Data Visualization

Dr. Reagan Mozer | Bentley University | MA250 Spring 2026

E-mail: rmozer@bentley.edu
Office: Morison Hall 337
Office Hours: TBD (or by appointment)

Class Meetings: M/Th 2:00–3:20 pm
Smith Technology Center 212

Overview

> "*Numbers have an important story to tell. They rely on you to give them a clear and convincing voice.*" – Visualization expert Stephen Few

This course covers the principles and practices of data visualization and storytelling with statistical graphics. Building on foundational statistics knowledge, students will learn how to construct clear and effective visualizations that highlight key insights from techniques like hypothesis testing, linear modeling, and multivariate analysis. A significant focus is placed on detecting misleading or confusing displays, improving integrity of visuals, communicating compelling narratives, and using data representation ethically. Topics include visualization best practices, visualization tools and technologies, visual perception and design theory, graphical storytelling with data, and real-world applications.

Learning Objectives

Students should become proficient in the design, presentation, and critique of statistical graphics. In particular, students should be able to:

1. Create impactful, interpretable data visualizations using statistical methods and design theory
    - Import, clean, and wrangle data to prepare it for analysis and visualization using leading analytics software such as Tableau and R
    - Construct effective visualizations for different data types (categorical, numeric, temporal, spatial) using appropriate graph and chart types
2. Apply critical thinking skills to evaluate and refine data visualizations
    - Critique existing visualizations, identifying issues and limitations in clarity, and accessibility
    - Improve and refine graphs and charts to enhance interpretability, highlight key insights, and fix misleading or biased visualizations
    - Defend visual representation choices and explain rationale behind design decisions
3. Communicate complex statistical insights through visual storytelling
    - Design effective presentations and narratives tailored to specific data sets and analysis techniques
    - Communicate statistical results clearly from data visualizations
    - Discuss the social and ethical impact of data visualizations in various contexts

Prerequisites

MA214 (or equivalent); Students should have a solid understanding of basic and intermediate statistical concepts such as mean, median, mode, variance, standard deviation, correlation, and regression as these

concepts are foundational for effective data visualization and interpretation in the settings covered in this course.

Course Materials

Format & Structure

This course will be conducted in-person and will meet twice per week for 80 minutes. Class time will consist of a mixture of traditional lectures, active discussions, and hands-on software practice. Some class time will also be dedicated to collaboration on group visualization projects. In general:

- Lectures and readings will introduce theoretical concepts and best practices in data visualization.
- Discussions will facilitate critique and evaluation of example visualizations.
- Hands-on tutorials and lab assignments will allow students to gain practical experience constructing visualizations using leading software tools.

Each week, class will typically begin with a lecture to introduce and explain the key concepts of the week, followed by a discussion segment where students are encouraged to engage with the material, ask questions, and share insights. The latter part of the week will then be dedicated to software tutorials and hands-on activities.

Textbooks & Readings

There is no single required textbook for this course. Instead, weekly readings draw from a curated set of book chapters, scholarly articles, and high-quality online resources that emphasize statistical reasoning, graphical integrity, and practical data visualization. Readings are selected to align closely with the topics covered each week and are listed in detail in the course schedule at the end of this syllabus.

The following free online textbooks will be referenced frequently throughout the course:

- *Fundamentals of Data Visualization* by Claus O. Wilke (2019)
- *Data Visualization: A Practical Introduction* by Kieran Healy (2018)
- *R for Data Science* (2nd ed.) by Hadley Wickham & Garrett Grolemund (2023)

All recommended readings will be posted on Brightspace or linked directly when openly available. Students are encouraged to complete the recommended readings for each week on their own time to reinforce and deepen their understanding of course concepts. However, students will not be graded on reading completion, and quizzes and assessments will not directly test detailed knowledge of the readings. The primary purpose of the readings is to support in-class learning and discussion and to serve as reference material when critiquing, designing, and justifying visualizations throughout the semester.

