Specialisation Mathematical engineering

MATHÉMATIQUES ET INGÉNIERIE DU RISQUE

MATHEMATICS AND RISK ANALYSIS

Lecturers: Marie-Christophette BLANCHET

| Lecturers : 0.0 | TC : 0.0 | PW : 0.0 | Autonomy : 0.0 | Study : 0.0 | Project : 0.0 | Language : FR

Objectives

The third year specialization « Applied mathematics and risk engineering » is devoted to mathematical modeling and numerical simulation of problems arising in engineering.Students study a wide range of stochastic and deterministic methods concerning ordinary and partial differential equa-tions, optimization problems, discrete and time-continuous stochastic processes, statistics., together with the associated numerical methods.Opportunity is given to the best students to complete their formation with a master degree in one of the three following fields : applied mathematics, fInance / insurance, biomathematics / biostatistics.

Keywords :

Programme

Learning outcomes

- Up to date mathematical technics
- Tools for scientific monitoring
- Necessary background for an applied mathematics PhD

Independent study

Objectifs :

Méhodes :

Core texts

Assessment

PARCIMONIE ET GRANDE DIMENSION

SPARE AND LARGE

Lecturers: Marie-Christophette BLANCHET, Alexandre SAIDI, Céline HARTWEG-

| Lecturers : 22 | TC : 4 | PW : 0.0 | Autonomy : 0.0 | Study : 4 | Project : 0.0 | Language : FR

Objectives

Sparsity and convexity are ubiquitous notions in Machine Learning and Statistics. In this course, we study the mathematical foundations of some powerful methods based on convex relaxation: L1-regularisation techniques in Statistics and Signal Processing; Nuclear Norm minimization in Matrix Completion. These approaches turned to be Semi-Definite representable (SDP) and hence tractable in practice. The theoretical part of the course will focus on the guarantees of these algorithms under the sparsity assumption. The practical part of this course will present the standard solvers of these learning problems.

Keywords : L1-regularization; Matrix Completion; Semi-Definite Programming; Proximal methods;

Programme

Learning outcomes

Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

Core texts

Christophe Giraud, *INTRODUCTION TO HIGH-DIMENSIONAL STATISTICS*, Chapman and Hall/CRC
Martin J. Wainwright *HIGH-DIMENSIONAL STATISTICS: A NON-ASYMPTOTIC VIEWPOINT*, Cambridge University Press
Simon Foucart and Holger Rauhut*A MATHEMATICAL INTRODUCTION TO COMPRESSIVE SENSING*

Assessment

PROCESSUS DE MARKOV ET PROCESSUS GAUSSIENS POUR LA MODÉLISATION DE

MARKOV AND GAUSSIAN PROCESSES FOR MODELING TEMPORAL AND SPATIAL

Lecturers: Marie-Christophette BLANCHET, Alexandre SAIDI, Céline HARTWEG-

| Lecturers : 18 | TC : 2 | PW : 0.0 | Autonomy : 0.0 | Study : 10 | Project : 0.0 | Language : FR

Objectives

This course is oriented towards the modeling of random phenomena depending on time or space. The first part will be devoted to Markovian processes, processes involved in the modeling of temporal phenomena. Both theoretical modeling tools and numerical aspects will be presented. Their use will be seen through models from ecology, the environment or finance. The second part will be mainly devoted to regression by Gaussian processes. This tool also known as kriging and historically introduced for the
modeling and forecasting of spatial quantities, is now widely used to model complex numerical experiments. We will also present the techniques of uncertainty quantification and Bayesian optimization.

Keywords : Markov process, Kolmogorov equation, Feymann-Kac formula, kriging, regression by Gaussian processes, Bayesian optimization, sensitivity analysis, computer experiments.

Programme

1/ Continuous Time Markov Chain
2/ MArkov processes in continuous time
3/ Kriging model for spatial data
4/ Kriging in the context of approximation of expensive codes: Bayesian optimization and uncertainty quantification.

Learning outcomes

- Modeling and simulation of Markovian processes. Know how to make the link between stochastic processes and partial differential equations.
- Implementation of a kriging forecast from spatial data
- Implementation of a global optimization approach based on a regression model using Gaussian processes.

Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

Core texts

TJ Santner, BJ Williams, WI Notz, BJ Williams, *THE DESIGN AND ANALYSIS OF COMPUTER EXPERIMENTS*, Springer, 2003
Noel A. C. Cressie *STATISTICS FOR SPATIAL DATA, REVISED EDITION*, John Wiley & Sons, Inc., 1993
Thomas M. Liggett*CONTINUOUS TIME MARKOV PROCESSES : AN INTRODUCTION*, Providence R.I. : American Mathematical Society, 2010

Assessment

Final mark =60% Knowledge + 40% Know-how
Knowledge= 100% final exam
Know-how= 100% continuous assessment

MÉTHODES VARIATIONNELLES POUR LES PROBLÈMES INVERSES EN IMAGERIE MÉDICALE

INTRODUCTION TO INVERSE PROBLEMS

Lecturers: Marie-Christophette BLANCHET, Alexandre SAIDI, Laurent SEPPECHER

| Lecturers : 20.0 | TC : 2.0 | PW : 0.0 | Autonomy : 0.0 | Study : 8.0 | Project : 0.0 | Language : FR

Objectives

Keywords :

Programme

Learning outcomes

Independent study

Objectifs : This activity is not concerned with framed autonomy activities outside personal work.

Méhodes : This activity is not concerned with framed autonomy activities outside personal work.

Core texts

Assessment

PROJET IM

PROJET IM

Lecturers: **Marie-Christophette BLANCHET**

| Lecturers : 0.0 | TC : 0.0 | PW : 0.0 | Autonomy : 0.0 | Study : 8 | Project : 50 | Language : FR

Objectives

Through this project, students will identify mathematical problems/ barriers, propose solutions and implement them. They will also improve their communication skills to present the results (in written and oral forms).

Keywords : Modelization, Analysis, Simulations.

Programme

Learning outcomes

- Build a model
- Analyzis of a determnistic or random model
- Use of an appropriated software to perform simulation

Independent study

Objectifs : rite a report, build a presentation.

Méhodes : Group Work, pair work.

Core texts

Assessment

Report and defense