Course Description

This class is intended to introduce students to statistical methods commonly employed in political science. It builds on prior classes in mathematical statistics and ordinary least squares in the methods sequence. The bulk of the material (approximately $\frac{2}{3}$ of the syllabus) is devoted to statistical models employed when our outcomes of interest assume discrete values. In particular, we will be focusing on maximum likelihood estimation (MLE) techniques for applying regression models to such situations. The remaining $\frac{1}{3}$ of the syllabus is devoted to data structures under which some of common assumptions regarding the data generating process are violated (i.e., duration data, panel data, time series cross sectional data, hierarchical data). We will explore different models which may be appropriate for these contexts, some of which rely on MLE, some of which may be obtained through least squares. An additional aim of the course is to familiarize students with the statistical software package R.

Assignments

I will distribute problem sets throughout the semester, on an approximately biweekly basis. Problem sets are due one week after they are distributed. Submission should be via email, and all responses and R code should be compiled in the same pdf document. Students may work in groups on the problem sets, but every student should submit her own completed problem set.

In addition to the problem sets, students will be required to draft a final paper which makes use of one or more of the methods we cover in class. Ideally, this paper will serve as a jumping off point for future (i.e., dissertation) work. The paper should specify empirical hypotheses, detail and execute an appropriate model to test these hypotheses, and interpret the results. I will grade the papers based on the appropriateness of the methods as a means of testing the hypotheses given and on the execution and interpretation of the results.

I would strongly advise either using this paper as an opportunity to get a jump start on dissertation work, or combining this paper with term papers you are either drafting or have already

drafted for other classes which might serve as theoretical basis for your hypotheses. However, it would also be acceptable to submit a replication/extension of an existing published work. On a case-by-case basis, it may be possible to submit a detailed research plan in lieu of a complete analysis if, for instance, a significant part of your future research plans involve (yet to be completed) data collection.

Grading

    45% problem sets
    45% final paper
    10% participation

Texts:

Gary King. *Unifying Political Methodology: The Likelihood Theory of Statistical Inference*. University of Michigan Press, 1998

James E. Monogan III. *Political Analysis Using R*. Springer, 2015

William H. Greene. *Econometric Analysis*. Prentice-Hall, Inc., 5th edition, 2002 (Recommended)

Software

All of our data analysis will be in R. R is freeware available from http://www.r-project.org.

To work effectively in R, you will need a text editor. I have heard positive things about RStudio, which is available as freeware (https://www.rstudio.com/), though have never used it myself. I have used Tinn-R (https://sourceforge.net/projects/tinn-r/), which is also freeware, works well, and is fairly user friendly.

Another option is to use a general purpose editor. I use the emacs (https://www.gnu.org/-software/emacs/download.html) editor, which is open source, highly customizable, and is an effective editor for just about any code you will encounter (e.g., T$_E$X, python, html, etc.). emacs will both act as an editor for R code and run the R GUI when the emacs speaks statistics (ESS) package is installed (https://ess.r-project.org/). The downside of emacs is that it isn't particularly user friendly – the GUI is minimal and it mostly operates via keystrokes which need to be memorized, its customizability implies that a lot of time must be spent customizing things and installing packages. So, there are considerable start-up costs.

I would recommend, but won't require, that all written work be conducted in T$_E$X. To draft

LaTeXdocuments, you will first need to download a compiler, namely MikTeX(https://miktex.org/-download). Then, as with R, you will require an editor. If you opt for a general purpose editor, like emacs, for R; this editor will handle TeXcode as well. With emacs, you can use the AUCTeXplugin (https://www.gnu.org/software/auctex/). There are many stand-alone TeXeditors available as well. In the past, I have used WinEDT, which sadly isn't freeware. I have heard positive things about TeXWorks. LyX (https://www.lyx.org/) offers a user-friendly wrapper that allows one to produce TeXdocuments with minimal coding (at the sacrifice of some user control).

Class Outline

**September 9th: Course Overview and the Linear Model: OLS vs. MLE**

Review of the syllabus and course requirements
Refreshing the derivation of OLS
Maximum likelihood theory
MLE derivation of the linear model

*Readings:*

- Skim chapters 1-3, Read 4-4.3 in Gary King. *Unifying Political Methodology: The Likelihood Theory of Statistical Inference*. University of Michigan Press, 1998

- Recommended: Chapters 17.1-3, 17.6 in William H. Greene. *Econometric Analysis*. Prentice-Hall, Inc., 5th edition, 2002. Appendix A is also a useful reference for matrix algebra.


