CSE 211 (Theory of Computation)

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Adapted from slides by
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Theory of Computation

- Three areas of theory of computation
    - Automata
    - Computability
    - Complexity
- Linked by the question
    - What are the fundamental capabilities and limitations of computers?

Theory of Computation

- Automata
    - Automaton - a machine made in imitation of a human being
    - DFA, NFA
    - Context-free grammar (CFG), pushdown automata (PDA)
- Computability
    - Decidability
    - What can or cannot be solved
- Complexity
    - Tractability
    - What can or cannot be solved "efficiently"
    - Time complexity: P, NP, NP-complete, NP-hard
    - Space complexity: PSPACE

Theory of Computation

"Computer science is no more about computers than astronomy is about telescopes. "

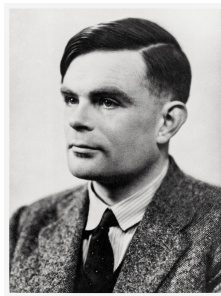— Edsger W. Dijkstra

Theory of Computation

- Computation and computability
    - Building fast vehicles vs can we exceed the speed of light?
    - Building efficient engines vs can we build a perpetual motion machine?

Models of Computation

- Finite Automata
    - DFA, NFA
    - Limited amount of memory
    - Applications in compilers, control units of hardware, etc.
- Context-free grammar
    - More expressive than finite automata
    - Applications in compilers, AI and many other areas
- Turing Machine
    - Even more powerful
    - Can simulate a computer!
    - Problems Turing machine cannot solve are beyond theoretical limits of computation

Alan Turing

- "father of theoretical computer science and artificial intelligence" - wiki
- Proposed Turing machines
    - A general model of computation
    - Can simulate a computer
- Helped break the Enigma code during WW II
- Proposed the Turing test for AI
    - Distinguishing humans and computers through interrogation

Syllabus

- Regular languages
    - Regular expressions
- Finite automata
    - Deterministic finite automata (DFA)
    - Nondeterministic finite automata (NFA)
- Context-free languages
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    - Pushdown automata (PDA)
- Turing machines
    - Equivalence with a computer
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    - Languages described by regular expressions
- Limitations
    - Finite number of states
    - Hence finite amount of memory
- An example of a non-regular language

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Context-Free Languages

- Context-Free Languages
  - Languages described by context-free grammars (CFG)
  - Languages recognized by pushdown automata (PDA)
- Extensively used in compilers (parsers)
- First used in study of human languages

Logistics

- Email
    - atif.bd@gmail.com
- Textbook
    - J. E. Hopcroft, R. Motwani, and J. D. Ullman, *Introduction to Automata Theory, Languages, and Computation*
- Reference books
    - M. Sipser, *Introduction to the Theory of Computation*
    - H. R. Lewis and C. H. Papadimitriou, *Elements of the Theory of Computation*