V22.0453-001: Theory of Computation

Fall 2010

Syllabus

What this course is about

This course introduces the Theory of Computation, which is the study of mathematical laws governing computation. The course will teach how to precisely define and reason about computation, and rigorously prove theorems about its capabilities and limitations. The course consists of two parts. The first part is on Automata and Computatability, which introduces various models of computation, and is concerned with what can be computed and what cannot be computed by each of these models. The second part is on Computational Complexity, which studies computational problems that are computable by a general purpose computer, and investigates how efficiently they can be computed, that is, how much time, space, or other resources are required to solve them.

Outline of Topics

1. Automata, Languages, and Computability:
   (a) Deterministic and Non-deterministic Finite Automata. Regular Languages.
   (b) Pushdown Automata and Context-Free Languages.
   (c) Turing Machines. The notion of an Algorithm. Decidability and Undecidability.
2. Computational Complexity:
   (a) Time Complexity. The classes **P** and **NP**. The **P** vs **NP** question. **NP**-Completeness.
   (b) One or more topics from the following list (though it is unlikely that we would even reach this point):
      - Space Complexity.

- Randomness in Computation.
- Circuit Complexity.
- Interactive Proofs.
- Approximability and Inapproximability of NP-Hard Problems.

Collaboration

Students are encouraged to discuss 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. Under no circumstances may a student copy solutions from any source, including another student's solutions, official solutions distributed in past terms, and solutions from courses taught at other universities. Violation of these rules may result in receiving no credit for a homework assignment, and further disciplinary actions.