Theory of Probability

Math-UA 233-001
MA-UY 3014 A

Instructor Info

Zhuo-Cheng Xiao

Office Hrs: online upon requests (Will fix time slots after 09/24/22)

Rm 921, WWH (Courant Bldg)

Brightspace and Gradescope

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Course Info

Mon & Wed

2:00 - 3:15 pm

CIWW Rm 101

Recitation Info

Fri

2:00 - 3:15 pm

CIWW Rm 101

TA Info

Eric Thoma

Office Hrs: TBD

ZOOM

Overview

We deal with uncertainty everyday, which may come from 1. the stochastic nature of physical world on the microscopic level or 2. our poor information of issues in human life. Theory of probability will provide us philosophy and methods to address the uncertainty in life. This course is introductory to stochastic analysis via a combination of theory and applying mathematics to real-world problems.

Topics covered will include axioms of mathematical probability, combinatorial analysis, binomial distribution, Poisson and normal approximation, random variables and probability distributions, conditional probability, generating functions, law of large numbers and central limit theorem. Time permitting, I will also introduce interesting theoretical applications like random processes and information theory.

Materials

Required Texts

A First Course in Probability. (Ross, 10th edition), ("R").

Suggested Reading

Introduction to Probability. (Blitzkein, 2nd edition)

Learning Objectives

Below lists samples of study objects (not inclusive) that students that are expected comprehend.

Computational objects:

- Bayes's formula;
- expectations and variances of random variables
- conditional probability & joint probability distributions
- the classical probability distributions, including their properties and the contexts in which they occur

Theoretical objects:

- the language of probability theory through probability spaces
- independence and correlation between random variables
- relating random variables to moment generating functions
- the law of large numbers & the central limit theorems

Grading Scheme

25%	Weekly Homework
5%	Class Participation
40%	Midterm I & II. 20% each
30%	Final Exam

Grades will follow the standard NYU math scale:

Letter Grade	A	A-	B+	B	B-	C+	C	D	F
Cutoff	93	90	87	83	80	75	65	50	<50

Curving may (or not) be added to uplift the letter grades during the final evaluation.

Exam Requirements

Generally, computational errors are less significant than correct and concise demonstrations of all computational steps. Conversely, only a small portion of scores will be granted if only the final answer is provided without any justifications. As for proof problems, students are expected to write mathematical proofs and explicitly relate theorems to their steps.

FAQs

Why there are incomplete information?

This is a tentative version of syllabus. TA and recitation information will be added soon.

Homework Policy

Homework should be submitted as pdf files on Gradescope, which always dues on *Monday, 5pm* unless otherwise specified, and our grader will return your homework grading with an explanation before Saturday. Both handwritten and latex formatted are fine, but the students are responsible for the submitted files' readability and completeness.

Unexpected issues are always popping up to everyone of us due to the great uncertainty of life. Therefore, the lowest two homework grades will be dropped. In addition, the "late" deadline for each homework is *Monday, 11:59pm* in case of emergent issues. However, submissions after the deadline but before the "late" deadline will receive a grade discounted by 10%, and submissions will not be accepted after the "late" deadlines.

Make-up Policy

Make-up exams or assignments are allowed in limited scenarios provided that the student gets approval from the instructor *before the due date*. An approval may be granted for typical excuses including medical reasons, religious holidays, and family emergencies.

Class Participation

Students are expected to attend the classes, including recitations. Although attendance will not be strictly recorded, 5% of the final evaluation is based on class participation, including in-class interactions and discussions.

If students have difficulty attending classes, they should consult the instructor and their advisors in advance.

Lecture Formality

The first five lectures of the course will be hold remotely via zoom until 09/23/22. Students are should check the lecture link under the "zoom" tab on Brightspace website, and inform the instructor any technical issue before the class.

For the rest of the semester, this course will primarily run in-person until the university instructs otherwise. The remote teaching method is a substitute for short-term and emergent reasons, based on students' requirements (due to covid issues, etc.). During the in-person period, most of the course materials will be presented on classroom blackboards.

Other Resources

- Tutoring: Courant tutoring center and the university tutoring center.
- Moses Center for Student Accessibility for students with any physical or mental inconveniences.

Academic Integrity

All students are expected to adhere to the codes of academic integrity specified by New York Univerisity.

Tentative Class Schedule

Section numbers refer to "R".

Week	Date	Section	Materials
MODULE 1: Eelemental of Probability Theory			
Week 2	09/05		Labor day; No class
	09/07	1.1-3	Introduction; Combinatorics
Week 3	09/12	1.4-5, 2.1-3	Combinatorics; Sample space; Axioms of probability
	09/14	2.4-5	Properties of sample space; Examples
Week 4	09/19	3.1-3	Conditional probabilities; Beyes' Formula
	09/21	3.4-5	Independence; More on conditional probabilities;
Week 5	09/26	4.1-2, 4.10	Random variables; (Probability & cumulative) distribution functions
	09/30	4.3-5	Expectation & variance of discrete random variables
Week 6	10/03	4.6-4.8	Examples of discrete random variables
	10/05	5.1-2	Expectation & variance of continuous random variables
Week 7	10/11	5.3-6	Examples of discrete random variables
	10/12	4.7, 4.9	Transformation rule; More on expectation
MODULE 2: Joint & Conditional Distributions; Moments			
Week 8	10/17		Midterm 1
	10/19	6.1, 6.7	Joint distributions
Week 9	10/24	6.2-3	Independent random variables and their sums
	10/26	7.1-2	Expectation of sums of random variables
Week 10	10/31	7.4	Covariance and correlations
	11/02	7.3	Moments
Week 11	11/07	6.4-5	Conditional distributions
	11/09	7.5-6	Conditional moments
Week 12	11/14	7.7	Moment generating functions
	11/16	7.8	More on normal random variables
Week 13	11/21		Midterm 2
	11/23		Fall break; No Class
Module 3: Limit Theorems and Other Topics			
Week 14	11/28	8.1-2	Stochastic convergence; The weak law of large numbers

	11/30	8.4	The strong law of large numbers
Week 15	12/05	8.3	The central limit theorem
	12/07	9.1	Poisson process
Week 16	12/12	9.2	Markov processes (overview)
	12/14	9.3-4	Information theory and entropy (overview)
	undetermined		Final Exam