**Multilevel Modeling in Developmental and Family Research**

**Course Information:**

**Class:** Tuesdays and Thursdays 1:30-2:45pm in SC 183

**Instructor Contact Information:**

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| **Professor:** Kristine Marceau  **Office:** 225 Hanley Hall  **Phone:** 494-9410  **Email:** [KristineMarceau@purdue.edu](mailto:KristineMarceau@purdue.edu)  **Office hours:** by appointment | **TA:** Olivia Robertson  **Office:** 356 Hanley Hall  **Phone:** 496-3656  **Email:** [rober511@purdue.edu](mailto:rober511@purdue.edu)  **Office hours:** by appointment |

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# Course Description and Objectives:

This course is an introduction to multilevel (mixed-effects) modeling, which is an analytic method used throughout the behavioral and social sciences. The course is designed to provide you with an understanding of both the statistical underpinnings and the application of multilevel models (MLMs). While mathematical basics of statistical methods are covered, emphasis is placed on model development, the conceptual understanding of models, and interpretation of model results. The course will introduce the basic two-level MLM and relate it to regression and ANOVA modeling methods. Nesting in both the contextual and longitudinal data situations are examined. Three-level MLMs are also covered. Data preparation, hypothesis testing and estimation approaches for MLMs are introduced throughout the course. Students should finish the course with the ability to apply MLMs to their substantive research questions and to understand and communicate their meaning.

**What can** **you expect this class to be like?**

I designed this class to be as applied and applicable to your personal research as possible:

**In Class.** Each class will start with some lecture, and will move back and forth between lecture, practice data preparation and running MLM models using SAS software, and equations and demonstrations on the whiteboard. You might find it useful to bring markers/colored pens to take notes, since I tend to color code on the board. I will ask you all questions a lot, and I love wrong answers. Please speak up and make guesses if you’re not sure – I want this class to be a judgement-free zone, and the kinds of answers you provide (right or wrong) gives me a ton of information about whether to stop and go back over something, explain something in a different way, or if you are getting it and I should move on. Usually there are a few students who are happy to speak up, and I love that. If you’re one of those, though, please try counting to 30 before putting up a hand to let others participate as well. If you’re quieter, please try to challenge yourself to speak up in class at least once a week, whether it’s with a question or an answer. Class attendance is highly recommended, as without class attendance, it will be much more difficult to master the material (and I may not have as good a read on how you’re doing!).

**Data.** If you have your own data that is suitable for MLM, I highly encourage you use it for homework assignments and the final presentation, and even that you adapt the course scripts to your own data. If you don’t have your own data, I do have data available, and may be able to help you locate data that are suitable and on a topic that is more interesting to you than the data I will use in class. All classes will occur in the lab.

**Outside of Class.** In the first week, I want to meet with each of you in order to get to know you and your research interests and goals in taking the class. I will, for example, tailor readings and examples to try and cover the interests of the class. Both Olivia and I are happy to meet to go over assignments, materials, and preparations for your final presentation whenever you’d like. We are happy to meet in person or via zoom, depending on your preference. If you’re struggling with content or code (especially the unique data problems that will crop up when using your own data), please go to Olivia first. If she can’t troubleshoot the problem, then it will escalate to me.

**Learning Resources, Technology & Texts**

**Class Website:** <https://purdue.brightspace.com/d2l/home/339918>

The course webpage is hosted by Brightspace. When you login to Brightspace you should automatically have access to the webpage. The webpage will contain: PowerPoints from presentations given in lecture, SAS scripts and data sets, homework assignments, supplemental readings, and other resources. I will also provide updates to the class through Brightspace.

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# Required Text:

# Raudenbush, S. W. & Bryk, A. S. (2002). Hierarchical linear models: Applications and data analysis methods (2nd ed). Thousand Oaks, CA: Sage Publications. (Referred to as HLM in the schedule)

# Communication:

In addition to posting announcements on Brightspace, I am likely to use email to communicate with the class. If you have any questions for me specifically, I prefer that you email me. You can also feel free to use the discussion boards on Brightspace to ask general questions that may be of interest to all students. From me, anything on Brightspace will be an “FYI” or reminder-style communication.

