

# Likelihood Theory and Extensions

University of Iowa

BIOS:7110

Fall 2022

**Instructor:** Prof. Patrick Breheny  
**Office:** N336 CPHB  
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**Office hours:** 12:30 p.m. - 1:30 p.m. Tuesday  
3:30 p.m. - 4:30 p.m. Thursday  
1:00 p.m. - 2:00 p.m. Friday  
Also, feel free to (1) knock if my door is ajar and  
(2) e-mail and set up an appointment. I'll be in my office  
during office hours, but also available via Zoom at these times

**Lecture:** 1:30 p.m - 3:20 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. Unfortunately, the book is out of print and difficult to obtain.
- *Theory of Point Estimation*, Second Edition (1998), LEHMANN EL and CASELLA G. Springer. A classic, and covers much of what we cover in the course, but not organized the same way and also covers many non-likelihood ideas (which is good in general, but less useful as a reference for this course specifically).

**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/f22>

**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.

**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 exams will take place during class time on the following dates:

- Exam 1    Wednesday, October 5
- Exam 2    Wednesday, November 9
- 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 will be based entirely on lecture material, so skipping lecture 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:** See <http://myweb.uiowa.edu/pbreheny/7110/f22/notes.html> for the schedule of topics.

**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](mailto: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 Ombuds-person. 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:** The University of Iowa is committed to providing an educational experience that is accessible to all students. If you have a diagnosed disability or any other condition that would impair your ability to complete the course requirements as stated above, please inform me as early in the semester as possible, preferably at least two weeks prior to the scheduled activity. Students needing accommodations must register with Student Disability Services, (SDS): <https://sds.studentlife.uiowa.edu/students/apply> to obtain a Letter of Accommodation (LOA). The office is located at 3015 Burge Hall (319.335.1462). Students with complaints about disability accommodation should notify Student Disability Services and may be counseled to file a complaint with the Office of Equal Opportunity and Diversity. Read more about Disability Resources at <https://diversity.uiowa.edu/disability-resources>.

**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>.

**Severe weather:** In severe weather, class members should seek appropriate shelter immediately, leaving the classroom if necessary. The class will continue if possible when the event is over. For more information on Hawk Alert and the siren warning system, visit <http://hawkalert.uiowa.edu>.

**Sexual harassment/misconduct:** The University of Iowa prohibits sexual misconduct, dating/domestic violence, and stalking in any form, including sexual assault or sexual harassment, and any form of nonconsensual sexual conduct. Students should be able to live, study, and work in an environment free from all forms of sexual misconduct, dating/domestic violence, and stalking. Incidents of sexual misconduct can be reported to the Office of Sexual Misconduct Response Coordinator (OSMRC) or to the Department of Public Safety (DPS). If you are uncertain if what you have experienced from a student is sexual misconduct, see Section IV, Chapter 2 of the operations manual. If you are uncertain if what you experienced from a faculty or staff member is sexual harassment, see Section II, Chapter 4 of the operations manual. Students impacted by a Title IX issue (sexual misconduct, dating/domestic violence, or stalking) may be eligible to request an academic accommodation. Contact the OSMRC for assistance, definitions, and the full University of Iowa policy. If you or someone you know experiences sexual assault, sexual harassment, dating/domestic violence, stalking, or any other behaviors prohibited under this policy, you are strongly encouraged to seek assistance and support. See below for link to confidential resources.

- <https://osmrc.uiowa.edu>
- <https://police.uiowa.edu>
- <https://opsmanual.uiowa.edu>
- <https://osmrc.uiowa.edu/victim-resources/confidential-support>

**Mental health:** Students are encouraged to be mindful of their mental health and seek help if they are feeling overwhelmed and/or incapable of meeting course expectations. For assistance with the class, students are encouraged to talk to me. For additional support and counseling, students are encouraged to contact The University Counseling Service (UCS) in 1950 University Capital Centre Suite or 3223 Westlawn South. Call 319.335.7294 to schedule appointments. Find out more about the UCS at <http://counseling.uiowa.edu>. After hours, call the Johnson County Crisis Line at 319.351.0140 or 911 if you are having a mental health emergency.

**Nondiscrimination in the Classroom and the College:** The University of Iowa prohibits discrimination in employment, educational programs, and activities on the basis of race, creed, color, religion, national origin, age, sex, pregnancy, disability, genetic information, status as a U.S. veteran, service in the U.S. military, sexual orientation, gender identity, associational preferences, or any other classification that deprives the person of consideration as an individual. The university also affirms its commitment to providing equal opportunities and equal access to university facilities. For additional information on nondiscrimination policies, contact the Director, Office of Institutional Equity,

the University of Iowa, 202 Jessup Hall, Iowa City, IA 52242-1316, 319-335-0705, <https://diversity.uiowa.edu/division/oie>, <mailto:oie-ui@uiowa.edu>. Students may share their pronouns and chosen/preferred names in MyUI, which is accessible to instructors and advisors.

**Free Expression:** The University of Iowa supports and upholds the First Amendment protection of freedom of speech and the principle of academic freedom in order to foster a learning environment where open inquiry and the vigorous debate of a diversity of ideas are encouraged. Students will not be penalized for the content or viewpoints of their speech as long as student expression in a class context is germane to the subject matter of the class and conveyed in an appropriate manner.

**Absences for Religious Holy Days:** The University is prepared to make reasonable accommodations for students whose religious holy days coincide with their classroom assignments, test schedules, and classroom attendance expectations. Students must notify their instructors in writing of any such Religious Holy Day conflicts or absences within the first few days of the semester or session, and no later than the third week of the semester. If the conflict or absence will occur within the first three weeks of the semester, the student should notify the instructor as soon as possible.