Theory of Computation Slides

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Also, let me know if you use them.

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introduction

mathematical background

regular languages and finite automata

context-free languages

computability and Turing machines

complexity, P and NP.

This class teaches two things:

- Mathematical maturity
- Theory of computation

Mathematical maturity

- Is the key to success in your scientific career
- In this class we will:
- Practice mathematical notation: sets, quantifiers, etc.
- Get some exposure to proofs

Theory of computation

- We develop models of computation, and ask: what can and cannot be computed in these models, and how quickly? with how much memory?

- Questions fundamental to all of science. Nature computes!

Theory of computation

- Most famous open question:

Is $P = NP?$

- "Millennium Problem" with prize $1M
- We will learn what this question means in this class

- Overview of material in Theory of Computation
- Automata Theory
- Computability Theory
- Complexity Theory

- Automata Theory

- Finite automata: Computers with no memory
  Motivation: Numbers, names, in Prog. Languages
  Example: *x = -0.0565*

- Context-free grammars: Memory = stack
  Motivation: Syntax, grammar of Prog. Languages
  Example: *if (…) then (…) else (…)*

- Computability Theory
- Turing Machines: “Compute until the sun dies”
- Motivation: What problems can be solved at all?
- Example: Given a program, does it have a bug?
  We will prove impossible to determine!

- Complexity Theory
- P, NP: Model your laptop
- Motivation: What problems can be solved fast?
- Example: Given a formula with 1000 variables like
  (X OR Y) AND (X OR NOT Z) AND (Z OR Y) …
  Is it satisfiable or not?

  Does it take 1 thousand years or 1 second to know?

- Recap
- Automata theory: Finite automata, grammars
- Computability Theory: Turing Machines
- Complexity Theory: P, NP
- Theme: Computation has many guises:
  Automata, grammar, Turing Machine, formula ...