

SC326: Statistical Graphics and Principles of Visualization

Spring 2024

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Office hours:	See our Moodle page
Lectures & Labs:	Mondays and Fridays, 1:00pm–1:50pm, Davis 308 Wednesdays, 1:00pm–1:50pm, Diamond 153
Weekly	Labs are due on Friday at 4:00pm, unless otherwise instructed.
Assignments:	Homeworks are due on Thursday at 4:00pm, unless otherwise instructed.
Lab Exam:	There will be one lab exam, tentatively on Friday, March 22 .
Static Graphics Project:	After mid-semester, there will be a group poster presentation project (tentatively scheduled for CLAS on Thursday, May 2).
Interactive Graphics Project:	There is no final exam. There will be a final group project involving an interactive graphic, accompanying paper, and peer critiques (due date TBD during finals week, May 15-20).
Prerequisites:	SC212 or consent of the instructor.

Course Description

An effective statistical graphic is a powerful tool for analyzing data and communicating insights. From tabular to geospatial and network datasets, students will learn to create and interpret visualizations that show the raw data, statistical models of that data, and the statistical precision of those summaries. Students will also apply principles of human visual processing and data science workflows to ensure their statistical graphics are effective and reproducible. With the help of the `tidyverse`, `ggplot2`, `rmarkdown`, and `shiny` R packages, students will create static and interactive graphics, culminating in an interactive data dashboard.

In addition to two weekly lectures, a weekly lab session will focus on the use of software.

Textbooks: Purchasing these books is **optional**. I will provide excerpts as needed.

Overviews: *The Functional Art*, by Alberto Cairo. New Riders, 2012.
Fundamental Statistical Concepts in Presenting Data, by Rafe Donahue.
 online: <https://biostat.app.vumc.org/wiki/Main/RafeDonahue>
Data Visualization: A Practical Introduction, by Kieran Healy. Princeton, 2019.
 online draft: <https://socviz.co/>
Fundamentals of Data Visualization, by Claus Wilke. O'Reilly, 2019.
 online draft: <https://clauswilke.com/dataviz/>

R code: *ggplot2: Elegant Graphics for Data Analysis*, by Hadley Wickham. Springer, 2016.
 PDF of 2nd ed: <https://link.springer.com/book/10.1007/978-3-319-24277-4>
 online draft of 3rd ed: <https://ggplot2-book.org/>
R Graphics Cookbook, by Winston Chang. O'Reilly, 2013.
 online draft of 2nd ed: <https://r-graphics.org/>

Graphic design: *The Non-Designer's Design Book*, by Robin Williams. Peachpit Press, 2014.

Course Objectives

- Apply principled frameworks to create effective statistical graphics (Wilkinson's Grammar of Graphics; research on human visual perception and graph comprehension; principles of graphic design and interaction design)
- Create and interpret visualizations that show the raw data, statistical summaries/models of that data, and the statistical precision/uncertainty in those summaries, for a variety of data structures (including tabular, geospatial, trees, and networks)
- Follow a responsible data science workflow, from ingesting and cleaning data through creating reports, by applying the principles of tidy data and reproducible research through the use of the R statistical software (including RStudio, RMarkdown, and tidyverse packages)
- Work in small teams to develop a static poster and an interactive, web-based data visualization app and justify their design choices

Course Components

1. **Lectures.** The main topics of the course will be covered during the lecture. You are also responsible for any additional material covered in the assigned readings, labs, and homework.
 If you miss a lecture, you are responsible for the material covered during the lecture you have not attended. Students are expected to take notes and follow along with example problems in class. Some (but not all) course notes and example code will be posted on the course website.
 During most lectures, we will also assign short small-group activities, resulting in a sketch or short writeup to be handed in at the end of class. These informal activities are designed to help you learn and will not be graded for correctness, only monitored for participation. Please always write your name on the sheets you hand in.
2. **Labs.** Labs are specifically designed to add context and give examples (using real-world datasets) of the concepts covered in lecture. They are also designed to prepare students for homework assignments due the following week. Labs will typically include example code to ease the introduction into new concepts.

Labs are designed to take 45 minutes to complete. The instructor is in lab to help you, so please ask questions when you need assistance. Additionally, please discuss the lab with other students, ask other students for help, and help other students in lab, as long as the talking is not disruptive. Talking is not allowed during the lab exam, however.

Lab attendance is mandatory. Questions about the lab assignment will not be answered after the lab session has ended.

Lab assignments are due at 4:00pm on the day of lab (unless otherwise specified), submitted through the course website. Students should submit a single .Rmd file and its knitted .html output file, unless otherwise specified. (This will be more clear when you complete Lab 01.)

3. **Homework.** Homework problems provide you with the opportunity to learn, practice, and test your knowledge and understanding of the material. All material found in the homework may show up in later homeworks and/or the lab exam.

Homeworks are due on Thursdays at 4:00pm, submitted through the course website. Students should submit a single .Rmd file and its knitted .html output file, unless otherwise specified.

