

PSCI 7155: Maximum Likelihood

University of Colorado Boulder

Fall 2021

Time: Friday, 8:30-11:00AM
Location: KTCH 1B31
Instructor: Dr. Andrew Q. Philips
Office: KTCH 131
Email: andrew.philips@colorado.edu
Office hours: Thursday 12:00-2:00, or by appointment

COURSE DESCRIPTION: Models utilizing maximum likelihood (ML) estimation are ubiquitous in political science. This course is designed to introduce you to a variety of ML estimators that you are likely to encounter in your research. We will start with a simple overview of probability models and show why we might need such an estimation technique. After discussing likelihood theory, we then move to more “novel” types of data, such as linear models with censoring and truncation, binary choice models, count models, and duration models. Much of the class will be spent on learning how to interpret these models and implement them in a statistical program.

By the end of this course you should be able to:

- Understand what is going on “under the hood” when estimating maximum likelihood models.
- Identifying which parametric model best fits your research question and the underlying data-generating process.
- Be able to interpret a variety of ML models and present your results using predictions, substantive interpretations, marginal effects, simulations, etc.
- Apply what you have learned to your own research.

PREREQUISITES: This an graduate level course; students should have a background in at least introductory (and preferably) advanced regression statistics (i.e., Data I and Data II). Students from other graduate programs must check with me before signing up for this course.

SOFTWARE: We will use both R and Stata in this course, the former slightly more so. Those unfamiliar with either program may want to purchase or borrow some of the suggested textbooks below, although there are copious amounts of information available for free online (also see Philips’ “brief introductions” in the course Dropbox). Please have R (<https://cran.r-project.org/>), RStudio (<https://www.rstudio.com>) and a copy of Stata installed on your computer before the first class session.

GRADES: Course grades will be based on the following. Participation and homework assignments are worth 20% of the final grade. The colleague critique is worth 15%. About halfway through the semester, a mid-term exam will be given that is worth 25% of the final grade. Last, the original research paper will comprise 40% of the final grade. Note that there are no opportunities for extra credit, nor is there a final exam.

Participation/Homework	20%
Colleague Critique	15%
Midterm Exam	25%
Original Research Paper	40%

The following scale will be used to turn numerical grades into letter ones. Note that I will round up a letter should your grade fall on the number (but on or above 0.5) between two letters (e.g., 89.5 up to 90 rounds up to an A-).

Grade Scale

A	95-100
A-	90-94
B+	87-89
B	84-86
B-	80-83
C+	77-79
C	74-76
C-	70-73
D+	67-69
D	64-66
D-	60-63
F	0-59

PARTICIPATION: Participation is an integral component of graduate courses. Students are expected to come to every class *having already read the assigned readings for that day*, and should be prepared to discuss them. Graduate-level courses only are successful when all participate actively in the discussion.

HOMEWORK: Most weeks we will have a lab portion. For homework, students will turn in a log file of the weekly lab in Stata or R, being sure to note any places where they had issues or did not understand the code/command.

MIDTERM EXAM: About halfway through the semester there will be a mid-term exam. There are two portions to this. This will be a take-home exam with a mix of theoretical questions as well as several applied questions where you will need to use R/Stata. Although you may consult help files, notes, and the internet for the midterm, *you cannot consult with other graduate students*. This will be considered a form of cheating.

ORIGINAL RESEARCH PAPER: By the end of the class, students should have a solo-authored research article-length working paper that is either: a.) a purely methodological paper (less common), or b.) an applied research paper that utilizes at least one of the maximum likelihood models discussed in the course. Since one semester is a short time in which to write such a paper, it is crucial to get some semblance of a research topic early in the semester. I encourage students to meet with me early on to discuss potential topics. Half-way through the semester, there will be a mandatory “check-in” to ensure all students have a feasible research topic. *I am very open to this paper being submitted for credit in another course, a substantial re-write from a previous semester, or a current coauthored working paper, but this needs to be cleared by me (and by the other professor if applicable)*. Note that the most important part of the research paper for the purposes of this class is the theory, hypotheses, research design, and presentation and interpretation of the results. Students are strongly encouraged to write the paper using \LaTeX .

