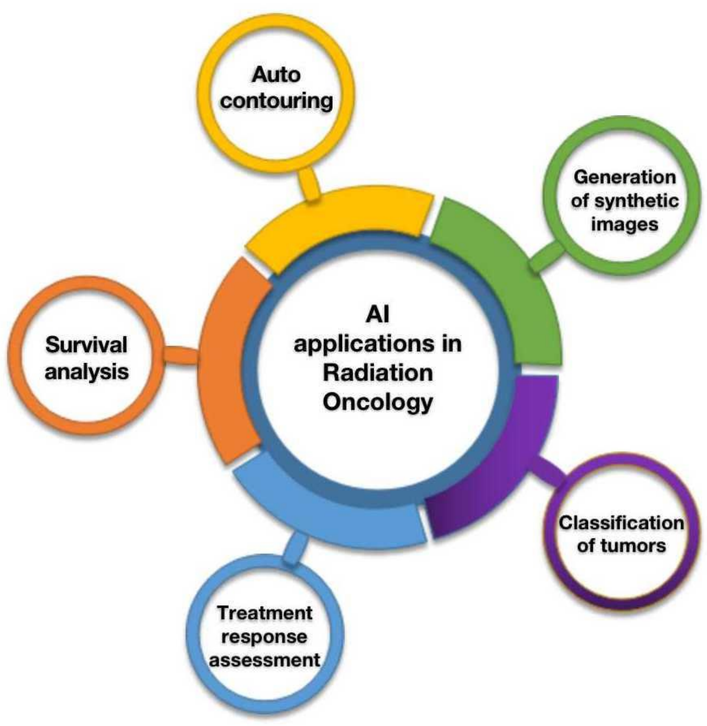
Artificial Intelligence in Radiation Oncology

Background

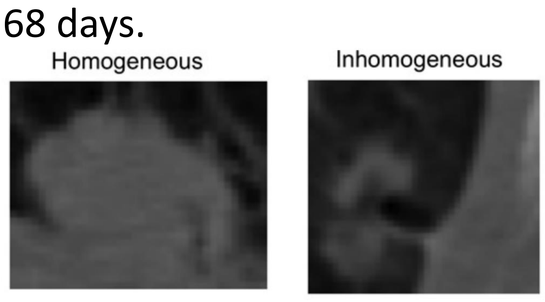
Recent advancements in machine learning and deep learning algorithms along with availability of extensive sets of medical image resulted in surge of interest of integraton of AI methods in clinical workflow. Recently, devoped AI based models can reduce the physicans workload, assist them in desicion making and pave the way for personalized medicine for cancer patients.



Already, in our group (Radiomics research group) at USZ, department of radiation oncology we are actively working on developing AI based model for screening, detection and follow-up of cancer patients. Different applications of AI in radiation oncology is represented in **Figure1.**

Survival analysis and response assessment

The idea of selecting the proper treatment strategy based on patients and tumor characteristics is precision medicine. Figure below represents the CT of the tumor of two different patients with lung cancer. The patients has similar histology and age but the survival for the right patient is 1357 days and the left patient is 68 days.

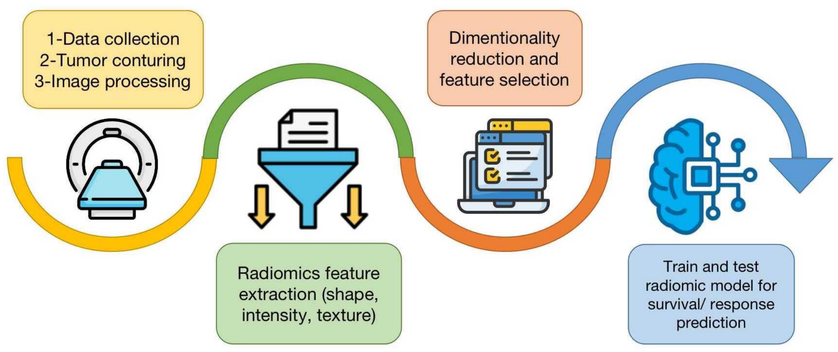


If the physician could predict the survival time of patients or the response to the treatment prior to treatment different strategies might

be choosen. Radiomics has the potential to predict the survival or response of patients to a specific treatment based on medical images.

Radiomics refers to comprehensive analysis of medical images to extract large number of quantitative phenotipic features which reflect cancer characteristics and analysing the relationship between features and patients prognosis to improve decision making. More than 1000 quantitative features can be extracted from region of interest (tumor) on medical image including shape features, intensity histogram, and texture features which quantify the inhomogenities in tumor region. The overal workflow for deveopment of a radiomic model is represented in the figure blow.

