

## Liste d'éléments pédagogiques

### Practical info

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#### Location(s)

 Toulouse

# High Dimensional Statistics and Deep Learning



ECTS  
3 crédits



Hourly volume  
60h

## Introducing

### Objectives

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

- How to use deep learning methods for classification in high dimension
- Classification of media or images
- Estimation of the prediction error
- Dimension reduction by projection onto orthonormal bases
- Anomaly detection
- Application of deep learning methods on real data set

At the end of this module, the student should be able to:

- Fit a deep neural network for media or image classification and regression
- Apply anomaly detection algorithms
- Implement deep learning methods in high dimension on real data sets with Python libraries.

## Practical info

### Location(s)

 Toulouse

## Necessary prerequisites

Statistical modelling  
Software for statistics

# High Performance Scientific Computing



ECTS  
3 crédits



Hourly volume  
59h

## Introducing

### Objectives

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

- the principle of Krylov's methods to solve linear systems or compute eigenvalues and eigenvectors,
- the concept of preconditioning, the construction and use of preconditioners,
- theory and basic concepts of direct methods for sparse linear systems. Operating complexity and parallelism of direct methods,
- basic notions of parallel computer architecture, programming models for shared memory (OpenMP) and distributed memory (MPI) systems,
- basic concepts and methods for analyzing the performance of a parallel algorithm or code (Amdahl's law, cache hierarchy, principles of spatial and temporal locality, roofline model, critical path computation and high and low scalability).

At the end of this module, the student should be able to:

- evaluate the costs (flops/memory) of the different methods,
- analyze the influence of preconditioners,
- use high-level languages for the discretization of partial differential equations,
- program solvers, to parallelise simple codes according to the most adequate standard and to execute them on the appropriate resources,

- to analyse the efficiency of a method with regard to the operational complexity, the computing time and the memory footprint used in a high-performance computing perspective.

### Necessary prerequisites

- Courses in Linear Algebra or Scientific Calculus, in particular the factorization methods LU or Cholesky
- Basics of computer architecture and imperative programming languages

## Practical info

### Location(s)

 Toulouse

# Physics constrained machine learning



ECTS  
3 crédits



Hourly volume  
59h

## Introducing

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Numerical algebra for large scale, statistical estimation, non-convex smooth optimization, numerical solution of PDEs, data assimilation, machine learning

## Objectives

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

- Main approaches for solving time dependent problem (EDP and Data assimilation) using ML
- Relevance of using physical constraints for solving problems with underlying physics (feature engineering), design of Neural networks
- Methods for handling nonlinearity and large scale (use of latent space, high performance computing)
- Performance of ML for solving problems with physical constraints.

At the end of this module, the student should be able to:

- Use ML for solving time dependent PDE and analysis the accuracy
- Analysis the HP performance of the solvers, and propose algorithmic enhancements
- Design a full data assimilation system based on ML, starting from a description of a system using partial differential equation and and observational system
- Assess the performance of a system, question the relevance of the mathematical assumptions

## Practical info

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### Location(s)

 Toulouse

## Necessary prerequisites

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# Trusted Systems



ECTS  
3 crédits



Hourly volume  
60h

## Introducing

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### Objectives

Software play a key role in many industrial domains, including safety critical ones (transportation, health, business, ...) where defects can have a strong direct, or indirect, impact on human life.

This UE provides 2 courses that contribute to improving the quality of software and the trust we can have in it.

-Software and System Engineering provides the core concepts needed to build trusted software intensive systems. Model Driven Engineering will be a core element as it allows to model application domain specific elements and to ease the building of domain specific tools.

-Modeling, Resolution and Proof provides the elements from discrete mathematics that allowing modeling formally the requirements for software systems and to carry formal proof of correctness about their behavior. These elements are also at the root of symbolic artificial intelligence in order to model knowledge, structured data and to explain the decision taking by systems. We will also illustrate how these tools can be used for discrete optimization.

This UE tackles both the theoretical knowledge and methods, and their use in representative tools.

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## Necessary prerequisites

Computer use  
Programming  
Basic general algebra

## Practical info

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### Location(s)

 Toulouse

## IA Frameworks



ECTS

3 crédits



Hourly volume

24h

## Introducing

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### Objectives

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

- Main concept of data labélisation and related tools.
- Main algorithms of natural language processing
- Main concepts of reinforcement learning.
- Main concepts of recommendation system.
- How to access tools to perform efficiently and with enough computation power those algorithms

The student will be able to:

- Organize en data labélisation strategy.
- Handle various types of complex datasets (Image, text, video, notations,...)
- Identify the correct algorithm to solve various problem on these data.
- run these algorithms on the appropriate ressource (cloud machine, container? GPU?)
- Share efficiently the results obtain

## Practical info

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### Location(s)

 Toulouse

## Necessary prerequisites

Exploratory Data Analysis

Machine Learning / Deep Learning (MLP, RNN, CNN)

R and Python languages

## [FRANCAIS] Formation en entreprise 4



ECTS  
15 crédits



Hourly volume

### Practical info

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#### Location(s)



Toulouse