**September 16th: Inference in MLE and R Implementations**

Likelihood ratio and Wald tests
Information matrix and MLE standard errors
Implementing the OLS regression using matrices in R
Maximizing likelihood functions in R

*Readings:*

- 4.4 through 4.7 in Gary King. *Unifying Political Methodology: The Likelihood Theory of Statistical Inference*. University of Michigan Press, 1998

- Chapters 10-11.5 in James E. Monogan III. *Political Analysis Using R*. Springer, 2015

- Recommended: Chapters 17.4-17.5 in William H. Greene. *Econometric Analysis*. Prentice-Hall, Inc., 5th edition, 2002

## September 23: Dichotomous Outcome Variables

General likelihood for dichotomous data
Logit and probit link functions
Latent variable interpretation of logit and probit
R implementation of logit and probit

*Readings:*

- 5-5.3 in Gary King. *Unifying Political Methodology: The Likelihood Theory of Statistical Inference*. University of Michigan Press, 1998

- 7-7.1 in James E. Monogan III. *Political Analysis Using R*. Springer, 2015

- Recommended: Chapters 21.3-21.4 in William H. Greene. *Econometric Analysis*. Prentice-Hall, Inc., 5th edition, 2002

## September 30: Logit and Probit Interpretation, Quantities of Interest, and Complications

Coefficients in logit and probit
Predicted probabilities and implementation in R
Functional form implication: marginal effects and scobit
Functional form implications: interaction terms
Model fit

*Readings:*

- Thomas Brambor, William Roberts Clark, and Matt Golder. Understanding interaction models: Improving empirical analyses. *Political Analysis*, 13:1–20, 2005

- Jonathan Nagler. Scobit: An alternative estimator to logit and probit. *American Journal of Political Science*, 38(1):230–255, February 1994

- William D. Berry, Jacqueline H.R. DeMeritt, and Justin Esarey. Testing for interaction effects in binary logit and probit models: Is an interaction term necessary. *The American Journal of Political Science*, 54(1):248–266, January 2010

- Michael C. Herron. Postestimation uncertainty in limited dependent variable models. *Political Analysis*, 8(1):83–98, 1999

## October 7: Ordinal Outcome Variables

Refreshing the latent variable interpretation of dichotomous models
Extending this interpretation to ordered data
Logit and Probit link functions
Marginal effects and quantities of interest

*Readings:*

- 5.4 in Gary King. *Unifying Political Methodology: The Likelihood Theory of Statistical Inference*. University of Michigan Press, 1998

- Emilie M. Hafner-Burton and Kiyoteru Tsutsui. Justice lost! the failure of international human rights law to matter where its needed most. *Journal of Peace Research*, 44(4):407–425, 2007

- Recommended: Chapter 21.8 in William H. Greene. *Econometric Analysis*. Prentice-Hall, Inc., 5th edition, 2002

## October 14: Ordinal Models in R

Running ordered logit and probit in R
Obtaining marginal effects
Plotting quantities of interest

*Readings:*

- 7.2 in James E. Monogan III. *Political Analysis Using R*. Springer, 2015

## October 21: Multichotomous Outcome Variables

Random utility models and multichotomous choice
Multinomial versus conditional logit
The IIA assumption
Mutlinomial probit

Overview of more complex extensions

*Readings:*

- Chapters 15.1-15.5, and 15.8 in A. Colin Cameron and Pravin K. Trivedi. *Microeconometrics: Methods and Applications.* Cambridge University Press, 2005

- R. Michael Alvarez and Jonathan Nagler. When politics and models collide: Estimating models of multiparty elections. *American Journal of Political Science*, 42(1):55–96, January 1998

- Teppei Yamamoto. A multinomial response model for varying choice sets, with application to partially contested multiparty elections. April 2014

- Recommended: Chapters 21.6-21.7 in William H. Greene. *Econometric Analysis*. Prentice-Hall, Inc., 5th edition, 2002

## October 28: Multichotomous Models in R

Running multinomial and conditional logit models in R
Demonstration of misspecification issues
Running multinomial probit in R
Demonstration of meaning of implications of IIA

*Readings:*

- https://stats.idre.ucla.edu/r/dae/multinomial-logistic-regression/

- https://cran.r-project.org/web/packages/mlogit/vignettes/Exercises.pdf

## November 4: Count Outcome Variables

Poisson model
Meaning and implications of overdispersion
Negative binomial model
Zero-inflated and hurdle models

