Capita Selecta In Algorithms and Complexity

Department of Electronic and Computer Engineering
Technical University of Crete

Syllabus – Spring 2007

Web site: `www.softnet.tuc.gr/~vsam/csalgo`

Instructors: Vasilis Samoladas `vsam @ softnet tuc gr`
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Meetings: Wednesdays, 3pm-5pm, MUSIC conference room.

Communication: We may communicate in the following ways (in order of preference):

- In the classroom.
- Through the course mailing list.
- Through email.
- In our offices during office hours.

Mailing list: To subscribe to the course mailing list, send an email to

`csalgo-list-subscribe@softnet.tuc.gr`

and follow the instructions therein. Detailed instructions are available on the course website.

Description: This is an advanced graduate-level course on selected topics of Algorithms and Complexity. It will cover (in random order) the following topics:

1. **Algorithms**
   - *Parallel algorithms.* The PRAM model, EREW and CREW. The speedup theorem. Valiant's BSP model. Prefix sums and list ranking on the PRAM. Sorting networks, the 0-1 theorem. Sorting on PRAMs.
   - *Algorithms for external memory.* Sorting. Basic data structures. Indexability and lower bounds. Cache-oblivious algorithms: the model, matrix algorithms, sorting, range search using the van Emde Boas layout.
   - *Randomized algorithms.* Simple combinatorial problems, indicator variables, the inequalities of Markov and Chebyshev. Randomized sorting and selection.
2. **Complexity**
   - *Complexity classes.* An overview of the "complexity zoo". The hierarchy of complexity classes (L, NL, NC, P, NP, co-NP, PSPACE, EXP). NP-Completeness. The theorems of Savitch and Hartmanis-Stearns.
   - *Extended models of complexity.* Randomized and alternating Turing machines, randomized complexity classes and their relationship to the polynomial hierarchy.

- *Advanced complexity topics.* Probabilistic complexity classes, Kolmogorov-Chaitin complexity, random numbers, incompressibility, the number of wisdom.
- *Non-standard models of complexity.* Communication complexity, Learning complexity.
- *Alternative models of computation.* Quantum computing, DNA computation.

Bibliography:

1. Rajeen Motwani and Prabhakar Raghavan. *Randomized Algorithms.* Cambridge University Press, 1995.
2. Michael R. Garey and David S. johnson. *Computers and Intractability: A Guide to the Theory of NP-Completeness.* W. H. Freeman and Company, 1979.

Requirements: The course requires a strong undergraduate background in Algorithms and Theory of Computation. Beyond that, some mathematical sophistication is desirable, but not necessary.

Lectures: Attending the lectures is essential in this course, as there is little chance to study independently. In each lecture, one student will be designated as **scriber** with the responsibility to take good notes and produce a 3–5 page summary of the lecture, which will be put online.

Grading: The course grade will be computed as follows:

- 20% for class attendance, participation, and grading.
- 30% homework (3 sets of problems, each counting 10%).
- 50% final written examination.

Homework: Three sets of problems will be given throughout the course. You will have roughly two weeks to complete each set and return it. As this class does not have Teaching Assistants, grading will be done by the students themselves, i.e. each student will grade the work of other fellow students. Thus, on average, each student is expected to grade three homeworks.

Latex: Another goal of this course is to familiarize all students with LaTeX, the best document preparation software for scientific texts. Thus, all homeworks, as well as scribing will be done in LaTeX.