Algorithms

• A recipe for mapping inputs to outputs efficiently
• Studied long before there were computers
• Eg: Gaussian elimination, gcd, multiplication
  …
• How to design algorithms?
• How to analyze efficiency and prove correctness?
Algorithms: Why?

Physics is like sex: sure it may give some practical results, but that’s not why we do it.

-Richard Feynman
Algorithms: Why?

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Skills you will learn:

• how to communicate your algorithms

• how to convince others that they work
Algorithms: Why?

Goal: be able to

• Describe a correct algorithm
• Describe a correct algorithm that other people can implement
• Describe a correct algorithm that other people can implement and understand
Approximate Schedule

**Weeks 1-2:** Introductions, asymptotics, some basic algorithms. Graphs, trees, connectivity, testing bipartiteness.

**Weeks 3:** Greedy algorithms for Interval Scheduling, Minimum Spanning Tree, Set Cover, Vertex Cover

**Weeks 4-5:** Divide and Conquer. Algorithms for Sorting, Selection, Closest, Multiplication. Midterm

**Week 6:** Dynamic Programming. Algorithms for Edit Distance, Longest Path, Knapsack.

**Week 7:** Flows and Cuts. Algorithms for Matching, Graph Partitioning.

**Weeks 8-10:** Linear programming, Randomized algorithms
Text Book

Everything you need to know will be in slides. Videos of lectures will be posted on website.
Evaluation

Final: 35%
- in class

Midterm: 25%
- in class

Homework every week: 40%
- You must write up solutions by yourself, but you can/should discuss homework with others.
Time Outside Class

Office Hours:

All office hours on zoom.

To get the most out of this class...

- Start working on the homework early, problems are often deceptively hard.
- Talk to {professor, TAs, students}. Brainstorming sessions really really help!
Anup’s research: Communication Complexity

If two or more people need to compute a function that depends on all their inputs, how long does their conversation need to be?
A recent result

**Thm:** Suppose $A, B \subseteq \{0,1\}^n, X$ uniform in $A,$ $Y$ uniform in $B.$ Then as long as $|A| \cdot |B| \geq 2^{1.01n},$ for any number $k,$
\[
\Pr_{X,Y}[\langle X, Y \rangle = k] \leq O(1/\sqrt{n}).
\]