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Creating Turbulent Flow Realizations with Generative Adversarial Networks RYAN KING, PETER GRAF, National Renewable Energy Laboratory, MICHAEL CHERTKOV, Los Alamos National Laboratory — Generating valid inflow conditions is a crucial, yet computationally expensive, step in unsteady turbulent flow simulations. We demonstrate a new technique for rapid generation of turbulent inflow realizations that leverages recent advances in machine learning for image generation using a deep convolutional generative adversarial network (DCGAN). The DCGAN is an unsupervised machine learning technique consisting of two competing neural networks that are trained against each other using back-propagation. One network, the generator, tries to produce samples from the true distribution of states, while the discriminator tries to distinguish between true and synthetic samples. We present results from a fully-trained DCGAN that is able to rapidly draw random samples from the full distribution of possible inflow states without needing to solve the Navier-Stokes equations, eliminating the costly process of spinning up inflow turbulence. This suggests a new paradigm in physics informed machine learning where the turbulence physics can be encoded in either the discriminator or generator. Finally, we also propose additional applications such as feature identification and subgrid scale modeling.

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