Lecture 0 – Course Overview

COSE215: Theory of Computation

Jihyeok Park

PLRG

2025 Spring

Course Information

- **Instructor:** Jihyeok Park (박지혁)
  - **Position:** Assistant Professor in CS, Korea University
  - **Expertise:** Programming Languages, Software Analysis
  - **Office hours:** 14:00–16:00, Tuesdays (appointment by e-mail)
  - **Office:** 609A, Science Library Bldg
  - **Email:** jihyeok_park@korea.ac.kr

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- **Teaching Assistant:**
  - Jungyeom Kim (김준겸) – kimjg1119@korea.ac.kr
  - Seongmin Ko (고성민) – 2018320221@korea.ac.kr
  - Hyunjoon Kim (김현준) – rickykhj@korea.ac.kr

Grading

- **6 Homework Assignments: 30%**
  - Programming assignments in Scala (submission in **LMS**)
  - You can utilize or refer to any other materials (e.g., ChatGPT), but you **MUST** write your **OWN** solution.
  - Cheating is strictly prohibited. Cheating will get you an F.

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- **Midterm exam: 30%**
  - April 23 (Wed.) 13:30 – 14:45 (in class, 75 min.)

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- **Midterm exam: 30%**
  - April 23 (Wed.) 13:30 – 14:45 (in class, 75 min.)
- **Final exam: 30%**
  - June 18 (Wed.) 13:30 – 14:45 (in class, 75 min.)

Grading

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- **Midterm exam: 30%**
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- **Final exam: 30%**
  - June 18 (Wed.) 13:30 – 14:45 (in class, 75 min.)
- **Attendance: 10%**
  - Please use **LMS** to attend the class with the code provided.
  - Today's attendance check is a test run.

Schedule

Weak	Contents	Weak	Contents
1	Basic Concepts	9	Pushdown Automata
2	Deterministic Finite Automata (DFA)	10	Deterministic Pushdown Automata
3	Nondeterministic Finite Automata (NFA)	11	Properties of Context-Free Languages
4	Regular Expressions and Languages	12	Turing Machines (TMs)
5	Properties of Regular Languages	13	Extensions of Turing Machines
6	Context-Free Grammars and Languages	14	Undecidability
7	Parse Trees and Ambiguity	15	P, NP, and NP-Completeness
8	**Midterm Exam (Apr. 23 - Wed.)**	16	**Final Exam (Jun. 18 - Wed.)**

- There will be no offline lectures on May 5 (Children's Day).
- Instead, a recorded lecture video will be uploaded to **LMS**.
- You don't need to check the attendance on May 5.

Course Materials

- **Self-contained lecture notes.**

https://plrg.korea.ac.kr/courses/cose215/

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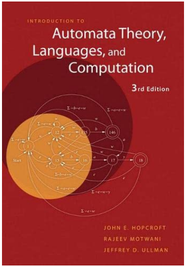
- Reference:



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

Goal of This Course

PLRG

- What is the *mathematical model* of computers?

Goal of This Course

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Turing Machine!

Let's learn **Turing Machine**

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- Is it possible to solve *every problem* using computers?

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- What is the *mathematical model* of computers?

Turing Machine!

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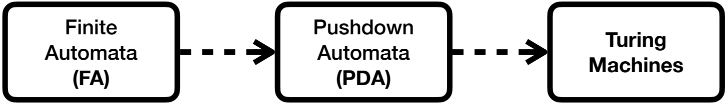
- Is it possible to solve *every problem* using computers?

No!

Let's learn **Undecidability** and **Intractability**

Roadmap: Towards Turing Machine

A Turing machine is a specific kind of **automaton**.