*Readings:*

- 5.7-5.10 in Gary King. *Unifying Political Methodology: The Likelihood Theory of Statistical Inference*. University of Michigan Press, 1998

- Christopher J.W. Zorn. An analytic and empirical investigation of zero-inflated and hurdle poisson specifications. *Sociological Methods and Research*, 26:368–400, 1998

- Recommended: Chapter 21.9 in William H. Greene. *Econometric Analysis*. Prentice-Hall, Inc., 5th edition, 2002

**November 11: Count Models in R**

Running Poisson and negative binomial models in R
Predicted probabilities
Marginal effects

*Readings:*

- 7.3 in James E. Monogan III. *Political Analysis Using R*. Springer, 2015

**November 18: Binary Time Series Cross Sectional Data**

Defining survival data
Implications of duration dependence
Parametric models: Exponential and Weibull
Semi-parametric models: Cox
Relation btwn. Cox and logit/probit specifications

*Readings:*

- Chapters 2-4 in Janet M. Box-Steffensmeier and Bradford S. Jones. *Event History Modeling: A Guide for Social Scientists*. Cambridge University Press, 2004

- Nathaniel Beck, Jonathan N. Katz, and Richard Tucker. Taking time seriously: Time-series-cross-section analysis with a binary dependent variable. *American Journal of Political Science*, 42(4):1260–1288, October 1998

- Recommended: Chapter 22.5 in William H. Greene. *Econometric Analysis*. Prentice-Hall, Inc., 5th edition, 2002

**November 25: BTSCS Ctn'd and Lab**

Semi-parametric specifications cnt'd
Competing risks
R implementation: Weibull and Cox

*Readings*

- Hein E. Goemans. Which way out? the manner and consequences of losing office. *Journal of Conflict Resolution*, 52(6):771–794, December 2008

- https://www.openintro.org/download.php?file=survival_analysis_in_R&referrer=/stat/surv.php


**December 2: Time Series and Time-Series Cross Sectional Data**

Stationarity and Non-Stationarity
Time-Series Operators
Dynamic Specifications: LDV, ADL, and ECM
Moving from TS to TSCS Data
Correcting standard errors: Clustering and PCSEs

*Readings:*

- Nathaniel Beck and Jonathan N. Katz. Modeling dynamics in time-series-cross-section political economy data. *Annual Review of Political Science*, 14:331–352, 2011

- Suzanna De Boef and Luke Keele. Taking time seriously. *American Journal of Political Science*, 52(1):184–200, January 2008

- https://www.princeton.edu/ otorres/Panel101R.pdf

- Recommended: Chapter 13 in William H. Greene. *Econometric Analysis*. Prentice-Hall, Inc., 5th edition, 2002 (appropriate for next session as well)


**December 9: Fixed Effects, Random Effects, and Multilevel/Hierarcical Modeling**

TSCS specification issues: Invariant characteristics
Issues with FEs 1: Nickel bias
Issues with FEs 2: Rarely varying covariates

REs and hierarchical models

*Readings:*

- Donald P. Green, Soo Yeon Kim, and David H. Yoon. Dirty pool. *International Organization*, 55(2):441–468, Spring 2001

- Nathaniel Beck and Jonathan Katz. Throwing the baby out with the bath water: A comment on green, kim, and yoon. *International Organization*, 55(2):487–495, Spring 2001

- Chapters 11-12 in Andrew Gelman and Jennifer Hill. *Data Analysis Using Regression and Multilevel/Hierarchical Models*. Analytical Methods in Social Science. Cambridge University Press, 2006

STANDARD STATEMENT ON COURSE REQUIREMENTS:

POLITICAL SCIENCE DEPARTMENT

(Note: For further information, please see the University "Classroom, Grading, and Examination Procedures" brochure online at http://www.cla.umn.edu/cgep/)

1. The two grading systems used are the ABCDF and S-N. Political Science majors must take political science courses on the ABCDF system; non-majors may use either system. In all political science courses the bottom line for the S grade is the equivalent of the C- grade; in other words, what is normally considered as D level work will be assigned a grade of N on the S-N system. All students, regardless of the system used, will be expected to do all work assigned in the course, or its equivalent as determined by the instructor.

2. The instructor will specify the conditions if any, under which an 'Incomplete' will be assigned instead of a grade. No student has an automatic right to an I. The instructor may set dates and conditions for makeup of work, if it is to be allowed. The Department of Political Science administers a general make-up exam every quarter for students who have written permission from the Instructor to make up a missed final examination. Inquire at the Undergraduate Advising office (1482 Social Sciences) for the date scheduled for the make-up.

