ERASMUS MUNDUS MASTER IN NUCLEAR PHYSICS

Academic Year 2024/2025

MASTER THESIS PROPOSAL

TITLE: Toxicity Prediction in Radiotherapy to Ensure Good Cancer Treatment Outcomes

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ABSTRACT

Radiotherapy is a cornerstone of cancer treatment, targeting malignant cells with ionising radiation to control tumour growth. However, the therapeutic success of radiotherapy is often hampered by the occurrence of adverse side effects, commonly referred to as toxicity. The severity of these toxicities, such as radiation-induced fibrosis, dysphagia, necrosis, can significantly affect the patient's quality of life, overall treatment adherence, and long-term survival outcomes. Moreover, individual variations in genetic, physiological, and tumour-specific factors make the prediction of these toxicities highly complex.
Recent advances in artificial intelligence (AI) offer promising tools for enhancing the precision of toxicity prediction, allowing for personalised radiotherapy regimens that maximise tumour control while minimising adverse effects. The proposed internship focuses on leveraging AI techniques to predict toxicity in cancer patients undergoing radiotherapy, with a specific emphasis on ensuring good treatment outcomes (Radiotherapy quality assurance).

The main objective of this internship is to develop and optimise AI models capable of predicting toxicity in cancer patients undergoing radiotherapy. The specific goals include:

- Process data for AI. In the database, there are 1438 patient from 99 radiotherapy centres. Each patient have radiotherapy plan and toxicity information. Radiotherapy plan consists of one or more CT, delineations of tumours and organs at risk, prescription and machine parameters in DICOM format. Toxicity is represented in tabular data indicating severity for each organ at risk (Multiclass-multioutput classification).
- Identifying key patient-specific, tumour-specific, and treatment-related features associated with toxicity.
- Explore various AI solutions such as deep neural decision forests if it is based on dose volume histogram, encoders if it is based on 3D dose maps and so on
- Developing and validating predictive models for toxicity based on patient data, including clinical, radiological, and dosimetric variables.

- Providing a framework for integrating the predictive model into clinical practice for radiotherapy quality assurance.

You will be supervised by a medical nuclear physicist and an radiation oncologist at the laboratory of LPC-Caen.

Expected background

Python, AI basics, fundamentals of radiotherapy