STA305H1/STA1004H - L0101
Design of Scientific Studies
Winter 2017

Instructor: Professor Nathan Taback
Email: nathan.taback@utoronto.ca
Office: SS 6027C

Office hours: after Monday's class until 1300 or by appointment. I may be late getting back to my office from class since my office is on the other side of campus in Sid Smith.

Teaching Assistants:

Classroom sessions: Mon 11:00-12:00, Wed 11:00-13:00 in AH400

Course webpage: Can be accessed through the learning portal

Course Notes: http://utstat.toronto.edu/~nathan/designscistudynotes.htm

Course Content

This course will provide an introduction to the fundamental concepts of the design of scientific studies including the design of experiments and observational studies. Students will be become acquainted with statistical methods used to design and analyze experiments and observational studies. In particular, this course will cover: experiments versus observational studies, clinical trial design, comparing several groups using a completely randomized design, randomized blocks, Latin squares, incomplete block designs, factorial designs, causal inference in randomized and non-randomized studies, and adjusting for selection bias using propensity score methods.

The learning objectives of this course are:

- Understand the ideas, principles, and considerations that are common to the design and analysis of scientific studies including the statistical design of experiments and observational studies.
- Develop a statistical toolbox of methods for the design and analysis of experiments and observational studies.
- Identify appropriate uses and interpretations of experimental designs, and observational studies, including their strengths and limitations.

Topics

Experiments, observational studies, and causal inference
Experiments versus observational studies, and causal inference in randomized experiments.

Selection Bias in Observational Studies
Causal inference in randomized experiments versus observational studies. Introduction to the propensity score and three ways to use the propensity score to adjust for selection bias: matching; sub classification; direct regression adjustment.

Probability and Statistics
Mathematical statistics used in experimental design.

Comparing Several Groups
Comparing several groups in an experimental and observational setting and deciding whether differences that are found are likely to be real or due to chance.

Power and Sample Size
Power and sample size will be introduced for several designs. Applications will include the design and analysis of clinical trials with continuous or binary endpoints.

Blocking techniques
Blocked designs, Latin squares, randomized incomplete block designs.

Factorial Designs
Factorial, blocked factorial, and fractional factorial designs will be discussed.

Split plot designs
Split plot designs will be discussed as an example of restricted randomization in the design of experiments.

Textbooks

Required
The required readings are available here (http://utstat.toronto.edu/~nathan/designscistudynotes.htm).

A draft of a textbook based on the course notes is freely available here (https://leanpub.com/designinfer).

Optional
1. Statistics for Experimenters: Design, Innovation, and Discovery. Box, G.E.P., Hunter, J.S., Hunter, W.G. Wiley 2nd Ed. 2005
2. Design and Analysis of Experiments. Dean, A., and Voss, D. Springer. 1999. UofT link to electronic copy: http://go.utlib.ca/cat/2573215
3. Design of Observational Studies. Rosenbaum, P. R. Springer 2010. UofT link to electronic copy: http://go.utlib.ca/cat/7890274

4. Experiments: planning, analysis, and optimization. Wu, C.F.J., Hamada, M.S. Wiley, 2009, 2nd ed.: http://go.utlib.ca/cat/8598479
5. Causal inference for statistics, social, and biomedical sciences. Imbens and Rubin. Cambridge University Press, 2015. http://go.utlib.ca/cat/10127748

NB: Textbooks 2-5 are available electronically through the UofT library (i.e., electronic copies of both these textbooks are available at no extra cost)

Evaluation

Undergraduate students will be evaluated according to the following marking scheme.

	Weight	Date	Time
Four hand-in assignments	5%x4=20%	Jan. 27, Feb. 17, March 17, April 5	Submitted electronically by 22:00 on Portal
Term test	35%	March 1	11:10-12:40
Final exam	45%	Scheduled by Faculty	

Graduate students will be evaluated at the graduate level according to the University Assessment and Grading Practices Policy. Graduate students in STA1004 may have some additional questions to do on assignments (these questions will not be required for undergraduates).

	Weight	Date	Time
Four hand-in assignments	7.5%x4=30%	Jan. 27, Feb. 17, March 17, April 5	Submitted electronically by 22:00 on Portal
Term test	35%	March 2	11:10-12:40
Final exam	35%	Scheduled by Faculty	

Assignment Due Date and Time

- Assignments are due by 22:00 on the due dates and must be submitted electronically on the UofT Learning Portal.
- Late assignments will be accepted within 48 hours after the due date (i.e., Sunday at 22:00).

    - Late penalty for assignments: 10% will be deducted from assignments submitted online within 24 hours after the due date (i.e., submitted between Friday at 22:01 and Saturday at 22:00); and 20% will be deducted from assignments submitted between 24 and 48 hours after the due date (i.e., submitted between Saturday at 22:01 and Sunday at 22:00).

    - Assignments submitted more than 48 hours (i.e., Sunday at 22:01) after the due date will receive a grade of zero except for documented reasons beyond the student's control. In the case of a medical reason this must be

documented using the UofT Student Illness or injury form. If an assignment is missed for a documented reason, then the weight for the assignment will be transferred to the weight for the final exam. For example, if an undergraduate student is unable to hand in one assignment during the term due to a documented illness then the weight for the student's final exam is 50%.

- Email submission of assignments will not be accepted. If an assignment is submitted by email, then it will NOT be marked.