We will give you adequate time to work on the problems, and the graders will work hard to return your homework in a timely manner. Unfortunately, this means that **late homework will not be accepted**. Instead, the grading policy allows for the equivalent of dropping 1 homework (see below).

4. **Code.** All code should be written in R and RMarkdown. Students should follow one of Hadley Wickham's popular style guidelines: the one-page [style guide from Advanced R](#), or its expanded version, the [tidyverse Style Guide](#).
5. **Lab Exam.** There is one lab exam during the semester. Specific details about the content and format of the lab exam will be available closer to the exam date (Friday, March 22).
6. **Static Graphics Project.** There will be a midterm project. Groups of students will be assigned a dataset to analyze. Each group will create a poster describing their work. A public group presentation of the analyses is (tentatively) scheduled for Thursday, May 2. More details will be available after mid-semester.
7. **Interactive Graphics Project and Paper.** There will be a final project. Groups of students will be assigned a dataset to analyze. A group paper describing the work is due during finals week. Students will also be assigned peer critiques of other groups' work. More details will be available near the end of the semester.

Grading Policies

- All numeric grades are on a scale from 0 to 100.
- Final grades will be computed according to the following weights (subject to change at the instructor's discretion):

Homework Score	20%
Lab Score	10%
Lab Exam Score	25%
Static Graphics Project/Paper/Presentation	20%
Interactive Graphics Project/Paper/Critiques	20%
Class Engagement	5%

- Final letter grades will be determined according to the following rules (subject to change at the instructor’s discretion):

A	≥ 90
B	$[80, 90)$
C	$[70, 80)$
D	$[60, 70)$
R	< 60

- Instead of accepting late work, I will calculate your final homework grades out of a point total equivalent to dropping one homework.

If there are $NrHWs$ homework assignments, and the max possible point total across all HWs is $MaxTotal$, then your final score will be scored out of $MaxTotal * (NrHWs - 1) / NrHWs$, up to a max of 100%:

$FinalScore = YourTotal / (MaxTotal * (NrHWs - 1) / NrHWs)$, capped at 100%.

For example, if there are 11 homeworks and each is worth 100 points, the max possible total is 1100 points—but your final HW grade would be scored out of only 1000 points:

$FinalScore = YourTotal / 1000$. Even if you miss a few points here and there, you could earn a full-credit final homework score by submitting all assignments.

Computing

- All projects and other course assignments must be written in R and RMarkdown unless otherwise specified.
- Students with laptops and personal computers should download the latest versions of R and RStudio. Instructions to do this will be given during the first week of classes.
- During lab time, students are welcome to use the campus computers in the first few weeks. Students may eventually need to use their own computers, since the lab computers may not support some recent R packages that we will use later in the course.
- If you do not have a laptop or personal computer that can run RStudio, and you will need to use lab computers all semester or to access Colby’s RStudio server instead, please **immediately** notify the instructor.

Administrative Procedures and Logistics

- **Masks.** According to guidance from the Dean of Faculty, “Regardless of campus-wide policies, faculty and teaching staff may require masks in classrooms and other teaching spaces. More generally, we appreciate everyone respecting the needs of others and wearing masks as requested, and we ask that you have a mask with you when you are on campus.”
Depending on conditions, I may expect the SC326 classroom and labs to mask in order to protect those of us with compromised immune systems, those of us with high-risk family members, and those of us who simply want to avoid transmitting the virus to others or being re/infected themselves.
- **Lectures.** Use common courtesies: arrive on time; do not leave early; no cell-phone use allowed; do not be disruptive in class; participate in class when the instructor asks questions; etc. The use of laptops/tablets/etc is allowed only for course-related purposes; students are encouraged to follow along and run code in class.

- **Course Materials and Announcements:** The syllabus, lab assignments, homework assignments, solutions, assigned readings, any supplementary material, and grades for this course can be found on the course web page on Moodle: <https://moodle.colby.edu/>. **Please check Moodle regularly.**

Moodle will also be used to send out course announcements. **Please check your Colby email account regularly.**

- **Communication.** If you have any questions related to the class material, homework problems and exams, please ask the instructor during class or office hours.

Please use email only to address administrative and logistic issues. Questions about homework submitted by email may not be answered quickly or at all. You should not expect a reply within 24 hours.

- **Homework Format.** Homeworks should have the student's name at the very top/beginning. Questions should be answered in order. All answers should be clearly marked and labeled. Answers should be written in the context of the problem when applicable. Proper spelling and grammar should always be used – this means using complete sentences, proper punctuation, etc. Deviating from this format may result in your assignment not being graded.

You are encouraged to discuss homework problems and collaborate with classmates. However, the work you submit must be **your own**. This means, in particular, that each student must independently write up each problem, including all code and written responses. Instances of identical, nearly identical, or copied homework will be considered cheating and plagiarism.

- **Deadline extensions and missed classes.** Colby College supports the religious practices of students, faculty, and staff. Students are expected to notify their instructors of their intent to fulfill the obligations of their religious tradition well in advance of these days. For this class I ask that you notify me by email at least 14 days in advance of the date in question.

