Carnegie Mellon University
HeinzCollege

Statistical Reasoning: 90-707
Fall 2024

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Office Hours:	Mondays 9:00–10:00 am (HBH 2110)
	Tuesdays 2:00–3:00 pm (HBH 2110)
	Fridays 1:00–2:00 pm (HBH 2110)
	By appointment via email
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Class Time & Location:	Section A: Monday/Wednesdays 3:30–4:50 pm (HBH 1007)
	Section B: Monday/Wednesdays 5:00–6:20 pm (HBH 1002)
	Section C: Tuesday/Thursdays 3:30–4:50 pm (HBH 2003)
Recitation Time & Location:	Fridays 3:30–4:50 pm (WEH 7500)

Course Description

This course will provide an introduction to quantitative research using statistical methods and reasoning. We will study the principles of data collection, description, and analysis. You will learn tools for statistical inference and modeling, as well as how to interpret results, their uncertainty, and their limitations. By the end of the course, you will be able to interpret statistical output to support public policy and management decisions.

The class will be a combination of lectures and in-class activities to support your learning process. The course is divided into three main units, each with problem sets, a case study, and an exam associated with it. To further practice the class content, the course has weekly recitation sessions where you will have the opportunity to solve additional problem sets and ask questions.

Course Resources

The slide decks for the class are going to be provided by 7 a.m. the day of the class. Slide decks will be updated with the solutions to the exercises on Tuesday and Thursday at 7 p.m. In Canvas, you will also have access to the formula sheet and additional materials that will be used through out the course and in the exams.

The textbook recommended for this course is **Weiss, Neil A. *Introductory Statistics*, 10th Edition, Pearson.** This textbook will serve primarily as a reference, so an older edition may be used. The textbook is available to purchase or rent in both physical and eBook through Pearson (https://www.pearson.com/en-us/subject-catalog/p/introductory-statistics-mylab-revision/P200000006415/9780136872832)

We will use Microsoft Excel for calculations and descriptive data analysis. Microsoft Excel is a program that specializes in computational analysis, allowing you to analyze data using the material in the lessons covered in the lectures. Downloading Microsoft Office will give you access to Excel and other programs. You may download Microsoft Office on your personal computers through CMU's Software Catalog, which you can find at https://www.cmu.edu/computing/software/titles/microsoft-office/index.html. You can also use any physical computer lab located across campus. More information about computing services can be found in https://www.cmu.edu/computing/services/teach-learn/tes/computer-labs/index.html.

Course Objectives

At the end of this course, you should be able to:

- Create and interpret graphs of sample data

- Summarize a set of observations by reporting central tendency measures

- Explain what sampling error is and why it exists

- Identify the proper summary statistics and tests for each data type

- Interpret the p-value and use it to conclude about the test statistic

- Explain what it means if test results or poll differences are statistically significant

- Interpret the output from a test of hypothesis and confidence interval

- Identify the dependent and independent variables and the output of regression analysis

Course Organization

The course is divided into three units.

Unit 1 focuses on the descriptive analysis of data. We will explore tools for describing and summarizing data, such as graphs, tables, and summary statistics. At the end of the unit, we will study probability theory, which will allow us to make scientific estimates and draw conclusions from sample data.

Unit 2 focuses on how to make inferences about larger populations that we cannot fully observe. We will make estimates about the population with some degree of confidence and allowance for error. We will also test hypotheses about the characteristics of the larger population and come to scientific conclusions. We will discuss real-life applications of population studies.

Unit 3 will focus on regression analysis. In this unit, we will learn to identify and model the relationships between variables. We will create linear models and use inferential statistics to make estimates and conclusions about the population studied.

Class expectations

Attendance:

Lectures: Everyone is expected to attend – and participate in – lectures. Students may miss **four** lecture with no penalty. Every additional missed class will have a penalty of 10 points in the final grade of the class. If you anticipate more absences, please let me know as early as possible. During the lectures, we will

work on simple example problems that will help you understand the material. I will teach the material using lecture slides and whiteboard explanations. If you miss a class, you are responsible for checking the lecture slides on Canvas and obtaining any additional class material from another student or me. You can request the material from me through email or in person at office hours. Beware that the material of this course is cumulative. Thus, catching up on time will allow you to follow up in the classes following the one you missed.

