LDST 249: Quantitative Social Science

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University of Richmond

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Classroom: Jepson Hall 102 Class Time: Tu/Th 3:00 - 4:15 PM
Office Hours: Fr 3:00 - 5:00 PM and by appointment Office: Jepson Hall 233

Course Description

In God we trust. All others must bring data.

W. Edwards Deming

We live in an era when many important decisions are supposedly data-driven. We are frequently exhorted to "follow the science." But we also live in an age of disinformation, conspiracy theorizing, and general confusion about what constitutes truth. Students and practicioners of leadership cannot hide from these phenomena, they have to upgrade their skillsets to face them. In other words, we are left with only one option—to learn how to think analytically about data and statistics. This is precisely what this course is designed to do. It will provide an introduction to causal inference, rudimentary data visualization, probability theory, and estimation. The emphasis will be on hands-on data analysis and practical application of basic quantitative methods to real-world problems.

Course Goals

- Students will become intelligent and critical consumers of information based on statistics, both in academic and popular literature.
- Students will be able to implement basic statistical methods and interpret the output they produce.

- Students will be able to use these methods in answering questions that are pertinent to their own interests and research.
- Students will become familiar with common evidentiary standards in academic literature in the social sciences.
- Students will gain basic familiarity with coding in R and they will learn how to communicate their findings using LaTeX syntax in R Markdown.
- Students will be able to understand, explain, and correctly apply the following concepts: *alternative hypothesis, average causal effect, average treatment effect, Bayesian interpretation of probability, Bernoulli distribution, binary variables, categorical variables, causal inference, central limit theorem, coefficient of determination, confidence interval, confounders, correlation coefficient, cross-tabulations, dataframes, descriptive statistics, dependent variable, difference-in-means estimator, experiments, external validity, factor variables, frequentist interpretation of probability, histograms, hypothesis testing, independent variable, intercept, internal validity, law of large numbers, least squares, linear model, linear regression, logarithmic transformation, mean, median, normal distribution, null hypothesis, observational data, omitted variables, p-value, parameter, population mean, population variance, post-treatment variables, potential outcome, random sampling, randomized control trials, residuals, sample, scientific significance, slope, standard deviation, t-statistic, unit of measurement, unit of observation, z-score.*

My Teaching Philosophy

When teaching in the undergraduate classroom, I proceed with three overarching goals in mind. The first and most fundamental is to cultivate a life-long passion for learning in my students. My philosophy is that a great teacher lights a spark of curiosity that is innate to all human beings. The second objective of my approach to undergraduate teaching is to give students the tools and cognitive habits that allow them to critically evaluate arguments and consider alternative explanations to claims they encounter. Finally, I seek to equip students with an ability to articulate their own ideas in clear language, whether spoken or written. Together, these principles coalesce to prepare my students for a life of curiosity, respectful yet critical appraisal of differing views, and a measure of comfort with sharing and defending their own ideas.

Course Materials

There is one required textbook for this class:

- Llaudet, Elena & Kosuke Imai. 2022. *Data Analysis for Social Science.* Princeton, NJ: Princeton University Press.

Much of what we will do during class will be based on this textbook and students are therefore required to purchase it. I will make a few additional course materials available via clickable links in this syllabus. Students should also download the Top Hat app. It will be used for interactive tasks during class time.

Assignments and Grading

In-Class Problem Sets (20%)

There will be a total of six in-class problems sets. Each in-class problem set will be due at the end of class on Thursday. See section Important Dates for a list of specific dates. The problem sets typically consist of hands-on data analysis tasks. Each problem set is meant to familiarize students with essential concepts that are covered in a given week. Each student is required to submit his/her own answers, including `R` code. Late assignments will not be accepted. While students may use the internet for in-class problem sets, the use of generative AI is explicitly prohibited and will be treated as a serious violation of the honor pledge.

