Multilevel Modeling PSYC 575

Units: 4

Term–Day–Time: Fall 2020–Thurs–10:00-11:50 am

Location: Online

Instructor: Hok Chio (Mark) Lai

Office Hours: Tues 11:00 am–12:00 pm, and by appointment.

Contact Info: Email: hokchiol@usc.edu (mailto:hokchiol@usc.edu).
Timeline for replying to emails: within 48 hours.

Course Description

This is a graduate-level class in statistical methods on multilevel modeling, a popular technique in behavioral and social science research. The course covers topics in multilevel modeling including two- and three-level hierarchical linear models (HLM), random intercepts and slopes, longitudinal models and growth curve models, as well as some recent development in multilevel modeling.

The course begins with a brief overview of the ubiquity of multilevel data and the problems of using conventional methods to handle such data and then transitions to the conceptual and statistical foundations of two-level multilevel models. Students will be exposed to real data examples and are required to perform analyses using real data of their own or that the instructor provides. Later material covers the use of multilevel modeling as a general framework for longitudinal data analysis, and other modeling considerations such as categorical data, non-hierarchical (e.g., cross-classified) data structure, and study designs. Students are also encouraged to provide input in suggesting topics to be covered for this course.

Learning Objectives

After the successful completion of this course, students will be able to . . .

1. Explain the problems of analyzing clustered data with multiple regression/ANOVA;
2. Identify the types of multilevel data structure in different research scenarios;
3. Describe the statistical and conceptual foundations of multilevel modeling;
4. Independently analyze real data using statistical software for multilevel modeling;
5. Evaluate published research that uses multilevel modeling;
6. Apply multilevel modeling in a research project, and effectively communicate findings/products in an oral research presentation or a written research report.

Prerequisite(s): None

Co-Requisite(s): None

Concurrent Enrollment: None

Recommended Preparation: PSYC 503: Regression and the General Linear Model (or a similar regression class); Experience with statistical software (preferably R)

Course Notes

Given the COVID-19 pandemic, this class will be fully online and will follow a flipped course design (http://cet.usc.edu/cet/wp-content/uploads/2020/06/Flipped-Course-Design.docx). The lecture videos and course materials will be available at https://quantscience.rbind.io/courses/psyc575/ (https://quantscience.rbind.io/courses/psyc575/) before Mondays, and students are expected to review these materials and the assigned readings on their own. Please note that the lecture slides only serve to guide class discussions and cannot replace the assigned readings. Every Thursday at 10:00–11:50 am there will be a synchronous session where students will work on in-class exercises and discuss questions regarding the learning materials and homework assignments. **Students are expected to have reviewed the posted materials for that week before attending that week's synchronous session.** The synchronous sessions will be recorded and be posted on Slack. Before attending the synchronous sessions, students are expected to have

1. Completed the assigned readings and reviewed the posted videos.
2. Identified questions that come up in their learning.
3. Started working on the homework problems.

Weekly contact time (recorded lecture videos, live Zoom sessions): 3 hours 20 minutes

Communication

To promote independence and critical thinking, students are encouraged to work through the following process for obtaining answers to course-related questions before contacting the instructor:

- consult the course syllabus;
- consult a classmate or post your questions on Slack;
- meet with the instructor during Zoom office hours at 11-12 on Tuesdays;
- ask your questions during the synchronous session at 10:00-11:50 am on Thursdays; and
- for personal questions, email the instructor at hokchiol@usc.edu (mailto:hokchiol@usc.edu)

Technological Proficiency and Hardware/Software Required

- R (https://cloud.r-project.org/) and RStudio (https://rstudio.com/products/rstudio/download/) are needed to complete the course assignments. If you have R and RStudio installed, it is highly recommended that you update to the latest versions of both software (R 4.0.0, RStudio 1.3.10XX, or above). We'll discuss how to set up R and RStudio in Week 1.
- Stable internet connection (for asynchronous lecture videos and synchronous sessions)

USC technology rental program

We realize that attending classes online and completing coursework remotely requires access to technology that not all students possess. If you need resources to successfully participate in your classes, such as a laptop or internet hotspot, you may be eligible for the university's equipment rental program. To apply, please submit an application (https://studentbasicneeds.usc.edu/resources/technology-assistance/). The Student Basic Needs team will contact all applicants in early August and distribute equipment to eligible applicants prior to the start of the fall semester.

