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Quantifying incompressible two-phase flow fields from the interface movement using physics-informed neural networks

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Physics-informed neural networks are applied to incompressible two-phase flow problems. We investigate the forward problem, where the governing equations are solved from initial and boundary conditions, as well as the inverse problem, where continuous velocity and pressure fields are inferred from data on the interface position scattered across time. We employ a volume of fluid approach, i.e. the auxiliary variable here is the volume fraction of the fluids within each phase. For the forward problem, we solve a two-phase Couette and Poiseuille flow. As for the inverse problem, three classical test cases in two-phase modeling are investigated. In particular, a drop in a shear flow, an oscillating drop and a rising bubble is studied. The data of the interface position over time is generated with a valitated CFD solver. The inferred velocity and pressure fields are then compared to the CFD solution. An effective way to distribute the spatial training points to fit the interface, i.e. the volume fraction field, and the residual points is presented. Furthermore, we show that the weighting of the losses that are associated with the residua of the partial differential equations is crucial for the training process. The benefit of using adaptive activation functions is evaluated for both the forward and inverse problem.

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