Take-Home Problem Sets (20%)

There will be a total of four take-home problems sets. Each take-home problem set will be due on Sunday at 11:59 PM. See section Important Dates for a list of specific due dates. The problem sets typically consist of theoretical and conceptual questions as well as a hands-on data analysis portion. Each take-home problem set is meant to familiarize students with essential concepts and methods that will be needed for a successful completion of the final project. Each student is required to submit his/her own answers, including `R` code. This means that no two students are likely to submit identical documents as their final product. Late assignments will not be accepted. Students may use generative AI for take-home problem sets.

Midterm Exam (20%)

Students will complete one in-person midterm exam on March 7. The exam will draw from the assigned readings, lectures, and class discussions through week 7. The exam will focus on theoretical and conceptual questions but it will not include any coding component. The exam will be closed-book but students may bring one sheet of paper (8.5 x 11 inches) with handwritten notes to the exam (notes can cover both sides). Students will have the entire class period to write the exam.

Final Exam (20%)

Students will complete one in-person final exam (date TBD). The exam will draw from the assigned readings, lectures, and class discussions through week 14. The exam will focus on theoretical and conceptual questions but it will not include any coding component. Even though the exam will focus on material covered after the midterm exam, much of that material cannot be understood without grasping the foundational concepts from weeks 1 through 7. The exam will be closed-book but students may bring one sheet of paper (8.5 x 11 inches) with handwritten notes to the exam (notes can cover both sides). Students will have the entire class period to write the exam.

Final Project (20%)

Students will complete a final project that will be due on May 3. The goal of the project will be to develop and execute an abbreviated version of a quantitative research study. This will include

specifying the research question, formulating hypotheses, finding the necessary data, identifying appropriate quantitative methods, and reporting findings. A number of the problem sets are tailored to help students prepare for the final project. The output for the project will consist of a written report (10 double-spaced pages maximum) and an appendix with `R` code (which does not count towards the page limit). I will circulate more details about the final project in the second half of the semester.

Letter grades for student performance will be assigned based on the following percentages:

A	93-100	**B-**	80-82	**D+**	67-69
A-	90-92	**C+**	77-79	**D**	60-66
B+	87-89	**C**	73-76	**F**	0-60
B	83-86	**C-**	70-72		

Important Dates

1. **Problem set due dates**: Thursdays at 4:15 PM (in-class). Sundays at 11:59 PM (take-home).
    - January 25 (in-class)
    - February 1 (in-class)
    - February 8 (in-class)
    - February 15 (in-class)
    - February 22 (in-class)
    - February 29 (in-class)
    - March 24 (take-home)
    - March 31 (take-home)
    - April 7 (take-home)
    - April 14 (take-home)
2. **Midterm exam**: March 7
3. **Final exam**: TBD
4. **Final project due date**: May 3

Course Policies

Attendance Policy

Attendance is both expected and absolutely crucial for student success in this course. Many of the assignments (particularly the midterm and final exams) will be partially based on lectures and in-class discussions and students will miss important information if they choose not to attend regularly. It will be hard for students who do not come to class to pass the course. Students can expect me to be prepared and organized, and to deliver lectures and answer questions. In turn, I expect students to have read *all* of the assigned readings and to come with questions and requests for clarification.

During Class

I understand that the electronic recording of notes and live coding will be important for class and so computers will be allowed in class. Students should refrain from using computers for anything but activities related to the class. Phones are prohibited unless they are used for recording of responses to questions posed via the Top Hat app. Eating and drinking are allowed in class but students are asked to ensure that it does not interfere with their learning or the class in general. Students should try not to eat their lunch in class as classes are typically active and require full attention.

Re-grading

I will do my best to grade problem sets and exams fairly, accurately, and quickly. However, mistakes can occur. If students have a concern about their grade, they can write a description of the mistake as they see it and and send it to me within one week of receiving their grade. Please note that the entire exam or problem set will be re-graded, and it is thus possible that students' final grade will go up or down.

Make-Up Exams and Late Assignments

The exams must be taken when scheduled except for the following reasons:

- documented attendance at a university-sanctioned event
- death in the family
- observation of a religious holiday
- illness or injury

If an exam is missed due to an *excused* absence, a make-up exam will be scheduled in consultation with me. It is the student's responsibility to initiate this process and to provide the necessary documentation. Exams missed due to an *unexcused* absence will receive a grade of 0 and cannot be made up. Unexcused late final projects will be penalized by a full letter grade for each 24-hour period by which the assignment is late. Late submissions for problem sets will not be accepted.

