STAT 5700

Probability (3 credits)
Fall 2025
Section 001, CRN 29057
Mendel Hall 260
TTh 2:30 – 3:45 PM

Instructor

Katie Fitzgerald, PhD Statistics
Assistant Professor of Statistics
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Student hours – come talk to me!
Tuesdays 11AM – 12PM
Wednesdays 4 – 5:30PM
Thursdays 1 - 2PM

Course Description
This course is an introduction to probability as used in statistics and data science. Topics include probability, random variables, discrete and continuous probability distributions, multivariate probability distributions, important families of distributions, distributions related to the normal, transformations, and moment generating functions.

Prerequisite: Calculus III (MAT 2500) or instructor permission

Course Objectives
After this course, you will be able to:
- Apply the basic axioms of probability to solve problems
- Formulate probabilistic models for real-world phenomenon using discrete and continuous distributions
- Compute and interpret moments of random variables
- Compute measures to describe the relationships between random variables
- Use appropriate technology to perform computations in probability and statistics
- Use available resources (the internet or books) to learn about and use other distributions as they arise

Tips for Success

- Dedicate yourself to being an engaged learner and contributing to a thoughtful learning environment for your peers.
- Be an engaged and curious reader. The textbook offers additional rich context, examples, and explanations that are intended to supplement lecture notes. You should spend time reading the relevant textbook sections each week. Take notes and ask questions as you read, then return to those questions to see if they have been answered by the time you finish the week's material.
- Start assignments *early* and come to class and student hours with questions
- Collaborate! Get to know your classmates. You are encouraged to work on homework assignments and labs together.
- Ask questions! Ask them in class, on Piazza, or in student hours.
- Embrace the struggle & don't shy away from confusion or uncertainty. After all, statistics is the "science of uncertainty," and being "good at math" is being good at being stuck…

How to access support for this class

- **Piazza** will be our preferred platform for questions about homework, code, and general course questions. The system is integrated with Blackboard and is highly catered to getting you help quickly and efficiently from classmates and the instructor. Rather than emailing questions to the instructor, you should post your questions on Piazza. Email should be reserved for personal questions such as those regarding absences or grades.
- Come to my student hours! I have over three hours *outside of class time* each week specifically dedicated to helping YOU succeed in this course. Even if you don't know what your specific questions or points of confusion are, we can figure that out together. For Homework 00, you will be asked to attend student hours at least once during the first two weeks of the semester; this will give us a chance to chat outside of class and to make sure you know where to find me throughout the semester :) Student hours will be held in person (Dr. Fitz's office) or Zoom by request:
    - Tuesdays, 11AM-12PM
    - Wednesdays, 4 – 5:30PM
    - Thursdays, 1 - 2PM
- Tutors may be available for this course in the Math Center. Reach out to Dr. Fitz to inquire.
- Contact me about any concerns. Best way to reach me is via email (kaitlyn.fitzgerald@villanova.edu). I do my best to respond within 24 hours Monday – Friday.

Required Course Materials

Textbook: *Mathematical Statistics with Applications*, 7th edition, by Wackerly, Mendenhall, and Scheaffer (ISBN 978-0-495-11081-1). We will cover material from Chapters 1 to 6 of the textbook in this course. Much of the remainder of the textbook will be covered in the highly recommended follow-up course STAT 5705.

Software: This course will utilize the free statistical software R and RStudio. You will receive instructions in the first week of class for how to download and install the software.

Hardware: Students are expected to bring a laptop to some class sessions. If access to a laptop is an issue, then please contact the course instructor and an accommodation will be made. This requirement will not prevent students from taking this course.

Assessment Factors Contributing to Final Grade

Homework & Labs
Homework will be assigned from the textbook and supplemental problems chosen by the instructor. Most homework assignments will be accompanied by an "R Lab" which will introduce code via the free statistical software R (and RStudio). You will receive instructions in the first week of class for how to download and install the software. Each assignment's instructions and due date will be posted on Blackboard, with most assignments being due on Blackboard on Thursdays at 11:59pm.

Attendance & Engagement
You are expected to contribute to a meaningful learning environment for yourself and your peers. Attendance, participation, and active engagement with the material are expected. A small percentage of your course grade is allocated to the following:
- **Weekly check-ins** – each week you will be asked to fill out a brief survey that provides the opportunity for you to give feedback about what was unclear or difficult about that week's material as well as to self-assess your own engagement with the course.
- **Attendance** – if you miss a class (life happens!), contact a classmate to see what you missed and get lecture notes for that day. Consulting Blackboard is also a good idea. Don't hesitate to reach out if a larger life circumstance is interfering with your ability to engage in the course or if you need additional support to get back on track.

