The Role of Algorithms in Computing

Data structures & algorithms (COSC202A)

Lecture 1

Logistics

- Instructor name: Reyan Ahmed
- Email me if you have any questions: rahmed1@colgate.edu
- Course schedule: Tuesday/Thursday 2:45-4:00 pm
- Office hours: Monday/Friday 11:00-12:00 pm
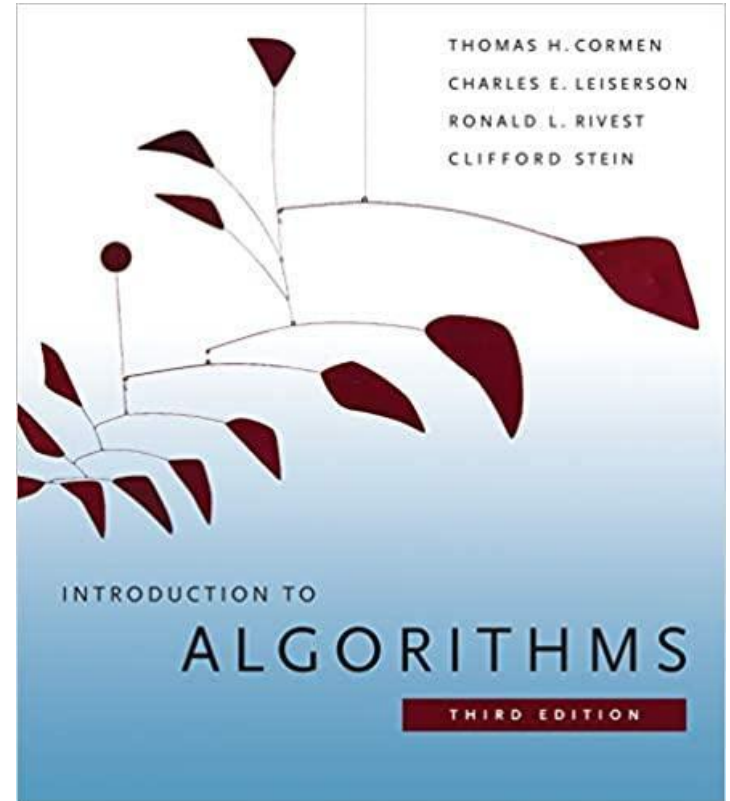- Email me if you need extra office hours
- Instructor room no.: 313A

Text book

- Algorithms
- Authors:
  - Robert Sedgewick
  - Kevin Wayne
- Availability: online
- Website:
  https://algs4.cs.princeton.edu/home/
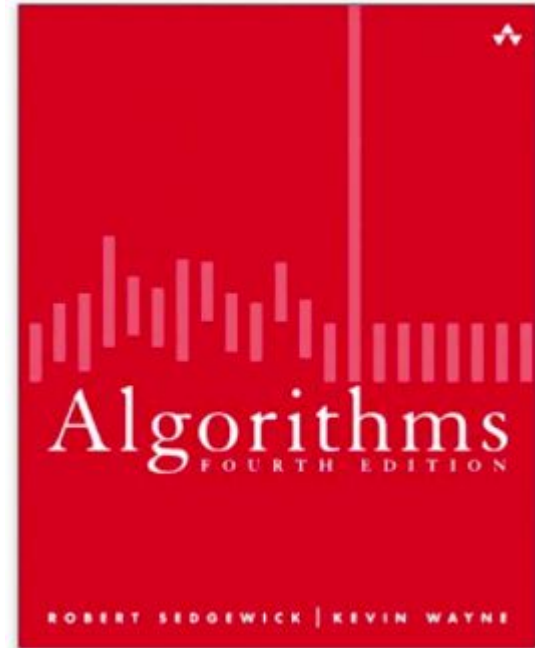
Another good resource

- Introduction to Algorithms
- Authors:
    - Thomas H. Cormen
    - Charles E. Leiserson
    - Ronald L. Rivest
    - Clifford Stein
- Availability: online

Logistics

- Exams:
  - 45% mark
  - First midterm: Week 5
  - Second midterm: Week 10
  - Final exam
- Online quizzes:
  - 10% mark
  - A set of simple questions after 3-5 lectures
- Homeworks:
  - 45% mark
  - Implementation of lab assignments
  - 10-11 homeworks, 5% mark each, will count best 9

