BIOL 343 – Syllabus

Advanced Data Analysis for Biologists

Course Information

Fall 2024 Semester
3.0 Credits
In-Person
Pre-requisites: BIOL 343
Lectures Tuesdays, 8:30-10:30, MACKINTOSH-CORRY RM D201
Tutorials Fridays, 10:30-11:30, MACKINTOSH-CORRY RM D201

Instructor

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About Me: My teaching takes a student-centered approach that is supportive of diverse learners. I set high expectations and provide extensive resources to encourage students to continue to learn beyond the constraining demands of a university course. I try to emphasize a growth mindset that is focused on effort, personal development, and quality of work, rather than mastery or excellence. I try to teach students how to recover and learn from failure, which I believe is essential for a successful career in any discipline. My teaching philosophy draws on two decades of research and mentorship experience, resulting in primary research in top journals (e.g., Science, PNAS, PRSB) and dozens of former students employed in the public and private sectors or continuing on to pursue advanced degrees. I have a broader perspective than many biologists, drawing from an MSc in aquatic ecology from the University of Windsor and a PhD in quantitative genetics at the University of Toronto, followed by bioinformatics and computational biology research at Duke University (North Carolina), the University of British Columbia, and the University of Tübingen (Germany). I have been involved in a wide range of research projects, from the genomics of COVID-19 and Lyme disease to plant ecology and rapid evolution. As a faculty member in the Biology Department at Queen's University, my goal has been to develop courses that cover everything I wish I had known when I was a student. From genetic engineering and genome sequencing to disease epidemiology and the global biodiversity crisis, the skilled analysis of biological data is foundational to discovery and innovation in biological systems. The result of this effort is the course material for BIOL 343, BIOL 432, BIOL 860 and BIOL 812.

Equity, Diversity, and Inclusivity Statement

Equity and diversity are central to our educational mission and standards of excellence in this course and at Queen's University. It is critical that we work together to dismantle direct, indirect, and systemic discrimination that still exists within our institutional structures, policies and practices -- and in our community. These take many forms and work to differentially advantage and disadvantage persons across social identities defined by race, ethnicity, disability, gender identity, sexual orientation, faith and socioeconomic status, among other factors. As students and educators, we all have important roles to play to identify and address systemic discrimination for the benefit of science and society.

Land Acknowledgement

As a descendant of uninvited colonists, I feel tremendously privileged to live, learn, work, and play on these lands. As Queen's University is situated on traditional lands of the Anishinaabe and Haudenosaunee, I invite you all to be mindful with me about the many lessons we learn while on these lands, and how we might apply our newfound skills and knowledge for the benefit of all.

Even as a well-established scientist, I admit I have much to learn from the teachings and traditions of the Anishinaabe and Haudenosaunee, who have lived on these lands since time immemorial. While researching some of this history, I was moved to learn about the Seven Grandfathers in the Anishinaabe tradition, which, as I understand, demonstrate principles for living a "good" life. These include Dabaadendiziwin (humility/compassion/patience), Gwayakwaadiziwin (bravery to be honest), Minaadendamowin (respect for all creation), Nibwaakaawin (wisdom/knowledge to help people) and Zaagi'idiwin (unconditional love given and received). It is worth reflecting on how well these principles resonate with other cultures and traditions around the world, suggesting a deep truth.

It can be difficult and even overwhelming as a student to struggle through the stresses and demands of a university degree and life more generally. When you feel this way, I encourage you to learn or return to these Indigenous teachings, and/or teachings from your own cultural traditions, to recall what really matters in life, and to let these insights guide you through difficult decisions.

Important University Dates

Key dates (first day of class, tuition due date, last day to add/drop courses) are important to your academic success. Please find them at the Important Dates website.

Welcome to BIOL 343!

This course is designed for biology students who want to develop the kinds of analytical skills that are essential to the life sciences. These skills are taught primarily through textbook tutorials that have been written specifically for this class, building on the foundations of BIOL 243.

In this course, we focus on the R coding environment and learn how to gain biological insights through data visualization and formal statistical analysis, translate between biological observations and the mathematical language of statistics, and then interpret and present findings in a professionally formatted document. We emphasize a professional mindset, with an emphasis on personal growth. This is taught through an applied, hands-on approach that emphasizes regular practice and assessments, supplemented with short, conceptual topics in lecture format.

