Data Structures

Department of Computer Science and Information Engineering
Fall 2023

Lecturer: Hui-Ling Chan, PhD

Location: 4204
Time: Period [7]-[9] (15:10-18:00), Thursday

# Introduction to lecturer: Hui-Ling Chan

- **Worked in both Industry and Academia:**
  - 2.5 years in National Chiao Tung University, Hsinchu
  - 1.5 years in Industrial Technology Research Institute (ITRI), Hsinchu
  - 3.5 years in Hiroshima University, Japan

- **Biomedical artificial intelligence and signal processing lab (BAISP)**
  - Algorithms of neuroimaging
  - Effects of neuromodulation using noninvasive stimulation
  - Biomedical AI applications:
    mind reading, brain-computer interface, etc.
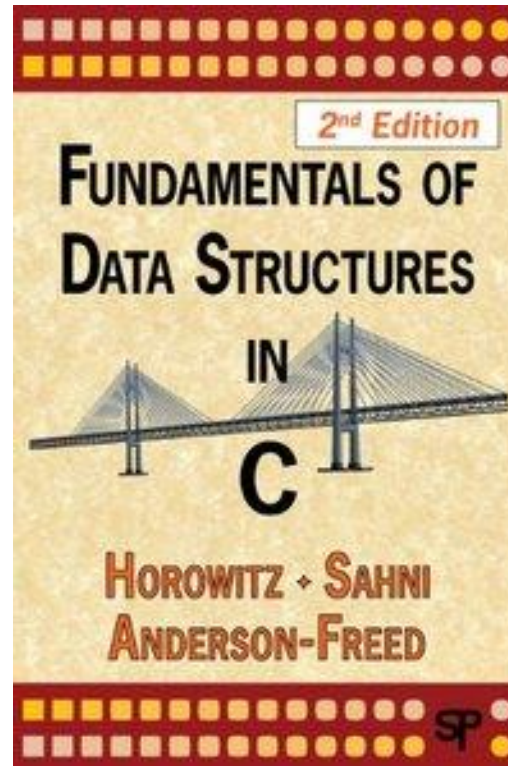 - Brain science and neuroscience
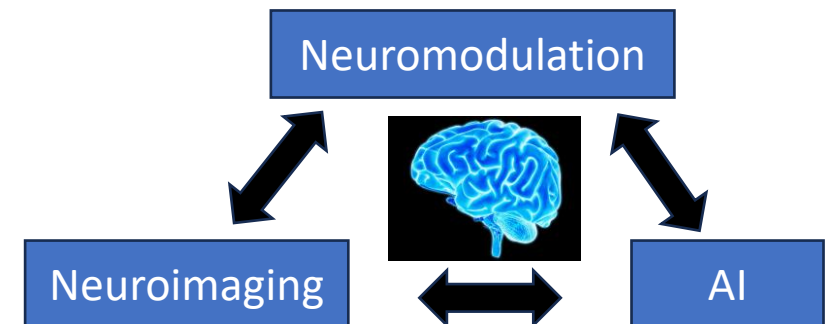
Textbook

- Authors: Ellis Horowitz, Sartaj Sahni, and Susan Anderson-Freed
- Title: Fundamentals of Data Structures in C, 2/e
- Publisher: Silicon Press

Please prepare your own textbook.

You may purchase it from bookstores and online shops, or you could ask CS student association (系學會).

Grading

- **Examination *70%***
  - Midterm exam 30% -> Scheduled date: 11/2 (the 9th week)
  - Final exam 40%   -> Scheduled date: 1/4 (the 18th week)
- **Participation *10%***
  - Roll call
  - Participation in discussions and class activity
- **Assignment *20%***
  - *Entry level: 2 assignments. Each is 2%.*
  - *Medium level: 2 assignments. Each is 3%.*
  - *Advanced level: 1 assignments (10%).*

    The assignments will be announced in a few weeks.

Website

- Moodle (https://moodle.ncku.edu.tw/)

- Please find announcements and slides from Moodle.

- Students who are added to this class will be able to access Moodle from Sep. 14.

Prerequisites

- C programming language

- Array

- Pointer

- Function

- Recursion

- Memory allocation

Policy of this class (1)

- ## Be Honest
  - No Plagiarism. Do not cheat or copy other people's work. You cannot learn anything from copy and paste.

- ## Respect everyone in the class.
  - Do not eat in class, because other students and I may also get hungry.
  - During lecture, please do not make noise. Noise disrupts people's concentration.
  - During group discussion, please talk and try your best to work with your team members.

- ## Be on time for class, assignments and exams

Policy of this class (2)

- **English as a Medium of Instruction (EMI)**
  - The <u>lecture</u> will be in English.

  - During <u>group discussion</u>, speaking English is encouraged. It's fine to speak any other languages if all team members are on the same page. But the presentation of your discussion results should be in English.
    - Don't laugh at others. Most of us are not native speakers. This is a good chance to practice your communication skills in English.

  - In the midterm and final <u>exams</u>, answers can be written in English or Chinese.

About signing up to this class

- Because the space of this classroom is limited, there is <u>upper limit for the number of students (92)</u> in this class. Current: 65

- **Priority** (Only for NCKU students): Until 9/6 11:30
  - Bachelor students in CS (class code: 002) 資工系大學部乙班 5
  - Master students in CS 資工碩士班 12
  - Double major in CS 雙主修資工 4
  - Minor in CS 輔修資工 0
  - None of the above 以上皆非 14

Total: 35

Procedure to sign up

Apply before 12:00 Sep. 12 2023:

1. Scan the QR code

2. Log in using your account of *gs.ncku.edu.tw*

3. Answer the form

You will get a notification of result via email by Sep. 13.

