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Surrogate Models for CFD Simulations Based on Convolutional Neural Networks

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Computational fluid dynamics (CFD) simulations are important in many application areas, such as civil and mechanical engineering, meteorology, geosciences, or medical science. However, accurate simulation results come at high computational costs, and they require high-quality meshes describing the computational domain.

In this talk, a machine learning-based model order reduction approach for predicting flow fields is presented. After an expensive offline phase, where a surrogate model based on a convolutional neural network (U-Net type architecture [3]) is trained using simulation data, the predictions can be performed much faster than classical numerical simulations. Moreover, the predictions do not require the generation of a complex computational mesh. The surrogate model can be 10^2 or 10^4 times faster on a CPU or GPU, respectively, of a normal workstation; see [2, 1] for details on the approach.

Numerical results investigating the accuracy and efficiency for varying types of geometries from different application areas are presented. Moreover, different aspects to improve the performance such as the choice of more sophisticated loss functions are discussed.

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