COSE215: Theory of Computation

Lecture 0 — Introduction

Hakjoo Oh
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Basic Information

Instructor: Hakjoo Oh

- **Position:** Associate professor in Computer Science and Engineering, Korea University
- **Expertise:** Programming Languages, Software Analysis
- **Office:** 616c, Science Library
- **Email:** `hakjoo_oh@korea.ac.kr`
- **Office Hours:** 1:00pm–2:00pm Mondays and Wednesdays (by appointment)

TAs:

- Class 02: Seongjoon Hong and Junhee Lee
- Class 03: Myungho Lee and Donghun Jeon

Course Website:

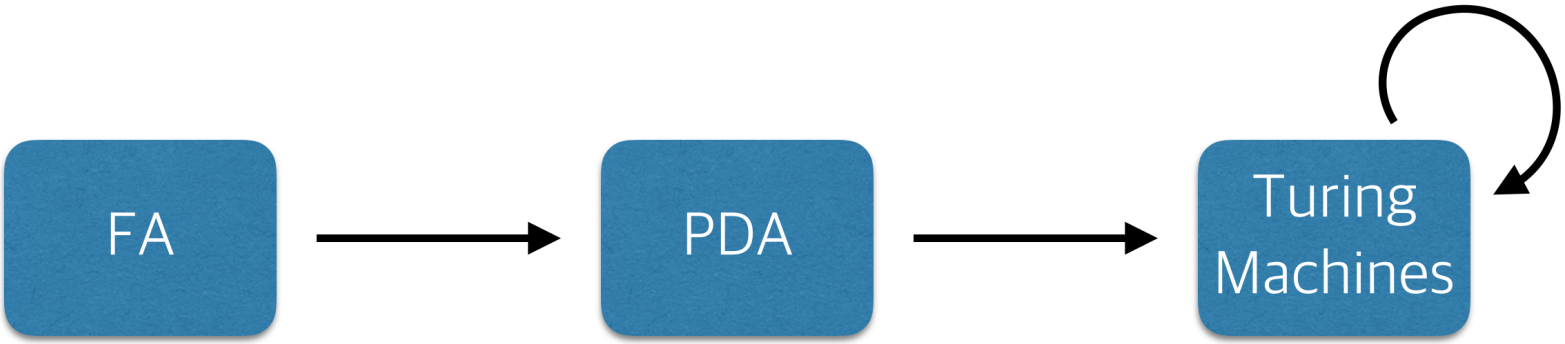
- `http://prl.korea.ac.kr/~pronto/home/courses/cose215/2019/`
- Course materials will be available here.

Goal of This Course

In this course, you will learn the most fundamental ideas in computer science:

- The mathematical model of computer
  - The core idea of computation
- The capability of computer
  - The class of problems that can be solved by computer
  - The class of problems that cannot be solved by computer
  - The class of problems that can be solved efficiently by computer
  - The class of problems that cannot be solved efficiently by computer

RoadMap: Towards Understanding Turing Machines



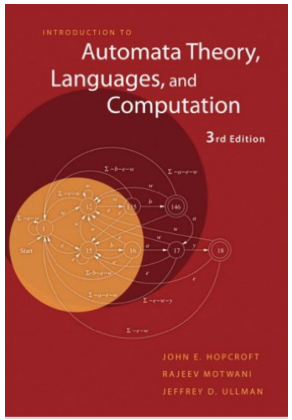
- Finite Automata
  - Regular expressions and languages
  - Applications: text search, pattern matching, etc.
- Pushdown Automata
  - Context-free languages and grammars
  - Applications: e.g., compilers, programming languages, natural language processing, webs, etc.
- Turing Machines
  - Decidability, universal Turing machine

Overview

- **Part 0:** basic concepts, mathematical backgrounds
- **Part 1:** finite automata, deterministic finite automata, nondeterministic finite automata, equivalence, regular languages, regular expressions, regular grammars, connections between regular languages and expressions/between languages and grammars, closure properties, pumping lemma, etc
- **Part 2:** context-free grammars/languages, parsing and ambiguity, normal forms, nondeterministic pushdown automata, relation with context-free languages, deterministic pushdown automata, pumping lemmas, closure properties, decision algorithms
- **Part 3:** turing machines, standard turing machine, Turing's thesis, variations of Turing machines, nondeterministic Turing machines, universal Turing machine, recursively enumerable languages, computability, decidability, halting problem, reduction, recursive functions, complexity, P/NP

Course Materials

- Self-contained slides will be provided.
- Reference:



John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman. Introduction to automata theory, languages, and computation. Third edition.

Grading

- 3–5 Homework assignments – 30%
- Midterm exam: (in class, 75 minutes) – 30%
- Final exam: (in class, 75 minutes) – 30%
- Attendance and participation – 10%

Assignments policy:

- You have roughly one and half weeks for each homework assignment.
- All the assignments must be as a stapled printout, in class, on the due date *before* lecture begins. **No late submissions will be accepted.**
- The writing must be clear and legible. What cannot be read/understood will not be graded.
- All homework assignments must be your own work.

Schedule (tentative)

Week 1	Introduction
Week 2	Finite Automata
Week 3	Regular Languages
Week 4	Properties of Regular Languages
Week 5	Context-free Languages
Week 6	Simplifications and Normal Forms
Week 7	Pushdown Automata
Week 8	Mid-term exam
Week 9	Properties of Context-free Languages
Week 10	Turing Machines
Week 11	Other Models of Turing Machines
Week 12	A Hierarchy of Formal Languages
Week 13	Limits of Algorithmic Computation
Week 14	(optional) Other Models of Computation
Week 15	(optional) Computational Complexity
Week 16	Final exam

Next Class

- Mathematical backgrounds and notation