Welcome to COSE214 - Algorithms!

Fall 2025, Korea University

Instructor: Gabin An (gabin_an@korea.ac.kr)

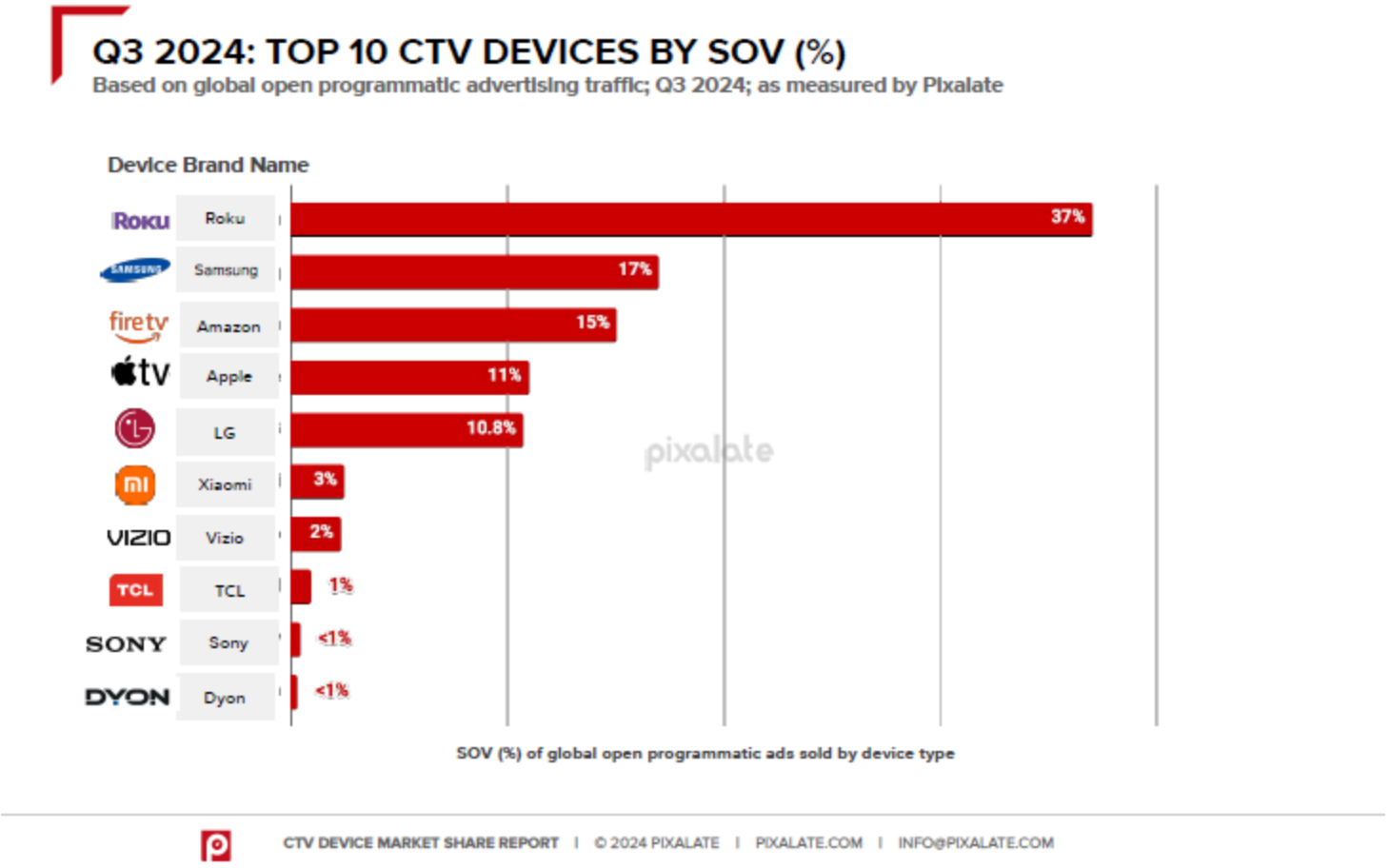
I. Introduction

Who Am I?

- Instructor: Gabin An (gabin_an@korea.ac.kr)
  - Assistant Professor, Department of Computer Science and Engineering
  - Ph.D. in Computer Science, KAIST (Major: Software Engineering)
  - Published in top **Software Engineering / Software Testing** venues, including FSE'24, ICSE'23, ASE'23, ICSE'22, ISSTA'21, and others
  - Served on program and organizing committees of major SE conferences (e.g., ICSE'25 PC, ASE'25 PC & OC, ICST'26 OC, ...)
- Websites:
  - 🌱 Personal: https://agb94.github.io
  - 🧫 Lab: https://ku-selene.github.io

Industry Experience

- Software Engineer in Test, Roku (Jun 2024 – Jul 2025)



Software Engineering Laboratory for next-gEN Ecosystems

> Our new research group, SELENE 🌙, launches this semester!