Colby rules state that student athletes are permitted to miss a class for a contest but only at the discretion of the professor of that class. Students should communicate with the professor directly and as soon as possible (ideally in the first week of classes) about any conflicts between their athletic schedule and our class schedule.

In general, extensions will not be granted for students because they are behind on work, had a busy week, etc. Extensions for **reasonable academic purposes** (e.g. job interview) or **extreme circumstances** (e.g. hospitalization) will generally be granted. If you believe you have a reasonable request for an extension, please request this at least 48 hours before an assignment is due, along with the reason for requesting an extension. At the top of the assignment, please clearly write that you received an extension on the assignment.

- **Academic accommodations.** I am available to discuss academic accommodations that any student with a documented disability may require. Please note that you'll need to provide a letter from the Dean of Studies Office documenting your approved accommodations. **Please meet with me within two weeks of the start of the semester to make a request for accommodations** so that we can work together with the College to make the appropriate arrangements for you. Colby's Office for Student Access and Disability Services is the primary contact for accommodations and any questions related to educational testing and documentation: <https://life.colby.edu/get-support/access-disability-services/>

- **Sexual misconduct/Title IX statement.** Colby College prohibits and will not tolerate sexual misconduct or gender-based discrimination of any kind. Colby is legally obligated to investigate sexual misconduct (including, but not limited to sexual assault and sexual harassment).

If you wish to speak confidentially about an incident of sexual misconduct, please contact Colby Counseling Services (207-859-4490) or the Director of the Gender and Sexual Diversity Program, Emily Schusterbauer (207-859-4093).

Students should be aware that faculty members are considered responsible employees; as such, if you disclose an incident of sexual misconduct to a faculty member, they have an obligation to report it to Colby's Title IX Coordinator. "Disclosure" may include communication in-person, via email/phone/text, or through class assignments.

To learn more about sexual misconduct or report an incident, visit <https://life.colby.edu/your-safety/sexual-violence-title-ix/>

- **Academic honesty and consequences for academic dishonesty.** Always ask if you are unsure whether your actions comply with the assignment instructions. Always acknowledge any help received on assignments: list the names of the people you worked with, and cite any external sources you used (including generative AI). You are encouraged to discuss assignments with your classmates, but the work you submit must be your own.

Honesty, integrity, and personal responsibility are cornerstones of a Colby education and provide the foundation for scholarly inquiry, intellectual discourse, and an open and welcoming campus community. These values are articulated in the Colby Affirmation and are central to this course. Students are expected to demonstrate academic honesty in all aspects of this course.

Academic dishonesty includes, but is not limited to:

- plagiarism (including quoting sources without “ ” around the borrowed words and a citation);
- presenting another's work as one's own (this includes generative AI such as ChatGPT);
- buying or attempting to buy papers or projects for a course;
- fabricating (or using generative AI to fabricate) information or citations;
- knowingly assisting others in acts of academic dishonesty;
- violating clearly stated rules for taking an exam (e.g., keeping your phone on your person when told to place it in a bag) or completing homework;
- misrepresentations to faculty within the context of a course; and
- submitting the same work, including an essay that you wrote, in more than one course without the permission of instructors.

Academic dishonesty is a serious offense against the college. Sanctions for academic dishonesty are assigned by an academic review board and may include failure on the assignment, failure in the course, or suspension or expulsion from the College. All students found responsible for violating academic integrity standards will have a disciplinary letter placed in their file for 6 years after they leave Colby. This letter can be released to requesting parties (e.g., medical/law school, employers). Thus, the consequences of dishonesty far exceed the benefits (not to mention the fact that cheating is a disservice to you and your learning process).

For more on recognizing and avoiding plagiarism, see:

<https://libguides.colby.edu/avoidingplagiarism>

For resources and information on academic integrity, see:

<https://www.colby.edu/academics/academic-integrity/>

- **A special note on AI and ChatGPT.** Under no circumstances should you be using any type of AI in preparing reports, projects, or exams. This includes, but is not necessarily limited to, using any kind of online AI chat (e.g. ChatGPT). All writing that is conducted in this class must be original and be your own. If you have any questions about this, ask me.
- **The Colby Affirmation.** Colby College is a community dedicated to learning and committed to the growth and well-being of all its members. As a community devoted to intellectual growth, we value academic integrity. We agree to take ownership of our academic work, to submit only work that is our own, to fully acknowledge the research and ideas of others in our work, and to abide by the instructions and regulations governing academic work established by the faculty. As a community built on respect for ourselves, each other, and our physical environment, we recognize the diversity of people who have gathered here and that genuine inclusivity requires active, honest, and compassionate engagement with one another. We agree to respect each other, to honor community expectations, and to comply with College policies. As a member of this community, I pledge to hold myself and others accountable to these values.
<https://www.colby.edu/academics/academic-integrity/the-colby-affirmation/>