Course Information

The design and analysis of algorithms is one of the central pillars of computer science. This course is designed to be a capstone course in algorithms, and will expose students to some of the most powerful and modern modes of algorithmic thinking —- as well as how to apply them. We will cover a wide variety of topics including hashing, dimension reduction, max flow, linear programming, semidefinite programming, approximation algorithms, multiplicative weights, gradient descent and compressed sensing, and bring students up to the level where they can read and understand research papers.

1 Introduction

Lectures will be held in the room 2-190 from 1:00 to 2:30 p.m. on Mondays and Wednesdays.

Instructor: Ankur Moitra 2-472
moitra@mit.edu

TAs: Michael Cohen
micohen@mit.edu

Christopher Musco
cpmusco@mit.edu

Ali Vakilian
vakilian@mit.edu

Website: http://people.csail.mit.edu/moitra/854.html

The office hours are held by appointment.

2 Prerequisites

The formal perquisites are a course in algorithms (6.046/18.410 or equivalent), probability (6.041 or 18.600) and discrete math (6.042 or 18.200). You will need to have done very well in these courses to keep up with the pace.

3 Office Hours

Monday 3-5pm, Ali Vakilian (32-G614)

Tuesday 3-5pm, Michael Cohen (32-G585C)

Wednesday 3-5pm, Christopher Musco (32-G578)

Friday 10-11am, Ankur Moitra (2-472)

4 Syllabus

- universal hashing, consistent hashing, load balancing, power of two choices
- count-min sketch, dimension reduction, locality sensitive hashing
- max flow, minimum cost flow, multi-commodity flow
- linear programming, duality theory, ellipsoid method, interior point methods
- gradient descent, multiplicative weights, experts, bandits
- semidefinite programming, hyperplane rounding, Grothendieck inequality, approximate coloring
- singular value decomposition, power method, Lanczos, eigenvalues of random matrices
- compressed sensing

5 TQE

Graduate students may count 6.854/18.415J toward their TQE

6 Final Grade

The final grade will be based on weekly problem sets, scribing a lecture and helping grade a problem set and a final project

The grading breakdown is as follows:

Problem sets	55%
Scribing and grading	10%
Final project	30%
Participation	5%

7 Final project

Registered students work individually or in pairs to complete a written final project. In the final project you will read a new (not yet textbook) algorithm from recent research literature and improve upon it via some combination of the following:

- Write a description of greater clarity than the original publication or
- Devise an an improved solution to the problem under consideration, and write up your improvement (with appropriate discussion of the original algorithm).

- Implement the algorithm in order to study its performance in practice. Considerations include choice of algorithm, design of good tests, interpretation of results, and design and analysis of heuristics for improving performance in practice.

The choice of topic and relevant paper(s) must be done with coordination with the instructor and TAs and receive a formal approval.

8 Problem sets

There will be weekly problem sets during the semester with usually four or five problems in each set. The problem sets will be assigned on Wednesdays and will be due **by 7pm** in the dropbox in the G5 lounge in the Stata Center one week after their assignment. Please observe the following:

- Write each problem in the PSET in a separate sheet (as each problem would be graded by separate graders) and write down your name on top of every sheet.
- Specify the name of your collaborators (if done solely on our own write "Collaborators: none") on the first page of the whole PSET.

9 Grading assignment

Each registered student is expected to participate in grading one of the problem sets. The graders will receive a model solution from one of the TAs, and will be expected to attend a grading meeting where you will grade your peers papers. You can work with your TA and the rest of the group of graders to find a time that is convenient for you.

Instructions: Concrete mistakes should be marked and explained. The purpose is that the students get a fair and useful feedback on their solutions.

The grader will receive a score on their performance based the overall quality, precision, and fairness of their grading.

10 Collaboration policy

You are allowed to collaborate on homework, however we ask that you dedicate enough time to think about each problem by yourself before consulting others. Moreover, even while collaborating **you must write up the solution on your own**. You are to identify your collaborators on problem sets, and if you did not work with anyone, you should write "Collaborators: none." If you obtain a solution through research (e.g., on the web), acknowledge your source, but write up the solution in your own words.