CS2040C+IT5003 Semester 2 2025/2026

Data Structures and Algorithms

Tutorial 01
Basic C++/Python, Basic OOP, Analysis, Hands-on 1
For Week 02 (Sat)/03 (Mon)

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1 Introduction and Objective

The purpose of this first tutorial+lab session is to recap the first few sessions of CS2040C/IT5003: Introduction, basic C++/Python, basic analysis of algorithm, and to ensure that all students can code a simple C++/Python program using their own computer/laptop at home and submit code to Kattis/LeetCode for automatic judging. The first half of the session is generally the 'tutorial' part and the second half of the session is generally the 'hands-on/lab' part. The tutors will control the timings and they don't have to divide the sessions exactly by half. There will be a short break during the transition.

As this is the first session, we will do a quick ice breaking at the start of the session. Your TA is your main contact person of CS2040C/IT5003 related queries this semester. Only contact Prof Halim for questions that you are sure that your TA cannot (or has no privilege to) answer, e.g., questions about class policy, appeal for plagiarism verdict (if caught beyond reasonable doubt and you want to plead your case), etc.

To get the most out of the tutorial part of these sessions, please try out all the questions in the tutorial component and give some answer even if you encounter difficulties in answering some of them. Before, during, or after the tutorial session, don't hesitate to clear up all doubts and questions you might have, with the TA. Allowed: You can use ask Gen AI tools of your choice for tutorial answers **after thinking about that question yourself for MORE THAN two hours, i.e., you currently cannot answer that question if a 'similar' question is asked in two-hours final. As the tutorial questions are mostly from past papers with editorials/reference solutions, Gen AI answers are more likely correct (as per early 2026 standard).**

Every week, you will try to solve one medium (or two easy) selected Kattis/LeetCode problem(s) during the 'hands-on/lab' component. The TAs already know the selected hands-on problems for this

semester. However, these selected problems will be revealed to you on the spot each week (if you happen to already solve it, then you are free to just leave the session or actually you can stay back to help your peers – you can learn more things by observing how others approached the problem that you have solved – possibly with just one way). TA will guide all students to get (near) Accepted solution for each problem. These problems are not graded but attempting them during the hands-on time (and possibly to fully complete them afterwards) is beneficial to better understand CS2040C/IT5003 material. **Allowed: You can use Gen AI tools of your choice for their 'near instant' and 'most likely correct' (as per early 2026 standard) answers AFTER the end of your own lab session**.

The tutorial/lab participation marks are there to encourage class participation. These marks will be given by the TA **at the end of the semester** using the following guideline:

- 0% if you only attend ≤ 5 out of 10 CS2040C/IT5003 tutorial/lab sessions,

- 1% for **at most the bottom three** most-passive students (assuming these students attend > 5 tutorial/lab sessions),

- Max 3% for CS2040C or max 5% for IT5003 for **at most the top three** most-active students (answering questions when asked by TA – the correctness of your answers are secondary; or even just by asking your own questions to TA before/during/after class/during consultation); in each tutorial group, and

- CS2040C: 2% for the rest.
  IT5003: 2%, 3%, or 4% for the rest (subjective judgment by your TA).

2   Tutorial 01 Questions

Q1). Please scrutinize ListArrayTest.cpp (CS2040C) or ListArrayTest.py (IT5003).

This code will be revisited soon during discussion of List ADT (read `https://visualgo.net/en/list?slide=2-1` until 2-8 and please also explore: `https://visualgo.net/en/array?mode=array`). For now, please answer the following sub-questions (see the comments inside the source code):

(a) What does this line means? (for IT5003: can Python accept ListArray of any type?)

(b) Anything wrong with this line? (for IT5003: is it really an issue?)

(c) Any potential issue with this line?

(d) For CS2040S: What is the difference of this 'add' versus the other 'add'
    (for IT5003: why can't we do that, i.e., the second 'add' is 'add_at_index')?

(e) What does this line means?

(f) What if we use this commented line instead of the line before it? Any potential issue?

(g) Any potential issue with this line?

(h) What does this line means? (for IT5003: isn't it easier to do this in Python?)

Analysis/Order of Growth

Q2). What is the <u>tightest</u> bound of the following function? $\mathbf{F}(n) = \log(2^n) + \sqrt{n} + 100\,000\,000$

1. $O(n)$

2. $O(n \log n)$

3. $O(n^2)$

4. $O(1)$

5. $O(2^n)$

Q3. What is the <u>tightest</u> bound of the following functions below: $\mathbf{F}(n)$, $\mathbf{G}(n)$, and $\mathbf{H}(n)$?
The options:

1. $O(2^n)$

2. $O(n^2)$

3. $O(n \log n)$

4. $O(n)$

5. $O(\log^2 n)$

6. $O(\log n)$

7. $O(1)$

8. None of the above

Q3.a). $\mathbf{F}(n) = n + \frac{1}{2}n + \frac{1}{3}n + \frac{1}{4}n + \frac{1}{5}n + \frac{1}{6}n + \frac{1}{7}n + \frac{1}{8}n + ... + 1$

Q3.b). $\mathbf{G}(n) = n + \frac{1}{2}n + \frac{1}{4}n + \frac{1}{8}n + \frac{1}{16}n + \frac{1}{32}n + \frac{1}{64}n + \frac{1}{128}n + ... + 1$
$\mathbf{G}(n)$ is basically the sum of the reciprocals of powers of two up to n.
To simplify the analysis, assume that n is a powers of two.

Q3.c). $\mathbf{H}(n) = n + \frac{1}{2}n + \frac{1}{3}n + \frac{1}{5}n + \frac{1}{7}n + \frac{1}{11}n + \frac{1}{13}n + \frac{1}{17}n + ... + 1$
$\mathbf{H}(n)$ is basically the sum of the reciprocals of prime numbers up to n.
To simplify the analysis, assume that n is a prime number.
The analysis is very mathematical...
For CS2040C/CS2040S/IT5003 level, just estimate the time complexity of $\mathbf{H}(n)$ w.r.t $\mathbf{F}(n)$ and $\mathbf{G}(n)$.

Hands-on 1

TA will run the second half of this session with one chosen Kattis/LeetCode problem involving List ADT.

Problem Set 1+2

We will end the tutorial with a short PS1 debrief. Recall that:

- IT5003 students are expected to solve problems A+B (problem C is optional/extra challenge/out of IT5003 syllabus and not-graded)

- CS2040S students are expected to solve problems B+C (with the easiest problem A (still within CS2040S syllabus) as optional/extra practice and non-graded for CS2040S students)