RECITATION SESSIONS (FRIDAYS): Recitation sessions are weekly spaces led by the teaching assistants where you will practice the material taught in class and clarify concepts. These sessions will help you gain hands-on experience and interact with other students. On the week before each exam (Week 5, Week 11, and Week 15) we are going to work on a case study to get some practice before the exam. **Attendance is mandatory for these case study sessions** (Week 5, Week 11, and Week 15). For the other recitation sessions, attendance is not mandatory but highly encouraged. While TAs will not solve the homework or problem sets for you, they can help you understand the concept. If you decide to not attend, you still have to submit on time the recitation problem set assigned for the week.

Classroom behavior: Please arrive on time. If you arrive after the class has started, please enter quietly to avoid distracting other students and interrupting the lecture. If you arrive more than 20 minutes late to the class, it will count as a missed lecture. Laptops, and ipads are permitted in class for taking notes or for class activities. Please refrain from using cellphones or electronics for other purposes during class. This might distract other students and keep you from fully understanding the material.

Participation: The class is going to be a combination of lectures and in-class activities. Participation is highly encouraged to keep the class interactive. All questions are good questions. You are all here to learn and your question might help other students. We are all responsible for creating a safe and collaborative learning environment. For doing so, I expect you to respect each other learning process.

Communication: If you need to communicate with me, please come to my office hours or send me an email. If you have time conflicts with my office hours, email me and we can arrange another time. I am committed to replying to your emails within 24 hours on weekdays. For emails sent after 6:00 pm on Fridays, please allow until Monday morning. If you have clarification questions of the material or the assignments, please use Piazza on Canvas. Other students might have the same question as you.

ASSESSMENT

Homework (80 points): To gain hands-on learning experience, you will have weekly homework. The homework consists of solving short problems based on key material of the course that will prepare you for problem sets and exams. Homework will cover the topics of the week they are posted.

Homework will be published on Thursdays at 5 p.m., and you should submit them by Mondays at 3:30 pm. At the end of the semester, the eight homework assignments with the highest scores will be considered for the final grade. Solutions will be posted the day after the deadline for the homework. To keep the class on track, no late homework will be accepted. If you have an emergency, please contact me through email and we can make arrangements for your submission.

Problem sets (150 points): There are five problem sets throughout the semester, two for units one and two, and one for unit three. Problem sets will cover the same topics as homework but at a more challenging level to help you prepare and study for the exam. Problem sets can be handwritten or typed and should be uploaded to Gradescope by the deadline.

Problem sets will be accepted up to 24 hours after the deadline. However, late assignments will only be eligible for 80% of the total grade. For example, if you get 40 points, your final grade for the assignment will be 32. No credit will be given for an assignment submitted more than 24 hours late unless you have made special arrangements with me in advance. I understand occasional emergencies can happen, so please notify me as soon as possible. You can contact me through email or in person in my office.

Exams (300 points): There will be three individual exams, one for each unit. Exams 1 and 2 will be given in class on week 6 and week 12, respectively, and will have a duration of 80 minutes. Please check the *Course Plan* section at the end of this syllabus for the specific date for your section. The final exam will be given in finals week (12/11 to 12/15), during the time period scheduled by the university. Exams must be taken at the scheduled time and they will have a duration of 80 minutes. If there is an extraordinary circumstance that prevents you from presenting the exam at the scheduled time, please notify me as soon as possible to coordinate a make-up exam. The make-up exam will happen no more than one week after the originally scheduled date and might have different questions to preserve a fair environment. Exams will consist of problem sets and short answer questions that will test your understanding of the course material.

The material of the course is, by nature, comprehensive. For this reason, the exams are also comprehensive. However, there will be a higher focus on the material covered since the prior exam. You can bring a non-programmable calculator and the formula sheet available on Canvas with handwritten notes to use during the exams. More details will be given near the exam dates.

Recitation session practice problems (50 points): Every week you will have practice problems to gain hands-on experience solving problems. You will have to submit by Saturday at midnight the assigned problems. Recitation session problem sets are a resource for you to practice, thus, the problem sets are going to be graded on completeness rather than correctness. Solutions will be posted on Saturday mornings.