Readings & Community Annotations
We live in an Information Age where data is all around us. Statistical literacy and probabilistic reasoning can provide us with tools to be better *stewards of information*. Throughout the semester, you will encounter many ways that probability and statistics are used (and misused) in our lives and society and how data can be harnessed to unearth knowledge, to illuminate injustices, and to reason critically about uncertainty. Each week you will engage with an assigned article or video about applications of statistics and/or ethical issues in the field. You will engage with the reading via the community annotation tool Perusall. Annotations are due Thursdays at 11:59pm.

Individual Quizzes

Most weeks (10x per semester), one class period will start with a brief quiz. There are no make-up quizzes if you are late or absent, but the lowest two quiz grades will be dropped at the end of the semester.

Exams

There will be two exams (each worth 15% of the overall grade) and a cumulative final worth 20%
- Exam 1: take-home & in-class portions
- Exam 2: take-home & in-class portions
- Final Exam: in-class, cumulative

The first 2 Exams will include both a take-home and an in-class portion. The in-class portions will be closed-note and closed-book but students will be allowed one double-sided 8.5"x11" sheet of notes, to be turned in with the exam. For the take-home portions, students may NOT work together or consult other people but are free to use their book, notes, homework assignments, and the internet when completing the exam. Note that students are allowed to utilize already existing resources on the internet, but are NOT allowed to post to any online forums or utilize AI to ask for help on the exam. Doing so will be considered a violation of academic integrity and will be handled according to university policy.

Students will be given the opportunity to submit annotated test corrections to earn up to 1/4 of the points back on exams. Specific instructions and expectations will be provided when the exams are graded.

A cumulative, in-class final exam will be given during finals week. It will cover material from the entire semester, and it is worth 20% of the course grade. Test corrections are not available for the final exam.

Late/makeup work

Here is how deadlines work in the real world: they exist and they're important. However, there's a certain amount of flexibility with them. If you need a little longer on something, you communicate with whoever has set you the deadline and ask if you can have a few more days. This is usually not a big deal, but if it happens a lot, people will start asking you if everything is all right.

That is also how deadlines work in this class. You may communicate with me (via an extension request form, available on Blackboard) to ask for an extension on anything you need, and that's mostly fine. If you ask for lots of extensions, we'll work together to find ways to help you keep up with the work in the course.

Extensions on take-home exams will not be granted. There are no makeup exams unless specifically coordinated with the instructor in advance.

If there are life circumstances that are having a longer-term impact on your academic performance or well-being, come talk to me, and we can work towards a solution and connect you to the support you need.

Grading

Homework	20%
Labs	5%
Attendance & Engagement	2%
Reading Annotations	3%
Individual Quizzes	10%
Exam 1	20%
Exam 2	20%
Final Exam	20%

Final letter grades will be assigned according to the scale below

A	93-100%	B+	87-89%	C+	77-79%	D+	67-69%	F	0-59%
A-	90-92%	B	83-86%	C	73-76%	D	63-66%		
		B-	80-82%	C-	70-72%	D-	60-62%		

Important Dates

August 26 (Tue)	First day our class meets
August 31 (Sun)	Add/Drop deadline
Sept 25 (Th)	Exam 1 in-class, take-home posted
Sept 30 (Tue)	Exam 1 take-home DUE
Oct 14, 16 (Tue, Th)	NO CLASS due to Fall Break
November 27 (Th)	NO CLASS due to Thanksgiving break
Nov 6 (Th)	Exam 2 in-class, take-home posted
Nov 11 (Tue)	Exam 2 take-home DUE
December 9 (Tue)	NO CLASS, deemed a Friday
December 16 (Tue)	Final Exam, 2:30 - 5pm

Course Community & Policies

Inclusive Community

It is my intent that this course models and fosters justice, equity, diversity, and inclusion. We will engage with these values both in content and in practice as we do probability and statistics in community with one another and critically engage with ethical issues in the discipline. You are expected to engage your peers and new perspectives with curiosity, empathy, and intellectual humility. It is my intent that all students be well-served by this course, that your learning needs are met inside and outside the classroom, and that the diversity that you bring to this class be valued and utilized as a resource and strength.

I (like many people) am continually learning how to honor diverse perspectives and identities. If something was said in class (by me or a peer) that made you feel uncomfortable, please let me know. You will also have the opportunity to express concerns anonymously via check-in surveys. Villanova also encourages community members to submit any campus climate concerns at the following website: https://www1.villanova.edu/university/diversity-inclusion/report-climate-concern.html

Villanova affirms that diversity, equity and inclusion are integral components of the teaching and learning experience and an essential element of the ongoing intellectual, social and spiritual development of every member of the Villanova community. We believe that an inclusive community fosters an understanding and appreciation for diversity among our students, faculty, staff and administrators. We are committed to cultivating an academic environment that is marked by genuine curiosity about different perspectives, ardent receptivity to knowledge generated through intercultural connections, and a genuine sensitivity to the variety of human experiences.

