Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Data-driven prediction of vortical structures in turbulent flows employing deep learning techniques BABAK KASHIR, MARCO RAGONE, VITALIY YURKIV, FARZAD MASHAYEK, University of Illinois at Chicago — The vortical structures are inherent characteristics of turbulent flows. Significant research has been conducted to understand, characterize and locate the vortical structures in turbulent flows in complex configurations. However, the identification of the size and location of the vortices in practical flows is often challenging due to the interplay of various parameters. To overcome these challenges, we have developed a deep learning model to identify and locate the vortical structures. The deep learning model is trained and tested in lid-driven cavity flow fields to predict the vortical structures in different conditions. The architecture of the model is characterized by multiple layers with random dropout and linear regularization, whereas the final prediction is performed through a binary classification. The second invariant of the velocity gradient tensor (known as the Q-criterion) is used to locate the vortical structures in fluid dynamics. This criterion describes a vortex as a continuous fluid region with the positive second invariant. The neural-network predictions are compared with the results from the previously validated numerical simulations. The present study allows for advance accelerated analysis of complex turbulent flows.

Farzad Mashayek
University of Illinois at Chicago

Date submitted: 27 Jul 2019 Electronic form version 1.4