CMPSCI 611: Advanced Algorithms

Course information: Fall 2004

Lecture: Tuesday and Thursday, 1:00-2:15 in CMPS 142.

Lecturer: Professor Micah Adler

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Description: This course provides a graduate-level introduction to the principles underlying the design and analysis of efficient algorithms for some of the most frequently encountered combinatorial problems. The algorithms and techniques to be covered in the course have been chosen for their generality, elegance, and practical relevance. The emphasis will be on obtaining a broad introduction to as many topics as possible, but references will also be provided for those who want to obtain a more in-depth understanding of the topics covered.

Textbook: Cormen, Leiserson, Rivest, and Stein. *Introduction to Algorithms*, Second Edition, MIT Press, 2001.

Additional reading:

- Papadimitriou and Steiglitz, *Combinatorial Optimization: Algorithms and Complexity.* Prentice-Hall 1982, Dover Publications 1998.
- Motwani and Raghavan, *Randomized Algorithms.* Cambridge University Press, 1995.
- M. Garey and D. Johnson, *Computers and Intractability: A Guide to the Theory of NP-Completeness.* Freeman, 1979.

Lecture Notes: The presentation of the material will in many cases differ from that in the textbook, and some of the material does not appear at all in the textbook. Thus, a set of lecture notes will be made available to the students. Note that this year, students will not be responsible for preparing scribe notes for this course.

Prerequisites: The equivalent of an undergraduate algorithms course, as well as general mathematical maturity will be assumed, but no specific prior knowledge is necessary.

Web page: Problem sets, lecture notes, and the like will be available from:
http://www.cs.umass.edu/~micah/cs611/index.html.

Syllabus: The following list is tentative. Items may be added and/or removed, depending on interest and available time.

- Divide-and-conquer algorithms: matrix multiplication; closest pair of points; fast Fourier transforms.

- Graph algorithms: review of basic algorithms; network flow; bipartite matchings.
- Matroids and greedy algorithms: minimum spanning trees; matroids and generalized greedy algorithms; union-find data structures; intersection of matroids.
- Dynamic Programming.
- Randomized algorithms: Quicksort and median finding; min-cut algorithm; polynomial zero testing; perfect matchings; primality testing; Markov, Chebyshev and Chernoff inequalities.
- Linear programming: simplex algorithm; duality; reducing problems to linear programming.
- NP-completeness: theory; Cook's Theorem; reductions.
- Approximation algorithms: classical examples; hardness results; linear programming relaxation; heuristics.

Assessment:

- **Homeworks.** There will be 5 assignments that contribute 50% to your overall grade. You will have 1 week for each assignment.
- **Exams.** There will be two exams for this course. They will both be evening exams: the first one on October 21, and the second on December 9. The second exam will cover only the second half of the course. Each of these exams counts for 25% of your grade.