# CS 206 A: 2020 FALL Final exam (pp. 1 – 3)

## Problem 0. Information (1 point)

Write your name and KAIST ID at the top of **EACH** page on your answer paper.

## Problem 1. (19 points):

1) (worth 11 points)

- Using the 64-bit memory cost model from lecture, how much memory does the following code use?
- Give ALL intermediate steps that show how you compute the memory usage.

```
int[][] data = new int[N][N];
```

2) (worth 8 points)

- Using the 64-bit memory cost model from lecture, how much memory does a MyString object use?
- Give ALL intermediate steps that show how you compute the memory usage.

```
public class MyString{
        private char[] value;
        private int hash;
}
```

## Problem 2. (10 points)

For the following function below,

1. Give the order of growth in terms of N, using the big-Oh notation. (5 points)
2. Explain why it takes that running time. (5 points)

```
public static void sunny(int N) {
        int count=0;
        int m = (int)(((20+Math.round(4.2/2)))*Math.random());
        for(int i=0;i<m;i++) {
                count++;
        }
 }
```

**Notes:**

- `Math.round(double a)` returns the value of the argument rounded to the nearest value.
- `Math.random()` returns a random double value greater than or equal to 0.0 and less than 1.0.

**Continue to the next page.**

## Problem 3. (20 points: 5 points @ each)

For **EACH** of the problems below, answer the following questions:

- Specify one Abstract Data Type(ADT) that would be best used in each of the following situations, and
- Justify why.

**Notes:** For each of the problems below,

- You should choose one of the ADTs that we studied in class.
- If you specify a data structure, no points will be given.

1) In a coffee shop, a manager should track the orders placed at a counter so that a coffee order can be served in the order it arrives.
2) Assume that in an Emergency Room (ER), a patient with the most severe symptom is given the top priority for medical treatment. A patient with the most severe symptom is treated first, and then a patient with the next most severe symptom is treated. Assume that any two medical symptoms are comparable.
3) When the final exam is graded, which student receives which score should be recorded.
4) Assume that a cafeteria manager is putting dinner plates into storage. If the manager wants to take a plate at the bottom of the pile, the manager must remove all the plates on top of it to reach that plate at the bottom.

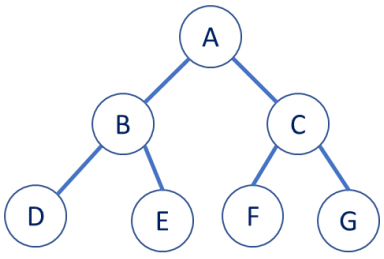
## Problem 4. (20 points: 10 points @ each)

We implement a hash table *T* using a dynamic array, and we use linear probing as a resolution strategy. When we insert a new entry, we double the table size if the table T is 50% full.

1) What is the range of the table *T*'s load factor? (5 points) Justify why (5 points).
2) Carol claims that a load factor of the hash table *T* should be strictly less than 1.
   A. Is it true or false? (1 point)
   B. Justify why. (9 points)

## Problem 5. (20 points)

We label each node of a binary tree as follows:




Each node stores one of seven keys [1, 4, 6, 2, 3, 5, 6 ], and the tree above must satisfy the max-heap property. For each node A, B, C, D, E, F, G, list the key values that each node could store and explain why.

**Continue to the next page.**

## Problem 6. (15 points)

Note: Use the definition of the height of a tree that we studied in class.

1) Consider a 2-3 tree T containing 8 keys.
    A. What is the minimum height of T? Justify why. (4 points)
    B. What is the maximum height of T? Justify why. (4 points)
2) Consider a binary heap H containing 15 keys.
    A. What is the minimum height of H? Justify why. (3 points)
    B. What is the maximum height of H? Justify why. (4 points)

## Problem 7. (20 points: 10 points @ each)

In Daejeon, there are a huge number of N incoming students. You are required to sort them by each of the following problems.

For **EACH** of the following problems,

A. Specify what sorting algorithm would be most efficient and
B. Justify why.

**Notes:**

- A faster correct sorting algorithm is considered to be more efficient.
- For EACH of the following problems, you should specify one of the sorting algorithms that we studied in class.

1) Students must be sorted by the number of programming languages they use. The number of programming languages each student uses is known. It is also known that the number of programming languages used by students ranges from 0 to 20.

2) Students must be sorted by the weight of their bags. We have a scale that can determine whether a bag has a total weight greater than, less than, or equal to another bag in O(1) time.