MATH-414 **Stochastic simulation**

Nobile Fabio

Cursus	Sem.	Type
Computational science and Engineering	MA1, MA3	Opt.
Computational science and engineering minor	H	Opt.
Financial engineering	MA1, MA3	Opt.
Ing.-math	MA1, MA3	Opt.
Mathématicien	MA1, MA3	Opt.
Statistics	MA1, MA3	Opt.

Language of teaching	English
Credits	5
Session	Winter
Semester	Fall
Exam	Written
Workload	150h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

The student who follows this course will get acquainted with computational tools used to analyze systems with uncertainty arising in engineering, physics, chemistry, and economics. Focus will be on sampling methods as Monte Carlo, quasi Monte Carlo, Markov Chain Monte Carlo.

Content

- Random variable generation
- Simulation of random processes
- Simulation of Gaussian random fields.
- Monte Carlo method; output analysis
- Variance reduction techniques (antithetic variables, control variables, importance sampling, stratification)
- Quasi Monte Carlo methods
- Markov Chain Monte Carlo methods (Metropolis-Hasting, Gibbs sampler)

Other topics that may be addressed if time allows:
- Stochastic optimization (stochastic approximation, simulated annealing)
- Rare events simulations
- Estimation of derivatives
- Filtering problem; particle filters

Keywords

Simulation of random variables and processes; Monte Carlo; Quasi Monte Carlo; Markov Chain Monte Carlo

Learning Prerequisites

Required courses

basic Probability and Statistics; Numerical Analysis;

Recommended courses

Applied Stochastic Processes (or equivalent)

Important concepts to start the course

Knowledge of basic courses in mathematics, probability, statistics and numerical analysis. Some experience of computer programming is assumed.

Learning Outcomes

By the end of the course, the student must be able to:
- Analyze the convergence of sampling algorithms
- Implement sampling methods for different stochastic processes
- Compare the efficiency of different sampling algorithms
- Choose appropriate sampling algorithms
- Propose efficient sampling methods for different stochastic problems

Transversal skills

- Plan and carry out activities in a way which makes optimal use of available time and other resources.
- Demonstrate a capacity for creativity.
- Demonstrate the capacity for critical thinking
- Write a scientific or technical report.

Teaching methods

course ex-cathedra + exercise sessions and computer labs

Expected student activities

Active participation to the course and practical sessions

Assessment methods

Project + written exam
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	Yes
Assistants	Yes
Forum	No

Resources

Virtual desktop infrastructure (VDI)

No

Bibliography

S. Asmussen and P. Glynn, Stochastic Simulation: Algorithms and Analysis. Springer-Verlag, 2007
D. Kroese, T. Taimre and Z. Botev, Handbook of Monte Carlo Methods, Wiley 2011
G. Robert and G. Casella, Monte Carlo statistical methods, Springer 2004

Ressources en bibliothèque

- Stochastic simulation Asmussen
- Monte Carlo statistical methods
- Handbook of Monte Carlo Methods

Notes/Handbook

lecture notes available on the webpage

Moodle Link

- https://go.epfl.ch/MATH-414