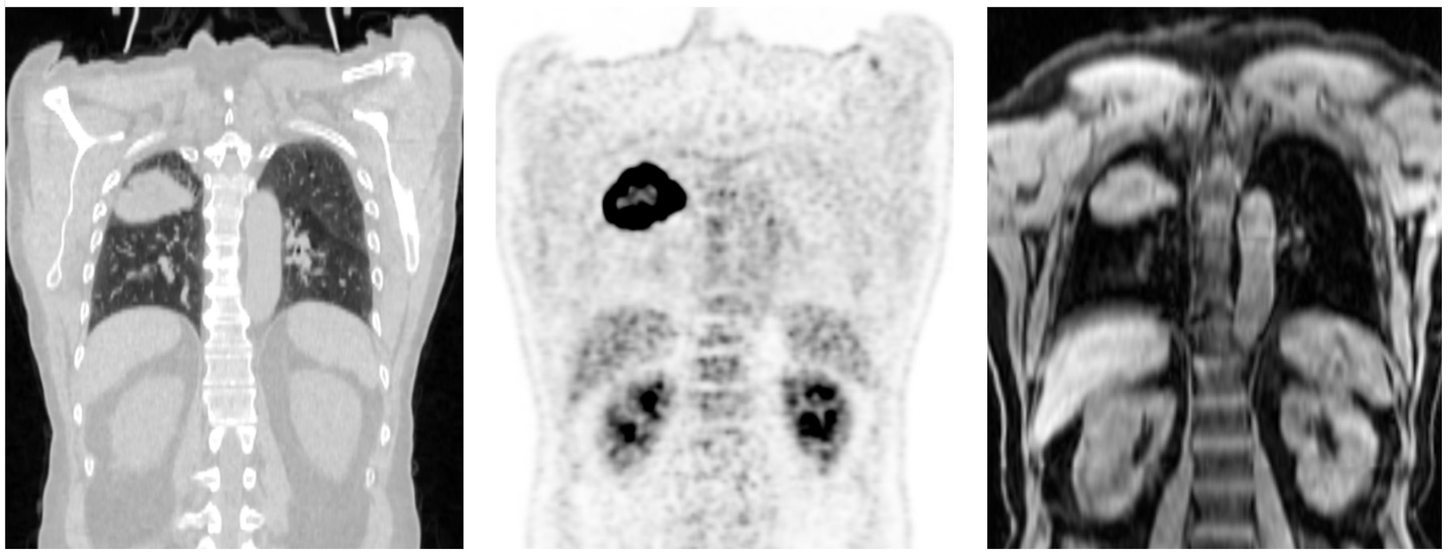
Radiomics & Deep Learning

Discovering patterns in medical images from cancer patients

Background

CT	FDG-PET	MRI



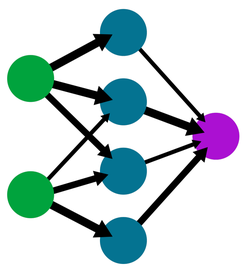
Cancer is a heterogeneous disease with respect to etiology, pathogenesis, therapy response and prognosis. Today, an increasing number of cancer treatment options are available thanks to rapid technical developments. Therefore, decision support systems are needed to offer the **right treatment to the right patient**.

In recent years, **medical imaging** has become increasingly important due to its non-invasive nature for the identification of new prognostic biomarkers. Imaging datasets, consisting for example of computed tomography (CT), positron emission tomography (PET) or magnetic resonance images (MRI) as shown on the left, are expected to hold more information than visible to the human eye.

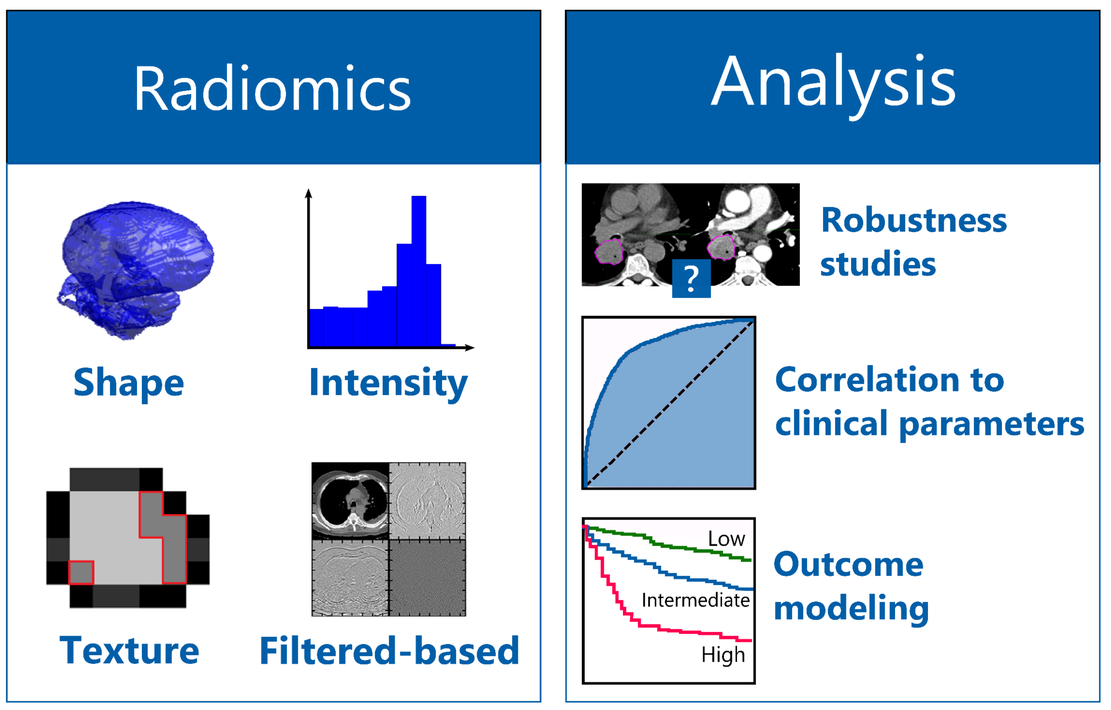
Using sophisticated computing and data analysis techniques, researchers are trying to obtain this hidden information in order to **improve decision making in cancer treatment**.

