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Non-invasive Inference of Thrombus Material Properties with Physics-informed Neural Networks[1] MINGLANG YIN, XIAONING ZHENG, Brown University, JAY HUMPHREY, Yale University, GEORGE KARNIADAKIS, Brown University — We employ physics-informed neural networks (PINNs) to infer properties of biological materials using synthetic data. In particular, we successfully apply PINNs on inferring the thrombus permeability and visco-elastic modulus from thrombus deformation data, which can be described by the fourth-order Cahn-Hilliard and Navier-Stokes Equations. In addition, to tackling the challenge of calculating the fourth-order derivative in the Cahn-Hilliard equation with automatic differentiation, we introduce an auxiliary network along with the main neural network to approximate the second derivative of the energy potential term. Our model can predict simultaneously unknown parameters and velocity, pressure, and deformation gradient fields by merely training with partial information among all data, i.e., phase-field and pressure measurements, and is also highly flexible in sampling within the spatio-temporal domain for data acquisition. We validate our model by numerical solutions from the spectral element method (SEM) and demonstrate its robustness by training it with noisy measurements. Our results show that PINNs can accurately infer the material properties with noisy synthetic data, and thus they have great potential for inferring these properties from experimental data.

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