COLLEAGUE CRITIQUE: After all research papers are due, I will assign each student to read and critique *two* of their fellow students’ papers. Students should treat this just as they would an invitation to peer review a manuscript. Theory, research design, data, methods, etc,... should be critiqued.

ATTENDANCE AND LATE POLICY: Attendance is a key component of succeeding in graduate school. I provide slides for each class, but we will have a much more comprehensive discussion than what ap-

pears on the slide. Attendance is mandatory.

Assignments are due on the day listed in the syllabus. Late assignments will not be accepted.

REQUIRED TEXTS: The following texts are required for the course. Any additional readings will be made available to you on the first day of class or as needed.

- Long, J. Scott. 1997. *Regression models for categorical and limited dependent variables*. Thousand Oaks, CA: Sage.
- Eliason, Scott R. 1993. *Maximum likelihood estimation: Logic and practice*. Thousand Oaks, CA: Sage.
- King, Gary. 1998. *Unifying political methodology: The likelihood theory of statistical inference*. University of Michigan Press.
- Ward, Michael D. and John S. Ahlquist. 2018. *Maximum likelihood for social science*. Cambridge University Press.

Note that it is expected to read the week's required readings before coming to class.

RECOMMENDED TEXTS: The following texts are not required, but may be helpful to some. I'm happy to talk more with you if you are interested in a particular topic. In the schedule below there are additional texts in the "suggested readings".

- Box-Steffensmeier, Janet M., and Bradford S. Jones. 2004. *Event history modeling: A guide for social scientists*. Cambridge University Press.
- Cameron, Adrian Colin and Pravin K. Trivedi. 2013. *Regression analysis of count data*. Second Edition. Cambridge University Press.
- Cameron, Adrian Colin, and Pravin K. Trivedi. 2009. *Microeconometrics using Stata Volume 5*. College Station, TX: Stata Press.
- Gelman, Andrew, and Jennifer Hill. *Data analysis using regression and multilevel/hierarchical models*. Cambridge University Press, 2006.
- Hosmer, D., Stanley Lemeshow, and Susanne May. 2008. *Applied survival analysis: Regression modeling of time to event data*. Second Edition. New York: Wiley.
- Long, J. Scott and Jeremy Freese. 2014. *Regression models for categorical dependent variables using Stata*. Third Edition. Stata Press.
- Monogan, James E. 2015. *Political analysis using R*. Springer.
- Neumayer, Eric and Thomas Plumper. 2017. *Robustness tests for quantitative research*. Cambridge University Press.
- Philips, Andrew Q. 2016. "L^AT_EX: A brief introduction". Available [here](#).
- Forbes, Catherine, Merran Evans, Nicholas Hastings, and Brian Peacock. 2010. *Statistical distributions*. Fourth Edition. Wiley.
- Greene, William. 2011. *Econometric analysis*. 7th Edition. Upper Saddle River, NJ: Prentice-Hall.

TENTATIVE SCHEDULE:

Week 1: Introduction to Probability Models

Required Readings:

- King Chapters 1 and 2
- Eliason Chapter 1 (pp. 1-18)
- Long Chapter 1
- Ward and Ahlquist Chapter 1

Suggested Readings:

- Burns, Patrick. 2011. *The R Inferno*.
- Philips, Andrew Q. 2020. "R: A brief introduction"
- Philips, Andrew Q. 2020. "Stata: A brief introduction"

Week 2: Estimation: Looking Under the Hood

Properties of ML models

Required Readings:

- King Chapter 3
- Eliason Chapters 1 (pp. 18-21), and 3
- Ward and Ahlquist Chapter 2 and 4

Week 3: Generalized Linear Model

Required Readings:

- King Chapter 4
- Eliason Chapter 2
- Ward and Ahlquist Chapter 7

Week 4: Censoring and Truncation, Selection Models and More

Required Readings:

- Eliason Chapter 5
- Reed, William, and David H. Clark. 2000. "War initiators and war winners: The consequences of linking theories of democratic war success." *Journal of Conflict Resolution* 44(3): 378-395.

