COMPUTATIONAL CARDIOLOGY: MODELING AND SIMULATING THE HEART

TRACK NUMBER 2100 (YOUNG INVESTIGATORS INITIATIVE)

MICHELE BUCELLI[1,*], STEFANO PAGANI[1], ROBERTO PIERSANTI[1], FRANCESCO REGAZZONI[1], MAXIMILIAN SCHUSTER[2], ELENA ZAPPON[1], ALBERTO ZINGARO[3]

[1] MOX, Dipartimento di Matematica, Politecnico di Milano, Via Bonardi 9, 20133 Milano (IT).
*Corresponding author: michele.bucelli@polimi.it

[2] Chair for Computational Analysis of Technical Systems (CATS), RWTH Aachen University, Schinkelstraße 2, 52062 Aachen (DE)

[3] ELEM Biotech SL, Plaça Pau Vila 1, 08003 Barcelona (ES)

Key words: Cardiac modeling, Multiphysics, Multiscale, Digital twin, Computational medicine

ABSTRACT

Cardiac modeling and simulation are emerging as powerful tools in clinical cardiology, providing insights into disease mechanisms. Through numerical simulations, cardiac models establish connections between microscopic and macroscopic quantities, enable the prediction of disease progression and response to therapy, and support the design of medical devices and personalized interventions. The development of these models, the associated numerical methods, and their patient-specific customization present many challenges arising from inter and intra-patient variability, multiscale and multiphysics processes, heterogeneous data, and computational complexity. This mini-symposium aims at bringing together novel approaches to address the simulation and the personalization of coupled models encompassing cardiac mechanics, electrophysiology and hemodynamics. Among the many topics are: advanced numerical methods for large-scale simulations in high-performance computing frameworks; machine learning and reduced-order modeling techniques for cardiac applications; integration of experimental and clinical data into multiphysics models; patient-specific modeling of cardiovascular diseases; model validation, verification and uncertainty quantification. By facilitating knowledge exchange, this symposium aims at advancing the field of cardiac modeling and simulation, paving the way for more detailed computational models and the effective integration of clinical data, towards the development of cardiac digital twins.

REFERENCES

[1] M. Peirlinck et al., "Precision medicine in human heart modeling: perspectives, challenges, and opportunities". Biomech. Model. Mechanobiol., 20, 803-831, (2021).