

Linear Models
STAT 231, Fall 2019

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Office Hours:	Monday, Wednesday, and Thursday 1:00PM-3:00PM, Tuesday 2:00PM – 4:00PM, and by appointment
Class Hours:	Tuesday, Thursday 9:30AM-10:45AM
Room:	223 Stein Hall
Textbook:	<i>Applied Linear Regression Models</i> by Kutner, Nachtsheim, and Neter <i>A Second Course in Statistics: Regression Analysis</i> by Mendenhall and Sincich **A course reader will be distributed on the first day of class**
Course Website:	Moodle
Prerequisites:	MATH 136 and one of: STAT 220, BIOL 275, ECON 249, PSYC 200, or SOCL 226

Welcome to Linear Models! This is a one semester course that covers the theoretical and practical foundations of linear regression, a powerful technique used in statistical modeling and data science. Since modern statistical analysis is done in a computing environment, this course will have a strong computational focus. We will be using the R statistical package, which is widely used in both industry and research. As an added bonus, R is *free*, open-source software, so obtaining this valuable skill will come at no extra cost to you. No previous statistical computing experience is expected or required.

At the end of the course you will be able to:

- 1) Understand the mathematical foundations of linear regression
- 2) Discern whether linear regression is an appropriate modeling technique for a given research question and data structure
- 3) Perform data management and statistical analyses using modern statistical software
- 4) Conduct a thorough exploratory data analysis involving a continuous response variable
- 5) Interpret results accurately and be able to both understand and communicate what they imply

The course calendar that follows will briefly describe each of the topics that we will cover. The class will, for the most part, follow the reader created for the course. Although not enforced, class attendance and reading of the designated sections of the text prior to class are highly recommended [see Student Attendance at Class and Excused Absence Policy: <https://hccatalog.holycross.edu/requirements-policies/academic-policies/#coursepoliciestext>]. The grade you earn will be a reflection of how well you have mastered the material in this course and will be based upon the following four criteria:

1) Homework (20%): Weekly homework assignments will be given. I truly believe that the only way to learn statistics (and mathematics, in general) is to *do* statistics. A majority of the problems will be drawn from the book, although I may incorporate some of my own questions. You are permitted (and encouraged!) to work with your classmates on these assignments. However, each student is expected to turn in their own set of solutions. To receive full credit, solutions to homework assignments should be clearly written on the provided worksheet and have all relevant work organized in the proper sequence. Homework assignments will be due on Thursdays by 4PM. *Note:* This may shift to Tuesday in the middle of the semester. Late homework assignments will not receive full credit and homework more than one day late will receive no credit.

2) Weekly Projects (20%): Each week, you will be given computational 'project' due by the end of the day on Monday. *Note:* This may shift to Friday in the middle of the semester. The project questions will be drawn only from the material covered in the homework assignment submitted the previous week and will resemble those seen on homework assignments, except the questions will be slightly more involved and require the use of R. Think of these like a take-home quiz.

3) Two Midterm Exams (40%): There will be two exams during the semester. The exams will be held at night, with the exact date set based on class availability (i.e. when the greatest number of students are available). The exams will not be exercises in memorization, but will try to be written so that students with a solid understanding of the concepts should have little, if any, trouble. The first exam is tentatively set for **Wednesday October 23rd**, the second for **Wednesday November 20th**. There are no make-ups allowed on exams.

4) Final Exam (20%): The date and time of the comprehensive final examination are set by the Registrar's office. Once this information becomes available, I will let you know. There are no make-ups or other alterations to the timing of the final exam allowed.

Should you ever need help with this course, there are two great options available to you:

- 1) Ask a classmate for help
- 2) Stop by my office during office hours or make an appointment to see me

Additional Course Policies:

Academic Integrity: A student found cheating on an examination or assisting others in the course of an examination will receive an F for the course and will be subject to further sanctions. Copying another student's assignment is considered cheating and will result in receiving a 0 for that assignment. As previously stated, you are encouraged to work together on homework assignments. However, each student is expected to write out their own solutions. For more information, please see the College's Academic Honesty Policy, which can be found at <https://catalog.holycross.edu/requirements-policies/academic-policies/#academicintegritytext>. Additionally, the Mathematics and Computer Science department has its own Academic Integrity policy that I will pass out for all of you to read and sign.

Information for Students with Disabilities: The College of the Holy Cross is committed to providing all students with equal access to learning. Any student who feels the need for accommodation based on the impact of a disability should contact the Office of Accessibility Services to discuss support services available. Once the office receives documentation supporting the request for accommodation, the student would meet privately with Accessibility Services to discuss reasonable and appropriate accommodations. Then, with your permission, each instructor will receive a letter (delivered by you) outlining the reasonable accommodations they are required to make. Once I have received this letter, you and I should meet to coordinate the way these will be implemented in this course. The Office of Accessibility Services can be reached by calling 508-793-3693 or by visiting Hogan Campus Center, room 505. For more information, go to <https://www.holycross.edu/health-wellness-and-access/office-accessibility-services>

Respect for Diversity: It is my intent that students from all diverse backgrounds and perspectives be well-served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that the students bring to this class be viewed as a resource, strength and benefit. 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. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally, or for other students or student groups. In particular, if a situation causes you discomfort or offense, please feel free to:

- i) Discuss the situation privately with me. I am always open to listening to students' experiences, and want to work with students to find acceptable ways to process and address the issue.
- ii) Discuss the situation with the class. Chances are there is at least one other student in the class who had a similar response to the material.
- iii) Notify me of the issue through another source such as your academic advisor, a trusted faculty member, or a peer. If for any reason you do not feel comfortable discussing the issue directly with me, I encourage you to seek out another, more comfortable avenue to address the issue.

