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**PSC 505**  
**MLE (+ Other Topics)**

Fall 2016  
Wed 10-11:30, Fri 9-10:15 H329

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**COURSE DESCRIPTION:** This course builds upon the analytical and applied foundations of PSC 404 and 405, taking the latter's emphasis on the classical linear model as its point of departure. Because the classical linear regression model is inappropriate for data that arises in many interesting areas of political science, students need additional statistical tools in order to conduct rigorous empirical research. In this course, students will learn methods to analyze models and data for event counts, durations, censoring, truncation, selection, multinomial ordered/unordered categories, and strategic choices – in other words, all the other data out there. From time to time, we will also venture into semi-parametric methods, nonparametric methods, and machine learning, especially when those topics complement the MLE techniques we are studying.

A major goal of the course will be to teach students how to develop new models and techniques for analyzing issues they encounter in their own research. “Canned” statistical routines are often not appropriate for most of the micro-level models we develop as political science researchers. Students will therefore be required to program their own statistical routines (primarily in R).

**PREREQUISITES:** PSC 404 and 405, or the equivalent.

**COURSE REQUIREMENTS:** Course grades will be based on a series of homeworks (45%), a midterm exam (20%), a final exam (30%), and participation (5%). The homeworks will consist of a mix of analytical problems, programming, and data analysis. For homeworks, students are encouraged to work in groups of any size, so long as that size is no greater than two.

**READINGS:** Students are responsible for keeping up with the reading each week. I post my lecture notes and will provide links or copies of articles from time to time. In addition, students should read the appropriate chapters in the following, many of which are available in the star lab:

- Yudi Pawitan. 2013. *In All Likelihood: Statistical Modeling and Inference Using Likelihood*. Oxford.
- Gary King. 1998. *Unifying Political Methodology*. Michigan.
- W. John Braun & Duncan J. Murdoch. *A First Course in Statistical Programming with R*. Cambridge.
- G.S. Maddala. *Limited-Dependent and Qualitative Variables in Econometrics*. Cambridge.
- William H. Greene. 1997. *Econometric Analysis*. 5<sup>th</sup> edition. Prentice Hall.
- Peter Kennedy. 1998. *A Guide to Econometrics*. 4<sup>th</sup> edition. MIT.
- The star lab introduction to R.
- Patrick Burns. 2011. *The R Inferno*.

- W.N. Venables and B.D. Ripley. *Modern Applied Statistics with S*. Springer.

## COURSE OUTLINE:

### 1. R Programming and Monte Carlo Simulation

- W. John Braun & Duncan J. Murdoch. *A First Course in Statistical Programming with R*.
- Burns, Patrick. 2011. *The R Inferno*. Manuscript.

### 2. Maximum Likelihood Estimation

- Pawitan, 2013. *In All Likelihood*. Chapters 1-3, 6.1.
- King, Gary. 1998. *Unifying Political Methodology*. Chapters 1-4.
- Rodriguez, G. 2001. "Appendix A: Review of Likelihood Theory."

### 3. Binary Data, Count Data, and Issues in Nonlinear Models

#### 3.1 Binary Data and Count Data

- Pawitan, 2013. *In All Likelihood*. Chapters 4.1-4.8. (Bernoulli, Binomial, Poisson)
- Pawitan, 2013. *In All Likelihood*. Chapter 6.2-6.3. (Logistic & Poisson Regression)
- King, Gary. 1998. *Unifying Political Methodology*. Chapters 5.6-5.10.

#### Recommended

- King, Gary and Curtis S. Signorino. 1996. "The Generalization in the Generalized Event Count Model, with Comments on Achen, Amato and Londegren." *Political Analysis* 6: 225-252.
- Prentice, R. L. 1986. "Binary Regression Using an Extended Beta-Binomial Distribution, With Discussion of Correlation Induced by Covariate Measurement Errors." *Journal of the American Statistical Association* 81: 321-327.

#### 3.2 Standard Errors and Confidence Intervals

- Pawitan, 2013. *In All Likelihood*. Chapter 5.
- King, Gary. 1991. "Calculating Standard Errors of Predicted Values based on Nonlinear Functional Forms." *The Political Methodologist* 4(2).
- Efron, Bradley and Gail Gong. 1983. "A Leisurely Look at the Bootstrap, the Jackknife, and Cross-Validation." *The American Statistician*. 37(1):36-48.

#### 3.3 Interaction Terms in Nonlinear Models

- Norton, Edward C., Hua Wang, and Chunrong Ai. "Computing Interaction Effects and Standard Errors in Logit and Probit Models." *The Stata Journal* 4: 103-116.
- Ai, Chunrong and Edward C. Norton. 2003. "Interaction Terms in Logit and Probit Models." *Economics Letters* 80:123-129.
- Braumoeller, Bear F. 2004. "Hypothesis Testing and Multiplicative Interaction Terms." *International Organization* 58: 807-820.
- Brambor, Thomas, William Clark, and Matt Golder. 2006. "Understanding Interaction Models: Improving Empirical Analyses." *Political Analysis*. 14:63-82.

