

## MATHEMATICS OF SOCIAL CHOICE

MATH 19-02 | STS 50-01

DEPARTMENT OF MATHEMATICS | PROGRAM IN SCIENCE, TECHNOLOGY, AND SOCIETY  
TUFTS UNIVERSITY, SPRING 2018

Professor: Moon Duchin (Moon.Duchin@tufts.edu), office hrs Tues 11-1 in BP 113  
TA: Matt Friedrichsen (Matthew.Friedrichsen@tufts.edu), office hrs Thurs 3-4, location TBD  
Lectures: MW from 1:30-2:45 (G+ block) in Eaton 201  
Textbook: *Mathematics of Social Choice* by Christoph Börgers  
Midterm: Thursday Feb 22 (Tufts Monday) in class | Final Exam: Monday May 7, 12-2pm

### OVERVIEW AND TOPICS

[Social Choice Theory](#) is the study of methods of incorporating many individual preferences into a collective decision. The centerpiece of social choice theory is **voting**, but it also encompasses problems of compensation and fair division of resources. This course focuses on the mathematical theory of voting, but I will also bring in topics from history, political science, civil rights, political philosophy, sociology, and psychology to provide context for, and explain limitations of, the mathematical approach.

### PLANNED PACING

Week 1	math background and course overview; Ch1 (preference schedules, basic methods and criteria; votes)
Week 2	Ch 1-2 (majority, unanimity, Condorcet)
Week 3	Ch 3 (spoilers), Ch 4 (Smith set)
Week 4	Ch 4 (Smith set) and Ch 5 (Smithification)
Week 5	<i>review and midterm</i>
Week 6	Ch 6 (beatpath) and Ch 7 (monotonicity)
Week 7	Ch 8 (probability of weird outcomes), Ch 9 (irrelevant candidates)
Week 8	Ch 9-10 and a gloss on Ch 11-12 (the impossibility theorems)
Week 9	More probability; Statistical ties, risk-limiting audits, Benford's law
Week 10	Introduction to Redistricting
Week 11	Gerrymandering and "Compactness"
Week 12	Partisan metrics
Week 13	Political geography: Algorithmic district sampling
Week 14	New metrics; Wrap-up of course

### LEARNING OBJECTIVES

Math 19 meets the following Learning Objectives for mathematics: basic understanding of higher mathematics; written communication; research skills; problem solving skills. We will also meet objectives from other disciplines, including: the ability to examine social structures analytically and critically; how political, economic and social systems shape crucial public domains; the skills to analyze systematic biases in neutral-seeming algorithms and political processes.

I will definitely be showing you mathematically rigorous **proofs** in this class, and I'll expect you to learn to write a persuasive mathematical argument.

## ASSIGNMENT STRUCTURE

This course has one weekly problem set and sporadic reading assignments, plus up to one in-class smartphone quiz per week, which can cover topics from lecture, homework, and/or readings.

There will be a midterm (in Week 5) and a final, and there are no makeup exams. See <http://math.tufts.edu/courses/examPolicy.htm> for information on excused exam absences.

You have the choice between a second midterm (outside of class in Week 10) and a short project—see below for the impact on scoring.

**Problem sets.** Average of 5 problems per week, either from the text or on a handout. Typically HW will be due Fridays and returned Mondays, but this is subject to modification as needed. Since homework is due Fridays and we do not have class that day, you may turn it in to the hallway mailbox in BP or online. To be accepted, homework must have your name or identifying information at the top and **must indicate collaborators and sources**.

**Grading schemes.** There is an optional project in this course, which will involve some reading and writing. Based on whether you choose a project or not, here are the two possible grading schemes. Each adds up to 90 points.

A: Problem Sets (20), Quizzes (10), Midterm 1 (20), Midterm 2 (20), Final (20)

B: Problem Sets (20), Quizzes (10), Midterm 1 (15), Project (30), Final (15)

Most problems will be graded on a 4 point scale, where 4 means “nailed it”; 3 means “mostly right”; 2 means “good start”; and 1 means “you started!” There is absolutely no pre-determined grade cutoff for an A, B, etc. Typically, in my classes, 80% earns an A, and I will be delighted to give A grades to everyone if that is appropriate. I will offer grade estimates after the first midterm so you know how you are doing.

## GENERAL COURSE POLICY

**Respectful atmosphere.** No laptops in class unless you have a documented reason or they are part of a class activity. (Laptops make zombies!) I will strive to treat everyone with respect and to get to know each of you. In particular, I’d like to call you by your preferred name and pronouns—you can enter pronouns on SIS now and I encourage everyone to do so. In a class of this size, it can be helpful for me to call on people to get more folks contributing. I will always try to do this in a respectful way, and just chat with me if you have feedback.

**Academic integrity.** You are encouraged to work together but **your written work must be in your own words, and you must indicate working partners and all other outside sources**. Academic integrity is taken very seriously in this course; please refer to the Code of Conduct in the Student Handbook (<http://students.tufts.edu/student-affairs/student-life-policies/student-handbook>) to review University policy with respect to plagiarism and related issues.

**Accessibility/accommodations.** We will gladly work to accommodate any disabilities brought to our attention. If you are requesting an accommodation due to a documented disability, please register with the Student Accessibility Services Office at the beginning of the semester. To do so, call 617-627-4539 to arrange an appointment. In this class, we’ll work to maximize your learning opportunities whether or not you have a documented disability.

**Homework identifiers.** Because homework is collected and returned in class and spends some time in mailboxes, you have the right to use a *unique identifier* instead of your name in order to protect your privacy. Your educational record is privileged information under the federal Family Educational Rights and Privacy Act (FERPA), and using your name as identifier means that you opt out of this guaranteed confidentiality with respect to homework assignments and scores.