

A Dynamics-Guided Objective for Long-Horizon Cardiac Electrophysiology Surrogates

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Cardiac electrophysiology simulations provide valuable insights into electrical propagation in patient-specific geometries, but their computational cost limits their use in large-scale studies and clinical workflows. In this talk, we investigate graph neural network surrogates to approximate long-horizon electrophysiological simulations directly on irregular cardiac meshes. We introduce a physics-inspired training strategy that combines data-driven prediction with temporal, spatial, Laplacian, and spectral constraints to improve rollout stability and physiological consistency. The model is evaluated across unseen anatomies, stimulation configurations, and simulation settings, with substantial computational speed-up compared with numerical simulation. Beyond synthetic validation, we also assess the surrogate on real electrophysiological measurements to investigate its ability to transfer beyond the simulation domain. These results highlight both the potential and current limitations of graph-based surrogates for fast cardiac electrophysiology modelling.