- It is strongly recommended that you do not try to upload or submit your assignment at 21:59 or 21:58 on the due date. Based on past experience there is a good chance that your assignment will be marked late. This will not be considered a valid reason for submitting your assignment late. So, if your assignment is submitted Friday at 22:01 then you will automatically lose 10%.

Term test and exam

The test will be written during class time (11:10 – 12:40) on Wednesday, March 1, 2017 in a location to be announced.

You are allowed a two-sided 8-1/2"x 11" (standard letter size) hand-written aid sheet on the term test and a two-sided hand-written aid sheet on the final exam. You must bring your student identification to the term test and the final exam.

You will not need to know R syntax on the tests and exam, but you will need to know how to interpret output from R.

Marking concerns

Any requests to have marked work re-evaluated must be made in writing within one week of the date the work was returned. The request must contain a justification for consideration.

Missed Tests

- If a test is missed for a valid reason, you must submit documentation to the course instructor.

- If a test is missed for a valid medical reason, you must submit the University of Toronto Verification of Student Illness or Injury form to your instructor within one week of the test.

- The form will only be accepted as valid if the form is filled out according to the instructions on the form.

- **The form must indicate that the degree of incapacitation on academic functioning is moderate, serious, or severe in order to be considered a valid medical reason for missing the term test. If the form indicates that the degree of incapacitation on academic functioning is negligible or mild then this will NOT be considered a valid medical reason.**

- If a test is missed for a valid reason, then you will be given an online makeup test worth 5% of your final grade and the remaining 30% of the midterm test weight will be shifted to the final exam. This means that the final exam will be worth 75% of your final grade, if you are an undergraduate, and 65% if you are a graduate student.

- Students must complete the midterm test or the online makeup test. If a student misses both the midterm test and the online makeup test then a grade of zero will be assigned to the original weight (i.e., 35%) of the midterm test.

- The online makeup test will typically occur within two weeks after the date of the midterm test. Students will be contacted by email about the details of the online makeup test.

- Other reasons for missing a test will require prior approval by your instructor. If prior approval is not received for non-medical reasons, then you will receive a term test grade of zero.

Computing

We will use R for all examples. R is freely available for download at http://cran.r-project.org for Windows, Mac, and Linux operating systems. For the test and exam, you will need to know how to interpret output from R. We will support the use of R to complete the assignments.

I recommend using R Studio as an integrated development environment to R. It is freely available at https://www.rstudio.com/products/rstudio/

If you wish to use R at UofT then you will need to sign up for a CQUEST account. To get an account and find out more information about using CQUEST go to http://www.cquest.utoronto.ca

I am assuming that students have never used R before. I will provide you with the R syntax for all examples in lecture, which should be sufficient for you to do your assignments.

Calculators

You will need a calculator. Any calculator that has logarithmic functions will be sufficient. Calculators on phones or other devices equipped to communicate with the outside world

(for example, through the internet or cellular or satellite phone networks) will not be permitted during the term test and the final exam.

Online Discussion Board

This term you will have the option to use Piazza for class discussion. If you decide not to use Piazza it will not disadvantage you in any way, and will not affect official University outcomes (e.g., grades and learning opportunities). If you choose not to opt-into Piazza then you can ask questions or discuss course material with the instructor or TAs during office hours.

Be sure to read Piazza's Privacy Policy and Terms of Use carefully. Take time to understand and be comfortable with what they say. They provide for substantial sharing and disclosure of your personal information held by Piazza, which affects your privacy. If you decide to participate in Piazza, only provide content that you are comfortable sharing under the terms of the Privacy Policy and Terms of Use.

The Piazza system is highly catered to getting you help fast and efficiently from classmates, the TA, and the lecturers. Rather than emailing questions to the teaching staff, we encourage you to post your questions on Piazza. To sign up for the discussion forum click on the link : https://piazza.com/utoronto.ca/winter2017/sta305h/home

Additional help

Need extra help with the coursework? Here are some options:

- For continued class discussion and questions outside of class, try posting on the discussion forums. The instructor and TAs will be monitoring them regularly.
- You can visit your instructor or the teaching assistants during their office hours.
- There is a drop-in Statistics Aid Centre in New College: Wetmore Hall 68A. See http://www.utstat.toronto.edu/wordpress/?pa ge id=154 for the schedule.

E-mail should only be used for emergencies or personal matters.

How to communicate with your instructor

Questions about course material such as:
How do I do question 3.7 in the textbook?
What is standard deviation?
When is the midterm?

Can be posted on the discussion forums. Questions can be posted anonymously (so that the author is anonymous to other students but not to the instructors), if desired.

For private communication, such as: I missed the test because I was ill e-mail your instructor.

Use your utoronto.ca e-mail account to ensure that your message doesn't automatically go to a Junk folder and include your full name and student number.

Academic integrity

You are responsible for knowing the content of the University of Toronto's Code of Behaviour on Academic Matters at http://www.governingcouncil.utoronto.ca/policies/behaveac.htm. If you have any questions about what is or is not permitted in this course, please do not hesitate to contact your instructor.

Accessibility needs

The University of Toronto is committed to accessibility. If you require accommodations for a disability, or have any accessibility concerns about the course, the classroom, or course materials, please contact Accessibility Services as soon as possible: accessibility.services@utoronto.ca or http://accessibility.utoronto.ca.

Your responsibilities

The classroom sessions for this class are designed to actively engage you in the course material. We hope you'll find them interesting, challenging, and fun, and an excellent opportunity to truly learn the material.