MATH-435

Bayesian Computation

Cursus	Sem.	Type
Data science minor	E	Opt.
Ing.-math	MA2, MA4	Opt.
Mathématicien	MA2	Opt.

Language of teaching	English
Credits	5
Session	Summer
Semester	Spring
Exam	Oral
Workload	150h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Remark

pas donné en 2021-22

Summary

This course aims at giving a broad overview of Bayesian inference, highlighting how the basic Bayesian paradigm proceeds, and the various methods that can be used to deal with the computational issues that plague it. This course represents a 70-30 split of practice versus theory.

Content

Key results that will be presented during the class:

- **The Bayesian paradigm**: choosing a model, evaluating model fit, improving a model, choosing the prior distribution
- Approximation methods: Laplace approximation, Variational Bayes, Expectation Propagation
- Sampling methods: Rejection sampling, Importance sampling, Markov-Chain methods
- Bayesian regression, Bayesian classification, sparse Bayesian methods, clustering methods
- Theory: Justifying Bayesian methods through Statistical Decision Theory, Bayesian large-data limit results (Bernstein-von Mises)

Exercise sessions will be focused on implementation of the methods presented during the class, and on practical aspects of Bayesian data analysis.
The evaluation consists of an oral presentation on a programming project carried out by the student during the semester.

Learning Prerequisites

Required courses

A master's level understanding of real analysis, linear algebra, statistics and of probability theory is required for this course.

Learning Outcomes

By the end of the course, the student must be able to:

- Formulate a Bayesian model to tackle a new problem.
- Identify the limits of how a model accounts for a given dataset.
- Propose one (or more) approximation method for the model.

- Implement the methods presented in the course.
- Recognize how the various methods compare to one another.

Teaching methods

Lecture ex cathedra, exercises in class, homework

Expected student activities

Evaluation is based on a programming project.

Assessment methods

Evaluation is based on a programming project.
Dans le cas de l'art. 3 al. 5 du Règlement de section, l'enseignant décide de la forme de l'examen qu'il communique aux étudiants concernés.

Supervision

Office hours	No
Assistants	Yes
Forum	No

Resources

Bibliography

C. Bishop, Pattern Recognition and Machine Learning
K. Murphy, Machine Learning: A Probabilistic Perspective
C. Robert, The Bayesian choice

Ressources en bibliothèque

- Bayesian choice / Robert
- (electronic version)
- Machine Learning / Murphy
- Pattern Recognition and Machine Learning / Bishop