Scientific Machine Learning for Cardiac Electrophysiology Applications

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Abstract: Cardiac modeling for precision cardiology is an emerging technology in clinical practice. Thanks to the sophistication of state-of-the-art electrophysiology models, it is possible to tailor treatments to patient characteristics, thus improving the therapeutic outcome. Patient-specific modeling requires a deep integration of clinical data into existing models. This aspect is, however, not straightforward. Cardiac models are computationally expensive, with several patient-specific parameters of difficult identification. Clinical data is scarce, multi-modal, and sparse in space-time. Thus, neither purely data-driven nor model-driven approaches are optimal in the digital twinning process.

In this talk, we will address the issue using a physics-informed strategy. The first problem consists of recovering the conduction properties–conductivity tensor, early activation sites, and Purkinje network–in the heart, starting from sparse electric recordings collected by clinicians. The second application concerns atrial fibrillation inducibility in a complex anatomical model of human atria. We propose a multi-fidelity classifier that learns the inducibility map on a manifold. Finally, we generalize the classifier so that it does not require any new simulation when the anatomy changes.