**A Machine learning problem: reduced order modelling and video prediction**

Data: 48 videos are available, describing the evolution of a physical field with different initial conditions. Each video is of dimension 128\*128\*16 (timesteps) with binary pixel values. For all the tasks please use the first 40 videos as training (including validation) data and the rest 8 as test data

Question 1. (simple)

1. Perform the Principle component analysis of the training dataset where each snapshot (i.e., image) is considered as a sample. Use the principle component for data compressing and decompressing.

Reference: <https://towardsdatascience.com/a-one-stop-shop-for-principal-component-analysis-5582fb7e0a9c>

1. Using a convolutional autoencoder (CAE) to perform the same task as (1) and compare the reconstruction accuracy of PCA and CAE against different dimension of the reduced space

Reference: <https://towardsdatascience.com/applied-deep-learning-part-3-autoencoders-1c083af4d798>

Question 2. (Simple)

Following question 1 (2), train a sequence to sequence (e.g., 4 timesteps to 4 timesteps) predictive model (e.g., LSTM) in the reduced space, and decode predicted results in the full space. Evaluate your algorithm performance on the test dataset using different metrics (e.g., MSE, RMSE, SSIM…).

Reference: <https://towardsdatascience.com/multivariate-time-series-forecasting-with-deep-learning-3e7b3e2d2bcf>

Question 3. (Medium)

Computing another video prediction algorithm (e.g., ConvLSTM, Vit..). Compare the results against CAE+LSTM in terms of prediction accuracy and online computational time. Make a short discussion of different methods.

Reference: <https://towardsdatascience.com/spatial-temporal-convlstm-for-crash-prediction-411909ed2cfa>

Reference: <https://towardsdatascience.com/video-prediction-using-convlstm-with-pytorch-lightning-27b195fd21a2>

Bonus (Medium to Hard)

Knowing that the field (i.e., the white area) can only be increasing. How this information can be used to enhance your model prediction?