Syllabus MAT/STA 336 Spring 2023

Contact Information

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Classroom: Noyce 2401

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Office Hours: Link to Office Hours times

Course Information

Course Description

A systematic treatment of mathematical statistics based on probability theory. Topics will include: principles of estimation and hypothesis testing, Bayesian methods, chi-square tests, linear models including regression and analysis of variance, nonparametric inference. Emphasis will be placed on refinement of problem-solving and mathematical modeling skills, along with R coding proficiency.

Prerequisites: MAT/STA 335

Textbooks

Required Texts

The following textbook is required for this course. Either paper or digital copy suffices. Day One Access has been enabled for this text and a digital copy can be accessed on the course page on Pioneer Web on the tab "Day One Textbooks"

- **Required** *Probability and Statistics* 4th edition by DeGroot and Schervish. We will cover chaptes 7 - 12.

Supplementary Texts

The following texts may be useful reference and can be browsed at the library. Exercepts may occasionally be assigned and will be distributed digitally through Pioneer Web.

- **Supplementary** *Mathematical Statistics and Data Analysis* 3rd edition by Rice.
- **Supplementary** *Statistical Inference* 2nd edition by Casella and Berger
- **Supplementary** *Mathematical Statistics with Resampling and R* 3rd edition by Chihara and Hesterberg

Course Resources

The following web-based resources will be used for communicating class information:

- Course Website https://https://grinnell-statistics.github.io/sta-336-s23/ (*announcements, documents, schedule, assignments*)

- Blackboard https://pioneerweb.grinnell.edu (*non-public documents, e-reserves, Day One Access Textbook*).
- Gradescope https://www.gradescope.com/ (*Homework & daily assignment submissions*)

Technology

You are encouraged to bring a laptop or tablet to class each day for notetaking, textbook reference, and live coding. Several classroom computers are also available during class time. Access to a computer with web-browser will be required for homework completion and submission.

We will make frequent use of the R programming language to perform calculations, sample random variables, and create probability models. Both R (the programming language) and RStudio (an editor and UI) are free to use, and can be accessed three ways:

- Through the cloud on the Grinnell RStudio Server: https://rstudio.grinnell.edu/
- On a classroom or library computer
- On your own computer by downloading R (http://www.r-project.org/) and RStudio (http://www.rstudio.com/)

Communication

If you would like to contact me, I can most easily be reached via email weekdays between 8am and 6pm. While I try to answer emails as soon as possible, in some cases, I may not be able to respond until the following school day. If you'd prefer to talk live, send me an email and we can schedule a time to chat on WebEx or Teams.

Office Hourse

You are free and encouraged to attend any scheduled office hours without prior appointment. These are times I have specifically set aside for answering questions, discussing class material, and helping with other college business. If you have a matter you'd prefer to discuss one-on-one, or if none of the scheduled times fit your schedule, please email me and we can arrangement another time to meet. On very rare occasions, I may need to reschedule office hours due to illness or other unavoidable conflict, and in these cases, I will notify the class via email.

Course Outcomes

By the end of the course, a student should be able to:

- Derive both frequentist and Bayesian statistical inference and estimation procedures, discuss essential properties of these techniques, and explain in both technical and non-technical terms how to implement these procedures.
- Determine which statistical inference procedure is most appropriate for a given task, implement the procedure effectively, and interpret the results accurately.
- Evaluate and compare the performance of common statistical inference procedures and assess appropriateness of models in context.
- Implement and analyze simulations for estimation and inference using R, and compare the simulated results to those predicted by theoretical methods.

Course Format

The course will be taught using in a group-based and problem-focused model. A typical class day will involve the following:

- *Reading Assignment*. Every class will have an assigned reading that you will be expected to review prior to the start of class. By 11am on the day of the class period covering the given material, you will answer several reflection question on those topics. You are also encouraged to submit any questions you have on the readings, or requests to review a particular topic.
- *Active Lecture Session*. Our 50-minute meetings will usually include a 30 - 40 minute lecture by the instructor, along with a short collaborative group work task. The lectures are intended to enhance, clarify and supplement the content from the assigned readings while the group work will allow you to practice key skills.
- *Homework*. After each class session, several homework problems will be assigned, due on the following Monday by 11:59pm.

