Linear Models

STATS 100C, Spring 2025

Department of Statistics and Data Science
University of California, Los Angeles

Course Instructor:
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Lectures:
Where: Kinsey Science Teaching Pavilion 1200B
When: Mondays/Wednesdays, 8:00am – 9:15am

Discussion sections:
Where: Bunche 3211

Course Description:

Theory of linear models, with emphasis on matrix approach to linear regression and connections to multivariate normal distribution. Topics include simple and multiple linear regression, model fitting, inference about parameters, testing general linear hypotheses, specification issues, model checking, and model selection.

Learning Outcomes:

By the end of the course, I aim for my students to take away the following outcomes:

- state and discuss the fundamental ideas behind the linear models
- be able to compare and contrast different modeling assumptions
- improve your fluency with linear algebra and be able to confidently work with linear models in more general linear algebraic formulations
- improve their ability to work as a team
- improve their ability to communicate mathematical and statistical concepts

Prerequisites:

This course is designed for students that have completed STATS 100B and have experience with linear algebra, at the level of completing Math 33A. Experience with R is helpful but not required.

Community Guidelines:

Our classroom is a community where everyone should feel valued, respected, and supported. As we engage with the challenging and exciting material of this course, it is essential to create a welcoming environment that encourages collaboration, curiosity, and growth. These guidelines are intended to help us achieve this goal:

- We can learn from everyone.
- Be patient and encouraging as we all navigate challenging material, offering and accepting constructive feedback.
- Uphold honesty and integrity in your work, collaborate appropriately, and respect others' contributions.
- Use constructive language and tone when discussing complex topics, whether in person or online.

Learning Management System:

We will be using BruinLearn to manage homework, lecture notes, and class discussions. For each assignment, we will have a discussion post where you can post your questions. Classmates are encouraged to answer questions. Rather than emailing questions, I encourage you to post your question to BruinLearn.

Attendance:

We will be using iClicker to manage attendance. Please use the following link to join: `https://join.iclicker.com/RHSJ`. Note that a minimum of a 70% attendance rate is needed to receive a full participation and attendance grade.

Organization of the Course:

The course will be organized as follows:

- **Lectures:** A majority of the course will consist of lectures, in which we cover the material corresponding to the core concepts described above. For a schedule of the topics we will cover, please see the end of this document.

  I strive for my course to be as engaging as possible for my students. I believe that part of creating an engaging classroom is for my students to feel comfortable actively participating in the course. To foster this, each class will have 1-2 activities, where we will work on a concrete problem either individually or in groups and we will come back to discuss it as a class. During class, students should be fully engaged, to the best of their ability.
- **Assignments:** There will be weekly on the lecture material and related core concepts. Assignments will be posted on BruinLearn. Each assignment is worth 100 points, but each problem may be worth a different amount of points. You are encouraged to *discuss and work on* assignments with other students, but you must prepare and submit your own assignment independently. A grace period of 24 hours will be allotted for late assignments, but outside of this interval, *late assignments will not be accepted*. At the end of the course, you may also choose to drop 1 assignment grade. Regrade requests will only be accepted up until 2 days after assignments are returned.
- **Exams:** There will be a midterm and final exam. Here are important dates:
  - **Midterm:** in-class on April 30th
  - **Final:** June 12, 2025, Thursday, 3pm–6pm
- **Grading:** The grading breakdown is as follows:

  30%: Homework assignments

  30%: Midterm

  35%: Final exam

  5%: Participation and attendance

If everyone does well, everyone will get a good grade. Grades *start from* an absolute scale (90% is an A, 80% is a B, etc.), but the cutoffs can be flexible to accommodate distributions that do not fit that very well. Both absolute scale (e.g., raw percentage) and relative standing (e.g., z-scores and percentiles) are considered when determining final grades. Plus and minus cutoffs will be determined at the end of the quarter.

Resources:

Lecture notes from each class will be posted on BruinLearn. The content from the course is inspired by several sources, including previous years' renditions of the course and related courses at other institutions. The following textbooks may be of interest.