Course Website

Announcements, assignments, and other course materials will be posted on Brightspace. From time to time, I will also provide references to other materials that may be useful to students, including online readings, tutorials, and/or instructional videos, which will also be made available to students through Brightspace. Lecture slides will typically be posted to Brightspace in advance of each lecture. Note that the lecture slides are intended to *accompany* the lecture. They are not designed to be a complete exposition of the material and will not serve as a self-contained reference.

Required Software

We will use two primary software tools in this course. Both are free to students and available for Mac and Windows operating systems.

- **R and RStudio**: Primary tools for statistical visualization and analysis
- **Tableau Desktop**: For exploratory analysis, business-facing graphics, and interactive dashboards. A free license and activation key will be provided to each student to use for the duration of the class.

Students are expected to install and use the required software throughout the semester for in-class activities, homework assignments, workshops, and the final project. Prior experience with these tools is not assumed, and time will be devoted in class to introducing core functionality and workflows.

Grading Policy

Final course grades will be calculated as follows:

Participation & in-class activities	10%
Online quizzes/exercises	10%
Visualization workshops	15%
Homework assignments	30%
Final project	35%
Total	**100%**

Throughout the semester, grading will conform to the system outlined in the Bentley Student Handbook. Grades are non-competitive (i.e., there is no curve, where the highest score is set as the top of the grading scale). However, *I reserve the right to add points or increase grades uniformly across the class at my discretion* ***at the end of the semester***.

Participation & in-class assignments

Regular attendance and active participation in class are imperative to performing well in this course. Participation credit will be based primarily on engagement in in-class exercises, discussions, and hands-on activities rather than attendance alone.

Online Quizzes/Exercises

There will be short "quizzes" consisting of a few multiple choice questions or open-ended discussion questions (administered on Brightspace) nearly every week. These exercises will be based on the material we are covering that week or the previous week and are intended as a low-stakes knowledge-check to make sure you are keeping up-to-date with the course.

Homework

There will be 4-5 homework assignments, to be completed individually, assigned throughout the semester. These will be announced in class and posted online at least a week in advance of the due date. Unless otherwise specified, assignments may be completed in alternative software with instructor approval, though R and Tableau are the expected tools for most coursework.

Visualization Workshops

There will be two visualization and storytelling workshops over the course of the semester to give you hands-on experience generating and communicating data-driven insights in real time. In each workshop, you will be given a data set and will work in teams to create a visualization that targets a specific business problem or research question. Workshops will culminate in a short presentation from each group discussing their visualization and offering an interpretation of their findings.

Workshops will be held during regular class times. If you must miss a workshop for any reason, please notify me in advance. Make-ups will not in general be permitted.

Final Project

The final project will provide an opportunity for students to demonstrate their data visualization skills on a comprehensive real-world task. Students will work in groups of 2–3 to identify a large open-source data set and create an interactive dashboard that explores and communicates key aspects of the data through visualizations. Students will apply techniques learned throughout the course, including appropriate graph types, design considerations, interactivity features, and presentation best practices. Each group will submit a final project report showcasing their work and will deliver an in-class presentation at the end of the semester to highlight their data exploration process, visualization choices, key insights, and design decisions.

Course policies and guidelines

All courses offered at Bentley University reflect our institution's commitment to a set of core values and practices. The links below will take you to full explanations of our policies and procedures related to accommodations and equitable learning environments. As a student, you are expected to review and be familiar with each of these policies:

- Bentley's honor code and academic integrity system
- Equity and bias reporting forms and procedures
- Student disability accommodations
- Religious observances
- Bentley's core values

Late work policy

The due dates for assignments are there to help you keep up with the course material and to ensure that I can provide feedback in a timely manner. However, I understand that things come up periodically that may make it difficult to submit an assignment by the deadline.

- Late quizzes will not be accepted and there are no make ups for missed quizzes.
- Homework assignments may be submitted up to 3 days late. There will be a 10% deduction for each 24-hour period the assignment is late.
- The late work policy for the final project will be provided with the project instructions.

Collaboration policy

Unless otherwise stated, students are expected to complete each homework assignment independently. The student's submissions must represent his or her individual work, and citations must be provided where content from other sources is referenced. Students may be assigned to groups for the purpose of completing

specific assignments. It is important that you participate as necessary in the groups to complete assignments. Low participation in your group may affect your final grade for any group assignments.