3. Inquiries regarding any change of grade should be directed to the instructor of the course. A student who alleges unfairness on the part of an instructor is entitled to file a grievance with the Department's Grievance Committee.

4. Students are responsible for class attendance and all course requirements, including deadlines and examinations. The instructor will specify if class attendance is required or counted in the grade for the class.

5. The instructor has the right to request, and the student must provide if requested, verification for absences, with the exception of a single episode medical absence that does not require medical services.

6. The instructor has the right to request verification for a single episode medical absence if (i) the student has had more than one single episode medical absence in the class, or (ii) the single episode medical absence involves missing laboratory sessions,exams or important graded in-class assignments.

7. The College does not permit a student to submit extra work in an attempt to raise his or her grade, unless the Instructor has specified at the outset of the class such opportunities afforded to all students.

8. The College has defined scholastic misconduct broadly as "any act that violates the rights of another student in academic work or that involves misrepresentation of your own work." Scholastic dishonesty includes (but is not necessarily limited to): cheating on assignments or examinations; plagiarizing, which means misrepresenting as your own work any part of work done by another; submitting the same paper, or substantially similar papers, to meet the requirements of more than one course without the approval and consent of all instructors concerned; depriving another student of necessary course materials; or interfering with another student's work. Instructors may define additional standards beyond these. Further information is available at `http://www1.urnn.edu/regents/policies/academic/Student_Conduct_Code.pdf`

9. The U of M is committed to providing all students equal access to learning opportunities. Disability Services (DS) is the campus office that works with students who have disabilities to provide and/or arrange reasonable accommodations. Students who have, or think they may have, a disability (mental health, attentional, learning, vision, hearing, physical or systemic), are invited to contact Disability Services to arrange a confidential discussion at 612-626-1333 (VTTY) or `ds@umn.edu`. Students registered with DS, who have a letter requesting accommodations, are encouraged to contact the instructor early in the semester to discuss accommodations outlined in their letter. Further information is available at the Disability Services website: `http://ds.umn.edu/`

10. University policy prohibits sexual harassment as defined in the 12/1111998 policy statement. The full statement is available at: http://www1.umn.edu/regents/policies/humanresources/-Sex.Harassment.html. Complaints about sexual harassment should be reported to the University Office of Equal Opportunity at 419 Morrill Hall.

11. As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, and feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. University of Minnesota services are available to assist you with addressing these and other concerns you may be experiencing. You can learn more about

the broad range of confidential mental health services available on campus via the Student Mental Health Website at http://www.mentalhealth.umn.edu/

- Student Conduct Code:

  The University seeks an environment that promotes academic achievement and integrity, that is protective of free inquiry, and that serves the educational mission of the University. Similarly, the University seeks a community that is free from violence, threats, and intimidation; that is respectful of the rights, opportunities, and welfare of students, faculty, staff, and guests of the University; and that does not threaten the physical or mental health or safety of members of the University community.

  As a student at the University you are expected adhere to Board of Regents Policy: Student Conduct Code. To review the Student Conduct Code, please see: `http://regents.umn.edu/sites/default/files/policies/Student_Conduct_Code.pdf`.

  Note that the conduct code specifically addresses disruptive classroom conduct, which means "engaging in behavior that substantially or repeatedly interrupts either the instructor's ability to teach or student learning. The classroom extends to any setting where a student is engaged in work toward academic credit or satisfaction of program-based requirements or related activities."

- Use of Personal Electronic Devices in the Classroom:

  The University establishes the right of each faculty member to determine if and how personal electronic devices are allowed to be used in the classroom. For complete information, please reference: http://policy.umn.edu/Policies/Education/Education/STUDENTRESP.html.

- Scholastic Dishonesty:

  You are expected to do your own academic work and cite sources as necessary. Failing to do so is scholastic dishonesty. Scholastic dishonesty means plagiarizing; cheating on assignments or examinations; engaging in unauthorized collaboration on academic work; taking, acquiring, or using test materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; altering, forging, or misusing a University academic record; or fabricating or falsifying data, research procedures, or data analysis. If it is determined that a student has cheated, he or she may be given an "F" or an "N" for the course, and may face additional sanctions from the University. For additional information, please see: `http://policy.umn.edu/`

`Policies/Education/Education/INSTRUCTORRESP.html`. The Office for Student Conduct and Academic Integrity has compiled a useful list of Frequently Asked Questions pertaining to scholastic dishonesty: http://www1.umn.edu/oscai/integrity/student/index.html. If you have additional questions, please clarify with your instructor for the course.

