

**27:202:543**  
**INTERMEDIATE STATISTICS**  
Spring 2023 Syllabus

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Class Location: Center for Law and Justice, Room 574  
Class Time: Tuesday, 1:00-3:40  
Office Hours: By appointment

### **COURSE DESCRIPTION**

This course is a continuation of Introductory Statistics (27:202:542) and is designed to provide a survey of statistical models for discrete or limited dependent variables, as well as clustered data structures. These models will be grounded in maximum likelihood estimation. The first half of the semester will be devoted to the *generalized linear model*. Following a review of probability and the linear model, this will include models for outcomes that are binary, categorical, and counts. The second half of the semester will consider the *multilevel model*. This is a broad class of models for data in which the units are nested within some hierarchy, as well as longitudinal designs in which the units are subjected to repeated measurements over time. Time permitting, the course will cover miscellaneous advanced topics, including resampling methods (e.g., bootstrapping), penalized regression, and Bayesian inference.

### **Course Objectives**

- Expertise with the logic and method of maximum likelihood estimation.
- Ability to discern the type of regression model that is suitable for any type of dependent variable, to estimate the model, and to correctly interpret the resulting parameter estimates.
- Working knowledge of statistical models for the analysis of multilevel data, including their underlying assumptions, data requirements, implementation, and interpretation.
- Familiarity with a statistical software for a wide range of applications.
- Application of a maximum likelihood model to an independent research problem.

### **Course Prerequisite**

It is assumed that students have completed at least one semester of graduate-level statistics, and are comfortable with the use of computer-based statistical programs, preferably R. For doctoral students in the School of Criminal Justice, the prerequisite includes Introductory Statistics (27:202:542). For students from other programs, this includes courses leading up to and including linear regression analysis. This course will begin with a review of the linear regression model, but minimum knowledge of least squares estimation will nevertheless be assumed.

## COURSE MATERIALS

In this course, we will use R and RStudio. Students are strongly encouraged to bring a laptop with them to class each week. Before the start of the course, they should download and install R (<https://cran.r-project.org>) and RStudio Desktop (<https://www.rstudio.com>) compatible with their operating system. Because these are open-source programs, there will be no need to purchase any software licenses.

Powerpoint slides covering weekly material will be made available by the instructor, along with the data files and R scripts used for in-class exercises. Students should print up the slides before each class and use them for notetaking purposes, and have the data files and R scripts loaded onto their laptops and ready for analysis.

### Required Books

- Gelman, Andrew, and Jennifer Hill. (2007). *Data Analysis Using Regression and Multilevel / Hierarchical Models*. New York: Cambridge University Press.
- Wickham, Hadley, and Garrett Grolemund. (2017). *R for Data Science: Import, Tidy, Transform, Visualize, and Model Data*. Boston: O'Reilly.

## COURSE GRADING

The grading scale that will be used for the final semester grades is as follows:

A	90.0% or higher	(Outstanding)
B	80.0% to 89.9%	(Good)
C	70.0% or 79.9%	(Satisfactory)
F	69.9% or lower	(Unsatisfactory)

Grading will be based on the following criteria:

Class Preparation	10%
Problem Sets	40%
<u>Empirical Project</u>	<u>50%</u>
	100%

### Class Preparation (10%)

Students are expected to have read and to be conversant (to the extent possible) with all of the required reading material for each class meeting. Some of this material will be of a technical nature, so the goal of the class meetings will be to help students understand what they have read (both conceptually and algebraically), and to work through empirical applications of key concepts. In fact, it might be good practice to read the assigned material on two occasions—once before the class meeting (for initial familiarity), and again after the class meeting (for improved comprehension).

### Problem Sets (40%)

There will be several problem sets assigned throughout the semester, using data made available by the instructor. They are to be e-mailed to the instructor by the beginning of the class periods during which they are due. The objective of the problem sets is to give students hands-on experience using

software (R and RStudio) to manipulate data, produce visualizations, and estimate a variety of regression models.

Problem sets and data files will be provided in advance. The teaching assistant will lead a weekly lab session to answer questions and provide assistance with the problem sets. Students are also encouraged to work in pairs or in small groups, and a course Slack page will be set up to facilitate communication outside of class (<https://slack.com>). While joint results may be reported, each student must provide his or her own interpretations of the findings. Late problem sets will not be accepted, unless the student has given prior notification and approval has been granted by the instructor.

