POLITECNICO DI MILANO

PhD in MODELLI E METODI MATEMATICI PER L'INGEGNERIA / MATHEMATICAL MODELS AND METHODS IN ENGINEERING - 41st cycle

THEMATIC Research Field: SENSOR-INTEGRATED CARDIAC COMPUTATIONAL MODELS FOR PERSONALIZED DIGITAL TWINS

Monthly net income of PhDscholarship (max 36 months)
1700.0 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	Cardiovascular diseases are the leading cause of death globally, demanding more precise, individualized approaches to diagnosis and treatment. This research aims to advance cardiac computational medicine by developing multiscale and multiphysics models for digital twins of the heart. These models will integrate clinical, sensor, and wearable data to create personalized simulations of cardiac function. Such digital twins can support cardiologists in diagnosis, therapy planning, and continuous patient monitoring. By combining scientific computing and scientific machine learning, the project will enable real-time, patient-specific simulations. The objective is to improve clinical decision-making and long-term outcomes. This innovative approach promotes preventive and precision medicine, reducing hospitalizations and healthcare costs. The research will also contribute to foundational advancements in applied mathematics and computational science. Ultimately, it bridges cutting-edge technology with clinical practice to address critical needs in cardiovascular care.
Methods and techniques that will be developed and used to carry out the research	The research will develop innovative methods combining scientific high-performance computing and scientific machine learning to advance cardiac digital twins for personalized medicine. It will integrate multiscale, multiphysics models grounded in the fundamental

	physical laws of cardiac function with data-driven techniques based on advanced machine learning algorithms. This hybrid modeling framework will capture both mechanistic understanding and patient-specific variability by fusing clinical data, sensor inputs, and wearable device information. The project will leverage state-of-the-art numerical methods to solve differential equations efficiently, with a strong emphasis on physics-based modeling to enable real-time patient-specific simulations. Focus will be placed on scalable algorithms and novel programming paradigms to exploit parallel computing architectures and AI accelerators. Additionally, uncertainty quantification and model calibration techniques will be developed to enhance prediction reliability. Together, these methods will support the creation of robust, adaptive digital twins that inform diagnosis, therapy design, and continuous monitoring in clinical settings.The research will be carried out within the framework of a funded collaboration with the company “Pertech Industries Inc,” which supports this project. Part of the research activities will take place at the company’s designated site.
Educational objectives	Train the student in cardiac computational medicine, with a focus on multiscale and multiphysics modeling for personalized digital twins. The student will develop advanced skills in scientific computing and scientific machine learning for differential models, integrating clinical data. Emphasis will be placed on algorithm development and patient-specific simulations using AI and high-performance computing to support clinical decision-making.
Job opportunities	The advanced training in applied mathematics, scientific computing, and machine learning - applied to personalized cardiac digital twins - will open up diverse career paths in academia, research hospitals, and industry, particularly in digital health. The PhD graduate will possibly join leading research centers, med-tech companies, or AI-health startups, taking on roles in both research and innovation.

Composition of the research group	1 Full Professors 2 Associated Professors 2 Assistant Professors 3 PhD Students
Name of the research directors	Prof. Luca Dedè

Contacts
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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	850.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Educational activities (purchase of study books and material, funding for participation to courses, summer schools, workshops and conferences): financial aid per PhD student per year: 1st year: max 2.310,30 euros 2nd year: max 2.310,30 euros 3rd year: max 2.310,30 euros. The PhD students are encouraged to take part in activities related to teaching, within the limits allowed by the regulations. 1 individual PC per student +several shared PC. Access to one cluster with 32 processors and 384 GB RAM, and to several multi-processor servers.