



College of Liberal Arts and Sciences  
Department of Mathematics, Physics, and Statistics

## **MATH 250**

**Data Analysis** (3 units)

**Fall 2023**

Seegerstrom 172

Section 01 Class #: 10680

TR 4:20PM – 5:45 PM

### **Student Hours:**

M 4:15-5:30PM (Seegerstrom 112 + Zoom)

T 2:30-4PM (Seegerstrom 112 + Zoom)

Th 10-11:30AM (Community Garden)

### **Instructor**

Katie Fitzgerald, PhD Statistics

*Assistant Professor of Statistics*

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### **APU Mission Statement**

Azusa Pacific University is an evangelical Christian community of disciples and scholars who seek to advance the work of God in the world through academic excellence in liberal arts and professional programs of higher education that encourage students to develop a Christian perspective of truth and life.

### **Course Description**

This course features hands-on experience using statistical tools to answer real-world questions. Emphasis is on analysis of actual data using statistical software. Statistical topics include numerical/graphical summaries, measures of association, and statistical techniques including chi-square tests, t-tests, ANOVA, and regression. Focus is on interpretation, not calculation.

**Prerequisite:** MATH 130 or MATH 361

### **APU Credit Hour Policy**

Following the APU Credit Hour policy, to meet the identified student learning outcomes of this course, the expectations are that this 3 unit course, delivered over a 15 week term will approximate 3 hours/week classroom or direct faculty instruction. In addition, out-of-class student work will approximate a minimum of 6 hours each week.

### **Other Important Policies and Information**

<https://goo.gl/2uDWh7>

## Course Objectives and Desired Student Learning Outcomes for Probability and Statistics

Student Learning Outcome "By the end of this course, students should be able to..."	IDEA Objective	Assignments Used to Assess
Prepare data for statistical analysis	Developing specific skills needed by professionals in the field	Labs, Project
Use methods for effectively organizing, interpreting, and presenting quantitative data based on type of data	Learning to Apply Course Materials	Labs, Project, Exam
Identify appropriate measures of association applied to different data types	Gaining a basic understanding of the subject	Labs, Project, Exam
Select and use hypothesis tests for different data types and scientific questions	Learning appropriate methods for collecting, analyzing, and interpreting numerical information	Labs, Project
Apply concepts of power, errors, assumptions, and biases in statistical analyses	Learning to Apply Course Materials	Labs, Project

## Required Course Materials

**Books:** This course has two textbooks, both of which are freely available online:

- [R for Data Science](#) by Hadley Wickham & Garrett Grolemund
- [Introduction to Modern Statistics](#) by Mine Çetinkaya-Rundel and Johanna Hardin

**Software:** This course will utilize the statistical software R and RStudio. Students will receive instructions in the first week of class for how download it onto their personal computer.

**Hardware:** Students are expected to bring a laptop to all class sessions. If access to a laptop is an issue, then please contact the course instructor and an accommodation will be made. This requirement will not prevent students from taking this course.

**Campuswire account:** This term we will be using [Campuswire](#) as our preferred platform for questions about homework, labs, and general course questions. The system is highly catered to getting you help quickly and efficiently from classmates and the instructor. Rather than emailing questions to the instructor, you should post your questions on Campuswire. *See Canvas for Enrollment Code.*

## Course design<sup>1</sup>

Modern data analysis is inherently tied to coding and computational tools, and coding is learned by doing. To facilitate this type of learning, this course utilizes a flipped learning design. Each week, you will watch a series of lecture videos and complete a preparation quiz *before* class on Tuesdays. Then class time will be dedicated to hands-on application exercises and lab assignments. The activities and assessments follow a *prepare, practice, perform* format and are designed to help you develop the foundational skills of a modern data scientist. You will also *engage* with current events and issues of ethics in the data science community.

- **Prepare:** Includes lecture videos and optional readings to introduce new concepts and a short quiz to ensure a basic comprehension of the material. The goal is to help you prepare for the in-class activities.
- **Practice:** Includes in-class application exercises where you will begin to apply the concepts and methods introduced in the lecture videos. The activities will be graded for completion, as they are designed for you to gain experience with the statistical and computing techniques before working on graded assignments.
- **Perform:** Includes weekly labs, one exam, and the final project. These assignments build upon the prepare and practice assignments and are the opportunity for you to demonstrate your ability to apply course material to analyze real-world data.
- **Engage:** Includes weekly data ethics readings & community annotations as well as “statistics experience” points.

### Preparation Quizzes (Prepare)

At the beginning of each week, you will watch a series of lecture videos and take a low-stakes preparation quiz in Canvas to check your understanding. Each quiz can be attempted up to 3 times before the deadline, and your score will be the average of your attempts. The quiz is due by class-time on Tuesdays (4:20pm).