Emails

The classroom is the best place to raise questions that are relevant to every student in the class. Office hours should be dedicated to discussing deeper questions related to class material as well as assignments. While I welcome communication via email, students should be sure to exhaust all other sources (especially the syllabus) that might help answer their questions and consider direct emails as a last resort. Students should include the title of the class in the subject line when writing an email.

Academic Integrity

The Jepson School supports the provisions of the Honor System. The shortened version of the honor pledge is: "I pledge that I have neither received nor given unauthorized assistance during the completion of this work." Integrity is expected of every student in all academic work. Plagiarism, which means intentionally or knowingly representing the words or ideas of another as one's own, is a serious and egregious violation and the perpetrator will be subject to any one or a combination of the following sections: report to the Honor Council, loss of credit for the work involved; reduction in grade; or a failing grade in the course. Visit studentdevelopment.richmond.edu/student-handbook/honor/pdfs/statutes.pdf for more information.

Generative Artificial Intelligence (AI) Policy

Generative artificial intelligence (AI) refers to quickly evolving tools that are capable of generating text, images, or other media. This type of AI can be immensely useful for coding and for that reason, its use is allowed in this course. That said, students have to disclose their use of AI and indicate how they used it in preparation of specific assignments. Failure to disclose the use of AI will be treated as violation of the Honor Code.

Religious Observance

Students should notify me within the first two weeks of classes if they will need accommodations for religious observance. Visit registrar.richmond.edu/services/policies/religious-observances.html for more information.

Disability Accommodations

Students with a Disability Accommodation Notice should let me know as soon as possible so that we may discuss arrangements for assignments and participation. Visit disability.richmond.edu for more information.

Additional Academic Support

Academic Skills Center

Academic coaches assist students in assessing and developing their academic and life-skills (e.g., critical reading and thinking, information conceptualization, concentration, test preparation, time management, stress management, etc.). Peer tutors offer assistance in specific subject areas (e.g., calculus, chemistry, accounting, etc.) and will be available for appointments in-person and virtually. Peer tutors are listed on the ASC website. Email Roger Mancastroppa (`rmancast@richmond.edu`) and Hope Walton (`hwalton@richmond.edu`) for coaching appointments in academic and life skills. Visit asc.richmond.edu for more information.

Boatwright Library Research Librarians

Research librarians help students with all steps of their research, from identifying or narrowing a topic, to locating, accessing, evaluating, and citing information resources. Librarians support students in their classes across the curriculum and provide individual appointments, class library instruction, tutorials, and research guides. Students can contact an individual librarian (library.richmond.edu/help/liaison-librarians.html) or ask a librarian for help via email (`library@richmond.edu`), text (804-277-9ASK), or chat (library.richmond.edu/chat.html). Visit library.richmond.edu/help/ask for more information.

Career Services

Career Services can assist you in exploring your interests and abilities, choosing a major or course of study, connecting with internships and jobs, and investigating graduate and professional school options. We encourage you to schedule an appointment with a career advisor early in your time at UR. Visit careerservices.richmond.edu for more information.

Counseling and Psychological Services

Students may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. Counseling and Psychological Services assists currently enrolled, full-time, degree-seeking students in improving their mental health and well-being, and in handling challenges that may impede their growth and development. Services include brief consultations, short-term counseling and psychotherapy, skills-building classes, crisis intervention, psychiatric consultation, and related services. Visit caps.richmond.edu for more information.

Quantitative Resource Center

The Quantitative Resource Center provides services related to quantitative and computational learning across the curriculum through tutoring, consultation, and training. The Center offers individual tutoring, drop-in tutoring, workshop sessions, as well as statistical consulting. Visit provost.richmond.edu/academic-initiatives/qrc.html for more information.

