MATH/STAT 354: Probability

Professor: Taylor Okonek (she/her)

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Office: Olin Rice 126

Section	Meeting Time	Room
01	M/W 8:00 - 9:30 am	OLRI 241

Office Hours: (Google Calendar Link)

This semester I am teaching Math/Stat 354 *and* Stat 454, so for office hours, I will give priority to students in certain classes. You are welcome and encouraged to come to ***any*** of the following office hours, but please know that if you come to 454 Prio-OH, for example, anyone in 454 will be prioritized first in terms of questions / assistance. Office hours are typically first-come, first-served. However, I will do my best to include everyone present in the conversation.

- Tuesday 10:00 - 11:00 am *(354 Priority)*
- Wednesday 11:00 am - Noon *(454 Priority)*
- Thursday 3:00 - 4:30 pm *(454 Priority)*
- Friday 9:30 - 11:00 am *(354 Priority)*

Note: If the office hour times listed above don't work for you, I am **available by appointment**; email me to set up a time to meet. More expectations on communication are in the Course Communication section.

Preceptors

We have a *wonderful* preceptor for MATH/STAT 354 this semester! The course Moodle site contains detailed information for preceptor office hour times/locations, along with a Google calendar for Preceptor Office Hours.

Data & R Support. In addition to the course preceptors, there is support on campus for working with data and R / RStudio. Though we will use R **infrequently** throughout the semester, this is a great resource for R setup and troubleshooting throughout the semester. See this site for more information.

The role of an MSCS preceptor is to help students with content questions, assist in the navigation of available resources, advise on studying approaches for classes, and assist with concepts, tools, and skills needed for problem sets. Students are accountable for their own learning; as such, preceptors are not allowed to share answers to assignments (unless specifically directed by the instructor), are not expected to immediately know the right approach, or provide assistance outside of office hours.

Additional guidelines and expectations on how to interact with preceptors can be here.

Textbook

There is no required textbook for this course. If you'd like an additional resource, the textbook Blitzstein & Hwang (2nd edition) is available for free online.

The best resources for this course are course content videos included in the checkpoint quizzes on Moodle, attending and participating in class / assignments, and office hours. I am happy to talk about possible additional materials / strategies for effective learning at any time throughout the semester!

Learning Objectives

Upon completion of this course, students should be able to…

- identify appropriate probability models for given variable(s), and express that model using formal probability notation
- approximate features of a probability model when analytic solutions are impossible or computationally prohibitive

- derive transformations of random variables, and determine contexts in which such transformations may be useful
- calculate and explain important properties of random variables (expected value, variance, etc.)
- distinguish between conditional, marginal, and joint measures of uncertainty
- use sampling distributions to model the behavior of various properties of a sample

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Tentative Schedule

A detailed, day-to-day schedule will be filled in throughout the semester in the Schedule tab of this website. A rough outline by unit / week is as follows:

Unit	Goal	Topic	~ Weeks
Events	Calculate, simulate, and communicate the uncertainty of an *event*	• Set theory & probability rules — Intersections, unions, complements — Properties of probability • Dependent & Independent events — Conditional probability — Law of Total Probability — Bayes' Rule — Independence • Combinatorial probability • Monte Carlo simulation	1-4

Unit	Goal	Topic	~ Weeks
Single Random Variables	Use *univariate probability models* to describe and explore the behavior of a *random variable*	• Modeling random variables – Discrete probability mass functions – Continuous probability density functions – Named probability models • Properties of random variables – Expected value & variance – Cumulative distribution functions	5-7

Unit	Goal	Topic	~ Weeks
Functions of Random Variables	Derive *transformations* of random variables and use moment generating functions to estimate properties	• Transformations of random variables • Moment Generating Functions	8-10
Multiple Random Variables	Use *multivariate probability models* to capture & explore the *joint* & *conditional* relationships among 2+ random variables	• Joint & conditional probability models • Correlation	11-13
Sampling Distributions	Use observed *data* to understand the underlying (but unknown) probability model	• IID samples • Sampling distributions & the CLT	13-15

Course Communication

Course Website: The course syllabus and course resources will be posted on the course website. The Schedule tab of this website will contain information about due dates, in-class activities, and general day-to-day going-ons, and the Documents tab contains any and all files we'll use throughout the course (updated frequently).

