

432 Syllabus for Spring 2024

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2025-01-07

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Welcome!

This is the Spring 2025 syllabus for PQHS / CRSP / MPHP 432: Data Science for Biological, Medical and Health Research II, taught by Professor Thomas E. Love.

Working With This Document

1. This document includes multiple sections. Use the table of contents to navigate, and the search box as needed.
2. A PDF download of this document is available by clicking the Acrobat icon next to the title at the top left of the screen.
3. The document will be updated occasionally through the semester.

Who, When and Where?

- The course instructor is [Professor Thomas E. Love](#).
 - Email him at **Thomas dot Love at case dot edu** if you have any questions before class.
- This year's course will be given virtually (via Zoom) until Spring Break, and then in person after that.
- The course is given on Tuesdays and Thursdays from 1:00 to 2:15 PM Eastern Time
 - Zoom sessions begin 2025-01-14.
 - In person classes (starting 2024-03-18) will be held in Room E321-323 in Robbins Hall, within CWRU's School of Medicine.
- The main course website is at <https://thomaselove.github.io/432-2025/>
- There are several [teaching assistants](#) helping with the course this semester.
 - The Teaching Assistants will hold regular office hours over Zoom, and the schedule for these sessions will be found on the [Contact Us page](#) and the [Course Calendar](#).

Outside of class, general questions about course materials are best asked through our [Campuswire Discussion Forum](#) or in Teaching Assistant Office Hours. The [Getting Help section](#) of this syllabus provides some additional resources.

Contact Information

Professor Love's email is **Thomas dot Love at case dot edu**. Professor Love's office at CWRU is on the ground floor of the Wood building (in the WG-82 Suite), specifically WG-82J. Email him if you need an appointment, either in person or via Zoom. He will only be available via Zoom through Spring Break, and will return to campus on 2025-03-18.

- If you have any unique concerns about the course, need special accommodations or have any other issues you want to discuss with Professor Love specifically, please email him directly.

1 Getting Started

Your first six steps in this course are to:

1. Register and enroll via the [CWRU Student Information System \(SIS\)](#).
 - Section 1 of PQHS 432, CRSP 432 and MPHP 432 are identical.
2. Review the [main course website](#), and be sure to visit the [Course Calendar](#), and skim through the Course Syllabus (this document.)
3. You need to buy Jeff Leek's **How to be a Modern Scientist**, available electronically through <https://leanpub.com/modernscientist>. The suggested cost is \$10, but you can pay what you want.
4. Please fill out the [Welcome to 432 Survey](#) at <https://bit.ly/432-2025-welcome-survey> to help us get to know you a little better. Note that you must **log into Google via your CWRU account** in order to access the survey, which should take about 10 minutes to complete.
5. Get started [installing the software](#) you'll need for the course.
6. Attend our first class session via Zoom starting at 1 PM on 2024-01-14. Zoom information will be sent to all registered students via their CWRU email.

2 Course Description

PQHS 432 (cross-listed as CRSP 432 and MPHP 432) is the second half of a two-semester sequence (with 431) focused on modern data analysis and advanced statistical modeling, with a practical bent and as little theory as possible. We emphasize the key roles of thinking hard, and well, about design and analysis in research.

The course is formally titled *Statistical Methods in Biological & Medical Sciences, Part 2*. A more accurate title is **Data Science for Biological, Medical or Health Research**.

We'll learn about managing and visualizing data, building models and making predictions, and other data science activities. This highly applied course focuses on modern tools for learning from data. We'll learn a lot of R, and we'll use RStudio and Quarto as tools to help make R work better, and help perform our research in rigorous and replicable ways.

2.1 Course Objectives

During the 431-432 sequence, students will:

1. Use modern data science tools to import, tidy/manage, explore (through transformation, visualization and modeling) and communicate about data.
2. Think hard and well about rigorous design and analysis in scientific research.
3. Gain sufficient background in the practical issues regarding linear and generalized linear models to give you a starting place for meaningful applied work, particularly in terms of making comparisons to address general types of statistical and analytic questions (exploratory, predictive, inferential, and causal, in particular.)
4. Learn about the importance of replicable research, and develop facility and practice in open source tools for doing it.
5. Complete a series of assignments (labs, projects and quizzes) designed to help you demonstrate what you've learned.
6. Program ("Code") in R sufficiently to accomplish the tasks above, with enough self-sufficiency afterwards to be able to debug and use new R tools without substantial troubleshooting help. What separates "doing data science" from "doing data analysis" is programming.

This is **NOT** a course in mathematical statistics or statistical inference. It's far more applied than that.

2.2 Key Topics in 431-432

1. Exploratory Data Analysis: “All graphs are comparisons” including data exploration, statistical graphics and more general visualization of information.
2. Placing biological, medical and health research questions into a statistical framework.
3. Study Development - making choices in designing and executing the collection and aggregation of data.
4. Data Handling - including important issues in importing, tidying and transforming data, as well as methods for dealing with missing data, including imputation.
5. Statistical Comparisons: “All of statistics are comparisons” - including methods for discrete and continuous variables: intervals, assumptions, some thoughts on statistical power, and the bootstrap, design of visualizations and models for rates, proportions and contingency tables.
6. The proper and rigorous use of multi-predictor models for continuous and discrete data, including...
 - Fitting, evaluating, and interpreting linear and generalized linear models.
 - Prediction and validation.
 - Critical role of graphics, including diagnostics and residual analysis.
 - Model choice, including variable selection, shrinkage and model uncertainty.
 - Dealing with categorical predictors and interactions meaningfully.
7. Using R and RStudio to make all of the things above happen; with particular emphasis on doing replicable research and using [Quarto](#)) to document the work in a replicable way.

2.3 432 Course Outline & Format

The main group sessions for the 432 course will include over two dozen virtual (Zoom) and in-person lecture sessions led by Professor Love, to be held on Tuesdays and Thursdays from 1:00 to 2:15 PM.

- The [Course Calendar](#) provides additional detail on specific sessions, and links to materials used in those sessions, including slides.

3 Professor Love



Figure 3.1: Thomas E. Love, Ph.D.

3.1 A More Complete Biography

Hi. I am Thomas E. Love, Ph.D. and I have at least three different jobs.

