EPSY 8282

STATISTICAL ANALYSIS OF LONGITUDINAL DATA I

Course Description

The objective of this course is to equip students with modern tools to analyze longitudinal data. This course will cover modern approaches to analyzing longitudinal data with emphasis on linear mixed effects models for continuous, normally-distributed data. Classical methods, such as repeated measures ANOVA/MANOVA, will also be discussed in reference to linear mixed effects models. We will discuss graphical data exploration, correlation structures, parameter estimation, testing, inference, model selection, diagnostics and model limitations.

Course Meeting Time

T, R, 2:30 p.m.–3:45 p.m.

Classroom

Wulling Hall 240

Website

https://github.com/ziefo002/epsy-8282

Required Textbook

None. But, see ***Suggested Textbooks***.

Required Reading

As part of the course, there are several articles, papers and technical reports that you will need to read during the semester. Most of the articles themselves are accessible through the University of Minnesota library website (http://www.lib.umn.edu). In order to access the full text of some of the articles, you will need to log in using your University x500 username and password. More detailed information, including references or links to specific readings, will be made available to students on the course website.

Statistical Computing

Statistical computing is an integral part of statistical work, and subsequently, EPsy 8282. To support your learning in this area, this course will emphasize the use of R. R is a free software environment for statistical computing and graphics. It compiles and runs on a wide variety of UNIX platforms, Windows and MacOS (http://www.r-project.org). It should be noted that while some R syntax and programming is taught during class time, there is also a fair amount that you may need to learn on your own outside of class. There are several tutorials and resources available on the web to help you learn R.

Course Prerequisites

Prerequisites include a year-long Ph.D.-level statistics sequence in the social sciences or equivalent (in the Department of Educational Psychology this is EPsy 8251 and EPsy 8252), The use of statistical computing software for modeling and analysis is also required. Familiarity with matrix notation is helpful; we will review this very briefly at the beginning of the course. During the semester, the underlying statistical theory will be outlined using matrix notation, but deep understanding of the theory is not necessary to complete the assignments; the main focus of this course will be on application. The course should be accessible to graduate students in all fields.

2017

Fall Semester

Andrew Zieffler
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Office Hours: Tuesdays 9:00 AM–10:00 AM; and by appointment
Email: ziefo002@umn.edu

Course Requirements

There are five required homework assignments. The homework assignments will be posted on the course website, or sent to you via email. These assignments include problems that will help you learn the course material through reflection and practice. To foster cooperation and collaboration, you are permitted to form groups of no larger than three to work on the homework. For all work handed in, list the names of each group members on the assignment. Each assignment will be assigned a grade and this grade will be applied to the individuals within the group.

There will also be a final project (due toward the end of the semester—no final exam) that students will need to individually complete. Project details will be handed out in the middle of October. At that time each student must submit a project proposal of no more than one page and get approval from the instructor by early November. Unlike the assignments, the ***final project must be completed independently***, without the help of others. Students are on their honor to do the final project completely independently; any student found doing otherwise will be subject to the maximum University penalties. The final project should be completed and turned in on the due date.

Evaluation of Student Performance

Your lab assignments and project will be turned into a grade and averaged using the following weights: (1) 60% for the total points on the five assignments; and (2) 40% for the total project points. Final letter grades will then be assigned based on the given scale (there will be no rounding).

Cutoff	Grade	Cutoff	Grade	Cutoff	Grade
93%	A	83%	B	73%	C
90%	A–	80%	B–	70%	C–
87%	B+	77%	C+	63%	D

If you are taking the course S/N, the minimum criterion to receive an S is 80% (the equivalent of a B– letter grade). Any student who does not complete all homework assignments without making prior arrangements with the instructor will receive a grade of F/N. Students who earn below 63% will receive the letter grade of F.

Due to possibly differing motivation levels, it is recommended that students taking the course as S/N not be part of a group whose other members are taking the course for a letter grade. People officially auditing the course are not allowed to join work groups or hand in any work. Unofficial audits (just "hanging out") are also not allowed. An incomplete for this course will be considered on a case-by-case basis. The most valid reason for an incomplete is an unforeseen event that gravely interferes with a student's ability to perform at an adequate level. An incomplete will not be given for unqualified poor performance.