### **Research Project (50%)**

Instead of a final exam, the semester will culminate in an independent research project of the student's choosing. Students are to submit a written report in the form (although not the length) of a journal manuscript, with sections for an introduction, literature review, hypotheses, data, methods, results, and discussion/conclusion, as well as references, tables, and figures. Because this class is concerned with quantitative methods, students will be expected to demonstrate proficiency with the statistical model that they choose for their project. This means that they will have to think carefully about the underlying assumptions of their model, evaluate the fit of the model to the data, diagnose potential violations of key assumptions or other problematic issues, and identify plausible solutions to these issues.

Details about this project will be left intentionally vague, so that students have maximum flexibility in identifying the question they intend to study. Students are urged to start thinking right away about potential topics for their project. Done strategically, this project can serve as the start of a comprehensive exam, dissertation prospectus, or other empirical paper. Students are welcome (and are in fact encouraged) to use this project as an opportunity to consult with their faculty advisor or mentor, and to make substantial progress on ideas that can lead to a publishable manuscript.

## **COURSE POLICIES**

### **Class Announcements**

As needed, e-mail will be utilized to post course announcements (e.g., class cancellation due to inclement weather) as well as to occasionally provide links to items that are relevant for the topics covered in this course (e.g., newspaper articles, journal articles).

### **Classroom Climate**

Disruptive behavior in the classroom cheats other students of the opportunity to learn. Examples include arriving late to class, leaving and re-entering the classroom during the seminar, talking excessively, using cell phones, eating, reading outside material, and persisting in speaking without being recognized. The instructor reserves the right to ask disruptive students to leave the classroom.

### **Academic Integrity**

The instructor will uphold Rutgers University policies concerning ethical behavior and academic integrity, and students are expected to familiarize themselves with these policies. The relevant

principles, policies, and disciplinary procedures can be accessed from the university's website at <http://academicintegrity.rutgers.edu>.

## **ACCOMMODATION AND SUPPORT STATEMENT**

Rutgers University Newark (RU-N) is committed to the creation of an inclusive and safe learning environment for all students and the University as a whole. RU-N has identified the following resources to further the mission of access and support:

**For Individuals Experiencing Disability:** The Office of Disability Services (ODS) works with students with medical, physical, and/or mental conditions who encounter disabling barriers in order to determine reasonable and appropriate accommodations for access. Students who have completed the process with ODS and have approved accommodations are provided a Letter of Accommodation (LOA) specific to each course. To initiate accommodations for their course students must both provide the LOA to and have a conversation with the course instructor about the accommodations. This should occur as early in the semester as possible. More information can be found at the RU-N ODS website ([ods.newark.rutgers.edu](http://ods.newark.rutgers.edu)). Contact ODS at (973) 353-5375 or via email at [ods@newark.rutgers.edu](mailto:ods@newark.rutgers.edu).

**For Individuals Who Are Pregnant:** The Office of Title IX and ADA Compliance is available to assist with any concerns or potential accommodations related to pregnancy. Students may contact the Office of Title IX and ADA Compliance at (973) 353-1906 or via email at [TitleIX@newark.rutgers.edu](mailto:TitleIX@newark.rutgers.edu).

**For Short-Term Absence Verification:** The Office of the Dean of Students can provide assistance for absences related to religious observance, emergency or unavoidable conflict (illness, personal or family emergency, etc.). Students should refer to University Policy 10.2.7 for information about expectations and responsibilities. The Office of the Dean of Students can be contacted by calling (973) 353-5063 or emailing [deanofstudents@newark.rutgers.edu](mailto:deanofstudents@newark.rutgers.edu).

**For Individuals with Temporary Conditions/Injuries:** The Office of the Dean of Students can assist students who are experiencing a temporary condition or injury (broken or sprained limbs, concussions, or recovery from surgery). Students experiencing a temporary condition or injury should submit a request using the following link: <https://temporaryconditions.rutgers.edu>.