Workload

A prepared student will attend class for 50 minutes per day, three days each week, and spend about two to four hours per day of class on work outside the classroom (reading, watching lecture videos, doing homework, discussing, studying, etc.). Together, this represents a 9 - 15 hour per week commitment.

Grading Criteria

Your grade in the class will be determined by your proficiency in each of the *Course Outcomes*, using the following weights:

1. Daily Assignments 10%
2. Homework 30%
3. Participation 10%
4. Exams 25% (12.5% each)
5. Final Project 25%

Letter grades will be assigned based on the following course percentages (with upper and lower 2% of each division corresponding to $+/-$, respectively).

- A: $90 - 100\%$
- B: $80 - 89\%$
- C: $70 - 79\%$
- D: $60 - 69\%$
- F: $< 60\%$

Daily Reading

Statistical intuition takes time to develop, and understanding deepens upon revisiting a concept a 2^{nd}, 3^{rd}, or n^{th} time. Studying basic terminology and elementary examples in the textbook before class means that class can be spent clarifying and expanding ideas, rather than introducing them.

Daily assignments will be posted on the schedule page of the course website, and will list the specific section(s) to read for each day, along with a link to a pre-recorded lecture. A brief set of reflection questions on the readings/videos will be included, to be completed by 11am each day of class (to give me time to review them before class). These questions are not intended to be overly difficult, but should help both you and I highlight topics that need further review. The assignment will be assessed primarily on the basis of completion. **No extensions on daily reading will be given, but up to three assignments may be missed without penalty.**

Homework

Homework will be due weekly on Mondays at 11:59pm, and should be submitted online to Gradescope. Homework assignments may either be typed and submitted as a .pdf file, or handwritten and scanned as an image. In both cases, solution must be legible in order to receive credit. Where appropriate, solutions should be written in complete sentences, and be thorough enough that another student in the class can follow your reasoning without any question. **Up to twice throughout the term, an extension of up to four days may be requested on a homework assignment. Except in extraordinary circumstances, requests must be made prior to an assignment's due date.** At the end of the term, your lowest *submitted* homework score will be dropped.

In-class Participation

Because of the collaborative nature of this course, it is essential that you strive to attend class every day, and that you complete the assigned reading / video prior to the start of class. Additionally, in order to foster a positive and inclusive classroom environment, you are expected to follow our class code of conduct. Frequent absences, as well as non-constructive in-class participation, will be reflected in your final course grade.

If you aren't able to attend class for any reason, please notify me before the start of class if possible (or within 2 days, if not), so that we can work out appropriate make-up arrangements. **Typically, you may miss up to three classes without penalty. However, prolonged or recurring illness, as well as other emergencies, may require individual adjustment, in which case you should contact me to make appropriate arrangements.**

Exams

Two take-home exams will be given throughout the term. Tentatively, the exams are scheduled for:

- Exam 1, Friday 3/3 (Week 6)
- Exam 2, Friday 4/21 (Week 11) *This date is VERY tentative, and will be discussed further in class*

Changes to exam dates will be announced at least 2 weeks prior to the scheduled time.

Take-home exams will be posted by 5pm on Friday of the exam day and due by 11:59pm the following Monday. They are intended to take between 3 and 4 hours to complete and allow reference to course notes and the textbook. No homework will be assigned in the week leading up to the exam. **Except in the case of illness or emergency, requests to reschedule take-home exam must be made a week before the exam.**

Final Project

A cumulative final course project will be due at the end of term, consisting of a research paper of approximately 5 - 10 pages.

Further details about this final project will be given the week before spring break.

Community Information

Accessibility

Grinnell College is committed to creating inclusive and accommodating learning environments. Please notify me as soon as possible if there are aspects of the instruction or design of this course that result in barriers to your participation. I also encourage you to have a conversation about and provide documentation of your disability to the Coordinator for Student Disability Resources, Jae Hirschman, located on the 1st floor of Steiner Hall(x3089). If you have already been approved for accommodations, please have Disability Resources provide a letter during the first week of classes, or as soon as possible after approval. I will then contact you to schedule a meeting during which we can discuss the particular implementation of your accommodations.

