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Neural Network approach to reduced order modeling of multiphase flows[1] CRISTINA P. MARTIN LINARES, TOM BERTALAN, JIACAI LU, Johns Hopkins University, SEUNGJOON LEE, Department of Applied Data Science, San Jose State University, YANNIS KEVREKIDIS, GRETAR TRYGGVASON, Johns Hopkins University — We explore the use of Neural Networks (NN) to learn black as well as grey box models of the Partial Differential Equations (PDE) that govern multiphase flows in a 2-Dimensional (2-D) vertical channel. The data is generated using Direct Numerical Simulations (DNS). The covariance method is used to perform Proper Orthogonal Decomposition (POD) on the velocity and void fraction to filter the data so we can learn an effective PDE. The selected POD modes are further reduced through an autoencoder. The selected minimum number of nonlinear projections have a one-to-one correspondence with the first few POD modes while reducing the loss function. The POD modes are used to evolve the solution in time using NN. We also use a NN to learn the functional form of the PDE and use the learned PDE to predict the dynamics. The closure terms in the averaged multiphase flow equations are predicted using NN and the predicted PDE is used to evolve in time the velocity and the void fraction, in another method. The developed models are used to predict the dynamics of flows with different initial and boundary conditions.

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