- I am a Professor in the Departments of Medicine and of [Population & Quantitative Health Sciences](#) at [Case Western Reserve University](#). I teach three courses per year there (PQHS 431, 432 and 500) and also lead the [Health Care Analytics track](#) of the MS program in Biostatistics.
- I direct [Biostatistics and Data Science](#) at the [Population Health Research Institute](#) and at the [Center for Health Care Research and Policy](#) at [The MetroHealth System](#).
- For ten years, I was the (founding) Data Director for [Better Health Partnership](#), an alliance of people who provide, pay for and receive care in Northeast Ohio. I still consult occasionally with them and hold the position of Chief Data Scientist there.
- I am a Fellow of the American Statistical Association, and have won numerous awards for my teaching and my research, including the 2018 [John S. Diekhoff Award for Graduate Teaching](#) from CWRU.
- I have been teaching at CWRU since 1994, and have taught every manner of CWRU student over the years, especially students in biostatistics, medicine, and management.

In research, I use statistical methods to look at questions in health policy and in particular the provision of health services. I mostly work with observational data, rather than data that emerge from randomized clinical trials, and I have a special interest in working with data from electronic health records.

- You may be interested in a [study in Health Affairs](#) showing the impact of a Medicaid-like expansion plan on care and outcomes of poor patients in Cleveland.
- Or you might be interested in our [New England Journal of Medicine study](#) of the effect of electronic health records on the care and outcomes of people with diabetes.
- In 2011, [James O'Malley](#) and I chaired the [Ninth International Conference on Health Policy Statistics](#), here in Cleveland. Here's a [recap](#).
- I've also worked on many projects involving the use of propensity scores to make causal inferences from observational studies, particularly in heart failure.

If you want to see a [pretty complete list of my publications](#), knock yourself out.

I hold degrees from Columbia University in the City of New York and from the University of Pennsylvania. My dissertation adviser was Paul Rosenbaum. I am married to a brilliant woman who is an attorney at Savant Systems, and we are raising two terrific sons. The elder is finishing a MS in Data Science at Carnegie Mellon University in Pittsburgh, and the younger is in his first year of law school at Fordham University in New York. We live in Shaker Heights. I sing and act occasionally in [community theater](#), do lots of puzzles and play golf when I can.

Thanks to Dr. Love's recovery from a broken leg and ankle surgery, this year's 432 class will be held remotely (via Zoom) before Spring Break, and then (mostly) in person starting March 18.

3.2 Email

- Thomas dot Love at case dot edu (for matters related to grades or individual concerns)
- I am available after class to chat.
- Remember we have [several ways for you to get help](#) with the 432 course.

3.3 Name and Pronouns

- I use he/him/his pronouns.
- Most students refer to me either as Professor Love or Dr. Love.
- I prefer my given name to be written "Thomas" as opposed to "Tom".
- Most of my friends and colleagues call him "Tom". You are welcome to do so, as well, if that makes you more comfortable.

3.4 Web

- My GitHub name is [THOMASELOVE](#).

4 Teaching Assistants

Most of this year's stellar group of teaching assistants have been in your shoes - they've taken the course in the past, and they enjoyed it enough to come back for more. They are volunteering their precious time and energy to help make the course happen, and we couldn't be more delighted to welcome you to the course. All office hours and all teaching assistant work will be done remotely.

There is a lot to learn in this class. Don't suffer in silence - talk to us! As mentioned earlier, **you shouldn't spend more than 15 minutes struggling with anything in this class without asking for help.**

Visit the [Getting Help with 432](#) section of this Syllabus for more details.

4.1 TA office hours

TA office hours are held via Zoom, will begin on Friday 2024-01-19 and continue through Wednesday 2024-05-01 except for Spring Break (no office hours March 9-16) and April 8 (Eclipse). The weekly schedule appears on our [Contact Us page](#) as well as our [Course Calendar](#).

- Our Shared Google Drive (432 Spring 2024 Dr Love and Students) will contain Zoom links for each of these sessions.
 - No appointment is necessary. Please just drop in.
 - Be sure to log into Google via CWRU to access the shared Drive.

Professor Love will also hold "office hours" after each class to the extent possible.

4.2 Getting To Know The TAs

The Spring 2024 Teaching Assistants for 432 are:

TA Name	For more, visit Section 4.2.1	Current Roles and CWRU Experiences
Ali Elsharkawi		third year MS student in Clinical Research

TA Name	For more, visit	Current Roles and CWRU Experiences
Chenyu Liu	Section 4.2.2	first year PhD student in Epidemiology & Biostatistics
Alex Olejko	Section 4.2.3	fifth year PhD candidate in the Developmental, Cognitive, and Affective Sciences program in the Department of Psychological Sciences
Lindsay Petrenchik	Section 4.2.4	PGY1 Pharmacy Resident at University Hospital Samaritan Medical Center and Clinical Instructor of Pharmacy Practice at Northeast Ohio Medical University and MS graduate
Miza Salim Hammoud	Section 4.2.5	MS student in Clinical Research and Postdoc Fellow at Cleveland Clinic
Monika Strah	Section 4.2.6	PhD student in Clinical Translational Science and MS graduate
Ria Tilve	Section 4.2.7	first year MD student and MPH graduate
Zoey Zou	Section 4.2.8	first year PhD student in Epidemiology & Biostatistics

4.2.1 Ali Elsharkawi



Figure 4.1: Ali Elsharkawi

Ali Elsharkawi is in his third year in the M.S program in Clinical Research. He completed his bachelor's in medicine, and fellowship in Electrophysiology at Metrohealth in Cleveland. For his research interest, he studied the outcome of atrial fibrillation ablation procedures. Ali took 431 and 432 two years ago and he is applying the skills he learned in his research projects. Ali enjoys spending time with his family, playing music, watching soccer, and traveling.

4.2.2 Chenyu Liu



Figure 4.2: Chenyu Liu

Chenyu Liu is a first-year Ph.D. student in Epidemiology and Biostatistics within the Department of Population & Quantitative Health Sciences. Chenyu completed her undergraduate studies in statistics at Wuhan University of Technology in China and her master's program in statistics at Case. Her current research interest is Bayesian Statistics, multi-omics data integration, and proteomics analysis. Outside of her Ph.D. life, Chenyu spends her time traveling, cooking, and watching movies.

4.2.3 Alex Olejko



Figure 4.3: Alex Olejko

Alex is a 5th year PhD candidate in the Developmental, Cognitive, and Affective Sciences program in the Department of Psychological Sciences. He completed my undergraduate education at Ohio State, and earned my Master's degree from CWRU in 2022. His research mainly resides in the field of behavior genetics, where he focuses on polygenic influences on behavioral outcomes. These outcomes mostly encompass educational and health phenotypes in the early to mid-twenties. Alex grew up outside of Cleveland and am a fervent Cleveland sports fan. He loves going to Guardians games and have already been to 20 this year (and counting). Some of his other favorite past-times include building Lego, mixology, exercise, and (mainly) single-player video games.

4.2.4 Lindsay Petrenchik



Figure 4.4: Lindsay Petrenchik

Lindsay Petrenchik is a PGY1 Pharmacy Resident at University Hospital Samaritan Medical Center and a Clinical Instructor of Pharmacy Practice at Northeast Ohio Medical University. Prior to residency, Lindsay worked at Novartis for two years where she evaluated Patient Reported Outcomes (PROs) in oncology clinical trials. She is excited to share with you how she has used 431/432 super-power skills daily in both pharmaceutical industry and residency research projects. Come to her TA sessions and you will have a blast learning R and statistical methods!

4.2.5 Miza Salim Hammoud



Figure 4.5: Miza Salim Hammoud

Miza Salim Hammoud is a postdoctoral research fellow at Cleveland Clinic's Pediatric and Congenital Heart Surgery Department and is in her second year of the Masters of Science in Clinical Research (CRSP) program at CWRU. Her research goal is to construct predictive models that illuminate the path ahead for little lives touched by congenital heart defects, predicting both clinical outcomes and the quality of life perceived by patients and their families. Miza took 431 and 432 last year and is applying the amazing research skills gained from these two classes in her research projects. Beyond the realm of academia and research, Miza enjoys playing the piano's melody, painting colors on canvas, and embarks on adventures that span the globe embracing the wonders of new countries and cultures.

4.2.6 Monika Strah



Figure 4.6: Monika Strah

Monika Strah is a Ph.D. student in Clinical Translational Science at CWRU and recently completed the Biostatistics M.S. program. She is looking forward to returning as a TA for PQHS 431/432 and also enjoyed TAing for PQHS 453 this summer. Monika's past research includes mathematical approaches to questions in population genetics and human evolution and is presently studying dietary factors associated with lung cancer risk and multiple sclerosis related fatigue management strategies. Monika enjoys reading, hiking and is a member of the National Ski Patrol.

4.2.7 Ria Tilve



Figure 4.7: Ria Tilve

Ria Tilve is a first year medical student at CWRU. After completing her bachelor's in Biochemistry, she obtained her MPH in Population Health Research at CWRU last spring. Her current research focuses on musculoskeletal health and biomedical imaging. Ria took 431 and 432 during the 2021-2022 school year, and she is applying those skills in her research projects. Outside of studying, Ria enjoys spending time with her family, running, watching sports, and exploring new places.

4.2.8 Zoey Zou



Figure 4.8: Zoey Zou

Zoey Zou is a first-year Ph.D. student in the Epidemiology & Biostatistics program within the Department of Population & Quantitative Health Sciences. She uses the pronouns “she/her/hers.” Her research interests lie in the methodology of clinical trial designs. Statistics is a fascinating field and can provide answers to many questions in clinical trial design, such as determining whether observed differences are real or due to chance. She also hopes to make contributions to oncology studies. She enjoys reading, skiing, and watching movies, specifically science fiction films. Her favorite movie is “2001: A Space Odyssey.” Zoey is excited about the opportunity to engage and connect with students this semester, both in and out of the classroom.

5 Getting Help with 432

Data science and statistical programming can be difficult. Computers are stupid and little errors in your code can cause hours of frustration (even if you've been doing this stuff for years!). **You shouldn't spend more than 15 minutes struggling with anything in this class without asking for help.**

We are fully committed to making sure that you learn everything you were hoping to learn from this class. If you tell us you're having trouble, I will not judge you or think less of you. I hope you'll extend me the same grace. You never owe us personal information about your health (mental or physical). If you need extra help, or if you need more time with something, or if you feel like you're behind or not understanding everything, do not suffer in silence! Talk to us! We will work with you.

Once the course begins, you have several ways to get help from us:

5.1 Campuswire is the place to ask questions and discuss the course

- We will use our [Campuswire](#) discussion forum this semester to facilitate questions and answers. We'll be conducting as much class-related discussion as possible there, instead of via email.
- You can sign up for this class' Campuswire by following the instructions and code provided at our [Contact Us](#) page.
 - Be sure to sign in with your full name and an email address that you will check daily.
 - If you're successfully enrolled in the class, you should be able to sign up immediately and gain access to Professor Love's 432 course.
 - * The quicker you begin asking questions on Campuswire (rather than via emails), the quicker you'll benefit from the collective knowledge of your classmates and instructors.
 - * We encourage you to ask questions when you're struggling to understand anything related to the class, and you can even do so anonymously.
 - * You'll also be able to help your colleagues by answering their questions (and you'll get some class participation credit for doing so), as well.

In general, we don't have a way to diagnose your problem with R, RStudio or Quarto if you don't show us what you're typing that causes an error, or a lack of results. If you wrote a Quarto file, we need to see it, along with a specific question (or series of them) about specific error messages or strange results you are getting. We need to replicate the problem in order to know how to fix your problem, and it also helps if we know what error message you're seeing, or what strange result you are getting.

5.2 TA Office Hours is the place to get one-on-one help for 432

You are strongly encouraged to visit TAs during office hours that are convenient for you, whenever you need help with the course. This is the best way to get one-on-one help, or try out a new idea.

- Teaching Assistant (TA) office hours will be held via Zoom.
- The schedule for TA office hours appears on the [Course Calendar](#), and on our [Contact Us](#) page.
- Office Hours are held for your benefit. Please visit the TAs, especially if you have questions about how to do things in R, or about the content of the class slides or course notes. They're volunteering their time to help you, and most of them have been in your shoes in previous years. They want to help you!
- More [information on the TAs is available here](#).

5.3 How We'll Use Canvas

The course's primary listing on [Canvas](#) is PQHS 432, but students in CRSP 432 and MPHP 432 should find the same information. We'll use the Canvas platform for (at most) two things:

- (definitely) turning in lab and project assignments
- (maybe) providing information about (and maintaining recordings of) our class sessions

Visit <https://canvas.case.edu/> to log in and see what's available there.

5.4 How We'll Use Google Drive

Professor Love will share some data and some other materials (answer sketches for lab assignments, and feedback on minute papers, as well as a grading roster) through a Shared Google Drive. You will need to log into Google through your CWRU account in order to view and use these materials. Visit the Important Links section of [our course website](#) to see more.

