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Potential of using deep neural networks for turbulent-flow predictions[1] RICARDO VINUESA, PREM A. SRINIVASAN, LUCA GUASTONI, HOSSEIN AZIZPOUR, PHILIPP SCHLATTER, KTH Royal Institute of Technology — The capabilities of deep neural networks to predict temporally evolving turbulent flows are evaluated in this work. To this end, we employ the nine-equation shear flow model by Moehlis *et al.* (*New J. Phys.* 6, 56, 2004) as a low-order dynamical representation of near-wall turbulence. We thoroughly tested two different neural networks: the multilayer perceptron (MLP) and the long short-term memory (LSTM) network, and determined the best configurations for flow prediction (*i.e.*, number of layers, number of units per layer, dimension of the input, weight initialization strategy and activation function). Because of its ability to exploit the sequential nature of the data, the LSTM network outperformed the MLP. In particular, relative errors of 0.45% and 2.49% were obtained in mean and fluctuating quantities respectively with the LSTM. Furthermore, this network also led to an excellent representation of the dynamical behavior of the system, characterized by Poincaré maps and Lyapunov exponents. The present results underpin future applications aimed at developing inflow and off-wall boundary conditions for turbulence simulations, and data-driven flow reconstruction of more complex wall-bounded turbulent flows, including channels and developing boundary layers.

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