

STA305H1S/STA1004HS - L0101 & L0201

Design of Scientific Studies

Winter 2020

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Office: HS 384

Office hours: Tues. 10:10-12:10 or by appointment

Teaching Assistants: To be announced

Classroom sessions:

- Section L0101: Mon 11:10-12:00 in ES 1050 and Wed 11:10-13:00 in OI G162
- Section L0201: Tues 13:10-14:00 in ES 1050 and Thurs 15:10-17:00 in ES 1050

Course website: Can be accessed through the UofT Quercus

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 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) (<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) (<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

Students will be evaluated according to the following marking scheme.

	Weight (Undergrads)	Weight (Grads)	Date (*tentative)	Time
Assignment 1	5%	10%	Feb. 4 (*)	Submitted electronically by 22:00 on Crowdmark
Midterm Test	35%	30%	[L01] Feb 26 [L02] Feb 27	[L01] 11:10-12:40 [L02] 15:10-16:40
Assignment 2	10%	15%	Mar. 30 (*)	Submitted electronically by 22:00 on Crowdmark
Final exam	50%	45%	Scheduled by Faculty	(3 hours)

Graduate students will be evaluated at the graduate level according to the [University Assessment and Grading Practices Policy](#).

Assignment Due Date and Time

- Assignments are due by 22:00 on the due dates and must be submitted electronically into Crowdmark.
- Late assignments will be not be accepted.
- 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.

Term test and exam

The test will be written during the foregoing class times in locations to be announced.

You are allowed a two-sided 8-1/2"x 11" (standard letter size) hand-written aid sheet on the tests and a two-sided hand-written aid sheet on the final exam. You must bring your student identification to the term tests 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. Further, the request must contain a justification and the additional marks you think you deserve.
- Students should review the grading scheme and solutions before submitting a regrade request.
- Electronic requests must be sent to regradesta305@gmail.com. Include your official name and student number for identification purposes.
- Regrading requests will be processed by the teaching team within two weeks of the request date. Any request for a partial review can result in a full review of the entire work. Finally, unsuccessful disputes will result in a deduction of one assessment mark.

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 original 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 7% of your final grade and the remaining the test weight will be shifted to the final exam.
- Students must complete a test or an online makeup test. If a student misses both the test and it's online makeup test then a grade of zero will be assigned to the original weight of the test.
- An online makeup test will typically occur within two weeks after the date of the 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/>

I am assuming that students have used R before. However, 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 TAs and the instructor. 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: piazza.com/utoronto.ca/winter2020/sta3051004

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 forum. The instructor and TAs will be monitoring them regularly.
- You can visit your instructor or the teaching assistants during their office hours.

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 are the term tests?

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.