POLS 603	Spring 2026
	TR 11:40am – 12:55pm
Quantitative Political Analysis II	Allen 1005

Professor:
Casey Crisman-Cox
Allen 3054
Office Hours: T 2-3pm
or by appointment
c.crisman-cox@tamu.edu

Teaching Assistants:
Reshi Rajan
Allen 3067
Office Hours: T & R 3–4pm

rrajan@tamu.edu

Purpose, objectives, and prerequisites

Maximum likelihood estimation and the generalized linear model are important tools for any applied researcher. They provides a broad framework for estimating the parameters or forming predictions in many different settings. Some common applications include:

1. Estimating marginal effects in cases where a particular parametric model seems reasonable
2. Predicting the probability of an event or treatment status (e.g., propensity scores)
3. Model-based inference (structural models) where we want to estimate causal effects based on an underlying theoretical model

We'll see that sometimes the same estimator (e.g., logistic regression) can be used for all three of these cases but what we take from the exercise is fundamentally different.

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

1. Understand and explain the statistical theory and concepts that underpin maximum likelihood estimator and its applications, particularly generalized linear models (GLM),
2. Use the R programming language to conduct applied data analysis and present your results,

3. Be comfortable implementing and interpreting maximum likelihood estimators

The only pre-requisite for this course is POLS 602. Some basic familiarity with game theory (e.g., from POLS 601) may helpful.

Catalog description

Quantitative Political Analysis II. Credit 3. Introduction to advanced applications of quantitative analysis in political science; critical evaluation of the use of several advanced statistical techniques in political analysis. Prerequisite: POLS 602 or equivalent.

Textbooks and readings

We'll be using selections from a few different books:

- Greene, William. *Econometric Analysis*. Any edition. Readings below refer to sections in the 8th edition.
- DeGroot, Morris H. and Mark J. Schervish. *Probability and Statistics*. Any edition. Readings below refer to sections in the 4th edition.
- Kochenderfer, Mykel J. and Tim W. Wheeler. *Algorithms for Optimization*. 2nd edition. Available at: `https://algorithmsbook.com/optimization/files/optimization.pdf`
- Little, Roderick J. A. and Donald Rubin. *Statistical Analysis with Missing Data*. Any edition. Readings below refer to the 2nd edition. `https://onlinelibrary-wiley-com.srv-proxy2.library.tamu.edu/doi/epdf/10.1002/9781119013563`
- Hortaçsu, Ali and Joonwi Joo. *Structural Econometric Modeling in Industrial Organization and Quantitative Marketing: Theory and Applications*. `https://ebookcentral.proquest.com/lib/tamucs/detail.action?docID=30670766`

Of these, you should buy (at least) Greene. Selections of other books will be provided on the course website. It may also behoove you to find a simple book (or online resource) for R programming. My `website` provides notes that I have used for graduate students in the past, you may or may not find them helpful.

Software

We will make frequent use of the R programming language this semester. I will also introduce you to the symbolic math package `sympy` for Python. It is not required that you use it, but you may find it helpful for algebra and calculus tasks.

Course website

In an effort to teach you something else worth while we use github for the course page. All materials will be available for download here: `https://github.com/ccrismancox/POLS603_Spring2026`.

Course Requirements

Evaluation is based on

- Homeworks (1/3 of your final grade): Weekly-ish equally weighted problem sets will be distributed throughout the semester. Answers to problem set questions will be typeset and written in complete sentences. Handwritten problem sets will not be accepted. Answers that do not show work or describe your process will be marked as zero. All code files should be included with your problem set submission and should run completely without trouble. I prefer separate code and write up files over any kind of markdown, but this is not a requirement.

  All problem sets and exams will be submitted using GitHub Classrooms. By the next class, please register a github account (I recommend getting an official, but free, academic account) and send your username to me. A PDF and video on the course website describe how to get setup and submit assignments.

- Exams (1/3 of your final grade): Two 72 take-home exams (a midterm and a final) will be given. We will negotiate on these dates when the time comes.

- Research paper (1/3 of your final grade). A short (less than 15 double-spaced pages) research paper. The paper can be on any topic and I encourage double-dipping from another class (be sure to get the consent of the other professor(s)). The paper should show me that

you can use at least *some* of the content you learn this semester. I mean this very loosely. Ideally, this will be something you eventually turn into an article, but not every idea makes it that far. A short draft/proposal will be due before Spring Break. The final draft is due at the end of the semester.

