18.415/6.854 Advanced Algorithms	September 5, 2001

Course Information

Fall 2001

General Information

Instructor:	Michel X. Goemans
Office:	2-351
e-mail:	goemans@math.mit.edu
Phone:	253-2688
Time and place:	Mon-Wed 2:30-4:00PM, room 4-370
Course webpage	http://www-math.mit.edu/~goemans/18.415/18415.html
TAs:	Mohammad Mahdian (mahdian@math.mit.edu) Jan Vondrak (vondrak@math.mit.edu
Office hours:	TBA

Time change!

Starting this Mon Sept 10, 2001, the lecture will meet from 2:30 to 4:00PM instead of 3:30PM to 5:00PM in the same room (4-370).

Level and Prerequisites

This is a graduate course on the design and analysis of algorithms, covering several advanced topics not studied in typical introductory courses on algorithms. Prerequisites include "Introduction to algorithms" (at the level of 18.410J/6.046J), linear algebra (at the level of 18.06 or 18.700), and mathematical maturity (since we'll be doing a lot of correctness proofs). The course is especially designed for doctoral students interested in theoretical computer science.

Class list

In order to maintain a class list, e-mail `goemans@math.mit.edu` with "register advanced algorithms" in the subject.

Syllabus

The emphasis will be on the design and (careful) analysis of algorithms (especially on tools and techniques), and not at all on their implementations. In most cases, we will go through mathematical preliminaries before diving into algorithms. The course will be divided into several topics listed below. The list is actually subject to change (and especially what exactly is covered), based on the level of the audience. Some of you may have seen some of these topics, especially linear programming and network flows, in other subjects, but here the emphasis is going to be on advanced results (after having covered or skimmed through background material). Here is the preliminary list:

- Linear Programming.
  - geometry, Farkas' lemma, strong duality
  - complexity
  - interior-point algorithms
  - ellipsoid algorithm and optimization vs. separation
  - extension to conic programming
- Network Flows.
  - maximum flows, min-cost flows
  - cycle cancelling algorithms
  - strongly polynomial-time analysis
  - minimum cuts without flows
- Approximation Algorithms.
  - limits to approximability
  - basic techniques and vertex cover
  - primal-dual technique
  - semidefinite programming
  - multicommodity cut via embedding metric spaces
  - approximation scheme for Euclidean TSP
- Planarity Testing of Graphs.
- Number-Theoretic Algorithms.
  - primality testing
  - Diophantine approximations
  - basis reduction for lattices
- Data Structures.
  - van Emde Boas queues
  - splay trees
  - dynamic trees

Scribing

At every lecture, one or two students will be responsible for taking good scribe notes, polishing them and turning them into typeset scribe notes (in LaTeX). The scribe notes will be available for download from the course homepage as soon as they are ready. Having good scribe notes with all the technical details is important. Please get in touch with the TAs to sign up for scribing (the earlier you do it, the easier) in advance; if we don't have volunteers ahead of time, we will randomly select a "volunteer" at the start of the lecture.

Students scribing should try their best to get the notes ready as quickly as possible. For people scribing on Monday, the notes should be ready by the end of the week-end, and for people scribing on Wednesday, they should be ready by the following Tuesday morning. As soon as the notes are ready, send the latex source file and any postscript figure to the instructor and TAs for review. We'll then contact you for changes if needed.

Students who prepare a good set of scribe notes on time will be exempted from one of the problem sets (at their choice; if they do all of them, we'll not count the lowest score).

Course Work

There will be about 6 problem sets, but no quizz, project or final. Problem sets will not be accepted late unless one of the TAs or the instructor has been informed well in advance, and for a good reason. Many students (but possibly not all depending on the enrollment) will be expected to scribe lecture notes; see above for details.

Textbook

There is no required textbook. Lecture notes from a few years ago are available for some of the topics from the course webpage. The webpage will also be updated with pointers and references, and also contains a list of reference textbooks when appropriate. As indicated before, scribe notes will be made available as soon as possible.