Enhancing 2D Patient Specific Electrophysiology with Physics-Informed Neural Networks

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Background: Neural networks, once trained, can offer predictions for personalized cardiac electrophysiology (EP) within a very short timeframe. Physics-Informed Neural Networks (PINNs) can combine the theoretical knowledge of a physical system with data, presenting a promising method for personalized electrophysiology simulations.

Methods: We have developed a PINN model that utilizes spatial and temporal coordinates along with local conductivities as input parameters to predict the spatio-temporal evolution of action potentials. 2D magnetic resonance images were used to establish a computational domain and infer local conductivities, providing a proof of concept for more detailed personalized 3-D models.

Results: Our study illustrates the capability of PINNs to precisely recreate action potential dynamics from limited in-silico voltage data. Importantly, we show that trained PINNs can accurately interpolate and extrapolate with local conductivity inputs beyond the range of training data and make predictions at a significantly reduced time-frame.

Inference run-time

	FEM	PINN
CPU	684 ± 60 s	3.62 ± 0.09 s
GPU	-	0.22 ± 0.01 s

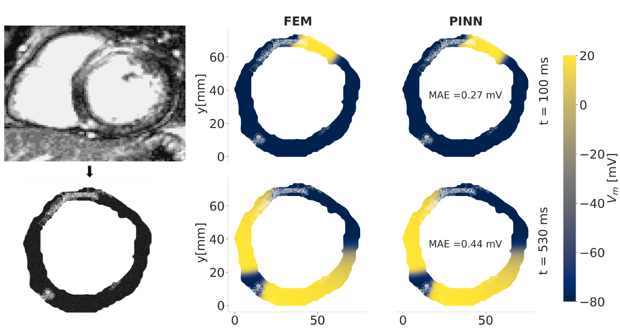

Figure 1. Computational model created from MRI and PINN-predicted transmembrane potential, V_m, compared to the corresponding Finite Elements Method solution.