Department of Mathematics & Statistics
Concordia University

STAT 461
Statistical Simulation
Summer 2019

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Office Hours: Mondays, 13:30-15:00.

Text: *Simulation, 5*th Edition, by Sheldon M. Ross (Academic Press).

Objectives: This course is an introduction to the methods of *simulation* and the *Monte Carlo* techniques. Simulation consists of formulating a suitable statistical model for a given system (in economy, industry, insurance etc.) in terms of appropriate random variables and their (joint) distributions, and generating values of those variables on a computer to see how the system works. Monte Carlo techniques are statistical methods for estimating various quantities of interest for the system, based on repeated simulations, which are difficult to compute theoretically based on the model. In Part I of the course we shall review basic probability theory and study methods for generating (pseudo) random variables. In Part-II we shall study simulation of a few complex systems and their estimation using Monte Carlo methods.

Assignments: There will be 3 or 4 assignments. Most of the assignments will involve use of the software –*R* that will be demonstrated during one class. R is installed on the PCs in the Department's Computer Lab, and a freely downloadable student version can be found at http://www.r-project.org. There will be a few separate questions for undergraduate and graduate students in the assignments and exams.

Midterm Test: There will be one **midterm test,** based on the material of lectures 1-6, which will contribute up to 25% to your final grade (see the **Grading Scheme** below). Midterm test will be held on **Monday, July 22, 2019 in class.** This exam, as well as the final, will be closed book exams.

NOTE: It is the Department's policy that tests missed for any reason, **including illness,** cannot be made up. If you miss the midterm test **because of illness *(medical note required)*** the final exam will count for 85% of your final grade, and the assignments will count for the remaining 15%.

Final Exam: The final examination will be three hours long and will cover all the material in the course. In order to obtain a good grade, the student **MUST** show that she/he has a THOROUGH understanding of the subject.

NOTE: Students are responsible for finding out the date and time of the final exams once the schedule is posted by the Examinations Office. Conflicts or problems with the scheduling of the final exam must be reported directly to **the Examinations Office**, **not to your instructor**. It is the Department's policy and the Examinations Office's policy that **students are to be available until the end of the final exam period. Conflicts due to travel plans will not be accommodated.**

Final Grade: (1) Assignments (15%)
(2**)** Mid-term test (25%)
(3) Final examination (60%)

IMPORTANT: **PLEASE NOTE THAT THERE IS NO "100% FINAL EXAM" OPTION IN THIS COURSE.**

Lectures	Chapters
1	**Chapter 2: Elements of Probability** Sample Space and Events Axioms of Probability Conditional Probability and Independence Random Variables Expectations Variance Chebyshev's Inequality and the Laws of Large Numbers
2 & 3	**Chapter 2: Elements of Probability** Some Discrete Random Variables Continuous Random Variables Conditional Expectation and Conditional Variance **Chapter 3: Random Numbers** Introduction to R Pseudorandom Number Generation Using Random Numbers to Evaluate Integrals
4 & 5	**Chapter 4: Generating Discrete Random Variables** The Inverse Transform Method Generating a Poisson Random Variable Generating Binomial Random Variables The Acceptance-Rejection Technique The Composition Approach The Alias Method of Generating Discrete Random Variables Generating Random Vectors

6 & 7	**Chapter 5: Generating Continuous Random Variables** Introduction The inverse Transform Algorithm The Rejection Method The Polar Method for Generating Normal Random Variables Generating a Poisson Process **Mid-Term Test**
8 & 9	**Chapter 5: Generating Continuous Random Variables** Generating a Nonhomogeneous Poisson Process Simulating a Two-Dimensional Poisson Process **Chapter 7: The discrete Event Simulation Approach** Introduction Simulation via Discrete Events A Single-Server Queueing System A queueing System with Two Servers in Series A queueing System with Two Parallel Servers An Inventory Model An Insurance Risk Model
10 & 11	**Chapter 7: The discrete Event Simulation Approach** A Repair Problem Exercising a Stock Option Verification of the Simulation Model **Chapter 8: Statistical Analysis of Simulated Data** Introduction The Sample Mean and Sample Variance Interval Estimates of a Population Mean The Bootstrapping Technique for Estimating Mean Square Errors
12 & 13	**Chapter 9: Variance Reduction Techniques** Introduction The Use of Antithetic Variables The Use of Control Variates Variance Reduction by Conditioning Stratified Sampling Applications of Stratified Sampling Importance Sampling

Academic Integrity and the Academic Code of Conduct

This course is governed by Concordia University's policies on Academic Integrity and the Academic Code of Conduct as set forth in the Undergraduate Calendar and the Graduate Calendar. Students are expected to familiarize themselves with these policies and conduct themselves accordingly. "Concordia University has several resources available to students to better understand and uphold academic integrity. Concordia's website on academic integrity can be found at the following address, which also includes links to each Faculty and the School of Graduate Studies: concordia.ca/students/academic-integrity." *[Undergraduate Calendar, Sec 17.10.2]*