5.5 Meeting with Professor Love

Professor Love does not hold regular office hours. He will stay after class to address any drop-in student concerns that can be addressed in that setting.

- If you have any unique concerns about the course, need special accommodations or have any other issues you want to discuss with Professor Love specifically, please email him ([Thomas dot Love at case dot edu](mailto:Thomas.dot.Love@case.edu)) and he'll respond as quickly as possible.
- Remember that most questions about course materials are best asked through [Campuswire](#) or at TA Office Hours so that we can share the answers across all students in the course.

5.6 Other Sources of Help

In addition, there are many, many online resources to help you learn R beyond those we provide.

- Building internet searches (“googling”) effectively is an important skill that requires practice. Don’t be afraid to use search engines to figure out how to code things in R, for example.
- The [RStudio Community](#) is a forum specifically designed for people using RStudio and the tidyverse (and that will be you.)
- A comprehensive guide to using Quarto [is available here](#).

6 Required Texts

6.1 Course Notes

Professor Love maintains a set of Course Notes, titled **Data Science for Biological, Medical and Health Research: Notes for 432**. Professor Love revises the Notes annually, and various updates will appear as the semester progresses.

Although these Notes share some of the features of a textbook, they are neither comprehensive nor completely original. The main purpose is to give 432 students a set of common materials on which to draw during the course, providing a series of examples using R to work through issues that are likely to come up during the semester, and in later work.

In addition, **slides** and video recordings from each of Professor Love's lectures, plus other in-class materials will be posted for your use throughout the semester.

Once class begins, you'll be able to access all materials (including the Course Notes) through the main course website at <https://thomaselove.github.io/432-2025/>.

6.2 Buy This Book!

You need to buy Jeff Leek's **How to be a Modern Scientist**, available electronically through <https://leanpub.com/modernscientist>. The suggested cost is \$10, but you can pay what you want.

You can read the book in about four hours. We will expect you to have done so by the end of January.

6.3 Other Books to Download

There are three additional **free** books that you will definitely want to obtain during the semester and may be interested in looking at before class begins. Simply visit the links below.

1. [Introduction to Modern Statistics](#) by Mine Cetinkaya-Rundel and Johanna Hardin.

2. [R for Data Science](#) by Garrett Grolemund and Hadley Wickham (first edition). Note that the second edition (work in progress) may be better for our purposes, and is found at <https://r4ds.hadley.nz/>.
3. [Biostatistics for Biomedical Research](#) by Frank E. Harrell Jr. The related set of YouTube videos can be found [here](#).

Our [432 Sources page](#) links to additional resources.

6.4 Key Articles and Posts

While I will recommend dozens, perhaps hundreds of articles, blog posts and the like to you over the course of the year, these are especially important in 432.

1. Several of the guides prepared by Jeff Leek and his group, including:
 - [Finally, a Formula for Decoding Health News](#), from fivethirtyeight.com
 - [Reading academic \(scientific\) papers](#),
 - [Writing your first academic paper](#)
 - [Write papers like a modern scientist](#)
 - [How to Share Data for Collaboration](#) by Shannon E. Ellis and Jeffrey T. Leek in *The American Statistician*, 2018 Special Issue on Data Science, or you can [read the PeerJ preprint version here](#).
2. [Data Organization in Spreadsheets](#) by Karl W. Broman and Kara H. Woo in *The American Statistician*, 2018 Special Issue on Data Science, or you can [read the PeerJ preprint version](#).
 - The Ellis/Leek and Broman/Woo papers are part of the [Practical Data Science for Stats](#) collection, which may be of interest.
3. [Project-oriented workflow](#) at tidyverse.org from Jenny Bryan.
4. From the Ten Simple Rules series at PLOS Computational Biology:
 - [Ten Simple Rules for Effective Statistical Practice](#) by Kass RE et al. 2016
 - [Ten Simple Rules for Graduate Students](#) by Gu J Bourne PE 2007
 - [Ten Simple Rules for Better Figures](#) by Rougier NP Droettboom M Bourne PE 2014
 - [Ten Simple Rules for Creating a Good Data Management Plan](#) by Michener WK 2015
5. [Statistical Inference in the 21st Century: A World Beyond \$p < 0.05\$](#) from 2019 in *The American Statistician*
6. The American Statistical Association's 2016 [Statement on p-Values: Context, Process and Purpose](#).

Don't forget that our [432 Sources page](#) links to these and additional resources. Professor Love's class-specific READMEs will provide additional links to recommended readings as the semester goes on.

7 Assignments

Course assignments include (in increasing order of importance):

- labs
- quizzes, and
- projects

The header of our [main website](#) links to detailed instructions for [Projects](#), [Quizzes](#) and [Labs](#).

7.1 Deadlines for Assignments

All deadlines are posted as part of the [Course Calendar](#), and the Calendar is the final word for all deadlines.

- On every assignment, Lab, Quiz, project-related task, whatever, we will be delighted to respond to questions **up to 12 hours before** the assignment is due. After that time, you *may* wind up on your own. The reason for this is that Professor Love and the teaching assistants will regularly post responses to frequently asked questions about assignments, and we need sufficient time to accomplish this task.

7.2 Class Participation

We cannot emphasize enough how much we want to hear from you about things that are relevant to this course.

1. If you're not shy, ask questions during class. Come to the (virtual) TA office hours if you need help.
 2. Contribute to [Campuswire](#) with questions, answers and helpful comments. That'll help us recognize you as someone trying to improve their understanding.
- If you find **typos** in the materials (code, slides, the Notes, this syllabus) send them to us on [Campuswire](#) using the **General** category.
 - See a cool visualization online? A nice use of statistical methods or design in a paper? Share them with us on [Campuswire](#) using the **General** category.

3. Email Professor Love if you want to discuss something that doesn't fit on Campuswire or in a conversation with a TA. Visit with him before or after class. Make an appointment to talk with him if you have something to discuss that doesn't work well in email.
 - It's always helpful if Professor Love knows who you are, and this is an especially difficult thing to achieve with a large class (and half of the semester Zoom only.)

7.3 Labs

During the semester, there are **seven** lab assignments scheduled. Professor Love reserves the right to adjust the number of labs depending on how the class is going during the semester.

The [Course Calendar](#) provides deadlines for all Labs, and instructions for each Lab are available on [our main website](#).