Assignments will be handed back in class or during office hours. Uncollected assignments and final projects will be retained for three weeks after the course and then discarded. Shortly after the course, you may access your grades on-line at http://www.onestop.edu.

Discussion/ Participation

While not a part of the course grade, active participation in the course is expected of all students enrolled in EPsy 8282. Active participation includes, but is not limited to, being engaged during the class, asking questions, providing additional insight and material, responding to other students and the instructor, and always being open and inquisitive.

Suggested Textbooks

Students may find the following texts useful for more in-depth mathematical treatment of course topics or alternative perspectives. Note, none of these texts is required.

- Fitzmaurice, G. M., Laird, N. M., & Ware, J. H. (2004). *Applied longitudinal analysis*. New York: Wiley.
- Hand, D. J., & Crowder, M. (1996). *Practical longitudinal data analysis*. New York: Chapman & Hall.
- Hedeker, D., & Gibbons, R. D. (2006). *Longitudinal data analysis*. New Jersey: Wiley.
* Long, J. D. (2012). *Longitudinal data analysis for the behavioral sciences using R*. Thousand Oaks, CA: Sage.
- Pinheiro, J. C., & Bates, D. M. (2000). *Mixed-effects models in S and S-PLUS*. New York: Springer.
* Singer, J., & Willett, J. (2003). *Applied longitudinal data analysis*. New York: Oxford.
- Verbeke, G., & Mollenberghs, G. (2000). *Linear mixed models for longitudinal data*. New York: Springer.
- Weiss, R. E. (2005). *Modeling longitudinal data*. New York: Springer.

R Resources

While the course requirements can be met using any statistical software you choose (so long as it can handle the analyses), I will teach using the R Statistical Computing Environment. Although we will spend time in class using R for data analysis, you may need to spend additional time learning the software outside of class. There are many resources available to help you learn R.

For example, you can find many tutorials and documents from the Web (especially through the Contributed Documentation link on the CRAN homepage). I will also post links to helpful resources on the course website. If you would like books that may help you in this endeavor, here are a couple recommendations:

- Chang, W. (2013). *R graphics cookbook: Practical Recipes for Visualizing Data*. O'Reilly Media.
- Grolemund, G., & Wickham, H. (2017). *R for data science*. (online at http://r4ds.had.co.nz/)
- Teetor, P. (2011). *R cookbook*. O'Reilly Media.

Mathematical Resource

Lastly, I recommend the Fox book as a resource for learning the mathematics (including matrix algebra) necessary to understand the theory that underlies methods you will learn in advanced statistical courses in the social sciences.

- Fox, J. (2013). *A mathematical primer for social statistics*. Thousand Oaks, CA: Sage.

Course Calendar

The calendar below lists the tentative dates of the course topics and assignments. These dates are subject to change at the instructor's discretion. Readings will be posted on the course website, and should be done prior to class.

Date	Course Content	Date	Course Content
Sept. 05	Welcome to EPsy 8282	Oct. 26	Inference with LME models
Sept. 07	Introduction to longitudinal analysis	Oct. 31	Inference with LME models
Sept. 12	Quick review of matrix algebra	Nov. 02	Inference with LME models
Sept. 14	Longitudinal data structures	Nov. 07	Matrix formulation of the LME
Sept. 19	Longitudinal data structures	Nov. 09	Matrix formulation of the LME
Sept. 21	Longitudinal data: Plotting and description	Nov. 14	Modeling covariance structures
Sept. 26	Longitudinal data: Plotting and description	Nov. 16	Modeling covariance structures
Sept. 28	ST. OLAF REVIEW	Nov. 21	Modeling covariance structures
Oct. 03	Classical procedures for analysis	Nov. 23	THANKSGIVING BREAK
Oct. 05	Classical procedures for analysis	Nov. 28	GLME models for non-normal data
Oct. 10	Classical procedures for analysis	Nov. 30	GLME models for non-normal data
Oct. 12	Classical procedures for analysis	De. 05	GLME models for non-normal data
Oct. 17	Introduction to linear mixed-effects models	Dec. 07	NATIONAL ACADEMIES MEETING
Oct. 19	Introduction to linear mixed-effects models	Dec. 11	GLME models for non-normal data
Oct. 24	Introduction to linear mixed-effects models	Dec. 13	GLME models for non-normal data

