

**CSE221**

# Intro to data structures

Fall 2021

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Acknowledgment: The content of this file is based on the slides of the textbook as well as the slides used in former lectures at UNIST.

# Acknowledgement & Others

- Lecture slides courtesy of Professor MJ Jeon and Professor Sam H. Noh

Acknowledgment: The content of this file is based on the slides of the textbook as well as the slides provided by Prof. Won-Ki Jeong and Prof. Tsz-Chiu Au.

# Why This Class Crucial?

- To go out and rock the interviews!

#	Title	Solution	Acceptance	Difficulty	Frequency	🔒
1	<a href="#">Two Sum</a>		38.8%	Easy		
2	<a href="#">Add Two Numbers</a>		29.1%	Medium		
3	<a href="#">Longest Substring Without Repeating Characters</a>		24.9%	Medium		
4	<a href="#">Median of Two Sorted Arrays</a>		23.7%	Hard		
5	<a href="#">Longest Palindromic Substring</a>		25.6%	Medium		
6	<a href="#">ZigZag Conversion</a>		28.4%	Medium		
7	<a href="#">Reverse Integer</a>		24.4%	Easy		
8	<a href="#">String to Integer (atoi)</a>		14.1%	Medium		
9	<a href="#">Palindrome Number</a>		37.9%	Easy		
10	<a href="#">Regular Expression Matching</a>		24.4%	Hard		
11	<a href="#">Container With Most Water</a>		38.1%	Medium		
12	<a href="#">Integer to Roman</a>		47.4%	Medium		
13	<a href="#">Roman to Integer</a>		49.3%	Easy		
14	<a href="#">Longest Common Prefix</a>		31.9%	Easy		
15	<a href="#">3Sum</a>		22.0%	Medium		
16	<a href="#">3Sum Closest</a>		32.4%	Medium		
17	<a href="#">Letter Combinations of a Phone Number</a>		37.8%	Medium		
18	<a href="#">4Sum</a>		28.2%	Medium		
19	<a href="#">Remove Nth Node From End of List</a>		33.7%	Medium		
20	<a href="#">Valid Parentheses</a>		34.5%	Easy		
21	<a href="#">Merge Two Sorted Lists</a>		42.8%	Easy		

Contribute Question

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# Recruitment: Kakao



## 2020 KAKAO BLIND RECRUITMENT

🕒 3 일 14 시간 26 분  
접수 종료까지

접수 19년 08월 19일 15:00 ~ 09월 04일 23:59  
전형 19년 09월 07일 14:00 ~ 09월 07일 19:00



접수하기



## 2020 KAKAO BLIND RECRUITMENT

### 접수 및 온라인 코딩테스트 안내 사항

- 접수 기간 : 19년 8월 19일(월) 15:00부터 9월 4일(수) 23:59까지
- 온라인 코딩테스트 전형 일자 : 9월 7일(토) 14:00 ~19:00
- 온라인 코딩테스트 사용 가능 언어 : C++, Java, Javascript, Kotlin, Python2, Python3, Swift

# Recruitmen

전형절차			
서류전형	Pre-Test 1차	Pre-Test 2차	Feel the TOAST
온라인 지원서 접수	서류합격자에 한하여 자택에서 진행되는 코딩 테스트	1차 합격자에 한하여 진행되는 SW지식 테스트	NHN의 체험형 면접 전형
8. 26(월) - 9. 17(화)	9. 22(일)	10월 중	10월 말

**TOAST**  
**ROOKIE:19**

[recruit.nhn.com](http://recruit.nhn.com)

접수기간  
**8.26 Mon. — 9.17 Tue.**

"Hello, World!"

INPUT / OUTPUT

AUXILIARY OPERATION

DOCUMENT

6 5 4

**NHN 2019년 하반기  
기술부문 신입사원 공개채용**

COMMUNICATION LINK

PREPARATION

MAGNETIC TAPE

OFF PAGE CONNECTOR

ONLINE STORAGE

**모집부문**

**SW개발**

- 서비스 구축에 필요한 클라우드/미디어/검색/광고 등의 플랫폼 개발
- 모바일, PC 환경에서의 웹 서비스 개발
- 모바일 서비스를 위한 앱과 Client SDK 개발(안드로이드, iOS, Unity3D)

**필수역량**

- 자료구조, 알고리즘, 운영체제, 네트워크, DB 등 전산학을 잘 이해하고 업무에 활용할 수 있는 자
- 자신 있는 개발 언어를 보유한 자 (최소 한 개)
- 언어의 특성을 이해하고 레퍼런스를 참고하여 개발이 가능한 자
- 요구사항을 분석하여 스펙을 정리하고 소프트웨어로 구현할 수 있는 자