- Most labs require straightforward demonstrations of mastery for core principles and fundamental skills. Some require deeper dives into more technically sophisticated material.
- The labs usually ask you to clean/visualize/analyze some data that we provide to you, and produce a Quarto document.
- You should anticipate that some coding in R (and Quarto), with detailed annotations and responses in complete English sentences will be required in all labs.

Lab assignments are submitted through [Canvas](#). The link to post your responses for each Lab will appear in time for you to submit the work, usually just after the deadline for the preceding Lab has passed.

Each lab is associated with a deadline. Late work is penalized (see information at the top of each Lab.)

7.3.1 A few tips for Early Lab Work

1. When writing anything for this course in English, use complete sentences, not just bullet points.
2. Clearly mark each Question in each Lab. There is no need to repeat the question before answering it, although you are welcome to do so.
3. You are welcome to discuss each Lab with anyone, including Professor Love, the teaching assistants, or your colleagues, but your answer must be prepared by you alone. We especially encourage you to take advantage of TA office hours and Campuswire.
4. Don't leave anything until the last day. Allow time for computer problems.

7.4 Quizzes

During the semester, you will have two quizzes to complete. Each quiz is taken online via a Google Form (like the Minute Papers or the [Welcome to 432 survey](#).) Each quiz includes both short-answer and multiple-choice items. The quizzes focus on whether you can apply the tools developed in class to address small problems.

The [Course Calendar](#) provides deadlines for each of the Quizzes, and the [main course website](#) provides links at the top to each Quiz.

You will receive access to the quiz several days before it is due, and each quiz will be designed to take about six hours to complete, so the time pressure should be minimal. **If you need to make alternate arrangements for a Quiz, please contact Professor Love via email as soon as possible**, at least a week before a Quiz is released.

7.4.1 Campuswire and the Quizzes

As we've discussed, for most of the course, [Campuswire](#) will be our tool for asking and answering questions outside of class time and TA office hours.

However, for questions about the Quizzes, we may provide an alternate method for you to ask questions of Professor Love and the Teaching Assistants, and if so, we will share that approach at the top of the Quiz instructions when they become available.

7.4.2 About the Quizzes

1. Quizzes typically involve 20-30 questions.
2. The questions are not arranged in any particular order, and you should answer all questions.
3. All questions involve relatively short responses, sometimes after working through a detailed analysis.
4. You will have the opportunity to edit your responses after completing the Quiz, but this must be completed by the deadline.
5. You are welcome (even encouraged) to consult the materials provided on the course website, but you are **not** allowed to discuss the questions on the Quizzes with anyone other than Professor Love or the teaching assistants.
6. We do not guarantee to answer questions we receive about the Quiz less than 3 hours prior to the Quiz submission deadline. As noted above, we will most likely **not** use Campuswire for Quiz questions, but instead an alternate approach we will provide to you with each quiz.
7. Quizzes that are more than an hour late will **not** be accepted, except in truly remarkable circumstances.

8. An answer sketch for each Quiz will be made available within 48 hours of the deadline.
9. Grades for the Quizzes are usually available within 48 hours of the deadline.
10. If you feel Professor Love has made an error in grading your Quiz, please let him know directly, by email, as soon as possible.

7.5 Projects

During the semester, you will have two projects to complete. Complete instructions for [Project A](#) and for [Project B](#) are available, through the link at the top of our main course website.

- [Project A](#) anticipates you using materials from 431 and from the first 12 classes of 432.
- [Project B](#) anticipates you using materials from the entire semester.

The [Course Calendar](#) provides deadlines for all Project elements.

8 Course Grades

Over the past five years, all students taking the course have eventually earned either an “A”, a “B” or an “Incomplete” in 432. I don’t see a reason why this won’t also be the case this year. The course cannot be taken “pass/fail.”

8.1 Grading Breakdown

Grading standards apply in the same way for all students, regardless of whether they are enrolled in PQHS 432, CRSP 432 or MPHP 432. Students in this class are not in competition with each other for grades. I have no set percentage of students who will receive any particular grade. We aim for substantial and timely feedback from the teaching assistants and myself on all elements of the course.

The course grade is based on three main areas of demonstrated accomplishment.

Course grades are based primarily on performance on labs, projects and quizzes. Your grade on each of these three elements will be determined separately.

To obtain your final class score, we will combine these elements as follows:

- 35% for Labs
- 40% for Projects
- 25% for Quizzes
- plus 0 to 5% for potential “bonus points”

Professor Love will then determine your final course grade using the following scale:

- course averages of 88.0% to 100% will receive a A
- course averages of 85.0% to 87.9% will be reviewed more closely to determine whether the grade will be A or B
- course averages of 70.0% to 84.9% will receive a B

For students in the 85.0-87.9% range, students who have improved from the first half of the course to the second will be more likely to receive an A than those whose performance has declined.

Students whose course average is near or below 70% usually have failed to complete some element of the course, and need to take an Incomplete to complete their work before I assign a final grade. We follow the University's Incomplete Policy, [as described here](#).

8.2 Bonus Points

Students receive bonus credit at Dr. Love's discretion, based on things like the following. Note that bonus points have a small impact, generally.

- finding typographical or coding errors in Professor Love's slides, notes and other published materials. Professor Love makes occasional typographic and grammatical errors, which irritate him enormously. Please post to Campuswire the details of any typos or errors you find in this syllabus or any other course materials. If you are the first to let us know, and we make the change, you will receive some credit in your class participation grade.
- asking especially helpful questions in the Minute Papers or on Campuswire
- providing helpful responses to questions and engaging in the discussion on Campuswire
- identifying interesting visualizations or uses of ideas we're discussing in class in the popular or scientific media (this is also done via Campuswire.)
- completing (in a timely fashion) special "partially hidden" tasks that Professor Love buries within longer documents to ascertain whether or not you're reading these documents effectively. For an example, see section 9.7 of this Syllabus.
- plus a few other things that come under the general heading of "being helpful."

Bonus credit is capped across the semester so that no one's score can fall and that no one's final score will increase by more than 5 points.

8.3 Grading Labs

Labs 1-5 and Lab 7 will be graded by the Teaching Assistants, according to a rubric and answer sketch. In grading labs, everything counts, including the quality of the presentation, as well as the coding and statistical work.

For each Lab we publish a detailed answer sketch (48 hours after the submission deadline). Later, when the grades become available (roughly one week after the deadline) you will also receive the grading rubric used by the teaching assistants. You should expect to receive your grade on each Lab you submit on time roughly one week after the deadline. Along with the grade, on-time labs will receive modest feedback about the work.