*A note on how I read/respond to emails*… To me, emails fall in the “semi-urgent” category. If I don’t respond within 48h please feel free to follow-up/email me again. I have two young children- Korra is 3 and Jakob is 5 (in Kindergarten), and my schedule is a little bit variable – I may not communicate after 3:30pm (if it’s my day to get Jakob from the bus) and you may see relatively early emails from me (they wake up super early, sigh). I do not expect you to email/respond ‘after hours’, and I ask that you be especially patient if you email me outside of the hours of 9-3:30. I am also happy to receive emails after hours. I’m pretty on top of emails so I don’t anticipate that you’ll be waiting long for a response.

I don’t think you’ll need to contact me ‘urgently’, but if you do, you may reach me on my cell phone (414-940-7380). It is probably safer to text me and include your name so I know you’re not spam.

**Learning objectives:**

* Develop a basic understanding of multilevel models including proper application, interpretation, and evaluation of the models
* Learn the benefits and limitations of MLMs including when it is advantageous to use this modeling approach
* Develop an understanding of the data structure and visualization techniques related to MLM
* Develop an understanding of the underlying statistics including model notation, model structure, and hypothesis testing
* Run MLM data analysis using SAS statistical software
* Improve analytic and critical thinking skills
* Improve written and verbal communication of analytic results
* Use MLM methods to test research questions using real data and statistical software

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# Course Components:

**Readings**: Reading assignments include the required text as well as optional supplemented course readings which will be provided on Brightspace. Reading assignments may be updated during class and on Brightspace. Completing the readings will greatly aid with your understanding of the material presented in class. Therefore, I encourage you to keep up with the reading as best you can. It is good practice to read statistics in shorter sections rather than reading through entire chapters in one sitting.

**Statistical Software:** We will learn how to analyze MLMs using SAS statistical software. SAS is available in all ITaP instructional labs across campus as well as through software remote: <https://engineering.purdue.edu/ECN/Support/KB/Docs/UsingITaPGoRemotesof>

SAS 9.4 (for your personal computer) is also available for immediate download by placing a free order on Purdue’s Community Hub: <https://communityhub.purdue.edu/storefront/browse/statistical>. Please contact the TA for additional information about downloading SAS for your personal computer. Note: SAS does not make a Mac version for their software. If you have a Mac, remote access is best.

Additionally, we will be providing scripts for the analyses in R as well, though this will not be primarily taught this semester. If you prefer to use the R scripts for homework just let me know.

**Homework**: There will be approximately five homework assignments over the course of the semester. These generally will involve application of MLMs to real data using SAS (or R), including communicating the results. The focus will be on proper application of the models and interpretation of model results, but will also include some calculations and problem solving. You may work together with others on assignments, but you should produce your own assignment, particularly with respect to written components. Use your PUID instead of name on all homework assignments. Homework will account for 50% of your final grade.

**Quizzes:** There will be five pop quizzes during the course of the semester. The quizzes will represent 20% of your final grade (5% each, the lowest score is dropped). A major component of the quizzes will be interpretation of statistics we learn about in the class in short answer format. We will release practice quizzes each week so that you can become comfortable with the format and type of content you can expect to see on in-class quizzes. Practice quizzes are not graded, but will help you succeed on this component of the course. Additional practice quizzes are available upon request. Use your PUID instead of name on all quizzes. Please inform Dr. Marceau or the TA of any known, planned absences (e.g., for conference travel) at the beginning of the semester so that we can plan around them and prepare a make-up quiz. We understand absence crop up, but please try to be considerate of our time and extra effort in the event that your absence requires a make-up quiz. A head’s up whenever possible is really helpful.

**Final Presentation**: There will be a final presentation at the end of the semester. The TA and I will work with each student to define an appropriate research question that can be tested using MLM for the final presentation. Students are encouraged to set a meeting with Dr. Marceau prior to November 15 by which date all topics must be approved. Presentations should be 10-15 minutes in length, and there will be an additional 5 minutes set aside for questions. Presentations should include a brief introduction (2-3 slides), research questions/hypotheses (1 slide), methods (1-2 slides on study and measures), analytic strategy (1-3 slides), results, conclusions (1 slide), and implications (1 slide). The TA will demonstrate an example final presentation before presentations begin. The final presentation will represent 30% of your final grade.

**Paper Option**: If you would like feedback on a final research paper I will be happy to read and comment on it. This option may be useful for students who are working on a paper or a thesis using the data they bring to this course. There will be no additional credit for papers, and it cannot be substituted for the final presentation.

