Internship proposal (MSc./Eng. Degree)

Deep learning representations and strategies for the identification of dynamical systems

Supervisor: Ronan Fablet, Cédric Herzet (ronan.fablet@imt-atlantique.fr)
Research team: IMT Atlantique, Lab-STICC, TOMS, Brest
Expected duration: 6 months

Contact person: ronan.fablet@imt-atlantique.fr

Scientific context and specific objective:

Deep learning [1] has experienced tremendous growth in a few years in the field of artificial intelligence and computer vision. Initially exploited for classification and recognition problems, it has also become a reference framework for the resolution of signal and image processing problems: image synthesis, super-resolution, denoising, inpainting, segmentation ....

Data-driven strategies for the analysis, modeling and reconstruction of dynamical systems are also currently emerging as promising research directions as an alternative to classic model-driven approaches for a wide variety of application fields, including atmosphere and ocean science, applied physics,.... [2,3,4]. In this context, this internship will aim to explore deep learning strategies and neural network (NN) representations for the identification of dynamical systems (i.e., the differential equation governing a dynamical system) [6]. Both learning-from-data and adversarial-learning self-learning strategies will be of interest [2,5].

Applications to both low-dimensional chaotic systems and spatio-temporal fields (including images) will be explored depending on the progress of the work. All experiments will be implemented under Python using dedicated libraries such as Keras and/or Tensorflow frameworks.

Keywords: neural networks, learning strategies, inverse problems, dynamical systems, model identification, application to image time series

Workplan

The envisioned workplan involves three main aspects:

- A study of the state-of-the-art in deep learning for dynamical systems and learning strategies (e.g., adversarial networks, self-learning,...)
- The definition of novel NN-based representation and associated learning strategies for identification, forecasting and assimilation issues
- The experimental evaluation and benchmarking of the proposed representations and learning strategies.

References

[1] Y. LeCun, Y. Bengio, and G. Hinton. Deep learning. Nature, 521(7553) :436– 444, May 2015.
[2] R. Lguensat, P. Tandeo, P. Aillot, R. Fablet. The Analog Data Assimilation. Monthly Weather Review, 2017.
[3] R. Lguensat, P. Viet, M. Sun, G. Chen, F. Tenglin, B. Chapron, R. Fablet. Data-driven Interpolation of Sea Level Anomalies using Analog Data Assimilation. Submitted
[4] R. Fablet, P. Viet, R. Lguensat. Data-driven Methods for Spatio-Temporal Interpolation of Sea Surface Temperature Images. IEEE Trans. on Computational Imaging, 2017.
[5] A. Radford, L. Metz, S. Chintala. Unsupervised Representation Learning with Deep Convolutional Generative Adversarial Networks. https://arxiv.org/abs/1511.06434
[6] R. Fablet, S. Ouala, C. Herzet. Bilinear residual Neural Network for the identification and forecasting of dynamical systems. Submitted