# PSL lectures on Machine learning for physics and engineering
## March 28th-April 1st 2022, Paris

Organizing committee : Alexandre Allauzen, David Ryckelynck
Lecturers: Arturo Baldo (Scikit Learn), Felix Fritzen (Stuttgart U.), Elie Hachem (Mines Paris), Matthieu Labeau (Télécom Paris), Ivan Laptev (INRIA), David Ryckelynck (Mines Paris), Kathrin Smetana (Twente U.)

Location : PariSanté Campus, PSL University

This week of lectures aims to share data and algorithms for machine learning applications in physics and model-based engineering.

Prerequisites : python programming, linear algebra.

Schedule :

|  | 9:00-10:00 | 10:15-12:15 | 14:00-15:00 | 15:15-17:15 |
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| Monday 03/28 | Introduction David Ryckelynck- Arturo Baldo (Scikit Learn) | Parallel sessions : 1-Machine learning, Arturo Baldo 2- Numerical modeling, Elie Hachem | Parallel sessions (TP): 1-Machine learning Arturo Baldo 2- Numerical modeling, Kathrin Smetana | Parallel sessions (TP): 1- Machine learning, Arturo Baldo 2- Numerical modeling, David Ryckelynck |
| Tuesday 03/29 | Deep classifiers of digital twins, David Ryckelynck | Exercises on Deep classifiers of digital twins, David Ryckelynck | Auto-encoders for model reduction, David Ryckelynck | Exercices on auto-encoders for model reduction, David Ryckelynck |
| Wednesday 03/30 | Computer vision Ivan Laptev | Exercises on computer vision, Ivan Laptev | Exercises on computer vision, Ivan Laptev | Exercices on computer vision, Ivan Laptev |
| Thursday 03/31 | Deep learning for time series, Matthieu Labeau | Deep learning for time series, Matthieu Labeau | Deep learning for time series, Matthieu Labeau | Deep learning for time series, Matthieu Labeau |
| Friday 04/1 | Multi-scale modeling of materials, Felix Fritzen | Multi-scale modeling of materials, Felix Fritzen | Reinforcement learning in engineering, Elie Hachem | Reinforcement learning in engineering, Elie Hachem |

Monday :
Introduction of the lectures, main motivations for the developpement of machine learning and artificial intelligence in physics and engineering, especially in model-based engineering. Two parallel sessions are proposed depending on the background of students. The session « Numerical modeling » presents the data in physics and in model-based engineering. The session « Machine learning » is an introduction to supervised and unsupervised machine learning, regressor, classifiers and stochastic gradient algorithm.

Tuesday :
Lectures and exercices on complexity reduction of physical models in engineering by using computer vision. Deep classifiers are presented for the recommandation of digital twins having a reduced setting. Auto-encoders and multi-modal auto-encoders are introduced for dimensionality reduction and model reduction.

Wednesday :
Lecture and exercices on deep learning for computer vision, via convolutional neural networks (CNN).

Thursday :
Recurrent neural networks, transformers, for natural langage processing and many other applications related to time series.

Friday :
A multi scale framework is proposed for machine learning applied to mechanics of materials.
Reinforcement learning is applied to computational fluid dynamics for process optimisation in industry.

Registration : Registration to the training courses is free of charge. Everyone will have to organize their own lunch. There are restaurants and food stores within walking distance of the campus. Both on-site and remote work will be offered, but teachers will only answer to on-site questions. Registration for on site work is limited to 25 listeners.
Contact for registration : bigmeca.chaire@minesparis.psl.eu