Recitation session Case Studies (60 points): On week 5 (09/27), week 11 (11/08), and week 15 (12/06), you will work in a case study that will help you see the concepts apply to a real-world problem. You must attend the recitation session and submit the case study by the end of class.

Reflection statement (15 points): At the end of the semester you will submit a one-page reflection statement on the use of statistics in your future career. More details about the assignment will be available on Canvas.

Regrade policy: We are committed to returning work to you as quickly as possible. Our goal is to grade assignments and return them within 1 week of the due date. All appeals for grading must be made within 2 weeks of the due date of the assignments. The appeal must be written and include the number of the question with the specific reason why you believe the grade is incorrect. You must submit the written appeal to me during office hours or after class. Please check the solution before appealing.

PERFORMANCE EVALUATION

The final grade for the course will consist of grades from the items mentioned above. Your final grade will be determined by your point placement on the following scale:

622 or more	A	550-569	B	478-497	C
590-621	A-	524-549	B-	458-477	C-
570-589	B+	498-523	C+	0-457	R

Be aware that I do not round up. That means that to pass the course you need 458 or more points. This applies to all the items on the placement scale. For example, if you get a 621.8 in the class, your grade will be an A-. You need 622 or more to get an A.

ACADEMIC INTEGRITY

Working with other students for assignments and problem sets is allowed. I encouraged you to get together and work on the problems. However, you must write your own solution and mention the students you collaborated with and the external resources you used, such as "I collaborated with (student name) on this homework". To guarantee that you understand the material, I recommend you sit down alone after the study session with your peers and write your solution. Do not copy homework from another student or from and AI generator. Sharing your solutions with other students is not allowed. In accordance

with CMU policy, *it is the responsibility of each student to produce her/his own original academic work.* (https://www.cmu.edu/policies/student-and-student-life/academic-integrity.html) If there is evidence that you copy from another student or/and shared your solution all the students involved will receive zero credit for the assignment and face academic sanctions according to the University policies. You are encouraged and expected to familiarize yourself with the University policy. If you have any questions please contact me or the TAs.

In this class we are focused on learning fundamental statistics. I expect that all the work students submit is their own. I have designed all assignments to support your learning. Working on the assignment, without any AI generator, is best for your learning process. Please refrain from using AI tools (such as ChatGPT) to generate ANY content for an assignment. Passing off any AI generated content as your own constitutes a violation of CMU's academic integrity policy. If there is evidence that you used an AI generator, all the students involved will receive zero credit for the assignment and face academic sanctions according to University policies.

OTHER INFORMATION

Accommodation

If you have a disability and have an accommodations letter from the Disability Resources office, I encourage you to discuss your accommodations and needs with me as early in the semester as possible. I will work with you to ensure that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, I encourage you to contact them at access@andrew.cmu.edu.

Well being

Graduate school can be challenging at times. Make sure to take time for yourself and do activities you enjoy. The University Provost provides the following thoughts that I believe are important to share.

Take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress.

All of us benefit from support during times of struggle. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is almost always helpful.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website athttp://www.cmu.edu/counseling/. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help.

Inclusion and Diversity

We must treat every individual with respect. We at Heinz College are diverse in many ways, and this diversity is fundamental to building and maintaining an equitable and inclusive campus community. Inclusion is ensuring everyone feels respected in the environments they interact with other. Diversity, can be broadly defined as the presence of people who identify with multiple attributes, these include but are not limited to race, color, national origin, language, sex, disability, age, sexual orientation, gender identity, religion, creed, ancestry, belief, veteran status, or genetic information. Each of these diverse identities, along with many others not mentioned here, shape the perspectives our students, faculty, and staff bring to our campus. I will work to promote and create an inclusive and equitable learning environment. I understand that diverse backgrounds require different learning tools and I am committed to provide each of you with the tools you need to grow and learn in my class.

