Lecture 1: Introduction to the algorithm

Algorithm

Jeong-Hun Kim

Table of Contents

Part 1

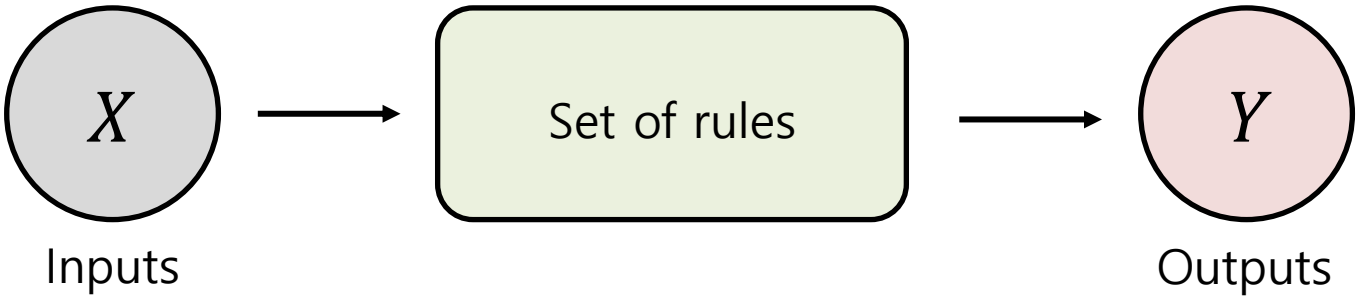
INTRODUCTION TO ALGORITHM

Intro to Algorithm

Al-Khwarizmi
(780?~850?)

- What is algorithm?
  - Procedures and methods to solve given problems
  - A well-defined and clear set of rules
  - Derived from the name of Persian mathematician, Al-Khwarizmi

- Algorithms convert inputs to outputs



Intro to Algorithm

❖ Examples of algorithms

- Cooking recipe

Input

Output

Recipe (algorithm)

1. Water boiling
2. Add noodles and soup base
3. Add an egg and vegetables
4. Serving

Is it unique?

Is it best?

Intro to Algorithm

- Research on algorithms
  - Originally a field of mathematics
  - Finding a method to solve all cases of the specific problem type using the same computational process to derive correct outputs

- Example) Euclidean algorithm
  - Let M, N be two arbitrary natural numbers ($N < M$, $M, N \in \mathbb{N}$)
  - Algorithm to calculate the greatest common divisor (GCD) of M and N:

Step 1. Divide M by N

Step 2. Assign the remainder to R

Step 3. If $R \neq 0$, M and N are reassigned as N and R, respectively, and return to Step 1

Step 4. If $R = 0$, N is GCD

Intro to Algorithm

- Characteristics of the algorithm
  1. Input specified
  2. Output specified
  3. Definiteness
     - ✓ All commands must be unambiguous
  4. Effectiveness
     - ✓ Unnecessary commands should not be included
  5. Finiteness
     - ✓ Must be terminated
  6. Independent
     - ✓ It executes identically in all languages

Part 2

ROLES OF THE ALGORITHM

Roles of the Algorithm

- Algorithms are used in all areas of ICT services
- Program
  - Representation of the algorithm that the computer can understand
  - Algorithm written in a programming language
    - E.g., C, C++, C#, Java, Fortran, MatLab, Python, JS, etc.
  - Sequantial instructions for a specific computing task
    - Instruction: an operation processed by the CPU
- Programming
  - Process of developing a program
  - Analysis + Coding (implementation) + Compiling + Debugging + etc.
- Coding
  - Converting an algorithm into a specific programming language

Roles of the Algorithm

❖ Example of the program

- An algorithm that distinguishes whether the input is odd or even

Step 1. Enter an integer N

Step 2.

