Python/Pytorch project

ECTS : 6

Volume horaire : 15

Description du contenu de l'enseignement :

Course Presentation

Neural Networks for Stochastic Modeling explores how deep learning techniques can be used to analyze and estimate stochastic processes. The course introduces statistical learning fundamentals, then focuses on neural network architectures and training procedures. Finally, we apply these methods to estimate stochastic differential models through both theoretical analysis and hands-on implementation.

Course Outline

Chapter 1 — Statistical Learning Foundations & Neural Network Structure

- Supervised vs. unsupervised learning; regression vs. classification
- Pipeline of supervised learning and model evaluation
- Feedforward neural network architecture & activation functions
- Universal Approximation Theorem

Chapter 2 — Training Neural Networks

- Loss functions and optimization objectives
- Gradient-based optimization, backpropagation, SGD, Adam
- Hyperparameter selection and training heuristics

Chapter 3 — Parametric Estimation of Stochastic Processes

- Simulation and data generation for SDEs
- Neural estimation of unknown parameters from sample paths

Chapter 4 — Non-Parametric Estimation of Stochastic Processes

- Neural approximation of drift functions
- Performance evaluation against classical methods
- Optional outlook: diffusion models and generative approaches

Compétence à acquérir :

- Understand key principles of statistical learning and neural networks.
- Train feedforward networks using gradient-based methods and hyperparameter tuning.
- Generate data from stochastic differential equations for learning tasks.
- Estimate parameters and drift functions of stochastic processes with neural networks.
- Evaluate neural estimators and compare them to classical statistical methods.

Mode de contrôle des connaissances :

Project (Report + code + oral defense)