# Recruitment: Google

- <https://careers.google.com/how-we-hire/interview/#interviews-for-software-engineering-and-technical-roles>

# What Should be Your Conclusion?

Be prepared for the interviews



Be aware of the key factor to win the interviews



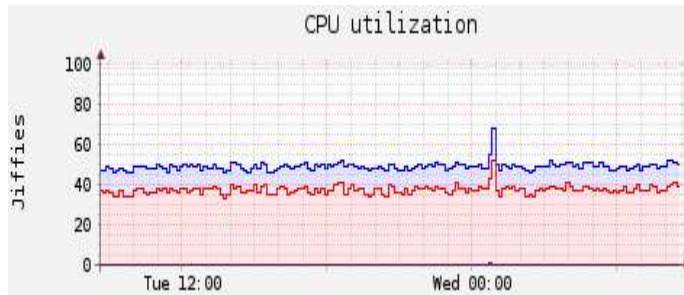
Master data structure

# Data

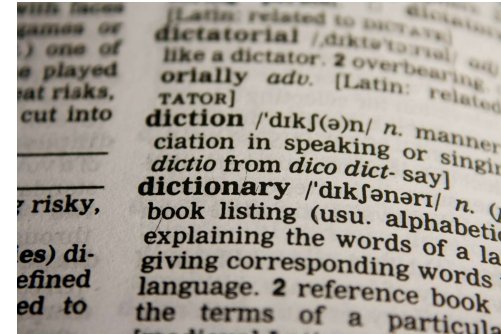
A value or a set of values of certain type(s)



# Types of Data



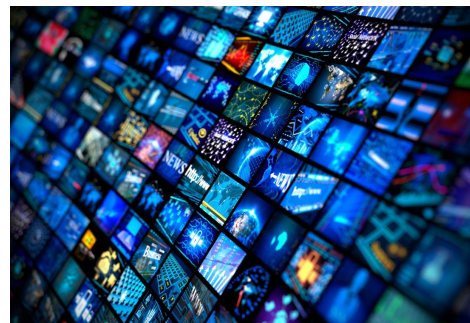
Numbers



Texts

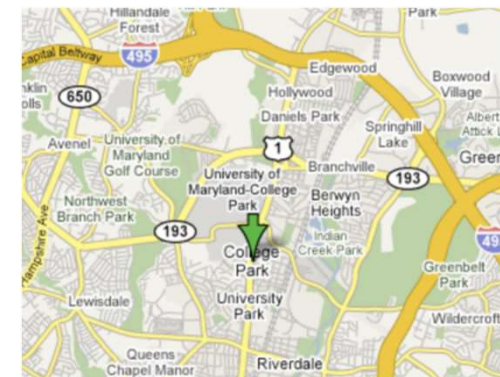


Images



Videos

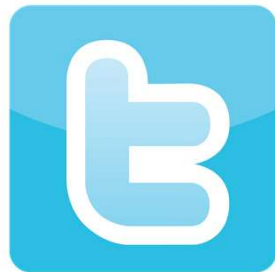
Geolocation



And many others!



6.66 Hours of video uploaded / sec



6000 Tweets / sec



66666 Likes / sec

# Structure

Organizing and storing data in a way that can be accessed and manipulated efficiently

# Real-world Examples

**e•merge** (ī-mûrj') *v.* **e•merged**, **e•merg•ing**.  
**1.** To rise up or come forth into view; appear. **2.** To come into existence. **3.** To become known or evident. [Lat. *emergere*.]  
**—e•mer'gence** *n.* **—e•mer'gent** *adj.*

**e•mergen•cy** (ī-mûr'jən-sē) *n., pl. -ies*. An unexpected situation or occurrence that demands immediate attention.

**e•merit•us** (ī-mēr'i-təs) *adj.* Retired but retaining an honorary title: *a professor emeritus*. [Lat., p.p. of *emereri*, to earn by service.]

**e•mer•ry** (ēm'ə-rē, ēm'rē) *n.* A fine-grained impure corundum used for grinding and polishing. [< Gk. *smuris*.]

**e•met•ic** (ī-mēt'ik) *adj.* Causing vomiting. [< Gk. *emein*, to vomit.] **—e•met'ic**, *n.*

**—emia** *suff.* Blood: *leukemia*. [< Gk. *haima*, blood.]

**e•mi•grate** (ēm'i-grāt') *v.* **-grat•ed**, **-grat•ing**. To leave one country or region to settle in another. [Lat. *emigrare*.] **—em'i-grant** *n.* **—em'i-gra'tion** *n.*

**ē•mi•gré** (ēm'i-grā') *n.* An emigrant, esp. a refugee from a revolution. [Fr.]

**e•mi•nence** (ēm'ə-nəns) *n.* **1.** a position of great distinction or superiority. **2.** A rise or elevation of ground; hill.