#### Homework Reading

- Martin, Lisa. 1992. *Coercive Cooperation*. Chapters 2 – 4.

- Chang, Eric C. 2005. "Electoral Incentives for Political Corruption under Open-List Proportional Representation." *Journal of Politics* 87: 716-730.

#### 4. Duration Models

##### 4.1 Parametric Models

- Pawitan, 2013. *In All Likelihood*. Chapters 4.9, 11.5-11.6.
- Box-Steffensmeier, Janet and Bradford S. Jones. 2004. *Event History Modeling: A Guide for Social Scientists*. Chapters 2 – 8.
- King, Gary, James E. Alt, Nancy Elizabeth Burns, and Michael Laver. 1990. "A Unified Model of Cabinet Dissolution in Parliamentary Democracies." *American Journal of Political Science* 34: 846-871.

##### Recommended

- 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: 1-24.

##### 4.2 Cox Proportional Hazard Models

- Pawitan, 2013. *In All Likelihood*. Chapter 11.7.
- Box-Steffensmeier, Janet and Bradford S. Jones. 2004. *Event History Modeling: A Guide for Social Scientists*. Chapter .
- Box-Steffensmeier, Janet M. and Christopher J. W. Zorn. 2001. "Duration Models and Proportional Hazards in Political Science." *American Journal of Political Science* 45: 972-988.

##### Recommended

- Blossfeld, Hans-Peter and Gotz Rohwer. 2001. *Techniques of Event History Modeling: A New Approach to Causal Analysis*. Chapters 1, 3, 8 – 10.
- Kalbfleisch, J. D. and R. L. Prentice. 1980. *The Statistical Analysis of Failure Time Data*. Chapter 4.

##### 4.3 Grouped Binary Duration Data

- Beck, Nathaniel, Jonathan N. Katz, and Richard Tucker. 1998. "Taking Time Seriously: Time-Series-Cross-Section Analysis with a Binary Dependent Variable." *American Journal of Political Science* 42: 1260-1288.
- Carter, David B. and Curtis S. Signorino. 2009. "Back to the Future: Modeling Time Dependence in Binary Data." *Political Analysis*. 18(3):271-292.
- Oneal, John R. and Bruce M. Russett. 1997. "The Classical Liberals Were Right: Democracy, Interdependence, and Conflict, 1950-1985." *International Studies Quarterly* 41:267-293.

##### Supplemental Reading on Splines

- Ruppert, David, M. P. Wand, and R. J. Carroll. 2003. *Semiparametric Regression*. Chapter 3.
- Ridgeway, Greg. "Splines."
- Fox, John. 2000. *Nonparametric Simple Regression: Smoothing Scatterplots*. Chapter 6.

#### 5. GLMs and IWLS

- Pawitan, 2013. *In All Likelihood*. Chapter 4.9, 6.5-6.7.

## 6. Censoring and Truncation

- Sigelman, Lee and Langche Zeng. 1999. "Analyzing Censored and Sample-Selected Data with Tobit and Heckit Models." *Political Analysis* 8. Read pages 167-177.
- King, Gary. 1998. *Unifying Political Methodology*. Chapter 9.
- Krehbiel, Keith and Douglas Rivers. 1988. "The Analysis of Committee Power: An Application to Senate Voting on the Minimum Wage." *American Journal of Political Science* 32: 1151—1174.
- Smith, Alastair. 1999. "Testing Theories of Strategic Choice: The Example of Crisis Escalation." *American Journal of Political Science* 43: 1254--1283.

### Recommended

- Amemiya, Takeshi. 1984. "Tobit Models: A Survey." *Journal of Econometrics* 24: 3-60.
- Maddala, G. S. 1983. *Limited-Dependent and Qualitative Variables in Econometrics*. Chapter 5.

## 7. Selection Models

- Sigelman, Lee and Langche Zeng. 1999. "Analyzing Censored and Sample-Selected Data with Tobit and Heckit Models." *Political Analysis* 8: 167-182.
- Heckman, James J. 1979. "Sample Selection Bias as a Specification Error." *Econometrica* 47: 153-162.
- Reed, William. 2000. "A Unified Statistical Model of Conflict Onset and Escalation." *American Journal of Political Science* 44: 84—93.

### Recommended:

- Heckman, James J. 1976. "The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for Such Models." *Annals of Economic and Social Measurement* 5: 475-492.
- Dubin, Jeffrey A. and Douglas Rivers. 1989. "Selection Bias in Linear Regression, Logit, and Probit Models." *Sociological Methods and Research*. 18:360-390.
- Meng, Chun-Lo and Peter Schmidt. 1985. "On the Cost of Partial Observability in the Bivariate Probit Model." *International Economic Review*. 26(1):71-85.

### Homework Reading:

- Toomet, Ott and Arne Henningsen. 2011. "Sample Selection Models in R: Package sampleSelection." Manual.
- Mroz, Thomas A. 1987. "The Sensitivity of an Empirical Model of Married Women's Hours of Work to Economic and Statistical Assumptions." *Econometrica*. 55(4):765-799.