Moodle: Moodle will be used *exclusively* for checkpoints, hosting Preceptor OHs, and Problem Set dropboxes later in the semester (once we've fully transitioned to LaTeX). Please check the course website *and* Moodle page every day before class, to make sure you aren't missing any assignments! The course schedule tab is the best place to look for overall information.

Feedback: Feedback on course assignments, grades, etc. will be available in your individual feedback spreadsheets, which I will share with you at the start of the semester.

Email: Outside of office hours, email is the best way to discuss topics of a personal nature (e.g., grades, missing class) or to ask other questions you don't feel comfortable asking in a group setting. **Note that I will not send same-day responses to messages sent after 6:00pm.**

Please communicate respectfully with your classmates and myself, and let me know if there are ways classroom communication can be made more accessible to you.

Classroom Environment

I am committed to helping you learn and succeed. Part of this means facilitating environments that support you in the ways that you need. Everyone comes from a different path through life, and it is our duty to listen to each other without judgment, and to respect one another. There will be **no tolerance** for discrimination based on race, ethnicity, gender, religion, sexual orientation, disability, or other identities.

Probability can be used to understand the world around us as it pertains to many relevant and timely issues. While this class focuses primarily on developing your theoretical toolkit, it is important to recognize and critique the circumstances under which this theory was developed. Ethical considerations come into play in both applied *and* theoretical mathematics and statistics. If you feel that you may not be able to complete a certain activity, do a reading, or partake in a discussion due to the nature of the topic at hand, please reach out to me so that you can help me understand your situation, and so that we can discuss the possibility of replacing the item with an alternative. I am more than happy to work with each of you to ensure that you feel comfortable in your learning.

Grades

Evaluations / Assessments

Quizzes: There will be four, in-person quizzes on Units 1-4 throughout the course of the semester. **You must schedule all travel, etc., around them - there will not be any alternative quiz times**. Note that while the quizzes are focused on individual units, the material is in some sense cumulative because of the way that material in this course builds on earlier ideas.

- Quiz 1 (Unit: Events): Monday 2/16

- Quiz 2 (Unit: Single Random Variables): Monday 3/9

- Quiz 3 (Unit: Functions of Random Variables): Monday 4/6

- Quiz 4 (Unit: Multiple Random Variables): Wednesday 4/22

Quiz format:

- All quizzes will be 1.5 hours in class.

- Fully individual, pen/pencil and paper.

- No calculators. Calculations will either be basic, or left in the form of an equation (e.g.: 0.14 * 0.17)

- Semi-closed note. You will be given an instructor-provided notes sheet ahead of the quiz.

Showing growth: You can earn up to 33% of missed points back on quizzes if you complete a quiz correction. You must:

- Submit your quiz corrections (on a separate sheet of paper!) along with your original quiz to the instructor, no later than one week after quizzes have been handed back.

Final Exam: There will be a cumulative, in-person final exam during the Final Examination period. The format will be the same as the quizzes. **You must schedule all travel, etc., around them - there will not be any alternative final times**.

The final exam will be weighted *equally* with each of the four quizzes when calculating final grades.

Problem Sets: There will be 8 problem sets throughout the course, that provide the opportunity to practice and explore the course material in more depth.

Problem sets will be due *on paper* (written or printed, if you typed your PS in LaTeX) at the beginning of class. You are encouraged to work together on problem sets, but **the work that you submit, including code (if relevant), should be your own**.

