Artificial intelligence applications in radiotherapy

Research impact

Sociocultural impact

In this thesis we proposed and analysed AI solutions that can shorten the gap between research and clinical implementation of AI-based applications and identified specific barriers. These barriers significantly delay the clinical translation of AI research findings. This delay has a negative impact, not only to the RT clinicians, but also to the patients. The continuous challenge and goal of RT is to improve patient care by providing the best treatment option fitted to an individual's life and disease. The most important question of patients to the clinicians when they are diagnosed with a cancer related disease is whether they will survive or how much survival time they have. The new trend of personalised medicine having not only a curative intent but also aiming to decrease radiation induced toxicities/implication should be aligned with the modern technological AI advancements. The current evidence for treatment choices originates from clinical trials that investigate a well-defined subset of the larger patient population according to the requirements of the trial design. Generally, the insights gained from these clinical trials are only applicable to a small percentage of the patient populations with similar characteristics to those in the trial. The exchange of data from all patients rather than a subset and subsequent building of prediction models in a privacy preserving manner constitutes a solution of unlocking the potential of medical imaging and big data in RT. In this thesis, the exchange of biomarkers extracted from medical images enriched with clinical data FAIR compliant data is presented. This AI-application can potentially support clinicians in the decision-making process having a promising future impact in patient care.

Economical and technological impact

During the last decades due to technological and medicine related advancements, different novel treatment options, such as brachytherapy, immunotherapy, proton RT and FLASH RT(ultra high doses of radiation), have been made available to cancer patients. Clinicians have a plethora of available treatments in their hands to implement. However, many of these novel treatment options are costly and time consuming. This is a problem for every national health system in the world. Hospitals board members and clinicians that need to find an equilibrium between cost effectiveness and the most efficient treatment for patients, have difficulties in selecting the best treatment modality. In this thesis, we presented the model based approach (MBA) comparing the photon and proton dosimetric differences in terms of normal tissue complication probability (NTCP) for proton therapy in the Netherlands which is one of the high cost treatment options. In this way, the patients that benefit the most from proton therapy are selected while those who will respond well to conventional therapy are offered that. Through this selection, significant resources are saved for future proton treatments. Specifically, according to Peeters et al.[1] the construction cost of a proton therapy centre can be four times higher in terms of a capital investment while the operational cost can be three times bigger per fraction compared to photon therapy. The aforementioned numbers stress the significance and necessity of a "mechanism" such as the model based approach that can clinically benefit cancer patients.

Moreover, this thesis presented and implemented a framework for the adoption of the FAIR data principles in RT involving different stakeholders in the domain. The FAIR approach does not only have a significant impact on the way researchers store and transform the different

data sources. There is an important economical impact in terms of data loss and data archive costs. According to the European Commission the annual cost of not transforming research data in a FAIR format reaches the "astronomic" amount of 10.2 billion euros[2]. In this cost, different parts of a research pipeline implementation are taken into account such as storage and licence costs. Although a FAIR compliant software is not developed in this thesis, we presented a FAIR compliant framework using RT multi-source data that can have a significant impact on the different RT stakeholders to implement the FAIR concept in the hospital systems changing the way that science and research is conducted.

Bibliography

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2. *Cost of Not Having FAIR Research Data* http://publications.europa.eu/resource/cellar/d375368c-1a0a-11e9-8d04-01aa75ed71a1.0001.01/DOC_1