Syllabus
STAT310/MATH310: Introduction to Probability and Mathematical Statistics II
Fall 2024, 3 Credits

Description STAT310 (cross-listed as MATH310) introduces the principles and mathematical foundations of statistical reasoning. Topics include samples and populations, estimation, hypothesis testing, analysis of variance, regression, nonparametric procedures, Bayesian methods, and the delta method.

Prerequisites Students are required to have taken

- at least one of STAT/MATH 309, STAT 311, STAT/MATH 431, or MATH 531
- and at least one of STAT 240, STAT 301, STAT 302, STAT 324, STAT 371, or ECON 310.

If you have no met these prerequisites or are unsure about your background, please speak to the instructor.

Instructor
Keith Levin, `kdlevin@wisc.edu`
Office: Medical Sciences Center (MSC) 6170
Instructor office hours: Tuesdays 1pm-2pm, Thursdays 4pm-5pm in Medical Sciences Center 6190, or by appointment.[1]

Teaching Assistant
Haoran Xiong, `haoran.xiong@wisc.edu`
TA office hours: Mondays 4pm-5pm in Medical Sciences Center 1217C.

Meetings
Lecture: Tuesdays and Thursdays 2:30pm to 3:45pm in Educational Sciences 228
Discussion Section: Mondays 8:50am to 9:40am 494 Van Hise Hall; 9:55am to 10:45am in 114 School of Social Work Building; 12:05pm to 12:55pm in 494 Van Hise Hall

Course Credit Information
This class meets twice a week for 75 minutes (150 minutes per week) over the semester. The course carries the expectation that for each class period, students will work on course learning activities (reading, writing, problem sets, studying, etc) for 3 hours outside of the classroom.

Textbook, Readings & Online Resources
The vast majority of this course will use *Mathematical Statistics and Data Analysis* (3rd Edition, 2007) by John Rice. Occasional supplemental readings will be supplied throughout the semester. These supplemental materials will be made available on the course web page, `https://www.pages.stat.wisc.edu/~kdlevin/teaching/Fall2024/STAT310/`. It is highly recommended, though not required, that students complete assigned readings before lecture.

[1] Office hours are times that your instructor specifically dedicates to fielding student questions. If you are struggling with homework, have questions about the readings or lecture materials, or just want to learn more about statistics as a field and/or career path, this is the time and place to ask!

Course Objectives
This course is intended as an introduction to the mathematics underlying modern statistical methods. After completing this course:

(1) Students will have basic knowledge of the most common probability distributions in use in statistics, including the normal distribution, t-distribution, F-distribution, Bernoulli, binomial and gamma.
(2) Students will have basic knowledge of the law of large numbers and central limit theorem and will be able to use them to motivate the use of sample means as estimators of population-level quantities. Students will be able to compute a CLT-based confidence interval for the mean of a population and explain when it is or isn't appropriate.
(3) Students will be able to explain the basic problem of statistical estimation and implement least-squares, method-of-moments, and maximum-likelihood estimators of a parameter for common distributions.
(4) Students will have a basic understanding of hypothesis testing under the Neyman-Pearson framework. Students will be able to explain and implement Student's t-test, likelihood ratio tests and ANOVA, and will be able to explain when each of these tests is or isn't appropriate.
(5) Students will have a basic understanding of the theory underlying simple linear regression, including the sampling distribution of the least-squares estimates of the slope and intercept.

Course Topics

- **Probability Models and Experiments**. Sampling, laws of large numbers, central limit theorem.
- **Estimation**. Mean squared error, bias-variance decomposition, Rao-Blackwell, method of moments, maximum-likelihood estimation.
- **Testing and Confidence Intervals**. Neyman-Pearson framework, likelihood ratio tests, duality of testing and confidence intervals.
- **ANOVA**. One- and two-way layouts, multiple comparison.
- **Regression**. Simple linear regression, linear least squares.
- **Asymptotics**. Asymptotics of MLEs, delta method.

Grading and Homeworks
The course will include three exams (each worth 30% of your grade), as well as (approximately) weekly homeworks throughout the semester (10% of your grade). Exams are not cumulative, but they build on one another in a natural progression. Students may contest a grade on an assignment up to two (2) weeks from the day that an assignment's grades are released, after which grades may not be changed. In order to ensure on-time delivery of final grades to the registrar, grades on the final exam may be contested up to one week from the day final exam grades are released. Homeworks are due in class on the listed due date, before the end of lecture. Homework due dates are strict, and late homeworks will not be accepted, no exceptions. Of course, if dire circumstances arise (e.g., long-term illness that causes you to miss multiple weeks of lecture), please speak with me as promptly as possible so that we can make arrangements.
Letter grades will be determined at the end of the course after all exams and homeworks have been collected and graded. The following grading scheme is *approximate*. Adjustments (i.e., curving grades) may be made based on overall class performance. Should a curve become necessary, your grade *will not* be curved down.

$\geq 93\%$	A
88% to 93%	AB
83% to 88%	B
78% to 83%	BC
70% to 78%	C
60% to 70%	D
$< 60\%$	F

Key Dates
First lecture: Thursday, September 5, 2024
Exam 1: Thursday, October 17, in class.
Exam 2: Thursday, November 14, in class.
Exam 3: Tuesday, December 10, in class.

Email and Communication
I am committed to answering emails promptly, but please bear in mind that professors receive a lot of email, especially at the start and end of the semester. To ensure that your email is seen promptly, please include "STAT310" in the subject line. Generally speaking, my working hours are 9am to 6pm Monday through Friday. If you do not receive a reply to your email within one working day, it is likely that I missed it, and you should email again. I promise that I will not be upset by a "ping" message!
Note that while canvas has a messaging feature, I would encourage you to use email rather than this messaging tool: canvas notifications are often buried in a daily digest email, making individual messages easy to miss. Similarly, I would prefer that you not rely on the "homework comment" feature in canvas to ask questions about your homeworks or grades, as these messages are easy to miss among the many daily canvas notifications. Instead, if you have a question about a homework problem or a concern about a grade, please ask your question via email or at office hours. Of course, if you greatly prefer to use canvas to contact me, you are welcome to do so. Simply bear in mind that I am liable to miss your message and it may be several days before you receive a reply.

Ethics and Class Policies
Academic misconduct includes such actions as copying solutions (including code) from the web or from your fellow students, providing solutions to your fellow students, looking up solutions online, turning in assignments from other classes or previous iterations of this course, and hiring others to complete your work for you. You are welcome to discuss homeworks with your classmates, but the work that you turn in must be yours and yours alone, and you must disclose in your homework the names of those with whom you collaborated. Use of AI or other software outside of manners explicitly permitted in an assignment is not permitted. AI use will be treated as the equivalent of searching online or asking a friend for solutions.
From the Office of Student Conduct and Community Standards:

> [A]cademic misconduct is behavior that negatively impacts the integrity of the institution. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these previously listed acts are examples of misconduct which may result in disciplinary action.

See `https://conduct.students.wisc.edu/academic-misconduct/` for more information.
Violations of these or other university ethical standards surrounding academic honesty will be met with serious consequences and disciplinary action. At a minimum, cheating on an assignment will result in a 0 for that assignment and the incident will be reported to the appropriate office. Depending on the circumstances, an additional full letter grade may be deducted from the student's final grade in the course.

Accommodations for Students with Disabilities
The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform faculty [me] of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. Faculty [I], will work either directly with the student [you] or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA.