

Advanced Psychological Statistics: The General Linear Model and Beyond

What: Psych 3890
When: M/W 10-11:20am
Where: Somers Family Hall 220

Instructor: Shelly Cooper, PhD (she/her)
Email: shelly.cooper@wustl.edu
Office: Somers Family Hall 453A & Zoom
Office Hours: [Make an appointment here](#)

Instructor: Joshua Jackson, PhD (he/him)
Email: j.jackson@wustl.edu
Office: Somers Family Hall 315B
Office Hours: Wednesday 3:00-4:00

COURSE DESCRIPTION

TEXT: *Regression and Other Stories*, Gelman, Hill, & Vehtari. Not required.

COURSE OBJECTIVES:

The General(ized) Linear Model (GLM) refers to a common family of statistical techniques popular in the social sciences, such as ANOVA, regression, and logistic regression. The primary goal of this course is for students to understand the basics and nuances of the GLM. We will also explore and introduce students to extensions of the GLM common in psychology and neuroscience research. These frameworks include multilevel modeling, generalized linear models, Bayesian analyses, machine learning, etc. Students will analyze data using each of these methods using R statistical software, therefore improving their advanced computing skills. By the end of the course, students will understand the general framework used in most statistical tests employed by psychological and neuroscientific researchers. Students will not be expected to know every detail of every test but will instead have a conceptual understanding of these tools and practice in deploying these tools.

Please note that some of these topics might be addressed in other courses on campus. Other courses in other departments may focus more on the statistical models themselves. This class focuses on how these models can be applied within the domain of Psychology.

COURSE PREREQUISITES:

Students must have successfully completed Psych 300 Introductory Psychological Statistics or its equivalent (SDS 2200, SDS 3200, or DAT 120). **Students also must be proficient in R statistical software.** Students may demonstrate their proficiency by either having successfully completed Psych 3175, Applied Statistical Analysis with R, or they must complete an assignment (provided by the instructors) at least 2 weeks before the semester begins.

COURSE LEARNING OBJECTIVES:

Understand the Basics of Linear Models

- Explain the concept of linear relationships between variables.
- Identify the components of a simple linear regression model (e.g., intercept, slope, residuals).

Model Fitting and Interpretation

- Fit a simple linear regression model to a dataset using statistical software.
- Interpret the coefficients of a linear model in the context of the data.
- Assess the fit of the model using metrics such as R-squared and root mean square error (RMSE).

Hypothesis Testing and Confidence Intervals

- Perform hypothesis tests on model coefficients to determine their statistical significance.
- Construct and interpret confidence intervals for model parameters.

Model Assumptions and Diagnostics

- Understand the key assumptions of linear regression (e.g., linearity, independence, homoscedasticity, normality).
- Use diagnostic plots to assess model assumptions and detect potential problems.

Multiple Linear Regression & More

- Extend simple linear regression to multiple linear regression.
- Interpret the coefficients in the context of multiple predictors.
- Understand the impact of multicollinearity and how to detect it.
- Explore extensions such as generalized linear models, multilevel models, structural equation models, etc.

COURSE FORMAT:

Class time will be devoted to lectures on the mathematical backbones of these analyses as well as an applied perspective with using code to execute, graph, and interpret the analyses.

COURSE WEBSITE: <https://glm2025.netlify.app/>; <https://glmbeyond.slack.com>

***OFFICE HOURS:** We are offering office hours. However, no one ever comes to office hours. What is the point of office hours? Here is our perspective: Dr. Jackson will hold office hours Wednesday 3:00-4:00pm, and Dr. Cooper will be the primary person answering Slack questions. You can always make an appointment with both of us using our Calendly links, and we will be happy to help! Additionally, if we find that everyone is asking Slack questions and no one is coming to office hours, we'll adjust. Similarly, if everyone comes to office hours and no one posts on Slack, we will adjust. The point is that we are here to help you – no matter the medium.

GRADING

ASSIGNMENTS: The vast majority of one's final grade will be based on completing weekly coding and analysis assignments. All assignments must be completed using R statistical software. Code must show all steps of the analysis including reading in data, cleaning data, analyses, and graphs when appropriate. Each assignment is worth 20 points. The lowest assignment will be dropped. Each day an assignment is late, you lose 5% up until 5 days late. After 5 days, it is an automatic 0. To reiterate, there are 12 coding assignments. We will drop your lowest graded assignment. That leaves 11 graded assignments, at 20 points each, for a total of 220 points.

PARTICIPATION: The material in this class can get quite complicated. To ensure success, students must come to class ready to engage. Students will receive 1 participation point per class for a total of 27 points. Excused absences will be allowed on a case-by-case basis and are subject to instructor approval. Students will receive their daily participation point if they ask or answer at least one question per class period. Instructors will ensure that ample opportunities are provided to do so.

FINAL GRADE:

Your final grade will be based on the points you obtain on assignments and participation.

- 12 Weekly coding assignments (lowest dropped, total graded = 11 assignments), 20 points each, 220 points total
- Participation, 1 point per class session, 27 points total
- **Total grade 247 points**

RATING SCALE (%):

A ≥ 93.00	C = 73.00-76.99
A- = 90.00-92.99	C- = 70.00-72.99
B+ = 87.00-89.99	D+ = 67.00-69.99
B = 83.00-86.99	D = 63.00-66.99
B- = 80.00-82.99	D- = 60.00-62.99
C+ = 77.00-79.99	F < 60

If you take this class as Pass/Fail, you need a minimum of 70% to Pass.

Some of you will be unhappy with a grade. Unfortunately, we are not able to change the laws of mathematics, no matter how much we like you. Instead, we work to build in grace throughout the semester by dropping the lowest grade of your coding assignments—this way everyone gets the same deal. **We do not adjust grades.**

ARTIFICIAL INTELLIGENCE POLICY:

Artificial Intelligence tools like Chat-GPT are rapidly changing the landscape of how we write code. These tools are wonderful for writing code quickly (rather than going down crazy rabbit holes). It is used frequently outside of the classroom for writing code in a variety of languages, including R. It would be crazy not to incorporate this tool into your learning.

That said, AI tools very, very often give you the *wrong* code. You must be proficient in R to take this course (that is a prerequisite). Therefore, the following policies are:

- You are allowed to use Chat-GPT and other similar AI tools. **However, you must include a link to the “conversation” you had with the tool.** This way, we can see the prompt you provided, the AI’s response, and your follow-up (if applicable). We can show you how to copy this link. You will put this link in every assignment.
- If you use an AI tool to get part of the way there, you must still supply this link to the “conversation”. In general, err on the side of over-sharing.
- You are expected to be able to debug any code that AI tools provide. It is your responsibility to make sure the code executes and gives the correct answer.
- If you have any questions on what is or is not authorized use, please see the instructors.

Course Outline and Assigned Reading

This is an approximate schedule. Lecture order and topics are subject to change at the professor's discretion. The dates of the exams may be changed depending on the coverage of the materials, but adequate notice will be given. See below this table for acronyms.

Week	Date	Topics Covered	Assignment	Associated Readings – (some still TBD)
Week 1	1/13	Introduction to course; R Code Refresher; R Projects		
Week 1	1/15	General Linear Models – basics 1		Chapter 6
Week 2	1/20	<i>MLK Day – No Class!</i>		
Week 2	1/22	General Linear Models – basics 2	#1 due	Chapter 7
Week 3	1/27	General Linear Models – basics 3		
Week 3	1/29	p -values; why they suck		
Week 4	2/3	Interactions – categorical	#2 due	Chapter 8
Week 4	2/5	Interactions – continuous		Chapter 10
Week 5	2/10	Interactions – continuous	#3 due	
Week 5	2/12	Interactions – mixed		
Week 6	2/17	Interactions – mixed	#4 due	Chapter 5
Week 6	2/19	Interactions – mixed		
Week 7	2/24	Interactions – categorical	#5 due	Chapter 21
Week 7	2/26	Interactions – factorial		
Week 8	3/3	Structural Equation Models – theory & rationale	#6 due	Reading from Rex Kline (will be provided)
Week 8	3/5	Structural Equation Models – application		
Week 9	3/10	<i>Spring Break!</i>		
Week 9	3/12	<i>Spring Break</i>		
Week 10	3/17	Multilevel Models – theory & rationale	#7 due	
Week 10	3/19	Multilevel Models – application		
Week 11	3/24	From General to Generalized – theory & rationale	#8 due	Chapter 13; Chapter 14
Week 11	3/26	From General to Generalized – application		Chapter 15
Week 12	3/31	Bayesian Inference – theory & rationale	#9 due	Chapter 9
Week 12	4/2	Bayesian Inference – theory & rationale		
Week 13	4/7	Bayesian Inference – application	#10 due	
Week 13	4/9	Bayesian Inference – application		
Week 14	4/14	Machine Learning – theory & rationale	#11 due	Yarkoni & Westfall
Week 14	4/16	Machine Learning – theory & rationale		
Week 15	4/21	Machine Learning – application	#12 due	
Week 15	4/23	Machine Learning – application		

Academic Policies and Resources

- **Contact Hours:**
 - This is a 3-credit course and we anticipate that we will meet for all class periods scheduled. However, should anything arise that would prevent us from meeting in class, we will make up all contact hours. This will be addressed on a case-by-case basis but may include: synchronous Zoom class, asynchronous recording of lecture material, Canvas assignment etc.
- **UNIQUE TO SPRING 2025:**
 - Dr. Cooper is pregnant and due mid April. We have planned a great semester and therefore do not anticipate any disruptions to the course. Here is the plan:
 - See class schedule above for topics on a day-by-day basis
 - Dr. Cooper will go through most of the 1st half of the semester. Dr. Jackson will cover most of the 2nd half of the semester
 - Please note that all the same class policies will apply no matter what! The grading will remain the same, assignments are the same, etc. The class does not magically change.
 - In the off chance that class must be canceled or rescheduled, note that all contact hours will be made up in some capacity as per the Contact Hours section above.
- **University Code of Conduct**
 - Any student found guilty of academic misconduct, such as cheating, plagiarizing, forgery, or furnishing false information to a University official will be subject to consequences including failing the class, suspension from the University, or expulsion from the University.
 - Please see the above Artificial Intelligence policy for this course. Importantly, AI tools are authorized if they are credited appropriately. If you have any questions on what is or is not authorized use, please see the instructors.
- **Special accommodations** (such as a learning, sensory, or physical disability or any other diagnosis that requires special accommodations and/or assistance with lectures, reading, written assignments, and/or exam taking)
 - Contact [Disability Resources](#) at disabilityresources@wustl.edu or call 314-935-5970
 - Please contact me as soon as possible if you need special accommodations. Once I have the Accommodation Letter from Disability Resources, we can discuss ways to modify the course experience for you.
- **Mental & Physical Health**
 - [Habif Health and Wellness Center](#), email HabifInfo@wustl.edu or call 314-935-6666
- **WUSTL Police Department**
 - On campus emergency, please call 314-935-5555
- **Relationship or sexual violence**, including sexual harassment and stalking
 - Contact a licensed [RSVP](#) counselor (confidential, with some limited information being shared as needed with the appropriate university administrator) at rsvpcenter@wustl.edu or call 314-935-3445
 - Contact the University's Title IX Director, Ms. Jessica Kennedy, at jwkennedy@wustl.edu or call 314-935-3118
 - **PLEASE NOTE** You can always come talk to me. Period. However, if you come to me with any issues surrounding child abuse, suicidal tendencies, or sexual assault, sexual discrimination, sexual harassment, dating violence, domestic violence, or stalking, I am required to report these to their appropriate administrators. Washington University

faculty and administrators strive to maintain confidentiality, but some information may need to be disclosed when it is a matter of safety.