

POLS6382: Quantitative Methods III: Maximum Likelihood Estimation

Mondays: 9:00-12:00PM, Room: PGH 405

University of Houston

Department of Political Science

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Course Description

This is the third (full) course in quantitative methods in the University of Houston's political science Ph.D. Program. This course introduces students to a number of new and useful generalized linear models, with an emphasis on likelihood-based methods. We emphasize in this course that good social science research involves an appropriately developed theory and a correctly specified statistical model to map the underlying theory. Maximum likelihood (ML) offers a variety of models to evaluate uncertainty. Most of our attention will be given to models where the traditional assumptions of ordinary least square (OLS) regression are violated, because the dependent variable is non-continuous. Among the topics we cover are logit and probit models for both binary and ordinal dependent variables, discrete choice models for multiple alternatives (e.g. voting for multiple candidates or parties), event count models (e.g. international conflicts in a decade, presidential appointments during an administrative term, congressional hearings in a year, etc.), models for survival (time-to-event) data, and models for non-random selection (e.g. when you observe voters' preferences, but not non-voters').

Learning Objectives

This course will prepare students to read and critically evaluate quantitative political science research that applies maximum likelihood estimation. Furthermore, this course will prepare

students to perform research of their own with attention to data management, data visualization, model specification, diagnostic analysis, post-estimation analysis, and the presentation of results. The goal of this course is to train students to produce independent, original research, and to provide a useful set of methodological tools for students to develop dissertation research.

Prerequisites

The background required for the course is a good introduction to probability and statistical inference, and at least one good regression course. Some familiarity with linear algebra and calculus is also assumed.

Textbooks and Additional Readings

Long, J. Scott. 1997. *Regression Models for Categorical and Limited Dependent Variables*. Thousand Oaks, CA: Sage Publications. (An excellent introduction to the basic models covered in this course, very clearly presented.)

Faraway, Julian J. 2006. *Extending the Linear Model with R: Generalized Linear, Mixed Effects, and Nonparametric Regression Models*. Boca Raton, FL: Chapman&Hall/CRC. (An accessible introduction to various generalized linear models with R.)

Box-Steffensmeier, Janet M. and Bradford D. Jones. 2004. *Event History Modeling: A Guide for Social Scientists*. New York, NY: Cambridge University Press. (An excellent text on event history analysis.)

(Recommended) King, Gary. 1989. *Unifying Political Methodology: The Likelihood Theory of Statistical Inference*. University of Michigan Press. (The book that made maximum likelihood required study for political science. This is the Michigan Press reprint of King's original Cambridge University Press Book.)

(Recommended) Long, J. Scott and Jeremy Freese. 2014. *Regression Models for Categorical Dependent Variables Using Stata*. College Station, TX: Stata Press. (A well-stocked toolbox of how to implement MLE models using **Stata**.)

(Recommended) James E. Monogan III. 2015. *Political Analysis Using R*. New York, NY: Springer. (A nice overview of how **R** can be useful in the analysis of public administration, public policy, and political science data.)

Additional readings as necessary, all of which will be available on Blackboard Learn and/or through JSTOR.

Software, Statistical and Otherwise

You can use whatever statistical software you choose to complete the homework assignments, so long as the manner by which your results are generated and conclusions are transparent. However, due to the limits of lecture and laboratory time, my teaching assistants and I will only support

two software packages, **R** and **Stata**. Both are available on the machines in the political science graduate student lab. All lectures and statistical labs will be instructed with an emphasis on **R**.

R

R is a statistical environment and high-level programming language for data analysis and visualization. It is the GNU version of the **S** language. **R** is a free and open-source software. The current (July 2019) version of **R** is 3.6.1 (*Action of the Toes*). **R** is an object-oriented language, unlike **Stata** and most other statistical packages, it operates by assigning values to objects in the workspace. In the lecture notes, handouts, etc., **R** commands and outputs will be marked by “**R Code**” and “**R Output**”, respectively.

-R Code-

```
Age<-cps2011$age
summary(Age)
```

-R Output-

```
Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
0.00  15.00   34.00   34.99  52.00   85.00
```

The [Comprehensive R Archive Network \(CRAN\)](#) is the to-go spot for all things **R**-related. You may also consider using [RStudio](#), which is an integrated development environment for **R**. It includes a console, syntax-highlighting editor that supports direct code execution, as well as tools for plotting, history, debugging and workspace management.

