Ph.D. in Information Technology
Thesis Defense

February 27th, 2026
at 10:00 am
Room "Alpha"– building 24

Emanuel Ricardo COIMBRA QUINTAS BRIOSO – XXXVIII Cycle

Computer Vision applied to Adaptive Radiotherapy

Supervisor: Prof. Daniele Loiacono

Abstract:

Deep learning has revolutionized medical image analysis, enabling solutions for tasks that challengetraditionalmethods. Thisworkusesdeeplearningtoaddresscriticalbottlenecks in Adaptive Radiotherapy (ART), specifically within the complex treatment process of Total Marrow and Lymph Node Irradiation (TMLI). The research is structured around four key contributions: segmentation, image generation, fairness, and trustworthiness.
First, we addressed the automation of target volume delineation for TMLI. Given the anatomical complexity and low contrast of lymph nodes in Computed Tomography (CT), we developed segmentation models to decrease the manual contouring burden of the radiation oncologist. Concurrently, we evaluated these models for algorithmic fairness, analyzing performance disparities across patient's sex to mitigate bias.
Second, we tackled data quality limitations in ART. As TMLI requires whole-body imaging, multipleConeBeamCT(CBCT)acquisitionsareaggregatedtogether, oftenresulting in anatomical gaps and artifacts. We proposed a generative framework designed to inpaint these missing regions and translate the corrected CBCT volumes into high-fidelity synthetic CTs suitable for dosimetric analysis.
Finally, to bridge the gap between clinical adoption and algorithmic performance, we investigated Uncertainty Quantification (UQ) and Explainable AI (XAI). We implemented methods to calibrate model confidence and visualize decision-making processes. By quantifying uncertainty and providing anatomical context for model predictions, this work aims to establish a transparent and trustworthy foundation for AI-driven radiotherapy workflows.
Keywords: Deep Learning, Adaptive Radiotherapy, Total Marrow and Lymph Node Irradiation (TMLI), Semantic Segmentation, Synthetic CT Generation, Image Inpainting, Uncertainty Quantification, Explainable AI, Algorithmic Fairness.

PhD Committee

Prof. **Pierluca Lanzi, Politecnico di Milano**

Prof. **Peter van Ooijen, University of Groningen**

Prof. **Matteo Maspero, University Medical Center Utrecht**