**Grading:**

Your grade will be weighted based on the following course component percentages:

|  |  |
| --- | --- |
| Homework: | 50% |
| Quizzes: | 20% |
| Final Presentation: | 30% |
|  |  |

Final grades will be assigned according to the following scale:

|  |  |  |
| --- | --- | --- |
| A+: | > | 98% |
| A: | 92% - | 97.9% |
| A-: | 90% - | 91.9% |
| B+: | 88% > | 89.9% |
| B: | 82% - | 87.9% |
| B-: | 80% - | 81.9% |
| C+: | 78% > | 79.9% |
| C: | 72% - | 77.9% |
| C-: | 70% - | 71.9% |
| D+: | 68% > | 69.9% |
| D: | 62% - | 67.9% |
| D-: | 60% - | 61.9% |
| F: | < | 60% |

# Attendance:

# There is no formal attendance policy. You are all graduate students with competing demands on your time and it is important to learn how to balance your priorities. I trust that you can weigh the importance of attending this class as is best for you. However, because I switch between lecture, software programs, and the whiteboard and encourage discussion and participation, I really think you’ll get the most out of class by coming. Please do let me know if you will be absent ahead of time, as it is courteous and so I don’t wait for you to start class.

**Academic Guidance in the Event a Student is Quarantined/Isolated**

# As noted above, if you are quarantined/isolated, let us know. You will still be responsible for all course materials for that week/those weeks, but we can work on a case-by-case basis on timing or mode of completion depending on your situation while isolated (i.e., connectivity, illness).

# Classroom Guidance Regarding Protect Purdue

Students are expected to keep up to date with and comply with Protect Purdue Protocols. (I’m not providing specific guidance here, as they are subject to change over time).

Any student who has substantial reason to believe that another person is threatening the safety of others by not complying with Protect Purdue protocols is encouraged to report the behavior to and discuss the next steps with their instructor. Students also have the option of reporting the behavior to the [Office of the Student Rights and Responsibilities](https://www.purdue.edu/odos/osrr/). See also [Purdue University Bill of Student Rights](https://catalog.purdue.edu/content.php?catoid=7&navoid=2852#purdue-university-bill-of-student-rights) and the Violent Behavior Policy under University Resources in Brightspace.

# Course Policies:

**Special Accommodations:** Our goal is for everyone to participate fully in this course. If you have a physical, psychological, medical, or learning disability that may impact your course work, please make an appointment to speak with me in order to discuss any needed adjustments. In addition, you should notify the Disability Resource Center of an impairment/condition that may require accommodations/documentation. <http://www.purdue.edu/drc>

# Academic Integrity: Students are advised to familiarize themselves with the University’s regulations regarding student conduct in academic endeavors. This information is located at the following website: <http://www.purdue.edu/univregs/pages/stu_conduct/stu_regulations.html.> Students who are suspected to be in violation of the University’s regulations regarding academic dishonesty, including but not limited to plagiarism and cheating, will be dealt with in accordance with University policy. This may result in a referral to the Office of the Dean of Students and penalties for the assignment(s) in question.

**Honor Pledge:**

***As a boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue.***

Please refer to [*Purdue’s Honor Pledge*](https://www.purdue.edu/provost/teachinglearning/honor-pledge.html) for more details.

**Nondiscrimination Statement:** We are a diverse group this semester, and that diversity makes the learning environment richer. You will have different perspectives and questions that will help your peers think about the topics in new and different ways. Please be sensitive to the fact that your fellow classmates belong to many different departments, come from many walks of life, and may face discrimination that you are unaware of. Specific to this course, some students are more or less confident in their statistical abilities. Particularly in methods courses like this one, students learn very differently, and each of you will struggle with different topics. You will really understand or really be lost when I explain aspects of the course in different ways (i.e., some will be visual and some will latch onto the equations). I try my best to present the material a few different ways, but this class works best when students are kind and understanding, and open to being helpful to each other – you can help explain things to each other and figure things out together leveraging your respective strengths. Please be kind, respectful, and inclusive in these efforts.

Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. Please see Purdue’s [Nondiscrimination Policy Statement](https://www.purdue.edu/purdue/ea_eou_statement.php) (also in the Brightspace template under University Policies) for more information.

# Campus Emergencies:

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor’s control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.