Final grades will follow the standard 10 point increments [90,100] is an A, [80, 90) is a B, [70, 80) is a C, and so on.

Academic Integrity

"An Aggie does not lie, cheat or steal, or tolerate those who do."

"Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one's work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case" (Section 20.1.2.3, Student Rule 20, `https://aggiehonor.tamu.edu/rules-procedures/sr20.html`).

You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at `https://aggiehonor.tamu.edu/`.

AI statement

AI can be very useful as a study aid, particularly if the instructors are unavailable or if you want a different perspective. I encourage you to use ChatGPT or other similar forms of AI for asking questions like:

1. How to do [X] in R? (e.g., how to I create a histrogram in R?)
2. What is [X]? (e.g., what does bias mean in statistics?)

Obviously, you should **not** use generated AI output (either verbatim or with minimal rewrites) for your write ups and explanations. You *can* use AI to help you understand concepts that you can rewrite in your own words. Note, that if code output works for you and is correct, you don't need to rewrite that; this goes with other code you may find online (e.g., from stackoverflow), but you *do* need to explain what it does in your code comments.

If your TA suspects that you have inappropriately claimed AI output as your own or out-right plagiarized then I have little choice but to involve

the Aggie Honor System Office. So please, be smart and be careful. Always write things in your own words. Treat AI like you would any other source and do not do anything remotely close to plagiarism.

Writing Center

Part of your exams requires that a submit written report that correctly uses statistical tools **and** follows good writing practices. If you want help or feedback with your writing (hint: you do) you are encouraged to reach out to the University Writing Center (UWC). UWC can help you with any part in writing process (e.g., brainstorming, drafting, documenting, revising, proofreading, and more). I *highly recommended* you schedule a meeting with them at least once this semester. For more information visit `https://writingcenter.tamu.edu/`.

Disability statement

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit `http://disability.tamu.edu`. Disabilities may include, but are not limited, to attention, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

If you are experiencing difficulties with your approved accommodations, contact the office responsible for approving your accommodations or the Texas A&M ADA Coordinator Julie Kuder at `ADA.Coordinator@tamu.edu` or (979) 458-8407.

Pregnancy Accommodations

Texas A&M provides reasonable accommodations to students due to pregnancy and/or related conditions, such as childbirth, recovery, and lactation. Students should contact the University's Pregnancy Coordinator (`https://titleix.tamu.edu/title-ix-and-pregnancy-students/`) as soon as they become aware of the need for accommodation. Depending on the circumstances, accommodations could include extended time to complete assign-

ments or exams, changes in course sequence, or modifications to the physical classroom environment.

Texas A&M will also allow a voluntary leave of absence, ensure the availability of lactation space, and maintain grievance procedures to provide for the prompt and equitable resolution of complaints of sex discrimination. For information regarding pregnancy accommodations, email: `TIX.Pregnancy@tamu.edu`.

Title IX and Statement on Limits to Confidentiality

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit discrimination and harassment based on an individual's race, color, sex, (including pregnancy and related conditions), religion, national origin, age, disability, genetic information, veteran status, or any other legally protected characteristic. This includes forms of sex-based violence, such as sexual assault, sexual harassment, sexual exploitation, dating/domestic violence, and stalking.

Students should be aware that all university employees (except medical or mental health providers) are mandatory reporters, which means that if they observe, experience or become aware of an incident that they reasonably believe to be discrimination/harassment alleged to have been committed by or against a person who was a student or employee at the time of the incident, the employee must report the incident to the university.

Students can report discrimination/harassment, access supportive resources, or learn more about their options for resolving complaints on the University's Civil Rights & Title IX webpage (`https://titleix.tamu.edu/`).

Students should be aware that all university employees (except medical or mental health providers) are mandatory reporters, which means that if they observe, experience or become aware of an incident that they reasonably believe to be discrimination/harassment alleged to have been committed by or against a person who was a student or employee at the time of the incident, the employee must report the incident to the university.

Statement on the Family Educational Rights and Privacy Act (FERPA)

FERPA is a federal law designed to protect the privacy of educational records by limiting access to these records, to establish the right of students to inspect and review their educational records, and to provide guidelines for the correction of inaccurate and misleading data through informal and formal hearings.

Currently enrolled students wishing to withhold any or all directory information items can do so within `howdy.tamu.edu` using the Directory Information Witholding Form. The complete FERPA Notice to Students and the student records policy is available on the Office of the Registrar webpage (`http://registrar.tamu.edu/Catalogs%2C-Policies-Procedures/FERPA/FERPA-Notice-to-Students#0-StatementofRights`).

