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When deep learning meets ergodic theory MICHELE ALESSANDRO BUCCI, INRIA-Saclay, ONOFRIO SEMERARO, LIMSI-CNRS, SERGIO CHIBBARO, UPMC, ALEXANDRE ALLAUZEN, ESPCI, LIONEL MATHELIN, LIMSI-CNRS — The reliable prediction of the temporal behavior of complex systems is required in numerous fields, including fluid mechanics. This strong interest is inherently connected with modeling issues: often, the governing equations describing the physics of the system under consideration are not accessible or, when known, their solution might require a computational time incompatible with the prediction time constraints. In this view, a data-driven approach is to approximate the system at hand in a generic functional format and inform it from available observations. Numerous successful examples are already available based on deep Neural Networks. Here, we consider Long-Short-Term Memory neural networks and thoroughly investigate the impact of the training set on the long-term prediction. Leveraging metrics and measures from ergodic theory, we analyze the amount of data sufficient for a priori guaranteeing a faithful model of the real system. In particular, we will show how an informed design of the training set, based on symmetries of the system and the topology of underlying attractor, significantly improves the resulting models, opening up avenues of research within the context of active learning. Our developments will be illustrated on the Lorenz63 model and shear flow models.

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