Neural Operator Models as Applied to Fluid Flow Systems and Real Ocean Dynamics

by

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S.B., Electrical Engineering and Computer Science and Mathematics, Massachusetts Institute of Technology, 2021

Submitted to the Department of Electrical Engineering and Computer Science
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ABSTRACT

Data-driven, deep-learning modeling frameworks have been recently developed for forecasting time series data. Such machine learning models may be useful in multiple domains including the atmospheric and oceanic ones, and in general, the larger fluids community. The present work investigates the possible effectiveness of such deep neural operator models for reproducing and predicting classic fluid flows and simulations of realistic ocean dynamics. We first briefly evaluate the capabilities of such deep neural operator models when trained on a simulated two-dimensional fluid flow past a cylinder. We then investigate their application to forecasting ocean surface circulation in the Middle Atlantic Bight and Massachusetts Bay, learning from high-resolution data-assimilative simulations employed for real sea experiments. We confirm that trained deep neural operator models are capable of predicting idealized periodic eddy shedding. For realistic ocean surface flows and our preliminary study, they can predict several of the features and show some skill, providing potential for future research and applications.

Thesis supervisor: Asu Ozdaglar
Title: Professor of Electrical Engineering and Computer Science

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