### Application Exercises (Practice)

The majority of class-time on Tuesdays will be dedicated to working on Application Exercises (AEs) in RStudio, designed to help you practice the new skills, code, and concepts introduced in that week’s lecture videos. AEs are due at the end of class on Tuesdays and serve as your “exit ticket”. AEs are graded

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<sup>1</sup> Much of the course design, activities, and assessments are adapted from Mine Çetinkaya-Rundel’s [Data Science in a Box](#) curriculum and Duke University’s open source [Introduction to Data Science](#) course under the Creative Commons Attribution Share Alike 4.0 International.

on completion; demonstrating that a good faith effort has been made on the assignment will earn full credit. If you are unable to attend class on a Tuesday, you may still submit your AE for half credit. The two lowest AE scores will be dropped at the end of the semester to accommodate occasional absences.

### **Labs (Perform)**

The majority of class-time on Thursdays will be dedicated to lab assignments. The labs are a more in-depth application of the week's material that will have you complete scaffolded analyses of a real dataset using RStudio. You will collaborate in randomly assigned teams of ~3, and teams will rotate approximately every 2 weeks. Labs are due by class-time the following Tuesday. *The lowest lab grade will be dropped at the end of the semester.*

### **Exam (Perform)**

There will be one take-home mid-term exam for you to demonstrate your individual ability to apply what you have learned. It will consist of an analysis and computational tasks related to the material in the prepare, practice, perform assignments. The exam is take-home and open-notes but must be completed individually, without discussing or seeking assistance from anyone inside or outside the course.

You will be given the opportunity to submit annotated test corrections to earn up to 1/3 of the points back on your exam. Specific instructions and expectations will be provided when the exams are graded and returned.

### **Project (Perform)**

The purpose of the final project is to apply what you've learned throughout the semester to investigate an interesting data-driven research question by analyzing a real-world dataset of your choosing. The project will be completed in self-assigned teams of 2-3. You will be asked to present your findings in a written report and an oral presentation. See course website for details.

### **Data Ethics Readings & Community Annotations (Engage)**

Each week, you will read an article or book excerpt that engages with issues related to data ethics. You will engage with the reading via the community annotation tool Perusall. Annotations are due by class-time on Thursdays.

### **Statistics Experiences (Engage)**

The world of statistics and data science is vast and dynamic! The goal of the Statistics Experience assignments is to help you engage with the statistics and data science communities outside of the classroom. There are a variety of ways you can participate in "Statistics Experiences," which include but are not limited to listening to a podcast, reading a book, getting coffee with a statistician or data scientist, joining the American Statistical Association, or participating in #TidyTuesday. Each experience is worth a varying number of points (see course website for details), and you are required to collect at least 5 "Statistics Experience points" throughout the semester. Up to 10 additional points can be collected and added to your lowest lab grade(s).

## Grading

Preparation Quizzes	10%
Application Exercises	5%
Readings & Annotations	5%
Statistics Experiences	5%
Labs	30%
Exam	15%
Project	30%

## Grading criteria and scale

- A Superior knowledge regarding details, principles, terms, and notation; superior skill in computation and application of the material.
- B More than adequate knowledge regarding the major themes; ability to compute correct answers and apply the material.
- C Basic knowledge and skill needed to solve problems relating to probability and statistics.
- D Serious gaps in knowledge, confusion of concepts, inability to recall basic information, inadequate skill in computation or application.
- F Absence of knowledge, incapable of correct computation, misunderstands most concepts.

*Final letter grades will be assigned approximately as indicated in the table below.*

A 93-100%	B+ 87-89%	C+ 77-79%	D+ 67-69%	F 0-59%
A- 90-92%	B 83-86%	C 73-76%	D 63-66%	
	B- 80-82%	C- 70-72%	D- 60-62%	

## Late work & extension policies

The coding skills gained in this course build cumulatively week-by-week, so it is important to complete and submit all assignments on time. Due dates are there to help you keep up with course material and ensure you receive feedback in a timely manner.

- Late work will not be accepted for preparation quizzes or application exercises, as these are designed to help you prepare for the in-class labs each week.
- All lab assignments will have a “Best By” date, meaning it’s best for your learning to submit them by the “Best By” date. For any lab assignment, you may submit a “Late work plan” form (available on Canvas) to propose an alternative submission date that is within one week of the Best By date.
  - All reasonable requests will be honored, but you must submit your Late work plan PRIOR to the Best By date.
  - Late work will not be accepted more than one week after the Best By date
  - To incentivize on-time work, you will have the opportunity to revise and re-submit any assignments that are turned in by the Best By date. A reasonable attempt needs to have been made on each problem in order to earn additional points on the re-submission. That is, it’s best to attempt each problem by the Best By date if you can, and it doesn’t have to be perfect on the first submission.
- Late exams will not be accepted unless specifically coordinated with the instructor in advance.

