INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

4th YEAR MA INSA_SEMESTER 8

Practical info

Location(s)

Toulouse

Finite Element Methods & Model Reductions

ECTS
4 crédits

Hourly volume

Location(s)

Toulouse

Introducing

Objectives

At the end of this course, the student will have understood and will be able to :

- Write the weak (variational) form of the classical PDE models (with the corresponding energy minimization in symmetric cases).
- Write and code a FE scheme (for linear and non-linear scalar models)

- Develop offline-online strategies to perform reduced basis models in real time (POD and Machine Learning based).

- Employ Finite Element libraries in Python, FEniCS (and FreeFEM++),

Necessary prerequisites

Fundamentals of PDE models and math. analysis, Numerical analysis.

Practical info

Modeling and scientific computing in fluid and structural mechanics

ECTS
4 crédits

Hourly volume
55h

Introducing

Objectives

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

The fundamentals of Mechanics for fluid and deformable solids, from a physical, mathematical and numerical point of view.

The student will be able to:
- Understand the physical meaning of the various terms used in fluid mechanics and elasticity models.
- Calculate exact solutions of simple problems and interpret them physically
- Evaluate orders of magnitude and know the physical meaning of the main dimensionless numbers
- Formulate and apply a finite volume method for numerically solving simple problems of fluid mechanics
- Formulate and solve the problem of elasticity by means of the finite element method.
- Use an industrial software to model and compute the elasticity problem in static as well as in dynamic.
- Write and implement a mixed formulation to couple different elastic domains and different numerical codes used as black-boxes.

Necessary prerequisites

Fundamentals in:
Continuum mechanics
Numerical analysis
Partial derivative equations

Practical info

Location(s)

Toulouse

Data analysis

ECTS
4 crédits

Hourly volume
58h

Introducing

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):
- Data base organisation of R and Python data frames. Syntaxes R and Python languages. R and Python functions design, program and test.
- Statistical analyses of multidimensional data: dimension reduction and clustering with R and Python.
- Statistical interpretation of various graphical displays including the different kinds of factor analyses and clustering.

The student will be able to:
- Manage big data sets with R and Python.
- Lead exploratory data analyses of real big data. It includes univariate, bivariate and multivariate data analyses featuring PCA, MCA, FDA, NMF kmeans, mixture models, DBSCAN¿ depending on data structures and analysis purposes;
- Detect relevant structures within complex data sets and compile insightful interpretations.

Practical info

Location(s)

Toulouse

Stochastic Processes: Time Series and Gaussian Processes

ECTS
4 crédits

Hourly volume
58h

Introducing

Objectives

At the end of this lecture, the student should have acquired the following skills, as well theoretically than practically with the R statistical Software and / or Python.

1) Time series
-Estimate or eliminate the trend and/or the seasonality of a time series
-Study the stationnarity of a time series
-Calculate and estimate the autocorrelogram and the autocorrelograms (total and partial) of a stationary process
-Study and/or adjust an ARMA (or ARIMA) model on a stationary time series
-Carry an optimal linear forecast of an ARMA process

2) Gaussian processes
-Know the fundamental properties of Gaussian processes
-Be able to characterize a Gaussian process through its covariance function
-Be able to use Gaussian Processes for modeling real life situations.

Necessary prerequisites

1) Time series
Probability and Statistics (MIC2) I2MIMT31
Statistics (MIC3) I3MIMT05
Probability and Inferential Statistics (I4MMMT21)

2) Gaussian processes
Advanced probabilities: martingales, stochastic algorithms and Montecarlo methods.
Markov chains.
Integration and probabilities.

Practical info

Location(s)

Toulouse

Signal II and Optimization

ECTS
4 crédits

Hourly volume
50h

Introducing

Objectives

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

1) Wavelet transform
2) Filter Banks with exact reconstruction
3) Properties of wavelets (localisation in space and frequency) and applications to the approximation of functions.
4) Notion of sub-gradient and proximal operator in convex analysis
5) Basic properties of proximal and Forward-Backward algorithms

The student will be able to:

1) Provide examples of wavelets
2) Carry out numerical approximation of images with wavelets.
3) Identify which convex problems can be solve using the previous algorithms and be able to implement these algorithms on simple cases

Necessary prerequisites

Signal 1
Optimization 1 & 2

Practical info

Location(s)

Toulouse

Project Research – Innovation

ECTS
8 crédits

Hourly volume
55h

Practical info

Location(s)

Toulouse

Machine learning

ECTS
4 crédits

Hourly volume
52h

Introducing

Objectives

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

- Properties and limits of the main machine learning algorithms.
- Bias - variance trade-off, model selection.
- Algorithms for risk estimation: bootstrap, cross validation.
- Optimization and algorithmic implementations with R and Python (Scikit-learn) of the studied algorithms.
- Ethical and legal concepts of artificial intelligence.

The student will be able to:
- Analyse big data sets from various domains: insurance, marketing, industry, by using R and Python libraries.
- Execute the main machine learning methods and algorithms (discriminant analysis, k-nn, support vector machines, classification and regression trees, random forests, neural networks..)
- Optimize hyper-parameters values and construct pipelines for automating.
- Optimize the missing values management.
- Detect ethical or legal failures (bias, discrimination, opacity) of machine learning algorithms.

Location(s)

Toulouse

Practical info

Communication in organisations with LV2

ECTS
6 crédits

Hourly volume

Introducing

Objectives

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

-How to answer the demand of the civil society for technical and scientific information
-How to carry out critical analysis in order to give appropriate answers when questioned about such issues
-How to consider the circulation and content of information within the organizations in which they will be hired

The classes given in English will focus on the specific linguistic characteristics of the English used in scientific contexts in order for the students to understand and master them.
The students will also be made aware of the specificities of scientific English as relates to publications in his specific field of research.

Module L 2
The objectives, defined in reference to the CEFRL for the 5 language activities, are specific for the language studied ¿ Chinese, German, Spanish ¿ and the level of the student.
They can be consulted on :
https://moodle.insa-toulouse.fr/course/view.php?id=44

In certain cases, students may be authorised to follow an English module instead of another language

Necessary prerequisites

Necessary knowledge:
For classes in English : understanding of scientific English

Practical info

Location(s)

Toulouse

Political sciences semestre 2

ECTS
3 crédits

Hourly volume

Practical info

Location(s)

Toulouse