Mission: Conduct research that leads to **BETTER software**

📣 We are looking for **undergraduate research assistants** who are interested in:

- Automated Software Testing and Debugging
- Applications of Large Language Models (LLMs) to Software Engineering
- Log Parsing & Analysis Algorithms

> E.g., Using LLMs to discover and resolve software bugs
> Detecting mismatches between code and documentation
> Designing efficient algorithms that can extract patterns from messy system logs

Who are you?

Why are you here?

Because...

- Algorithms are **fundamental**, **useful**, and **fun**! 😊

Now, let’s be real… 🤓

- COSE214 is a **required course** for Computer Science majors.

Okay, why is COSE214 required then?

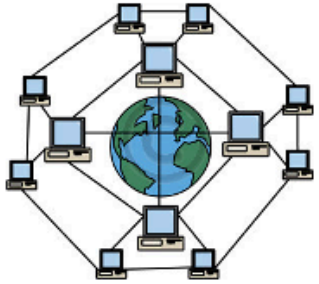
Because...

- Algorithms are **fundamental**.
- Algorithms are **useful**.
- Algorithms are **fun**.

1. Algorithms are fundamental.

- Algorithms are the **backbone of computer science**.
- Wherever CS goes, algorithms are there:

Operating Systems
- Scheduling Algorithms
- Efficient Data Structures



Networking
- Shortest-path Algorithms
- Congestion Control

Compiler
- Parsing algorithms
- Register Allocation (Graph Coloring)

Cryptography
- Fast *Modular Arithmetic*
- *Integer Factorization Algorithms*

2. Algorithms are useful.

- Two major drivers of technological progress:
    i. **Hardware improvements** (e.g., Moore's Law)
    ii. **Algorithmic breakthroughs**

> **Hardware alone isn't enough.**
> Smarter algorithms can outperform brute force hardware gains.

3. Algorithms are fun.

- Algorithm design is where **logic meets creativity**.
- Some problems still lack efficient algorithms. We're still searching.
- Unexpected solutions and counterintuitive insights abound.

> Algorithms aren't just about coding. They're really about how we think 🧠.

🧐 What *is* an Algorithm?

Let's build this up step by step:

1. **What is a Problem?**

   A *problem* is a binary relation between inputs and correct outputs.

2. **What is an Algorithm?**

   An *algorithm* is a finite, well-defined procedure that maps inputs to outputs.

   > Think of an algorithm as a function.

3. An algorithm **solves** a problem if:

   It produces the **correct output for every input** in the problem's domain.

14. Longest Common Prefix

Easy | Topics | Companies

Write a function to find the longest common prefix string amongst an array of strings.

If there is no common prefix, return an empty string `""`.

Example 1:

```
Input: strs = ["flower","flow","flight"]
Output: "fl"
```

Example 2:

```
Input: strs = ["dog","racecar","car"]
Output: ""
Explanation: There is no common prefix among the input strings.
```

Constraints:

- `1 <= strs.length <= 200`
- `0 <= strs[i].length <= 200`
- `strs[i]` consists of only lowercase English letters if it is non-empty.

Python3 | Auto

```python
class Solution:
    def longestCommonPrefix(self, strs: List[str]) -> str:
        # your algorithm!!!!

```

Course Goals

- Get to know a variety of **interesting and classic problems**
  - e.g., sorting, shortest paths, scheduling, etc.
- Learn to **think analytically** about algorithms
- Build your own **algorithmic toolkit**
- Learn to **communicate clearly and precisely** about algorithms

Course Outline (Before Midterm) - *subject to change*

- Part 1: Basics
  - Divide and Conquer (w/ Integer Multiplication)
  - Basic Sorting Algorithms (Insertion Sort & Merge Sort)
  - Asymptotic Analysis (Big-O, Big-Theta, Big-Omega)
  - Solving Recurrences Using Master Method
- Part 2: Advanced Selection and Sorting
  - Median and Selection Algorithm
  - Solving Recurrences Using Substitution Method
  - Quick Sort, Counting Sort, Radix Sort
- Part 3: Data Structures
  - Heaps, Binary Search Trees, Balanced BSTs

Course Outline (Before Midterm) - Main Problems to Cover (1/2)

- Integer Multiplication

$$9 \cdot 8 = 72$$

$$5678 \cdot 1234 = 7006652$$

$$3141592653589793238462643383279502884197 \cdot 271828182845904523536028747135266249775 7 = ?$$