**e•mi•nent** (ēm'ə-nənt) *adj.* **1.** Outstanding, as in reputation; distinguished. **2.** Towering above others; projecting. [< Lat. *eminēre*, to stand out.] **—em'i-nent•ly** *adv.*

**e•mpha•tic** (ēm-fāt'ik) *adj.* Expressed or performed with emphasis. [< Gk. *emphatikos*.] **—e•mpha'tic•ly** *adv.*

**e•mphy•se•ma** (ēm'fi-sē'mə) *n.* A disease in which the air sacs of the lungs lose their elasticity, resulting in an often severe loss of breathing ability. [< Gk. *emphusēma*.]

**e•m•pire** (ēm'pīr') *n.* **1.** A political unit, usu. larger than a kingdom and often comprising a number of territories or nations, ruled by a single central authority. **2.** Imperial dominion, power, or authority. [< Lat. *imperium*.]

**e•m•pir•ic** (ēm-pīr'i-kəl) *adj.* Also **e•m•piric** (-pīr'ik). **1.** Based on observation or experiment. **2.** Relying on practical experience rather than theory. [< Gk. *empeirikos*, experienced.] **—e•m•pir'ic•ly** *adv.*

**e•m•piri•cism** (ēm-pīr'i-sīz'əm) *n.* **1.** The view that experience, esp. of the senses, is the only source of knowledge. **2.** The employment of empirical methods, as in science. **—e•m•pir'icist** *n.*

**e•m•place•ment** (ēm-plās'mənt) *n.* **1.** A prepared position for guns within a fortification. **2.** Placement. [Fr.]

**e•m•ploy** (ēm-ploi') *v.* **1.** To engage or use the services of. **2.** To put to service; use. **3.** To devote or apply (one's time or energies) to an activity. **—n.** Employment. [< Lat. *implicare*, to involve.] **—e•m•ploy'a•ble** *adj.*

**e•m•ploy•ee** (ēm-ploi'ē, ēm'ploi-ē') *n.* Also **e•m•ploy•e**. One who works for another.

ă pat â pay â care â father ē pet ē be ĭ pit ĭ tie ĭ pier ō pot ō toe ō paw, for oi noise  
 ōō took ōō boot ou out th thin th this ũ cut ũ urge yoo abuse zh vision ă about, item,  
 edible, gallop, circus

- Key-value list
- Alphabetically sorted

Key  
Value



- Can you find the word I'm giving now?

14

# Real-world Examples

- We will learn hash table to make it easy

WIKIPEDIA

The Free Encyclopedia

Main page

Contents

Featured content

Current events

Random article

Donate to Wikipedia

Wikipedia store

Interaction

Help

About Wikipedia

Community portal

Recent changes

Contact page

Tools

What links here

Related changes

Upload file

Special pages

Permanent link

Page information

Wikidata item

Cite this page

Print/export

Create a book

Download as PDF

Printable version

In other projects

Wikimedia Commons

Languages

Français

한국어

日本語

Edit links

## Ulsan National Institute of Science and Technology

From Wikipedia, the free encyclopedia

This article **needs additional citations for verification**. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed.  
(March 2014) *(Learn how and when to remove this template message)*

**Ulsan National Institute of Science and Technology**, simply referred to as **UNIST** (Hangul: 울산과학기술원; Hanja: 蔚山科學技術院; RR: *Ulsan Gwahak Gisurwon*), is one of the four public universities in South Korea which are dedicated to research in science and technology, along with KAIST, GIST, and DGIST. UNIST was founded in 2007 in response to growing demand for higher education in the Korean industrial capital of Ulsan,<sup>[2]</sup> where world-renowned automotive (Hyundai Motor), shipbuilding (Hyundai Heavy Industries), petrochemical (SK Energy), and secondary cells industries are clustered. At the time of its foundation, UNIST was known for being the first national university in South Korea to be incorporated and thus administered by an independent board of trustees despite being funded by the central government. UNIST has the vision of becoming a world-leader in the advancement of science and technology for the prosperity of humankind. With strong support from central and local governments, UNIST aims to develop at least 10 competitive areas of research with the goal of being ranked top 10 globally by the year 2030.<sup>[3]</sup> The strategies for reaching this goal include creative, interdisciplinary and global education and research.

