

MA252: Regression Analysis

Bentley University | Dr. Reagan Mozer | Fall 2021

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Office: Morison Hall 337

Office Hours: TBD

Class Meetings: M/Th 11-12:20pm

12:30-1:50pm

Smith Hall 101

Course Overview

An in-depth introduction to statistical methods with linear models and related methods. Topics include hypothesis tests, linear regression models and their extensions, model checking and refinement, model selection, cross-validation. Emphasis is made on thinking statistically, evaluating assumptions, and developing tools for real-life applications.

Learning Objectives

By the end of the course, students should be able to:

1. Formulate statistical models and understand the strengths and limitations of different approaches for drawing inferences from data.
2. Use data to pose research questions of substantive interest and develop an appropriate plan for statistical analysis.
3. Perform exploratory data analysis tasks, conduct hypothesis tests, and build predictive models using statistical software.
4. Interpret analytically results in a business context and communicate findings to a general audience.
5. Critique data-based claims and evaluate data-driven decisions.
6. Complete a research project demonstrating mastery of statistical data analysis from exploratory analysis to inference to modeling.

Communication intensive (CI) designation

Your ability to communicate results, which may be technical in nature, to your audience, which is likely to be non-technical, is critical to your success as a data analyst. Many of the assignments and activities in this course will place an emphasis on the clarity of your writing.

Course Materials

Textbooks

- *Introduction to Modern Statistics*, by Mine Cetinkaya-Rundel and Johanna Hardin. PDF is freely available at <https://www.openintro.org/book/ims/> or can be purchased as a paperback on Amazon for around \$20.
- *OpenIntro Statistics*, 4th Ed, by David Diez, Mine Cetinkaya-Rundel, and Christopher Barr. PDF is freely available at <https://www.openintro.org/stat/>.
- **(Optional):** *A Second Course in Statistics: Regression Analysis (7th Ed.)*, by Mendenhall and Sincich (available at the bookstore).

Throughout the semester I will indicate what sections of the texts correspond to the topics discussed in class. When appropriate, I may also post other open-source (i.e., free) supplemental materials relevant to course topics. Readings are optional in the sense that they will not be graded, but they will help you succeed in this course.

Course Website

Announcements, assignments, other course materials will be posted on Blackboard. 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 Blackboard. Lecture slides will typically be posted to Blackboard in advance of each lecture. Note that the lecture slides are intended *accompany* the lecture. They are not designed to be a complete exposition of the material and will not serve as a self-contained reference.

Statistical Computing

Statistical computing is a key part of the class. In class analysis will be conducted in R and all course material (code and data) is in R format. R is free (as in speech) and available for download at <http://www.r-project.org>, and you can find manuals and installation guidelines on this site. Alternatively, R can be accessed virtually through a cloud-computing platform called [Rstudio.cloud](https://rstudio.cloud).

Assignments, exams, and grading

Final grades and grading throughout the semester 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.*

Final grades will be calculated as follows:

Participation & engagement	5%
Weekly quizzes	10%
Data analysis workshops	10%
Homework assignments	20%
Midterm exam	25%
Final project (written report + presentation)	30%
Total	100%

Weekly quizzes

There will be a short multiple choice quiz (administered on Blackboard) nearly every week based on the material we are covering that week or the previous week. Quizzes will typically be posted on Mondays and are to be completed outside of class before the end of the week.

Homework

There will be regular homework assignments over the course of the semester. These reinforce and extend the material introduced in the lectures and labs. Many homework problems are intentionally open-ended, designed to explore and struggle with issues that often manifest in everyday practice. This is where you

learn and practice data analysis skills closer to the real world. Policies for completing and submitting homework assignments are as follows:

- Assignments must be submitted to Gradescope and should have a clear and professional presentation. See the homework formatting guidelines posted on Blackboard for additional information.
- Homework must be submitted on time (i.e., before the posted due-date). **Late homework submissions will not be accepted.**
- **Collaboration policy:** You are encouraged to discuss homework with other students (and with the teaching staff), but you must write your final answers **yourself, in your own words**. Solutions prepared by copying or paraphrasing someone else's work are not acceptable. All computer output you submit must come from work that you have done yourself. Please indicate on your problem sets the names of the students with whom you worked.

Labs

There will be regular labs (approximately weekly) designed to give you hands on experience with data analysis using modern statistical software. The labs will also provide you with tools that you will need to complete the project successfully. For each lab, we will spend some class time discussing a brief overview of the lab and learning goals and working through some of the exercises. From time to time, exercises from the lab that are not completed during class time may be assigned as homework problems or quiz questions.

Data Analysis Workshops

There will be two **communication-intensive** data analysis workshops over the course of the semester to give you hands-on experience acting as a statistical consultant. In each workshop, you will be given a data set and will work in teams to solve a specific business problem or address a research question using the methods covered in class. Workshops will culminate in a short presentation or write-up from each group summarizing their analysis and offering an interpretation of their findings.

