

# PP 487: Maximum Likelihood Estimation & Applied Research Methods in Political Science

CLAREMONT GRADUATE UNIVERSITY

Spring 2023

Seminar: Tuesdays, 1:00-3:50PM (PST)

Course Location: Harper 65 &

Zoom Room [<https://cgu.zoom.us/j/84344131139>]

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**Instructor:** Carlos Algara, Ph.D.

**Office:** 227 McManus Hall

**Office Hours:** Please email me to schedule.

**Course Structure:** 2 hours concurrent (online/in-person) with 1 hour synchronous lab component

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🌐 <https://calgara.github.io>

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## Course Objectives: Moving beyond the classical linear model & assessing limited dependent variables (LDVs)

This course is designed to be the second part of the Politics & Government's methods sequence in political methodology. We build on the analytical and applied foundations of PP 480 (The Nature of Inquiry), PP 481 (Introduction to Statistical Analysis), and PP 482 (Multivariate Regression), taking the latter's emphasis on the classical linear model as our point of departure. This course also builds on the applied programming taught in SPE 489 (Computational Tools for Social Science), as we will be using the R computing environment for all applied work (i.e., problem sets, final project analysis) in this course.

The main focus of this course will be on the theory and application of maximum likelihood estimation (MLE) for data – binomial, multinomial (unordered and ordered), and discrete count models – where the classic linear model is inappropriate. Such limited dependent variables (LDVs) are ubiquitous in political science research and our goal will be to develop your ability to analyze and apply models designed for these data.

Given our severe time limitations, not all topics that are relevant to MLE/LDVs can be covered. Students should consider this course a beginning rather than an endpoint of their training and career-long engagement with political methodology. Ideally, this course will serve as a gateway to more advanced topics, such as panel and hierarchical models, mixed effects and nonparametric regression, as well as other applications you might encounter in the research settings you choose to focus on. The objectives of this course include:

- ★ (1) Provide you with a broad understanding of the fundamental problem of causal inference & limitations of various research design strategies
- ★ (2) Providing you with the tools needed to assess standing work in political science that incorporates maximum likelihood estimation methods within their broader research design
- ★ (3) Developing your understanding of the regression estimators covered in this course beyond running canned routines in a statistical package
- ★ (4) Helping you become a critical user, and presenter, of models for analyzing limited dependent variables (LDVs)
- ★ (5) Providing you with an opportunity to apply the statistical techniques covered in this course to a research question for your choosing

Taken together, this course introduces participants to a variety of statistical models that are used when assumptions of classical linear regression are violated. Participants will learn to estimate, interpret and present logistic and probit regression models for use with binary, ordinal and nominal dependent variables, as well as models for event count data. Maximum likelihood unifies these models by providing a single, coherent approach to estimation and thinking about the data generating process. Participants will learn the logic underlying these models, although the course's emphasis will be applying these methods to substantive social science research questions.

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## Course Expectations

This course is designed for Ph.D.-level students, with this course designed to give you the skills necessary to be *applied political scientists*. **This course assumes no familiarity with programming.** However, in this course, we will work with relatively clean datasets and I encourage you to take SPE 489 Computational Tools for Social Science for a more comprehensive treatment of data management principles. Studying political methodology is a labor-intensive activity. Students will be expected to complete the assigned readings in advance each week and actively participate in class sessions. Students will also be expected to devote significant time to learning how to implement the statistical techniques covered in this course in the R computing environment. We will use R for the lecture material and applications in this course.

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## Course Logistics & Requirements

This section of the syllabus serves as a guide for course expectations (both for me and for you) and logistical information such as grade breakdown and course texts.

**Course Texts, Materials, & Announcements:** All course materials, such as lecture slidsets and problem set prompts, will be made available on the [Course Canvas Page](#). We will be using

the following books in this course, note that I mark whether you have e-book access through the Claremont Colleges Library:

- ★ Agresti, Alan. 2019. *An Introduction to Categorical Data Analysis*. Third Edition. Hoboken: John Wiley & Sons, Inc. (**E-Book available through the Claremont Colleges Library**)
- ★ Bilder, Christopher R. & Thomas M. Loughin. 2015. *Analysis of Categorical Data with R*. Boca Raton, FL: Chapman & Hall/CRC Press.
- ★ Ward, Michael D. & John S. Ahlquist. 2018. *Maximum Likelihood for Social Science: Strategies for Analysis*. First Edition. Cambridge, MA: Cambridge University Press. (**E-Book available through the Claremont Colleges Library**)

**Course Lab Hour:** While there is no explicit lab component to this course, the remaining hour (from 2:45 pm to about 3:50pm) will serve as a course lab to assist students through the coding essentials and provide for more detail of in-class exercises and graded problem sets where appropriate. Moreover, students may work on their own projects and ask the instructor coding questions specifically as it relates to their projects. This hour is to assist students with applied computing and no agenda will be supplied by the instructor.

