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Neural network models for spatio-temporal geophysical fields reconstruction : application to sea surface temperature

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In this work, we investigate neural network representation for the representation and assimilation of dynamical systems. Data assimilation based techniques are the state-of-the-art approaches in the reconstruction of spatio-temporal geophysical fields. These methods heavily rely on an explicitly given dynamical model to compute forward simulations of the state of interest. The increasing availability of remote sensing observations, in-situ monitoring and simulation datasets support the development of data-driven strategies to learn computationally-efficient representation of hidden dynamics.

Here, we explore a specific class of neural-network-based representation, which makes explicit the relationship with dynamical operators stated as ordinary differential equations. We consider bilinear residual neural networks for the representation of spatio-temporal fields. The considered representations reproduce a numerical integration scheme such as Runge-Kutta using as a building block a bilinear neural network. We perform numerical experiments for Lorenz63 dynamics and sea surface dynamics, which demonstrate the relevance of the proposed framework both in terms of forecasting and assimilation performance with respect to other state-of-the-art data-driven schemes, including analog methods.