Radiomics and machine learning for cancer imaging and its implications for radiation oncology

Host institute: Universities of Applied Sciences (UAS), HES-SO Valais-Wallis, Techno-pole, Sierre, Switzerland

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In the research lab

I am a trained radiation oncologist, working at the India Institute of Medical Sciences, Rishikesh, India. I am thankful to ESTRO for supporting my visit to the Universities of Applied Sciences (UAS) in Switzerland. The aim of my visit was to learn about and understand radiomics for cancer image analysis, especially using a machine-learning approach. I wanted to get a picture of how workflow is managed and to learn about the advantages, disadvantages, applications, and limitations of hand-crafted radiomics in comparison to deep radiomics.

UAS is undertaking lots of interdisciplinary work and it was an eye-opener for me to see how this can lead to great research. As a practicing radiation oncologist, I was also interested in learning how this new image analysis tool can help to improve patient care and the delivery of radiation therapy in order to improve the cancer control rate and decrease side effects.

Radiomics is a relatively new field of study, which involves quantitative analysis of various imaging features for a defined end point, such as detection of malignancy, control rate or prognosis. It can be performed on any kind of medical images such as CT, MR PET scans and even histopathological and retinal images. The radiomics workflow can be divided into segmentation of desired area of image, feature extraction and analysis.

Broadly it can be divided into hand-crafted radiomics, where the user selects the features themselves, depending upon various factors, and uses it for analysis, and the fully automated or semi-automated approach for feature selection

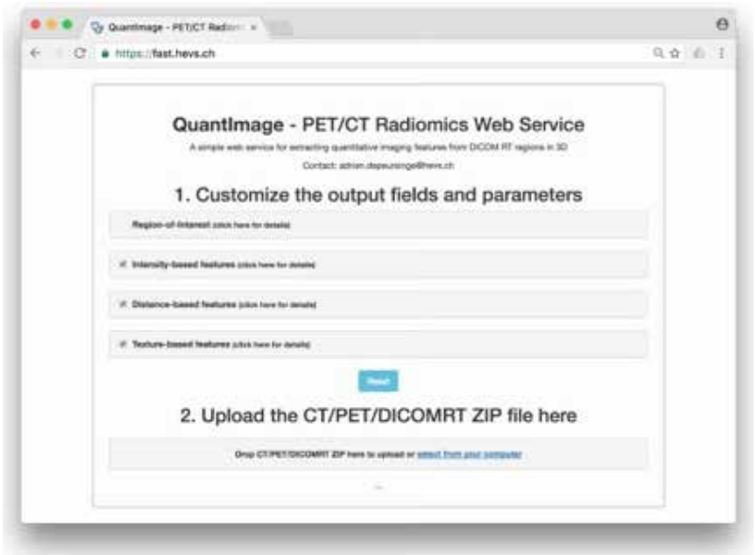

Figure 1- Screen-shot of cloud-based software – Quantimage used for radiomic feature extraction

My visit to CHUV University Hospital, Lausanne

With my guide, Professor Henning Müller

and analysis, which uses machine learning algorithms, such as deep neural networks. The latter approach is termed 'deep radiomics'.

I gained lots of experience at UAS by observing ongoing research projects. My visit improved my understanding of the complexities of different approaches to radiomics, and the potential applications of these techniques to improve our understanding of tumour biology. The technique also has implications for various aspects of radiation oncology, including defining gross tumour volume (GTV), quantification of clinical target volume (CTV) and use of radiomics features for analysing on-board CBCT images.

I aimed to observe various aspects of radiomics workflow processes, especially those featuring extraction. I wanted to learn about the process of feature extraction of segmented regions using in-house developed cloud-based software (Quantimage) and understand the methodologies used for feature selection for analysis, and finally the formulation of a model and internal validation of the model using statistical techniques like random forest and boot strapping.

During my time at the UAS, I visited partner hospitals at Lausanne and Bern and was able to meet radiation oncologists, radiologists and nuclear medicine specialists, as well as physicists and data scientists, involved in research on image analysis using radiomics. I also observed the workflow for implementation of radiomics in clinical settings.

I attended weekly research meetings and multidisciplinary meetings to learn about current practices in the use of machine learning techniques for various aspects of medical

image analysis, including images other than radiologic images, as well as to learn about current research.

I am very grateful to Professor Henning Müller and his colleagues, especially Professor Adrien Depeursinge for allowing me in their lab, guiding me in understanding the nuances of this new technique and agreeing to work on a paper regarding implications of radiomics in low resource settings.

I believe this experience provided a unique opportunity to gain knowledge and insights into this complex topic, as well as form networks that will pave the way for similar interdisciplinary research in India where such collaborations are currently rare.

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