Assignment/Project Due Dates (Tenative)

- Required Assignment #1: Matrix Algebra Review (due Sept. 21)
- Required Assignment #2: Description and Plotting of Longitudinal Data (due Oct. 05)
- Required Assignment #3: Classical Analyses of Longitudinal Data (due Oct. 24)
- Project Proposal (due Nov. 02)
- Required Assignment #4: LMER Analyses of Longitudinal Data (due Nov. 09)
- Required Assignment #5: Model and Predictor Selection (due Nov. 21)
- Final Project (due Dec. 13)

Email

Email is the primary source of communication among instructors, teaching assistants, and students for this course. As such, you will be expected to check your email frequently (i.e., at least once per day). As per the University policy, "students are responsible for all information sent to them via their University assigned email account. If a student chooses to forward their University email account, he or she is responsible for all information, including attachments, sent to any other email account."

Course Technology Policy

The course uses technology on a regular basis during both instruction and assessments (e.g., homework assignments, exams, etc.). Student difficulty with obtaining or operating the various software programs and technologies–including printer trouble–will not be acceptable as an excuse for late work. Due to the variation in computer types and systems, the instructor or TA may not be able to assist in trouble shooting all problems you may have.

Campus Computer Labs

The Office of Information Technology (OIT) manages numerous computer labs on the Twin Cities campus. Students from all colleges may drop in to use the computer labs during open hours. The OIT website contains information pertaining to the location, hours, and software available for each of the computer labs (http://www.oit.umn.edu/computer-labs/).

Use of Personal Electronic Devices in the Classroom

Using personal electronic devices in the classroom setting can hinder instruction and learning, not only for the student using the device but also for other students in the class. To this end, the University establishes the right of each faculty member to determine if and how personal electronic devices are allowed to be used in the classroom. For complete information, please reference: http://policy.umn.edu/Policies/Education/Education/CLASSROOMPED.html

R

In order to download and install R your computer must be connected to the Internet. The latest version of R can be obtained from the R Project for Statistical Computing at http://www.r-project.org/

After navigating to the website click on "CRAN" under "Download, Packages" on the left-hand side of the welcome screen. You must choose a server in your country of origin, called a CRAN mirror. After doing so, select the appropriate operating system for your computer–Linux, MacOS, or Windows. For Linux and MacOS, follow the directions at the top of the download page. For Windows, download the base package and install it like any other executable file. On Windows machines you might need to have "administrator" privileges to successfully install and use the program.

RStudio

RStudio is an integrated development environment (IDE) for R. A free application, RStudio combines an intuitive user interface with powerful coding tools to help you get the most out of R. It can be downloaded at http://www.rstudio.org/

Microsoft Office

Microsoft Office 365 Pro Plus is available free of charge for University of Minnesota faculty, staff and students. Download and install the latest version of Microsoft Office from https://it.umn.edu/microsoft-office-pro-plus-365-faculty-o

Quantitative Methods in Education Mission Statement

The Quantitative Methods in Education (QME) track offers educational opportunities in both quantitative and qualitative methods with a broad array of introductory and advanced coursework. Students who choose QME as their track within educational psychology may specialize in any of four areas: measurement, evaluation, statistics, and statistics education. The goal of QME is to provide students with broad but rigorous methodological skills so that they may conduct research on methodologies, may help to train others in methodology, or will have the skills necessary to conduct research in related fields.