You will receive qualitative feedback on all questions on these problem sets. Each question on a problem set will be scored on the following scale:

High Pass	Pass	Low Pass	No Credit
All work was shown, you arrived at the correct answer, and you demonstrated mastery of the material.	You arrived at the correct answer, and most work was shown and/or sufficient understanding of the material was demonstrated.	You may not have arrived at the correct answer, but you demonstrated some understanding of the material and showed your work.	You did not attempt the question OR you showed no work, and instead only stated the answer.

By the end of the semester, you will be required to typeset all of your problem sets in LaTeX. We'll slowly build up to this, and I'll provide you with template files at the start! You'll be

required to type up 0 exercises in PS 1 - 3, 1 exercise in PS 4, 2 exercises in PS 5, 3 exercises in PS 6, and all exercises in the remaining PS. See below in the syllabus for more on LaTeX.

Checkpoints: Some class periods will have course videos assigned ahead of time, to help you prepare for class. For each class period where this is the case, a low-stakes checkpoint quiz (on Moodle) must be completed *at least 30 minutes before class starts*. This will help us prepare for class, build a common foundation, and maximize our in-class time together – just how readings & reflections might be used in another class! There will be roughly 14 checkpoints throughout the semester.

You may reattempt *most* checkpoint questions with a 33% penalty for each incorrect response. Exceptions are open-ended questions or multiple choice questions with only 2 options (TRUE/FALSE).

Checkpoints will be a grade **modifier**. If your overall checkpoint average is ≥ 80%, your final course grade will not be impacted. If your overall checkpoint average is below 80%, your final course grade *will* be lowered by **one third** of a letter grade (i.e. A -> A-, B+ -> B).

Group Assignments: Throughout the semester, there will be **four** group assignments; the first will be completed outside of class time, and the remaining three will be completed in class. These assignments will be a grade **modifier**. The assignment will be given a score of "Pass" or "Needs Improvement," and you will get qualitative feedback on the assignment. If your group received a "Needs Improvement," you will be expected to revise and resubmit the group assignment within one week after you have received feedback, to bump your score up to a "Pass." If you do not participate in group assignments and/or in the revision process as necessary, your final course grade *may* be modified by up to **one** letter grade (i.e. A -> B, B -> C).

Late Policy

Throughout the quarter, you may use up to **three**, three-day extensions. These three extensions can be used on Problem Sets *only*, not quizzes or checkpoints. The purpose of deadlines (and extensions) are to keep you accountable for your own learning, to keep you on track with the pace of the course (which builds upon itself throughout the semester), and to provide preceptors and myself with the ability to provide you with timely feedback on assignments.

Extensions can be used automatically, without letting me know in advance. If you do not hand in a Problem Set at the beginning of class when it is due (with a maximum, 5-minute grace period), I will assume you are using an extension. To hand in an assignment you are using an extension on, you must either hand it to me personally within 72 hours of the deadline, or slide it under my office door within 72 hours *and* send me an email confirming that you have done so. If you do not submit an assignment on time or within the extension period, I

may have the preceptors provide you with feedback, but you will **not receive credit** for the assignment.

I expect you to keep track of how many extensions you've used. I will email you a reminder if you have used all three of your extensions and have none remaining.

If you have run out of extensions and/or an extenuating circumstance occurs that impacts your ability to submit assignments on time, please email me to discuss the situation. I am happy to be flexible as long as you communicate!

Academic Integrity

As a globally- and community-oriented institution, Macalester College expects respectful exchange of ideas. Students are expected to be familiar with the college standards on academic integrity (link). You are encouraged to work with your classmates on assignments and activities, but in order to receive individualized feedback on your own learning, **all submitted work (including code) must be written in your own words**. Issues of academic integrity will be taken very seriously, and any concerns about this policy being violated will be followed up on individually.

AI Use

I *strongly* encourage you *not* to use AI at all throughout this course. While it might feel helpful in the moment, it certainly won't help you with your long-term retention of the material, and it won't help you be prepared for the in-class assessments. Remember that learning comes from *you* actually thinking through and coming to a solution, not a machine producing the correct answer for you. If you do use AI on a problem set, I expect you to cite when/how/where you used it, in accordance with Macalester's academic integrity policies. If you use AI and *do not* cite it, that will be considered an academic integrity violation.

