Introductory course on Deep Learning for Ocean and Atmosphere Sciences

Pre-requisites: basics in math., statistics and Python programming

Detailed program

Day #1, 9.30am-12.30pm **Introduction to Deep Learning** ● What's learning ? ● MLP / backprop ● Practice on toy regression/classification examples	**Day #1, 2.00pm-5.30pm** **Project session #1:** ● Project selection ● Learning-based problem formulation ● Exploratory analysis/visualization of the considered dataset
Day #2, 9.30am-12.30pm **Convolutional Neural Networks** ● From MLP to CNN ● Deep Learning methodology ● Practice on MNIST digit classification	**Day #2, 2.00pm-5.30pm** **Project session #2:** ● Tutorial on PyTorch Lighning ● Selection of neural architectures ● Design of the training scheme
Day #3, 9.30am-12.30pm **Auto-encoders and Generative models** ● Auto-encoder architectures (Dense AEs/PCA, Convolutional AEs, U-Net) ● Practice on MNIST dataset ● Opening towards generative models: VAE, NF, GAN	**Day #3, 2.00pm-5.30pm** **Project session #3:** ● First results for a simple architecture ● Sensitivity analysis ● Updated architectures
Day #4, 9.30am-12.30pm **Recurrent Neural Networks** ● RNN / LSTM ● Neural ODE / PINN ● Practice on L63 system	**Day #4, 2.00pm-5.30pm** **Project session #4:** ● Optimization of the architecture ● Synthesis of the experiments, incl. the benchmarking of several architectures
Day #5, 9.30am-12.30pm **Deep Learning and Inverse Problems** ● DL, AutoDiff and minimization ● Deep inverse models ● Deep unfolded architectures ● Practice on L63 system	**Day #5, 2.00pm-5.30pm** **Project session #5:** ● Presentation for each project (10'+5' for each project)

Preliminary lists of project themes:

- Data-driven discovery of governing equations
- Space-time interpolation of satellite-derived geophysical fields
- Short-term forecasting of space-time dynamics
- Downscaling of space-time geophysical dynamics
- Classification and segmentation from 2D geophysical fields