- B. Abraham and J. Ledolter, Introduction to Regression Modeling, 2006
- J. J. Faraway, Practical Regression and Anova using R: Introduction to doing regression in R.
- G. Strang, The Four Fundamental Subspaces: 4 Lines: Short overview of linear algebra.

Schedule of topics:

Below is a tentative list of topics and dates for our lectures. Note that these are subject to change depending on the course's progression and student feedback.

Lecture	Date	Topic
1	3/31	Introduction + Linear Algebra review: vector spaces, basis, dimension
2	4/2	Linear Algebra review: image, column span, rank, inner product, projections
3	4/7	Linear Algebra review: spectral decomposition and positive semi-definite matrices
4	4/9	Random vectors and covariance matrices
5	4/14	Multivariate normal distribution
6	4/16	Linear models and maximum likelihood
7	4/21	Maximum likelihood estimation of parameters
8	4/23	Geometric interpretation of MLE
9	4/28	Statistical properties of estimator (projections)
10	4/30	**Midterm exam**
11	5/5	Hypothesis testing (HI) and confidence intervals (CI)
12	5/7	HT and CI for scalar parameters
13	5/12	CI for regression
14	5/14	General linear hypothesis
15	5/19	Comparing models; ANOVA; R^2 and overfitting
16	5/21	Quadratic forms and their distributions
17	5/26	No lecture - Memorial Day Holiday
18	5/28	Gauss-Markov theorem
19	6/2	Generalized least-squares (GLS) and multicolinearity
20	6/4	Model selection

University and Departmental Policies

Academic Integrity: As a student and member of the University community, you are here to get an education and are, therefore, expected to demonstrate integrity in your academic endeavors. All students must uphold University of California Standards of Student Conduct as administered by the Office of the Dean of Students. Students are subject to disciplinary action for several types of misconduct, including but not limited to: cheating, multiple submissions, plagiarism, prohibited collaboration, facilitating academic dishonesty, or knowingly furnishing false information. For more information about academic integrity, please go to `http://www.deanofstudents.ucla.edu/`.

In addition, each student is the sole owner of their own work and/or code and must NOT:

- Submit work that is not original.
- Publish solutions or code online.

- Post the course questions on forums other than the designated course discussion forum. This means students cannot post questions on places like Stack Overflow, Chegg, ChatGPT, or other similar places.
- Submit someone else's work, or a modification of that work, with or without that person's knowledge.
- Allow someone else to submit their work, or a modification of their work.
- Contract course work out to others.
- Plan or execute with another student some form of cheating during an exam.
- Make use of unauthorized material during an exam.

Zero Tolerance Policy: Any and all issues of potential academic dishonesty will be reported to the Dean of Students without warning after the end of the quarter.

Accessible Education: If you have a disability that will require academic accommodation, please contact the UCLA Center for Accessible Education (CAE). Please contact the CAE as soon as possible to allow for sufficient time to coordinate accommodations.

Title IX: Title IX prohibits gender discrimination, including sexual harassment, domestic and dating violence, sexual assault, and stalking. If you have experienced sexual harassment or sexual violence, you can receive confidential support and advocacy at the CARE Advocacy Office for Sexual and Gender-Based Violence, 1st Floor Wooden Center West, CAREadvocate@caps.ucla.edu, (310) 206-2465. In addition, Counseling and Psychological Services (CAPS) provides confidential counseling to all students and can be reached 24/7 at (310) 825-0768. You can also report sexual violence or sexual harassment directly to the University,Äôs Title IX Coordinator, 2241 Murphy Hall, titleix@conet.ucla.edu, (310) 206-3417. Reports to law enforcement can be made to UCPD at (310) 825-1491. Faculty and TAs are required under the UC Policy on Sexual Violence and Sexual Harassment to inform the Title IX Coordinator should they become aware that you or any other student has experienced sexual violence or sexual harassment.