DFD19-2019-002988

Abstract for an Invited Paper
for the DFD19 Meeting of
the American Physical Society

Machine learning for Predictive Turbulence Modeling : A Cautiously Optimistic Perspective[1]

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Machine learning has shown promise in describing, reconstructing or even predicting properties of a *given* system, given large amounts of relevant data. This talk focuses on how one can construct data-augmented models for turbulent flows that can learn from different systems, and transfer this modeling knowledge to make predictions in other systems in a non-parametric context. This defines a paradigm of transfer learning in the sense that the learning should target *global rules* - rather than problem-specific information - that is common to a *class of systems that share similar physics*. In the limit of finite (big or small) data, this requires the enforcement of a variety of physical, physics-inspired and empirically-known constraints. We embed learning architectures within PDE models and train the hybrid model in an integrated fashion, thus enforcing consistency between the learning and model construction. Examples of the enforcement of hard and soft constraints will be provided. These hybrid models are trained across different systems that are representative of the underlying model discrepancy, yielding predictions on unseen problems with quantified error bounds. Algorithmic, physical and data-related challenges will be discussed toward the end of achieving truly robust and generalizable models.

[1]Supported by the National Science Foundation & the Office of Naval Research