Topics in Algorithms

Lecturer: Shay Solomon
email: shayso@tauex.tau.ac.il

Brief course description

The course revolves around graph algorithms. We will cover basic principles in algorithm design, including randomized algorithms and linear programming, and demonstrate their applicability to areas such as dynamic graph algorithms and distributed computing.

At least a third of the course will be devoted to dynamic graph algorithms, which are, roughly speaking, algorithms that aim to efficiently cope with the constantly changing physical world.

A *tentative* list of topics that will be covered

- Introduction to graph spanners: Spanners for general graphs and geometric spanners
- Introduction to randomized algorithms: Matrix multiplication, Karger's min-cut algorithm, Turan's theorem
- Introduction to linear programming
- Dynamic graph algorithms: Maximal and approximate maximum matching, vertex cover, MIS, forest decomposition
- Distributed algorithms: Luby's algorithm, forest decomposition, and more (if time permits)

Course Material

The course is based on material from several textbooks (see the list below) as well as papers that have been published in the last few years, which will be linked from the course website.

Textbooks:

- M. De Berg et al. *Computational Geometry.* Springer, 1997.
- R. Motwani and P. Raghavan. *Randomized Algorithms.* Cambridge University Press, 1995.
- C. H. Papadimitriou and K. Steiglitz. *Combinatorial optimization: algorithms and complexity.* Courier Corporation, 1998.
- D. Peleg. *Distributed computing: a locality-sensitive approach.* Society for Industrial and Applied Mathematics, 2000.
- V. Vazirani. *Approximation Algorithms.* Springer, 2001.

Course Requirements

Scribing (50% of final grade): Each student or pair of students will scribe a (2 hour) lecture throughout the semester. The goal is to produce a clearly written PDF document containing the lecture's content, ideally via LaTeX. This may involve filling in details that were skipped in class.

The remaining 50% of the final grade can be achieved via one of the two following options. **Enrolling to the research track is subject to the lecturer's approval.**

Option I: Regular track (50% of final grade): There will be two homework assignments throughout the semester, each constituting 25% of the final grade. Students are allowed to submit the homework individually or in pairs. Cooperation between students is allowed to some extent but ultimately each student or pair of students must write their own solution to the homework.

Option II: Research track (50% of final grade): Instead of submitting homework as in the regular track, each student or pair of students can choose to do a research project. The goal of such a project is to study a research question—to be chosen jointly with the lecturer, which should ideally (but not necessarily) be related to the lecture that the student or pair of students scribe. A successful research project *need not* solve or make progress towards solving the studied question, but should nonetheless obtain some new (nontrivial) insight into the question.