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1.1 Timeline

2 University rankings

3 Academics

3.1 Undergraduate and Graduate Schools

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7 See also

### History

Despite the fact that Ulsan, with over 1.1 million residents, is an industrial powerhouse of South Korea with the highest GDP per capita among any region in the country, there only existed one university within the city limits, the University of Ulsan. The former president Roh Mu-hyun included the establishment of a national university in Ulsan as part of his campaigning platform and a discussion regarding the university began three years into his presidency along with the construction of a new high speed rail station, Ulsan Station, for the city.<sup>[4]</sup>

The location of the campus was finalized in 2006<sup>[5]</sup> and in 2007, Moo Je Cho was selected as the first president of the new university. Cho appealed to the public that the school should be a science and technology oriented institute in order for the new school to find its niche and to take advantage of a possible synergetic effect resulting from a collaboration between the researchers and the local industry as seen in the case of Stanford University and Silicon Valley or KAIST and Daedeock Innopolis.

UNIST was established by the UNIST bill that was passed in 2007 by the request of the people and city of Ulsan. In 2009, UNIST opened its doors to welcome its first class of undergraduate students.

In March 2015, a new bill was passed in the national assembly recognizing UNIST as one of the four nationally funded research institutes in Korea. Besides changing the Korean name of the school from Ulsan Gwahak Gisurdæ (울산과학기술대) to Ulsan Gwahak Gisurwon (울산과학기술원), the passage of this bill implied a new set of additional changes and benefits from the national government including but not limited to a greater emphasis on graduate education and the waiver of the alternative military service examination for its PhD students.

Timeline

April 6, 2007

*The Act on Establishment and Operation of the National University Corporation, Ulsan National Institute of Science and Technology* was enacted.

September 1, 2007

The first president, Dr. Moo Je Cho, was appointed

October 10, 2007

The first board of directors meeting was held

울산과학기술원

UNIST

ULSAN NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY

울산과학기술원

Motto

First in Change

Type

Public

Established

2007

Budget

152 million USD (2015)

President

Mooyoung Jung

Academic staff

391<sup>[1]</sup> (2016)

Administrative staff

288<sup>[1]</sup> (2016)

Undergraduates

4052<sup>[1]</sup> (2016)

Postgraduates

1332<sup>[1]</sup> (2016)

Location

Ulsan, South Korea

Colors

UNIST Navy, UNIST Emerald

Mascot

Uni(울이) the unicorn

Website

www.unist.ac.kr

Ulsan National Institute of Science and Technology

울산과학기술원, 울산과학기술원, 유니스트

울산과학기술원, 울산과학기술원, 유니스트

Revised

Ulsan Gwahak Gisurwon

Romanization

Ulsan Gwahak Gisurwon

McCune–Reischauer

# Real-world Examples



- Graph
- Shortest path



# Real-world Examples

- Separate queues for different priorities



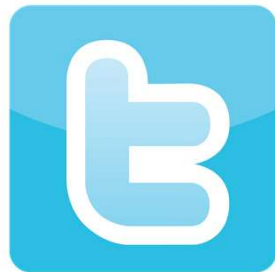


# Does it make a difference?





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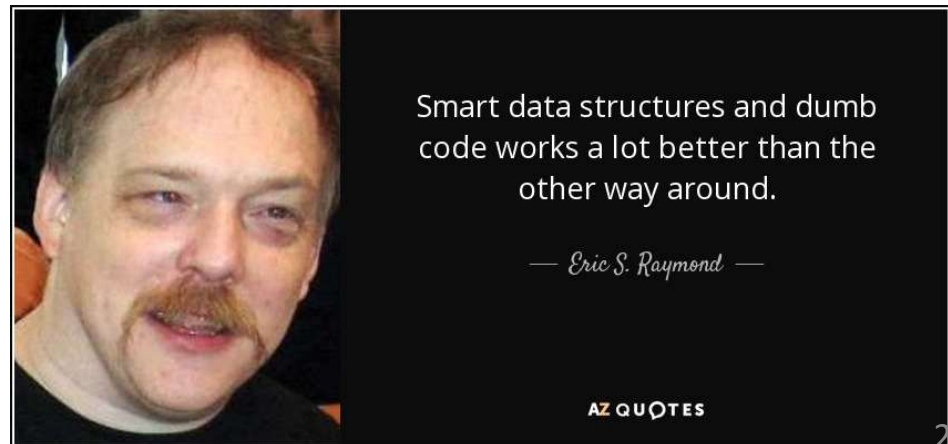
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# Does it make a difference?



# Does it make a difference?

- 2 seconds vs 2 microseconds?
- More cost effective
  - Less memory and storage
  - Less costly CPUs



# CSE221 Data Structures Class

- Data structure
  - Organization of data
- Algorithm
  - Outline of computational procedure
- Language
  - Tool to implement data structures and algorithms
- We will study **data structures and algorithms using C++** in this class!

# Questions?