Syllabus
STAT310/MATH310: Introduction to Probability and Mathematical Statistics II
Fall 2023, 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 and Thursdays 11am to noon in MSC 6190, or by appointment.

Teaching Assistant
Hao Yan, hyan84@wisc.edu
TA office hours: 9:30am to 10:30am in MSC 1274.

Meetings
Lecture: Tuesdays and Thursdays 9:30am to 10:45am in Service Memorial Institute 331
Discussion Section: Mondays 8:50am to 9:40am 114 School of Social Work Building; 9:55am to 10:45am in 114 School of Social Work Building; 12:05pm to 12:55pm in 140 Bardeen

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 out 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/Fall2023/STAT310/. It is highly recommended, though not required, that students complete assigned readings before lecture.

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 cumulative, though each will focus on the most recent material more than on previous material. 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 rubric is *approximate*, and adjustments may be made based on overall class performance.

$\geq 93\%$	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 7, 20230
Exam 1: Thursday, October 19, in class.
Exam 2: Thursday, November 16, in class.

Final exam: Tuesday, December 12, in class.

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.

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. At the instructor's discretion, 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.