If $N \% 2 = 0$, N is even

If $N \% 2 \neq 0$, N is odd

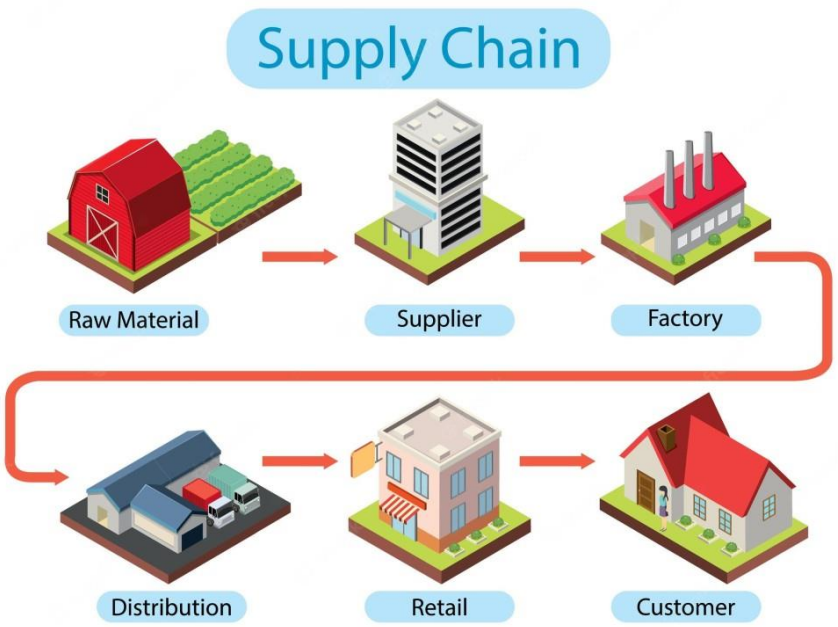
* % is modulo operator

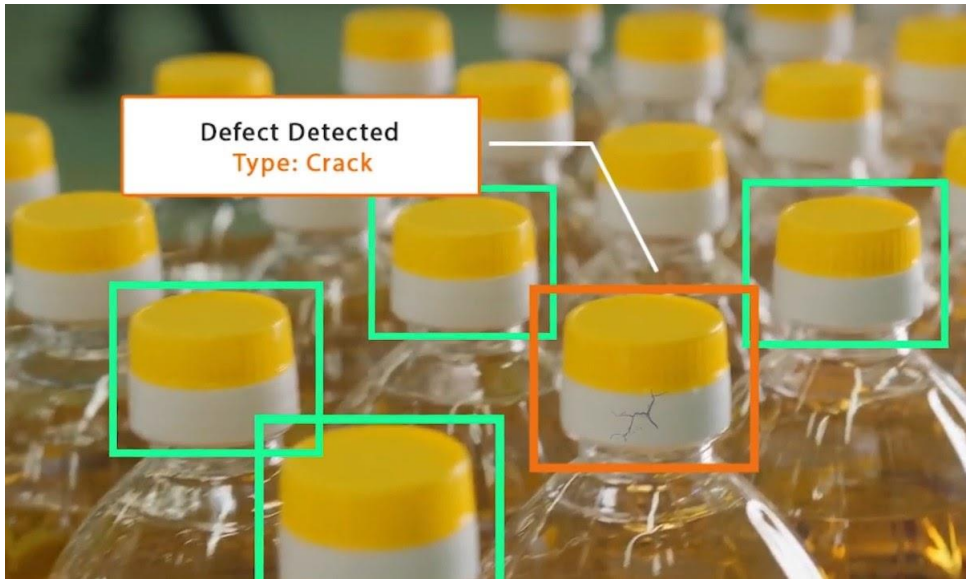
```c
// C programming language
#include <stdio.h>

int main(void){
	int number;
	printf("Input an integer: ");
	scanf("%d", &number);
	if(number % 2 == 0)
		printf("%d is even.₩n", number);
	else
		printf("%d is odd.₩n", number);
	return 0;
}
```

```
Input an integer: 3
3 is odd.
```

