

**Political Science 584/Mathematics 584C/Public Health Sciences M19-530: Multilevel Modeling for Quantitative Research Fall 2013 Seminar**

Thursday, 4:00-6:00 PM, Richmond Room (#2132) on the 2nd floor of the [Taylor Avenue Building](#), medical campus.

- Course Description:** This **3-credit 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.
- 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.
- 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.
- Course Grade:** The final grade will be based on two components: weekly attendance and participation (20%) and exercises (80%). Graduate students will have one additional component of their exercise grade that constitutes 30 points out of the 80 points total: submission of an analysis of real dataset using a multilevel model 3-5 pages of discussion to include a description of the data, model diagnostics, and the subsequent findings. Due December 5. Consider this assignment to be the start of a research manuscript to be eventually submitted to an academic journal. Graduate students will still submit all exercises assigned below in addition to this work.
- Office Hours:** Thursday 11-12, in Taylor Avenue Building 7322.
- Incompletes:** Due to the scheduled nature of the course, no incompletes will be given.
- Teaching Assistant:** [Taeyong Park](#). Office hours: 4:30-6:00 PM on Tuesdays in Seigle 278.
- 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. Readings should be completed before class. For those interested in deeper statistical modeling of radon, see this [paper](#).
- Topics (subject to minor change):**
  - August 29:** Introduction To the Course and Motivation.
    - Reading: Gelman & Hill, Chapters 1, 2, and 9, [R Tutorial](#) online, [Intro code](#) from the lecture. [Chapter 9 code](#) from the lecture.
    - Exercises: Gelman & Hill 2.2, 2.3, 9.4, 9.13.
  - September 5 and September 12:** Linear and Generalized Linear Models Review.
    - Reading: Gelman & Hill, Chapters 3 and 4, [linear model code](#) from the lecture, [Chapter 3-4 code](#) from the lecture, [Binomial PMF likelihood grid search](#).
    - Exercises: Gelman & Hill 3.4, 4.4, 5.4, 6.1.
  - September 19:** 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). [Chapter 11-12 code](#) from the lecture.
    - Exercises: Gelman & Hill 11.4, 12.2, 12.5.
  - September 26:** Multilevel Linear Models: Varying Slopes, Non-Nested Models and Other Complexities.
    - Reading: Gelman & Hill, Chapter 13, [Chapter 13 code](#) from the lecture.
    - Exercises: Gelman & Hill 13.2, 13.4, 13.5.
  - October 3:** Multilevel Logistic Regression, Multilevel Generalized Linear Models.
    - Reading: Gelman & Hill, Chapter 14 (skip Section 14.3), Chapter 15, [Chapter 14 code](#) from the lecture.
    - Exercises: Gelman & Hill 14.5, 14.6, 15.1, 15.2.
  - October 10:** Multilevel Modeling in Bugs and R: the Basics, MCMC Theory.
    - Reading: Gelman & Hill, Chapter 16, [Bayesian Estimation Case Study](#) (Gill and Witko 2012), [R to JAGS code](#) for the model (get data from the download site: <http://jgill.wustl.edu/download>), [Chapter 16 code](#) from the lecture.
    - Exercises: Gelman & Hill 16.1, 16.2, 16.3, 16.8.
  - October 17:** Fitting Multilevel Linear and Generalized Linear Models in Bugs and R, MCMC Coding.
    - Reading: Gelman & Hill, Chapter 17, [Chapter 17 code](#) from the lecture.
    - Exercises: Gelman & Hill Rerun 16.3 using the instructions in 17.2 and 17.3, 17.5 (rerun the model in 16.3 (b) by adding group-level predictors for the varying slopes; you then have to use this model to answer sections 16.3 (c) and (d)).
  - October 24:** Likelihood and Bayesian Inference, Computation, MCMC Diagnostics and Customization.
    - Reading: Gelman & Hill, Chapter 18
    - Exercises: Gelman & Hill 18.1, 18.2, 18.4.
  - October 31:** Treatment of Missing Data.
    - Reading: Gelman & Hill, Chapter 25, [Paper](#) by van Buuren and Groothuis-Oudshoorn, [Chapter 25 code](#) from the lecture.
    - Exercises: [missing data problems](#).
  - November 7:** Understanding and Summarizing Fitted Models
    - Reading: Gelman & Hill, Chapter 21, [Chapter 21 code](#) from the lecture,

- Exercises: 21.1, 21.3, 21.4
- **November 14:** Multilevel Analysis of Variance.
  - Reading: Gelman & Hill, Chapter 22, [Chapter 22 code](#) from the lecture.
  - Exercises: 22.1.
- **November 21:** Model Checking and Comparison.
  - Reading: Gelman & Hill, Chapter 24, [Chapter 24 code](#) from the lecture.
  - Exercises: 24.1, 24.4.
- **November 28:** Thanksgiving Holiday.
- **December 5:** Sample Size and Power Calculations.
  - Reading: Gelman & Hill, Chapter 20, [Chapter 20 code](#) from the lecture.
  - Exercises: 20.1, 20.2, 20.3.