HDFS 517: The General Linear Mixed Model (applications to multilevel modeling)
Fall 2013
Tuesdays and Thursdays 1:00 – 2:15 p.m.
Room 203 Sackett Building

Instructor

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COURSE DESCRIPTION

The purpose of this course is to familiarize students with the general linear mixed model (aka multilevel model, hierarchical linear model, latent growth curve model, random coefficients model) that is commonly used to analyze data from longitudinal, repeated measures and hierarchical designs. The course is organized to take students through each of the cumulative steps in a multilevel analysis: deciding which type of model is appropriate, setting up the data file and coding variables, fitting models, evaluating fixed and random effects and/or interpret covariance structures, predicting between- and within-person variation using covariates, interpreting and displaying empirical findings. By the end of the semester, students should have acquired enough background knowledge (i.e., theory) and technical expertise to apply these methods in practice.

COURSE OBJECTIVES

A key objective of this course is for students to acquire the skills necessary for implementing statistical analyses. Emphasis will be placed on the linkage of substantive theories to statistical models by discussing how to formulate testable hypotheses, assess model assumptions, and interpret output from SAS (and/or other statistical software programs). Although the examples from lectures will primarily use SAS, students may discuss with the instructor the possibility of using other software for the class.

STATISTICAL SOFTWARE

For students without personal access to a statistical software package, Penn State provides access to the Penn State Computer lab from your own personal computer or device. This service, called "WebApps" is available to anyone with a Penn State Access Account. To access WebApps, follow these instructions:

1. Navigate to the Web Application Server page: http://webapps.psu.edu
2. Click on the application (e.g., SAS) you would like to use
3. Authenticate using your Penn State Access Account userid and password
4. The application will open in your browser window

PLEASE NOTE: This is NOT the same as using an application installed on your local computer. That is, ***WebApps does not connect to your desktop!*** WebApps does not 'see' your desktop but it will connect with your PASS space, so you MUST be familiar with uploading and managing files within your PASS space to open program files to use this version of the application successfully.

You cannot copy and paste directly to or from the application being used in your web browser to a Word document you have open locally, or from your local computer to the application. You MUST use alternative methods to copy output, log notes, graphs and tables into other documents or paste any data or commands into these applications.

A couple useful tutorial videos about using WebApps are available from the Department of Statistics can be accessed at this address: http://clc.its.psu.edu/UnivServices/WebApps

RECOMMENDED TEXTS

Singer, J.D., & Willet, J.B. (2003). *Applied longitudinal data analysis: Modeling change and event occurrence*. New York: Oxford University Press.

Hox, J. (2010). *Multilevel analysis: Techniques and applications (2nd ed).* New York, NY: Routledge

OPTIONAL TEXT

Bickel, R. (2007). *Multilevel analysis for applied research: It's just regression*. New York, NY: Guildford Press.

OTHER GOOD BOOKS

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods (2nd ed.)*. Thousand Oaks, CA: Sage.

Snijders, T., & Bosker, R. (1999). *Multilevel analysis: An introduction to basic and advanced multilevel modeling*. Thousand Oaks, CA: Sage.

Verbeke, G., & Molenberghs, G. (2000). *Linear mixed models for longitudinal data*. Cary, New York, NY: Springer.

Littell, R. Milliken, G., Stroup, W., Wolfinger, R., & Schabenberger (2006). *SAS system for mixed models.* Cary, NC: SAS Institute.

SELECTED READINGS

Diez-Rous, A. V. (2002). A glossary for multilevel analysis. *Journal of Epidemiology and Community Heatlh, 56*, 588-594.

Singer, J. B. (1998). Using SAS PROC MIXED to fit multilevel models, hierarchical models, and individual growth models. *Journal of Educational and Behavioral Statistics, 24,* 323-355.

Hayes, A. F. (2006). A primer on multilevel modeling. *Human Communication Research, 32,* 385-410.

Comparing the SAS GLM and MIXED Procedure for Repeated Measures. By Wolfinger, R and Chang, M. (http://support.sas.com/rnd/app/papers/mixedglm.pdf).

Sliwinski, M. J., Hoffman, L., & Hofer, S. M. (2010). Evaluating convergence of within-person change and between-person age differences in age-heterogeneous longitudinal studies. *Research in Human Development, 7*(1), 45-60.

Enders, C. K., & Tofighi, D. (2007). Centering predictor variables in cross-sectional multilevel models: A new look at an old issue. *Psychological Methods, 12*(2), 121-138.

Schwartz, J. E. & Stone, A. A. (1998). Strategies for analyzing ecological momentary assessment data. *Health Psychology, 17,* 6-16.