Roles of the Algorithm

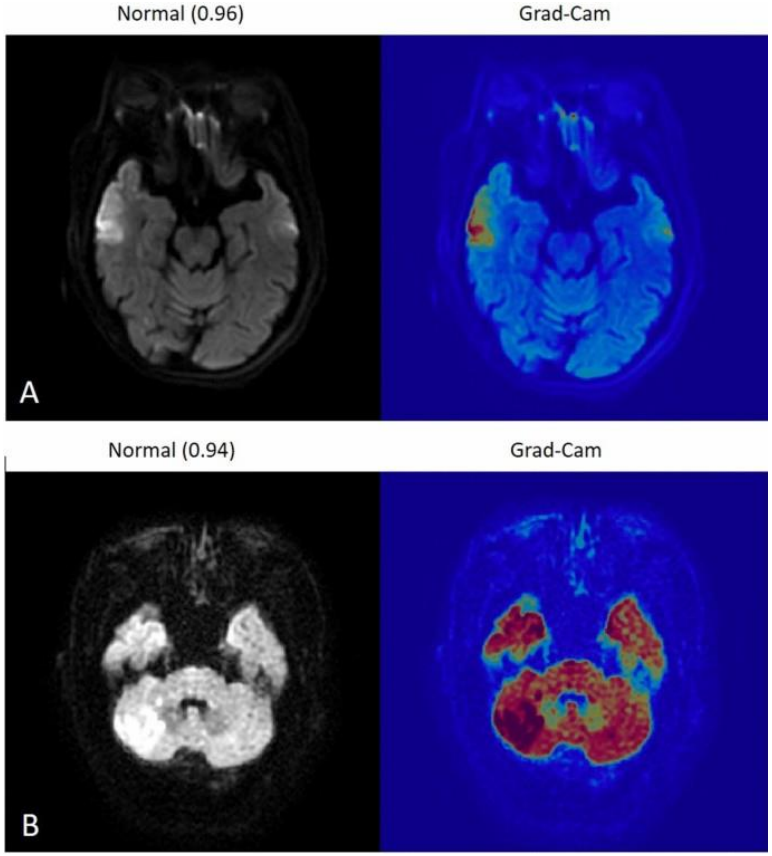
- Algorithms are widely used in various industrial fields
  - Manufacturing
    - Optimize production processes and supply chain management
    - Reduce waste and defects





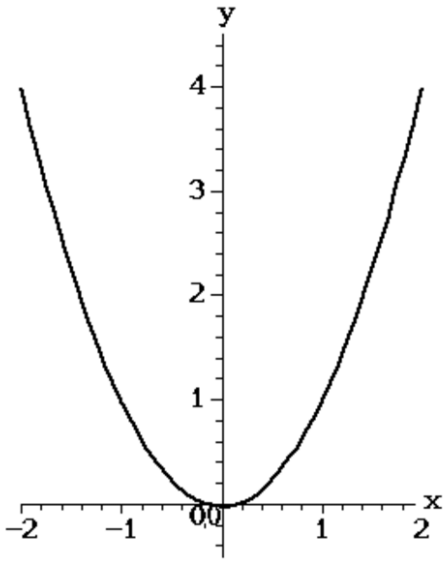
Roles of the Algorithm

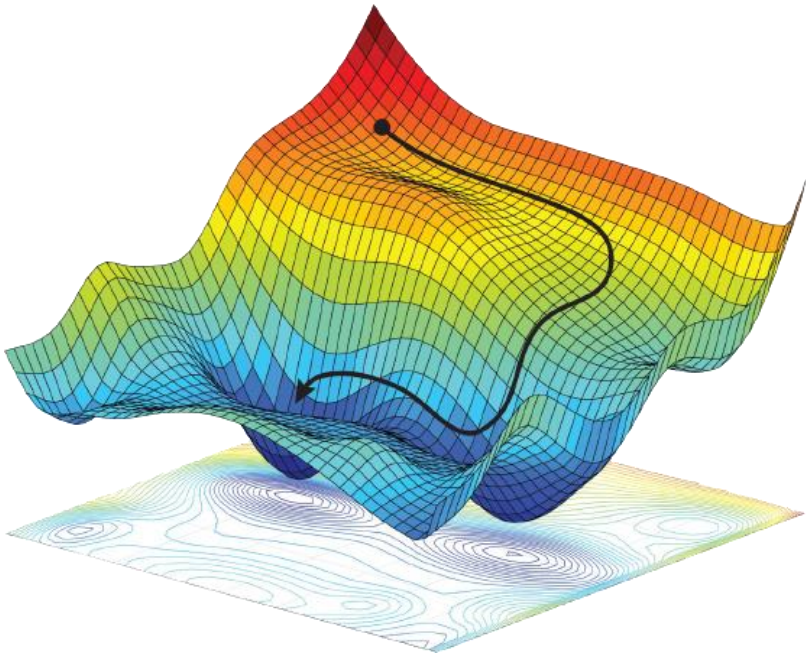
- Algorithms are widely used in various industrial fields
  - Finance
    - Make a decision
  - Healthcare
    - Assist in diagnosing diseases
    - Optimize treatment plans
  - Transportation, energy, security, etc.