Incompletes are rare and are available only in “special or unusual circumstances” as negotiated with the instructor prior to the end of the term. See the Catalog for policies regarding Withdrawals and grade record permanence.

If there are life circumstances that are having a longer-term impact on your academic performance or well-being, come talk to me, and we can work towards a solution and connect you to the support you need.

### Tips for success & how to access support for this class

- Dedicate yourself to being an engaged learner and contributing to a thoughtful learning environment for your peers
- Utilize Campuswire to ask questions, respond to your peers, and upvote others’ questions and responses.
- Come to student hours. Even if you don’t know what your specific questions or points of confusion are, we can figure that out together. You are welcome to attend in-person (Segerstrom 112) or on Zoom; Zoom details will be provided on Canvas. You can also email me to set up an appointment at an alternative time.
- Collaborate! Get to know your classmates. This is a very hands-on class, and you will be working together extensively.
- Google is a coder’s best friend! Answers & discussions on [stackoverflow.com](https://stackoverflow.com) are often particularly helpful for R related questions
- Embrace the struggle & don’t shy away from confusion or uncertainty. After all, statistics is the “science of uncertainty,” and being “good at math” is [being good at being stuck...](#)
- Contact me about any concerns. Best way to reach me is via email ([kfitzgerald@apu.edu](mailto:kfitzgerald@apu.edu)). I do my best to respond within 24 hours during weekdays.

### Important Dates

August 29 (Tue)	First day our class meets
September 8 (Fri)	Drop Deadline
September 26 (Tue)	Exam 1 assigned
October 3 (Tue)	Exam 1 due
November 20 - 26	Thanksgiving break (NO CLASSES)
December 11 - 15	Final Exams (Project presentations)

## Course Community & Policies

### Inclusive Community

It is my intent that this course models and fosters justice, equity, diversity, and inclusion. We will engage with these values both in content and in practice. Data and statistics can be tools to tell diverse stories and help us learn about the state of the world from a perspective beyond our own lived experience. When used responsibly and with integrity, they can amplify the experiences of vulnerable and historically excluded populations. For example, they can be used to shed light on disparities in our schools, healthcare system, and criminal justice system.

The research questions we ask, the data we collect, and the way we use that data are infused with (often hidden) values about who and what matters in the world. For example, we should examine if and when marginalized people and their experiences are being excluded from our data, particularly when that data is used in countless ways to drive decision-making and inform society about the state of the world.

You will be asked to continually and critically engage with these ideas with each dataset and analysis you encounter. You are expected to engage your peers and new perspectives with curiosity, empathy, and intellectual humility. It is my intent that all students be well-served by this course, that your learning needs are met inside and outside the classroom, and that the diversity that you bring to this class be valued and utilized as a resource and strength.

I (like many people) am continually learning how to honor diverse perspectives and identities. If something was said in class (by me or a peer) that made you feel uncomfortable, please let me know. You will also have the opportunity to express concerns anonymously via check-in surveys. APU encourages community members to resolve conflicts directly, when possible. If an APU community member perceives that hostile words or behaviors were directed toward an individual or a group based upon that individual's or group's identity, they can submit a Bias Incident Report. Information on the reporting process is available on the website at [www.apu.edu/diversity/bias/](http://www.apu.edu/diversity/bias/).

Affirming that diversity is an expression of God's image, love, and boundless creativity, it is APU's aim to collectively nurture an environment that respects each individual's uniqueness while celebrating our collective commonalities. It is in this spirit that we collectively strive to create an inclusive environment in which all students, staff, faculty, and administrators thrive.

### Faith Integration Statement

Academic Faith Integration is recognized as an important feature of courses at APU. My identity as a Christ-follower shapes my worldview and therefore shapes my understanding of data and statistics. You can expect to discover how relevant themes from Christianity and data science meaningfully inform one another. I respectfully recognize that students come from a diversity of faith backgrounds and that they have a variety of perspectives. This diversity in perspective will be valued as a strength and resource that enriches the learning community.

