MAJORS FIELD (= Common Core)_15 ECTS

Introducing

Description

Évaluation

L'évaluation des acquis d'apprentissage est réalisée en continu tout le long du semestre. En fonction des enseignements, elle peut prendre différentes formes : examen écrit, oral, compte-rendu, rapport écrit, évaluation par les pairs...

Practical info

Location(s)

Toulouse

INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

High Dimensional and Deep Learning (HDDL)

Introducing

Description

Program (detailed contents):

This course is dedicated to deep learning methods for processing complex data such as signals, images or sequential data (time series or textual data). It also covers methods for anomaly detection, especially in functional data.

* Convolutional neural networks: convolutional layer, pooling, dropout, architecture of convolutional networks (ResNet, Inception), transfer learning, applications to signal and image classification and object detection.

* Encoder-decoder, variational auto-encoder, generative adversarial networks.

* Functional decomposition on Spline, Fourier, wavelet or functional PCA bases: cubic splines, penalized least squares criterion, Fourier bases, wavelet bases, application in non-parametric regression, linear and non-linear estimators by thresholding, links with the LASSO method.

* Anomaly detection, Main algorithms: One Class SVM, Random Forest, Isolation Forest, Local Outlier Factor. Applications to anomaly detection for functional data.

* Recurrent networks (RNN, LSTM) for the analysis of sequential data.

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):

- The use of deep learning algorithms (convolutional neural networks) for the classification of complex data (signals, images) in high dimension with estimation of the prediction error
- The main algorithms for signal or image classification
- Dimension reduction methods for complex data
- Anomaly detection algorithms
- Recurrent neural networks for the study of sequential data
- The use of convolutional networks for object detection in images

The student will be able to:

- Adjust deep neural networks for signal or image classification.
- Apply anomaly detection algorithms.
- Use recurrent neural networks for time series prediction
- Implement and optimize deep learning algorithms on real data using Python libraries.

Necessary prerequisites

Elements of Statistical Modeling (4MA)
Machine Learning (4MA)
Introduction to Python

Software for statistics (R,Python)

Évaluation

L'évaluation des acquis d'apprentissage est réalisée en continu tout le long du semestre. En fonction des enseignements, elle peut prendre différentes formes : examen écrit, oral, compte-rendu, rapport écrit, évaluation par les pairs...

Practical info

Location(s)

Toulouse

Metamodelling

Introducing

Description

Program (detailed contents):

* Introduction: computer experiments and metamodeling. Examples.
* Metamodeling with Gaussian process (GP) and kriging. a) Probabilistic and functional (RKHS) interpretation of the approximation problem. b) Simulation of GPs. c) Customization of covariance models. Physically informed GPs.
* Design of computer experiments. a) Initial designs: focus on space-filling designs. b) Adaptive methods. Example of Bayesian optimisation.
* Uncertainty quantification. a) Uncertainty propagation. b) Global sensitivity analysis: focus on the ANOVA decomposition (Sobol-Hoeffding decomposition).
* Case study.

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):

* Metamodeling for optimization / uncertainty quantification of a computer code, with a limited computational budget
* Gaussian processes
* Kernel customization to account for external knowledge
* Design of computer experiments
* Global sensitivity analysis

The student will be able to:

At a theoretical level, to do computations for:
* covariance kernels and Gaussian process
* ANOVA decomposition, Sobol indices

At a practical level, to perform the complete methodology for analyzing a computer code
* design of experiments
* metamodel construction / evaluation
* application to optimization / uncertainty quantification

Necessary prerequisites

Gaussian vectors (Complements of Probability, 3rd year)

Évaluation

L'évaluation des acquis d'apprentissage est réalisée en continu tout le long du semestre. En fonction des enseignements, elle peut prendre différentes formes : examen écrit, oral, compte-rendu, rapport écrit, évaluation par les pairs...

Practical info

Location(s)

Toulouse

RI Project

Introducing

Description

The student will work on an open problem in applied science and will implement
the four major skills of the engineer in applied mathematics

- Reformulate a user need to produce a problem that can be treated mathematically
- Analyze and design a digitally implementable solution to the mathematical problem posed
- Implement the digital solution to make it a demonstrator
- Use the technical and digital solution to produce a decision support tool (a study or a calculation code) meeting user needs

Objectives

The student will be able to:
• Interact with a specialist or engineer from another discipline.
• Organize collaborative work in small groups.
• Define the framework and specifications of an original mathematical modeling problem.
• Conduct the necessary bibliographic research to solve the problem.
• Develop the deterministic and/or stochastic model adapted to its resolution.
• Implement its numerical resolution.
• Report in writing and orally on the results obtained.

Necessary prerequisites

Applied Mathematics L3/M1-M2

Évaluation

L'évaluation des acquis d'apprentissage est réalisée en continu tout le long du semestre. En fonction des enseignements, elle peut prendre différentes formes : examen écrit, oral, compte-rendu, rapport écrit, évaluation par les pairs...

Practical info

Location(s)

Toulouse