All Labs should be turned in by the deadline specified on the [Course Calendar](#). In this class, it is far better to turn in timely, but only partially complete work than nothing at all. **We don't give extensions on Labs.** Instead, we use the following grading policy.

- To receive full credit on a Lab, it must be received on Canvas no later than 59 minutes after the posted deadline. (This allows for small issues with uploading to Canvas to occur without penalty.)
- Work submitted 1 to 48 hours after the deadline will lose 5 of the available 50 points.
- Work submitted more than 48 hours after the deadline will not be graded.

Your lowest lab score (out of Labs 1-5 and 7) over the course of the semester will be dropped before we calculate your overall lab grade. At the end of the semester, I will take the average of the 5 largest grades (out of Labs 1-5 and 7) to help create your Lab grade, before I factor in Lab 6.

- If you decide to skip a lab, please submit a note to Canvas by the deadline saying that you are skipping the lab.
- Should you run the risk of needing to miss more than one lab during the semester, contact Professor Love via email.

8.4 Lab 6

[Lab 6](#) will be graded according to the specifications provided in that Lab's instructions.

8.5 Lab Appeal Policy - Request a Review via Google Form

Clarification of concerns related to potential typographical or other errors in our Lab answer sketches is welcome at any time, but haggling over points on assignments can be a real time sink in a large class. To that end, students are **requested not to dispute** any grading on Labs 1-7 during the semester. Instead, should you receive a lower grade on a Lab than you feel you deserve based on the feedback the TA provides, the answer sketch and the grading rubric, you can submit a request for a regrade by Professor Love by submitting the Google Form found at <https://bit.ly/432-2025-lab-regrades> by the deadline in the [Calendar](#).

Students are welcome to ask questions of Professor Love about grading during the term. The TAs and Professor Love are happy to discuss in a general sense any questions about an assignment, but no grades will be changed until the end of the term. - The one exception is if there is a mistake in adding up points, or some similar clerical error. If you find such an issue, please bring it to Professor Love's attention via email, and such problems will be corrected immediately.

At the end of the semester, **after** Professor Love has worked out what letter grade to give each student, he will go through the requests on the form and determine for each whether the student's letter grade would change if all of the points in dispute were granted. If the answer is no, then he won't even look at the disputed grade(s). If the answer is yes, then he will look

very carefully to see if enough extra points are merited to change a grade. (It will not help your case to submit frivolous requests.)

The main advantage of this system is that it saves all of us the hassle of haggling over points that are never going to mean anything anyway. It also provides “equal access” to students who are too timid to express their concerns. Finally, if there is an issue with grading a particular problem or assignment that needs to be reconsidered, Professor Love will have access to all papers and can make a universal decision¹.

8.6 Grading the Quizzes

Each quiz will be graded solely by Professor Love. A detailed answer sketch and grading rubric will be provided to you when grades are available, usually within 48 hours of the quiz deadline.

In calculating your quiz average for your course grade, Professor Love weights your stronger Quiz performance at 60% and your other Quiz at 40%.

8.7 Grading the Projects

Some elements of each project will be graded by Professor Love, and others by the teaching assistants.

In calculating your project average for your course grade, I will weight Project A at 40% and Project B at 60%.

Students who cannot complete a project (either A or B) in a timely fashion will receive an incomplete grade until both Projects are completed. A penalty will be applied to late work on projects.

Once the complete project instructions are available, please contact Professor Love directly if you are in any way concerned about your ability to complete a project on time.

8.8 Late Assignments

If an emergency arises that will keep you from timely completion of work that has a deadline, like a lab, minute paper, or the like, send an email directly to Professor Love containing the following:

¹I got this idea from Jessica Utts.

I have an emergency that will keep me from completing (list things you're worried about completing) in a timely fashion. I will contact you again when I am able to make plans.

Professor Love will respond with “OK” and temporarily excuse you from things until you send a “re-connection” email to make plans for making up the work you missed, at which time he’ll evaluate the situation and together you can make that plan. At no time do you owe us any information about your health or the nature of the emergency.

8.9 Incomplete Grades

Here is the official University policy:

The grade of Incomplete is assigned at the discretion of an instructor provided that:

1. There are extenuating circumstances, explained to the instructor before the assignment of the grade, which clearly justify an extension of time beyond the requirements established for other students in the class. It is the student’s responsibility to notify the instructor of the circumstances preventing completion.
2. The student has been passing the course and only a small segment of the course remains to be completed, such as a term paper, for which the extenuating circumstances justify a special exception.

An Incomplete grade may not be assigned if a student is absent from a final examination, unless the dean has authorized the absence. Unauthorized absence from a final examination will result in a failing grade. When the student completes the work, the Incomplete is changed to an A, B, C, D, P, F, or NP.

All work for the incomplete grade must be made up and the change of grade recorded in the Office of the University Registrar by the date specified by the instructor, but no later than the last day of class in the semester following the one in which the Incomplete was received. A student who has a permanent Incomplete for a required course must retake the course in a later term. If the student cannot complete the work by the end of the following semester, he or she must petition for an extension which must be endorsed by the instructor, explain the reasons why the work has not been completed, and include a new date for completion. Students will be allowed only one extension of no more than one additional semester to complete the work for an Incomplete grade.

9 Advice for Students

My most important piece of general advice to people is to be kind. That's not always the thing I do as well as I'd like.



The Meanest TA
@MeanestTA

Hell hath no fury like a full professor mildly inconvenienced.

11:32 AM · Jun 12, 2019 · [Twitter for iPhone](#)

9.1 On Graduate School

For graduate students, I urge you to take as much advantage of this learning experience as you can. While I'll refer to some of the pieces below during the course, I've gathered a few favorites here.

1. From [matt.might.net...](#)
 - [12 Resolutions for Grad Students](#)
 - [How to get a great letter of recommendation](#)
 - [How to send and reply to email](#). You might also want to look at [Email Etiquette: Guidelines for Writing to Your Professors](#)
2. [Four Things You Should Do When You're Bored](#), on YouTube (the four things are Exercise / Read / Meditate / Find and Engage a Hobby with Passion). Also, [Get Up and Move. It May Make You Happier](#) by Gretchen Reynolds, in the *New York Times*, 2017-01-25.
3. [Why academics need to focus on structuring their time](#) from *University Affairs*.