Speech Center

The Speech Center assists with preparation and practice in the pursuit of excellence in public expression. Recording, playback, coaching and critique sessions offered by teams of student consultants trained to assist in developing ideas, arranging key points for more effective organization, improving style and delivery, and handling multimedia aids for individual and group presentations. Remote practice sessions can be arranged; we look forward to meeting your public speaking needs. Visit speech.richmond.edu for more information.

Writing Center

The Writing Center assists writers at all levels of experience, across all majors. Students can schedule appointments with trained writing consultants who offer friendly critiques of written work. Visit writing.richmond.edu for more information.

How to Do Well in This Class

1. Do all readings ahead of time and take detailed notes.
2. Attend all class sessions and take detailed notes.
3. Class time is your chance to ask questions when you are confused about something. Use it.
4. Start take-home problem sets right after Tuesday's class.
5. Do not fall behind. This course is cumulative and getting lost early on will cost you later. Ask for help when you need it.

Course Schedule

Week 1 (January 16 & 18): Introduction

TUESDAY: **Introduction to the Course and Required Software**

- familiarize yourself with the syllabus
- bring your laptop

THURSDAY: **A Refresher on the Scientific Method**

- Pinker, Steven. 2021. *Rationality.* New York, NY: Viking. **Chapter 1**.
- "Karl Popper, Science, and Pseudoscience." YouTube video.

Week 2 (January 23 & 25): Basic Concepts & Terminology

TUESDAY: **Variables and Measurement in Social Science**

- Llaudet, Elena & Kosuke Imai. 2022. *Data Analysis for Social Science.* Princeton, NJ: Princeton University Press. **Chapter 1**.
- "Variables and Types of Variables." YouTube video.

THURSDAY: **Introduction to** `R`

- Llaudet, Elena & Kosuke Imai. 2022. *Data Analysis for Social Science.* Princeton, NJ: Princeton University Press. **Chapter 1**.

Week 3 (January 30 & February 1): The Potential Outcomes Framework

TUESDAY: **Randomized Experiments as the Gold Standard**

- Llaudet, Elena & Kosuke Imai. 2022. *Data Analysis for Social Science.* Princeton, NJ: Princeton University Press. **Chapter 2**.
- "What is randomisation?" YouTube video.

THURSDAY: **Applied Example in** `R`**: Project STAR and the Difference-in-Means Estimator**

- Llaudet, Elena & Kosuke Imai. 2022. *Data Analysis for Social Science.* Princeton, NJ: Princeton University Press. **Chapter 2**.

Week 4 (February 6 & 8): Descriptive Statistics

TUESDAY: **Mean, Mode, Median, Variance, Standard Deviation**

- Llaudet, Elena & Kosuke Imai. 2022. *Data Analysis for Social Science.* Princeton, NJ: Princeton University Press. **pp. 51-76**.
- "Standard deviation." YouTube video.

THURSDAY: **Applied Example in R: Frequency Tables**

- Llaudet, Elena & Kosuke Imai. 2022. *Data Analysis for Social Science.* Princeton, NJ: Princeton University Press. **pp. 51-76**.

Week 5 (February 13 & 15): Rudimentary Data Visualization

TUESDAY: **Histograms, Scatter Plots, Correlation**

- Llaudet, Elena & Kosuke Imai. 2022. *Data Analysis for Social Science.* Princeton, NJ: Princeton University Press. **pp. 76-97**.
- Bergstrom, Carl T. & Jevin D. West. 2021. *Calling Bullshit.* New York, NY: Random House. **Chapter 7**.

THURSDAY: **Applied Example in R: Visualizing the Brexit Vote**

- Llaudet, Elena & Kosuke Imai. 2022. *Data Analysis for Social Science.* Princeton, NJ: Princeton University Press. **pp. 76-97**.

Week 6 (February 20 & 22): The Linear Regression Model

TUESDAY: **Ordinary Least Squares (OLS) Regression**

- Llaudet, Elena & Kosuke Imai. 2022. *Data Analysis for Social Science.* Princeton, NJ: Princeton University Press. **Chapter 4**.
- "Introduction to Ordinary Least Squares With Examples." YouTube video.