- Makeup Work for Legitimate Absence:
  Students will not be penalized for absence during the semester due to unavoidable or legitimate circumstances. http://policy.umn.edu/Policies/Education/Education/MAKEUPWORK.html.

- Appropriate Student Use of Class Notes and Course Material:
  Taking notes is a means of recording information but more importantly of personally absorbing and integrating the educational experience. However, broadly disseminating class notes beyond the classroom community or accepting compensation for taking and distributing classroom notes undermines instructor interests in their intellectual work product while not substantially furthering instructor and student interests in effective learning. Such actions violate shared norms and standards of the academic community. For additional information, please see: `http://policy.umn.edu/Policies/Education/Education/STUDENTRESP.html`.

- Grading and Transcripts:
  The University utilizes plus and minus grading on a 4.000 cumulative grade point scale. The two grading systems used are the ABCDF and S-N. Political science majors and minors must take POL courses on the ABCDF system. An S grade is the equivalent of a C- or better. Inquiries regarding grade changes should be directed to the course instructor. Extra work in an attempt to raise a grade can only be submitted with the instructor's approval. For additional information, please refer to: http://policy.umn.edu/Policies/Education/Education/GRADINGTRANSCRIPTS.html.

- Incompletes:
  The instructor may set dates and conditions for makeup work using a "Completion of Incomplete Work" contract form. All work must completed no later than one calendar year after the official last day of the class.

- Sexual Harassment:
  "Sexual harassment" means unwelcome sexual advances, requests for sexual favors, and/or other verbal or physical conduct of a sexual nature. Such conduct has the purpose or effect of unreasonably interfering with an individual's work or academic performance or creating

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an intimidating, hostile, or offensive working or academic environment in any University activity or program. Such behavior is not acceptable in the University setting. For additional information, please consult Board of Regents Policy: [http://regents.umn.edu/sites/default/files/-policies/SexHarassment.pdf](http://regents.umn.edu/sites/default/files/-policies/SexHarassment.pdf). University of Minnesota employees must report sexual misconduct they learn about in accordance with University policy. More information on mandated reporting can be found here: [http://diversity.umn.edu/eoaa/reporting](http://diversity.umn.edu/eoaa/reporting)

- Equity, Diversity, Equal Opportunity, and Affirmative Action:
  The University provides equal access to and opportunity in its programs and facilities, without regard to race, color, creed, religion, national origin, gender, age, marital status, disability, public assistance status, veteran status, sexual orientation, gender identity, or gender expression. For more information, please consult Board of Regents Policy: `http://regents.umn.edu/sites/default/files/policies/Equity_Diversity_EO_AA.pdf`.

- Disability Accommodation:
  The University of Minnesota is committed to providing equitable access to learning opportunities for all students. The Disability Resource Center is the campus office that collaborates with students who have disabilities to provide and/or arrange reasonable accommodations. If you have, or think you may have, a disability (e.g., mental health, attentional, learning, chronic health, sensory, or physical), please contact DS at 612-626-1333 to arrange a confidential discussion regarding equitable access and reasonable accommodations. If you are registered with DS and have a current letter requesting reasonable accommodations, please contact your instructor as early in the semester as possible to discuss how the accommodations will be applied in the course. For more information, please see the DS website `https://diversity.umn.edu/disability/`.

- Mental Health and Stress Management:
  As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance and may reduce your ability to participate in daily activities. University of Minnesota services are available to assist you. You can learn more about the broad range of confidential mental health services available on campus via the Student Mental Health Website: [http://www.mentalhealth.umn.edu](http://www.mentalhealth.umn.edu).

- Academic Freedom and Responsibility:
  Academic freedom is a cornerstone of the University. Within the scope and content of the

course as defined by the instructor, it includes the freedom to discuss relevant matters in the classroom. Along with this freedom comes responsibility. Students are encouraged to develop the capacity for critical judgment and to engage in a sustained and independent search for truth. Students are free to take reasoned exception to the views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled. Reports of concerns about academic freedom are taken seriously, and there are individuals and offices available for help. Contact the instructor, the Department Chair, your adviser, the associate dean of the college, or the Vice Provost for Faculty and Academic Affairs in the Office of the Provost. Students are responsible for class attendance and all course requirements, including deadlines and examinations. The instructor will specify if class attendance is require or counted in the grade for the class.