We, at CMU, will work to promote diversity, equity and inclusion not only because diversity fuels excellence and innovation, but because we want to pursue justice. We acknowledge our imperfections while we also fully commit to the work, inside and outside of our classrooms, of building and sustaining a campus community that increasingly embraces these core values. Each of us is responsible for creating a safer, more inclusive environment. The university encourages anyone who experiences or observes unfair or hostile treatment on the basis of identity to speak out for justice and support, within the moment of the incident or after the incident has passed. Anyone can share these experiences using the following resources:

- Center for Student Diversity and Inclusion: csdi@andrew.cmu.edu, (412) 268-2150

- Ethics Reporting Hotline. Students, faculty, and staff can anonymously file a report by calling 844-587-0793 or visiting cmu.ethicspoint.com.

All reports will be documented and deliberated to determine if there should be any following actions. Regardless of incident type, the university will use all shared experiences to transform our campus climate to be more equitable and just.

Other university resources

Student academic success center: The center supports student success through a number of group and individual programs. You can find more information about their programs at https://www.cmu.edu/student-success/index.html. If you are unsure of what programs will best suit your needs, you can sign up for a consultation with a staff member to identify the support you need.

CMU food pantry: Free resource committed to reducing hunger among students. For more information, visit https://www.cmu.edu/student-affairs/resources/cmu-pantry/ or contact cmu-pantry@andrew.cmu.edu

Emergency support funding: The university has several resources to provide emergency funds for students in times of need. More information about these resources and the application process is available at https://www.cmu.edu/student-affairs/dean/loans/

Course Plan

There may be adjustments to the schedule throughout the semester.

Week	Dates	Topics	Additional resources
1	08/26 - 08/27	The scientific process	Ch.1.1, 1.2
	08/28 - 08/29	Organizing and displaying data	Ch. 2.1-2.4
	08/30	Recitation session: Excel	
2	09/02 - 09/03	Labor day - No class on Monday / office hours on Tuesday	
	09/04 - 09/05	Numeric summaries: measures of central tendency and variability	Ch. 3.1-3.5
	09/06	Recitation session: Numeric summaries	
3	09/09 - 09/10	Probability review	Ch. 4.1- 4.8
	09/11 - 09/12	Probability review: Bayes theorem	
	09/13	Recitation session: Probability	
4	09/16 - 09/17	Discrete probability distribution	Ch. 5.1-5.3
	09/18 - 09/19	Continuous probability distribution	
	09/20	Recitation session: Probability distributions	
5	09/23 - 09/24	Normal distribution	Ch. 6.1-6.3 and 6.5
	09/25 - 09/26	Normal distribution	
	09/27	Recitation session: Case study	
6	09/30 - 10/01	Exam 1	
	10/02 - 10/03	Central limit theorem	Ch. 7.1-7.3, 12.1
	10/04	Recitation session: Central limit theorem	
7	10/07 - 10/08	Sampling and Confidence intervals	Ch.8.1, 8.2, 8.3
	10/09 - 10/10	Confidence intervals	Ch. 12.1
	10/11	No recitation session: end of mini 1	
8	10/14 - 10/18	Fall Break - No class	
9	10/21 - 10/22	Recitation session: Monday and Tuesday - Confidence intervals	
	10/23 - 10/24	Hypothesis test	Ch. 9
	10/25	Class on Friday: Critical value and p-value	Ch. 9 -10
10	10/28 - 10/29	Type of errors	Ch. 9 -10
	10/30 - 10/31	2 sample confidence intervals and hypothesis test	
	11/01	Recitation session: critical value and p-value	
11	11/04 - 11/05	2 sample Hypothesis test	Ch. 9
	11/06 - 11/07	Review	
	11/08	Recitation session: Case study	
12	11/11 - 11/12	Exam 2	
	11/13 - 11/14	ANOVA	
	11/15	Recitation session: ANOVA	
13	11/18 - 11/19	Simple regression analysis	Ch. 14
	11/20 - 11/21	Regression and inferences	Ch. 15
	11/22	Recitation session: Regression analysis	
14	11/25 - 11/26	Regression and inferences	Ch. 15
	11/27 - 11/29	Thanksgiving break	
15	12/02 - 12/03	Multiple regression	Slides
	12/04 - 12/05	Review - Game	
	12/06	Recitation session: Case study	