THURSDAY: **Applied Example in R: Predicting GDP**

- Llaudet, Elena & Kosuke Imai. 2022. *Data Analysis for Social Science.* Princeton, NJ: Princeton University Press. **Chapter 4**.

Week 7 (February 27 & 29): Interpretation and Model Fit

TUESDAY: **Interpreting OLS Output, Calculating Coefficient of Determination**

- Kumar, Anshul. 2021. *Advanced Quantitative Methods and Measurement.* Chapter 8.

THURSDAY: **Applied Example in R: Displacement and Weight in Cars**

- Kumar, Anshul. 2021. *Advanced Quantitative Methods and Measurement.* Chapter 8.

Week 8 (March 5 & 7): Midterm Review and Exam

TUESDAY: **Midterm Exam Review**

We will review concepts introduced in the first half of the course and thus facilitate preparation for the midterm exam. Students should come with questions and requests for clarification.

THURSDAY: **Midterm Exam**

Week 9 (March 12 & 14): Spring Break

Week 10 (March 19 & 21): Causal Effects with Observational Data

TUESDAY: **Dealing with Confounding Variables**

- Llaudet, Elena & Kosuke Imai. 2022. *Data Analysis for Social Science.* Princeton, NJ: Princeton University Press. **Chapter 5**.
- "Endogeneity: An inconvenient truth." YouTube video.

THURSDAY: **Applied Example in R: The Effect of Russian TV on Voting Behavior**

- Llaudet, Elena & Kosuke Imai. 2022. *Data Analysis for Social Science.* Princeton, NJ: Princeton University Press. **Chapter 5**.
- Pinker, Steven. 2021. *Rationality.* New York, NY: Viking. **Chapter 9**.

Week 11 (March 26 & 28): Probability I

TUESDAY: **Basics and Probability Distributions**

- Llaudet, Elena & Kosuke Imai. 2022. *Data Analysis for Social Science.* Princeton, NJ: Princeton University Press. **pp. 162-179**.
- "Are you Bayesian or Frequentist?" YouTube video.

THURSDAY: **Applied Example in R: TBD**

- Llaudet, Elena & Kosuke Imai. 2022. *Data Analysis for Social Science.* Princeton, NJ: Princeton University Press. **pp. 162-179**.
- "The Normal Distribution and the 68-95-99.7 Rule." YouTube video.

Week 12 (April 2 & 4): Probability II

TUESDAY: **Population Parameters vs. Sample Statistics**

- Llaudet, Elena & Kosuke Imai. 2022. *Data Analysis for Social Science.* Princeton, NJ: Princeton University Press. **pp. 179-195**.

THURSDAY: **Applied Example in `R`: TBD**

- Llaudet, Elena & Kosuke Imai. 2022. *Data Analysis for Social Science.* Princeton, NJ: Princeton University Press. **pp. 179-195**.

Week 13 (April 9 & 11): Quantifying Uncertainty I

TUESDAY: **Confidence Intervals**

- Llaudet, Elena & Kosuke Imai. 2022. *Data Analysis for Social Science.* Princeton, NJ: Princeton University Press. **pp. 196-211**.
- "What are confidence intervals?" YouTube video.

THURSDAY: **Applied Example in `R`: TBD**

- Llaudet, Elena & Kosuke Imai. 2022. *Data Analysis for Social Science.* Princeton, NJ: Princeton University Press. **pp. 196-211**.

Week 14 (April 16 & 18): Quantifying Uncertainty II

TUESDAY: **Statistical Significance and Hypothesis Testing**

- Llaudet, Elena & Kosuke Imai. 2022. *Data Analysis for Social Science.* Princeton, NJ: Princeton University Press. **pp. 211-229**.
- "P-values and significance tests." YouTube video.

THURSDAY: **Bonus Topic: Logistic Regression in `R`**

- Kumar, Anshul. 2021. *Advanced Quantitative Methods and Measurement.* Chapter 11.1 (stop at 11.2).

Week 15 (April 23 & 25): Final Project Presentations

TUESDAY: **Final Project Presentations I**

THURSDAY: **Final Project Presentations II**