USC Technology Support Links

Zoom information for students (https://keepteaching.usc.edu/students/student-toolkit/classroom/zoom/)
Slack information for students (https://keepteaching.usc.edu/students/student-toolkit/classroom/slack/)
Blackboard help for students (https://studentblackboardhelp.usc.edu/)
Software available to USC Campus (https://software.usc.edu/)

Required Materials

- Snijders, T. A. B., & Bosker, R. J. (2012). *Multilevel analysis: An introduction to basic and advanced multilevel modeling* (2nd ed.). Thousand Oaks, CA: Sage.

    - Tom Snijders's website (including R code examples): https://www.stats.ox.ac.uk/~snijders/mlbook.htm (https://www.stats.ox.ac.uk/~snijders/mlbook.htm)
- Other required readings will be posted on Slack

Optional Materials

- Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: applications and data analysis methods* (2nd ed.). Thousand Oaks, CA: Sage.
- Hox, J. J., Moerbeek, M., & van de Schoot, R. (2018). *Multilevel analysis: Techniques and Applications* (3rd ed.). New York, NY: Routledge.
- Gelman, A., & Hill, J. (2006). *Data analysis using regression and multilevel/hierarchical models*. Cambridge, UK: Cambridge University Press.
- Singer, J. D., & Willett, J. B. (2003). *Applied longitudinal data analysis: Modeling change and event occurrence*. Oxford, UK: Oxford University Press. [For longitudinal data analysis]
- West B. T., Welch, K. B., & Gałecki, A. T. (2014). *Linear mixed models: A practical guide using statistical software* (2nd ed.). Boca Raton, FL: CRC. [For reference of using different software]
- Heck, R. H., Thomas, S. L., & Tabata, L. N. (2014). *Multilevel and longitudinal modeling with IBM SPSS (2nd ed.)*. New York, NY: Routledge. [For reference of SPSS users]

Description and Assessment of Assignments

1. In-class exercises (10%). During the Thursday synchronous sessions, students will participate in group exercises, and credits will be given on completion of those exercises. If students miss a session for any reasons (including time zone differences), they can complete an alternative assignment within 36 hours after the synchronous session (i.e., Friday by end of day, Pacific Time) to get credits.

2. Homework problems (54%). There will be 9 homework assignments for you to apply the concepts and techniques discussed in class to analytic problems. The assignments typically involve performing data analyses using data sets of your own or provided by the instructor, and interpreting the results with some guided questions.
   You must submit your work electronically to Blackboard by **Friday 11:59 p.m. Pacific Time** on the assigned due date. See policy on late work.

3. Final project (36%; 5% prospectus, 5% peer review, 26% presentation/final paper). You will complete a research project related to multilevel modeling, typically a research report of an empirical study using real data or a theoretical/methodological paper about certain aspects of multilevel modeling. Students interested in project ideas other than an empirical research report (e.g., software package development, systematic review/meta-analysis) are encouraged to discuss their ideas with the instructor. You can choose to work by yourself or work in a group of up to three people. Each student/group will schedule an appointment with the instructor to talk about their project during week 8 (October 5–9).

   There are three grading components for your final project:

    - Prospectus (5%)
      A prospectus about your project should be submitted by **Monday, October 5, 9 am Pacific Time**. The prospectus should contain a concise description of what you (or your group) plan to do for your project, including a preliminary plan for statistical analysis. The prospectus should be limited to 1 single-spaced page (excluding tables, figures, references, and other supplemental materials).

    - Peer Review (5%)
      After the individual meeting with the instructor, each individual/group will refine their research questions and post a summary of their research questions and preliminary analyses to the dedicated forum on the Discussion Board by **Friday, October 30**. Each student will then give specific comments to the summaries of two other students/groups by **Monday, November 9**. More information on what feedback to give will be included in the grading rubric.

    - Final Presentation/Paper (26%)
      If you choose to do a presentation, on **November 17 or November 19**, you or your group will give a 20-minute presentation (including Q&A) on your project. You can choose to do your presentation live, or pre-record a 15-minute presentation for the instructor to show during the Zoom sessions; however, you must be present during your

assigned presentation time to answer questions. The final presentation should include the following four sections: introduction, method, results, and discussion, or something comparable for methodological or theoretical work; however, **more emphasis should be put on describing the technical details of the analysis and the interpretations of the results**. You will also need to submit your slides to Blackboard for grading by **November 24 at 10:00 a.m. Pacific Time**, which should include a link to the reproducible codes for your analyses. A grading rubric on the research presentation will be posted on Blackboard.