Items that can never be identified as public information are a student's social security number, citizenship, gender, grades, GPR, or class schedule. All efforts will be made in this class to protect your privacy and to ensure confidential treatment of information associated with or generated by your participation in the class.

Directory items include name, UIN, local address, permanent address, email address, local telephone number, permanent telephone number, dates of attendance, program of study (college, major, campus), classification, previous institutions attended, degrees, honors and awards received, participation in officially recognized activities and sports, medical residence location, and medical residence specialization.

Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors influencing a student's academic success and overall well-being. Students are encouraged to engage in healthy self-care practices by utilizing the resources and services available through University Health Services (`https://uhs.tamu.edu/`). The TELUS Health Student Support app (`https://uhs.tamu.edu/mental-health/student-support.html`) provides access to professional counseling in multiple languages anytime, anywhere by phone or chat, and the 988 Suicide & Crisis Lifeline offers 24-hour emergency support at 988 or 988lifeline.org.

Students needing a listening ear can contact University Health Services at 979.458.4584. Call 911 or visit your nearest emergency room if you are

currently experiencing a life-threatening situation or if your safety is at risk. 24-hour emergency help is also available through the 988 Suicide & Crisis Lifeline (988) or at `988lifeline.org`.

On respect, Non-discrimination, Free Speech and Civil Discourse

Respect is a core value. The university website describes the importance of respect as follows:

> We appreciate, learn from and create a welcoming and inclusive environment that values uniqueness, diversity and a sense of community.[1]

This means that I expect everyone to engage with me, each other, and the course material in good faith regardless of any individual's race, ethnicity, religion, age, sex, gender, sexual orientation, class, disability, and nationality.

Texas A&M University is committed to providing safe and non-discriminatory learning, living, and work environments for all members of the University community. The University provides equal opportunity to all employees, students, applicants for employment or admission, and the public, regardless of race, color, sex (including pregnancy and related conditions), religion, national origin, age, disability, genetic information, or veteran status.

Texas A&M University will promptly, thoroughly, and fairly investigate and resolve all complaints of discrimination, harassment (including sexual harassment), complicity, and related retaliation based on a protected class in accordance with System Regulation 08.01.01, University Rule 08.01.01.M1, Standard Administrative Procedure (SAP) 08.01.01.M1.01, and applicable federal and state laws. In accordance with Title IX and its implementing regulations, Texas A&M does not discriminate on the basis of sex in any educational program or activity, including admissions and employment.

The following person has been designated to handle inquiries and complaints regarding the non-discrimination policies: Jennifer M. Smith, TAMU Associate VP & Title IX Coordinator at YMCA Ste 108, College Station, TX 77843, 979-458-8407, or email civilrights@tamu.edu. For other reporting options, visit the U.S. Department of Education Office for Civil Rights Complaint Assessment System (`https://ocrcas.ed.gov/contact-ocr`) to

[1] `https://www.tamu.edu/about/purpose-values.html`

locate the address and phone number of the office that serves your area, or call 1-800-421-3481.

Texas A&M recognizes that the pursuit of truth through open and robust discourse is critical to academic inquiry. However, as a community of scholars, the university has an aspirational expectation that such discourse will be conducted in accordance with Aggie Core Values. In this "marketplace of ideas," we encourage civil dialogue creating an environment that allows individuals to express their ideas and to have their ideas challenged in respectful and responsible ways. Students can learn more about Freedom of Expression and Free Speech on the University's website about the First Amendment (`https://firstamendment.tamu.edu/wp-content/uploads/2020/08/Free-Speech-8.7.20.pdf`).

Course Topics

We will cover as many of the following topics as we can

1. Maximum likelihood: theory, results, and other background
    - Review of random variables and distributions
    - Method of maximum likelihood
    - Results: Consistency, normality, efficiency, invariance, variance estimation, and hypothesis testing
    - MLE under model misspecification
    - **Readings:** D&S sections 7.5, 7.6, & 8.8; Greene 14.1–14.4, 14.6, 15.1–15.2, 15.4
2. Numeric optimization: theory and practice
    - Bisection
    - Newton and quasi-Newton methods
    - Coding derivatives versus finite-differences
    - Computational tools: Monte Carlo simulation, inverse uniform sampling, parametric and non-parametric bootstraps
    - **Readings:** K&W sections 3.7, 2.1–2.3, 6.1, 6.5, & 7.5; Greene 15.5
3. GLMs 1: Continuous and continuous-ish setings

