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Interpretable and Generalizable Machine Learning for Fluid Mechanics[1]

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Many tasks in fluid mechanics, such as design optimization and control, are challenging because fluids are nonlinear and exhibit a large range of scales in both space and time. This range of scales necessitates exceedingly high-dimensional measurements and computational discretization to resolve all relevant features, resulting in vast data sets and time-intensive computations. Indeed, fluid dynamics is one of the original big data fields, and many high-performance computing architectures, experimental measurement techniques, and advanced data processing and visualization algorithms were driven by decades of research in fluid mechanics. Machine learning constitutes a growing set of powerful techniques to extract patterns and build models from this data, complementing the existing theoretical, numerical, and experimental efforts in fluid mechanics. In this talk, we will explore current goals and opportunities for machine learning in fluid mechanics, and we will highlight a number of recent technical advances. Because fluid dynamics is central to transportation, health, and defense systems, we will emphasize the importance of machine learning solutions that are interpretable, explainable, generalizable, and that respect known physics.

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