Course Outline (Before Midterm) - Main Problems to Cover (2/2)

- Sorting

```
sort([3, 6, 4, 8, 1])
# Expected: [1, 3, 4, 6, 8]
```

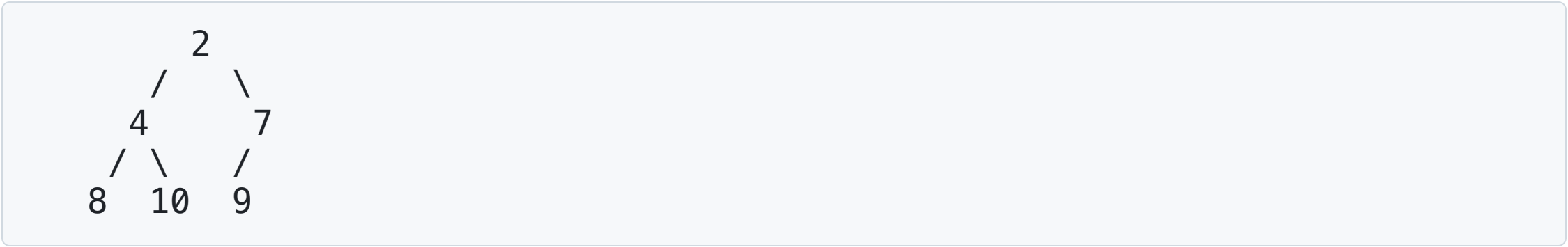
> There are many sorting algorithms. How can we formally prove their *correctness* and demonstrate that one is more efficient than another?

- Selecting the k-th smallest element

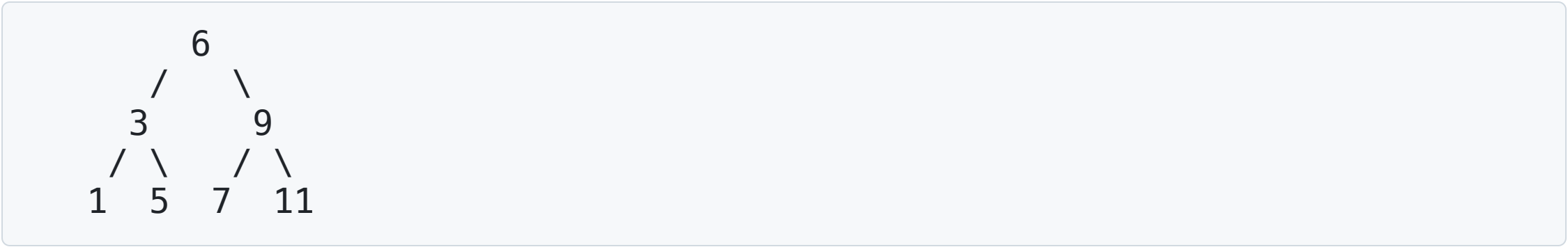
```
select([3, 6, 4, 8, 1], 2)
# Expected: 3

select([3, 6, 4, 8, 1], 5)
# Expected: 8
```

Course Outline (Before Midterm) - Data Structure Examples

- Heap (Min-Heap): The parent is always less than or equal to its children.



- Binary Search Tree: left child < parent < right child



Course Outline (After Midterm) - *subject to change*

- Part 3: Data Structures - Continued
  - Graphs, Graph Search and Applications
- Part 4: Dynamic Programming
  - Shortest-Path: Dijkstra, Bellman-Ford, Floyd-Warshall Algorithms
  - More Dynamic Programming: Longest Common Subsequence, Knapsack Problem
- Part 5: Greedy Algorithms
  - Scheduling Problem, Huffman Coding
  - Minimum Spanning Trees
  - Max Flow, Min Cut and Ford-Fulkerson Algorithms
  - Stable Matching, Gale-Shapley Algorithm

II. Logistics

Offline Lectures

- Time: 1:30-2:45pm, Tuesdays & Thursdays
- Place: Room #610, Jung Woonoh IT & General Education Center
    - 정운오IT교양관 610호

Course Resources

- Course website: KULMS (https://mylms.korea.ac.kr/courses/73181)
  - Announcements, lecture notes, assignments, and all other resources will be posted here!

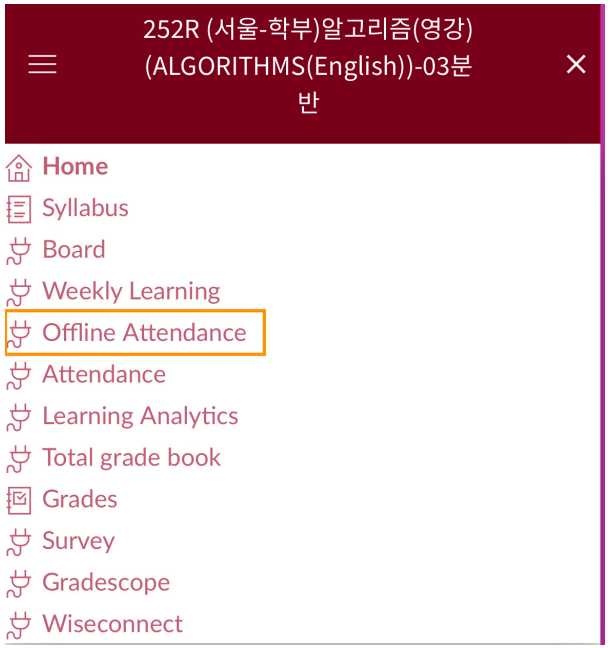
Office Hours

- Time
  - 3:00-5:00pm, Thursdays
- Place
  - Room #204, Woo Jung Informatics Building (우정정보관)
    - Tentative for September — location may change later in the semester
- Details
  - **September only**: Appointment required - *please email me to schedule*. ‼️
  - **From October onward**: No appointment needed — feel free to drop by with questions!
    - The new office location will be announced later.
  - You're also welcome to ask questions right after the lecture.

Grading

- Attendance: 5%
- Quizzes & Assignments: 15%
- Midterm Exam: 40%
- Final Exam: 40%

Attendance Check

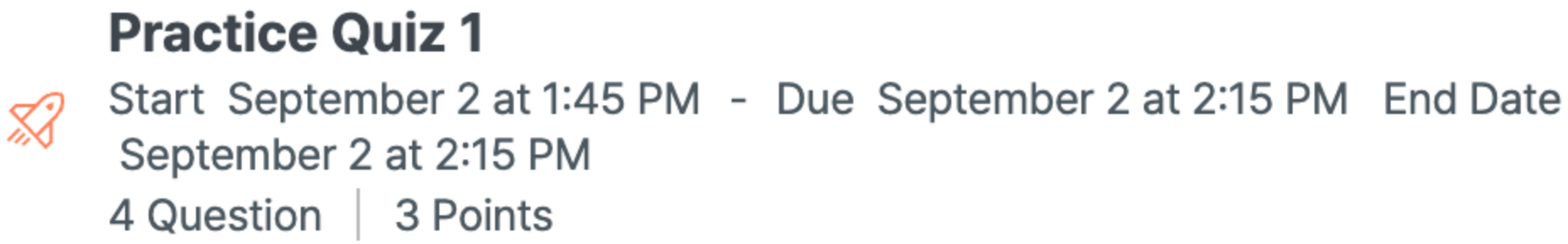


- Hybrid Use of Manual & Smart Attendance
- Each student will receive **two** tokens:
  - 1 token → Covers one absence
  - 0.5 token → Excuses one late arrival

Quizzes & Assignments

- Quizzes will be conducted in class through the LMS system.
- The **lowest quiz score will be dropped**. For example, if there were four quizzes, and you scored `[10, 8, 9, 0]`, the `0` would be excluded.
- Assignments will be either “problem-solving” or “programming” (Python) assignments (TBD).
- Quizzes and assignments carry equal weight. For instance, if there are 3 quizzes and 2 assignments, the lowest quiz score will be dropped, and the remaining 4 items will be equally weighted in the final grade.

Practice Quiz!



- Check out at https://mylms.korea.ac.kr/courses/73181! 📝
- passwd: `algorithmisfun!`

Exams

We will have **offline, in-person exams**:

- **Midterm Exam**
  - 1:30–2:45 PM, Thursday, October 23
- **Final Exam**
  - 1:30–2:45 PM, Thursday, December 18
- **Format:** Closed book, with **one A4 cheat sheet (both sides)** allowed
- **Alternate exams** will be provided **only** for students with a documented scheduling conflict. Please notify the instructor in advance if this applies to you.

Collaboration and Academic Dishonesty

- Plagiarism is strongly prohibited. Do not copy other students' work. If this happens, that will be reported to the department.
- I can’t stop you from using LLMs (e.g., ChatGPT or Gemini), but keep in mind that *algorithms are a fundamental part of computer science*. You’ll retain much more if you take the time to study and work through the material yourself.

Credits & Resources

Lecture materials adapted from:

- Stanford CS161 slides and lecture notes
  - https://stanford-cs161.github.io/winter2025/
- *Algorithms Illuminated* by Tim Roughgarden
  - https://algorithmsilluminated.com/