AI Policy

Generative AI tools (ChatGPT, Claude, Copilot, etc.) have fundamentally changed how people work with data and create visualizations. Rather than pretending these tools don't exist, in this course we will embrace them as part of the modern data visualization workflow while focusing on the *human skills* that AI cannot replace.

The Core Philosophy

AI tools can now generate technically correct visualizations for a given data set. This raises an important question: *What's left for humans to learn?*

The answer is **judgment**. AI can execute, but humans must:

- **Decide *what questions* to ask**. Knowing what's worth visualizing requires domain knowledge, curiosity, and understanding of stakeholder needs.
- **Evaluate whether a visualization is *appropriate*** for the data, the audience, and the context.
- **Detect when something is *misleading***. Even technically correct graphics can deceive.
- ***Defend and explain* design choices** to colleagues, clients, and decision-makers.
- **Exercise *ethical responsibility***, determining what to show, what to omit, and how to frame findings honestly.

How You May Use AI in This Course

Appropriate Uses	Prohibited Uses
• Getting help with R syntax and debugging code • Exploring alternative visualization approaches • Learning how to use unfamiliar R packages • Creating draft visualizations to compare against your own • Brainstorming ideas for workshops and projects	• Having AI write your interpretations, critiques, or reflections • Submitting AI-generated explanations as your own analysis Learning how to use unfamiliar R packages • Using AI to complete assignments without engaging with the material • Copying AI responses without understanding or verification

The distinction is simple: **AI can help you learn and execute; it cannot think for you.** The value of this course lies in developing the ability to look at a graphic and know whether it's effective, honest, and appropriate.

Disclosure Requirements

When you use AI tools to assist with any assignment, you must include an **AI Acknowledgment** statement that describes:

1. Which AI tool(s) you used (e.g., ChatGPT-4, Claude, GitHub Copilot)
2. How you used them (e.g., "to debug my ggplot code," "to explore different chart types," "to understand the geom_errorbar syntax")

3. What you learned or changed as a result

AI and Academic Integrity

Using AI to generate content that you present as your own original thinking—particularly written interpretations, critiques, and reflections—is a violation of academic integrity. The goal of assignments is for *you* to develop skills and demonstrate understanding; outsourcing that work to AI defeats the purpose and constitutes academic dishonesty.

If you are ever uncertain whether a particular use of AI is appropriate, ask before submitting!

Dissemination of course materials

All course materials are for teaching purposes for this course during this term only. You may not reproduce these materials to distribute outside of class. Lectures and course materials, including PowerPoint presentations, outlines, tests, and similar materials are protected by copyright even if there is no copyright notice on the material. You may take notes and make copies of course materials for your own use. You may not reproduce or distribute these materials publicly, without the instructor's express written consent. Any suspected violations of this policy are regarded as acts of academic dishonesty and will be reported through Bentley's Academic Integrity System.

Diversity and Inclusion

As an instructor, I recognize that every student has their own perspectives and life experiences that they bring with them into the classroom and I will do my best to create a space for learning that is safe and accessible for all. It is my intent to present materials and activities that are respectful of diversity: gender identity, sexuality, disability, age, socioeconomic status, ethnicity, race, nationality, religion, and culture. Throughout the semester, I welcome (and encourage!) your feedback on how to foster a positive and inclusive environment in this class. Any and all suggestions will be appreciated and given serious consideration. In addition, I invite all students to inform me of any personal and/or professional courtesies that I may be unaware of. If you have a name and/or pronouns that differ from those that appear in my course roster, please let me know so that I may address you appropriately. If something said in class (implicitly or explicitly) by myself or another student that has made you feel uncomfortable, please talk to me about it.

Mathematics Learning Center

The Mathematics Learning Center (MLC) provides drop-in tutoring to undergraduate and graduate students enrolled in mathematics or statistics courses at Bentley. The goal is to have students leave a tutoring session with an increased understanding and confidence in their own ability to do mathematics. During the academic year, the center is open most days and evenings. Students can get help with all 100-level undergrad math courses. In addition, **there are selected hours in which students may get help with math electives including this one**. Computer assistance as it relates to a mathematics course is also provided. Please check the MLC website for the hours of operation and tutor/course schedule.