Religious Observance

Grinnell College offers alternative options to complete academic work for studnets who observe religious holy days. Please contact me within the first three weeks of the semester if you would like to discuss how to meet the terms of your religious observance and also the requirements for this course.

Academic Integrity

Students are allowed and encouraged to collaborate on most in-class and homework assignments. However, any work that you turn in for grading must be your own. If you collaborate on homework, you should clearly indicate the names of your collaborators on the first page of your assignment.

You are welcome to use other paper or internet resources to supplement content we cover in this course; however, with the exception of existing solutions to homework or exam problems. Copying or paraphrasing solutions from the internet or other sources is an example of academic dishonesty. Exams will explicitly mention what resources may be consulted. All written work that references material outside of the textbook or lecture should be accompanied by an appropriate citation.

Code of Conduct

I expect all members of the class to make participation a harassment-free experience for everyone, regardless of age, body size, visible or invisible disability, ethnicity, sex characteristics, gender identity and expression, level of experience, education, socio-economic status, nationality, personal appearance, race, religion, or sexual identity and orientation.

I expect everyone to act and interact in ways that contribute to an open, welcoming diverse, inclusive, and healthy community of learners. Examples of unacceptable behavior include: using sexualized language or imagery, making insulting or derogatory comments, harassing someone publicly or privately, monopolizing discussion or otherwise preventing others from meaningfully participating. Instead you can contribute to a positive learning environment by demonstrating empathy and kindness, being respectful of differing viewpoints and experiences, giving and gracefully accepting constructive feedback, and making space for everyone to contribute.

Assignment Feedback

You will receive timely feedback on your homework via Gradescope, usually within a week of the assignment's due date. Each homework problem can earn up to five points, and correspond loosely to letter grades (5 points $\approx$ A, 4 points $\approx$ B, etc.)

I recommend you review comments on your solutions and rework missed problems. You are welcome to talk to me about them during office hours or via email.

Help

I strongly encourage you to attend my office hours each week. You are welcome to come either with specific questions, or just with general uncertainties about content we've discussed. If you are unable to attend scheduled office hours, please email me to schedule an alternative appointment (either in-person or virtual).

The Data Science and Social Inquiry Lab (DASIL) in HSSC S1310 is staffed by mentors who are experienced in R programming and may be able to troubleshoot coding problems you are having.

Tentative Schedule

This is the schedule as of Day 1. A detailed and updated schedule is available on our course webpage. Section numbers are from DeGroot and Schervish's *Probability and Statistics* 4th ed.

Week	Dates	Topic	Sections
1	1/23 - 1/28	Intro to Inference, Bayes	7.1, 7.2
2	1/30 - 2/3	Bayes Estimation	7.3, 7.4
3	2/6 - 2/10	Maximum Likelihood Estimators	7.5, 7.6, 8,1
4	2/13 - 2/17	The Sampling Distribution	8.2 - 8.4,
5	2/20 - 2/24	Confidence Intervals	8.5 - 8.7
6	2/27 - 3/3	Hypothesis Testing; Exam 1	9.1
7	3/6 - 3/10	Hypothesis Testing	9.2, 9.3
8	3/13 - 3/17	Likelihood Ratio Test	9.1, 9.5, 9.7
-	3/20 - 3/24	Spring Break	-
-	3/27 - 3/31	Spring Break	-
9	4/3 - 4/7	Linear Models	11.1 - 11.3
10	4/10 - 4/14	More Linear Models	11.4, 11.5
11	4/17 - 4/21	Monte Carlo, Exam 2	12.4, 12.5
12	4/24 - 4/28	Working Differently Week	TBA
13	5/1 - 5/5	Bootstrapping	10.6, 12.6
14	5/8 - 5/12	Randomization Tests	-
15	5/15 - 5/19	Finals Week	-