- **Part 1: Finite Automata (FA)**
  - Regular Expressions (REs)
  - Regular Languages (RLs)
  - Applications: text search, etc.
- **Part 2: Pushdown Automata (PDA)**
  - Context-Free Grammars (CFGs)
  - Context-Free Languages (CFLs)
  - Applications: programming languages, natural language processing, etc.
- **Part 3: Turing Machines (TMs)**
  - Lambda Calculus (LC)
  - Recursively Enumerable Languages (RELs)
  - Undecidability and Intractability

Roadmap: Towards Turing Machine

	Automata	Grammars	Languages
(Part 3) Turing Machines	(Lecture 23) ETM $\rightleftarrows$ (Lecture 21/22) TM $\rightleftarrows$	(Lecture 24) LC	(Lecture 21) REL $\cup$ DL (Lecture 25) $\supset$ (Lecture 26) $\mathbf{NP} \overset{?}{=} \mathbf{P}$ $\supseteq$
(Part 2) Pushdown Automata	(Lecture 14/15) $\mathrm{PDA}_{\mathrm{FS}} \rightleftarrows \mathrm{PDA}_{\mathrm{ES}}$ (Lecture 16) $\rightleftarrows$ $\cup$ $\mathrm{DPDA}_{\mathrm{FS}} \supset \mathrm{DPDA}_{\mathrm{ES}}$ $\cup$ (Lecture 17) $\not\cup$	(Lecture 11/12) CFG **Chomsky Normal Form** (Lecture 18)	(Lecture 11) CFL - - (Lecture 13) **Parse Trees & Ambiguity** **Closure Properties** (Lecture 19) **Pumping Lemma** (Lecture 20)
(Part 1) Finite Automata	(Lecture 4) NFA $\rightleftarrows$ (Lecture 3) DFA $\rightleftarrows$ (Lecture 5) ϵ-NFA $\leftarrow$ (Lecture 7) **Equivalence & Minimization** (Lecture 10)	(Lecture 6) RE	(Lecture 3) RL **Closure Properties** (Lecture 8) **Pumping Lemma** (Lecture 9)
(Part 0) Basic Concepts	(Lecture 1) **Mathematical Preliminaries**	(Lecture 2) **Scala**	

Introduction of Automata

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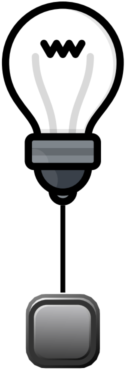

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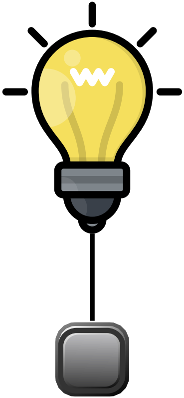

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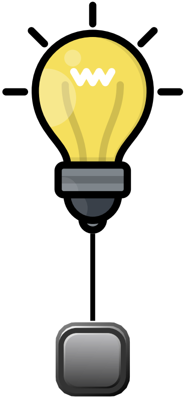
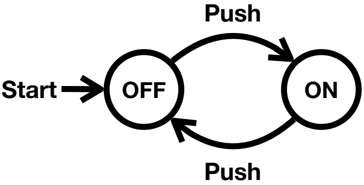
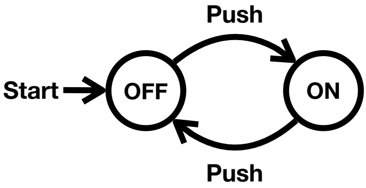


$\Longrightarrow$



Introduction of Automata



Theorem

The current state is OFF *if and only if the button is pushed even times.*

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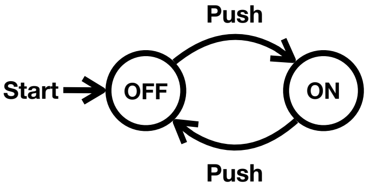

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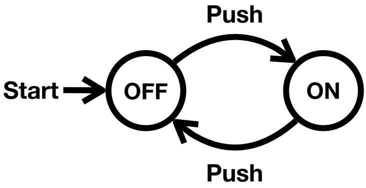

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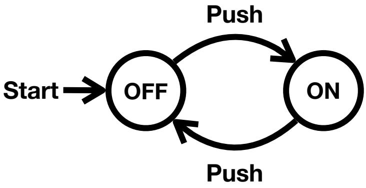

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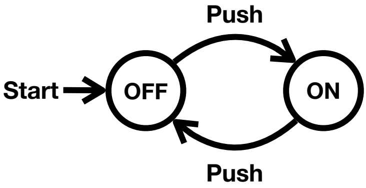

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- Is it possible to implement the automaton?

Let's learn **Scala** as an implementation language.

Next Lecture

- Mathematical Preliminaries

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