Monte Carlo Simulation (Honours)

Stat 4555, Winter 2021

Instructor - Gennady Shaikhet (gennady@math.carleton.ca)

Course schedule – online, synchronous

- **Lectures:** Tuesday and Thursday, **4:05 pm - 5:25 pm**, via Zoom

The course will be mainly delivered via live lectures, at times augmented by prerecorded sessions.

Course overview

- Basic ideas and algorithms of Monte Carlo. Simulation of basic stochastic processes, in particular, discrete and continuous Markov processes, including Brownian motion and Poisson process. Applications to financial markets and queueing networks.
- Importance sampling and other techniques for improving simulation accuracy and efficiency.
- Markov Chain Monte Carlo methods: Gibbs Sampling and simulated annealing, Metropolis - Hastings and applications to Ising model, travelling salesman, Bayesian analysis, machine learning.

Course structure and evaluation

- Home assignments (30%)
- Midterm (30%)
- Final project & presentation (40%).

Prerequisites

Students are required to have a fair experience in probability (e.g., STAT 3558 or equivalent). Any prior experience in stochastic processes (e.g., STAT 3506) is advantageous, but not required.

Literature (No textbook. We will also be using the following references)

- R. Shonkwiler, *Finance with Monte Carlo*. Springer 2013.
- N. T. Thomopoulos, *Essentials of Monte Carlo Simulation*. Springer, 2013.
- H - J. Bungartz, et. al. *Modeling and Simulation*. Springer, 2014
- A. Barbu and S - C. Zhu, *Monte Carlo Methods*. Springer, 2020

Tentative class outline for Winter 2021

1. Introduction and motivation. Examples of simulations for random walk, Poisson process, Brownian motion.
2. Review of probability. Inverse transform method.
3. Acceptance - rejection method.
4. Normal random variable and Brownian motion. Brownian motion and Geometric Brownian motion.
5. Simulating Brownian motion and Geometric Brownian motion.
6. Poisson Process. Homogeneous and non-homogeneous. Simulating Poisson process.
7. Statistical analysis of the output.

Midterm (Feb. 23, 2021; @ 4 pm)

8. Discrete event simulation. G/G/1 networks.
9. Simulation of the queueing networks.
10. Variance reduction.
11. Markov Chain Monte Carlo. Optimization
12. Applications

Presentations, via Zoom, or BigBlueButton (last 2-3 weeks of the course)

Policies

Academic Integrity

All tests, assignments and exams are to be done independently. Any instance of suspected cheating or plagiarism will not be tolerated. Suspected cheating will be reported to the Dean, according to the policies stated in General Regulations. For more information, please consult: https://carleton.ca/registrar/academic-integrity/

Academic Accommodations for Students with Disabilities

The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send the course instructor your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable).

After requesting accommodation from PMC, communicate with the instructor to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam. For more information, see: https://carleton.ca/pmc/