Stata

At the present time, **Stata** is probably the most widely-used statistical package in the social science. It is a powerful tool for data management, analysis, display, and boasts some of the best manuals and online help for any existing software package. **Stata** is a commercial software package. The current version of **Stata** is 15.0, but previous versions (back to v.9, at least) can also be used for this class. In the class notes, handouts, etc., **Stata** command will be preceded by a period (“.”).

```
. logit Y X, vce(robust)
```

There are a number of useful **Stata** references on the web, including the [Stata](#) homepage, [Scott Long’s page](#) at IU, and an excellent **Stata** “[help page](#)” sponsored by UCLA.

Grading

Grades will be based on multiple assignments. First, homework assignments will be set up to use either the **R** language or the **Stata** statistical package. I encourage group study/discussion on these data assignments, but students should compile their reports independently. The goal of homework assignments is to help you to learn the materials and enable you to master various statistical models covered in this course. There is also a required term paper. The term paper must focus on a substantive question that is related to your main research area, and applies the statistical techniques covered in this class. You should format your term paper by following the

[APSA Style Manual for Political Science \(Revised 2006\)](#). The term paper counts for 40% of the final grade and the exercises (weighted equally) together account for 40% of the final grade. At the end of the semester, we will hold a mini-conference to give you an opportunity to present your term paper and draw feedback from your peers. Each working paper will be assigned with a peer “reviewer” (i.e. a fellow student from this class). The peer-reviewer will provide a one-page review of the working paper. Your research presentation will account for 10% of the final grade. Your peer-review and regular class-participation together will account for 10% of the final grade.

The work you turn in (both exercises and term paper) should be professional quality. That means you **MUST** use proper mathematical notation. If you use **Microsoft Word**, I insist that you master their equation editors to make professional looking papers. Likewise, you must learn how to include figures and edit tables properly within your word processor. You would be **MUCH** better off learning and using **L^AT_EX** and R Markdown. If at all possible, you should convert your Word document to Adobe Acrobat .pdf files before submitting them.

Five exercises: 40%

Term paper: 40%

Research presentation: 10%

Participation and peer review: 10%.

Final Grades:

A	=	100-95 (Excellent)
A-	=	94-90
B+	=	89-87 (Good)
B	=	86-84
B-	=	83-80 (Fair)
C+	=	79-77
C	=	76-74 (Poor)
C-	=	73-70
D+	=	69-67
D	=	66-64
D-	=	63-60
F	=	59-0 (Failing)

Academic Integrity

As commonly defined, presenting the words or works of others’ as your own is plagiarism. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues, without which research cannot be safely communicated. Plagiarism is also a violation of the UH Academic Honesty Policy. If you are uncertain of what constitute academic dishonesty, you should contact me prior to submitting the assignment and/or check the UH Academic Honesty Policy from the university website: <http://www.uh.edu/provost/policies/honesty/>. Students are expected to adhere to the UH Academic Honesty Policy. Cheating or plagiarism in course assignments, exams, and the final paper will lead to a grade of F.

Face Covering Policy

To reduce the spread of COVID-19, the University strongly encourages everyone (vaccinated or not) to wear face coverings indoors on campus including classrooms for both faculty and students.

Presence in Class

Your presence in class each session means that you:

- Are NOT exhibiting any Coronavirus Symptoms that makes you think that you may have COVID-19
- Have NOT tested positive or been diagnosed for COVID-19
- Have NOT knowingly been exposed to someone with COVID-19 or suspected/presumed COVID-19

If you are experiencing any COVID-19 symptoms that are not clearly related to a pre-existing medical condition, do not come to class. Please see Student Protocols for what to do if you experience symptoms and Potential Exposure to Coronavirus for what to do if you have potentially been exposed to COVID-19. Consult the (select: Undergraduate Excused Absence Policy or Graduate Excused Absence Policy) for information regarding excused absences due to medical reasons.

COVID-19 Information

Students are encouraged to visit the University's COVID-19 website for important information including on-campus testing, vaccines, diagnosis and symptom protocols, campus cleaning and safety practices, report forms, and positive cases on campus. Please check the website throughout the semester for updates.

Vaccinations

Data suggests that vaccination remains the best intervention for reliable protection against COVID-19. Students are asked to familiarize themselves with pertinent vaccine information, consult with their health care provider. The University strongly encourages all students, faculty and staff to be vaccinated.

Excused Absence Policy

Regular class attendance, participation, and engagement in coursework are important contributors to student success. Absences may be excused as provided in the University of Houston Undergraduate Excused Absence Policy and Graduate Excused Absence Policy for reasons including: medical illness of student or close relative, death of a close family member, legal or government proceeding that a student is obligated to attend, recognized professional and educational activities where the student is presenting, and University-sponsored activity or athletic competition. Under these policies, students with excused absences will be provided with an opportunity to make up any quiz, exam or other work that contributes to the course grade or

a satisfactory alternative. Please read the full policy for details regarding reasons for excused absences, the approval process, and extended absences. Additional policies address absences related to military service, religious holy days, pregnancy and related conditions, and disability.

