STAT 151A: Linear Modeling: Theory and Applications

Lectures: Tuesday, Thursday 11:00-12:30pm
VLSB 2060

Lab: Fri 10 am – 12 pm, 204 Wheeler
Fri 12 – 2 pm, 220 Wheeler

Bring your laptop. If you do not have access to a laptop, you can borrow one from the University library. See https://studenttech.berkeley.edu/hardware-lending for more details. The Student Technology Equity Program is another good resource. Feel free to contact the instructor if you have concerns about your access to needed technology.

Instructor: Sam Pimentel
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Preferred pronouns: he/him
Office Hours: Tuesdays 1:30-3:30 PM
Remote: Zoom link.
In-person: 429 Evans (4 person limit in room at one time).

GSI: Fangzhou Su
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Preferred pronouns: he/him
Office Hours: TBD

Topics:

- Regression modeling
- Visualization and diagnostics
- Confidence Intervals
- Hypothesis Testing
- Generalized Linear Models
- Model selection and shrinkage
- Generalized linear models
- Nonlinear approaches

Textbook:

Applied Regression Analysis and Generalized Linear Models, J. Fox, 3rd Edition.

Selected readings from:

Statistical Models: Theory and Practice, D. Freedman. Available electronically via Berkeley Library.

An Introduction to Statistical Learning with Applications in R, G. James et al. Available online.

This is a working draft of the syllabus and is subject to change.

Learning goals

By the end of the semester you should be able to:

1. Understand the purposes and benefits of linear modeling in common applied contexts.
2. Design and conduct regression analyses in R for common data settings.
3. Interpret statistical models, estimates of model parameters, and inferences correctly.
4. Evaluate the quality of a regression analysis and suggest improvements.
5. Communicate the process and results of a data analysis simply and clearly for a broad audience, using well-organized prose and code and effective data visualizations.

Prerequisites:

STAT 135. STAT 133 is strongly recommended. STAT 135 implies other prerequisite courses (**STAT 134 and its prerequisites**). In particular, you must have had linear algebra, so you should be familiar with basic matrix operations, vector subspaces and projections, rank and invertibility of matrices, and quadratic forms. This will form a core component of the course and is a real requirement. We also assume **familiarity with R**, and unless otherwise noted assignments involving computing must be completed in that language.

Lecture:

Lectures will cover core theory and concepts, with supporting data analysis examples. The current plan is to record lectures using a built-in classroom camera and post the videos for asynchronous viewing on bCourses. However, I cannot yet vouch for the quality of the video capture and **strongly recommend in-person attendance**. To get the full benefit of lecture, it is best to read the supporting material ahead of time. I encourage active engagement and discussion during lectures, and will frequently pose questions and call on students to answer. When slides or R code are shown in class, they will be posted online after class. However, many lectures will not have associated slides.

Lab:

Lab time will be spent working on practice problems and data analysis in R, and you should plan to bring your laptop. You may attend a lab for which you are not enrolled (physical space permitting). Slides and audio for labs will be recorded and posted for asynchronous viewing, but in-person attendance is strongly recommended.

Assessment:

Homework

We anticipate giving five homework assignments during the semester. Homework will be posted to bCourses, and will generally be due 2 weeks later on Thursdays. All homework is due **via Gradescope** (linked through bCourses) unless otherwise noted. Homework will be a combination of analytical and computational exercises done "by hand" and data analysis using the computer.

Exams

A take-home midterm and a proctored final exam will be given. The completion period for the take-home midterm will run from **noon PDT Wednesday October 20th to 11:59 PM PDT Saturday October 23rd** . This will be a data analysis task in R to be conducted independently by each student and submitted via Gradescope. The final exam time and day are Wednesday December 15, 8:00 AM - 11:00 AM.

Final project

Students will work in groups of three to carry out the final project, a regression analysis on a research question of your choice. A written project proposal will be due by **11:59 PM PST on Thursday November 4th**, and the final project report will be due in Gradescope by **11:59 AM PST on Friday, December 17** (finals week).

Lab participation:

Students will submit lab worksheets **each Friday by 11:59 PM PST** to Gradescope. These will be graded for completion and effort as a measure of course participation; in selected weeks these assignments may also be graded for correctness.

Overall score

Your letter grade for the course will be based on the total points for all work in the semester, as follows:

- Homework (each assignment weighted equally): 35%
- Take-home midterm: 10%
- Final exam: 15%
- Group project (including proposal): 30%
- Lab participation: 10%

Grades will not be curved. Students scoring 90% or above overall will receive letter grades in the A-range, students scoring 75%-90% will receive letter grades in the B-range, and students scoring 60%-75% will receive letter grades in the C-range.

Online Resources

bCourses

Homework assignments, grades, and material from lecture (where applicable) will be posted here. I will also make course announcements through bCourses.

Piazza

I have created a Piazza site for this course, which you can access through the link in bCourses. This is an online forum to ask questions to fellow students and course staff. Involvement in the discussion on Piazza will factor into your course participation score.

Gradescope

Homework assignments, take-home exams, and regrade requests (see Policies section below) will be submitted through Gradescope, which you can also access through the link in bCourses.

Policies

Possibility of revisions to course policies

All course policies, including assessment, are subject to change during the course of the semester in response to unforeseen events including but not limited to developments in the COVID-19 pandemic, power outages, forest fires, and medical emergencies among members of the course staff.