Workshops will be conducted during regular class times on **Thursday 10/21** and **Monday 11/22**. If you must miss a workshop for any reason, please notify me in advance. Make-ups will not in general be permitted.

Midterm Exam

There will be one midterm exam tentatively scheduled for **Thursday, October 28**. The exam will focus on your conceptual understanding of course topics. Make-ups will not in general be permitted.

Final Project

The final project consists of three deliverables:

1. A short (1-2 page) project proposal that describes your data, highlights the main research questions you plan to address through your project, and outlines your analysis plan.
2. A brief (<10 minutes) video presentation showcasing your work.
3. A final report (6-8 pages) that summarizes your project, highlights important findings, and describes the impact and implications of your work in a business context.

Projects will be completed in groups of two or three and will focus on a topic of your team's choosing. You may investigate any empirical question you choose: you will find the data, decide on the analyses to

perform, and draw all the conclusions. The project is meant to be an open-ended exercise. Additional details about the project requirements and guidelines will be distributed mid-semester.

Important notices and guidelines

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 described below.

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 MA252**. Computer assistance as it relates to a mathematics course is also provided. Please check <https://www.bentley.edu/offices/academic-services/mathematics-learning-center> for the hours of operation and tutor/course schedule.

General course policies

This class will be conducted in full accordance with the Bentley Core Values. Please reread these values, which can be found at <http://www.bentley.edu/about/mission-and-values>.

Academic Integrity

The Bentley University Honor Code formally recognizes the responsibility of students to act in an ethical manner. It enjoins all students to maintain academic honesty in their own work (recognizing that most will do so because of their own high standards), to promote ethical behavior throughout the Bentley community, and to take responsible action when there is a reason to suspect dishonesty. It reads:

The students of Bentley University, in a spirit of mutual trust and fellowship, aware of the values of a true education and the challenge posed by the world, do hereby pledge to accept the responsibility for honorable conduct in all academic activities, to assist one another in maintaining and promoting personal integrity, to abide by the principles set forth in the honor code, and to follow the procedures and observe the policies set forth in the academic integrity system.

In fulfillment of the Honor Code, all students are expected to adhere to Bentley's Academic Integrity policy which can be found on Blackboard (via the Academic Integrity course page) and the Undergraduate Student Handbook/Graduate Catalog. For the complete details about Bentley's policies regarding academic integrity and the Bentley Honor Code you may visit Bentley's [academic integrity web page](#).

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. In particular:

- If you have a name and/or set of pronouns that differ from those that appear in my course roster, please let me know.
- If you feel your performance is being impacted by your experiences outside of class, please don't hesitate to talk with me. If you prefer to speak with someone outside of the course, your academic dean is an excellent resource.
- I (like many people) am still in the process of learning about the diverse perspectives and identities of my students. If something was said in class (by anyone) that made you feel uncomfortable, please talk to me about it.

Bias Incident Response

The Bias Incident Response Team (BIRT) provides students affected by bias or bias-related incidents with access to appropriate resources. Where appropriate, BIRT assists the University in its response to situations that may impact the overall campus climate related to diversity and inclusion. Working closely with appropriate students, faculty, committees, organizations, and staff, BIRT plays an educational role in fostering an inclusive campus community and supporting targeted individuals when bias or bias-related incidents occur. More information about BIRT and how to file a bias incident report can be found at: <https://www.bentley.edu/offices/student-affairs/birt>.

Disability Services

Bentley University abides by Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990 which stipulate no student shall be denied the benefits of an education solely by reason of a disability. If you have a hidden or visible disability which may require classroom accommodations, please call Disability Services within the first 4 weeks of the semester to schedule an appointment. **Disability Services** is located in **Academic Services (JEN 336, 781.891.2004)**. Disability Services is responsible for managing accommodations and services for all students with disabilities. Students registered with DS should also (privately) identify themselves to the professor as soon as possible to go over their accommodation plan.

Schedule & Topics Covered

Important: class readings are 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.

Week	Topics	Reading & References
1	Introduction to the course, regression, and R	OI 1.2 & 2.1
2	Statistics concepts, exploratory data analysis	OI 5.1–5.3, 7.1–7.5 M&S Ch.1
3	Simple linear regression & method of least squares	OI Ch.5, M&S Ch.2
4	Statistical inference in regression	OI Ch.7–8, M&S Ch.3
5	Evaluating assumptions and model fit	
6	Multiple linear regression	OI Ch.9, M&S Ch.4
7	Multiple linear regression (cont'd)	
8	Review, Midterm exam	
9	Model evaluation, diagnostics and transformations	M&S Ch.5
10	More complex linear models	M&S Ch. 8
11	Variable selection and model comparison	
12	Model building in practice	
13	Residual analysis & regression pitfalls	M&S Ch.6
14	Advanced topics (time permitting)	M&S Ch.7–8

IMS = Introduction to Modern Statistics, OI = OpenIntro Statistics, M&S = Mendenhall & Sincich