Internship proposal: Learning multimodal invertible representations from ocean remote sensing data

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Keywords: neural networks, invertible representations, ocean remote sensing data, upper ocean dynamics

Context and objective: Invertible neural networks (INN) [1] have recently involved a significant research interest. Such representations jointly embed the prediction of the outputs given the inputs as well as the inputs given the outputs. This property is particularly apealing when dealing with inverse problems, *i.e.* aiming to reconstruct some hidden processes from some observed variables.

In the context of the space-based remote sensing of the oceans, a variety of satellite missions provide observations of sea surface parameters (e.g., temperature, salinity, current). We may now benefit from such large-scale observation datasets to explore, characterize and model upper ocean dynamics. In this respect, theoretical evidence has been provided that sea surface tracers may exhibit relationships, which relate to specific dynamical regimes [2].

In the spirit of our previous work [3], the goal of this internship will be to explore ocean remote sensing datasets using deep learning strategies to reveal new data-driven representations of upper ocean dynamics. Whereas we considered latent class regression models in [3], the focus will be given to INN representations.

This internship is proposed in the framework of ANR Melody (Bridging geophysics and MachinE Learning for the modeling, simulation and reconstruction of Ocean DYnamics, PI: R. Fablet) and ERC STUOD (Stochastic Transport in Upper Ocean Dynamics, PI: B. Chapron).

Skills: Msc./Eng. degree in Applied Math., Data Science and/or Physical Oceanography with a good background in applied statistics. Knowledge on deep learning models and experience in deep learning frameowrks (eg, tensorflow, keras, pytorch) would be a plus.

References

[1] J. Behrmann, W. Grathwohl, R.T.Q. Chen, D. Duvenaud, and J.-H. Jacobsen. Invertible Residual Networks. *arXiv:1811.00995 [cs, stat]*, May 2019. arXiv: 1811.00995.

[2] J. Isern-Fontanet, B. Chapron, G. Lapeyre, and P. Klein. Potential use of microwave sea surface temperatures for the estimation of ocean currents. *GEOPHYSICAL RESEARCH LETTERS*, 33, 2006. L24608.

[3] Pierre Tandeo, Bertrand Chapron, Sileye Ba, Emmanuelle Autret, and Ronan Fablet. Segmentation of mesoscale ocean surface dynamics using satellite SST and SSH observations. *IEEE Transactions on Geoscience and Remote Sensing*, 52(7):4227 – 4235, July 2013.