Logistics

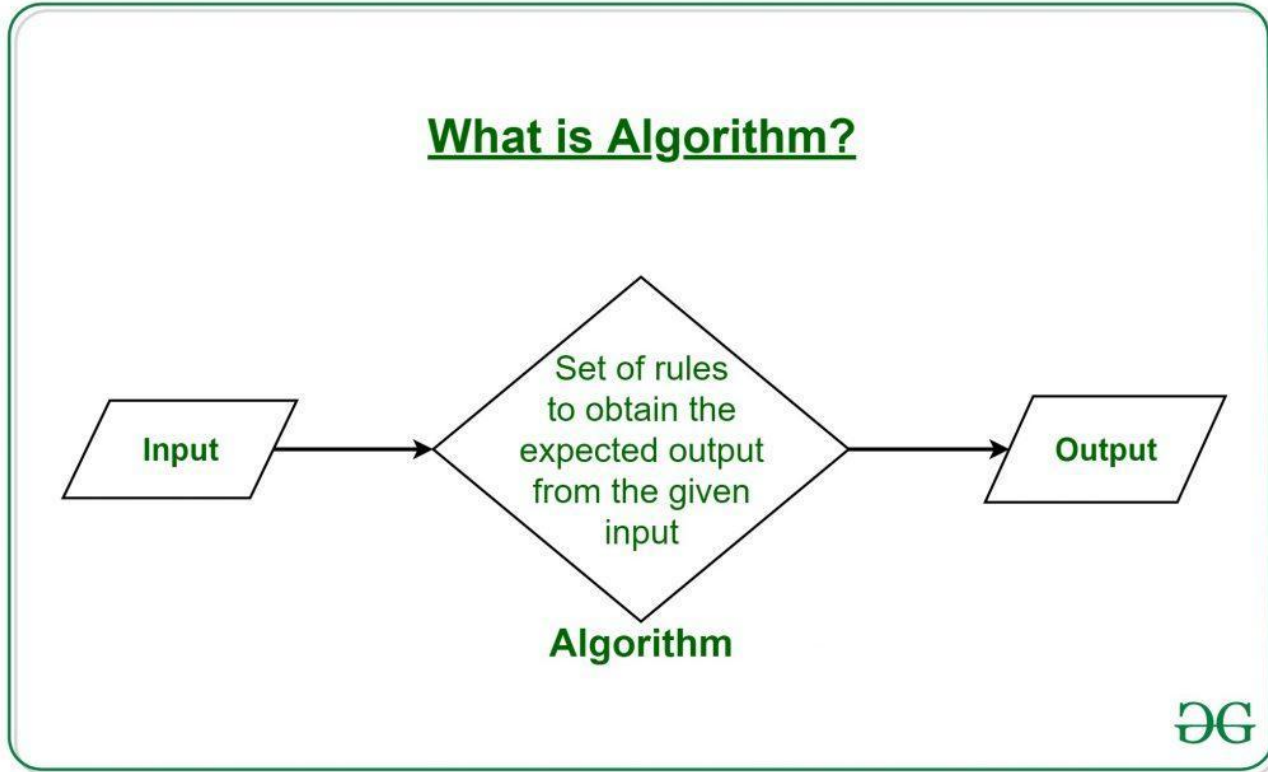| Week	Topic
1	Intro
2	Basic data structures
3	Sorting
4	Divide and conquer
5	Binary search tree

Logistics

Week	Topic
6	Tries (data structure for string operation)
7	Priority queue/heaps
8	Graphs, searching in graphs
9	Application of graph search
10	SP, MST, UF

Logistics

Week	Topic
11	Max flow
12	Greedy algorithms
13	Dynamic programming
14	NP-completeness/reductions

Algorithm

What is Algorithm?

