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Deep Learning Time-Dependent Hagen-Poiseuille Flow NINA PRAKASH, WEI HU, AMIR BARATI FARIMANI, Carnegie Mellon University —
Deep learning has emerged as a valuable tool for data-driven modeling of fluid flow systems. Rather than a traditional physics-based computational approach based on governing equations, deep learning can be used to derive models of flow systems directly from experimental or simulation data. In this work, we use Long Short Term Memory (LSTM) to learn the velocity profile development of Hagen-Poiseuille Flow in its time-dependent entry region. Given arbitrary boundary conditions including the pipe diameter, fluid properties, and axial pressure gradient, the network is able to predict the entry region velocity profiles as flow develops from rest with a mean squared error of less than 1%. The model is trained solely on simulation data and thus is able to learn the behavior of the system with no knowledge of the physical mathematical model. This work contributes to a growing body of work on the application of machine learning to fluid modeling by proving the success of LSTM to model a time-dependent fluid flow system. The deep learning framework presented in this work has the potential to be successful for systems that involve complex geometries or turbulence that can make traditional approaches computationally inefficient and cumbersome, or for systems for which the underlying mathematical model is unknown.

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