BIOENGINEERING AND MEDICAL-SURGICAL SCIENCES

Ateneo - Enabling Patient-Specific Cardiovascular Care with Computational Hemodynamics, AI Surrogates, and Reduced Order Modelling

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Context of the research activity	Machine learning and Deep Learning has rapidly emerged as a core technology for scientific computing, paving the way to advancements in the fields of experimental and computational fluid dynamics accelerating research and industrial applications. Among the areas of highest potential impact, we mention: (i) accelerating direct numerical simulations; (ii) predicting hemodynamics based on anatomic features; (iii) the development of enhanced reduced-order cardiovascular models. In the biomedical engineering fields, this reflects in the possibility to translate the adoption of computational models into a clinical framework, as well as to support effectively design and optimization strategies of modelling devices.
Objectives	The research objective of the Ph.D. will involve the development and implementation of tools and methodologies of Artificial intelligence, optimization, and model reduction for in vivo, experimental, and computational fluid dynamics applications to speed up the calculation/extraction of patient-specific hemodynamic quantities of clinical interest, with the aim to promote the clinical adoption of biomechanical indicators of vascular disease to be used for diagnostics and prognostics. The research is intended to be strongly linked to cardiovascular medicine, and the goal of the activity will be to develop solutions that can be directly available for use for both research purposes and clinical practice. The proposed topic is consistent with the Piano Nazionale di Ripresa e Resilienza in the structural thematic areas of intervention on Digitalizzazione, innovazione, competitività, cultura e turismo" (Mission 1, M1), "Istruzione e ricerca" (Mission 4, M4), "Salute" (Mission 6, M6). In line with these areas, the proposed topic aims at enhancing research, advancing scientific knowledge, creating an ecosystem of innovation for the common good, and improving the competitiveness of enterprises with specific focus on the most innovative ones (M1, component C2); strengthening basic and applied research systems and technology transfer (M4, component C2); and promoting scientific research in biomedical and health fields (M6, component C2).

	The PhD student will rely on the competences and the computational and experimental facilities of the PolitoBIOMed Lab Interdepartmental Centre and the Research Infrastucture PAsTISs.

Skills and competencies for the development of the activity	Candidates should have experience in: computational fluid dynamics; data analysis; machine learning; deep learning; computer programming; biomechanical analysis. Candidates should be independent and self-motivated, with scientific creativity and originality, strong team spirit and collaborative capacity, excellent time management, rigour, perseverance, strong writing skills. Fluency in English is mandatory.