Cell Phones: Texting and/or playing games during class will hinder your ability to learn. As a deterrent, the first offense will be a warning, the second will result in dismissal from class for the day, and the third will result in a much longer suspension from class. In short, turn your cell phones off during class.

Calculators: A calculator is highly recommended but not required. You do not need to go out and buy a graphing calculator - a basic calculator will be sufficient for our course. Using your cell phone as a calculator is not permitted since phones are meant as communication devices (See Academic Integrity and Cell Phone policies above).

Grading: Final grades will be given according to the following percentage cutoffs. These cutoffs, although fairly strict, can be lowered (according to class performance), but not raised, no matter how well the class performs

Final Grade	Percentage
A	93 to 100
A-	90 to <93
B+	87 to <90
B	83 to <87
B-	80 to <83
C+	77 to <80
C	73 to <77
C-	70 to < 73
D+	67 to <70
D	63 to <67
F	0 to <63

Course Calendar (subject to change)

Note: (D) implies that the reading comes from the Daniels textbook, (H) = Hill textbook, (K) = Kutner textbook, and (M) = Mendenhall textbook. The reader for the course is separated into “units”

- Unit 1 → Hill Probability Primer and Mendenhall Chapter 1
- Unit 2 → Daniel Chapter 8
- Unit 3 → Kutner Chapters 1&2
- Unit 4 → Kutner Chapter 3
- Unit 5 → Mendehnnall Chapter 4
- Unit 6 → Mendenhall Chapter 5
- Unit 7 → Kutner Sections 6.8 & 7.6

Course Calendar (subject to change)

Date	Section	Topic	Notes
Sept 5 – R		Syllabus; Introduction to R	
Sept 10 – T		R Activities (i.e. learning how to do things in R)	
Sept 12 – R	H: P.1-P.5	Random Variables and Expected Values	HMWK #1
Sept 16 – M			Project #1 Due
Sept 17 – T	H: P.6 H: P.7	Scatterplots, Covariance, and Correlation Linear Combinations of RVs	
Sept 19 – R	M: 1.6 M: 1.7	The Normal Distribution [Brief] Sampling Distributions	HMWK #2
			Project #2 Due
Sept 24 – T	N/A	The χ^2 , T, and F Distributions	
Sept 26 – R	M: 1.8-1.11	Review of Confidence Intervals	HMWK #3
Sept 30 – M			Project #3 Due
Oct 1 – T	M: 1.8-1.11	Review of Hypothesis Testing	
Oct 3 – R	D: 8.1	Introduction to ANOVA and Details of Calculations	HMWK #4
Oct 7 – M			Project #4 Due
Oct 8 – T	D: 8.2	ANOVA – Efficient Calculations and Examples	
Oct 10 – R	D: 8.2	Multiple Comparisons in ANOVA Review for Exam	

Date	Section	Topic	Notes
Oct 12 - Oct 20		No Class! Fall Break!	
Oct 22 – T	K: 1.1-1.3 K: 1.4-1.5 K: 1.6	Simple Linear Regression – Motivation and Model Basic Assumptions of Linear Regression The Method of Least Squares	
Oct 23 - W		Exam #1 – Probability and ANOVA Topics	
Oct 24 – R	K: 1.6-1.8	Method of Least Squares, cont. Estimating the Variance, Properties of Estimators	
Oct 29 – T	K: 2.1-2.3	CI and Hypothesis Testing of Regression Parameters	HMWK #5
Oct 31 – R	K: 2.4-2.5	Estimation and Prediction	
Nov 1 – F			Project #5 Due
Nov 5 – T	K: 2.6-2.7	The ANOVA Table for Simple Linear Regression Dummy Variables	HMWK #6
Nov 7 – R	K: 2.9-2.11 K 2.8	Correlation and the Coefficient of Determination The General Linear Test	
Nov 12 – T	K: 3.1-3.3	Regression Diagnostics	
Nov 14 – R	K: 3.8-3.9	Regression Diagnostics	HMWK #7
Nov 15 – F			Project #6/7 Due
Nov 19 – T		Finish Regression Diagnostics Review for Exam	
Nov 20 – W		Exam #2 – Simple Linear Regression	
Nov 21 – R	M: 4.1-4.3 M: 4.4	Multiple Linear Regression (MLR): Motivation and Assumptions MLR – Least Squares and Matrix Formulation	
Nov 26 – T	M: 4.5-4.6	MLR – Properties, Model Utility Test	
Nov 27 – Dec 1		No Class! Thanksgiving Break	
Dec 3 – T	M: 4.7 M: 4.9	MLR – CI and Hypothesis Testing of Parameters MLR – Estimation and Prediction of a New Observation	
Dec 5 – R	M: 4.8	MLR – Multiple and Partial Correlation Coefficient	HMWK #8
Dec 10 – T	M: 4.11 M: 4.10 M: 4.12 M: 4.13	MLR – Polynomial Models MLR – Interaction Terms MLR – More Complex Multiple Regression Models MLR – A Test for Nested Models	
Dec 12 – R	M: 5.7-5.9 K: 6.8, 7.6	MLR – Categorical Variables Diagnostics for Multiple Regression	HMWK #9 Last Day of Class
Dec 13 – F			Project #8/9 Due

Final Exam: TBA [on or before Saturday December 21st]