Late Assignments

All students will have 5 late days that they may use for turning in homework after the due date. This will take the place of any extensions due to sickness or conflicts, unless there are extenuating circumstances, so use them wisely. To use a late day, **you must submit a Google Form at https://forms.gle/eSetZmHbKqtQTYzd7 requesting a late day before the homework is due**, or you risk receiving a large penalty or a zero. Late day requests by email will not be answered. Late days cannot be used for the group project or the midterm.

Regrade requests

Regrade requests on an assignment are **due within one week of the release of the graded assignments and the solutions** (if applicable). Regrade requests should be submitted through Gradescope. In writing a regrade request, please be specific about the nature and exact location of the error you feel the grader has made, with reference to the solutions if available.

Academic Honesty Policy

The student community at UC Berkeley has adopted the following Honor Code: *"As a member of the UC Berkeley community, I act with honesty, integrity, and respect for others."* My expectation is that you will adhere to this code. Beyond the importance of respecting your fellow students, acting with integrity in completing course assignments helps ensure that they achieve their purpose, which is to help you learn and develop valuable statistical understanding and skills.

- Homework must be done independently. If you get stuck or want to explore alternative approaches, feel free to discuss issues with students or course staff (including on Piazza); however, you may not do the homework jointly, nor may you ask for or share complete code or solutions. Sharing solutions or obtaining and/or using solutions from previous years or from the Internet, if such are available, is considered cheating.
- During the take-home midterm, you must not consult with any other person besides the course staff, although you will be allowed free use of books, class notes, and online resources.
- On all written assignments, including the homework, you should include a section listing all the sources you drew on in producing your answers; on the homework, you should also list the names of other students with whom you consulted.

Anyone caught cheating will be given a score of zero (0) on the assignment/exam and will be reported to the University's Office of Student Conduct.

Email

1) If you wish for your email to make it into my inbox, the subject of your email must contain the text "**151A**."
2) Neither I (nor the GSIs) explain course material over email and will not respond to emails with such requests. Please use Piazza, office hours, discussion section, or GSI's office hours (or schedule another time to meet if you have irreconcilable conflicts with the office hours).
3) I respond to email regarding the class roughly once a day, and rarely during the weekend.

Inclusivity and Accommodation

My hope is to establish a learning environment in this course that welcomes diversity of thought, perspective, and experience, and to be respectful of your individual identity as a student. I am happy to use your preferred name and/or personal pronoun. If you feel uncomfortable as a result of anything that is said in class, or if you feel that your performance in the course is being impacted by experiences outside of class, please do not hesitate to reach out to me about your concerns.

In addition, if you need accommodations for any physical, psychological, or learning disability, please speak to me after class or during office hours. Please note that you must make arrangements in a timely manner through DSP so that I can make the appropriate accommodations.

Acknowledgments

Most of the materials used in this course, including this syllabus, are close adaptations from materials originally created or compiled by Profs. Deborah Nolan and Aditya Guntuboyina and generously provided for the current semester. In writing this syllabus I also adapted content from Prof. Chris Paciorek and from Prof. Monica Linden of Brown University.

Anticipated Course Schedule

Week	Topics	Assignments Due & Exams	Assigned Reading (from Fox unless otherwise noted)
Aug 30	Transformation and simple regression		Ch 3, 4.1-4.3, 4.5 5.1 Freedman Ch. 1
Sep 6	Multiple regression, geometric perspective		5.2, 10.1-10.2 Freedman 2.3-2.4
Sep 13	Probability model for multiple regression, collinearity	HW #1 due Tuesday	10.3
Sep 20	Statistical inference		6.1-6.2
Sep 27	Categorical variables as predictors	HW #2 due Tuesday	9.2 (skip 9.2.1), 9.3.1-2, 9.4.1-3
Oct 4	ANOVA	Form project groups by Thursday	Ch. 7 (skip 7.2.1), 9.1, 9.2.1, 10.4
Oct 11	Bootstrap	HW #3 due Thursday	21.1- 21.4 (skip 21.2.3), studentized bootstrap notes
Oct 18	Review and take-home midterm	Midterm (Wednesday-Saturday)	
Oct 25	Influential Observations, Diagnostics, Interpreting Models Model Selection		11.1—11.5 (skip 11.3.2), 11.7-11.8.2, 12.1-12.2 (skip 12.1.1, 12.2.2) 13.2.2, 22.1 (skip "Closer look at AIC," "Closer Look at BIC")
Nov 1	Shrinkage methods	Project proposal due Thursday	13.2.3 James et al. 6.2 (skip "Bayesian interpretation")
Nov 8	Logistic Regression		14.1
Nov 15	Binomial logistic model, polytomous outcomes, GLMs	HW#4 due Thursday	14.2,1 4.3 (skip p. 396)
Nov 22	Thanksgiving Break (no lecture on Thursday)		
Nov 29	Nonlinear regression, regression trees	HW #5 due Thursday	James et al. 7.1-7.4, 7.7, 8.1
Dec 6	RRR week		
Dec 13		Final exam: Wed Dec 15, 8:00-11:00 AM PST. Final projects due: 11:59 AM, Friday Dec 17	