A VERY HELPFUL WEBSITE

ULCA Statistical Computing Resources (Software guides, textbooks, examples, etc.)

http://www.ats.ucla.edu/stat/

http://www.ats.ucla.edu/stat/examples/alda/default.htm

http://www.ats.ucla.edu/stat/examples/ma_hox/default.htm

ASSIGNMENTS AND GRADING

The activities of this course are designed to provide students with scaffolded learning experiences that engage the student in the skills and activities required in the culture of academia (e.g., engaging in scholarly discourse and group discussion, critically evaluating research, conceiving of and conducting data analyses, interpreting statistics, writing up research reports, and scientific collaboration). Students' final grades will be determined by the following four components:

1. Class participation and attendance (10 points)

Career success (both in academics and elsewhere) is, in part, related to individuals' ability to communicate effectively. Students are expected to attend all classes and should come prepared to participate and contribute to in-class discussion. This includes asking questions, raising issues, sharing knowledge, and expressing opinions – all in a constructive and respectful manner.

2. Article summary (10 points)

DUE IN CLASS THURSDAY SEPTEMBER 12, 2013

The purpose of this component is to introduce the student to scientific literature (in his/her own area) that utilizes multilevel modeling. By **Thursday, September 12, 2013,** each registered student will complete a 1-page written summary of a scientific article of their choice. The written document should summarize the following:

- The APA-style citation of the article
- The study's hypotheses or research questions
- The study's need for multilevel analyses
- A brief description of the measures
- The most important findings
- Any unanswered questions or points of confusion in your mind

3. Homework (30 points total)

DUE IN CLASS AS ASSIGNED

Throughout the semester, students shall complete a selection of data analysis exercises and prepare short reports that present, describe, and elaborate their data. Students will be asked to conduct an analysis of a given data set using the methods described in class and provide a written summary of their findings. Generally, the completed report will include software scripts and outputs (with important elements highlighted and commented upon) and an accompanying text summary (e.g., substantive interpretation of parameters). Publication-quality tables and/or figures may also need to be included.

4. Final project (50 points total)

The ultimate goal of this course is to provide students with the skills required to apply the analytic techniques to their own data. Towards this end, each registered student will prepare a written document in the form of a completed empirical manuscript – with concentration on the Methods and Results sections, including figures and tables – but also framed by concise Introduction and Discussion sections. Evaluation criteria will include style of presentation, clear communication of research question, description of data, analysis model, results, and interpretation. Prior to final completion, students will have the option to have a complete draft of their manuscript reviewed and constructively critiqued by two peers.

We will primarily use SAS software for the course, but students may use whatever statistical package they like to analyze the data, however, two points qualify this statement: 1) the program needs to be able to do the analyses that are required to answer the questions well, and 2) the farther away you get from the packages I know well, the less help I will be able to give you. Students may use their own data set or one provided by the instructor for this assignment.

The project will be divided into the following meaningful chunks and turned in along the way as follows:

Phase 1: ***Definition and approval of the data set, variables, and study design (5 points)***

For this phase, each student will submit the following:

- a brief description of the **original study** (its design, goals, and background)
- a very brief description of the **proposed study**
- a fairly detailed, codebook-like description of all potential study variables used in the proposed analysis

DUE IN CLASS THURSDAY SEPTEMBER 26, 2013

Phase 2: ***Conceptualization of research questions, hypotheses, and analysis plan*** **(5 points)**

For this phase, each student will submit the following:

- a list of the main research questions and study hypotheses
- a specific description of how you are going to go about testing the hypotheses (e.g., what procedures you will use on what X and Y variables, etc.)

DUE IN CLASS THURSDAY OCTOBER 17, 2013

Phase 3: ***Exploratory data analysis*** **(10 points)**

For this phase, each student will submit annotated output from your exploratory and preliminary analysis procedures. This may include the following:

- data cleaning and transformations, data reduction and/or recoding procedures
- preliminary data exploration results

DUE IN CLASS THURSDAY OCTOBER 31, 2013

Phase 4: *Peer Review* (BONUS 5 POINTS)

Students will have the option to earn up to 5 bonus points by completing a peer review of drafts of two other students' project drafts. To be eligible for these points, the student must do the following:

- submit a complete draft version of your own project by **THURSDAY, NOVEMBER 21, 2013**
- read and provide critical feedback to each of the other two students' projects, using a provided rubric, by **TUESDAY DECEMBER 3**, **2013** and emphasizing the following:
    - vocabulary, spelling, and grammar
    - clear articulation of background and objectives
    - accurate description of methods
    - clarity of results
    - concise summary and conclusions
- Students who satisfactorily complete the two peer reviews will receive **5 BONUS POINTS.**

Phase 5: *Final Report* (30 points)

The project will culminate in an APA-style research report of the results of your analysis. This report will include the following:

- a brief introduction to the topic
- a brief methods and procedures section
- an expanded results section (in which you describe what was done, and why, and what was found)
- a brief discussion of the results and possible implications

DUE FRIDAY 12/13/13 BY 5:00 P.M.

