INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

SEMESTER 7_4th YEAR AM

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

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Statistical Modelling

Introducing

Description

Programme (detailed contents):

-Nonparametric tests: empirical distribution function, goodness-of-fit test of Kolmogorov, tests of comparison of two populations, (Kolmogorov-Smirnov and Wilcoxon tests), normality tests (Kolmogorov and Shapiro-Wilk)
-Chi-square test of goodness-of-fit, of independence, of homogeneity
-Linear models: estimation of the parameters, confidence intervals, prediction intervals, Fisher test for a sub-model, variable selection
Linear regression, ANOVA, ANCOVA
-Generalized linear model: statistical inference, variable selection.
Logistic regression, loglinear model

Objectives

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

-The use of statistical tests for goodness-of-fit, independence, populations comparisons
-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 and Statistics (I2MIMT31)
Statistics (I3MIMT15)

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

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Optimisation

Introducing

Description

Program (detailed contents):

- Elements of convex analysis: convexity, lower semi-continuity, notion of subdifferential, elements of analysis for algorithmic purposes (Lipschitz gradient functions, strong convexity, conditioning)

- Optimality conditions (Karush Kuhn Tucker conditions, second order sufficient conditions)

- Lagrangian duality

- Algorithms for unconstrained differentiable optimization and link with ODEs: generalities on descent methods, gradient algorithms, Newton and quasi-Newton algorithms. Convergence study and convergence speed depending on the geometry of the functions to be minimized.

- Algorithms for constrained differentiable optimization: SQP, penalization methods, augmented Lagrangian.

- Convex optimization: how convexity can improve the convergence speed of algorithms.

- Inertial algorithms, Nesterov acceleration. Subgradient algorithms. Notion of proximal operator, Moreau regularization, proximal algorithms. Splitting methods: Forward Backward algorithm and Nesterov acceleration (FISTA). Study of convergence and convergence rate on the class of convex functions.

Objectives

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

* Existence and uniqueness conditions for solutions of an optimization problem (constrained differentiable optimization, non-differentiable convex optimization)

* Optimality conditions: Karush Kuhn Tucker points in the constrained differentiable case, optimality NHA in unconstrained convex optimization.

* The duality principle: Lagrangian duality, Fenchel-Rockafellar duality

* Gradient and Newton type algorithms, and their convergence results, classical algorithms of constrained optimization:

* The general principle of inertial algorithms: acceleration of gradient algorithms, generalization to the composite case.

The student will be able to:

- Interpret the behavior of an algorithm as a discretization of a dynamic system
- Identify classes of optimization problems and propose algorithms adapted to the geometry of the functions to be minimized.
- Implement and numerically calibrate these algorithms.

Necessary prerequisites

Basics of differential calculus and linear algebra.

3rd year MIC optimization course

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

PDE 2 (OPTIONAL TEACHING)

Introducing

Description

Program (detailed contents):

Modeling with PDE (nonlinear PDEs in one dimension space)
1. Ecology, Population Dynamics, Epidemiology (reaction-diffusion equations)
2. Traffic, Ecology (forest fire): nonlinear advection equations
3. Wave propagation phenomena (elliptic equations)

Elliptic equations : analysis and simulation

1. Variational formulation: weak derivatives, weak solutions, Sobolev spaces
2. Finite element methods (in one dimension space): Galerkin methods, P1 and P2 elements, convergence and error estimates, qualitative properties

Hyperbolic equations: analysis and simulation

1. Method of characteristics, weak solutions, formation of shocks in finite time, maximum principle
2. Finite volume methods (in one dimension space): centered and upwind schemes, discrete maximum principle, order 1 and 2 methods.

Objectives

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

¿ Main PDE models found in the literature in biology, ecology, physics and engineering.
¿ Notions of weak derivatives, weak solutions and variational formulations
¿ Finite elements and finite volume methods: formulation, implementation and convergence.

The student will be able to:

¿ Derive a variational formulation of an elliptic problem
¿ Implement finite elements method in 1d for elliptic equations.
¿ Solve nonlinear scalar hyperbolic equations with method of characteristic
¿ Implement finite volume method in 1d for hyperbolic equations.

Necessary prerequisites

Ordinary differential equations : modeling, existence of solutions, qualitative study, numerical simulation (convergence, stability, order)

Introduction to PDE (EDP1): linear equations, analytic resolution, finite difference methods

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

Advanced probability (OPTIONAL TEACHING)

Introducing

Description

Syllabus (detailed contents):
- Conditional expectation, filtration, martingale, submartingale and supermartingale, Doob¿s theorem, optional stopping theorem, convergence theorems, law of large numbers and central limit theorem for martingales. Parametric estimation through maximum likelihood estimation in Markovian models.
- Background on deterministic gradient descent, Introduction to Robbins-Monro algorithms and links with classical results (Law of Large Numbers), Robbins-Siegmund Lemma, Robbins-Monro Convergence Theorems, Applications (Two-Armed Bandit, quantile, quantization, Linear Regression in high dimension).

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):
- The notion of conditional expectation, the main properties of martingales and their classical use in modelling,
- Stochastic algorithms of Robbins-Monro type.

The student will be able to:
- To compute a conditional expectation, to show that a random process is a martingale, to use the various theorems (Doob, optional stopping and convergences), in particular for the maximum likelihood estimation.

