Algorithms and Problem Solving

Slides from Heejin Park

Classes

- (1반) Tue. 10:30 & Thu. 13:00 (IT/BT 813, 202)
- (2반) Tue. 16:00 & Thu. 9:00 (IT/BT 508)

Professor: 백은옥

eunokpaek@hanyang.ac.kr

Office Hour

- Tue. 15:00–16:00
- Thu 14:30-15:30

Prerequisite

- Data structure

Teaching Assistants

추유진
chooyu98@hanyang.ac.kr

박지선
sgs04023@hanyang.ac.kr

(02) 2220-4704

Exam 90%
(Midterm I, II & Final)

Attendance 10%

Introduction to Algorithms, 3rd Ed.

MIT Press

T. Cormen, C. Leiserson, R. Rivest, and C. Stein

- **Data structure**
  - List, stack, queue, skip list
  - Trees: binary heap, BST, AVL, red-black tree, B-tree
  - Hashing / Bloom filter
  - Graph: Dijkstra algorithm

- **Algorithm**
  - Sorting: insertion, merge, quick, counting, radix
  - Complexity analysis: Big-oh, recursion tree, amortized analysis, NP completeness
  - Dynamic programming
  - Graph: DFS, topological sort, minimum spanning tree, disjoint set, Bellman-Ford

What is an algorithm?

- **What is a *problem*?**
  - A well-specified input and output.

- **What is an *algorithm*?**
  - A well-defined procedure to solve a problem.

A problem example

- Cooking instant noodles
  - Input
    - chinese noodles,
    - Powder soup,
    - an egg,
    - green onions,…
  - Output
    - Cooked instant noodles

An algorithm example

- Algorithm
  - Boil 500cc of water.
  - Put Chinese noodles and powder soup.
  - Boil for 5 minutes.
  - Put an egg and green onion.
  - Boil for 1 minute.

- **A *computer algorithm***
  - A well-defined *computational* procedure to solve a *computational* problem

- **A *computational problem* example**
  - Computing the sum of integers from 1 to n
    - $S = 1 + 2 \ldots + n$

- **Elementary school algorithm**
  - Compute each addition one by one from the left.
  - $S = (\ldots(((1 + 2) + 3) + 4)\ldots) + n$
- **High school algorithm**
  - $S = n(n+1)\ /2$
- **Are the algorithms above correct?**

- **Elementary school algorithm**
  - Obvious
- **High school algorithm**
  - $S = n(n+1)/2$
    - $2S = 2(1 + 2 + \ldots + n)$
    - $2S = (1 + 2 + \ldots n-1 + n) +$
      $(n + n-1 + \ldots 2 + 1)$
    - $2S = n(n + 1)$
    - $S = n(n + 1)/2$

- **Which one is better?**
  - Elementary school algorithm
  - High school algorithm

- **Performance of algorithms**
  - Running time
  - Space consumption

- **Performance of algorithms**
  - Running time
    - Elementary school algorithm?
    - High school algorithm?
  - Space consumption
    - Elementary school algorithm?
    - High school algorithm?

- **Problem**
  - Computing the sum of integers from 1 to n
    - $S = 1 + 2 \ldots + n$
- **A problem instance**
  - Computing the sum of integers from 1 to 100
    - $1 + 2 \ldots + 100$

- **Problem**
  - Why the problem?
  - Problem definition.

- **Algorithm**
  - Description
  - Correctness
  - Performance