POLITECNICO DI MILANO

PhD in BIOINGEGNERIA / BIOENGINEERING - 41st cycle

THEMATIC Research Field: MULTIOMIC XAI ANALYSIS TO PREDICT IMMUNOTHERAPY RESPONSE IN LUNG CANCER

Monthly net income of PhDscholarship (max 36 months)
1400.0 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	Immunotherapy (IO) is the new standard of care for patients with advanced Non-Small Cell Lung Cancer (aNSCLC). However, only about 30–50% of treated patients benefit from IO in the long term. Programmed Death-Ligand 1 (PD-L1) remains the only biomarker currently used to predict patient response to IO, although its predictive power is limited. Several other potential biomarkers have been identified, but they have yet to be validated in prospective randomized clinical trials and therefore provide only partial evidence.Growing evidence underscores the pivotal role of the gut microbiota in human health, particularly in shaping systemic immune responses. Recent mechanistic studies and clinical trials of microbiome-based therapies have revealed a direct link between the gut microbiome and the modulation of IO efficacy, positioning it as both a potential biomarker and a therapeutic target to enhance IO response in cancer treatment. However, there is limited consistency among the microbial species associated with treatment efficacy or resistance identified across studies, many of which involved small patient cohorts and employed heterogeneous analytical methods. A comprehensive analysis of microbial community composition, function, interactions, and their relationship with the host would be desirable to elucidate the dynamic complexity linking the microbiota, the immune system, the tumor and to clarify their collective role in immunotherapy efficacy. This PhD program aims to use explainable machine learning (ML) to

	analyze and predict response/resistance to IO in patients with aNSCLC. By integrating multiomics (microbiome, genomics, metabolomics, circulating immune profiling) the research will focus on predictive models of treatment outcomes in NSCLC patients receiving IO. Given the complexity of these models, explainable artificial intelligence (XAI) methodologies will be employed to enhance their transparency and usability for clinicians. The PhD candidate will engage in cutting-edge research, collaborating with a multidisciplinary team of clinicians and researchers, contributing to the development of explainable and personalized approaches for predicting immunotherapy efficacy in lung cancer patients and improving patient care.
Methods and techniques that will be developed and used to carry out the research	To achieve the research objectives, the PhD student will be trained in various techniques and methods, including, medical statistical analysis, data analysis, machine learning, and explainable AI (XAI). The candidate will be involved in standardization of the data for analysis. The PhD candidate will work on the data analysis, build on already-developed state-of-the-art models, adapting them for this complex dataset. Finally, the candidate will use different XAI approaches to make the reasoning behind the model's decision making understandable to end-users, medical oncologists and patients. The candidate will work closely with medical Oncologists and researchers from Fondazione IRCCS Istituto Nazionale dei Tumori, on data of collaborative research between the two institutions, such as APOLLLO11 and the I3LUNG project (https://i3lung.eu/). During this collaboration the candidate will develop a better understanding of the clinical needs and data requirements. The candidate will have access to advanced computing resources, including high-performance computing and cloud-based services. Overall, the candidate will gain a unique blend of technical and clinical expertise in the field of XAI and medical oncology.

Educational objectives	Our PhD program in Bioengineering provides advanced scientific training designed to enhance the research and problem-solving skills of doctoral candidates. The program emphasizes both theoretical and experimental competencies, equipping students with the expertise needed to independently develop and execute original research. Graduates will be prepared to lead research groups or work collaboratively within teams. In addition, the educational experience will be enriched through specialized schools and workshops tailored to the research topic, as outlined on the PhD in Bioengineering website.
Job opportunities	After finishing the PhD, the candidate can pursue a career in national and international academic institutions, research institutions or the biotech industry, as the research program involves interdisciplinary knowledge in AI, medicine, and data analysis. Potential job opportunities include positions as a data scientist, AI engineer or consultant. The candidate may also consider pursuing a postdoctoral fellowship to continue research in the field or start their own research program.
Composition of the research group	2 Full Professors 2 Associated Professors 7 Assistant Professors 20 PhD Students
Name of the research directors	Prof. Alessandra Pedrocchi - Dr. Tiziana Triulzi

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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

Educational activity: The student will be encouraged to attend to courses at POLIMI, summer schools, workshops and conferences in Italy and abroad.

Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD student. There are various forms of financial of for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities within the limits allowed by the regulation.

Computer and desk availability: the student will be allowed to access facilities of the DEIB. In addition a desk will be given to the student for the time needed to carry out research. Student will also have an access to 4 workstations with GPUs (3 Dell Precision 3660 Tower with RTX A5000 and 1 Precision 7920 Tower with RTX A6000) at AIONLab.

Three research units will be involved in this project:
(1) the Neuroengineering section of the **NEARLAB**, within the Department of Electronics, Information and Bioengineering of Politecnico di Milano https://nearlab.polimi.it/,
(2) **AI-ON-Lab**, joint research platform between Fondazione IRCCS Istituto Nazionale Tumori di Milano and Politecnico di Milano, (3[VM1]) Microenvironment and biomarkers in solid tumors Unit Fondazione IRCCS Istituto Nazionale dei Tumori (INT).