Machine learning for outcome prediction from magnetic resonance imaging in colorectal cancer

Colorectal cancer is one of the most common types of cancer in Sweden, with about 2000 individuals diagnosed every year. Patients with colorectal cancer are commonly treated with radiation therapy, where the ionizing radiation is used to kill malignant cells, prior to surgery. The effects of radiation therapy, however, varies between patients. For some tumors, the radiation therapy has little or no effect, and there are currently no established methods to predict the outcome of radiation therapy for an individual patient.

Magnetic resonance imaging (MRI) is a medical imaging technique that can be used to non-invasively capture three-dimensional images of the inside of the human body. MRI is routinely used in both healthcare and medical research.

At the division of radiology, Uppsala University, a dataset of MRI scans of patients with colorectal cancer has been collected, both pre- and post-neoadjuvant therapy (preoperative radiotherapy, alone or with concomitant chemotherapy). Experienced radiologists are manually *segmenting* this image data, to identify and outline the tumor regions. The aim of this project is to investigate if such data can be automatically analyzed, to predict the outcome of radiation therapy. In particular, we want to investigate if an analysis method called *radiomics* could be used for this purpose. Within segmented regions, Radiomics allows for quantitative assessment of features (e.g. volume, shape and texture) and their association with disease, potentially also revealing visually obscure disease characteristics. Some features extracted by Radiomics have been shown to reflect underlying pathophysiology and genetics. Tumors with more genomic heterogeneity are more likely to develop resistance to treatment and to metastasize (1). Genomic heterogeneity in the primary tumor and its metastases, both at diagnosis and over time, could translate into an imaging intra- and inter-tumoral spatial and temporal heterogeneity (reflected by the Radiomic´s texture analysis), which has been shown in so-called radiogenomics (2). Several studies have demonstrated the predictive and diagnostic ability of Radiomics features in different types of cancer using various medical imaging modalities.

Project goals:

- To review the literature on radiomics and deep learning applied to therapy prediction in various types of cancers, specifically colorectal cancer.
- Plan an implementation and evaluation of one or more methods that appear most suited for this task.
- Perform the implementation and evaluation of this/these methods.
- Write a report describing the conclusions.

The project will be supervised by Filip Malmberg, with co-supervisors Håkan Ahlström and Joel Kullberg. All three are at the Division of Radiology, Uppsala University.

References:

1. Campbell P, et al. Nature 467, 1109-1113, 2010.
2. Jamshidi et al. Eur Radiol 26(8), 2798-2807, 2016.