CMPUT 675, Fall 2005: Randomized Algorithms

Course web page: `http://www.cs.ualberta.ca/~mreza/courses/Random05`

All announcements for this course will be posted on this web page.

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Motivation:

The last two decades have witnessed a tremendous growth in the area of randomized algorithms. During this period, randomized algorithms went from being a tool in computational number theory to finding widespread application in many types of algorithms. Two benefits of randomization have spearheaded this growth: simplicity and speed. This course will explore a collection of techniques for effectively using randomization and for analyzing randomized algorithms, as well as examples from a variety of settings and problem areas.

Pre-requisites: A 3rd or 4th year undergraduate course in algorithms and an undergraduate course in probability or statistics. Good mathematical background helps.

Tentative syllabus (may change as we go):

- Basics: random variables, expectation, complexity classes
- Min-cut algorithm
- Moments and deviations: Markov and Chebyshev inequalities
- Coupon collector's problem
- Occupancy and Hashing, Bloom filters, Universal Hash functions (?)
- Balls and Bins, power of two choices (?)
- Randomized selection
- Chernoff bounds and randomized rounding
- The probabilistic method, method of conditional probability
- The Lovász Local Lemma, packet routing
- Sampling, Approximate counting
- Random walks and cover time, rapidly mixing Markov chains (?)
- Amplifying probability by random walks on expanders (?)
- Streaming (?)
- Derandomization

Topics may be covered in a different order, may be skipped, or new topics may be added.

Grading Scheme:

- 3 assignment sets: 60%.
- A take-home final exam or a project: 30%.

The rest of your mark will be based on class participation and providing typed scribe notes for one or two weeks of lectures. Notes for each week are due the next Monday at noon. You will be provided with a LaTeX template.

Collaboration Policy: You are allowed to collaborate with each other for *some* of the questions in the *assignments*. But:

- You are allowed to collaborate within a group of size at most 3 or 4.
- All students must explicitly state the name of other students whom they have discussed with the questions in the assignment.
- You must NOT take any notes from your discussions. In particular, you must write your solutions independently (and in your own words).
- For some questions (as will be indicated) you are *not* allowed to collaborate with each other or use any resources other than the text book.

Text book: Randomized Algorithms, by R. Motwani and P. Raghavan, Cambridge University Press, 1995. (reprinted 1997, 2000).

Further readings:

- "Probability and Computing, randomized algorithms and probabilistic analysis", by M. Mitzenmacher and E. Upfal, Cambridge University Press, 2005.
- "The Probabilistic Method", by N. Alon and J. Spencer, 2nd edition, John Wiley, 2000.
- "Approximation Algorithms", by V. Vazirani, Springer-Verlag, Berlin, 2001.

Other sources: See the course web page for more notes and other sources.