POLITECNICO DI MILANO

PhD in BIOINGEGNERIA / BIOENGINEERING - 37th cycle

THEMATIC Research Field: A TECHNICAL FRAMEWORK FOR COMBINING MULTI-PARAMETRIC IMAGING WITH ADVANCED MODELLING IN PERSONALIZED RADIOTHERAPY*

Monthly net income of PhDscholarship (max 36 months)
€ 1250.0 In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	During the past decade, advanced medical imaging in oncology has gained increasing interest for its potentials in radiotherapy image guidance and more recently for treatment personalization. There exists a general consensus that the information derivable from the multi-modal image dataset, which is typically acquired on patients during the radiotherapy treatment workflow, can serve for identifying image-based biomarkers, which exhibit relevant predictive power on treatment outcomes. Despite these evidences, the current models applied in the clinics to tune the treatment plan dosimetry, as a function of the expected tumour response and radiation-induced toxicity, do not make use of patient-specific imaging data, but rely on radiobiological parameters typically derived from in-vitro experiments, thus abdicating from describing the in-vivo biological complexity of the pathology and organs at risk on a patient-specific and multi-scale basis.The research proposed stands upon the hypothesis that a personalized and multi-scale description of external beam radiotherapy given by the integration of patient-specific multi-parametric imaging and advanced mathematical models revealing macroscopic, microscopic and radiobiological information, may provide the empowerment of treatment outcome prediction, patients' stratification and subsequent treatment optimization and personalization.Primary aim of this proposal is to develop advanced mathematical models based on optimized multi-

	parametric imaging to be used as decision-making tools in radiation therapy. The core methodology consists in the use of anatomical and functional multi-modal images to be fed into novel computational models, able to predict tumour control and toxicity accounting for tissue radiation interaction at different scales.
Methods and techniques that will be developed and used to carry out the research	Through a key collaboration with clinical institutions, a repository of multi-modal imaging data will be collected and serve as a database for the identification and testing of imaging biomarkers able to predict tumour treatment response through machine learning techniques. Additional efforts will lead to novel image-driven radiobiological models granting a personalized approach. Further investigations will concern modelling of tissue microstructure and its interaction with the treatment beam. Technical and clinical validation will be performed in the frame of a prospective observational study with the collaborating institutions.Expected results are: (i) to identify and test image-based biomarkers predictive of treatment outcome; (ii) to integrate image derived quantitative data in personalized radiobiological models of tumour control and radiation-induced toxicity; (iii) to derive novel biomarkers descriptive of the radiation beam interaction with the tissue microstructure; (iv) to build clinically usable decision-support systems integrating patient-specific information and multi-scale modelling tools.
Educational objectives	During the PhD project the candidate will have to attend educational courses provided by the PhD school of Bioengineering and Politecnico di Milano. Participation to national and international conferences is also foreseen.
Job opportunities	After the PhD, different job opportunities will be available as Post-Doc or Research Scientist in national or international institutions. Careers in medical image processing are recently evolving in many enterprise organizations, including job opportunities such as data scientists, big data engineers and machine learning engineers. Also, possible collaborations with clinical institutions specialized in radiotherapy treatments can be

	established.
Composition of the research group	1 Full Professors 0 Associated Professors 1 Assistant Professors 0 PhD Students
Name of the research directors	GUIDO BARONI

Contacts
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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	564.01 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
The PhD student will be involved in educational activities along with teaching assistantship covering topics of advanced image processing, image feature extraction, machine learning and others mathematical modelling for prediction of treatment response to be applied in the field of radiation oncology.A shared desk and computer will be given to the student at the CartCasLab (Prof. Guido Baroni) for the time needed to carry out the research.