

## CS 860 (SEC 002): Algorithmic Gems

This course is a journey through several beautiful algorithmic ideas and results, many of which have already had a profound impact on theoretical computer science. We will cover a mix of classical and modern results. A tentative list of topics (which may evolve) is below:

- 1) Karger's Min cut algorithm and Cut Sparsifiers for graphs.
- 2) Fingerprinting: Equality testing, Matrix multiplication verification, Polynomial Identity testing, Schwarz-Zippel Lemma, Matchings.
- 3) The PCP Theorem and the proof of the  $PCP(n^3,1)$  verifier.
- 4) Random walks in graphs: s-t connectivity, the Pagerank algorithm, matchings in regular bipartite graphs.
- 5) The Multiplicative Weights Algorithms (MWU) and its Applications.
- 6) Small space computation: distinct elements sketch,  $\epsilon$ -samplers, and its applications to graph connectivity in dynamic streams.
- 7) Submodular Function Minimization.
- 8) The AKS Primality Testing Algorithm (Annals of Mathematics, 2004).
- 9) Cut Matching Game and Sparsest Cut (JACM 2009).
- 10) Polylogarithmic-Time Deterministic Network Decomposition and Distributed Derandomization (STOC 2020).
- 11) Matching Size Estimation in Sublinear Time (FOCS 2021).
- 12) Nearly Optimal Communication and Query Complexity of Bipartite Matching (FOCS 2022).
- 13) Almost-Linear-Time Algorithms for Maximum Flow and Minimum-Cost Flow (FOCS 2022).

**Format of the class:** The class will be organized as a blend of lectures and a reading group. I will give lectures on several classical results (say, topics 1 through 5) in the first few weeks, during which period students can sign up to present other topics. This will be a great opportunity for us to collectively learn about exciting algorithmic results.

**Meeting Time:** 1:30 PM to 4:20 PM on Thursdays, starting January 11.