With any mathematical arguments, AI tends to give *very* (needlessly) wordy responses / answers to questions. If you use AI, I expect you to translate the results into your own words in a streamlined, mathematical argument (this is a skill I want you to gain from this course!). For example:

- **AI generated:** "Our goal is to calculate P(A and B). We can write P(A and B) as P(A and B) = P(A | B) P(B). We know that P(A | B) = 0.2 and P(B) = 0.1. Thus, P(A and B) = P(A | B) P(B) = 0.2 * 0.1 = 0.02.
- **Personally translated:** P(A and B) = P(A | B) P(B) = 0.2 * 0.1

How I expect you cite any AI use (not recommended!) for this course: Include a paragraph at the end of your problem set, explaining what you used AI for and what prompts you used to get the results.

Course Grading System

The course grading system is designed to help you achieve the learning objectives while allowing space to make and learn from mistakes along the way. The table below presents the criteria for earning an A, B, C, or D/NC. Depending upon the level of progress towards each goal, half-letter grades (e.g. A-, B+) may be assigned when some but not all expectations for a higher letter grade are met.

Important details & caveats:

- The goal of sharing this specific information is to provide transparency around final grades, hence clear goals to work toward. That said, assigning grades is much more nuanced than *any* grading rubric / framework might suggest (for good reasons!).

- Note that the cutoffs for letter grades above may be altered at the end of the semester to be *lower*, but will not be moved higher than what is listed above (i.e. they would only potentially move in your favor).

- Remember the grade modifiers for the course: checkpoint average, group assignments, and course engagement!

Letter Grade	Expectations
A	• Problem Sets: Earn at least a "low pass" score on all PS questions, and $\geq 70\%$ "high pass" scores otherwise • Quizzes + Final: Average $\geq 90\%$ (with revision)
B	• Problem Sets: Earn $\geq 60\%$ "high pass" and "pass" scores combined, with *very* few "low pass" or "no credit" scores • Quizzes + Final: Average $\geq 80\%$ (with revision)
C	• Problem Sets: Earn a majority ($\geq 50\%$) of "high pass", "pass", or "low pass" scores • Quizzes + Final: Average $\geq 70\%$ (with revision)

> D/NC   D/NC will be given when expectations for a C or higher are not met. To achieve credit for this course, you must sit for (and demonstrate effort on) all quizzes and the final exam.

Statistical Software

We will use the free, R programming language *sparingly* throughout this course. RStudio (an interface for R) will facilitate our use of R. You may use RStudio in one of two ways:

1. Online: Go to https://rstudio.macalester.edu, and log in with your full Mac email address and your usual Mac password to get access
2. Desktop version: Download for Windows or Mac at https://posit.co/downloads/. **Note**: You first need to download and install R on your computer in order to use the desktop version of RStudio

More detailed instructions on downloading, installing, and getting started with R, RStudio, and an important package called Quarto is available on the R & LaTeX Resources tab.

LaTeX

LaTeX is a document preparation system used to create high-quality scientific and technical communications. We will be using LaTeX to typeset mathematical notation. It is freely available, and we will primarily be using it in Overleaf to create compiled pdf documents. I will provide .tex templates for every problem set, for use in Overleaf or on your desktop. If you have used LaTeX in Quarto (.qmd files) before and prefer to use that, you are welcome to, but I will only provide .tex templates, with the exception of PS3 which must be done in R. Note that if you have not previously used Overleaf you will need to make an account to get started, but making an account is free.

If you choose to use LaTeX within Quarto, you will need to download TinyTex, and either MacTex (Apple) or MiKTeX (Windows) to be able to knit to pdfs. Additional LaTeX resources are available on the R & LaTeX Resources tab. If you use Overleaf instead, you do not need to download anything.

