

Course Outline
Statistical Computing
STAT *4000
University of Guelph, F 2018

I. General Information

Calendar description: (0.5 credits)

The topics in this course will include pseudorandom number generation, numerical optimization as used in statistics, simulation study design, Monte Carlo integration and variance reduction, and bootstrapping. Other topics may include permutation tests, visualization of multivariate data, and Big Data.

Prerequisite(s): MATH*2130, STAT*3110, STAT*2050

Instructor: Julie Horrocks

Office: MACN518

E-mail: jhorrock@uoguelph.ca

Office hours: Wednesdays 3:30 or by appointment (email me!)

TAs: Harry Potter hpotter@hogwarts.ca

Lecture Days and Times: MWF 2:30-3:20 MCKN 307

II. Learning outcomes

After successful completion of the course, students will be able to:

1. Explain various techniques and methods in statistical computing, and effectively communicate the results of statistical computing procedures.
2. Select and implement appropriate methods for computer simulation of (pseudo)random numbers.
3. Describe various numerical optimization methods, their advantages and limitations, and their applications to statistics.
4. Implement numerical evaluation of integrals via Monte Carlo methods and use techniques to reduce the variance of these methods.
5. Design and implement simulation studies to test and compare statistical methods.
6. Describe and implement bootstrap methods and permutation tests.
7. Effectively visualize multivariate data.
8. Describe the challenges involved in handling Big Data and the strategies used to address these challenges.
9. Show proficiency in writing, debugging, testing, and commenting code.

III. Course content

Class meetings will involve a combination of instructor presentation, class discussion, and computer demo/work. Assignments and materials will be posted on the Courselink site.

TENTATIVE Schedule of topics:

Week	Topic
Week 0 (1 day)	Intro
Week 1 Week of Sept 10	Simulations in Statistics. Generating uniform random variables
Week 2 Week of Sept 17	Chapter 3. Generating other random variables
Week 3 Week of Sept 24	Chapter 4. Data visualization
Week 4 Week of Oct 1	More about Simulations
Week 5 Week of Oct 8 Monday, October 8 Holiday--NO CLASS	Chapter 5. Monte Carlo integration
Week 6 Week of Oct 15	Chapter 5. Variance reduction
Week 7 Week of Oct 22	Chapter 5. Importance sampling
Week 8 Week of Oct 29. Friday, November 2 Fortieth class day-- Last day to drop one semester courses	Reflection
Week 9 Week of Nov 5	Chapter 7. Bootstrap and Jackknife
Week 10 Week of Nov 12	Chapter 8. Permutation Tests
Week 11 Week of Nov 19	Chapter 11: Numerical Methods in R
Week 12 Week of Nov 26 Last day of class – Nov 30.	Intro to Big Data

IV. Course Resources

Recommended Textbook

Maria Rizzo, Statistical Computing with R, Chapman and Hall / CRC (2008).

Other Resources

- Zuur, A.F., Ieno E.N., & Meesters, E.H.W.G., A Beginner's Guide to R, Springer (2009).
- Venables, W.N. & Ripley, B.D. Modern Applied Statistics with S (4thEd.) Springer (2002).
- Murrell, P., R Graphics, Chapman & Hall/CRC (2006).
- Wickham, Hadley, Chief Scientist at RStudio. <http://hadley.nz/>

Statistical software:

- R. Free! Available on campus computers eg in the library. For installation on your own computer, get it here: <http://cran.r-project.org>.
- RStudio. Also free! This is an interface for R which I highly recommend. Get it here: <https://www.rstudio.com/>

V. Methods of Assessment

Submit your Journal Article Reflections and Assignments to Dropbox on Courselink before the due date/time. Daily Challenge questions will be completed and given to the instructor in class. **NO LATE WORK WILL BE ACCEPTED.**

	Percent of Final Grade	Due Date
Journal Article Reflection 1	5%	Sept 20 midnight
Assignment 1	20%	Oct 4 midnight
Journal Article Reflection 2	5%	Oct 18 midnight
Journal Article Reflection 3	5%	Nov 1 midnight
Assignment 2	20%	Nov 15 midnight
Journal Article Reflection 4	5%	Nov 29 midnight
Participation/Daily Challenge	10%	Every day
Final Project/Take home exam	30%	Dec 17 midnight

Journal Article Reflections:

Journal articles will be posted on Courselink along with a set of questions. You will write a SHORT reflection paper (1 page, double-spaced, 1 inch margins all around, 12 point font) that addresses the posted questions. We will have a class discussion on the article on the day after the due date.