If you choose to do a final paper, your paper will be due **Tuesday, November 24, at 10:00 a.m. Pacific Time** (which is the assigned exam time for the class). The final paper should include four sections: introduction, method, results, and discussion, or comparable sections; however, **more emphasis should be put on describing the technical details of the analysis and the interpretations of the results**. There should also be a link to the reproducible codes for your analyses. The final paper should be 8-15 double-spaced pages of text (i.e., excluding title page, abstract, references, tables, figures, and appendices).

If you're interested in methodological research, here are some ideas for topics:

- Using AIC to decide whether a level of clustering is needed
- Demonstration of the Bayesian Student's t model to account for outliers
- Demonstration paper of Bayesian model averaging
- Application of Bayesian location-scale modeling
- Comparing performances of model building strategies: step-by-step model building with LRT, AIC/BIC, model averaging, data splitting, etc
- Systematic review of intraclass correlations and design parameters for longitudinal studies

Grading Breakdown

Assignment	**% of Grade**
In-class exercises	10
Homework 1-9	54
Prospectus	5
Peer Review	5
Final Presentation/Paper	26
TOTAL	100

Grading Scale

Course final grades will be determined using the following scale

A 93-100
A- 89-92
B+ 85-88
B 81-84
B- 77-80
C+ 73-76
C 70-72
C- Below 70 (failing)

Course-specific Policies

Assignment Submission

The assignments should be submitted through Blackboard by Friday at 11:59 p.m. Pacific Time, before the class starts.

Grading Timeline

Generally, all graded work will be returned no later than one week from the submission deadline. However, given the high number of students in the class, the instructor may only grade selected questions in each assignment. Solutions will be posted so that students can check their own work.

Late work

Late work will be penalized by a 10% deduction in the assignment grade every 24 hours late unless due to an emergency excused by the instructor. Email the instructor as soon as possible to discuss alternate arrangements due to an emergency.

Technology during the Zoom sessions

During the synchronous Zoom sessions, students are encouraged to use a laptop with R, RStudio, and the needed R packages installed to participate in the in-class exercises.

Attendance

Students are expected to attend all synchronous Thursday sessions on time. If they miss a session, they should review the recording of that session.

Classroom norms

The following applies to both the synchronous sessions and the asynchronous learning time (e.g., Slack discussions, group project discussions, email communications)

- Respect each other's views.
- In written communication messages, make sure they're something you could say to someone to their face.
- Recognize and/or remember that we have different backgrounds.
- Criticize ideas, not individuals or groups.
- Either support statements with evidence, or speak from personal experience.

Zoom etiquette

Students are expected to actively participate in the exercises and discussions during the synchronous sessions. It is okay to join using your phone. Given the class size, students are required to mute their microphones when not speaking. It is okay to eat during the synchronous sessions (as long as you can still actively participate and not distracting the class). Students can use the chat box and the raise hand feature in Zoom to indicate their questions or other things they want to say. Students are encouraged to contact the instructor with questions or concerns about complying with a policy.

On having cameras on

To facilitate a sense of community for the class, students are encouraged to have their cameras on during the synchronous sessions, especially for the first few minutes when they can see their classmates and during the breakout sessions, if possible. Students are encouraged to use the virtual background function on Zoom for privacy concerns. However, it is understood that some students may find it challenging to have their cameras on, so this is not a strict requirement.

Synchronous session recording notice

Per USC's policy (https://coronavirus.usc.edu/faculty/academic-faqs-for-faculty/), the synchronous sessions will be recorded and provided to all students asynchronously.

Sharing of course materials outside of the learning environment

USC has a policy that prohibits sharing of any synchronous and asynchronous course content outside of the learning environment. See SCampus Section 11.12(B)

Course Evaluation

Student feedback is essential to the instructor and the Department to keep improving this course. Students are encouraged to share their feedback and suggestions in an early-term feedback survey around week 4 to 5, and respond to the standard USC course evaluation survey at the end of the semester.