For selected students:

- The CS office will manually add your names into the system during Sep. 18-20.

- TAs will add your names into Moodle by Sep. 14.

If you have questions

- Lecturer:
  Hui-Ling Chan
  E-mail: hlchan@gs.ncku.edu.tw
  Office: 4219 (Please make an appointment except for true emergencies.)

- Teaching assistances (TAs)
  - Contact information and office hours will be announced in Moodle.

- Q&A is limited to the content of this class and the assignments.

What is data structure?

- Data structures are storages to organize and store data which can be accessed and updated efficiently.

- The lecture will focus on conveying the concepts and ideas of data structures. Implementation them using C will be your assignments.

Why is data structure important?

- My friends working in Google:

  "Once you've gained proficiency in data structures, tackling many problems in LeetCode can help you to ace a Google code interview."

- It's a joke. But it's real that good data structures are fundamental for writing efficient programs.

Why is data structure important?

- One of the five fundamental classes in CS:
  - Programming languages, data structures, algorithms, computer organization, operating system

- Examination for
graduate schools of CS

資工所考科	主要代表資工所	
	台大資工所	NTU
	清大資工所	NTHU
	陽明交大資訊聯招	NYMU
	成大資訊聯招	NCKU, CS
線性代數+離散數學+資料結構+作業系統+計算機組織與結構+演算法	成大電機所-己組	NCKU, EE
	政大資科所	NCKU
	台科大資工所	NTUST
	台師大資工所	NTNU
	中央資工所	NCU
	中興資工所-甲組	NCHU
線性代數+離散數學+資料結構+作業系統+資安概論+演算法	中興資工所-乙組	NCHU
計算機概論+資料結構+計算機數學	成大工科所-乙組	NCKU
數學+軟體設計+計算機系統	中正資工所-甲組	
數學+計算機概論(含程式設計)	中正資工所-乙組	

https://www.daso.com.tw/exam/   Date:2023/09/05

Let's ask ChatGPT why data structure is important?

- They play a crucial role in organizing and managing data efficiently, which is essential for several reasons:

    1. **Data Organization**: Data structures provide a way to organize and store data in a structured and logical manner. This organization makes it easier to access, manipulate, and retrieve data when needed.

    2. **Efficiency**: Choosing the right data structure can greatly impact the efficiency of algorithms and operations on data. For example, certain data structures excel in searching, while others are optimized for insertion or deletion operations.

    3. **Optimized Algorithms**: Many algorithms rely on specific data structures to perform efficiently. For instance, searching and sorting algorithms often depend on data structures like arrays, linked lists, or trees.

    4. **Resource Management**: Data structures help manage memory and other system resources effectively. They allow for efficient allocation and deallocation of memory, reducing wastage and improving performance.

    5. **Real-World Applications**: Data structures are used extensively in real-world applications. Databases, file systems, compilers, and many other software systems rely on data structures to store and manage information efficiently.

    6. **Problem Solving**: When solving complex computational problems, the choice of an appropriate data structure can simplify the problem-solving process and lead to more elegant and maintainable code.

    7. **Scalability**: As data grows in size and complexity, the choice of data structure becomes critical for maintaining system performance and scalability. Well-designed data structures can handle large datasets efficiently.

    8. **Understanding Algorithms**: Learning about data structures is closely tied to understanding algorithms. Many algorithms are best understood when you can visualize how data is organized and manipulated within specific data structures.

    9. **Coding Interviews**: Data structure and algorithm knowledge is a common requirement in technical interviews, especially for software engineering and computer science roles. A strong foundation in data structures is essential for success in such interviews.

This class will cover the following data structures.

- Array, Stacks, Queues, Linked list, Trees, Graphs, Hashing, Priority queues, Binary search trees, Multiway search trees, Digital search structures

- Some of the content in the textbook might be discarded.
  - Ex: Polynomial, Shortest path, Sorting, etc.

Course outline

1	Introductions of this course and basic concepts
2	Array, stack, queue, linked list
3	Binary tree, heap, leftist, binary search tree, etc.
4	Binary tree, heap, leftist, binary search tree, etc.
5	Binary tree, heap, leftist, binary search tree, etc.
6	Binary tree, heap, leftist, binary search tree, etc.
7	Advanced tree (B-heap, F-heap, min-max heap, deap, etc.)
8	Advanced tree (B-heap, F-heap, min-max heap, deap, etc.)
9	Midterm
10	Searching (B-tree, AVL, Redblack tree, B+, 2-3-4 , tries, PATRICIA, hash, Bloom, etc.)
11	Searching (B-tree, AVL, Redblack tree, B+, 2-3-4 , tries, PATRICIA, hash, Bloom, etc.)
12	Searching (B-tree, AVL, Redblack tree, B+, 2-3-4 , tries, PATRICIA, hash, Bloom, etc.)
13	Searching (B-tree, AVL, Redblack tree, B+, 2-3-4 , tries, PATRICIA, hash, Bloom, etc.)
14	Searching (B-tree, AVL, Redblack tree, B+, 2-3-4 , tries, PATRICIA, hash, Bloom, etc.)
15	Searching (B-tree, AVL, Redblack tree, B+, 2-3-4 , tries, PATRICIA, hash, Bloom, etc.)
16	Searching (B-tree, AVL, Redblack tree, B+, 2-3-4 , tries, PATRICIA, hash, Bloom, etc.)
17	Searching (B-tree, AVL, Redblack tree, B+, 2-3-4 , tries, PATRICIA, hash, Bloom, etc.)
18	Final exam