LATE ASSIGNMENTS AND OTHER REQUIREMENTS.

It is the responsibility of the students to print out and turn in hard copies of all course assignments. Electronic versions will not be accepted. Note that all assignments (with the exception of the final project) are due at the **beginning of the class period on the specified date.** All assignments turned in after the class has begun will be penalized by an automatic reduction of 1 point per day. For example, an assignment turned in after the class session has begun will receive a 1-point deduction. An assignment turned in the following day will receive a 2-point deduction, and so forth.

Please note that the components of the Final Project assignment are cumulative. Thus, all prior components must be submitted before subsequent components will be accepted for grading.

TENTATIVE COURSE SCHEDULE

Topic	Reading
1. Course Overview • Rationale for multilevel analysis	S & W Ch. 1 Hox Ch. 1 Bickel, Ch. 1
2. Introduction to the Basic Multilevel Model • Random intercept model • Random slope model • HLM and Mixed Model representation • Notation	Hox Ch. 2 Diez-Rous, 2002 Singer, 1998 Hayes, 2006
3. Regression/GLM Review • GLM approach to repeated measures • Continuous and categorical predictors • Interactions	S & W Ch. 2 Wolfinger & Chang
4. The Multilevel Model for Longitudinal Data • Intra-individual and inter-individual change • Fixed Effects • Variance components	S & W Ch. 3 Hox pp. 79-93
5. Estimation and Hypothesis Testing • The composite specification of the MLM for change • ML vs. REML for model comparison • Comparing nested and non-nested models • Hypothesis testing • Effect size and how much variance is explained	S & W Ch. 4 Hox Ch. 3-4
6. Extending the MLM for change • Fixed vs. varying measurement occasions • Time-varying predictors • Centering • Lagged effects • The “age-convergence” model for development	S & W Ch. 5 Enders & Tofighi, 2007 Hox pp. 93-99 Silwinski 2010
7. Modeling Discontinuous and Nonlinear Change • Discontinuous individual change • Polynomial functions • Nonlinear change	S & W Ch. 6
8. Assessing Assumptions of the Multilevel Model • Diagnostic plots and tests • Heterogeneous variance models • Robust standard errors, bootstrapping, and Bayesian estimation • Missing data???	S & W pp. 127-137 S & W Ch. 7 Hox pp. 99-111 Hox Ch. 13

***Extended Topics (as time permits)	
9. Applications to Intensive Repeated Measures Data (Daily Diary/Experience Sampling) • Decomposing variance • Separating between and within effects • Data management and manipulation • Lagged analysis	Schwartz & Stone, 1998
10. Generalized Linear Mixed Model for Binary Outcomes	Hox Ch. 6
11. Generalized Linear Mixed Model for Categorical and Count Data	Hox Ch. 7
12. Cross-Classified Multilevel Models	Hox Ch. 9

Changes to this syllabus

The instructor reserves the right to modify the course syllabus if necessary and will make formal announcements of these changes in class and provide written notices of changes via ANGEL email. Students are responsible for noting these changes.

University Statement of Academic Integrity (Policy 48-20):

Academic integrity is the pursuit of scholarly activity in an open, honest and responsible manner. Academic integrity is a basic guiding principle for all academic activity at The Pennsylvania State University, and all members of the University community are expected to act in accordance with this principle. Consistent with this expectation, the University's Code of Conduct states that all students should act with personal integrity, respect other students' dignity, rights and property, and help create and maintain an environment in which all can succeed through the fruits of their efforts. Academic integrity includes a commitment not to engage in or tolerate acts of falsification, misrepresentation or deception. Such acts of dishonesty violate the fundamental ethical principles of the University community and compromise the worth of work completed by others.

Statement of Accommodations

Penn State welcomes students with disabilities into the University's educational programs. If you have a disability-related need for reasonable academic adjustments in this course, contact the Office for Disability Services (ODS) at 814-863-1807 (V/TTY). For further information regarding ODS, please visit the Office for Disability Services Web site at http://equity.psu.edu/ods/.

In order to receive consideration for course accommodations, you must contact ODS and provide documentation (see the documentation guidelines at http://equity.psu.edu/ods/guidelines/documentation-guidelines). If the documentation supports the need for academic adjustments, ODS will provide a letter identifying appropriate academic adjustments. Please share this letter and discuss the adjustments with your instructor as early in the course as possible. You must contact ODS and request academic adjustment letters at the beginning of each semester.