

CS 5984: RANDOMIZED ALGORITHMS

This is a graduate level course focused on the use of probabilistic methods in computer science. Probabilistic techniques and randomized algorithms play an increasingly important role in numerous areas, such as, combinatorial optimization, machine learning, communication networks, AI reasoning, data mining, cryptography and bioinformatics. Randomized algorithms are often much simpler than deterministic ones for the same problem, more suited for distributed implementation, and in many cases, *provably* more efficient than any deterministic algorithm. The goal of this course is to introduce students to randomized algorithms and techniques for rigorous probabilistic analysis; important paradigms in designing randomized algorithms would be discussed, along with their applications to different areas, such as computer networks. The main topics include

- (1) (2-3 lectures) Basic probability (random variables and expectation, some common distributions), probabilistic complexity classes, and introduction to randomized algorithms
- (2) (6-8 lectures) Moments and large deviation bounds (Markov, Chebyshev and Chernoff bounds), and applications (computing the median, packet routing in networks, low congestion routing and load balancing)
- (3) (6-8 lectures) Applications of randomization in data structures and graph algorithms: hashing, treaps, skip lists, minimum cut and minimum spanning tree. If time permits, we will also discuss randomized algorithms in data mining.
- (4) (5-6 lectures) Application of randomization in parallel and distributed computing: maximal independent set and contention resolution in mobile ad hoc networks, coloring and perfect matching problems for scheduling in parallel machines
- (5) (1-2 lectures) Markov chains, random walks and approximate counting
- (6) (If time permits) Some sampling from the use of randomization in protocol and network design, online algorithms, and basic probabilistic method (thresholds in random graphs)

Course material: The material would be based on the following books: *Randomized Algorithms*, by Rajeev Motwani and Prabhakar Raghavan, and *Probability and Computing*, by Michael Mitzenmacher and Eli Upfal, in addition to some recent papers.

Prerequisites: A prior course in algorithms (CS 5114) or instructor approval is needed.

Grading: There would be 3-4 homework assignments (50%), a take home mid term exam (20%) and a final exam (30%).

Class hours: Tue, Thurs 3:30-4:45 pm

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