



Jeff Gill

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Political Science 430/Mathematics 425C: Multilevel Modeling Fall 2012 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 a knowledge of basic statistics as taught in a first year undergraduate or graduate sequence. Topics should include: probability, cross-tabulation, basic statistical summaries, and linear regression in either scalar or matrix form. Knowledge of R, 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%). Homework must be prepared using LaTeX and submitted electronically as a PDF file. Readings should be completed *before class*.
5. **Office Hours:** Friday 8-10, and by appointment.
6. **Incompletes:** Due to the scheduled nature of the course, no incompletes will be given.
7. **Teaching Assistant:** [Adrian Lucardi](#). Office Hours: Tuesdays from 4:30 to 6:30, Seigle 255.
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. **August 30** : No Class (APSA Meeting).
 2. **September 6:** Introduction To the Course and Motivation, Causal Inference Using Regression on the Treatment Variable.
 - Reading: Gelman & Hill, Chapters 1, 2, and 9, [R Tutorial](#) online, [Code](#) from the lecture. [Code](#) from the lecture.
 - Exercises: Gelman & Hill 2.2, 2.3, 9.4, 9.13.
 3. **September 13:** Linear and Generalized Linear Models Review.
 - Reading: Gelman & Hill, Chapters 3 and 4, [Code](#) from the lecture, [Binomial PMF likelihood grid search](#).
 - Exercises: Gelman & Hill 3.4, 4.4, 5.4, 6.1.
 4. **September 20:** Multilevel Structures and Multilevel Linear Models: the Basics.
 - Reading: Gelman & Hill, Chapters 11 and 12, [Introductory Chapter](#) (Gill and Womack, Forthcoming The SAGE Handbook of Multilevel Modeling). [Code](#) from the lecture.
 - Exercises: Gelman & Hill 11.4, 12.2, 12.5.
 5. **September 27:** Multilevel Linear Models: Varying Slopes, Non-Nested Models and Other Complexities.
 - Reading: Gelman & Hill, Chapter 13, [Code](#) from the lecture.
 - Exercises: Gelman & Hill 13.2, 13.5.
 6. **October 4:** Multilevel Logistic Regression, Multilevel Generalized Linear Models.
 - Reading: Gelman & Hill, Chapter 14 (skip Section 14.3), Chapter 15, [Code](#) from the lecture.
 - Exercises: Gelman & Hill 14.5, 14.6, 15.1, 15.2.
 7. **October 11:** Multilevel Modeling in Bugs and R: the Basics, MCMC Theory.
 - Reading: Gelman & Hill, Chapter 16, [Code](#) from the lecture.
 - Exercises: Gelman & Hill 16.1, 16.3.
 8. **October 18:** Fitting Multilevel Linear and Generalized Linear Models in Bugs and R, MCMC Coding.
 - Reading: Gelman & Hill, Chapter 17 [Code](#) from the lecture.
 - Exercises: Gelman & Hill Rerun 16.3 using the instructions in 17.2 and 17.3.
 9. **October 25:** Likelihood and Bayesian Inference, Computation, MCMC Diagnostics and Customization.
 - Reading: Gelman & Hill, Chapter 18
 - Exercises: Gelman & Hill 18.2, run the jags model from week 1.
 10. **November 1:** Treatment of Missing Data.
 - Reading: Gelman & Hill, Chapter 25, [Code](#) from the lecture.
 - Exercises: [missing data problems](#).
 11. **November 8:** Understanding and Summarizing the Fitted Models, Multilevel Analysis of Variance.
 - Reading: Gelman & Hill, Chapter 21 and 22, [Chapter 21 Code](#) from the lecture, [Chapter 22 Code](#) from the lecture.
 - Exercises: 21.1, 21.3, 21.4, 22.1.
 12. **November 15:** Model Checking and Comparison.
 - Reading: Gelman & Hill, Chapter 24,
 - Exercises: 24.2, 24.3.
 13. **November 22:** Thanksgiving Holiday.
 14. **November 29:** Sample Size and Power Calculations.
 - Reading: Gelman & Hill, Chapter 20, [Code](#) from the lecture.
 - Exercises: 20.1, 20.3.
 15. **December 6:** TBD.