4. Most people are really bad at meetings, including Professor Love. In a series of tweets, [Greg Wilson argues that](#) “the single most useful training you can give an adult is how to run a meeting and how to participate in someone else’s.” He then provides some nice tips in subsequent tweets, although the link provided there to a blog post is no longer working.
5. Some people need help taking notes. You might be interested in [Cornell Note Taking](#) or the [5 other methods described here](#).
6. You may be interested in the American Statistical Association, and its [This is Statistics](#) program.

9.2 On Seeking a Job

If I have a job or internship to offer, I'll be noisy about it in class. In the meantime, I'd consider joining the [American Statistical Association as a student member](#) and perhaps joining the [Greater Cleveland R Meetup Group](#).

Here are some gathered thoughts from other folks that you might enjoy:

1. [General Advice on an Academic Career Path](#) (which is filled with useful advice, especially for those studying biostatistics.)
2. [Advice for Applying to Data Science Jobs](#) from Emily Robinson
3. [Academic job search advice](#) from [matt.might.net](#)
4. [Career Advice for Data Scientists](#) was a panel at rstudio::conf 2020 focused on building a career around R.

9.3 On Writing, Presenting & Communicating

I write all the time. It's my job. It's yours, too. You'll do more of it here than you may be expecting in this class, and in life. So you'll need to take advantage of every opportunity you have to write more effectively tomorrow than you do today.

Here's what I find to be a compelling argument from George Cobb ...

If you want your work with data to make a difference, devote time and effort to choosing the words and pictures you use to present your evidence and conclusions. If you teach or supervise, seek to reward those - they who learn from you, and they who report to you – when they spend time crafting their message.

Think back to the last “report” you were expected to read. Is it easy to recall the main points? The answer, yes or no, depends not so much on the quality of the data, the effort, and the thinking that went into the report, nor on your own dutiful diligence in reading the report, but rather, and mainly, on whether the

people who wrote the report had learned and practiced the skills of how to use words and pictures, first, to claim attention, and second, to claim retention: to deliver a message that sticks in the mind.

9.4 Campus Resources

The [University Resources for Student Support](#) section in this Syllabus links to several important resources for improving your English and your communication skills. We strongly encourage you to take advantage of these resources.

9.5 Advice from Other People

1. [Preparing Manuscripts for Submission to Medical Journals: The Paper Trail](#) by H. Gilbert Welch, from *Effective Clinical Practice* in 1999.
 - Start early, focus on high-visibility components, develop a systematic approach to the body of the paper, finish strong.
 - Use [thinkchecksubmit](#) and [see this tweet](#) for some related suggestions when selecting a journal or publisher for your work.
2. [Writing a Scientific Paper in Four Easy Steps](#) from Claus Wilke at [The Serial Mentor blog](#).
3. [Rules to write a good research paper](#) from Daniel Lemire.
4. [Hey-here are some tips on communicating data and statistics!](#) from Andrew Gelman 2017-06-02.
5. [Writing Pet Peeves: Correctness, References, and Style](#) from Tamara Munzner.
6. Frank Harrell's [Checklist for Authors of Statistical Problems to Document and to Avoid](#)

9.6 A Few Tips from Professor Love

1. Statistics is a “getting the details right” business - we care deeply about details, and this applies to writing code or complete English sentences. RStudio has a spell-checker. To use it, click F7.
2. Nothing impresses us as much as a clear and concise argument, presented using well-written English sentences, effective and well-labeled figures and tables.
3. Don’t parrot back material that Professor Love wrote or said. State ideas in your own words. Stating them in my words is, technically, plagiarism.
4. Edit your more adventurous output; don’t present everything you know how to do in R, and don’t forget that someone is trying to read both your code and your results.

5. Make your work easy to evaluate. In responding to an assignment, be sure to answer the question that was asked, restating it as necessary.
6. Clearly label everything: graphs, tables, your answer to a specific question. Everything. Again, make your work easy to evaluate.
7. Simplify. Emphasize ideas in plain language. Avoid jargon. Use English well.
8. Data are plural. Use “the data **are** ...” rather than “the data *is* ...”
9. A paragraph must contain more than one sentence.

10. Don’t switch tenses. If you want to write in the present tense, stick to it throughout.
11. Don’t write or say random sample unless you used a random number generator. If you used haphazard sampling or convenience sampling, call it what it is, and indicate whether any problems could have cropped up as a result.
12. Similarly, don’t defend a method of data collection because it is random. Most of the time we want to represent some population, and a random sample is just one way to ensure that certain types of biases have a low probability of creeping in.
13. If you want to write that you used $\alpha = 0.05$ as a significance level, then state that your results were obtained using a 95% confidence level, not a 95% confidence interval, unless you are actually interpreting a confidence interval.

14. If you find yourself in the appalling situation of writing about a p -value, then you should state something like:
 - [1] We’re using a 95% confidence level.
 - [2] We’re using a 5% significance level.

 - [3] We’re using $\alpha = 0.05$.

 - Don’t use more than one of these expressions.

15. Again, don’t use p -values in most settings, but if you must, refer to all p -values that are less than 0.001 or perhaps less than 0.0001 as $p < 0.001$, rather than, for instance, $p = 0.00000001$ or, worse yet, $p = 0$. In a similar vein, write all p -values that exceed 0.99 as $p > 0.99$ instead of, for instance, $p = 1$.
16. To the extent possible, don’t use **computer-ese** to label variables, plots or tables. R and Quarto allow you to change the labels on graphs and tables to meaningful things – do so. Use meaningful abbreviations, as necessary, explaining what they mean on the first usage.
17. When in doubt, err on the side of clarity. Clear thinking leads to clear writing.

Finally, don’t use the phrase “statistically significant” or “statistically detectable” in your writing. It’s not helpful.

9.7 A Bonus Opportunity

Once you have read through this Syllabus, please e-mail Professor Love a note using the subject line **432 Favorite TV Series** containing:

1. the name of one of your favorite television series
2. information on how the series can be streamed (if it can, in the US)
3. a sentence or two describing why you like this series and think others in the class might enjoy it.

If Professor Love receives your email by 9 AM on Thursday 2025-01-23, he will add some bonus credit to your class participation grade.

Thank you.

10 General Policies

All Case Western Reserve University policies apply to this class, including those summarized below. To the extent that those policies are unclear, I would regard an appropriate code of conduct as mirroring [this one from the R Consortium](#).

