancer treatment options in the future.

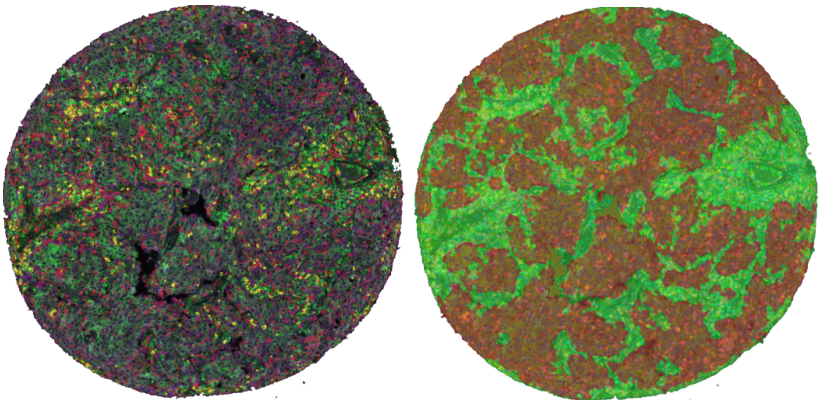

Fig.1 The multiplex imaging system quantifies multiple cell types on a single section by multispectral scanning (left). The stromal and cancer regions are delineated (right).

Task:
To select, apply, and evaluate a number of modern deep learning-based methods on the supervised task of patient survival prediction from multiplex images.

From the best performing model, to extract information on what image information (related to cell types and their inter-relations) is the most relevant for the prediction, utilizing modern explanation and heat mapping techniques (XAI) approaches.

Data:
Multiplex (multispectral, multilayer) images of lung cancer tissue for close to 300 patients, capturing different types of immune and cancer cells. Additional information (e.g., cell segmentation and classification into different types), including patient survival-related annotations, is also available.

Required programming background: (Excellent command of) Python, PyTorch

Prerequisites:
- *Introduction to Image Analysis*, or *Computer-Assisted Image Analysis I*, or similar (Grade 4 at least);
- *Deep Learning for Image Analysis,* or similar, (Grade 4 at least);
- Excellent command of written English.

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