- Build and study the convergence of stochastic optimization algorithms, apply these methods to different problems (quantile, quantization,¿)

The student will be able to:
- To compute a conditional expectation, to show that a random process is a martingale, to use the various theorems (Doob, optional stopping and convergences), in particular for the maximum likelihood estimation.

- Build and study the convergence of stochastic optimization algorithms, apply these methods to different problems (quantile, quantization,¿)

Simulate a random variable by different methods, use probabilistic, choose appropriate techniques for variance reduction and error estimation

Necessary prerequisites

Necessary knowledge:

A basic course on probabilities.

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)

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Toulouse

High Performance Computing, Tools and methodologies for software development

Introducing

Description

Program (detailed content):

HPC
-Computation of eigenvalues ¿¿for large systems (2 Lectures, 1 Lab Work)

- Machine architecture: calculation units and typology (CPU, GPU and others), cache memory hierarchy, interconnection networks, principles of spatial and temporal locality, vectorization, etc.
- Parallelization: degrees of parallelism (Amdahl's law, scalability, etc.), shared memory paradigm with OpenMP, distributed memory paradigm with MPI, principles of reduction, data race, etc.
Subtotal: (4 Lectures, 3 Lab Works)

IT tools and methods
- IT development tools and methods: desirable interdisciplinary project implementing IT project management logic: agile project management methods and tools, software engineering methods and tools (object-oriented design and production, advanced algorithmics), collaborative tools , programming support tools, continuous integration tools. The acquisition of the knowledge necessary for the implementation of the tools and methods will be done through self-training through a series of micromodules provided (agile method, Monday, Teams, Trello, GitLab, Linter, Mattermost, Jira, etc.).
(1 Lab Works, 1 Mentored Project=36h)

Objectives

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

- General concepts of project management and collaborative IT development
- General concepts of high performance computing with parallelization techniques.
- Galerkin approximation of an eigenvalue problem, Krylov spaces and the Arnoldi process

The student must be able to:
- Structuring an IT development project according to its main dimensions and an agile method: organization and comitology, sizing, planning, sprints and main milestones, collaborative development and continuous integration tool chain, communication, documentation
- Know the vocabulary of high performance computing and know the basic elements of parallelization.
- Implement the Arnoldi method for calculating extreme eigenvalues of a matrix

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)

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Toulouse

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Quality, security, environment

Introducing

Description

Program (detailed contents):
- Specific QSE: Statistical process control (SPC); notions of metrology; capability of a process; control cards; the SPC system in a company.
- Health and Safety at work: notions of risks, evaluation, prevention, protection.
- Notions of IT security: bases of cryptography; electronic certificates; protocol https; digital signature.

Objectives

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

- Mains concepts and tools for quality control
- The principles and stakes in the health and in the safety at work.
- The main concepts of the IT security.

The student will be able to:
- Integrate the aspects of Quality, Security, Environment into the analysis of problems and the development of solutions.

Necessary prerequisites

For the statistical process control part, the Probability and Statistics course of 2MIC and the Inferential Statistics course of 3MIC.

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

Reding Seminar (or Challenge based learning)

Introducing

Description

During the Reading Seminar, students will work on different bibliographic resources (research articles, books, digital resources) in order to prepare the S8 Research Innovation project. Their objective will be to understand in depth certain mathematical results or to reproduce certain numerical experiments proposed in the articles. They will produce a summary explaining their work in an educational manner and according to precise specifications (summary, citations, elements of evidence, statement of results, production of graphs).

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):
- Principles and operation of a collaborative work environment
- Project management (PERT, GANTT, WBS)
- Self-evaluation of the results obtained in relation to the objectives.

The student will be able to:
- Produce a synthesis of the results of a research article
- Carry out relevant bibliographic research to deepen the understanding of a mathematical result (theoretical or numerical)
- Work collaboratively in a small group
- Use bibliographic and digital collaborative tools

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

Law (elective)

Introducing

Description

The law course is backed by digital support in Moodle including course elements, tutorials and a Bibliography + webography

The main areas studied are as follows:

Legal structures of the company
The main contracts and institutions of business life
Risk and liability

Objectives

At the end of this course, students will know the legal context and legal implications of the company's activity

Necessary prerequisites

None

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

Finance (elective)

Introducing

Description

Financial diagnosis: Analysis of Balance sheet. The break even point. Analysis of profit or loss account. The capacity for self-financing. Ratios.
Investment process: Net Cash Flows and selection criteria with or without updating based on the profitability of an investment.

Objectives

Be able to objectively assess the financial health of a company and evaluate the profitability of an investment.

Necessary prerequisites

financial management course (3td year) : to know about the company's financial statements, balance sheet and income statement

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

Strategies for Responsible Companies

Introducing

Description

The resources of the responsible business strategy module are 100% online in Moodle

The main areas studied are as follows:

Reflection on the engineer of tomorrow

Definitions, issues and limits of conventional business strategy

Knowledge of the markets

Design and develop a sustainable offer

Build a fair pricing policy

Develop responsible and effective communication

Objectives

At the end of this course, students will be able to:

- Carry out a diagnosis of the market and the company to make decisions and set strategic objectives

- Mobilize market knowledge to implement a responsible strategic action plan with regard to ecological, economic and social issues.

Necessary prerequisites

None

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

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Foreign Language

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

Physical Education

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