Reasonable Academic Adjustments and Auxiliary Aids

The University of Houston complies with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990, pertaining to the provision of reasonable academic adjustments/auxiliary aids for disabled students. In accordance with Section 504 and ADA guidelines, UH strives to provide reasonable academic adjustments/auxiliary aids to students who request and require them. If you believe that you have a disability requiring an academic adjustments/auxiliary aid, please contact the Justin Dart Jr. Student Accessibility Center (formerly the Justin Dart, Jr. Center for Students with DisABILITIES).

University of Houston CAPS Statement

Counseling and Psychological Services (CAPS) can help students who are having difficulties managing stress, adjusting to college, or feeling sad and hopeless. You can reach CAPS (www.uh.edu/caps) by calling 713-743-5454 during and after business hours for routine appointments or if you or someone you know is in crisis. No appointment is necessary for the “Let’s Talk” program (www.uh.edu/caps/outreach/lets_talk.html), a drop-in consultation service at convenient locations and hours around campus.

Recording of Class

Students may not record all or part of class, livestream all or part of class, or make/distribute screen captures, without advanced written consent of the instructor. If you have or think you may have a disability such that you need to record class-related activities, please contact the Justin Dart, Jr. Student Accessibility Center. If you have an accommodation to record class-related activities, those recordings may not be shared with any other student, whether in this course or not, or with any other person or on any other platform. Classes may be recorded by the instructor. Students may use instructor’s recordings for their own studying and note-taking. Instructor’s recordings are not authorized to be shared with anyone without the prior written approval of the instructor. Failure to comply with requirements regarding recordings will result in a disciplinary referral to the Dean of Students Office and may result in disciplinary action.

Syllabus Changes

Due to the changing nature of the COVID-19 pandemic, please note that the instructor may need to make modifications to the course syllabus and may do so at any time. Notice of such changes will be announced as quickly as possible through email.

Late Assignment Submission

Late work will be penalized by one letter grade for each day after the deadline. For example, an A-paper turned in one day late will become a B-paper. Late work would only be accepted without grade-penalty if the student has university-accepted excuses.

Course Calendar

Week 1 (August 23): Course Overview

- Syllabus
- No required readings

Week 2 (August 30): Getting Started with R

Readings

- Faraway Chapter 1; Long Chapter 1.
- Lab 1 Handout: Getting Start with R.

Week 3 (September 6): Labor Day Holiday.

Week 4 (September 13) : Maximum Likelihood: Derivation and Properties

Readings

- Long, Chapter 2
- Aldrich, John. 1997. "R. A. Fisher and the Making of Maximum Likelihood 1912-1922." *Statistical Science* 12(3): 162-176.
- Franklin, Charles H. 1991. "Eschewing Obfuscation? Campaigns and the Perception of Senate Incumbents." *American Political Science Review* 85:1193-1214.
- (Recommended) Fisher, Ronald A. 1925. "Theory of Statistical Estimation." *Proceedings of the Cambridge Philosophical Society* 22: 700-725.
- (Recommended) Neyman, Herze. 1934. "On the Two Different Aspects of the Representative Methods: The Method of Stratified Sampling and the Method of Purposive Selection." *Journal of the Royal Statistical Society* 97(4): 558-625.
- (Recommended) King 1989, Chapter 1-3 (skim), 4.1-4.3.
- Lab 2 Handout: Data Visualization Using R and Normal Generalized Linear Models
 - Introduction to *ggplot2* and workflow tools: *tidyr* and *dplyr*
 - Estimating a linear regression model using MLE.

Week 5 (September 20): Binary Response Models: Fundamentals

Readings

- Long, Chapters 3.
- Faraway, Chapter 2.
- Zhu, Ling. 2017. "Voices from the Frontline: Network Participation and Local Support for National Policy Reforms." *Journal of Public Administration Research and Theory*, 27(2): 284-300.
- Esarey, Justin and Andrew Pierce. 2012. "Assessing Fit Quality and Testing for Misspecification in Binary-Dependent Variable Models." *Political Analysis* 20(4): 480-500.

