MATH 160 Monte Carlo Methods | Syllabus

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A Monte Carlo method is any algorithm that makes random choices during the execution of the algorithm. This allows us to build algorithms that cannot be tricked by unusual data, and are much faster than deterministic ones. These algorithms have an enormous number of applications, from high dimensional integration to model selection to finance. In this course the major types of Monte Carlo methods will be introduced. This includes one-dimensional methods such as inverse transformation and the alias method, and high dimensional methods such as Markov chains, and partially recursive acceptance rejection. The last part of the course will cover simulation of continuous processes such as Brownian Motion.

Textbook

The textbook is *Monte Carlo Methods (2019 Edition)*. This book is open access, free to download, and available on the class website. It is still in the draft stage of writing, which means that it will be updated as the courses continues.

Office hours and communication

I will hold office hours on Monday from 1:15-2:15, Tuesday from 1:30-5:00, and Friday from 11:00-11:50. I am happy to make an appointment with you if there are time conflicts with regular office hours. Another option is to email me. Please begin your subject line with **MATH 160** so that I can filter your emails from the spam. While I try to check my email often, I have not yet been assimilated into the collective, and so you should not assume that I will answer your emails immediately. If you do send an email with a question and later figure it out on your own, please send me a second email and let me know. That will help me clear the queue of questions faster for the entire class.

Exam dates

The exams for the course depend on whether you are a senior or not a senior. If you are a senior, there will be three midterms:

Midterm 1	27 Feb at regular class time
Midterm 2	10 Apr at regular class time
Midterm 3	8 May at regular class time

If you are not a senior, then you will have two midterms and a final.

Midterm 1	27 Feb at regular class time
Midterm 2	10 Apr at regular class time
Final	See `https://www.cmc.edu/registrar/final-exam-schedules`

The date for the final is set by the registrar and cannot be changed. Please bear this in mind when making your travel arrangements. Unfortunately, I am prevented by the handbook from giving the senior midterm to non-seniors, so you must take the two midterms and a final unless you are graduating.

Assignments

There will be weekly assignments, posted on Wednesday and due back the next Wednesday. While you are welcome to work together on the assignments, the final write ups should be your own. In the write ups, indicate your calculations and reasoning for all work submitted. For numerical answers, draw a box around your answer and sue four significant figures for approximation (unless instructed otherwise in the problem statement.)

Homework will be graded from 0 (nothing right) up to 10 points for perfect papers. There are ten questions on each assignment, each worth one point. Problems vary from easy to difficult, so be sure to look over an assignment to see what you are up against before Tuesday night. You should not assume that late homework will be graded; grading time is limited and late papers have the lowest priority.

Before handing in your homework, please staple all papers together and write your name and the assignment number on the first page. Turn in papers held together by paper clips or origami at your own risk.

The two lowest homework scores of each semester will be thrown out. This is basically to handle those emergencies where you are unable to complete an assignment for external reasons that would just sound silly if you tried to email them to me as an excuse. I strongly recommend you save these free passes as long as possible and do not blow off an early assignment, since the later assignments tend to be more difficult. This especially applies to those of you with term papers (or senior thesis) for other courses—that free homework assignment can be lifesaver for the last week of the semester.

The homework is designed to take 4 to 6 hours each week. Roughly speaking, this involves an hour of looking over notes, an hour or two of solving the problems, an hour in office hours getting strategies for tackling more difficult exercises, and an hour or two on the final write up. Your time needs will vary, and I always recommend starting the assignment as early as possible, especially the computer related parts.

You are allowed to work together on the homework, but the write up must be your own. The homework is a service provided for your benefit to gauge your understanding of the material.

Just to emphasize: the homework is worth at most 1/4 of your grade. The homework are exercises that allow you to test yourself on your comprehension of the material, and practice your skills in preparation for the tests. I'm often asked what the best way to prepare for the tests. The answer: try to do the homework by yourself, and only after questions arise talk with friends or come in and see me.

Labs

Occasionally a session of class will be declared (at least 24 hours in advance) as a lab session. Turning in a lab will gain you one extra credit point, so you are highly encouraged to attend these sessions.

If you cannot attend a session due to illness or conflict, please let me know as soon as possible so that

you can make up the lab session.

You will be required to use a computer to do these labs. If you have a CMC account you may use the computers already in the room. If you have a laptop, you are welcome to bring and use that to do the labs. All of the labs use open source, free software. If you do not have a laptop or a CMC computer account please let me know as soon as possible and we will get you set up with a CMC guest account for the semester.

During labs, you are encouraged to ask myself or your fellow students for assistance on the lab worksheet.

Instant Failure

Failure to turn in 5 or more homeworks in the course on time will result in an F being giving for the course, no matter what your score is on the labs, midterms or final. Even if you can only do one problem half right, turn it in and it will not count against your 5 homeworks. This policy holds unless extraordinary circumstances (as determined by me) hold.

More about the exams

For each of the midterms, you will be allowed to create a sheet (US letter size) of notes (using both sides) that you can use during the test.

The final will be twice the length of the midterms, and you will be allowed to use two sheets, so four sides.

You may also use a scientific calculator (not your phone!) during the test if desired.

The exams will test your ability to read and write R code, use packages related to data sequence, as well as R Markdown.

Class Participation

As part of the classroom experience, I will at times ask questions of randomly chosen members of the class. This is not meant to torture students, rather there are several reasons for this approach. First, I need to determine how understandable the lecture is to the class. I understand the material, but it can be difficult without direct questioning to discover how much the class understands. Second, very few students have the experience of speaking about mathematical topics at the collegiate level out loud. Mathematics and computer science has a language all its own, and homework typically only tests your ability to write the language, and not your ability to speak it. Third, by practicing now in a relatively laid back environment, it will be much easier to converse mathematically when it really matters, such as at a job interview or when presenting work at conferences. Fourth, it keeps people awake.

Grading

For seniors, your homework and three midterms are each worth 100 points. For non-seniors, your final is worth 200 points, so counts twice as much as for seniors.

After calculating your percentage grade, it will be converted into a letter grade as follows.

Score	Grade
93% and up	A
90%-93%	A-
87%-90%	B+
83%-87%	B
80%-83%	B-
77%-80%	C+
73%-77%	C
70%-73%	C-
70% and below	Let's not find out

Note: I do not round scores as mathematically all that does is change the cutoff points. If I wanted 89.5 to be an A-, I'd have said that 89.5 is an A-. It is not. To be clear, if your percentage grade is 89.9999995%, then you will receive a B+. You'll be extraordinarily upset if this happens, but since many of the widths are only three percentage points wide, it is not unlikely that someone in the class will be within 0.1% of a cutoff. I know it's terrible, but changing the cutoff points just puts another student in that position. If your percentage is exactly 90%, however, you will receive the A-.