Department of Mathematical Sciences
Division of Applied Mathematics

2025 | Monte Carlo Methods for Machine Learning

Information

Course organiser: Prof. Hugo Touchette
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Assessment: 50% courseworks (3 in total), 50% exam

Description

This course gives an introduction to Monte Carlo and stochastic approximation methods with applications in machine learning. The focus is on Markov chain Monte Carlo methods used for sampling probabilistic models and stochastic gradient descent methods used for minimisation.

Content

1. **Random variables and sampling**

   Revision of probability theory, generation of random variables, sampling, estimators.

2. **Markov chain Monte Carlo**

   Markov chains, Metropolis–Hastings algorithm, variations, applications.

3. **Stochastic approximations**

   Stochastic approximations, stochastic gradient descent, simulated annealing, optimisation.

References

- S. Ross, A First Course in Probability, Prentice-Hall, 2010.
- G. Grimmett and D. Stirzaker, *Probability and Random Processes*, OUP, 2001.
- S. Asmussen, P. W. Glynn, *Stochastic Simulation*, Springer, 2010.
- J. S. Liu, *Monte Carlo Strategies in Scientific Computing*, Springer, 2001.
- D. J. C. MacKay, *Information Theory, Inference, and Learning Algorithms*, CUP, 2003.
- C. A. L. Bailer-Jones, *Practical Bayesian Inference*, CUP, 2017.
- K. P. Murphy, Machine Learning: A Probabilistic Perspective, MIT, 2012.
- A. Guyader, Méthodes Monte Carlo, Lecture notes, Sorbonne Université, 2020.

Plagiarism and use of published code

- You must work independently on your courseworks, although you are allowed to discuss.
- You cannot use last year's solutions in your courseworks. If you have access to these solutions, for some reasons, you must tell me immediately.

- Except for last year's solutions, you are allowed to use any sources in your courseworks and project (books, internet, ChatGPT, etc.), but you must cite them all.
- You are allowed to use published codes, but you must cite their source.
- Any suspected cases of copying, plagiarism or use of last year's solutions will be referred to the academic director at AIMS.