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Deep Neural Networks for Data-Driven Turbulence Models ANDREA BECK, DAVID FLAD, CLAUS-DIETER MUNZ, University of Stuttgart — Machine learning methods and in particular deep learning via artificial neural networks have generated significant enthusiasm in the last years. Since these methods can provide approximations to general, non-linear functions by learning from data without a-priori assumptions, they are particularly attractive for the generation of subspace models for multi scale problems. In this presentation, we present a novel data-based approach to turbulence modelling for Large Eddy Simulation by deep learning via artificial neural networks. We first discuss and define the exact closure terms and generate training data from direct numerical simulations of decaying homogeneous isotropic turbulence. We then present the design and training of artificial neural networks based on local convolution filters to predict the underlying unknown non-linear mapping from the coarse grid quantities to the closure terms without a-priori assumptions. All investigated networks are able to generalize from the data and learn approximations. We further show that selecting both the coarse grid primitive variables as well as the coarse grid LES operator as input features significantly improves training results. Finally, we show how to construct a stable and accurate LES model from the learned closure terms.

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