

# MATH36A: Probability

Brandeis University Summer 2018

**Instructor:** Duncan Levear ([people.brandeis.edu/~dlevear](mailto:people.brandeis.edu/~dlevear))

**Course Description:** From flipping coins to shooting hoops, “predictable uncertainty” can be found everywhere. With the requisite care, it is possible to mathematically assign numbers to such events in a way that measures their likelihood. This course is about these numbers, called *probabilities*. Unlike vague adjectives such as “likely” or “rather unlikely”, numbers can be compared, added, subtracted, multiplied, etc. This leads to many beautiful techniques to calculate the likelihood of a given outcome, and even sophisticated machinery such as integral calculus can sometimes be used. Here are some of the questions you will see answered:

- If 100 families have four children, about how many of them will have two girls and two boys?
- In the game of poker, should a straight beat a flush?
- In a room of 30 people, would you expect that any two of them share a birthday?
- Two archers fire at a target, with accuracies modeled by some bell curves. Given the appropriate parameters, what is the chance the second archer hits closer to the bulls-eye?
- Is there any rigorous guarantee that “most outcomes are within a standard deviation of average”? Can we be specific about the worse-case?

**Learning Goals:** Successful participants will...

- Learn how to solve a variety of “what’s the chance that–” questions. These include dice, cards, urns, waiting times, and more dressed up questions.
- Learn how to predict the average-case in situations of “predictable uncertainty”.
- Gain some fluency with mathematical computation (counting tricks, sums, integrals).
- Learn enough Python to simulate relatively simple experiments on a computer.

**Course Textbook:** Our course will follow *Probability* by Jim Pitman. Some homework exercises will come from here, so you will need access to a copy. The book is well-written with many pictures, and it is not too expensive (well under \$100).

**Course Outline:** We will closely follow the text, omitting most of Chapter 6. Some extra topics will be added, including simulation with Python, random walks, and generating functions.

<b>Textbook chapters</b>	<b>Description</b>	<b>Lectures</b>
Ch. 1	Basic Examples	2 lectures
Extra	Simulation	1 lecture
Ch. 2	Binomials and Poissons	3 lectures
Ch. 3	Abstract Random Variables	2 lectures
Ch. 4	Continuous Distributions	4 lectures
Ch. 5	Joint Distributions	2 lectures
Extra	Random Walks	1 lecture
Extra	Generating Functions	1 lecture

This scheme totals 16 lectures, leaving two for midterms plus one extra.

**Assessment:** You will be tested through a variety of media: homework, quizzes, exams, and participation. Homework assignments and deadlines can be found on LATTE. Feel free to collaborate with peers on your homework, but the other media will be solo.

<b>Category</b>	<b>Weight</b>	<b>Notes</b>
Participation	10%	Attendance and Presentation
Homework	20%	Assignments are on LATTE
Quizzes	20%	There will be six of these in class
Exam 1	15%	Date: TBD in-class
Exam 2	15%	Date: TBD in-class
Exam 3	20%	Date: TBD

When I compute your quiz and homework averages I will drop the lowest two grades.

**Presentations:** Each student is required to give a short presentation (5-10 minutes) in class. You can either present your solution to a homework problem, or present some research on a prominent historical figure in Probability. Details are on LATTE.

**Pre-requisite:** In this course you will need to take a few derivatives and solve some double integrals. At a minimum, you need two semesters of Calculus, and ideally you have seen multivariable Calculus.

**Disability Accommodation:** If you are a student who needs academic accommodations because of a documented disability, please contact me and present your letter of accommodation as soon as possible.

**Academic Integrity:** You are expected to be familiar with and to follow the University's policies on academic integrity (see [brandeis.edu/studentlife/sdc/ai](http://brandeis.edu/studentlife/sdc/ai)). I will report any instances of alleged dishonesty to the Office of Student Development and Conduct. Repercussions may include failing the course or suspension from Brandeis. Please ask me for any clarification.

**Disclaimer:** Elements of this syllabus may change as the course wears on, if I see the need to modify them.