Roles of the Algorithm

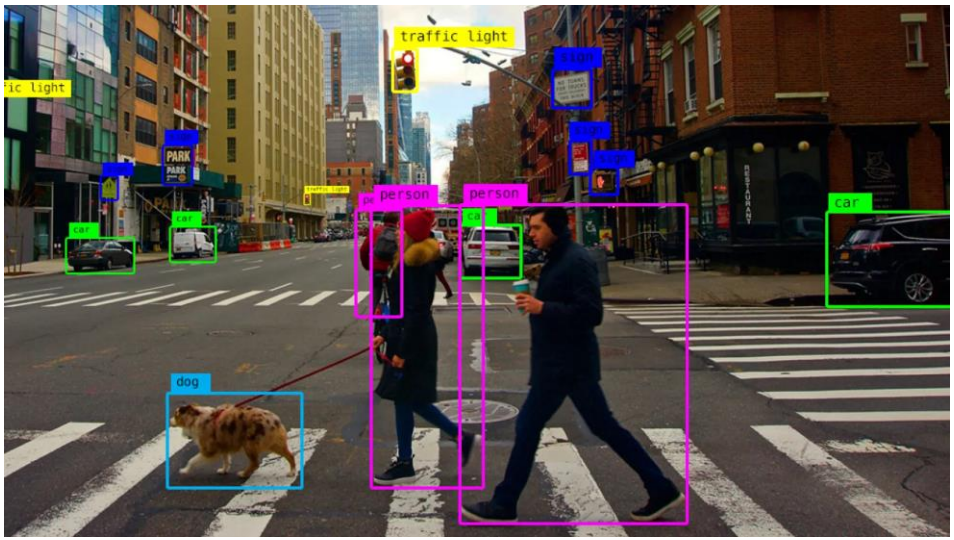
- Algorithms are fundamental to computing and play a crucial role
  - Data processing
    - Analyze large amounts of data, e.g., sorting and searching algorithms
  - Problem solving
    - Mathematical problems, optimization problems, and decision-making





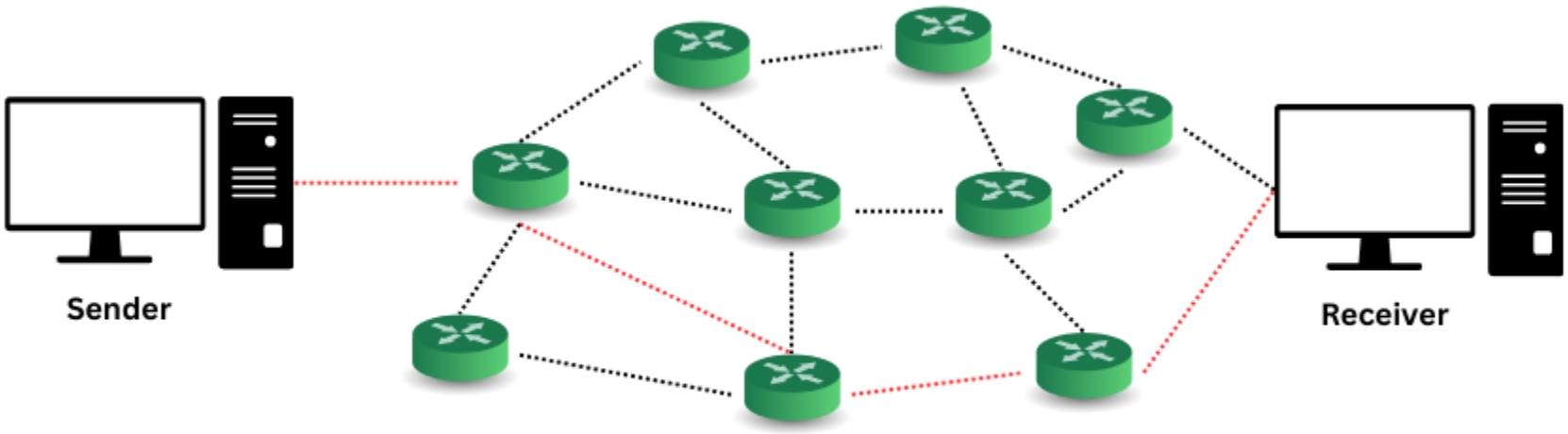
Roles of the Algorithm

- Algorithms are fundamental to computing and play a crucial role
  - Computer grahpics
    - Image compression, image generation, etc.
  - Artificial Intelligence
    - Machine learning, natural language processing, computer vision, etc.
  - Operating systems
    - Process scheduling, memory management, and disk management, etc.