### **Grade Breakdown & Schedule:**

- ★ 5% Class Discussion Participation
- ★ 45% Homework Problem Sets
- ★ 50% Final Project

**Class Discussion Participation (5%):** To make the seminar a useful experience, you **must** come to class prepared to discuss the readings and engage with other course material. This means you should already be familiar with each of the readings and be ready to raise (and answer) interesting questions about their arguments, findings, methodological strategies, etc., during class discussion.

**Homework Problem Sets (45%):** Each student will complete **nine** homework assignments based on specific readings and/or datasets I will distribute. These assignments are to be completed in the R computing environment (unless otherwise instructed). These assignments will be due in class one week after they are distributed. You are allowed (and **encouraged**) to discuss the assignments with other students and work collaboratively. However, the final written work for the assignments (e.g., criticisms, interpretations) must be your own. Please complete the write-up of all of the assignments independently and note that **no late problem sets will be accepted without prior arrangements**. All problem sets are to be completed in R Markdown and turned in as a compiled HTML document.<sup>1</sup> Problem sets will be simply graded on the following scale:

- ✓+: Student put in the effort and got most of the answers correct

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<sup>1</sup>We will go through the structure of R Markdown in the first week of class. This format allows you to submit your code, output, and analysis in the same compiled document.

- ✓: Student finished the problem set but did not put the effort towards being thorough in responses
- ✓—: Student turned in an incomplete or did not turn in a problem set.

**Final Project (50%):** Each student will conduct a systematic analysis of data that addresses a substantively interesting question in political science and implements one of the methods assessing a LDVs covered in this course. *Note that this requires choosing a suitable LDV outcome variable corresponding to your research question and using on of the methods taught in this course.* Students can choose to collect original data for their final project, although this is not a requirement (and not recommended, if such data collection leaves you too little time to prepare a high-quality research paper). Each student will:

1. Prepare a 12-18 page research paper describing the project. The research paper should include a brief discussion of the: (1) research question, (2) theory and hypotheses to be investigated, (3) a detailed description and justification of the method being used, (4) and a full presentation of the model results (i.e., interpretation of model specification, post-estimation of relevant effects of interests, model fit) used for assessment of hypotheses.
2. An initial 1-2 page double-spaced research proposal describing the research question, *dataset* to be analyzed with identification of relevant variables, the statistical method to be used, and research design will be due on March 20<sup>th</sup>.
3. May 2<sup>nd</sup> (Week 15): *Students will give presentations during the last seminar meeting to present their research projects.* These mandatory presentations are not graded and are an opportunity to get feedback from the class. Presentations should be approximately 10-15 minutes in length and will be oral accompanied by electronic slides, much like presentations at major academic conferences such as APSA and MPSA. If you are looking to present independent conference research in the spring, I strongly encourage you to take advantage of this opportunity.

Note that students must have their proposals *approved* prior to beginning their final research projects and will receive comprehensive feedback on their proposal with ample time left in the semester. ***Final research projects will be due on May 10<sup>th</sup> at 12:00 midnight***

## Course Policies

**Course Attendance:** Students are expected to attend all classes. Students who are unable to attend class must seek permission for an excused absence from the course director or teaching assistant. Unapproved absences or late attendance for three or more classes may result in a lower grade or an “incomplete” for the course. If a student has to miss a class, he or she should arrange to get notes from a fellow student and is strongly encouraged to meet with the teaching assistant to obtain the missed material. Missed assignments will not be available for re-taking unless *prior arrangements are made with the course instructor.*