Any concerns or questions regarding these general policies, the teaching assistants or the course itself should be directed to Professor Love, if at all possible.

10.1 Attendance

Things happen, and people occasionally cannot make it to class in person. For 432, we expect all students to attend **at least 80%** of the planned in-person classes in person.

- If you need to miss a class session, or even two, just review the materials and move on, and please feel encouraged to ask for help.
- If you must miss **more than two in-person classes** in a row, then it is your responsibility to email Professor Love as soon as possible to let him know. There's no need to let him know about shorter absences.
 - An appropriate email would read “I am unable to attend class on [specific dates] and I will complete all necessary work while I am away.” No additional explanation is required.

10.2 Auditing

Enrolled students and teaching assistants are the only people permitted to attend the course without special permission from Professor Love.

- I do not permit anyone to audit the course who has not previously taken it, without exception.

10.3 Recordings

We aim to have video recordings available the day after each class session.

- “Live” Zoom attendance will not (generally) be possible.
- Technical problems may occur during the semester with the recordings.
- You should assume that anything you say in class will be recorded.

10.4 Masks

We strongly encourage you to wear an appropriate mask (or stay home and watch the Zoom recording) if you are ill to reduce the chances of spreading that illness during 432 class meetings for the entire Spring 2025 semester. Professor Love will wear a mask (or pivot to Zoom) if he isn’t feeling well, and will maintain a substantial distance from you when he isn’t doing so.

- Multiple students and teaching assistants in this course either care for small children, those suffering with medical problems, or both.

We want you to learn lots of things from this class, but we primarily want you to stay healthy, balanced, and grounded during this crisis. We also want to make our classroom space as safe as possible. If you are uncomfortable with this expectation, contact Professor Love immediately.

10.5 Diversity and Inclusion

It is our intent that all students regardless of their background and perspective be well-served by this class. Further, we intend to present material whose content is respectful of diversity (gender identity, sexuality, disability, age, socioeconomic status, ethnicity, race, nationality, religion, and culture) and deliver it in a way that respects these differences as well. We expect that all students, instructors and guests will help foster an atmosphere of respect, trust and safety in the classroom.

If you have suggestions for how to make the class content or environment more inclusive, or have specific incidents to report, please reach out to Professor Love directly. If you are not comfortable reaching out to him, please feel encouraged to reach out to someone else, such as the School of Medicine Graduate Education Office (som-geo@case.edu) or the Office of Inclusion, Diversity and Equal Opportunity (OIDEO) (oideo@case.edu). More information on University policy and resources are available on OIDEO’s website at <https://case.edu/diversity/>.

10.6 Disability Resources

In accordance with federal law, if you have a documented disability, you may be eligible to request accommodations from Disability Resources. In order to be considered for accommodations you must first register with the Disability Resources office. Please contact their office to register at 216.368.5230 or visit their website at <https://case.edu/studentlife/disability/> to get more information on how to begin the process.

Once you have registered with Disability Resources, they will contact Professor Love to discuss any necessary arrangements. Please feel encouraged to get in touch with Professor Love directly to discuss any specific concerns you have.

10.7 Laptop and cell phone use

Here is the official University policy:

“Although having a laptop in class opens up new learning possibilities for students, it can be used in ways that are inappropriate. It is easy for your laptop to become a distraction to you and to those around you. Laptops are to be used only when essential to the task at hand. Please turn off or silence all cell/smart phones, tablets, and other electronic devices for the duration of the course. Inappropriate uses will be noted and may affect the final grade.”

Professor Love adds that, in this class, the use of a laptop or other device is welcomed, and even encouraged, for taking notes on our slides, or following along with the presentation, or trying out ideas in R, but it is inappropriate for you to use such a machine for activities unrelated to the class during our time together. Silence your phone during class. The temptation to look at your phone or Facebook or email during class is nearly irresistible. Resist anyway, if only to avoid distracting your instructor and your fellow students.

Thank you.

10.8 Academic Integrity

Here is the official policy of the University on Academic Integrity.

Any violation of the University’s Code of Ethics will not be tolerated. All forms of academic dishonesty including cheating, plagiarism, misrepresentation, and obstruction are violations of academic integrity standards and will result in a minimum penalty of receiving a zero for the assignment, the potential for failing the

entire course. Cheating includes copying from another's work, falsifying problem solutions or laboratory reports, or using unauthorized sources, notes or computer programs. Plagiarism includes the presentation, without proper attribution, of another's words or ideas from printed or electronic sources. It is also plagiarism to submit, without the instructor's consent, an assignment in one class previously submitted in another. Misrepresentation includes forgery of official academic documents, the presentation of altered or falsified documents or testimony to a university office or official, taking an exam for another student, or lying about personal circumstances to postpone tests or assignments. Obstruction occurs when a student engages in unreasonable conduct that interferes with another's ability to conduct scholarly activity. Destroying a student's computer file, stealing a student's notebook, and stealing a book on reserve in the library are examples of obstruction. In addition, the incident will be reported to the Dean of Undergraduate Studies and Academic Review Board for undergraduates or Senior Associate Dean of Graduate Studies, for Graduate Students.

The CWRU Statement of Ethics for graduate students can be found here: <http://case.edu/gradstudies/about-the-school/policies-procedures/>

10.9 Plagiarism

Professor Love, and the faculty of the Department of Population & Quantitative Health Sciences expect and require original writing for all assignments given. Submitting plagiarized work for an academic requirement is a violation of the academic integrity standards set forth by the University. Plagiarism is the representation of another's work or ideas as one's own; it includes the unacknowledged, word-for-word use and/or paraphrasing of another person's work, and/or the inappropriate unacknowledged use of another person's ideas. Submitting substantially the same work to satisfy requirements for one course that has been submitted in satisfaction of requirements for another course, without permission of the instructor of the course for which the work is being submitted, is also prohibited.

If you have any questions about this policy as it applies to 431, please direct them to Professor Love.

10.10 University Resources / Student Support

Case Western Reserve University has a wide range of student support resources on campus. These resources can assist students both in the classroom and outside of it. CWRU offers these resources to enrich and enhance each student's academic experience and to create an

environment that encourages personal growth and development. The Department of Population and Quantitative Health Sciences provides a detailed list [on its website in the Resources section](#). Please take advantage of these resources.

In particular, visit <https://case.edu/studentsuccess/academic-resources> for links to various programs and opportunities to help you learn more effectively. In particular, students needing some help with English, or writing skills will find multiple resources that have proven very helpful in the past.