Recently instead of using conventional machine learning algorithms to develop radiomic models researchers are implementing deep-learning based radiomics which is more

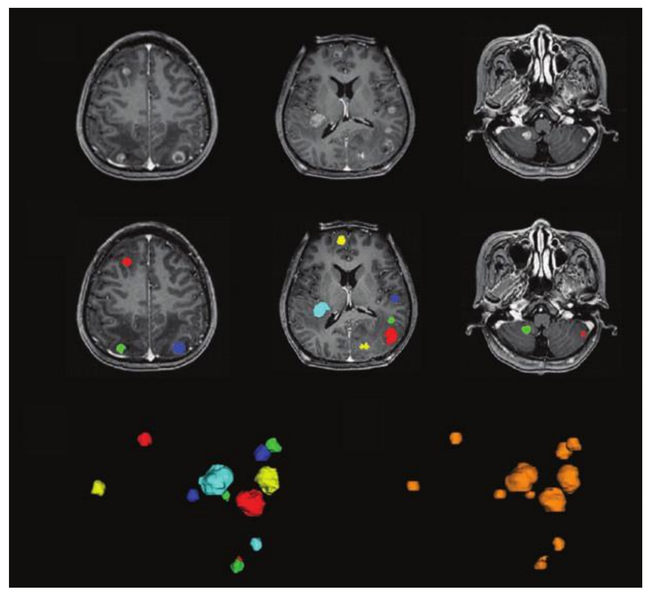


powerful and do not require segmentation, feature extraction and feature selection steps.

Automatic Tumor Detection and Segmentation

Detection and deliniation of tumor burdon are major tasks in clinical management of cancer patients. However, manual segmentation of tumors is tedious, time-consuming and prone to inter-observer variability This task is more challenging in patients with brain metastases since most of the patients have multiple lesions at the same time (In some cases > 15 lesions) and precise detection and conturing of metastases is crucial before stereotactic radio surgery. **Already, the average required time of manual segmentation of lesions based on T1-contrast enhanced MRI scan of patients is around 2.8 minutes per lesions.**

With advancements in computer vision field, several alorithms has been developed for this purpose, the most popular one is **U-Net**. The models based on these algorithms can **reduce the delineation time to 30 second.**

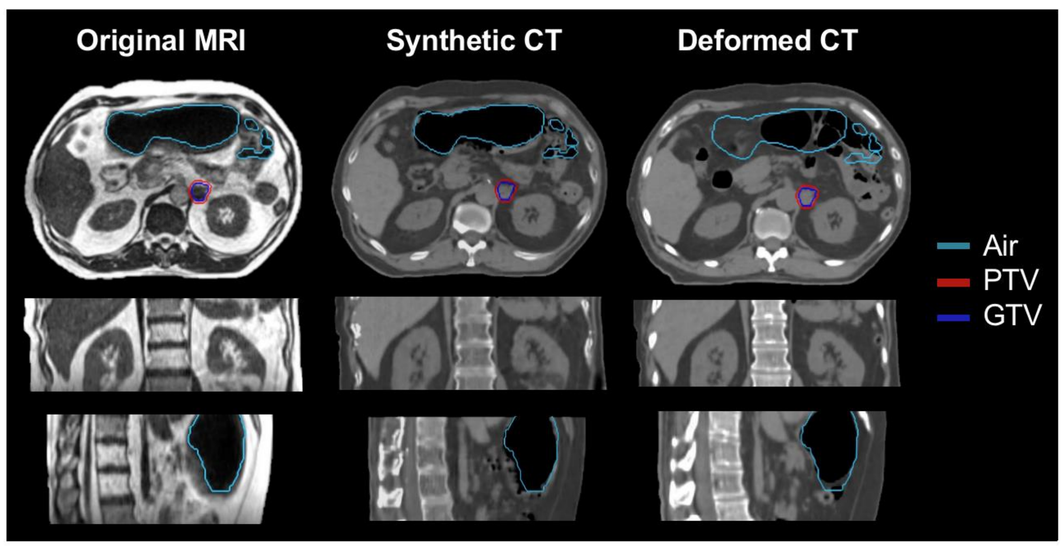


In our research group we are trying to develop a reliable deep learning model with high accuracy and sensitivity to integrate it in clinical workflow for management of patients with brain metastases.

Synthetic medical image generation

In daily radiotherapy workflow the aquisition of CT images using x-rays before the begining of treatment is required for radiation dose calculation. However, this imaging expose the patient to additional radiation dose. One of the research area in our group is to use artificial intelligence to synthetically create CT images based on MRI images aquired at each fraction. The ultimate goal is to **remove the need for CT imaging** and instead rely on MRI images which can better represent the anatomy and do not expose the patients to ionized radiation.

Synthetic CT images can be generated using **generative adversarial networks (GANs).** The below image is generated by cycleGAN which compose of two GANs.



Medical Physics Research Group

Contact: zahra.khodabakhshi@usz.ch
philipp.walliman@usz.ch

Supervisors: Prof Jan Unkelbach| jan.unkelbach@usz.ch
Dr Stephanie Tanadini-Lang | stephanie.tanadini-lang@usz.ch