**For Gender or Sex-Based Discrimination or Harassment:** The Office of Title IX and ADA Compliance can assist students who are experiencing any form of gender or sex-based discrimination or harassment, including sexual assault, sexual harassment, relationship violence, or stalking. Students can report an incident to the Office of Title IX and ADA Compliance by calling (973) 353-1906 or emailing [TitleIX@newark.rutgers.edu](mailto:TitleIX@newark.rutgers.edu). Incidents may also be reported by using the following link: [tinyurl.com/RUNReportingForm](https://tinyurl.com/RUNReportingForm). For more information, students should refer to the University's Title IX Policy and Grievance Procedures located at <https://uec.rutgers.edu/wp-content/uploads/60-1-33-current-1.pdf>.

**For Support Related to Interpersonal Violence:** The Office for Violence Prevention and Victim Assistance (VPVA) can provide any student with confidential support. The office does not have a reporting obligation to Title IX. Students can contact the office by calling (973) 353-1918 or emailing [run.vpva@rutgers.edu](mailto:run.vpva@rutgers.edu). There is also a confidential text-based helpline available to students; students can text (973) 339-0734 for support. Students do not need to be a victim/survivor of violence; any student can receive services, information and support.

**For Crisis and Concerns:** The Campus Awareness Response and Education (CARE) Team works with students in crisis to develop a plan of support plan and address personal situations that might impact their academic performance. Connect with the CARE Team by using the following link: [tinyurl.com/RUNCARE](https://tinyurl.com/RUNCARE) or emailing [careteam@rutgers.edu](mailto:careteam@rutgers.edu).

**For Stress, Worry, or Concerns about Well-Being:** The Counseling Center has confidential therapists available to support students. Students should reach out to the Counseling Center to schedule an appointment: [counseling@newark.rutgers.edu](mailto:counseling@newark.rutgers.edu) or (973) 353-5805. If students are not quite ready to make an appointment with a therapist but are interested in self-help, check out Sanvello for an easy, web-based approach to self-care and support. Visit <https://my.rutgers.edu/>, click on Sanvello: Wellness @ RUN, and log in with your netid to begin your journey toward wellness.

For emergencies, call 911 or contact Rutgers University Police Department (RUPD) by calling (973) 353-5111.

### **HEALTH AND SAFETY PROTOCOL**

Use of face coverings in offices, conference rooms, research labs, housing, and public spaces in buildings is optional. Face coverings are required in all teaching spaces (classrooms, lecture halls, seminar rooms, etc.), teaching labs, computer labs, buses, libraries, and clinical facilities. Additionally, face coverings will continue to be required in student-staff and student-faculty meeting spaces.

## COURSE SCHEDULE

Readings refer to chapters in Gelman and Hill's *Data Analysis Using Regression and Multilevel / Hierarchical Models* (G&H) and Wickham and Grolemund's *R for Data Science* (W&G), and are to be completed by the class date listed. Problem sets are listed on the dates they are due. The schedule is subject to change depending on time demands and adverse weather.

Class Date	Class Topic	Reading
Tue, Jan 17	1 - Course Introduction and Review	G&H 2
	Single-Level Models	
Tue, Jan 24	2 - Continuous Outcomes, Part I	G&H 3; W&G 1, 22
Tue, Jan 31	3 - Continuous Outcomes, Part II	G&H 4; W&G 3, 5
Tue, Feb 7	4 - Continuous Outcomes, Part III	G&H 3, 4 (reread); W&G 14, 18
Tue, Feb 14	5 - Binary Outcomes, Part I *** Problem Set #1 Due ***	G&H 5
Tue, Feb 21	6 - Binary Outcomes, Part II	G&H 5 (reread)
Tue, Feb 28	7 - Categorical Outcomes	G&H 6
Tue, Mar 7	8 - Count Outcomes *** Problem Set #2 Due ***	G&H 6 (reread)
Tue, Mar 14	NO CLASS – SPRING RECESS	
	Multilevel Models	
Tue, Mar 21	9 - Varying Intercepts, Part I	G&H 11, 12
Tue, Mar 28	10 - Varying Intercepts, Part II	G&H 11, 12 (reread)
Tue, Apr 4	11 - Varying Slopes	G&H 13
Tue, Apr 11	12 - Nonlinear Model *** Problem Set #3 Due ***	G&H 14, 15
Tue, Apr 18	13 – To Be Determined	TBD
Tue, Apr 25	14 – To Be Determined	TBD
Tue, May 2	Final Project Due via E-mail	NA