**Course Late Work & Incomplete Policy:** Late assignments will not be accepted except in

## Claremont Graduate University Course Grading Scheme

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<b>Letter Grade Grade</b>	<b>Grade Point</b>	<b>Grade Description</b>	<b>Learning Outcome</b>
A	4.0	<i>Complete mastery of course material and additional insight beyond course material</i>	<i>Insightful</i>
B	3.0	<i>Complete mastery of course material</i>	<i>Proficient</i>
C	2.0	<i>Gaps in mastery of course material; not at level expected by the program</i>	<i>Developing</i>
U	0	<i>Unsatisfactory</i>	<i>Ineffective</i>

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*Note that grades may contain pluses or minus designations as appropriate.*

the event of a medical or family/personal emergency and with coordination with the instructor. Any request for an incomplete must be approved prior to the last day of class or accompanied by a doctor's note or evidence of a family emergency. No incompletes will be given after the conclusion of the semester and without completion of over half the course work assigned.

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### CGU Academic Policies

**Class Policies:** The CGU institutional policies apply to each class offered at CGU. Students are encouraged to review the student handbook for their program as well as policy documentation in the Bulletin and on the Registrar's webpages: <http://bulletin.cgu.edu/> and <http://www.cgu.edu/registrar>. The protocols defined by the CGU's Student Conduct Code must be upheld in all classes. For more information, please visit for [CGU's Basic Code of Conduct](#) (Links to an external site.).

**Credit Hour:** Credit hour refers to the units or credits earned by a student for the successful completion of a course at CGU. These are the units recorded on transcripts and the units that are counted toward degree requirements. For CGU courses, a single unit or credit is determined by 10.5 hours of instructional activity per semester. Instructional activity includes direct instructor contact in a physical or virtual classroom as well as asynchronous instructional content for online or hybrid courses. See the full policy [here](#).

**Academic Integrity:** The work you do in this class must be your own. Information on CGU's Policy and Procedures for Violations of Standards of Academic Integrity can be found [here](#). In addition, the Claremont Colleges Library has a number of resources on academic honesty and integrity, including the following online tutorial: [here](#).

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## CGU Accommodations

**Accommodations for Students with Different Abilities:** CGU is committed to creating courses that are inclusive and accessible. If you would like to request academic accommodations due to temporary or permanent disability, contact the CGU Dean of Students and Coordinator for Student Disability Services at [DisabilityServices@cgu.edu](mailto:DisabilityServices@cgu.edu) or (909) 607-9448. Reasonable accommodations are considered after you have conferred with the Office of Disability Services (ODS) and presented the required documentation of your disability to the ODS. Planning is essential, so please communicate to the ODS as soon as possible.

**Religious Accommodations:** Students who expect to miss classes or assignments as a consequence of their religious observance shall be provided with a reasonable alternative opportunity to complete such academic responsibilities.

**Mental Health and Well Being:** Graduate school is a context where mental health struggles can arise or be exacerbated. If you ever find yourself struggling, please ask for help. If you wish to seek out campus resources, here is some basic information: [services.claremont.edu/mcaps/](http://services.claremont.edu/mcaps/). Monsour Counseling and Psychological Services (MCAPS) is committed to promoting psychological wellness for all students at The Claremont Colleges. Professional and well-trained psychologists, psychiatrists, and post-doctoral and intern therapists offer support for a range of psychological issues in a confidential and safe environment.

Phone (909) 621-8202  
After hours emergency (909) 607-2000  
Tranquada Student Services Center, 1st floor  
757 College Way  
Claremont, CA 91711

**Title IX:** Title IX. One of my responsibilities as an instructor is to help create a safe learning environment. I am a mandatory reporter. Thus, if I learn of any potential violation of CGU's gender-based misconduct policy (e.g., rape, sexual assault, dating violence, domestic violence, or stalking) by any means, I am required to notify the CGU Title IX Coordinator at [Deanof.Students@cgu.edu](mailto:Deanof.Students@cgu.edu) or (909) 607-9448. Students can request confidentiality from the institution, which I will communicate to the Title IX Coordinator. If students want to speak with someone confidentially, the following resources are available on and off campus: EmPOWER Center (909) 607-2689, Monsour Counseling and Psychological Services (909) 621-8202, and The Chaplains of The Claremont Colleges (909) 621-8685. Speaking with a confidential resource does not preclude students from making a formal report to the Title IX Coordinator if and when they are ready. Confidential resources can walk students through all of their reporting options. They can also provide students with information and assistance in accessing academic, medical, and other support services they may need.

