

## MAJORS FIELD (common core) \_12 ECTS

### Introducing

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### Description

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### 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

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### Location(s)

 Toulouse

## Machine learning

# Introducing

## Description

Program (detailed contents):

- Introduction to machine learning
- Risk estimation (or generalization error), Optimization of the bias/variance trade-off
- Model selection and variable selection via penalized criteria: Mallows CP, BIC, Ridge, Lasso
- Linear and quadratic discriminant analysis, k nearest neighbors.
- Binary classification and regression trees (CART)
- Tree aggregation, random forests
- Support Vector Machine and Support Vector Regression
- Neural networks, multilayer perceptron, gradient backpropagation algorithm, optimization algorithms, introduction to deep learning.
- Boosting algorithms
- Missing data imputation.
- Bias of algorithms
- Legal framework and societal impacts of AI.

## Objectives

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

- The properties of the main learning methods and their limitations.
- The principle of bias-variance trade-off, model selection
- Algorithms and methods for estimating a risk (cross

validation, bootstrap..)

- Optimization and implementation of the main methods in R and Python (Scikit-learn).
- Ethical and legal principles of Artificial Intelligence.

The student will be able to:

- Analyze datasets from various domains (meteorology, marketing, industry, ...) with R and Python libraries.
- Implement the main methods and run the following learning algorithms: discriminant analysis, k-nearest neighbors, classification and regression trees, random forests, neural networks, SVM, boosting.
- Optimize the values of the hyper-parameters, automate the processing chain.
- Optimize the management of missing data.
- Detect legal or ethical flaws (bias, discrimination, opacity) in machine learning algorithms.

## Necessary prerequisites

Statistical modelling

Introduction to R and Python languages

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## Practical info

## Location(s)

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## Signal

# Introducing

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## Description

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## Necessary prerequisites

Signal 1  
Optimization 1 & 2

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## Practical info

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## Location(s)

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## Project Research – Innovation

### Introducing

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#### 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

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

- Principles of mathematical modeling of an application problem in relation to another discipline or a particular industrial sector
- Self-evaluation of the results obtained in relation to the 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

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