

**Political Science 430: Multilevel Modeling Fall 2011 Seminar**

Thursday, 4:00-6:00 PM, Seigle L016.

1. Course Description: This course covers statistical model development with explicitly defined hierarchies. Such multilevel specifications allow researchers to account for different structures in the data and provide for the modeling of variation between defined groups. The course begins with simple nested linear models and proceeds on to non-nested models, multilevel models with dichotomous outcomes, and multilevel generalized linear models. In each case, a Bayesian perspective on inference and computation is featured. The focus on the course will be practical steps for specifying, fitting, and checking multilevel models with much time spent on the details of computation in the R and bugs environments.
2. Competencies: At the conclusion of this course participants will: be able to specify and estimate multilevel (hierarchical) models with linear and nonlinear outcomes, treat missing data in a principled and correct manner using multiple imputation, gain facility in the R and bugs statistical languages, know how to compute the appropriate sample size and power calculations for multilevel models, gain exposure to Bayesian approaches including MCMC computation, and be able to assess model reliability and fit in complex models.
3. Prerequisite Details: This course assumes only a knowledge of basic statistics as taught in a first year graduate sequence. Topics should include: probability, cross-tabulation, basic statistical summaries, and linear regression in either scalar or matrix form. Knowledge of basic matrix algebra and calculus is helpful.
4. Course Grade: The final grade will be based on three components: weekly attendance and participation (20%) and homework (80%). Readings should be completed *before class*.
5. Office Hours: Thursday 9-11, and by appointment.
6. Incompletes: Due to the scheduled nature of the course, no incompletes will be given.
7. Teaching Assistant: [TBD](#). Office Hours Thursday TBD.
8. Required Reading: Gelman and Hill, "Data Analysis Using Regression and Multilevel/Hierarchical Models (Cambridge University Press 2007). Some papers will be available at [jstor.org](#) or distributed by the instructor.
9. Topics (subject to minor change):
  1. **September 1**: No Class.
  2. **September 8**: Introduction To the Course and Motivation.
    - Reading: Gelman & Hill, Chapters 1 and 2, [R Language Fundamentals](#).
    - Exercises: Gelman & Hill 2.2, 2.3.
  3. **September 15**: Linear Models Review.
    - Reading: Gelman & Hill, Chapters 3 and 4, [R Model syntax summary](#).
    - Exercises: Gelman & Hill 3.4, 4.4.
  4. **September 22**: Generalized Linear Models.
    - Reading: Gelman & Hill, Chapters 5 and 6, [Binomial PMF likelihood grid search](#).
    - Exercises: Gelman & Hill 5.4, 6.1.
  5. **September 29**: Multilevel Structures and Multilevel Linear Models: the Basics.
    - Reading: Gelman & Hill, Chapters 11 and 12
    - Exercises: Gelman & Hill 11.4, 12.2, 12.5.
  6. **October 6**: Multilevel Linear Models: Varying Slopes, Non-Nested Models and Other Complexities.
    - Reading: Gelman & Hill, Chapter 13
    - Exercises: Gelman & Hill 13.2, 13.5.
  7. **October 13**: Multilevel Logistic Regression.
    - Reading: Gelman & Hill, Chapter 14 (skip Section 14.3)
    - Exercises: Gelman & Hill 14.5, 14.6.
  8. **October 20**: Multilevel Modeling in Bugs and R: the Basics.
    - Reading: Gelman & Hill, Chapter 16
    - Exercises: Gelman & Hill 16.1, 16.3.
  9. **October 27**: Fitting Multilevel Linear and Generalized Linear Models in Bugs and R.
    - Reading: Gelman & Hill, Chapter 17
    - Exercises: Gelman & Hill Rerun 16.3 using the instructions in 17.2 and 17.3.
  10. **November 3**: Likelihood and Bayesian Inference, Computation.
    - Reading: Gelman & Hill, Chapter 18
    - Exercises: Gelman & Hill 18.2.
  11. **November 10**: Treatment of Missing Data.
    - Reading: Gelman & Hill, Chapter 25
    - Exercises: [missing data problems](#).
  12. **November 17**: Understanding and Summarizing the Fitted Models.
    - Reading: Gelman & Hill, Chapter 21
    - Exercises: 21.1, 21.3, 21.4.
  13. **November 24**: Thanksgiving Holiday.
  14. **December 1**: Multilevel Analysis of Variance.
    - Reading: Gelman & Hill, Chapter 22
    - Exercises: 22.1.
  15. **December 8**: Sample Size and Power Calculations.
    - Reading: Gelman & Hill, Chapter 20
    - Exercises: 20.1, 20.3.