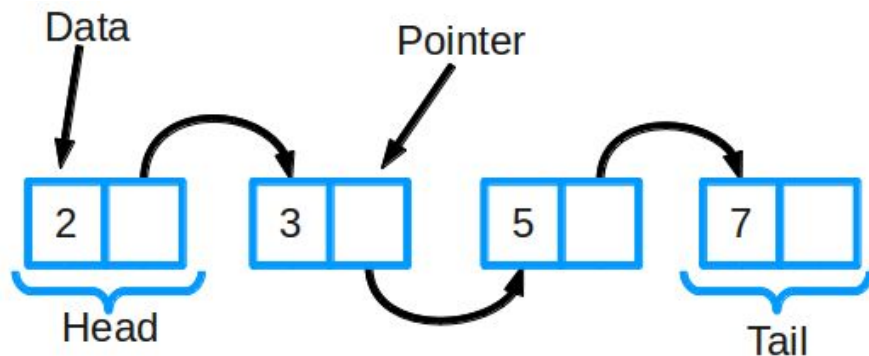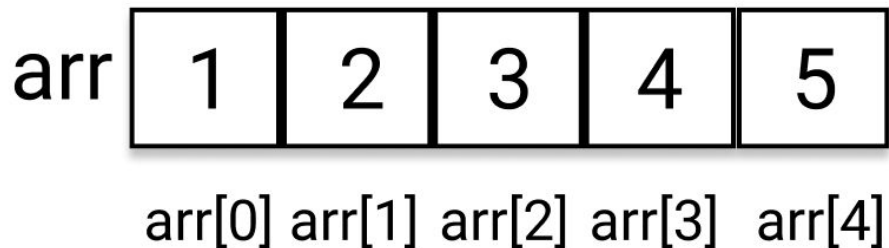Input → Set of rules to obtain the expected output from the given input → Output

Algorithm

Application

- Bioinformatics
- Information technology
- E-commerce
- …
- Application in everywhere

Data structure

- Information access
- Modification
- Some common data structures:
  - Array
  - Link list
  - ...

arr | 1 | 2 | 3 | 4 | 5 |

arr[0] arr[1] arr[2] arr[3] arr[4]

Data

Pointer

2

3

5

7

Head

Tail

Problem classification

P vs. NP

- **P is definitely subset of NP**
  - Every problem with poly-time solution is verifiable in poly-time

- **Is it proper subset or equal?**
  - No one knows the answer

Most guesses are
leaning towards P ≠ NP
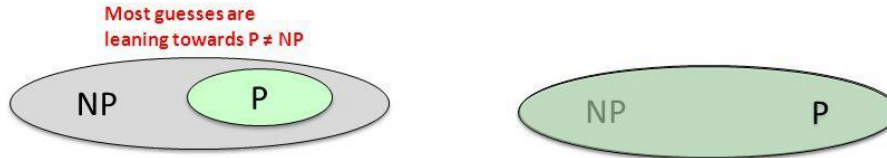
- **NP family has set of problems known as "NP-Complete"**
  - Hardest problems in NP
  - No poly-time solution for NP-Complete problems yet

Efficiency

- Efficiency in terms of what?
    - Number of computation
    - Memory usage
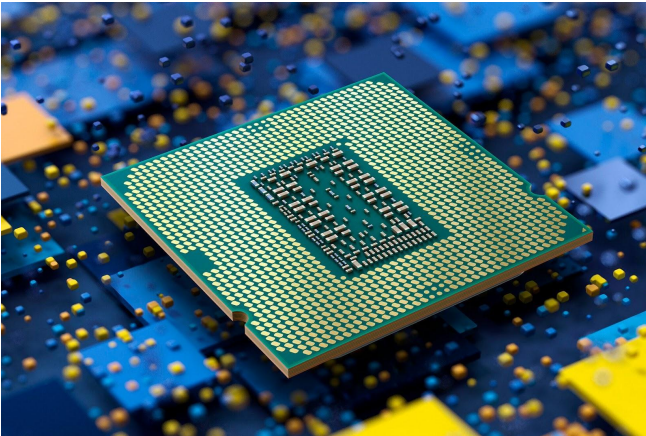
Efficiency

- How many operations?
- Compute # operations in terms of the size of problem
- Is # operations proportional to problem size?
  - Then it is O(n) (say order n)
- We will discuss more about order notation in future.

$O(n!)$ $O(c^n)$ $O(n^c)$

Running Time
Complexity
in terms of
Big-O
$O(f(n))$

$O(nlogn)$

$O(n)$
$O(logn)$

Input Size n

$O(n!), O(c^n), O(n^c)$ - Worst

$O(nlogn)$ - Bad

$O(n)$ - Fair

$O(logn)$ - Good

$O(1)$ - Best