**Your Physical Health:** . I am also committed to ensuring the health and safety of the CGU community. Information on CGU's COVID Semester protocol can be found here: <https://info.cgu.edu/emergency/> and I suspect it will be updated, as needed, as we progress.

**Campus security:** Campus security can be reached 24 hours/day at (909) 607-2000. Please download the [CGU Safety Resource Card](#) to your phone's contacts.

**Tech Issues:** The Office of Information Technology has a helpdesk to support you with CGU wireless access and email issues. They also have good documentation you can use to learn to connect and use online resources. Website: <https://mycampus.cgu.edu/web/it>.

**Center for Writing and Rhetoric (CWR):** CGU has a graduate studies-focused Center for Writing and Rhetoric that works with you no matter where you are in the writing process. The CWR is not just for remediation of your writing, but for all writers to provide partnership and consultation to improve your academic work at all levels. The CWR can work with you in planning, outlining, drafting, and final review of documents and presentations for class work, conferences, and publications. Website: <https://mycampus.cgu.edu/web/writing-rhetoric>.

**Library:** The Claremont Colleges Library has a wealth of resources, including subject specialist librarians, to support your academic work. Use the library for class work and research to access and use data-bases for articles, books, and data sets, to understand how to conduct effective searches and evaluate sources, use digital tools, and much more. The library offers workshops and 1-1 consultations with students as well. Website: <https://library.claremont.edu/>.

## Course Road-Map

1. Week 1 (1/17/2023): Introduction to the Course Syllabus, Canvas, and Installing R, R Studio, & L<sup>A</sup>T<sub>E</sub>X Distribution

- ★ Please see Canvas for materials regarding how to install R & R Studio.
- ★ For additional information regarding the installation of R, see: [here](#).
- ★ For additional information regarding the installation of L<sup>A</sup>T<sub>E</sub>X, see: [here](#).
- ★ For a comprehensive introduction of R Markdown, see: [here](#).

2. Week 2 (1/24/2023): The Fundamental Problem of Causal Inference (An Introduction)

- ★ Angrist & Pischke's *Mostly Harmless Econometrics*. Princeton University Press. 2009. **Chapters 1- 2, instructor will distribute this on Canvas.**
- ★ Kellstedt & Whitten's *The Fundamentals of Political Science Research*. Cambridge University Press. 2018. **Chapters 3- 4, instructor will distribute this on Canvas.**
- ★ **Recommended (but not required):** Rosenblum's *Design of Observational Studies*. Springer Press. 2010. **Chapters 1-4, instructor will distribute this on Canvas.**

**Causal Inference Problem Set 1 Due February 7<sup>th</sup>**

**Short OLS Review Problem Set 2 Due February 7<sup>th</sup>**

3. Week 3 (1/31/2023): Methodological Preliminaries & Shortcoming of Ordinary Least Squares (OLS) Regression for Discrete Categorical Outcome Variables

- ★ Fox's *Applied Regression Analysis & Generalized Linear Models*. Sage Press. 2016. **Chapter 14 (pp. 370-391)**
- ★ James et al.'s *An Introduction to Statistical Learning with Applications in R*. Springer Press. 2013. **Chapters 3-4 (pp. 59-133), instructor will distribute this on Canvas.**
- ★ Kellstedt & Whitten's *The Fundamentals of Political Science Research*. Cambridge University Press. 2018. **Chapter 6, instructor will distribute this on Canvas.**
- ★ **Recommended for a comprehensive review for regression:** Kellstedt & Whitten's *The Fundamentals of Political Science Research*. Cambridge University Press. 2018. **Chapter 8 & 9**

**OLS Shortcomings Problem Set 3 Due February 14<sup>th</sup>**

4. Week 4 (2/7/2023): Introduction & Properties to Maximum Likelihood Estimation (MLE)



- ★ Agresti, **Chapter 1.**
  - ★ Bilder and Loughin, **Chapter 1**
  - ★ Ward, **Chapters 1 & 2**
5. Week 5 (2/14/2023) & 6 (2/21/2023): Binary Choice Models Unit I: Introduction to Logistic and Probit Regression
- ★ Agresti, **Chapters 3-4.**
  - ★ Bilder and Loughin, **Chapter 2.**
  - ★ Ward, **Chapter 3**
  - ★ **Recommended but not required:** Agresti, **Chapter 5.**