## 8. More on the Score Function, Fisher Information, and Large Sample Theory.

- Pawitan, 2013. *In All Likelihood*. Chapters 8-9.

### Recommended

- Pawitan, 2013. *In All Likelihood*. Chapter 7.

## 9. Categorical Data and Random Utility Models

- King, Gary. 1998. *Unifying Political Methodology*. Chapter 5, Section 4.
- Amemiya, Takeshi. 1981. "Qualitative Response Models: A Survey." *Journal of Economic Literature*. 19(4):1483-1536.
- Maddala, G. S. 1983. *Limited-Dependent and Qualitative Variables in Econometrics*. Chapter 5.

#### Recommended

- So, Ying. "A Tutorial on Logistic Regression." SAS Institute, Inc.

### 10. Strategic Models, part I

#### 10.1 Bounded Rationality and the Quantal Response Equilibrium (QRE)

- McKelvey, Richard D. and Thomas R. Palfrey. 1996. "A Statistical Theory of Equilibrium in Games." *The Japanese Economic Review* 47: 186-209.
- McKelvey, Richard D. and Thomas R. Palfrey. 1998. "Quantal Response Equilibria for Extensive Form Games." *Experimental Economics* 1: 9-41.
- Fey, Mark, Richard D. McKelvey, and Thomas Palfrey. 1996. "An Experimental Study of the Constant-Sum Centipede Game." *International Journal of Game Theory* 25: 269—287.

#### 10.2 Private Information, Regression, and Misspecification

- Signorino, Curtis S. 1999. "Strategic Interaction and the Statistical Analysis of International Conflict." *American Political Science Review* 93: 279—297.
- Signorino, Curtis S. 2003. "Structure and Uncertainty in Discrete Choice Models." *Political Analysis* 11:316—344.
- Signorino, Curtis S. and Kuzey Yilmaz. 2003. "Strategic Misspecification in Regression Models." *American Journal of Political Science* 47: 551—566.
- Bas, Muhammet, Curtis S. Signorino, and Robert W. Walker. 2008. "Statistical Backwards Induction: A Simple Method for Estimating Strategic Models." *Political Analysis* 16: 21—40.

#### Recommended:

- Signorino, Curtis S. 2002. "Strategy and Selection in International Relations." *International Interactions* 28: 93—115.
- Signorino, Curtis S. and Ahmer Tarar. 2006. "A Unified Theory and Test of Extended Immediate Deterrence." *American Journal of Political Science* 50: 586—605.
- Plaxina, Elena. 2003. "An Evaluation of the Effectiveness of Financial Transfer Institutions for the Environment: The Global Environment Facility of the World Bank." University of Rochester. Working Paper.

### 11. Model Discrimination

- Pawitan, 2013. *In All Likelihood*. Chapters 13.5-13.6.
- Clarke, Kevin A. 2001. "Testing Nonnested Models of International Relations: Reevaluating Realism." *American Journal of Political Science* 45: 724-744.
- Clarke, Kevin A. 2003. "Nonparametric Model Discrimination in International Relations." *Journal of Conflict Resolution* 47: 72-93.
- Clarke, Kevin A. and Curtis S. Signorino. 2010. "Discriminating Methods: Tests for Non-nested Discrete Choice Models." *Political Studies* 58: 368—388.

### 12. Strategic Models, part II

#### 12.1 Bargaining Models

- Ramsay, Kristopher and Curtis S. Signorino. 2010. "A Statistical Model of the Ultimatum Game." Working Paper.
- Haptonstahl, Stephen. 2009. "Bargaining Under Uncertainty: a Strategic Statistical Model of the Ultimatum Game." Working paper

#### 12.2 Signaling Models

- Lewis, Jeffrey B. and Kenneth A. Schultz. 2003. “Revealing Preferences: Empirical Estimation of a Crisis Bargaining Game with Incomplete Information.” *Political Analysis* 11: 345—367.
- Wand, Jonathan. 2005. “Comparing Models of Strategic Choice: The Role of Uncertainty and Signaling.” *Political Analysis* 14: 101—120.
- Bas, Muhammet, Curtis S. Signorino and Taehee Whang. 2013. “Knowing One’s Future Preferences: A Correlated Agent Model with Bayesian Updating.” *Journal of Theoretical Politics*.

### **13. Machine Learning & Flexible Functional Form Estimation**

- Penalized Estimators: Ridge Regression, LASSO, Adaptive LASSO
- Kenkel & Signorino working papers.
- Das, Mitali, Whitney K. Newey, & Francis Vella. “Nonparametric Estimation of Sample Selection Models.” *Review of Economic Studies*. 70:33–58.
- Neural nets
- Recursive Partitioning and Regression Trees
- Random Forests

### **14. Parallel Computing in R**

Midterm Exam – After Section 3  
 Final Exam – During Finals Week