Emergency information and updates will be posted on Purdue's homepage at [http://www.purdue.edu.](http://www.purdue.edu/) Students should sign up for emergency text messages here: [http://www.purdue.edu/securepurdue/.](http://www.purdue.edu/securepurdue/) Also, the following webpage details university policies and procedures during various emergency events: [https://www.purdue.edu/emergency\_preparedness/flipchart/index.html.](https://www.purdue.edu/emergency_preparedness/flipchart/index.html)

# Basic Needs:

Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact the Dean of Students for support. There is no appointment needed and Student Support Services is available to serve students 8 a.m.-5 p.m. Monday through Friday. Considering the significant disruptions caused by the current global crisis as it related to COVID-19, students may submit requests for emergency assistance from the [Critical Needs Fund](https://www.purdue.edu/odos/resources/critical-need-fund.html).

# Mental Health/Wellness:

If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try [WellTrack](https://purdue.welltrack.com/). Sign in and find information and tools at your fingertips, available to you at any time.

If you need support and information about options and resources, please contact or see the [Office of the Dean of Students](http://www.purdue.edu/odos). Call 765-494-1747. Hours of operation are M-F, 8 am- 5 pm.

If you find yourself struggling to find a healthy balance between academics, social life, stress, etc. sign up for free one-on-one virtual or in-person sessions with a [Purdue Wellness Coach at RecWell](https://www.purdue.edu/recwell/fitness-wellness/wellness/one-on-one-coaching/wellness-coaching.php). Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is completely free and can be done on BoilerConnect. If you have any questions, please contact Purdue Wellness at [evans240@purdue.edu](mailto:evans240@purdue.edu).

# If you’re struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact [Counseling and Psychological Services (CAPS)](https://www.purdue.edu/caps/) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office on the second floor of the Purdue University Student Health Center (PUSH) during business hours.

# Tentative Schedule:

The tentative schedule of topics and readings is provided below. **There will inevitably be changes to this schedule and specific readings during the semester.** I will provide updated schedules as we move through the course topics. Additional readings may be added.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Dates** | **Topics Covered** | **Readings** | **Optional Readings** | **Scripts** |
| Aug 24 & 26 | Course Overview  Nested Data Structures  SAS primer I | Hayes, 2006 |  | SAS Primer I \_ dataintro.sas |
| Aug 31 & Sep 2 | SAS primer II  Regression & ANOVA | HLMa, pp. 3-14 |  | SAS Primer II \_ reg\_anova.sas |
| Sept 7 & 9 | The Basic MLM and Submodels | HLM, pp. 16-28,  HLM, pp. 68-81 | Albright & Marinova, 2010  Marceau et al., 2017 | Wk3 Basic Models\_Subs.sas |
| Sept 14 & 16 | Generalizing the Basic Model  Centering & Notation | HLM, pp. 29-37 | Enders & Tofighi, 2007  Paccagnella et al., 2006 | Wk4 Extension and Center.sas |
| Sept 21 & 23 | Estimation and Hypothesis Testing | HLM, pp. 38-67 |  | Wk5 Estimation HypTesting.sas |
| Sept 28 & 30 | Applications in Longitudinal Research | Nessleroade & Baltes, 1979  Hoffman & Stawski, 2009 | Marceau, Ram, et al., 2015 | Wk6 Longitudinal Plots MLM.sas |
| Oct 5 & 7 | Analysis of Change | HLM, pp. 160-202 | Marceau, Ruttle, et al., 2015 | Wk7 Longitudinal Predictors.sas |
| Oct 12 | **No Class** (fall break) |  |  |  |
| Oct 14 | Applications I | HLM, pp. 99-158 |  | Wk8 Applications.sas |
| Oct 19 & 21 | Finish Applications I  Applications II (article discussion) | **TBD** |  |  |
| Oct 26 & 28 | Three Level Models | HLM, pp. 228-250 | Singer, 1998 | Wk 10\_3levelMLM.sas |
| Nov 2 & 4 | Model Assumptions & Assessment I | HLM, pp. 252-266 |  | Wk11&12 Assumptions and Assessment.sas |
| Nov 9 & 11 | Model Assumptions & Assessment II | HLM, pp. 267-286 |  | Wk11&12 Assumptions and Assessment.sas |
| Nov 15 & 18 | Final Presentation example & power | Lane & Hennes, 2018 Snijders 2005 |  | Wk 13 Power Code Simulations.sas; SAScode and Rcode for Lane and Hennes2018.sas; Proc Power.sas |
| Nov 23 & 25 | **No Class** (Thanksgiving break) | | | |
| Nov 30 & Dec 3 | **Final Presentations I** | | | |
| Dec 7 & 9 | **Final Presentations II** | | | |

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