Department of Educational Psychology Mission Statement

Educational psychology involves the study of cognitive, emotional, and social learning processes that underlie education and human development across the lifespan. Research in educational psychology advances scientific knowledge of those processes and their application in diverse educational and community settings. The department provides training in the psychological foundations of education, research methods, and the practice and science of counseling psychology, school psychology, and special education. Faculty and students provide leadership and consultation to the state, the nation, and the international community in each area of educational psychology. The department's scholarship and teaching enhance professional practice in schools and universities, community mental health agencies, business and industrial organizations, early childhood programs, and government agencies. Adopted by the Department. of Educational Psychology faculty October 27, 2004

College of Education + Human Development Mission Statement

The new College of Education and Human Development is a world leader in discovering, creating, sharing, and applying principles and practices of multiculturalism and multidisciplinary scholarship to advance teaching and learning and to enhance the psychological, physical, and social development of children, youth, and adults across the lifespan in families, organizations, and communities.

Tilly the Therapy Chicken
@TherapyChicken

Stress Management

Stress management is an important piece of the skill set needed for success in graduate school. Pet Away Worry & Stress (PAWS) is one of the many resources available to students. Find out more at http://www.bhs.umn.edu/services/wellness-paws.htm.

University of Minnesota Policies and Procedures

Academic Freedom and Responsibility

Academic freedom is a cornerstone of the University. Within the scope and content of the course as defined by the instructor, it includes the freedom to discuss relevant matters in the classroom. Along with this freedom comes responsibility. Students are encouraged to develop the capacity for critical judgment and to engage in a sustained and independent search for truth. Students are free to take reasoned exception to the views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled.* Reports of concerns about academic freedom are taken seriously, and there are individuals and offices available for help. Contact the instructor (Andrew Zieffler; zief0002@umn.edu), the Department Chair (Geoff Maruyama; geoff@umn.edu), your adviser, the associate dean of the college (Kenneth R. Bartlett; bartlett@umn.edu), or the Vice Provost for Faculty and Academic Affairs in the Office of the Provost (Arlene Carney; carne005@umn.edu).

*Language adapted from the American Association of University Professors "Joint Statement on Rights and Freedoms of Students".

Disability Accommodations

The University of Minnesota views disability as an important aspect of diversity, and is committed to providing equitable access to learning opportunities for all students. The Disability Resource Center (DRC) is the campus office that collaborates with students who have disabilities to provide and/or arrange reasonable accommodations.

- If you have, or think you have, a disability in any area such as, mental health, attention, learning, chronic health, sensory, or physical, please contact the DRC office on your campus (612.626.1333) to arrange a confidential discussion regarding equitable access and reasonable accommodations.
- Students with short-term disabilities, such as a broken arm, can often work with instructors to minimize classroom barriers. In situations where additional assistance is needed, students should contact the DRC as noted above.
- If you are registered with the DRC and have a disability accommodation letter dated for this semester or this year, please contact your instructor early in the semester to review how the accommodations will be applied in the course.
- If you are registered with the DRC and have questions or concerns about your accommodations please contact your (access consultant/disability specialist).

Additional information is available on the DRC website: diversity.umn.edu/disability or e-mail drc@umn.edu with questions.

Equity, Diversity, Equal Opportunity, and Affirmative Action

The University will provide equal access to and opportunity in its programs and facilities, without regard to race, color, creed, religion, national origin, gender, age, marital status, disability, public assistance status, veteran status, sexual orientation, gender identity, or gender expression. For more information, please consult Board of Regents Policy: http://www1.umn.edu/regents/policies/administrative/Equity_Diversity_EO_AA.html.

Makeup Work for Legitimate Absences

Students will not be penalized for absence during the semester due to unavoidable or legitimate circumstances. Such circumstances include verified illness, participation in intercollegiate athletic events, subpoenas, jury duty, military service, bereavement, and religious observances. Such circumstances do not include voting in local, state, or national elections. For complete information, please see: http://policy.umn.edu/education/makeupwork.

Mental Health and Stress Management

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance and may reduce your ability to participate in daily activities. University of Minnesota services are available to assist you. You can learn more about the broad range of confidential mental health services available on campus via the Student Mental Health Website: http://www.mentalhealth.umn.edu.