Radiomics & Deep Learning

Radiomics: the extraction of a large number of meaningful quantitative features from medical images for a systematic analysis. We can extract more than **1000 radiomic features describing tumor shape, tumor intensity, tumor texture** from medical images. They are potential biomarkers of the cancer phenotype, and hence can be used for **patient outcome prognosis or for correlation to the tumor biology using advanced statistical methods**.



Deep Learning (DL): a field within machine learning that comprises several advantages such as the ability to **automatically extract features from raw data**. Convolutional Neural Networks (CNNs) are DL models specialized in image pattern recognition tasks, which are able to **detect hidden motifs and inter-voxel relationships** in a translation-invariant fashion. CNNs can be applied to a wide range of medical image analysis tasks, including **pathology detection, tumor segmentation and image-to-image translation.**



Research

Our group is part of the radiation therapy department at the University Hospital of Zurich (USZ). We work in a highly interdisciplinary setting with medical doctors and radiation biologists to address clinical needs.

Our research focuses on:

- the **image preprocessing methods** required to obtain clean and comparable data
- the **robustness** of radiomic features against scanning and imaging uncertainties
- the correlation of radiomic features **to clinical parameters or patient outcome** modeling to stratify patients into different risk groups for different tumor types
- the correlation of radiomic features with **tumor biology** (such Gleason score or Human Papillomavirus status)
- the **repetitive monitoring** of tumor and organs at risk using the concept of **delta radiomics** (time variation in radiomic features) and recently installed **MRI-Linac**
- the implementation of **deep learning** concepts for medical image analysis & outcome modeling (figure 1)
- Privacy preserving **distributed learning** for outcome modelling.

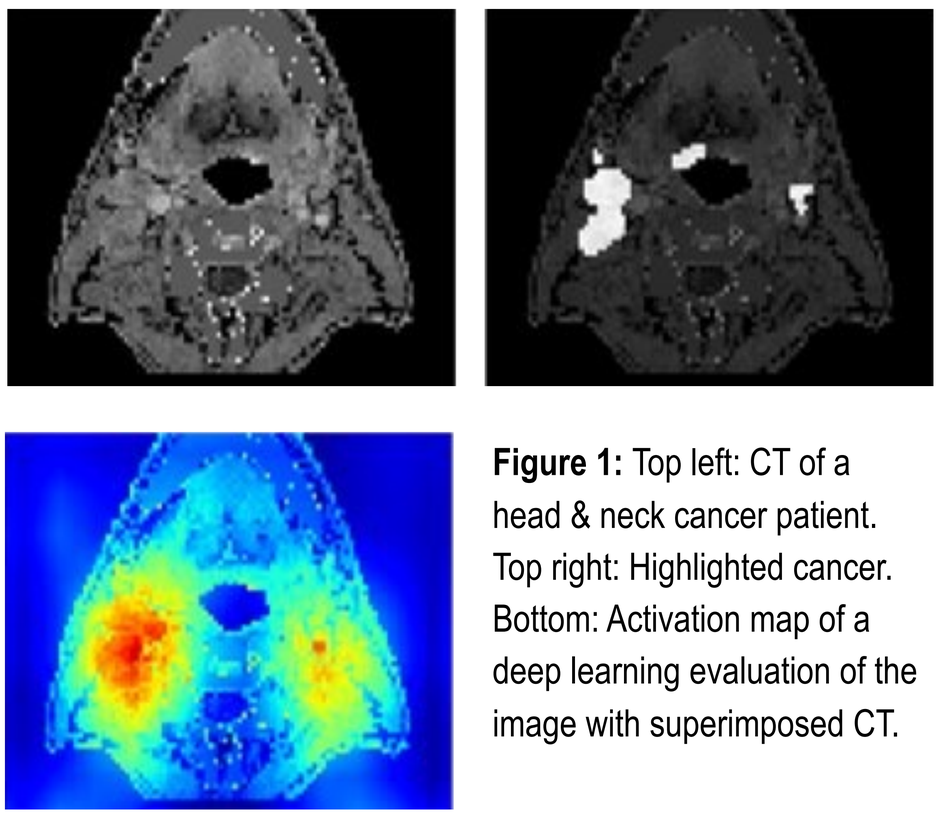


Figure 1: Top left: CT of a head & neck cancer patient. Top right: Highlighted cancer. Bottom: Activation map of a deep learning evaluation of the image with superimposed CT.

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