# COMP 5112: Data Structures and Database Systems
## Assignment 1
Prof. Ken Yiu and Dr. Kevin Yuen

<mark>Deadline: 14:00 on 3rd October 2024</mark>    (no further extension)

**Guidelines**

- Please refer to `course_info.pdf` for the late submission policy.
- You are free to use any IDE to develop your program. The Java environment is based on JDK 21.
- For written questions (1-3), please write your solution in a document and then convert it to PDF with the filename `A1_<studentID>.pdf`
- For coding questions (4-5), please name each Java source code file as `A1_Q<questionID>_<studentID>`.java
- **Submit** a zip file (including the above PDF file and two Java files) to learn.polyu.edu.hk.

**Question 1.  [written question]**                                      **[20 marks]**

In this question, we use the insertion algorithm for AVL tree.

**Insert** the following sequence of keys (one-by-one) into an empty AVL tree:
$$12, \ 23, \ 34, \ 45, \ 56, \ 67, \ 78, \ 89.$$

In each insertion operation, you may encounter 0 rotation, 1 rotation, or more than 1 rotations.

**Draw** the trees as follows:
  - **Draw** the tree just before you perform a rotation.
  - **Draw** the final tree.


**Question 2.  [written question]**                                      **[25 marks]**

You are given two doubly linked lists of sorted integers (in the ascending order).
Let L and R be the head pointers of these two doubly linked lists.

**Write** an algorithm to merge them into a linked list of sorted integers.
*Note*: Marks will be given based on
  (i)      the correctness of your algorithm and
  (ii)     the amount of space used by your algorithm
           (e.g., you should not create a new array to store data).


**Question 3. [written question]**                                       **[10 marks]**

**Prove** that $3n^3 + 20n^2 + 5$ is $O(n^3)$ using the definition of the $O(\ldots)$ notation.
You are required to show the steps in your inequality proof clearly.
*Hint*: find the constants c and $n_0$ such that $3n^3 + 20n^2 + 5 \leq cn^3$ for all $n \geq n_0$.

**Question 4.  [programming question]**                                              **[20 marks]**

Please download the zip file from https://bcs.wiley.com/he-bcs/Books?action=resource&bcsId=8635&itemId=1118771338&resourceId=35121
then extract `sourcecode.jar` to the same directory as your Java program.

You are given the Java code template in `A1_Q4_yourStudentID.java`.
- **Replace `yourStudentID`** in both the file name and the class name.
- **Write down** your name and student ID as comments at the top of the Java file.

**Complete** the Java program based on the following requirements.
  I.    import `net.datastructures.*`. Create an ArrayStack object.
 II.    Insert numbers 20, 19, 37, 48, and 10 into that ArrayStack object one by one.
        Print that ArrayStack object using one statement.
III.    Let the old ArrayStack object be the object in step II.
        Create a new ArrayStack object.
        Create a loop to move the elements from the old ArrayStack object to the new
        ArrayStack object <mark>in the reverse order</mark>, and remove all elements of the old
        ArrayStack object.
        Print the old ArrayStack object using one statement.
        Print the new ArrayStack object using one statement.
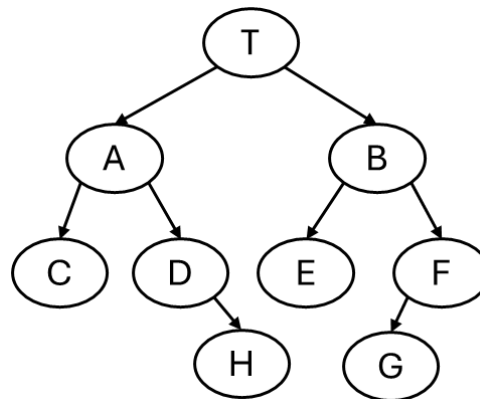
We will test your program by the following commands in Windows command prompt:
- `javac -cp sourcecode.jar A1_Q4_<yourStudentID>.java`
- `java -cp .;sourcecode.jar A1_Q4_<yourStudentID>`

**Question 5.  [programming question]**                                    **[25 marks]**

You are given the tree below.



You are given the Java code template in `A1_Q5_yourStudentID.Java`.
- **Replace** `yourStudentID` in both the file name and the class name.
- **Write down** your name and student ID as comments at the top of the Java file.

**Complete** the Java program to print the node labels with pre-order traversal.

We will test your program by the following commands in Windows command prompt:
- `javac A1_Q5_<yourStudentID>.java`
- `java A1_Q5_<yourStudentID>`