Suggested Readings:

- White, Halbert. 1980. "A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity." *Econometrica: Journal of the Econometric Society*: 817-838.
- Heckman, James. 1979. "Sample selection bias as a specification error." *Econometrica: Journal of the Econometric Society*: 47(1): 153-161.
- Tobin, James. 1958. "Estimation of relationships for limited dependent variables." *Econometrica: Journal of the Econometric Society*: 24-36.
- Sigelman, Lee and Langche Zeng. 2000. "Analyzing censored and sample-selected data with Tobit and Heckit models." *Political Analysis* 8(2): 167-182.

Week 5: Binary Choice Models

Logit and probit

Required Readings:

- Long Chapter 3
- King Chapter 5
- Ward and Ahlquist Chapter 3 (pp. 43-54)

Week 6: No Class (APSA/Exam time)

Due by TBA

Week 7: Binary Choice Models Continued

Heteroskedastic probit, binary choice interpretation, and more

Required Readings:

- Ward and Ahlquist Chapter 3 (pp. 54-78)
- Alvarez, R. Michael and John Brehm. 1995. "American ambivalence towards abortion policy: Development of a heteroscedastic probit model of competing values". *American Journal of Political Science* 39(4): 1055-1082.
- Ai, Chunrong, and Edward C. Norton. 2003. "Interaction terms in logit and probit models". *Economics Letters* 80:123-129.
- Mood, Carina. 2010. "Logistic regression: Why we cannot do what we think we can do, and what we can do about it." *European Sociological Review* 26:67-82.

Suggested Readings:

- Greenhill, Brian, Michael D. Ward, and Audrey Sacks. 2011. "The separation plot: A new visual method for evaluating the fit of binary models." *American Journal of Political Science* 55(4): 991-1002.
- Nagler, Jonathan. 1994. "Scobit: An alternative estimator to logit and probit." *American Journal of Political Science* 38(1):230-255.
- Yatchew, Adonis and Zvi Griliches. 1985. "Specification error in probit models." *The Review of Economics and Statistics* 67(1):134-139.
- Bushway, Shawn, Brian D. Johnson and Lee Ann Slocum. 2007. "Is the magic still there? The use of the Heckman two-step correction for selection bias in criminology." *Journal of Quantitative Criminology* 23:151-178.
- Rainey, Carlisle and Kelly McCaskey. 2021. "Estimating logit models with small samples." *Political Science Research and Methods* 9: 549-564.

Week 8: Ordered and Multinomial Choice Models

Ordered and multinomial logit and probit

Required Readings:

- Long Chapters 5 and 6
- Eliason Chapter 4
- Ward and Ahlquist Chapter 8 and 9
- 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*: 231-260.
- Alvarez, R.M. and J. Nagler. 1995. "Economics, issues and the Perot candidacy: Voter choice in the 1992 presidential election". *American Journal of Political Science*: 714-744.

- Dow, Jay K. and Endersby, James W. 2004. "Multinomial probit and multinomial logit: A comparison of choice models for voting research." *Electoral Studies* 23: 107-122.

Suggested Readings:

- Cheng, Simon and J. Scott Long. 2007. "Testing for IIA in the multinomial logit model." *Sociological Methods & Research* 35(4): 583-600.
- Imai, Kosuke and David A. van Dyk. 2005. "A Bayesian analysis of the multinomial probit model using marginal data augmentation." *Journal of Econometrics* 124(2): 311-334.
- Alvarez, R. Michael, and Jonathan Nagler. 1998. "When politics and models collide: Estimating models of multiparty elections." *American Journal of Political Science* 42(1): 55-96.
- Duch, Raymond M. and Harvey D. Palmer. 2004. "It's not whether you win or lose, but how you play the game: Self-interest, social justice, and mass attitudes toward market transition." *American Political Science Review* 98(3):437-452
- Rudolph, Thomas J. 2003. "Who's Responsible for the Economy? The Formation and Consequences of Responsibility Attributions." *American Journal of Political Science* 47(4): 698-713.