Assignments:

Assignments will be done in pairs. They will involve some of the underlying theory of the statistical methods discussed in the course, as well as coding and implementing these methods. Use Word or some other text editor to produce your written assignments. Graphics should be shrunk to $\frac{1}{4}$ page at most. Discussion often leads to better

understanding, so we encourage you to discuss course concepts with the other member of your pair, and with other pairs. However, each pair is responsible for their own work. Each pair must hand in a separate complete assignment, that is entirely their own work (no part of the assignment can be copied from another pair). Academic dishonesty, such as plagiarism (including copying all or part of an assignment) and impersonation is grounds for loss of course credit and dismissal. More information on the subject of academic misconduct can be found at the following website:
http://www.uoguelph.ca/undergrad_calendar/c08/c08-amisconduct.shtml

Inclass Participation/Daily Challenge: Each student is expected to ask questions and participate in class discussions. A daily challenge question will be given every day. You will complete the challenge and hand it in during class. Your best 90% of these challenge questions will be counted toward your final mark.

Final Project/Take home exam: This will be cumulative, combining many topics learned in this course.

NO LATE Work will be accepted.

VI. Course Policies

Academic Accommodation of Religious Obligations

If you are unable to complete a course requirement due to religious obligations, please let the instructor know within the first two weeks of class. See the academic calendar for more information:

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml>

When You Cannot Meet a Course Requirement: When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons, please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact, and be prepared to provide supporting documentation. See the undergraduate calendar for information on regulations and procedures for Academic

Consideration:

Consideration may be granted at the instructors discretion. Please note that consideration for medical, compassionate or university-related conflicts (e.g., varsity sports) may require additional discussion with your program counsellor. Consideration is generally more likely when the student proactively advises the instructor of issues well in advance of deadlines.
<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Academic misconduct: The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic

misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

The Academic Misconduct Policy is detailed in the Undergraduate Calendar:
<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

Calendars: The calendar is the source of information about the University of Guelph's procedures, policies and regulations that apply to undergraduate, graduate and diploma programs:

<http://www.uoguelph.ca/registrar/calendars/index.cfm?index>

Copies of out-of-class assignments: Keep paper and/or other reliable back-up copies of all out-of-class assignments; you may be asked to resubmit work at any time.

Course evaluations: Each course taught by the Mathematics and Statistics Department is evaluated in the last two weeks of the semester. Note that the completed evaluation and any comments will not be passed on to the instructor, the Chair, and the Departmental Tenure and Promotion Committee until after all the final grades have been submitted following the final examination period.

- Your input provides important feedback to the instructor and becomes an important part of the Departmental Tenure and Promotion Committee's teaching evaluation of the instructor.
- Numerical results calculated from the 7 questions are provided to the instructor and are used by the Departmental Tenure and Promotion Committee in making faculty salary and promotion decisions.
- Comments from unsigned evaluation forms are passed only to the instructor after the final grades have been submitted following the final examination period.
- If you wish your comments to also go to the Chair and the Departmental Tenure and Promotion Committee, you must include your clearly legible handwritten signature, with your legibly printed name and student number in the provided spaces. Note that comments that do not include a clearly legible handwritten signature are not allowed to be passed on to the Chair and the Departmental Tenure and Promotion Committee.

- These comments are made available to the Promotion and Tenure Committee only after the faculty member has had the opportunity to read and respond to the contents. Your identity will be made available to the Chair, the Department committee and the faculty member after final grades have been submitted.

Drop date: The last date to drop one-semester courses, without academic penalty, is the 40th class day: Friday, November 2. To confirm the actual date please see the schedule of dates in the Undergraduate Calendar. For regulations and procedures for dropping courses, see the Undergraduate Calendar:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

E-mail communication: As per university regulations, all students are required to check their <mail.uoguelph.ca> e-mail account regularly; e-mail is the official route of communication between the University and its students.

Recording of materials: Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, a classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

Student responsibilities: You should plan on spending between 10 to 12 hours per week working on this course, including the time spent in lectures. This time includes reading the required sections of the textbook, reviewing and/or rewriting lecture notes, preparing questions on any material with which you need help, doing practice problems, and working on your assignments. The Instructors and TAs will offer as much assistance as possible. However, remember that this is your learning experience, and you will get as much out of this class as you put into it.

VII. Campus Resources

If you are concerned about any aspect of your academic program:

-make an appointment with a program counsellor in your degree program.

<http://www.bsc.uoguelph.ca/index.shtml> or

<https://www.uoguelph.ca/uaic/programcounsellors>

If you are struggling to succeed academically:

-There are numerous academic resources offered by the Learning Commons including Supported Learning Groups for a variety of courses, and workshops related to time management, taking multiple choice exams, and general study skills. You can also set up individualized appointments with a learning specialist.

<http://www.learningcommons.uoguelph.ca/>

If you are struggling with personal or health issues:

-Counselling services offers individualized appointments to help students work through personal struggles that may be impacting their academic performance.

<https://www.uoguelph.ca/counselling/>

-Student Health Services is located on campus and is available to provide medical attention. <https://www.uoguelph.ca/studenthealthservices/clinic>

-In addition to Health Services and Counselling Services, Kathy Somers runs training workshops and one-on-one sessions related to stress management and high performance situations. <http://www.uoguelph.ca/~ksomers/>

Accessibility

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability or a short-term disability should contact the Student Accessibilities Services (SAS) as soon as possible. For more information, contact SAS at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: <http://www.uoguelph.ca/csd/>