# CS 6520: Computational Complexity

**Spring 2008**

## General Information

**Lecture Time and Place**: Tuesday & Thursday 12:05 – 1:25, Bunger-Henry 311

**Instructor**: Yan Z. Ding, ding@cc.gatech.edu
Office: Klaus 3138
Phone Number: 404-385-2880

All emails concerning this course should have a subject entitled CS6520.

**Administrative Assistant**: Dani Denton, denton@cc.gatech.edu
Office: Klaus Building 2132
Phone Number: 404-385-6440

## What this course is about

Complexity Theory is concerned with the mathematical laws of efficient computation. In complexity theory, one typically asks questions of the following two forms:

1. How much time or space is *necessary* for *any* algorithm to solve a given computational problem?

2. What are the relations between various computational problems? How to characterize all the problems that can be solved within a given amount of computational resources?

Answering questions of the first form is an ultimate goal of complexity theory. However, these questions have turned out to be extremely difficult — it is currently far beyond our reach to provide satisfactory answers to such questions in general. On the contrary, research aiming to answer questions of the second form has enjoyed great success.

This course introduces complexity theory at the graduate level, and consists of two parts.

- The first part will be devoted to basic results, in particular, various complexity classes (such as P, NP, RP, BPP, PH, L, NL, RL, PSPACE, IP, etc.) and their known relations.
- The second part will cover some of the more advanced topics, such as
  - Probabilistic Checkable Proofs (PCP) and Hardness of Approximation.
  - Derandomization.
  - Circuit Lower Bounds.
  - Quantum Computation.

## Textbook

There is no required textbook. Two good references are:

- A draft of the upcoming book "Computational Complexity: A Modern Approach" by Sanjeev Arora and Boaz Barak. Available at the authors' home pages.
- "Computational Complexity: A Conceptual Perspective" by Oded Goldreich. Available at the author's home page.

## Prerequisites

Some background in algorithms and theory of computation at the undergraduate level.

## Requirements

- Homework Assignments
- A Term Paper
- A Take-Home Final Exam

## Collaboration

Students are encouraged to disuss course materials and homework problems in small groups. However, **collaboration in homework assignments is limited to discussion of ideas only, and students must write solutions completely independently**. Students are required to write the names of their collaborators, if any, on each homework assignment. For the term paper, students may work in groups of size up to 3. **No collaboration is allowed for the take-home final exam**.