Week 9: Event Count Models

Poisson, negative binomial, dealing with overdispersion and zero-inflation

Required Readings:

- Long Chapter 8
- Ward and Ahlquist Chapter 10
- King, Gary. 1989. "Event count models for international relations: Generalizations and applications." *International Studies Quarterly* 33(2): 123-147.
- King, Gary. 1988. "Statistical models for political science event counts: Bias in conventional procedures and evidence for the exponential poisson regression model". *American Journal of Political Science* 32:838-63.

Suggested Readings:

- Cameron, Adrian Colin and Pravin K. Trivedi. 2013. *Regression analysis of count data*. Second Edition. Cambridge University Press.

Week 10: Event Count Models Continued

Required Readings:

- Wilson, Matthew C., and James A. Piazza. 2013. "Autocracies and terrorism: Conditioning effects of authoritarian regime type on terrorist attacks." *American Journal of Political Science* 57(4): 941-955.
- Ruggeri, Andrea, Theodora-Ismene Gizelis, and Han Dorussen. 2013. "Managing mistrust: An analysis of cooperation with UN peacekeeping in Africa." *Journal of Conflict Resolution* 57(3):387-409.

Week 11: Duration Models

Required Readings:

- Box-Steffensmeier, Janet M., and Bradford S. Jones. 1997. "Time is of the essence: Event history models in political science." *American Journal of Political Science*: 1414-1461.
- Berliner, Daniel. 2014. "The political origins of transparency." *The Journal of Politics* 76(2): 479-491.
- Bueno de Mesquita, Bruce, and Randolph M. Siverson. 1995. "War and the survival of political leaders: A comparative study of regime types and political accountability." *American Political Science Review* 89(2):841-55.

Suggested Readings:

- Berry, Frances Stokes, and William Berry. 1990. "State lottery adoptions as policy innovations: An event history analysis." *American Political Science Review* 84(2): 395-415.
- Box-Steffensmeier, Janet M., and Bradford S. Jones. 2004. *Event history modeling: A guide for social scientists*. Cambridge University Press.
- Hosmer, D., Stanley Lemeshow, and Susanne May. 2008. *Applied survival analysis: Regression modeling of time to event data*. Second Edition. New York: Wiley.

Week 12: Duration Models Continued

Required Readings:

- Box-Steffensmeier, Janet M., and Christopher JW Zorn. 2001. "Duration models and proportional hazards in political science." *American Journal of Political Science*: 972-988.
- Ward and Ahlquist Chapter 11
- Kropko, Jonathan and Jeffrey J. Harden. 2017. "Beyond the hazard ratio: Generating expected durations from the Cox proportional hazards model." *British Journal of Political Science* 1-18.
- Box-Steffensmeier, Janet M., Suzanna De Boef and Kyle A. Joyce. 2007. "Event dependence and heterogeneity in duration models: The conditional frailty model." *Political Analysis* 15:237-256.

Suggested Readings:

- Alt, James E., Gary King and Curtis S. Signorino. 2001. "Aggregation among binary, count, and duration models: Estimating the same quantities from different levels of data." *Political Analysis* 9(1):21-44.
- Park, Sunhee, and David J. Hendry. 2015. "Reassessing Schoenfeld residual tests of proportional hazards in political science event history analyses." *American Journal of Political Science* 59(4): 1072-1087.
- Beck, N, J. N. Katz and R Tucker. 1998. "Taking time seriously: Time-series-cross-section analysis with a binary dependent variable." *American Journal of Political Science* 42: 1260-1288.
- Carter, D. B. and C. S. Signorino. 2010. "Back to the future: Modeling time dependence in binary data." *Political Analysis* 18: 271-292.
- Philips, Andrew Q. 2020 "An easy way to create duration variables in binary cross-sectional time-series data." *The Stata Journal* 20(4): 916-930.

Week 13: Missing data and imputation

Required Readings:

- Ward and Ahlquist Chapter 12
- Little, Todd, Terrence Jorgensens, Kyle Lang and Whitney Moore. 2013. "On the joys of missing data." *Journal of Pediatric Psychology* 39(2): 151-162.
- Schafer, Joseph. 1999. "Multiple imputation: A primer." *Statistical Methods in Medical Research* 8: 3-15.
- White, Ian, Patrick Royston and Angela Wood. 2011. "Multiple imputation using chained equations: Issues and guidance for practice." *Statistics in Medicine* 30: 377-399.

