Lecture Notes from DD2440, Lecture 1, first hour

Notes by Isak Nilsson.

General Information

The requirements for passing the course, as well as the basis for grading, are 2 projects and 3 homework assignments with deadlines distributed over the autumn. The projects may be done alone or in pairs and can be awarded at most 100 points per project. Deadlines are November 5th and December 8th. The homeworks must be done individually and can be awarded at most 40 points per homework. Most likely they will consist of 5 questions worth 8 points each, to be handed in on paper. Homework deadlines are October 17th, November 19th and December 17th. The sum of points from homeworks and projects will be the sole base for the grade of the course. See the homepage for grade levels.

The programming language used will be anything accepted by Kattis, presumably. The first homework will hopefully be up Monday.

Topics We'll Cover in the Lectures

The course contains 15 lectures, including this introductory lecture. One lecture will probably be a guest lecture held by Torbjörn Granlund on the 3rd or 5th of November. The following topics will be covered:

1. Computational models.

2. Sorting, Hashing, Searching.

3. Integer factorization and primality.

4. Efficient arithmetic on large integers; the Karatsuba algorithm multiplying in $o(n^2)$ will be covered.

5. Approximation algorithms; linear programming with applications such as the Traveling Salesperson problem will be covered. (Linear programming seem to be largely unknown to us students so the basic theory will also be covered in a lecture.)

6. Semidefinite programming for approximation; Max-Cut is an example problem. Up-to-date methods for making approximation algorithms that are fast in theory (polynomial time) but not yet in practice. We'll see some simple applications of this.

7. Parallel algorithms; using many processors, achieving sublinear time. Used in multi-core machines which are getting increasingly common. We'll go through the theory of this for some arithmetic and sorting (although many students have come across the subject earlier).

8. Computational geometry; we'll look at some $o(n^2)$ algorithm. We could have a look at finding-the-closest-point, for instance.

9. Kolmogorov complexity; data compression. We'll do the basic theory.

Optional Topics

Also, some topics were listed as optional:

Optional-1: Lattices basis reduction; handles discrete lattices, used in many applications. The algorithms is known as "L^3" as it appeared in a paper by Arjen Lenstra, Hendrik Lenstra and Laszlo Lovasz.
Optional-2: Planarity of graphs; layout a graph to 2D without any crossing edges.
Optional-3: General matching; an algorithm for matching things that are of one type, for instance pairing up friends. This is much harder than bipartite matching where we match items of different types, say sellers and buyers.
Optional-4: Quantum algorithm for factoring; designed for implementation on a quantum computer.
Optional-5: Network flows.

Upon voting, the popularity of the optional topics from most popular to least popular was 4, 3, 2, 5, 1, so the quantum algorithm won. This is not yet implementable for lack of quantum computers and so might be suitable for the very last lecture, which we won't have time to include in the homeworks anyway.

Lecture Notes

A system was suggested for updating the old lecture notes from 1999. The idea was that one student per lecture would take responsibility for recording the lecture's contents using LaTex, so that fresh notes may be posted continuously on the course homepage for repetition purposes or for people who miss lectures. The student taking notes would be compensated with some extra project/homework points for their effort.