This course covers fundamentals of statistics through real-world application in biology, beginning with frequency distributions, central moments, and summary statistics, followed by linear models and model selection as a basis for exploring more advanced models. To help you apply these methods in a global context, examples related to the United Nations Sustainable Development Goals (UN SDGs) are used in the tutorials and learning assessments in this course.

University courses in biology tend to emphasize observation, phenomenon, and foundational theory. In contrast, this course is more like learning a written language. Coding and quantitative skills (i.e., math) learned in this course are developed through extensive practice, trial, and repeated failure. The philosophy of this course is that you won't learn to code and analyze data by reading and rote memorization – only through extensive application and practice.

To get the most from this course, you are STRONGLY ENCOURAGED to find opportunities to practice coding wherever possible, not just in activities associated with this class. In many applications you will find that it will take longer at first, but it will get easier with practice, and save time in the long run. Finally, be prepared to get frustrated – you will make many errors and most of your coding time will be spent debugging and searching for answers on the internet. It is important to know that this is COMPLETELY NORMAL. Perhaps the most crucial skill you will learn in this course is how to use self-directed research to identify, understand, and solve coding problems. Office hours are scheduled as weekly 1-hour tutorials to ensure that there are no schedule conflicts preventing you from receive additional help.

Quotes from Previous Students

The quotes below come from past student evaluations and point to key features of the course design that may not be typical of other biology courses you have taken. Understanding these differences will help you better prepare for this course.

"I took this course because I need a statistics prerequisite to apply for veterinary school, and I did not put in the effort required in intro stats to get an adequate grade. I put more effort into this class than any of my other courses this semester, and it did pay off."

"In some cases the lack of background doing this kind of assignments required much more effort and time from my side which was sometimes quite frustrating even though the answer was not really complicated."

"The assignments sometimes were very quick and brief and sometimes took a long time."

"The weekly assignments were also extremely time consuming, often taking up to 7-10 hours for each."

Lesson Learned: This course requires a lot of dedicated focus time, problem solving, and practice. This is a very different kind of effort than most biology courses and there are not many shortcuts.

"We were being tested on week 1 material in week 8."

Lesson Learned: Everything in this course is cumulative, because coding involves only a few key elements that are remixed and recombined into larger and more complicated programs. If you skip over something in the early weeks, it can come back to haunt you.

"I just wanted to say that I learned a lot in your classes. The tutorials and assignments worked well for me, and you and your TAs were very helpful… Most importantly, the coding skills turned out to be transferrable (who could have guessed!) and I have been making use of this knowledge a lot lately."

"I took your BIOL 343 and 432 course in Fall 2022 and Winter 2023 and these courses provided me with a strong foundation in understanding R, statistical analyses, and data visualization. These skills I developed in your class have been invaluable and have helped me to better understand the importance of data-driven decision making."

Testimony: Quotes from former students show that the course is challenging, but the extra effort pays dividends beyond the timeline of the course!

Expectations

For Instructors & Teaching Assistants

The teaching team is responsible for developing and editing the course material, which was written specifically for this course and for you, the biology student. We will ensure that all relevant course material is available online and released on a weekly basis so that you know where you should focus your available time and energy. The course content is always a work in progress, so we welcome any feedback on this material, from small spelling/grammar errors to points of confusion and general suggestions for improvement.

To accommodate variability in learning, we will make the main content available in complementary forms including two original textbooks and pre-recorded videos with annotated scripts. The textbooks lean heavily on a tutorial style, with step-by-step instructions that are reiterated in the online videos. The videos and textbook are designed to be complementary, with overlap emphasizing important skills and techniques.

You will make mistakes, both in coding and in learning about coding. Everyone makes mistakes, and coding is particularly prone to error, especially when there are distractions. I will use these opportunities to demonstrate how to troubleshoot errors by carefully reading the warning messages and running smaller subsets of code to identify where the problems lie. **Learning how to troubleshoot code is perhaps the most important skills you can learn in this course.** But it requires a different kind of mindset (see 'For Students' Section).

The entire teaching team (instructor + teaching assistants) is committed to establishing and maintaining a healthy and inclusive learning environment. We recognize that mistakes and errors are an important part of your learning process. We respect and value students who are not afraid to take risks or try things that might be 'wrong'. Above all, we value students who are not afraid to fail. We will use frequent assignments and testing to limit the impact of mistakes on your final grade. We will provide timely feedback – usually within two to three weeks. This represents a very large time and energy investment from the teaching team. We do it to help you learn from your mistakes, focus on learning, and succeed on future assignments.

We will communicate twice per week during lecture and tutorial. Lectures will cover only part of the assigned readings, so that there will be ample time available for questions or assistance.

For Students

It is expected that you will attend weekly lectures and tutorials, though we understand this may not be possible for everyone, all the time, particularly in the post-COVID era. Therefore, everything you need to succeed in this course will also be available online.

You are expected to bring a laptop capable of running Windows, MacOS, or Linux programs, and you must be able to access Queen's wireless network during lecture and tutorial sessions (see also "Technology Requirements"). Be sure to charge your laptop battery as there may not be enough plugs for everyone who needs one. When working in class or following recorded lectures, **you will code along in real-time**. The only way to effectively learn to program is to practice, and you are expected to practice as much as possible!

You are expected to complete the assigned readings each week, write down any questions that you have, and complete the online quizzes before the posted deadline. Then, review your answers to check for sources of confusion. You are expected to organize your thoughts into questions to ask during class. Please do not email questions that can be addressed during lecture or tutorial/office hours. If you aren't comfortable asking questions verbally, you may hand in written questions to the instructor or TA during class or tutorial. These steps help to ensure that you are organized and prepared before attending lectures and tutorials.

Weekly assignments are also submitted online and generally due with 48-72 hours of being posted online. Working through the assigned chapters and quizzes will prepare you for these short deadlines, which are essential to reinforce and build on what you have learned each week. Except where explicitly stated, you must complete quizzes and assignments alone, without communicating with other students. **Any attempts to communicate about quiz or assignment answers will be treated as a breach of academic integrity**. Plan to devote 3-5 hours to learning the lecture material and up to 10 hours to complete the assignments.

You are expected to check the course website regularly (or use alerts) to keep track of deadlines. **Late assignments are scored as zero** (but see below regarding accommodations).

Any questions or concerns about the course should be raised in lecture or tutorial, or privately during weekly office hours (no appointment needed). Email is generally not an effective tool for course material, and questions that can be addressed in person will not receive an email response. However, email is encouraged for urgent issues (e.g., medical or other personal emergencies, broken/incorrect website links, and other time-sensitive issues).

For Interactions

You will have regular interactions with the teaching team (TAs, instructor) and with your classmates. In all interactions, you are expected to be respectful and always behave with integrity, both in face-to-face interactions and when engaging online.

This course will also involve group-based activities that may require communication outside the classroom. You are responsible for maintaining contact and collaborating with all members of your group in a respectful and timely manner. Remember that other members of your group may not have the same resources or privileges and may need some flexibility or accommodation. **Developing skills to collaborate effectively within a diverse group of peers is an important goal of this course**.

Technology Requirement

You must have a laptop computer with internet access to participate in this course. Be sure to charge the battery as plugs may not be available for all students. Before attending the first lecture, you should install the following software:

- The R programming environment (free): https://www.r-project.org/
- R Studio Desktop (Open Source Edition, free): https://www.rstudio.com/products/rstudio/#rstudio-desktop
- Open R Studio and run the following lines in the terminal and press enter after each. NOTE: this will install some of the R packages that we use in the course. It may take several minutes to install each one. Be sure to type each line EXACTLY:
    - install.packages("ggplot2")
    - install.packages("tidyverse")
    - install.packages("dplyr")
    - install.packages("lubridate")

Course Learning Outcomes

Students completing this course shall be able to:

1. Identify different data types to enable coding for visualization and analysis.
2. Translate real-world observations into appropriate data types to produce visualization and analysis.
3. Reflect on how positionality may bias one's experimental design and data interpretation by exploring historical and contemporary biases on scientific progress.
4. Contrast the use of fixed vs random effects and linear vs generalized linear models to ensure appropriate interpretation of statistical output for real-world questions.
5. Simulate data relevant to sustainable development goals to explore assumptions of statistical models.
6. Develop a robust strategy for quality assurance and quality control to assess the reliability of statistical models.
7. Write clean and coherent code in R markdown to create reports with professional formatting and an analysis that is OPEN and REPRODUCIBLE.
8. Apply appropriate statistical models to test biological hypotheses related to sustainable development goals.

Assessment

20% Weekly Quizzes
30% Weekly Assignments
10% Participation & Peer Review
40% Final Exam

Assessment Description

Learning in this course is cumulative, meaning that content from early weeks is still relevant to quizzes and assignments in later weeks. Therefore, assessments of the course are scaffolded to help you achieve the learning outcomes. The specific topics covered in each weekly quiz and assignment are listed in the Course Timeline (see below).

All students may opt to remove the two lowest assignment scores before calculating the final grade. This includes incomplete or late assignments that receive a 0 mark. However, due to the cumulative nature of this course, the information on incomplete assignments should be reviewed as they will be relevant to future assignments and the final exam.

Generative AI programs like Chat-GPT and Bing copilot may be used and encouraged only in certain cases (see "Generative AI"). Note that the final exam is hand-written to assess learning of R code programming concepts taught in the weekly quizzes and assignments (see details below). Using generative AI to complete these quizzes and assignments will undermine your learning and your grade on the final exam.

Weekly Quizzes (20%)

- Weekly quizzes are completed before each lecture and are graded on a pass/fail basis. You will receive a full grade if you complete the quizzes on time.
- These quizzes are self-assessments of the weekly assigned readings to support learning of the background knowledge needed to complete the weekly assignments.

Weekly Assignments (30%)

- Weekly assignments are assigned in each lecture and due by the end of class.
- These assignments reinforce coding knowledge learned in assigned readings and support development of coding skills that are tested in the final exam.
- A mix of group and individual projects will be assigned. Students who are absent or unable to complete group work may submit individual assignments to avoid grade penalties.
- All students receive a grace period (an extension of up to 24 hours) without the need to make a request through the Academic Considerations Portal. You do not need to send an email or explain in person; simply take the time if you need it.
- Longer extensions are discouraged because of the cumulative nature of the course. Delays will prevent learning of new content and the frequency of assignments can quickly become overwhelming when deadlines overlap. For students who have the need for longer extensions, please submit a request through the Academic Considerations Portal (see below).

Participation & Peer Review (10%)

- The participation and peer review grade has two main components.
- The first part of the grade is assigned by the instructor and TAs, and it is designed to motivate attendance and active participation in lectures and tutorials.
- The second part of the grade is based on peer evaluation forms, following two criteria: “contribution to group projects” and “collegial collaboration.”

Final Exam (40%)

- The final exam is designed to assess your overall learning in the class, and it requires independent work (you cannot ask for help from classmates, internet searches, generative AI, etc.)
- The format of the exam includes two parts. The first part is similar to the weekly quizzes you will practice throughout the semester. The second part is similar to the weekly assignments, but shorter and more focused on particular tasks rather than comprehensive reports.
- To succeed on the final exam, you will need to work independently through the self-tutorials, quizzes and assignments (unless otherwise directed by your instructor or TA). This will help you develop the knowledge and skills needed for the final exam without the need for additional work.

Grading Scheme and Grading Method

All components of this course will receive numerical marks, weighted by the percentage shown in the “Assessment” section, above. The final grade you receive for the course will be derived by

converting your numerical course average to a letter grade according to Queen's Official Grade Conversion Scale:

Queen's Official Grade Conversion Scale

Grade	Numerical Course Average (Range)
A+	90-100
A	85-89
A-	80-84
B+	77-79
B	73-76
B-	70-72
C+	67-69
C	63-66
C-	60-62
D+	57-59
D	53-56
D-	50-52
F	49 and below

Course Materials

The following texts are required readings for this course and made available at no cost.

R Crash Course for Biologists *by Robert I. Colautti*

This introductory textbook is available for purchase (print) with a free (online) version on the course website. Within the first few lectures, you will learn how to program basic functions in R to import, manage, and visualize data, produce reports, and collaboratively code online to support science that is open and reproducible.

This book adopts a self-tutorial style, and it is important that you take the time to follow along and physically type out the commands in your computer. The simple act of typing is critical to develop coding skills, and it will prepare you for the final exam. Sometimes you will not get the same output, and that's a good opportunity to learn how to troubleshoot typos and other errors.

R STATS Crash Course for Biologists *by Robert I. Colautti*

The second part of the course applies to the concepts and tools from the *R Crash Course* to analyze biological data. This book is also available for purchase (print), with a free (online) version on the course website. As with the R Crash Course, this book adopts a self-tutorial style and you should physically code along on your computer.

Course Timeline

The following is the planned timeline for the course however an updated version is available on the course website.

	Topics
	PART I: Introduction to Coding for Data Science
Week 01	Introduction and R fundamentals, Part I
Week 02	R fundamentals, Part II
Week 03	Visualizing data with ggplot()
Week 04	Introduction to data science and data management
Week 05	Understand math through code: distributions and probabilities
	PART II: Data Analysis
Week 06	Central moments and other summary statistics
Week 07	Basic linear models with QA/QC
Week 08	Advanced linear models
Week 09	Likelihood, information criteria, and model selection
Week 10	Generalized Linear Models (GLM) and experimental design
Week 11	Linear Mixed Models (LMM)
Week 12	Generalized Additive Models (GAM)

Suggested Time Commitment

Each week, you should commit 3 to 6 hours working through the assigned readings (self-tutorials), and ~ 2 hours completing assignments, with additional time to practice writing code, as your schedule permits. It is strongly recommended that you budget at least 10 hours per week reviewing and practicing the code in the assigned readings so that you are prepared to complete the associated assignment during scheduled class time.

Support for Success

The workload in this course is **demanding by design**, because frequent and regular practice is essential to develop competence as a data scientist. However, we have incorporated "Universal Design for Learning" and other best practices to support your success.

- Parallel content is presented in both video and written form on the course website.
- Content is taught primarily through self-guided tutorials, outside of the time limitations of class, allowing you to work at your own pace.
- A 24-hour grace period is added to the assignment deadline in case you need a bit more time.

- Mistakes are encouraged in readings and quizzes because learning to identify and deal with coding errors is a very important skill that you will learn in this class.
- Regular quizzes and assignments provide frequent feedback opportunities to help you identify strength and bridge knowledge gaps.
- Assignments are done in different formats with opportunities to ask questions and discuss ideas with peers.
- Assignments are structured to allow application of concepts and skills in realistic case studies.

Learning Tips

Coding involves a lot of trial-and-error that can be frustrating for students new to the discipline. First, know that this is completely normal, even to seasoned data scientists. A very common and effective approach to solving errors or other problems is to search Google or Stack Overflow. Often, simply copying and pasting an error into an online search will produce a helpful link. **Very often you can just type 'How do I X in R' (or the R package name like ggplot2, dplyr) into a search engine and look for links to similar questions answered on the Stack Overflow website**.

In addition, we (instructor and TAs) will generally leave ample time at the end of lectures and tutorials. You are strongly encouraged to ask the question in lecture or tutorial so that all students can benefit from the answer. Any private questions or issues can be discussed during weekly scheduled office hours (no appointment necessary). Email is not an effective mode of communication in this course, except for time-sensitive issues.

Course Announcements

News and general announcements are posted on the home page of the course website, and new content is released to the course website every week (e.g., lecture topics, assigned reading, quizzes, assignments).

Course Feedback

Course feedback is welcome throughout the semester. Your feedback is very important to the teaching team and may be used to adjust the course both in the future and the present. In addition to the feedback that we ask for during lectures and tutorials, we welcome any suggestions for improvement (email is a good format for this).

Accommodation for Students with Disabilities

Queen's University is committed to achieving full accessibility for people with disabilities. Part of this commitment includes arranging academic accommodations for students with disabilities to ensure they have an equitable opportunity to participate in all of their academic activities. The Senate Policy for Accommodations for Students with Disabilities was approved at Senate in November 2016 (https://www.queensu.ca/secretariat/sites/webpublish.queensu.ca.uslcwww/files/files/policies/senateandtrustees/ACADACCOMMPOLICY2016.pdf).

If you are a student with a disability and think you may need academic accommodations, you are strongly encouraged to contact the **Queen's Student Accessibility Services (QSAS)** and register as early as possible. For more information, including important deadlines, please visit the QSAS website at: http://www.queensu.ca/studentwellness/accessibility-services/

If you are registered with Queen's Student Accessibility Services (QSAS) you must submit your Letter of Accommodation to the Ventus Accommodation Management for Students portal (https://ventus.queensu.ca/ventus/student/).

Academic Considerations for Students in Extenuating Circumstances

Queen's University is committed to providing academic consideration to students experiencing extenuating circumstances that are beyond their control and are interfering with their ability to complete academic requirements related to a course for a short period of time. See the Senate Policy on Academic Consideration for Students in Extenuating Circumstances.

Each Faculty has developed a protocol to provide a consistent and equitable approach in dealing with requests for academic consideration for students facing extenuating circumstances. Arts and Science undergraduate students can find the Faculty of Arts and Science protocol and the portal where a request can be submitted. Students in other Faculties and Schools who are enrolled in this course should refer to the protocol for their home Faculty.