- Herron, Michael C. 2000. "Postestimation Uncertainty in Limited Dependent Variable Models." *Political Analysis* 8(1): 83-98.
- (Recommended) Berry, William D., Jacqueline H.R. Demeritt and Justin Esarey. 2010. "Testing for Interaction in Binary Logit and Probit Models: Is a Product Term Essential?" *American Journal of Political Science* 54(1): 248-266.
- (Recommended) Zhu, Ling and Christine Lipsmeyer. "Policy Feedback and Economic Risk: The Influence of Privatization on Social Policy Preferences." *Journal of European Public Policy*, forthcoming.
- Lab 3 Handout: Estimating a Logit/Probit Model

Week 6 (September 27): Binary Response Models: Advanced Topics

Readings

- Long, Chapter 4.
- (Recommended) King, Chapter 5.3.
- Nagler, Jonathan. 1994. "Scobit: An Alternative Estimator to Logit and Probit." *American Journal of Political Science* 38(1): 230-255.
- Alvarez, R. Michael and John Brehm. 1995. "American Ambivalence Toward Abortion Policy: A Heteroskedastic Probit Method for Assessing Conflicting Values." *American Journal of Political Science* 39(4): 1055-1082.
- King, Gary and Langche Zeng. 2001. "Logistic Regression in Rare Events Data." *Political Analysis* 9:137-163.
- King, Gary and Langche Zeng. 2001. "Explaining Rare Events in International Relations." *International Organization* 53(3): 693-715.
- Lab 4 Handout: Binary Response Models: Advanced Topics.

Week 7 (October 4): Ordered Response Models

Readings

- Long, Chapter 5.
- Faraway, Chapter 5.3
- (Recommended) King, Chapter 5.4.
- Jones, Bradford S. and Michael E. Sobel. 2000. "Modeling Direction and Intensity in Semantically Balanced Ordinal Scales: An Assessment of Congressional Incumbent Approval." *American Journal of Political Science* 44(1):174-185.
- Franklin, Charles H. and Liane C. Kosaki. 1989. "Republican Schoolmaster: The U.S. Supreme Court, Public Opinion, and Abortion." *American Political Science Review* 83(3):751-771.
- Espenshade, Thomas J. and Haishan Fu. 1997. "An Analysis of English Language Proficiency among U.S. Immigrants." *American Sociological Review* 62(2): 288-305.
- Sanders, Mitchell. 2001. "Uncertainty and Turnout." *Political Analysis* 9(1):45-57.

- Lab 5 Handout: Models for Ordinal Outcomes

Week 8 (October 11): Multinomial Choice Models

Readings

- Long, Chapter 6.
- Faraway, Chapter 5
- Born, Richard. 1990. "Surge and Decline, Negative Voting, and the Midterm Loss Phenomenon: A Simultaneous Choice Analysis." *American Journal of Political Science* 34(3): 615-645.
- Whitten Guy D. and Harvey D. Palmer. 1996. "Heightening Comparativists' Concern for Model Choice: Voting Behavior in Great Britain and the Netherlands." *American Journal of Political Science* 40(1):231-260.
- Dow, Jay K. and James W. Endersby. 2004. "Multinomial Probit and Multinomial Logit: A Comparison of Choice Models for Voting Research." *Electoral Studies* 23(1):107-122.
- Lab 6 Handout: Multinomial Logit and Probit Models

Week 9 (October 18): Censored and Truncated Variables

Readings

- Long, Chapter 7.
- Sigelman, Lee and Langche Zeng. 1999. "Analyzing Censored and Sample-Selected Data with Tobit and Heckit Models." *Political Analysis* 8(2):167-182.
- Timpone, Richard J. 1998. "Structure, Behavior and Voter Turnout in the United States." *American Political Science Review* 92(1):145-158.
- Lassen, David Dreyer. 2005. "The Effects of Information on Voter Turnout: Evidence from a Natural Experiment." *American Journal of Political science* 49(1):103-118.
- Lab 7 Handout: Models for Censored and Sample Selected Data

Week 10 (October 25): Event Count Models

Readings

- Long, Chapter 8.
- Faraway, Chapter 3
- King, Gary. 1988. "Statistical Models for Political Science Event Counts: Bias in Conventional Procedures and Evidence for Exponential Poisson Regression Model." *American Journal of Political Science* 32(3):838-863.
- (Recommended) King, Chapter 5.5-5.10.
- Lab 8 Handout: Poisson Regression models

Week 11 (November 1): Event Count Models: Advanced Topics

Readings

- (Recommended) King, Chapters 8.3, 9.4-9.5.
- King, Gary. 1989a. "Variance Specification in Event Count Models: From Restrictive Assumptions to a Generalized Estimator." *American Journal of Political Science* 33(3): 762-784.
- King, Gary. 1989b. "A Seemingly Unrelated Poisson Regression Model." *Sociological Methods and Research* 17(3): 235-255.
- King, Gary. 1989c. "Event Count Models for International Relations: Generalization and Applications." *International Studies Quarterly* 33 (2):123-147.
- Winkelmann, Rainer. 2000. "Seemingly Unrelated Negative Binomial Regression." *Oxford Bulletin of Economics and Statistics* 62(4): 553-560.
- Lab 9: Event Count Models: Advanced Topics