Academic Integrity Policy

TL;DR: Don't cheat! And use AI responsibly and within guidelines provided

See full AI / LLM policy at the end of this document. Additionally, please abide by the following as you work on assignments in this course:
- You may discuss individual homework and lab assignments with other students; however, you may not directly share (or copy) code or write-ups with other students.
- Citing code or proofs/solutions: Unless explicitly stated otherwise, you may make use of online resources (e.g. StackOverflow) for coding and/or proof examples on assignments. If you directly use code or a proof from an outside source (or use it as inspiration), you must explicitly cite where you obtained the code or proof. Any recycled code or proof that is discovered and is not explicitly cited will be treated as plagiarism.

All students are expected to uphold Villanova's Academic Integrity Policy and Code. Any incident of academic dishonesty will be reported to the Dean of the College of Liberal Arts and Sciences for disciplinary action. For the College's statement on Academic Integrity, you should consult the Student Guide to Policies and Procedures. You may view the University's Academic Integrity Policy and Code, as well as other useful information related to writing papers, at the Academic Integrity Gateway web site: https://library.villanova.edu/research/subject-guides/academicintegrity

Office of Disabilities (ODS) and Learning Support Services (LSS)

If there is any portion of this class that is not accessible to you due to course format or challenges with technology, please let me know so we can make appropriate accommodations.

It is the policy of Villanova to make reasonable academic accommodations for qualified individuals with disabilities. All students who need accommodations should go to Clockwork for Students via myNOVA to complete the Online Intake or to send accommodation letters to professors. Go to the LSS website http://learningsupportservices.villanova.edu or the ODS website https://www1.villanova.edu/university/student-life/ods.html for registration guidelines and instructions. If you have any questions please contact LSS at 610- 519-5176 or learning.support.services@villanova.edu, or ODS at 610-519-3209 or ods@villanova.edu.

Absences for Religious Holidays

Villanova University makes every reasonable effort to allow members of the community to observe their religious holidays, consistent with the University's obligations, responsibilities, and policies. Students who

expect to miss a class or assignment due to the observance of a religious holiday should discuss the matter with their professors as soon as possible, normally at least two weeks in advance. Absence from classes or examinations for religious reasons does not relieve students from responsibility for any part of the course work required during the absence.
https://www1.villanova.edu/villanova/provost/resources/student/policies/religiousholidays.html

Course Calendar (Tentative)

Week	Dates (M-F)	Topics	DUE (Th, 11:59pm)
1	Aug 25 - 29	Introduction & Syllabus 2.1 - 2.5: Probability basics, Set Notation Lab 01 – Intro to R/RStudio/Quarto	Reading Annotation 01 Week 01 check-in
2	Sept 1 - 5	2.6 - 2.7: Counting tools, conditional probability, independence	HW 01 Lab 01 Reading Annotation 02 Week 02 check-in
3	Sept 8 - 12	2.8 - 2.10: Probability laws, Bayes Rule 3.1 - 3.2: Discrete random variables	HW 02 Lab 02 Reading Annotation 03 Week 03 check-in
4	Sept 15 - 19	3.3 - 3.4: Expected value, Binomial Distribution	HW 03 Lab 03 Reading Annotation 04 Week 04 check-in
5	Sept 22 - 26	3.5: Geometric distribution **Exam 1 In-Class, Take-home handed out (Th)**	HW 04 Lab 04
6	Sept 29 – Oct 3	**Exam 1 Take-home DUE (Tue)** 3.6 - 3.8: Negative Binomial, Hypergeometric, Poisson	Reading Annotation 05 Week 06 check-in
7	Oct 6 - 10	3.9, 3.11: Moments, MGFs, Tchebysheff's Theorem	HW 05 Lab 05 Reading Annotation 06 Week 07 check-in
	Oct 13 - 17	FALL BREAK	
8	Oct 20 - 24	4.1 - 4.4: Continuous random variables, Uniform distribution	HW 06 Lab 06 Reading Annotation 07 Week 08 check-in
9	Oct 27 - 31	4.5 - 4.9: Normal, Gamma, and Beta distributions, MGFs & Other expected values	HW 07 Lab 07 Reading Annotation 08 Week 09 check-in
10	Nov 3 - 7	5.2: Bivariate discrete distributions **Exam 2 In-Class, Take-home handed out (Th)**	HW 08 Lab 08
11	Nov 10 - 14	**Exam 2 Take-home DUE (Tue)** 5.2 - 5.3: Bivariate continuous distributions, marginal & conditional distributions	Reading Annotation 09 Week 11 check-in
12	Nov 17 - 21	5.4 - 5.6: Independent RVs, properties of expected value	HW 09 Lab 09 Reading Annotation 10 Week 12 check-in
13	Nov 24 - 28	5.7 - 5.8 Covariance, properties of expected value & variance Thursday – Thanksgiving Break (No class)	
14	Dec 1 - 5	5.11 Conditional Expectation 6.1 - 6.4: Distributions of Functions of Random Variables	HW 10 Lab 10 Week 14 check-in
15	Dec 8 - 12	Tuesday NO CLASS – deemed a Friday Final Review	HW 11 Lab 11 End-of-course reflection
	Dec 16	FINAL EXAM, Tue 2:30 - 5PM	

