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15-121 Fall 2021 Quiz 9

Up to 25 minutes. Show your work. No calculators, no notes, no books, no computers, no other people.

1. Short Answer

- (a) (1 point) Name an $O(N^2)$ (worst case) sort. Write your answer, and nothing else, in the box below.

- (b) (1 point) Name an $O(N \log N)$ (worst case) sort.

- (c) (3 points) Assume that you are given the following array of unsorted numbers: `[90, 2, 58, 39]`. If it is sorted using the Bubble Sort algorithm that we practiced in class, how many swap operations are performed while sorting? (Your answer to this question is a number: The number of swaps that occur while sorting that array with Bubble Sort.) Write your answer, and nothing else, in the box below, but show your work in the empty space next to the box.

- (d) (2 points) What does it mean for a sort to be stable?

- (e) (3 points) Assume I am building a simple calculator that has the following behavior. When I see an integer, I push its value onto a stack. When I see an operator (+, -, *, /), I pop the stack once, and store the result in a variable called `op2`. I then pop the stack a second time, and store the result in a variable called `op1`; I then perform the arithmetic operation specified by that operator (`op1 operator op2`) and push the result of that operation back onto the stack.

For example, if I entered `7 2 -`, `peek()` would return 5 since 7 would be pushed onto the stack, then 2, and then the `-` would cause 2 to be popped and stored in `op2`, 7 to be popped and stored in `op1`, and the result of `7-2`, which is 5, would be pushed onto the stack.

Tell me what value is returned by `peek()` after the following sequence of values is processed. Write your answer, and nothing else, in the box below, but show your work in the empty space next to the box.

`6 3 5 * 4 - +`

2. (10 points) **Iterator Free Response:** Consider the following code for a `Student` class and a `School` class:

```
public class Student {
    private String name;

    public Student(String name) {
        this.name = name;
    }

    public String toString() {
        return this.name;
    }
}

public class School {
    private ListNode head;

    private class ListNode {
        private Student data;
        private ListNode next;

        private ListNode(Student data) {
            this.data = data;
            this.next = null;
        }

        public String toString() {
            return data.toString();
        }
    }

    // Adds to the end of the linked list
    public void add(Student p) {
        ListNode tmp = head;
        if (tmp == null) {
            head = new ListNode(p);
            return;
        }
        while (tmp.next != null) {
            tmp = tmp.next;
        }
        tmp.next = new ListNode(p);
    }

    public static void main(String[] args) {
        School mySchool = new School();

        mySchool.add(new Student("Bob"));
        mySchool.add(new Student("Ahmed"));
        mySchool.add(new Student("Nora"));

        /*
         * The following loop should output:
         * Bob
         * Ahmed
         * Nora
         */
        for (Student s : mySchool) {
            System.out.println(s);
        }
    }
}
```

Right now, the for-each loop in the `main` method of `School` does not work. Java reports the following error:
`Can only iterate over an array or an instance of java.lang.Iterable`

Modify the `School` class so that for-each loops work properly on it.

Note: You should write your answer on the previous page, showing the modifications you would make to the existing code.

Hint: If you aren't sure how to make for-each loops work, look at the title of this question for a hint.

Your answer should be written on the previous page, not on this page. (But if you need more space, you can write here as long as you have a note on the previous page mentioning that part of your answer is here.)