Week 12 (November 8): Duration Analysis: Introduction

Readings

- Box-Steffensmeier, Janet M. and Bradford D. Jones. 2004. *Event History Modeling: A Guide for Social Scientists*, Chapters 1-3.
- Alt, James and Gary King. 1994. "Transfers of Governmental Power: The Meaning of Time Dependence." *Comparative Political Studies* 27(2): 190-210.
- Bienen, Henry and Nicolas van de Walle. 1992. "A Proportional Hazard Model of Leadership Duration." *The Journal of Politics* 54(3): 685-717.
- McCarty, Nolan and Rose Razaghian. 1999. "Advice and Consent: Senate Responses to Executive Branch Nominations." *American Journal of Political Science* 43(4): 1122-1143.
- (Recommended) Allison, Paul D. 2014. *Event History and Survival Analysis*. Second Edition. Thousand Oaks, CA: Sage Publication, Chapters 1-2.
- Lab 10 Handout: Cox's Proportional Hazards Model

Week 13 (November 15): Duration Analysis: Advanced Topics

Readings

- Box-Steffensmeier, Janet M. and Bradford D. Jones. 2004. *Event History Modeling: A Guide for Social Scientists*, Chapter 8.
- Box-Steffensmeier, Janet M. and Christopher Zorn. 2001. "Duration Models and Proportional Hazards in Political Science." *American Journal of Political Science* 45(4): 972-988.
- Keele, Luke. 2010. "Nonproportionally Difficult: Testing for Nonproportional Hazards in Cox Models." *Political Analysis* 18(2):189-205.
- Zorn, Christopher. 2000. "Modeling Duration Dependence." *Political Analysis* 8(3):367-380.

- Lab 11 Handout: Duration Models: Testing for Non-proportional Hazards and Duration Dependence

Week 14 (November 22): Survival Analysis: Extensions

Readings

- Faraway, Chapters 8-9
- Beck, Nathaniel, Jonathan N. Katz, and Richard Tucker. 1998. "Taking Time Seriously: Time-Serious-Cross-Section Analysis with a Binary Dependent Variable." *American Journal of Political Science* 42(4):1260-1288.
- Signorino, Curt and David Carter. 2010. "Back to the Future: Modeling Time Dependence in Binary Data." *Political Analysis* 18(3): 271-292.
- Box-Steffensmeier and Jones, Chapters 9, 11.
- Banerjee, Sudipto, Melanie M. Wall, and Bradley P. Carlin. 2003. "Frailty Modeling for Spatially Correlated Survival Data, with An Application to Infant Mortality in Minnesota." *Biostatistics* 4(1):123-142.
- Yi, Hongtao and Wenna Chen. 2019. "Portable Innovation, Policy Wormholes, and Innovation Diffusion." *Public Administration Review*, forthcoming.
- Lab 12 Handout: Survival Analysis: Extensions.

Week 15 (November 29): MLE and Measurement Models

Readings

- Quinn, Kevin M. 2004. "Bayesian Factor Analysis for Mixed Ordinal and Continuous Responses." *Political Analysis*, 12(4): 338-353.
- Ling Zhu. 2015. "Measurement Approaches in Public Administration Surveys." In Melvin Dubnick and Domonic Bearfield Ed. *Encyclopedia of Public Administration and Public Policy*, 3rd edition, 3173.
- Ling Zhu and Christine S. Lipsmeyer. 2015. "Policy Feedback and Economic Risk: The Influence of Privatization on Social Policy Preferences." *European Journal of Public Policy*, 22(10): 1481-1511.
- Ling Zhu, Scott E. Robinson and René Torenvlied. 2015. "A Bayesian Approach to Measurement Bias in Networking Studies." *The American Review of Public Administration*, 45(5): 542-564.
- Bertelli, Anthony et al. 2013. "Measuring Agency Attributes with Attitudes Across Time: A Method and Examples Using Large-Scale Federal Surveys." *Journal of Public Administration Research and Theory*, 25(2): 513-544.
- Lab 13 Handout: Introduction to IRT Scaling and Bayesian Factor Analysis for Mixed Measurement Scales
- **Term paper draft due by 5:00pm on Blackboard Learn.**

Week 16 (December 6): Mini-Conference: Student Research Presentations.

December 13: Term paper final version due on Blackboard Learn by the end of the day (5:00pm).