Suggested Readings:

- Rubin, Donald B. 1976. "Inference and missing data" *Biometrika* 63(3):581-592.
- Kropko, Jonathan, Been Goodrich, Andrew Gelman and Jennifer Hill. 2014. "Multiple imputation for continuous and categorical data: Comparing joint multivariate normal and conditional approaches." *Political Analysis* 22:497-519.
- Honaker, James, Gary King, and Matthew Blackwell. 2011. "Amelia II: A program for missing data." *Journal of Statistical Software* 45(7):1-47.

Week 14: NO CLASS (Thanksgiving Break)

Week 15: Model selection and ‘robustness’

Required Readings:

- Ward and Ahlquist Chapter 5
- Hartman, Erin and Daniel Hidalgo. 2018. “An equivalence approach to balance and placebo tests.” *American Journal of Political Science* 62(4): 1000-1013.
- Gross, Justin. 2015. “Testing what matters (if you must test at all): A context-driven approach to substantive and statistical significance.” *American Journal of Political Science* 59(3): 775-788.

Suggested Readings:

- Neumayer, Eric and Thomas Plumper. 2017. *Robustness tests for quantitative research*. Cambridge University Press.
- Rainey, Carlisle. 2014. “Arguing for a negligible effect.” *American Journal of Political Science* 58(4): 1083-1091.
- Esarey, Justin and Nathan Danneman. 2015. “A quantitative method for substantive robustness assessment.” *Political Science Research and Methods* 3(1): 95-111.
- Munoz, John and Cristobal Young. 2018. “We ran 9 billion regressions: Eliminating false positives through computational model robustness.” 48(1): 1-33.

Research papers due by 11:59 PM on December 10

Student critiques due by 11:59 PM on December 12

SYLLABUS CHANGES

I reserve the right to make changes to the syllabus during the course of the semester as needed and will make the most updated copy available to you and announce said changes during class.

Last updated: November 8, 2021

UNIVERSITY-MANDATED STATEMENTS

Classroom behavior

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on classroom behavior and the Student Code of Conduct.

Requirements for COVID-19

As a matter of public health and safety due to the pandemic, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements, and public health orders in place to reduce the risk of spreading infectious disease. Required safety measures at CU Boulder relevant to the classroom setting include:

- maintain 6-foot distancing when possible,
- wear a face covering in public indoor spaces and outdoors while on campus consistent with state and county health orders,
- clean local work area,
- practice hand hygiene,
- follow public health orders, and
- if sick and you live off campus, do not come onto campus (unless instructed by a CU Healthcare professional), or if you live on-campus, please alert CU Boulder Medical Services.

Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to Student Conduct and Conflict Resolution. For more information, see the policies on COVID-19 Health and Safety and classroom behavior and the Student Code of Conduct. If you require accommodation because a disability prevents you from fulfilling these safety measures, please see the “Accommodation for Disabilities” statement on this syllabus.

All students who are new to campus must complete the COVID-19 Student Health and Expectations Course. Before coming to campus each day, all students are required to complete the Buff Pass.

Students who have tested positive for COVID-19, have symptoms of COVID-19, or have had close contact with someone who has tested positive for or had symptoms of COVID-19 must stay home. In this class, if you are sick or quarantined, email me.

Accommodation for disabilities

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the Disability Services website. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see Temporary Medical Conditions on the Disability Services website.

Preferred student names and pronouns

CU Boulder recognizes that students’ legal information doesn’t always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors’ class rosters. In the absence of such updates, the name that appears on the class roster is the student’s legal name.

Honor code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to

academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found at the Honor Code Office website.

Sexual misconduct, discrimination, harassment and/or related retaliation

The University of Colorado Boulder (CU Boulder) is committed to fostering an inclusive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or cureport@colorado.edu. Information about the OIEC, university policies, anonymous reporting, and the campus resources can be found on the OIEC website.

Please know that faculty and graduate instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

Religious holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, I will try to accommodate your requests, but you must contact me early in the semester. See the campus policy regarding religious observances for full details.