Course schedule, topics, exams and assignments may be changed at the instructor's discretion

AI /LLM policy (i.e. usage of ChatGPT, Gemini, etc.)[1]

TLDR: you're responsible for understanding how to solve problems, cite any use of AI

In general, we treat AI-based assistance, such as ChatGPT, the same way we treat collaboration with other people; you are welcome to talk about your ideas with other people, both inside and outside the classroom, as well as with AI-based assistants.

However, **all work you submit must be primarily your own,** and **may not be completed, in whole or in substantial part, by other humans or chatbots, AI, etc.** You also **must properly acknowledge (cite) any ideas / code / solutions that did not originate from you**. In all cases, you are responsible for understanding all work that is turned in and may be periodically asked to orally explain your answers.

I expect you *will* use AI / LLMs periodically to assist you in this course. Responsible use of AI is not "against the rules" and you should not feel the need to hide it. **If/when you use AI while working on an assignment, you are expected to provide the following with your submission:**
- A statement acknowledging your use of AI and which tool you used
- A precise description of the prompt(s) you used on which problem(s)
- A brief reflection of your takeaway / analysis of the output provided by the tool, including your level of confidence in it. A couple of sentences will suffice.

Considerations for responsible AI / LLM usage
AI / LLMs are likely to be used in your future workplace and can be an effective tool for the modern statistician / data scientist. However, there are both effective and detrimental ways that LLMs can be used in a learning context. Here are a few things to consider when choosing whether/how to use AI in your coursework:
- AI / LLMs can hallucinate and provide incorrect answers. You must develop your own foundational knowledge of a subject in order to effectively judge and verify whether an LLM's output is trustworthy.
- AI / LLMs use an enormous amount of energy. In order to be climate-conscious, we need discerning use of AI and should be careful not to over-rely on it when other methods (e.g. Google search, non-AI computational tools, human effort) will suffice.
- Employers are interested in people who can, among other things, achieve Task X (with or without LLMs) correctly and efficiently and who can effectively document and communicate *how* they achieved Task X so that it can be verified and reproduced by someone else. This motivates the policy described above.
- One of the broader / more existential threats posed by AI is its potential to diminish human connection. Be mindful of how often you are turning to AI for help when you otherwise would be turning to a human. There is value in day-to-day interactions with classmates, tutors, and professors that go beyond efficiently completing an assignment.

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[1] This policy has been adapted from language provided by Drs. Keegan Kang (Bucknell), Yimin Zhang, Michael Posner, and Villanova University

Tips for when AI assistance can be especially *useful* and *appropriate*
- Debugging code or interpreting error messages
- Clarifying course concepts. For example:
    - "provide me with an intuitive explanation of XYZ"
    - "help me understand why ABC happens in this context"
    - "I'm confused about the difference between ABC and XYZ"
- Deepening understanding of posted solutions
- Generating additional practice questions and step-by-step explanations when studying

(Non-exhaustive) scenarios when AI assistance would be *inappropriate*
- Copying / typing a homework problem into ChatGPT and having it generate a full solution from start to finish. Homework is intended to build your general problem solving intuition, and you are responsible for coming up with the steps to solve the problem.
- Copying output from ChatGPT directly into your submission. Just as you should not let a classmate write content directly into your submission, so also should you avoid using AI assistance in such a way that directly adds content to your submission.
- Using AI on an open-ended problem or writing assignment that asks for your reflection, opinion, or meta-cognitive thought-processes. It is considered academic irresponsibility to use AI to generate an answer that does not reflect what *you* truly think and believe. I am interested in what you think, not what an LLM thinks.
- Submitting an assignment that has ideas, code, or solutions that originated from AI but is not properly cited. This is plagiarism.

If at any point you are unsure whether a particular use-case of AI is appropriate, please ask!