- GLM: Normal, log-normal, Poisson, and negative binomial regressions
- Interpretation: Predicted values, coefficients, average marginal effects
- Topic: Robust and clustered standard errors for GLMs
- Topic: Nested and non-nested model testing
- Topic: Instrumental variables with Poisson regression
- Topic: Two-step MLE
- **Readings:**
  - Greene 14.5, 14.7–14.10, & 18.4
  - D&S 5.4, 5.6, & 5.5.
  - Murphy, Kevin. M., & Topel, Robert H. 2002. "Estimation and Inference in Two-Step Econometric Models." *Journal of Business & Economic Statistics*, 20(1):88–97.

4. GLMs 2: Binary outcomes

   - The binomial GLM: logits and probits
   - Interpretation: coefficients, predicted probabilities, average marginal effects
   - Topic: Separation
   - Topic: Panel data (fixed effects, incidental parameters, conditional MLE, and Mundlak)
   - Topic: Instrumental variables with binary outcomes
   - **Readings:**
     - Greene 17.1–17.7
     - D&S 5.1 & 5.10
     - Heinze, Georg and Schemper, Michael. 2002. "A solution to the problem of separation in logistic regression." *Statistics in Medicine*. 21(16): 2409–2419.
     - Crisman-Cox, Casey. 2021. "Estimating Substantive Effects in Binary Outcome Panel Models: A Comparison." *Journal of Politics*. 83(2): 532–546

5. GLMs 3: Duration

   - Parametric models: Exponential and Weibull regression

- Semi-parametric model: Cox regression
- Interpretation: coefficients, predicted duration, average marginal effects
- Topic: Discrete time duration
- **Readings:** Greene 19.5, D&S 5.7

6. Missing data

   - Types of missingness
   - Multiple imputation
   - The EM algorithm
   - **Readings:** Little & Rubin Chapters 1, 4–6, 8–9, 11

7. Structural models: Some basics

   - Random utility models
   - Ordered logits and probits
   - Multinomial logit and probits
   - Heckman's selection model
   - **Readings:** H&J 1–2.2; Greene 18.1–18.3, & 19.4

8. Structural models: Ideal point estimation

   - **Readings:**
     - Poole, Keith T., and Howard Rosenthal. 1985. " A Spatial Model for Legislative Roll Call Analysis ." *American Journal of Political Science*. 29(2) 357–384.
     - Poole, Keith T., and Howard Rosenthal. 1991. "Patterns of Congressional Voting." *American Journal of Political Science*. 35(1) 228–78.
     - Imai, Kosuke, James Lo, and Jonathan Olmstead. 2016. "Fast Estimation of Ideal Points with Massive Data." *American Political Science Review*. 110(4): 631–656.

9. Structural models: Static games with a unique equilibrium

   - Estimating and analyzing the parameters of static, extensive form games
   - **Readings:**

  - Signorino, Curtis S. 1999. "Strategic Interaction and the Statistical Analysis of International Conflict." *American Political Science Review* 93(2):279–298.
  - Bas, Muhammet Ali, Curtis S. Signorino, and Robert W. Walker. "Statistical backwards induction: A simple method for estimating recursive strategic models." *Political Analysis.* 16(1): 21-40.

10. Structural models: Static games with multiple equilibria

    - Bayesian games
    - The Lewis and Schultz signaling model
    - **Readings:**
      - Ellickson, Paul B. and Sanjog Misra. 2011. "Estimating Discrete Games." *Marketing Science.* 30(6):997–1010.
      - Lewis, Jeffery B. and Schultz, Kenneth A. 2003. "Revealing preferences: empirical estimation of a crisis bargaining game with incomplete information." *Political Analysis* 11(4): 345–367.
      - Crisman-Cox, Casey and Michael Gibilisco. 2021. "Estimating signaling games in international relations: problems and solutions." *Political Science Research and Methods.* 9(3):565–582.

Final Disclaimer

The schedule, policies, procedures, assignments, and topics discussed in this course are subject to change in the event of extenuating circumstances and/or to provide for better student learning. These changes are entirely at the discretion of the instructor and may include discussions that may seem outside the scope of this course or syllabus; they are not. This syllabus provides an overview of topics that we may discuss, time permitting, but the instructor and teaching assistants do not preemptively agree to limit themselves to just what is listed here or that the topics will match the listed dates exactly.