(Tentative) Course Schedule: A Weekly Breakdown

	Topics/Daily Activities	Readings	Activities and Homework
Week 1 8/17	• Overview of Multilevel Models • R Markdown	• SB ch 1, 2 • R Markdown Intro (https://vimeo.com/178485416) • Markdown Quick Reference (https://web.mit.edu/r/current/RStudio/resources/markdown_help.html)	• Exercise: R Markdown • HW 1
Week 2 8/24	• What are Statistical Models? • Review of Regression	• Gelman et al. ch 1.1, 1.2, 1.4 • Gelman et al. ch 4.1, 4.2, 4.4, 4.5 • 10 quick tips to improve your regression modeling (https://statmodeling.stat.columbia.edu/wp-content/uploads/2020/07/raos_tips.pdf)	• Exercise: Interpreting interactions • HW 2
Week 3 8/31	• The Random Intercept Model	• SB ch 3.1–3.4, 4.1–4.5, 4.8	• Exercise: Empirical Bayes estimates • HW 3
Week 4 9/7	• Effect Decomposition • Random Coefficient Model • Cross-level Interactions	• SB ch 4.6, 4.7, 5	• Exercise: Effect decomposition • HW 4
Week 5 9/14	• Model Estimation • Model Testing • Reporting Results	• SB ch 6	• Exercise: Maximum likelihood estimation (MLE) • HW 5
Week 6 9/21	• Bayesian MLM	• SB 12.1 • Supplemental materials	• Exercise: Comparing Bayesian and MLE

	Topics/Daily Activities	Readings	Activities and Homework
Week 7 9/28	• MLM for Experimental Designs • Cross-classified Models	• SB ch 13.1 • Hoffman & Rovine (2007) (https://link.springer.com/content/pdf/10.3758/BF03192848.pdf)	• Exercise: Identifying data structure • HW 6
Week 8 10/5–10/9	Individual meeting on final research project (No class meeting		• Project Prospectus (10/5, 9 am PDT)
Week 9 10/12	• Longitudinal Data Analysis I	• SB ch 15	• Exercise: Autoregressive covariance structure • HW 7
Week 10 10/19	• Longitudinal Data Analysis II	• Hoffman ch 8	• Exercise: Time-varying covariates • HW 8
Week 11 10/26	• Exploratory analyses • Regularization and big data	• Supplemental reading	• Exercise: Model averaging • Post draft for peer review
Week 12 11/2	• Multilevel logistic regression • Discrete outcomes	• SB ch 17	• Exercise: Probability vs. odds ratio • HW 9 • Peer review (due 11/9)
Week 13 11/9	• Sample size planning	• SB ch 11	• Exercise: Required sample size
Week 14 11/17 & 11/19	Final presentation		• Final slides due 11/24
Week 15 11/24	Final paper (due **11/24, 10:00 am**)		

Statement on Academic Conduct and Support Systems

Academic Conduct:

Plagiarism—presenting someone else's ideas as your own, either verbatim or recast in your own words—is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, "Behavior Violating University Standards" https://policy.usc.edu/scampus-part-b/ (https://policy.usc.edu/scampus-part-b/). Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, https://policy.usc.edu/scientific-misconduct (https://policy.usc.edu/scientific-misconduct).

Support Systems:

Student Health Counseling Services - (213) 740-7711 – 24/7 on call
studenthealth.usc.edu/counseling/ (https://studenthealth.usc.edu/counseling/)
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call
https://www.suicidepreventionlifeline.org (https://www.suicidepreventionlifeline.org)
Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL), press "0" after hours - 24/7 on call
https://studenthealth.usc.edu/sexual-assault/ (https://studenthealth.usc.edu/sexual-assault/)
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED) - (213) 740-5086/Title IX - (213) 821-8298
https://equity.usc.edu/ (https://equity.usc.edu/), https://titleix.usc.edu/ (https://titleix.usc.edu/)
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
https://usc-advocate.symplicity.com/care_report/ (https://usc-advocate.symplicity.com/care_report/)
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity |Title IX for appropriate investigation, supportive measures, and response.

The Office of Disability Services and Programs - (213) 740-0776
https://dsp.usc.edu (https://dsp.usc.edu)
Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Campus Support and Intervention - (213) 821-4710
https://uscsa.usc.edu/ (https://uscsa.usc.edu/)
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101
https://diversity.usc.edu/ (https://diversity.usc.edu/)
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
https://dps.usc.edu/ (https://dps.usc.edu/), https://emergency.usc.edu (https://emergency.usc.edu)
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call
https://dps.usc.edu (https://dps.usc.edu)
Non-emergency assistance or information.