Roles of the Algorithm

- Algorithms play a critical role in networking and communications
  - Routing
    - Determine the best path for data to travel from one device to another
    - Shortest path algorithms and load balancing algorithms



Routing Working Example

Roles of the Algorithm

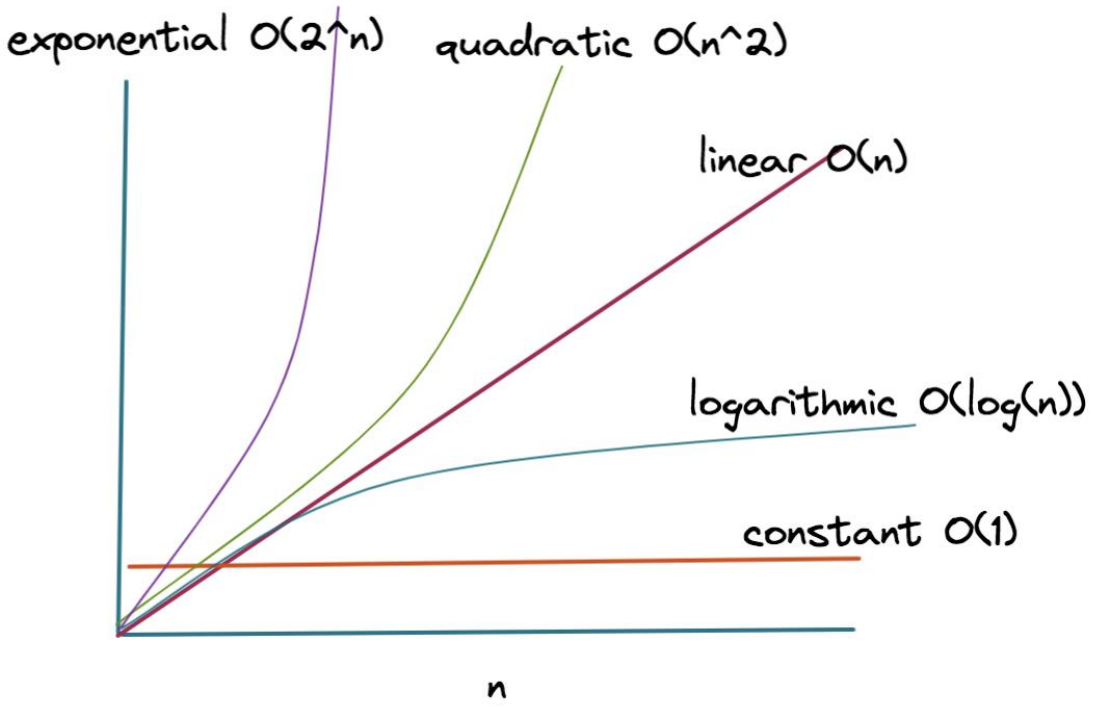
- Algorithms play a critical role in networking and communications
  - Error correction
    - Cyclic redundancy check (CRC) and forward error correction (FEC)
  - Data compression
    - Reduce the amount of data being transmitted
    - Huffman coding and run-length encoding algorithms
  - Network security
    - Encryption and authentication algorithms
  - Quality of Service (QoS), wireless networks, network topology, etc.

Part 3

COMPUTER SCIENCE AND ALGORITHM

Computer science and Algorithm

- Computer science: academic discipline related to algorithms
  - How to create the optimal algorithm under various constraints
  - Typical constraints
    - Space complexity
    - Time complexity



Computer science and Algorithm

- Scope of computer science
  - Various topics applying academic achievements from other fields
  - E.g., Mathematics, engineering, psychology, economy, linguistics, etc.

- Influence of computer science technology
  - Tremendous impact on technologies used for various tasks
  - Significant societal implications

Questions?

SEE YOU NEXT TIME!