Respecting Intellectual Property

Students may not distribute instructor-provided notes or other course materials, except to other members of the same class or with the express (written) consent of the instructor. Instructors have the right to impose additional restrictions on course materials in accordance with copyright and intellectual property law and policy. Students may not engage in the widespread distribution or sale of transcript-like notes or notes that are close to verbatim records of a lecture or presentation. For additional information, please see: http://policy.umn.edu/Policies/Education/Education/STUDENTRESP.html.

Scholastic Dishonesty

You are expected to do your own academic work and cite sources as necessary. Failing to do so is scholastic dishonesty. Scholastic dishonesty means plagiarizing; cheating on assignments or examinations; engaging in unauthorized collaboration on academic work; taking, acquiring, or using test materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; altering, forging, or misusing a University academic record; or fabricating or falsifying data, research procedures, or data analysis. (Student Conduct Code: http://regents.umn.edu/sites/default/files/policies/Student_Conduct_Code.pdf) If it is determined that a student has cheated, he or she may be given an "F" or an "N" for the course, and may face additional sanctions from the University. For additional information, please see: http://policy.umn.edu/Policies/Education/Education/INSTRUCTORRESP.html.

The Office for Student Conduct and Academic Integrity has compiled a useful list of Frequently Asked Questions pertaining to scholastic dishonesty: http://www1.umn.edu/oscai/integrity/student/index.html. If you have additional questions, please clarify with your

Sexual Harassment

"Sexual harassment" means unwelcome sexual advances, requests for sexual favors, and/or other verbal or physical conduct of a sexual nature. Such conduct has the purpose or effect of unreasonably interfering with an individual's work or academic performance or creating an intimidating, hostile, or offensive working or academic environment in any University activity or program. Such behavior is not acceptable in the University setting. For additional information, please consult Board of Regents Policy: http://www1.umn.edu/regents/policies/humanresources/SexHarassment.html

Student Conduct Code

The University seeks an environment that promotes academic achievement and integrity, that is protective of free inquiry, and that serves the educational mission of the University. Similarly, the University seeks a community that is free from violence, threats, and intimidation; that is respectful of the rights, opportunities, and welfare of students, faculty, staff, and guests of the University; and that does not threaten the physical or mental health or safety of members of the University community.
As a student at the University you are expected adhere to Board of Regents Policy: Student Conduct Code. To review the Student Conduct Code, please see: http://regents.umn.edu/sites/default/files/policies/Student_Conduct_Code.pdf.

Note that the conduct code specifically addresses disruptive classroom conduct, which means "engaging in behavior that substantially or repeatedly interrupts either the instructor's ability to teach or student learning. The classroom extends to any setting where a student is engaged in work toward academic credit or satisfaction of program-based requirements or related activities."

Senate Grading Policy

The University of Minnesota's grading policy is available online. For additional information, please refer to http://policy.umn.edu/Policies/Education/Education/GRADINGTRANSCRIPTS.html. The University utilizes plus and minus grading on a 4.000 cumulative grade point scale in accordance with the following:

A	4.000	Represents achievement that is outstanding relative to the level necessary to meet course requirements
A–	3.667	
B+	3.333	
B	3.000	Represents achievement that is significantly above the level necessary to meet course requirements
B–	2.667	
C+	2.333	
C	2.000	Represents achievement that meets the course requirements in every respect
C–	1.667	
D+	1.333	
D	1.000	Represents achievement that is worthy of credit even though it fails to meet fully the course requirements
S		Represents achievement that is satisfactory, which is equivalent to a C– or better
F/N		Represents failure (or no credit) and signifies that the work was either (1) completed but at a level of achievement that is not worthy of credit or (2) was not completed and there was no agreement between the instructor and the student that the student would be awarded an I (see also I).
I	Incomplete	Assigned at the discretion of the instructor when, due to extraordinary circumstances, e.g., hospitalization, a student is prevented from completing the work of the course on time. Requires a written agreement between instructor and student.