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DATA-DRIVEN METHODS IN COMPUTATIONAL FLUID DYNAMICS

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ABSTRACT

The machine learning revolution is changing the computational fluid dynamics field in fundamental ways. Although FVM/FEM and other numerical methods have reached maturity, we are experiencing the emergence of new and simpler data-driven methods based on machine learning techniques [1, 2]. This revolution allows for the development of new techniques to solve problems known to be very challenging with traditional methods and allow for improvement of existing algorithms through data informed parameter selection.

However, the urgent and unmet need to develop algorithms that can scale in statistical and computational efficiency to the size of modern data sets, and the complexity of contemporary mathematical models, must be addressed. Many central problems, e.g. enforcement of physical constraints in machine learning techniques, are unmet in existing methods.

This will require a holistic approach involving both new foundational theory, algorithms, and programming language design. The emerging research theme of “Data-driven methods in Computational Fluid Dynamics” lies at the intersection of these overlapping directions. It aims to improve the statistical quantification of uncertainty, improve computational efficiency and build more scalable and effective numerical methods for complex and inverse problems, taking advantage of the natural correspondence between computation and inference.

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