INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

APPRENTICESHIPS 4th YEAR ModIA

Practical info

Location(s)

Toulouse

Modelling & Scientific Computing

ECTS
4 crédits

Hourly volume
73h

Location(s)

Toulouse

Introducing

Objectives

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

-How to model a problem in physics, biology, economics, etc. using a system of ode or pde
-How to numerically solve such a problem in simple cases

The student should be able to:
-model a problem via ode or pde
-classify problems according to their mathematical structure and choose appropriate numerical methods of solution
-implement (in PYTHON or JULIA) these numerical methods

Necessary prerequisites

Undergraduate courses in analysis and linear algebra.
Basics of Physics
PYTHON language

Practical info

Statistical modelling

ECTS
3 crédits

Hourly volume
76h

Introducing

Objectives

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

-The principle of nonparametric statistical tests for goodness-of-fit, independence, comparison of two populations
-The characteristics of a linear model and a generalized linear model, and their use for statistical modelling

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

-Choose a test procedure suited to a given problem
-Build nonparametric test procedures to compare two populations
-Build goodness-of-fit tests for a single distribution or a family of distributions
-Choose a linear model or a generalized linear model suited to a given problem
-Estimate the parameters in a linear model and a generalized linear model
-Use statistical tests to validate or invalidate hypotheses on these linear models and generalized linear models.
-Implement a variable selection strategy
-Perform a complete statistical analysis on a real data set using a linear model or a generalized linear model

Necessary prerequisites

Probability: random variables, usual probability laws, expectation, variance, cumulative distribution function, limit theorems, Gaussian vectors, ¿
Inference statistics: moment estimators, maximum likelihood estimators, confidence interval for the mean / the variance for a Gaussian / non-Gaussian sample.
Basics of R software

Practical info

Location(s)

Toulouse

Optimization and Stochastic Optimization

ECTS
4 crédits

Hourly volume
86h

Introducing

Objectives

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

-The theory aiming at caracterise local/global minimum of a real function with or without respect to constraints.

-The main first-order methods in optimisation.

-How to find a subdifferential of a convex function, and a subgradient.

-The worst-case complexity of an algorithm.

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

-Model and solve an optimisation problem numerically with/without constraint.

Necessary prerequisites

Linear algebra, Calculus, Unconstrained optimisation, Newton and Gauss-Newton algorithms.

Practical info

Location(s)

Toulouse

Data analysis

ECTS
3 crédits

Hourly volume
62h

Introducing

Objectives

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

-The main steps of a data science analysis: preparation, visualization & exploration, prediction, interpretation.
-The main methods in data exploration.
-The main concepts / dangers of statistical learning.
-The main methods of statistical learning on vector data, requiring little expert knowledge / tuning.
-The functioning of R and Python software for data science.

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

-Solve simple exercises about the underlying mathematical theory.
-Put in action the data science methodology on case studies with R and Python.
-Criticize the assumptions and results, summarize the main conclusions.

Necessary prerequisites

Statistics: descriptive statistics
Probability: random vectors, probability distribution, Bayes law, multivariate normal distribution.
Algebra: vector spaces, Euclidean spaces, matrix calculus, eigenvalue decomposition.
Geometry / mecanics: barycenter, inertia, Huygens formula.

Practical info

Location(s)

Toulouse

Human sciences S7

ECTS
4 crédits

Hourly volume
45h

Introducing

Objectives

ENGLISH
- Develop awareness of scientific publications and presentations
- Prepare students for technical courses given in English on Artificial Intelligence
- Linguaskill preparation for the weakest students

LAW
- Understand the legal structures of companies and how they operate
- Understand the concepts of risk and the resulting responsibilities

Practical info

Location(s)

Toulouse

[FRANCAIS] Formation en entreprise 1

ECTS
12 crédits

Hourly volume

Practical info

Location(s)

Toulouse

[FRANCAIS] FLE Semestre 7

ECTS

Hourly volume
12h

Practical info

Location(s)

Toulouse

[FRANCAIS] Accompagnement recherche d'entreprise

ECTS

Hourly volume
24h

Practical info

Location(s)

Toulouse

Signal Processing/ Hilbert spaces and Wavelets

ECTS
3 crédits

Hourly volume
69h

Introducing

Objectives

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

-Hilbert Spaces: definition, Hilbertian basis, projection on a convex set, Fourier analysis
-Wavelets: Haar wavelets, connection coefficients/regularity
-Approximation of functions in Hilbert Spaces

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

-Provide examples of Hilbert spaces
-Give examples of Hilbertian basis
-Fourier analysis of a 1d and 2d signal
-Use and analyze the results of Fast Fourier Transform
-Use and analyse the results of Wavelet transform
-Understand the decomposition of a function in a basis of wavelets.

Necessary prerequisites

Python: numpy, scipy, matplotlib
Fourier Analysis: Fourier Series, Fourier Transform, L^2 space.

Practical info

Location(s)

Toulouse

Infrastructure for cloud and big data

ECTS
3 crédits

Hourly volume
38h

Introducing

Objectives

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

-General concepts of cloud and big data computing infrastructures
-Principles of virtualized infrastructures
-Cloud services
-ools associated with cloud infrastructures
-Principles of big data computing platforms (map-reduce, stream processing)
-Big data treatment environments (Hadoop, Spark, Storm)

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

-Use virtualization platforms
-Use cloud platforms
-Program big data applications
-Execute big data applications in a computing infrastructure

Necessary prerequisites

Algorithmic, Java programming, Linux environment handling (shell commands)

Practical info

Location(s)

Toulouse

Functional Programming and Graph Theory

ECTS
4 crédits

Hourly volume
81h

Introducing

Objectives

This unit builds on two courses related to the development of complex software:

-Functional programming : Data collecting and network computing applications cannot be programmed efficiently with the common shared memory paradigm (centralized state that can accessed by all components from the application). Functional programming rely on the stateless paradigm derived from the notion of mathematical functions to avoid bottlenecks.

-Graph theory : Graphs are mathematical objects that are used to model many problems relying on complex data. Many dedicated data structures and algorithms have been design to represent and use them efficiently.

Necessary prerequisites

Computer system use
Imperative Programming

Location(s)

Toulouse

Practical info

Machine learning

ECTS
4 crédits

Hourly volume
82h

Introducing

Objectives

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

-Main concepts and risks of machine learning.
-Advanced methods of machine learning on vector data, requiring tuning effort and/or expert knowledge.
-Ethics of artificial intelligence.

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

-Solve simple exercises about the underlying mathematical theory.
-Put in action the data science methodology on case studies with R and Python.
-Explain to non-experts the tuning choices in the algorithms.
-Criticize the assumptions and results, summarize the main conclusions.
-Detect legal defects (bias, discrimination) in the algorithms.

Necessary prerequisites

Course « Data science »
Course « Generalized linear model »

Practical info

Location(s)

Toulouse

[FRANCAIS] Développer ses compétences managériales

ECTS
4 crédits

Hourly volume
43h

Practical info

Location(s)

Toulouse

[FRANCAIS] Formation en entreprise 2

ECTS
12 crédits

Hourly volume
12h

Practical info

Location(s)

Toulouse

[FRANCAIS] FLE Semestre 8

ECTS

Hourly volume
12h

Practical info

Location(s)

Toulouse