For guidance on **submitting requests**, please refer to the Resource Guides available on the Academic Consideration website under "Applying for Academic Consideration."
If you need to request academic consideration for this course, you will be required to provide the name and email address of the instructor/coordinator. Please use the following:
Instructor Name: Dr. Robert I. Colautti
Email: robert.colautti@queensu.ca

Academic Integrity

Queen's students, faculty, administrators, and staff all have responsibilities for upholding the fundamental values of academic integrity; honesty, trust, fairness, respect, responsibility, and courage. These values are central to the building, nurturing, and sustaining of an academic community in which all members of the community will thrive. Adherence to the values expressed through academic integrity forms a foundation for the "freedom of inquiry and exchange of ideas" essential to the intellectual life of the University (see the Senate Report on Principles and Priorities).

Students are responsible for familiarizing themselves with the regulations concerning academic integrity and for ensuring that their assignments and their behaviour conform to the principles of academic integrity. Information on academic integrity is available in the Arts and Science Calendar (see Academic Regulation 1), on the Arts and Science website, and from the instructor of this course. Departures from academic integrity include plagiarism, use of unauthorized materials, facilitation, forgery, use of forged materials, contract cheating, unauthorized use of

intellectual property, unauthorized collaboration, failure to abide by academic rules, departure from the core values of academic integrity, and falsification, and are antithetical to the development of an academic community at Queen's. Given the seriousness of these matters, actions which contravene the regulation on academic integrity carry sanctions appropriate to the severity of the departure that can range from a warning or the loss of grades on an assignment to the failure of a course to a requirement to withdraw from the university.

Plagiarism is a form of cheating and includes copying code written by students. There is no 'right answer' for the assignments in this class – there are often many potential coding solutions. You will also develop your own coding style, which will make it obvious when code has been copied. To avoid potential for plagiarism, ALWAYS COMPLETE ASSIGNMENTS ON YOUR OWN. As a bonus, you will learn to code better. On the other hand, it is completely fine to ask others to help you troubleshoot an error message or help you figure out why your code isn't working properly. If you become aware of anyone trying to share or solicit code for the assignments, please point them to this passage and inform the teaching team immediately.

Queen's Student Academic Success Services (SASS) offers a self-directed, online academic integrity module which we encourage all students to take which will help with:

- Understanding the nature of the academic integrity departure.
- Understanding the expectations of and role of sources in scholarly writing.
- Integrating sources into your writing (paraphrasing, quoting, summarizing).
- Understanding when and how to cite your sources.
- Managing your time effectively to avoid the need for shortcuts.
- Taking effective notes to ensure accuracy of source material and correct attribution.

Generative AI

As discussed in the introduction of the *R Crash Course for Biologists*, it is very likely that professional biologists who code will benefit from using Large Language Models (LLMs) and other forms of generative AI on a regular basis. Therefore, it's worth learning how to use LLMs now, as a student, to write effective code. LLMs can save you a lot of time and effort but they can also compromise your learning. Here are some tips to ensure that your use of LLMs in this course does not violate Queen's Academic Integrity guidelines nor interfere with your ability to do well on the final exam.

- **DO** be skeptical of everything AI tells you, even if it seems right at first.
- **DO** try to figure it out yourself, ask AI for help only when you get stuck.
- **DO** ask AI for help interpreting warning or error messages in your code.
- **DO** read the R help yourself. It's difficult at first, but it gets easier. Ask AI for help with terms or concepts that you don't understand in the R help.
- **DO** ask AI for feedback on your code, but don't use code that you don't understand, and read the code carefully.
- **DO** ask AI to explain code to you, as you would ask a tutor.

- DON'T ask AI which packages or functions you should use. Unless you like to spend lots of time memorizing functions and package names, the best way to learn them is by forcing yourself to think about what you know and how you can apply it for a given problem.
- DON'T ask AI to write code for you. Not only will it limit your ability to learn to write effective code through repetition and practice, it might produce something that is completely wrong!

Copyright of Course Materials

Course materials created by the course instructor, including the textbooks, online tutorials, slides, presentations, quizzes, assignments, and other similar course materials, are the instructor's intellectual property. It is a departure from academic integrity to distribute, publicly post, sell or otherwise disseminate an instructor's course materials or to provide an instructor's course materials to anyone else for distribution (including note sharing sites), posting, sale or other means of dissemination without the instructor's express consent. A student who engages in such conduct may be subject to penalty for a departure from academic integrity and may also face adverse legal consequences for infringement of intellectual property rights.