Computational Complexity - Fall 2001/2002

Dr. Amos Beimel

The notions of "computation" and "efficient computation" are among the fundamental notions in computer science, if not the most fundamental notions. Complexity theory defines these notions and classifies the computational problems according to their computational hardness, that is, their "complexity." In this course we will cover the basics of complexity theory.

The course is a mandatory graduate students. Good third year undergraduate students (average 85 and above) who are interested in theoretical computer science are invited to join.

Prerequisite Course: Design of algorithms.
Grades: Final exam, 70%. Students MUST PASS the exam to pass the course.
Homework assignments, 30%. There will be about 6 homework assignments.

Syllabus:

1. Undecidability. Turing machines and the Church thesis. The halting problem is undecidable. Rice's theorem and other undecidable problems.
2. The P vs. NP question. NP-completeness of SAT and other problems.
3. Time and Space Complexity. The relation between deterministic and non-deterministic complexity classes (Savitch's and Immerman-Szelepcsenyi's Theorems). Time and space hierarchies.
4. Complexity classes. We will cover *some* of subjects below:
   - Efficient reductions. Problems complete for NL, P, and PSPACE.
   - Boolean circuits and the class P/poly. Parallel computation and the class NC.
   - Probabilistic algorithms and Probabilistic complexity classes. The classes RP and BPP.
   - Counting problems and the class #P.
   - Interactive proof systems. The class IP and its equivalence to PSPACE.
   - Approximation algorithms and hardness of approximation. PCP characterization of NP.

Books:

1. M. Sipser. *Introduction to the Theory of Computation*. PWS Publishing Company, 1997.
2. C. H. Papadimitriou. *Computational Complexity*. Addison-Wesley, 1994.
3. J. E. Hopcroft, R. Motwani, and J. D. Ullman. *Introduction to Automata Theory, Languages, and Computations*. Second Edition, 2001.
4. M.R. Garey and D.S. Johnson. *Computers and Intractability, a guide to NP-completeness*. 1979.

Information:

Lectures hours:	Tuesday 14:00-16:00, Building 90, Room 235,		
	Wednesday 14:00-16:00, Building 90, Room 241.		
Reception hours:	Wednesday 12:00-14:00, Building 58 (Math and CS), Room 205.		
E-mail:	beimel@cs.bgu.ac.il	**Phone:**	647 7858
Course home page:	http://www.cs.bgu.ac.il/~beimel/Courses/complexity2001/		