Prof. Kristin Heysse has a nice guide on getting started with Overleaf that you are welcome (encouraged!) to use as a resource, linked here. All sections of the document other than the TIKz one are relevant for this course.

Accommodations

I am committed to ensuring access to course content for all students, including those with disabilities. If you have a disability, please meet with me early in the semester to discuss your accommodation plan. If you have not yet obtained a plan or are unsure if you have a disability that requires accommodation, please contact the Center for Disability Resources: disabilityresources@macalester.edu, or call 651-696-6275.

Religious Observance

Students may wish to take part in religious observances that occur during the semester. If you have a religious observance/practice that conflicts with your participation in the course, please contact me before the end of the second week of the semester to discuss appropriate accommodations.

In an effort to respect religious diversity, I request that students who plan to observe a religious holiday during scheduled class meetings/ class requirements talk to me about reasonable consideration by the end of the second week of the course.

Title IX

Macalester is committed to providing a safe and open learning and living environment for all students, staff, and faculty. Any community member experiencing sexual harassment, sexual violence, relationship violence, or stalking, is encouraged to seek help and support.

Please be aware that as a faculty member, it is my responsibility to report disclosure about sexual harassment, sexual misconduct, relationship violence, and stalking to the Title IX Office. The purpose of this report is to ensure that anyone experiencing harm receives the resources and support they need. I will keep this information private, and it will not be shared beyond this required report.

You may also contact Macalester's Title IX Coordinator directly (phone: 651-696-6258; e-mail: titleixcordinator@macalester.edu); she will provide you with supportive measures, resources, and referrals. Additional information about how to file a report (including anonymously) is available on theTitle IX website.

If you prefer to speak with someone confidentially, or need 24/7 support, there are resources available on- and off-campus to assist you:

- Counseling Services at the Hamre Center – on-campus counseling resource for students **Free, Urgent, Phone Counseling (Press 2) is available to Macalester students anywhere in the world, 24/7/365.** Speak to a licensed mental health counselor 24 hours a day by calling Hamre Center at 651-696-6275, then press or say option 2 when prompted.

- Center for Religious and Spiritual Life – chaplains may be reached via 651-696-6298 or email religiouslife@macalester.edu

- SOS Sexual Violence Services of Ramsey County 651-266-1000 (24-Hour Crisis Hotline staffed by trained advocates)

- Rape, Assault, and Incest National Network (RAINN) 1-800-656-4673 (24-Hour Hotline and Live Chat)

- Additional local and national resources can be found at https://www.macalester.edu/title-ix/find-support/

Land Acknowledgement

I would like to honor the fact that we are on Dakota land. This is the ancestral homeland of the Dakota people who were forcibly exiled from the land because of aggressive and persistent settler colonialism. I make this acknowledgment to honor the Dakota people, ancestors, and descendants, as well as the land itself.

About Your Professor

Hi! Please call me Taylor or Professor Okonek (never Dr. Okonek, it sounds weird to me). My pronouns are she/her. I was born on Madeline Island, Wisconsin, and grew up partially there / partially in White Bear Lake, Minnesota. I went to St. Olaf College for undergrad, and double majored in Mathematics and Religion, with a concentration in Statistics. I am a first-generation college student from a low-income background and was a part of the TRIO McNair program at St. Olaf. I completed my Ph.D. in Biostatistics at the University of Washington, Seattle in 2023. My research interests are in demography, mortality estimation, spatial and survey statistics, and survival analysis (and their intersections!).

When I'm not thinking about / doing Statistics, I like to hike, cook, read, play video games (recently Silksong and Stardew Valley, and Celeste is my favorite game of all time), and hang out with my three cats, Alice, Ellie, Norra. I'm always happy to talk about research if you have any questions, and happy to chat about your interests/goals as well, be they statistics-adjacent or not!

Note

This syllabus is subject to change at any time! Announcements of changes will be made in class or via email.