Lagrangian data generation by Machine Learning

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We use a novel Generative Adversarial Network to produce Lagrangian trajectories of high Reynolds homogeneous and isotropic turbulence. The training and validation of the supervised learning is made on a statistical basis, by minimizing the Earth-Mover (Wasserstein) distance between the Probability Distribution Function of the empirical (ground-truth) Lagrangian paths and the ones generated by the convolutional network. Trajectories are generated up to a total length of one eddy turn over time and for the three components simultaneously. Issues connected to generalizabiity and accuracy are discussed on a quantitative basis for the probability distribution function of the acceleration and for the local scaling exponents of the Lagrangian Structure Functions. Data used for this study are made openly downloadable and usable from the Smart-TURB database.[1] This work was supported by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (Grant Agreement No. 882340).

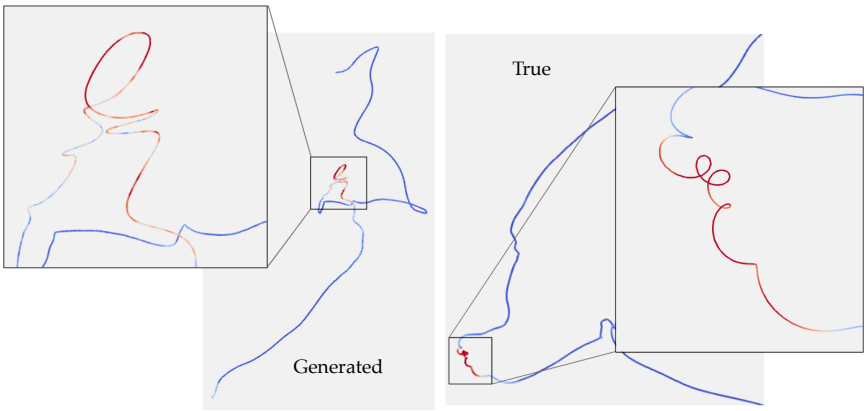

Figure 1: Qualitative comparison between a 3d trajectory of a Lagrangian tracer from the Smart-Lagr data base obtained from a DNS of homogeneous and isotropic turbulence at 1024^3 resolution (rigth) and the one generated with our Wasserstein-GAN (left).

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[1]Smart-TURB: an open data base for Eulerian and Lagrangian turbulence. https://smart-turb.roma2.infn.it/