Adjustments to the course

The scope, timing, and due date/time of any assignments, projects, homework, exams, or any other required work may be adjusted by the instructor as needed to maximize learning opportunities for students and/or better serve the goals of the course. The syllabus may likewise be modified at the discretion of the instructor.

Any adjustments will be communicated to students in class and on Brightspace with as much advance notice as possible.

Course Schedule & Topics

Disclaimer: Schedule is subject to change, contingent on mitigating circumstances and the progress we make as a class. Students are encouraged to attend lectures and check the course website for updates.

Wk	Dates	Topic	Readings
1	1/22	Course overview and intro to statistical graphics	• Dattani (2025) Why Data Visualization Matters • Wilke Ch. 1 Introduction • Healy Ch. 1: Look at Data • Wickham (2010). A Layered Grammar of Graphics
2	1/26 1/29	Design principles and graphical integrity	• Wilke Ch. 2 Aesthetic Mapping • Wainer (1984) How to Display Data Badly • Cairo (2015). Graphics Lies, Misleading Visuals • Cleveland & McGill (1984). Graphical Perception
3	2/2 2/5	Exploratory data analysis and software foundations	• Healy Ch. 3: Make a Plot • R4DS Ch. 2: Data Visualization • R4DS Ch. 10: Exploratory Data Analysis • Barton (2021). Recreating One Chart Using 24 Tools
4	2/9 2/12	Distributions and uncertainty	• Wilke Ch. 7: Visualizing Distributions • Wilke Ch. 8: Visualizing Distributions II • Wilke Ch. 16: Visualizing Uncertainty • Cumming and Finch (2005). Inference by Eye
5	2/16 2/19	Categorical data and proportions	• Wilke Ch. 6: Visualizing Amounts • Wilke Ch. 10: Visualizing Proportions • Healy Ch. 4: Show the Right Numbers
6	2/23 2/26	Survey data and Likert scales	• Wilke Ch. 10–11: Visualizing Proportions • Robbins & Heiberger (2011). Plotting Likert and Other Rating Scales • Wexler (2022). Visualizing Survey Data
7	3/2 3/5	Group comparisons and ANOVA **Visualization Workshop I**	• Ho et al. (2019). Moving Beyond P Values • Weissgerber et al. (2019). Reveal, Don't Conceal
8	3/16 3/19	Regression I: Relationships and linear models	• Wilke Ch. 12: Visualizing Associations • Healy Ch. 6: Work with Models • Kastellec & Leoni (2007). Graphs Instead of Tables
9	3/23 3/26	Regression II: Diagnostics and model comparison	• Anscombe (1973). Graphs in Statistical Analysis
10	3/30 4/2	Time series and trends	• Wilke Ch. 13: Visualizing Time Series • Wilke Ch. 14: Visualizing Trends • Few (2008). Time on the Horizon • Datawrapper: A Complete Guide to Line Charts • Datawrapper: The Case Against Dual Axis Charts
11	4/6 4/9	Multivariate data	• Wilke Ch. 12.3: Associations with 3+ Variables • Emerson et al. (2013). The Generalized Pairs Plot • factoextra Package

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Wk	Dates	Topic	Readings
12	4/13 4/16	Spatial data and mapping	• Wilke Ch. 15: Visualizing Geospatial Data • Geocomputation with R, Ch. 8: Making Maps • Datawrapper: What to Consider When Creating Choropleth Maps • Monmonier (1996). *How to Lie with Maps*
13	4/20 4/23	No class (Patriot's Day) **Visualization Workshop II**	
14	4/27 4/29	Statistical storytelling and advanced topics	• Segel & Heer (2010). Narrative Visualization: Telling Stories with Data • Gelman & Unwin (2013). Infovis and Statistical Graphics • Knaflic (2015). *Storytelling with Data*, Ch. 7 (Brightspace)
–	5/6	**Final Project Presentations**	