### Academic Integrity Policy

***TL;DR: Don't cheat!***

Please abide by the following as you work on assignments in this course:

- You may discuss individual homework and lab assignments with other students; however, you may not directly share (or copy) code or write up with other students. For team assignments, you may collaborate freely within your team. You may discuss the assignment with other teams; however, you may not directly share (or copy) code or write up with another team. Unauthorized sharing (or copying) of the code or write up will be considered a violation for all students involved.
- You may not discuss or otherwise work with others on the exam. Unauthorized collaboration or using unauthorized materials will be considered a violation for all students involved. More details will be given closer to the exam date.
- **Reusing code:** Unless explicitly stated otherwise, you may make use of online resources (e.g. StackOverflow) for coding examples on assignments. If you directly use code from an outside source (or use it as inspiration), you must explicitly cite where you obtained the code. Any recycled code that is discovered and is not explicitly cited will be treated as plagiarism.

Any violations in academic integrity standards as outlined in the [APU Academic Integrity Policy](#) and those specific to this course will automatically result in a 0 for the assignment and will be reported to the Office of the Provost for further action.

The mission of Azusa Pacific University includes cultivating in each student not only the academic skills that are required for a university degree, but also the characteristics of academic integrity that are integral to a sound Christian education. It is therefore part of the mission of the university to nurture in each student a sense of moral responsibility consistent with the biblical teachings of honesty and accountability. Furthermore, a breach of academic integrity is viewed not merely as a private matter between the student and an instructor but rather as an act which is fundamentally inconsistent with the purpose and mission of the entire university. A complete copy of the Academic Integrity Policy is available in the Office of Student Life, the Office of the Vice Provost, and online.

## Support Services Policy

If there is any portion of this class that is not accessible to you due to course format or challenges with technology, please let me know so we can make appropriate accommodations. If you have a disability that might prevent you from fully demonstrating your abilities, you should meet with an advisor in [Accessibility and Disability Resources](#) as soon as possible to initiate disability verification and discuss reasonable accommodations that will allow the opportunity for full participation and for successful completion of course requirements. For more information, please contact Accessibility and Disability Resources by phone at 626-815-3849, or email at [disabilityservices@apu.edu](mailto:disabilityservices@apu.edu).

## Bibliography

Çetinkaya-Rundel, M. & Hardin, J. Introduction to Modern Statistics. <https://openintro-ims.netlify.app>

Kuhn M, Wickham H (2020). *Tidymodels: a collection of packages for modeling and machine learning using tidyverse principles*. <https://www.tidymodels.org>.

Tipton, E., Kuyper, A.M., Fitzgerald, K.G. – Adapted from Kim, A.Y. & Ismay, C. Introduction to Statistics and Data Science: A modern dive into R and the tidyverse. <https://nustat.github.io/intro-stat-ds/index.html>

Wickham, H. & Grolemund, G. (2017). R for Data Science. O'Reilly Media. <https://r4ds.had.co.nz>



## Course Calendar (Tentative)

Week	Dates (T-Th)	Topics	Tuesday (in-class)	Thursday (in-class)	Other Assigned
1	Aug 29 – 31	Welcome to MATH 250! Meet the toolkit	AE 01	Lab 01	Annotations 01
2	Sept 5 – 7	Data visualization	AE 02	Lab 02	Annotations 02
3	Sept 12 – 14	Data wrangling I	AE 03	Lab 03	Annotations 03
4	Sept 19 – 21	Data wrangling II	AE 04	Lab 04	SE 01
5	Sept 26 – 28	Scientific Practice & Data Science Workflow	Project Work Session	No class – work on Exam	Exam
6	Oct 3 – 5	Data importing Data cleaning	AE 05 <b>Exam DUE</b>	Lab 05	Annotations 04
7	Oct 10 – 12	Data Ethics	Faith Integration Discussion <b>Project Proposal DUE</b>	Faith Integration Discussion Project Work Session	Annotations 05
8	Oct 17 – 19	Simple & Multiple Linear Regression	AE 06	Lab 06	Annotations 06
9	Oct 24 – 26	Uncertainty Quantification Confidence Intervals Hypothesis Tests	AE 07	Project Work Session <b>Project cleaning &amp; EDA DUE</b>	Annotations 07
10	Oct 31 – Nov 2	Inference for Numerical Data	AE 08	Lab 07	Annotations 08
11	Nov 7 – 9	Inference for Categorical Data	AE 09	Project Work Session	Annotations 09
12	Nov 14 – 16	Communicating results	AE 10 <b>Project Rough Draft DUE</b>	Project Peer Review	SE 02
	Nov 20 - 26	THANKSGIVING BREAK			
13	Nov 28 – 30	Special Topics: Shiny apps	AE 11 <b>Project Peer Review DUE</b>	Lab 08	End of Course Reflection
14	Dec 5 - 7	Communicating results, Part II	Project Work Session <b>Project Slides Draft DUE</b>	Project Peer Review	
15	Dec 11 - 15	Exam Week – Final Project Presentations			

*Course schedule, topics, exams and assignments may be changed at the instructor's discretion*