Likelihood Theory and Extensions

University of Iowa
BIOS:7110
Fall 2025

Instructor:	Prof. Patrick Breheny
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Office hours: 4:00 p.m. - 5:00 p.m. Tuesday
11:00 a.m. - 12:00 p.m. Thursday
11:00 a.m. - 12:00 p.m. Friday
Also, feel free to e-mail me and set up an appointment.
I'll be in my office during office hours, but also
available via Zoom.

Lecture: 1:30 p.m - 3:15 p.m.
Monday & Wednesday
C301 CPHB

Course description: This course has three fundamental goals: (1) To gain familiarity with the use of rigorous mathematical techniques to prove statistical theorems, with an emphasis on multivariate results and on technical arguments involving regularity conditions that are typically skipped in other courses; (2) To focus on theoretical results involving likelihood, the most widely useful inferential construct in modern statistics; and (3) To introduce and illustrate some of the challenges that likelihood-based analyses may face, and various modifications to the likelihood that have been proposed for addressing those challenges.

Textbook: There is not one specific textbook that this course will follow. The content of the course was influenced by and adapted from several sources:

- *In All Likelihood* (2001), Pawitan Y. Oxford. The concept and organization of the course with respect to its emphasis on likelihood was partially inspired by this book.
- *A Course in Large Sample Theory* (1996), Ferguson TS. Chapman & Hall. Our theoretical derivations tend to follow from this book most closely.
- *Theory of Point Estimation*, Second Edition (1998), Lehmann EL and Casella G. Springer. A classic that covers much of what the course does, but organized differently and not specific to likelihood (good in general, less useful for this course specifically).
- *Essential Statistical Inference* (2013), Boos DD and Stefanski LA. Springer. This is the most recent book on the list, and provides a nice, modern update to Ferguson and Lehmann. I was not aware of its existence when making the course, but have been incorporating more of its ideas lately.

Prerequisite: BIOS:5720 (or equivalent) and either STAT:4101 or STAT:5101.

Course website: The course notes, assignments, proofs, and other relevant materials will be made available on the course web site: http://myweb.uiowa.edu/pbreheny/7110/f25

Homework: There will be (approximately) one homework assignment per week, due the following week at the beginning of class on Monday. Graded assignments will be returned the following week.

Feel free to compare answers with other students, although each student must turn in a copy of each assignment. Group discussions are great ways to make lasting friendships and valuable for retention and understanding of the material. Furthermore, working well in a group is a vital part of being a professional. However, make sure you understand the material, as the majority of your overall grade comes from your exam scores.

Computing: Assignments for this course will occasionally involve the use of a computer. You may use any statistical software you would like for this, although the software I will cover is R.

Exams: There will be three exams in this class. All exams are closed-book, although students may bring one page of notes if they wish to do so. The first two exams will take place during class time on the following dates, the final exam will be a take-home exam.

Exam 1	Wednesday, October 8
Exam 2	Wednesday, November 19
Exam 3	Take home (Finals week)

Grading: Your grade will be based on a weighted average of homework (25%), Exam 1 (25%), Exam 2 (25%), and Exam 3 (25%).

Attendance: Regular attendance in this course is expected. No direct penalty will be applied for missing lectures. However, assignments and exams are based on lecture material, so skipping them is likely to hurt your grade and, of course, your understanding of the material.

Corrections: Despite my best efforts, there will undoubtedly be mistakes in the notes (both slides and online supplemental proofs). If you spot a mistake, I very much want you to let me know about it so that I can correct it. I will award 1 bonus point (to be added to your homework total) for pointing out a typographical error and 3 bonus points for an error in content. Corrections will be made online and any substantive errors announced on the course home page.

Electronic communication: I will occasionally send notices to the class through e-mail (to your `uiowa.edu` account), so please check that account regularly.

Course schedule: http://myweb.uiowa.edu/pbreheny/7110/f25/notes.html

Feedback: I would love to hear feedback on how the course is going, both positive and negative aspects. I plan to request anonymous feedback mid-semester, but would love to hear any feedback any time.

I look forward to getting to know you, and I hope that we have a great semester together.

Academic misconduct: During exams, you are not allowed to copy off another student, consult reference materials (beyond the one sheet of allowed notes), or use a cell phone or any device capable of messaging, texting, or accessing the internet. Any of these actions will be considered cheating. On homework assignments, you are not allowed to copy and paste text from another student (if you copy text from some other source, it must be cited). Doing so will be considered plagiarism. The University of Iowa takes cheating and plagiarism very seriously. You can read more about the consequences of academic misconduct at http://dos.uiowa.edu/policies/academic-misconduct.

PhD in Biostatistics competencies:

- Demonstrate an increased level of knowledge and understanding of current statistical theory, methods, and practices in the health sciences.
- Communicate research findings, including new statistical methods developed, effectively to various audiences in writing and through oral presentation.

MS in Biostatistics competencies:

- Demonstrate a broad knowledge and understanding of current statistical theory, methods, and practices in the health sciences.

Concerns: Students with suggestions or complaints should see me first, and if we cannot come to an agreement, I will direct you to the Departmental DEO, Prof. Joseph Cavanaugh, N332 CPHB, joe-cavanaugh@uiowa.edu. Students may also contact the Undergraduate Program Director (if appropriate) or the Associate Dean for Academic Affairs in the College of Public Health. Another resource for students is the Office of the University Ombudsperson. If a complaint cannot be resolved at the departmental and/or collegiate level, students may file a formal complaint utilizing the procedure specified in Section II, Chapter 29.7 of the Operations Manual: http://opsmanual.uiowa.edu.

Accommodations for students with disabilities: If you have a diagnosed disability or any other condition that impacts your ability to complete the course requirements, please inform me as early in the semester as possible, preferably at least two weeks prior to the scheduled activity. For additional information, see https://sds.studentlife.uiowa.edu/students/apply.

Administrative home: This course is given by the College of Public Health. This means that class policies on matters such as requirements, grading, and sanctions for academic dishonesty are governed by the College of Public Health. Students wishing to add or drop this course after the official deadline must receive the approval of the Associate Dean for Academic Affairs in the College of Public Health. Details of the University policy of cross enrollments may be found at: https://www.provost.uiowa.edu/sites/provost.uiowa.edu/files/crossenroll.pdf.

University policies and resources: At the University of Iowa, we strive for a climate that encourages learning while also protecting the freedoms and rights of our students and faculty. Please review the following course policies, expectations, and resources at https://provost.uiowa.edu/student-course-policies. Visit the Dean of Students website for additional student policies and procedures.

- Absences for religious holy days
- Basic needs and support for students
- Classroom expectations
- Free speech and expression
- Mental health
- Nondiscrimination in the classroom
- Sexual harassment/misconduct and supportive measures
- Sharing of class recordings