### Binary Choice Model I Set 4 Due February 21<sup>st</sup>

6. Week 7 (2/28/2023) & 8 (3/7/2023): Binary Choice Models Unit II: Diagnostics & Interpretation of Binary Choice Models (with an emphasis on model post-estimation of quantities of interest such as predicted probabilities & marginal effects)
- ★ Bilder and Loughin, **Chapter 5, pp. 265-300, 318-329.**
  - ★ Ward, **Chapters 4, 5, 6**
  - ★ Hainmueller, Jens, Mummolo, Jonathan, & Xu, Yiqing. 2018. “How Much Should We Trust Estimates from Multiplicative Interaction Models? Simple Tools to Improve Empirical Practice.” *Political Analysis*, 1–30.
  - ★ Arel-Bundock, Vincent. 2022. `marginaleffects`: Marginal Effects, Marginal Means, Predictions, and Contrasts. R package version 0.8.1, <https://vincentarelbundock.github.io/marginaleffects/><sup>2</sup>
  - ★ **Not required, but subject of an in-class replication:** Algara, Carlos & Isaac Hale. 2023. “Race, Partisanship, and Democratic Politics: The of Racial Attitudes in Motivating White Americans’ Electoral Participation.” *Forthcoming at the Journal of Race, Ethnicity, and Politics*.

### Binary Choice II Problem Set 5 Due March 14<sup>th</sup>

★ CGU Spring Break from March 13<sup>th</sup>-18<sup>th</sup> ★

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<sup>2</sup>Note that this is an interactive, comprehensive, R package tutorial that allows for the post-estimation of quantities of interest (i.e., marginal effects, predicted probabilities, interactive relationships) that will make interpretation of all models discussed in this course (and more!) intuitive. We will rely on this package for post-estimation and interpretation this point moving forward in the course.

### Research Proposal Problem Set 6 Due March 21<sup>st</sup>

7. Week 9 (3/21/2023) & 10 (3/28/2023) Multi-Category Nominal Choice Regression Models: Multinomial Logistic Regression

- ★ Agresti, **Chapter 6, pp. 159-167.**
- ★ Bilder and Loughin, **Chapter 3, pp. 141-170.**
- ★ Ward, **Chapter 9**
- ★ **Not required, but subject of an in-class replication:** Dancey, Logan & Geoff Sheagley. 2023. "Heuristics Behaving Badly: Party Cues and Voter Knowledge." *American Journal of Political Science*.

### Multinomial Logit Problem Set 7 Due March 28<sup>th</sup>

8. Week 11 (4/4/2023) & 12 (4/11/2023): Ordered Choice Regression Models: Introduction to Ordered Logistic & Probit Regression

- ★ Agresti, **Chapter 6, pp. 167-187.**
- ★ Bilder and Loughin, **Chapter 3, pp. 170-187.**
- ★ Ward, **Chapter 8**
- ★ **Not required, but subject of an in-class replication:** Gadarian, Shana Kushner, Sarah Wallace Goodman, & Tom Pepinsky. 2013. "Partisanship, health behavior, and policy attitudes in the early stages of the COVID-19 pandemic." *PLoS One*.

### Ordered Logit Problem Set 8 Due April 11<sup>th</sup>

9. Week 13 (4/18/2023) & 14 (4/25/2023) Discrete Count Models: Introduction to Poisson & Negative Binomial Regression

- Bilder and Loughin, **Chapter 4 and 5, pp. 301-318, 329-345.**
- Ward, **Chapter 10**
- Algara, Carlos, & Zamadics, Joseph. 2021. "Ideological cross-pressures or random error? An analysis of spatially inconsistent voting in the US House and US Senate." *The Journal of Legislative Studies*, 1–35.

### Count Models Problem Set 9 Due April 25<sup>th</sup>

10. Week 15 (5/2/2023): **No new course module readings**

**\* 10-15 Minute PP 487L Research Project Presentations on May 2<sup>nd</sup> \***

**Final Research Project Due May 10<sup>th</sup>**

**\* CGU Finals Week from May 8<sup>th</sup>-13<sup>th</sup> \***

This syllabus was last updated on: March 13, 2023

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