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Supervisor Expression of Interest
MSCA - Marie Sklodowska Curie Action - (PF) Postdoctoral Fellowship 2021

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Link pagina docente:	https://mox.polimi.it/people-detail/?id=211
Department Name:	Department of Mathematics
Research topic: (https://www.polimi.it/en/scientific-research/research-at-the-politecnico/departments/)	PE1_18 Scientific computing and data processing PE1_17 Numerical analysis PE1_20 Application of mathematics in sciences PE1_21 Application of mathematics in industry and society
MSCA-PF Research Area Panels:	☐ CHE_Chemistry ☐ ECO_Economic Sciences ☐ ENG_Information Science and Engineering ☐ ENV_Environmental and Geosciences ☐ LIF_Life Sciences X MAT_Mathematics ☐ PHY_Physics ☐ SOC_Social Sciences and Humanities
Politecnico di Milano Areas:	☐ Cultural Heritage ☐ Smart Cities ☐ Horizon Europe Missions X Health ☐ Industry 4.0
Title and brief description of the Department and Research Group (including URL if applicable):	The Life Sciences research group at the Laboratory of Modeling and Scientific Computing (MOX) of the Department of Mathematics (bio.mox.polimi.it) gathers 25 active researchers with a long-standing experience in the development of mathematical, numerical and statistical models for the life sciences. In particular, it currently benefits of the ERC AdG grant *iHeart* (PI Prof. A. Quarteroni, https://iheart.polimi.it/en/) that aims to develop an integrated heart model for the simulation of the cardiac function. Numerous collaborations with hospitals, clinical research centers and biomedical and pharmaceutical companies are currently in progress.

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Brief project description: **(max 1 page)**	Biophysical patient-specific models are used to encode known physics and physiology within mathematical equations and to tune these models to represent individual patients. The aim is to use these *digital twins* to predict disease progression, better estimate risk and predict treatment response so that the outcome might be known before a decision is made. A *digital twin* is a computer-based replica of a system that is "seamlessly interconnected" with the real system. The application of this technology to personalized medicine requires the integration of a mechanistic understanding of the system with detailed and heterogeneous data about the current system state. To overcome this challenge, both physics-based and data-based models must be synergistically employed to foster a comprehensive description of the system that dynamically mirrors to the reality. In this scenario, *mathematical learning* approaches used as reduced order models of the forward problem as well as for addressing the inverse problem of data assimilation, are arising as ideal tools to tackle the challenge. In particular, machine learning algorithms will play a central role in this context, as tools for addressing the mathematical learning problem as well as for accelerating/augmenting the performance of the classical numerical solution methods for physics-based models. Even though such approaches show great potential in accurately modeling physics with exceptional computational efficiency, their application to realistic, complex problems is still at its infancy. We believe that this project is timely and provides scientific challenges for a young researcher in applied mathematics and scientific computing. Given the consolidated expertise of the research group on modeling the cardiovascular system and in particular the heart, we plan to apply the proposed modeling approach to develop digital twins for precision medicine with particular focus on cardiac applications, as for example, on the perfusion of the human heart. For this activity will leverage on two main assets: (i) a computational multiscale/multiphysics model of heart perfusion, accounting for a realistic description of the coronary arteries and the heart active contraction driven by electrophysiology (ii) the current collaboration with *Centro Cardiologico Monzino IRCSS, Milan, Italy* for the collection and analysis of patients' data about myocardial blood flow.