# CISC 3130 Exam 2 (Section TY2)

November 26, 2024

Name: ______________________________

**Question 1 (10 points)**

Complete the `replace` method of the following SinglyLinkedList class. The method should replace all element that are equal to `target` with `replacement`. Assume that no element is null and that e is not null.

Additionally, state the big-Oh running time of your method.

```java
public class SinglyLinkedList<E> {
    private static class Node<E> {
        E data;
        Node<E> next;
    }
    private Node<E> head, tail;
    private int size;
    // Methods addFirst, addLast as usual (don't write)

    public void replace(E target, E replacement) {













    }
}
```

**Question 2 (8 points)**

Suppose we have a SinglyLinkedList<E> class with the following methods: addFirst(e), addLast(e), removeFirst(), removeLast(), getFirst(), and getLast().

Additionally, suppose we have a DoublyLinkedList<E> class with the same methods.

Assume each method behaves in the obvious manner and has the obvious running time.

Now, suppose we have the following interface:

```java
public interface Queue<E> {
    void add(E e); // aka enqueue(e)
    E remove();    // aka dequeue()
    E peek();
}
```

We would like to implement the Queue interface, using a linked list to store the elements.

The table below contains eight proposed implementations. The table indicates what kind of linked list is used to store the elements, and how the Queue methods are implemented in terms of the linked list methods. For example, the top left empty cell represents an implementation where the elements are stored in a SinglyLinkedList, add(e) calls addFirst(e), remove() calls removeFirst(), and peek() calls getFirst().

For each proposed implementation, write "correct" if it is correct; otherwise, write "incorrect." An implementation is correct if each method produces the behavior expected by users, regardless of how it works under the hood. For example, peek() should return the least recently added element; we don't care where it is stored.

Additionally, for each correct implementation, write "efficient" if its big-Oh running time is efficient; otherwise, write "inefficient." (We don't care about the efficiency of incorrect implementations.)

| | SinglyLinkedList | DoublyLinkedList |
|---|---|---|
| add(e): addFirst(e), remove(): removeFirst(), peek(): getFirst() | | |
| add(e): addLast(e), remove(): removeLast(), peek(): getLast() | | |
| add(e): addLast(e), remove(): removeFirst(), peek(): getFirst() | | |
| add(e): addFirst(e), remove(): removeLast(), peek(): getLast() | | |

**Question 3 (8 points)**

Use a stack to evaluate the following postfix expression. Follow the algorithm that was covered in class. Make sure to write the final result. You will be graded on your tracing of the stack, as well as on your final result.

```
17 1 - 4 5 2 3 - + * /
```

**Question 4 (6 points)**

Consider the following method:

```java
public static void mystery(Deque<Integer> stack) {
    Queue<Integer> queue = new LinkedList<>();

    while (!stack.isEmpty()) {
        queue.add(stack.peek());
        queue.add(stack.pop());
    }

    while (!queue.isEmpty()) {
        stack.push(queue.remove());
    }

    while (!stack.isEmpty()) {
        System.out.print(stack.pop() + " ");
    }
}
```

(a) Write the method's running time in big-Oh notation.

(b) Suppose the method is passed the following stack:

```
top [20, 10, 30] bottom
```

Write the method's output in this case.

**Question 5 (10 points)**

Complete the following method named `contains` that determines whether the stack contains e as an element.

Rules:

- When the method ends, the stack must be in its original state.
- Do not use any auxiliary collections (arrays, ArrayLists, etc.) as storage, except for a single stack or queue (not both).
- If your auxiliary collection is a stack, represent it with a Deque.
- You may only use the following Deque methods: push(e), pop(), peek(), size(), and isEmpty().
- You may only use the following Queue methods: add(e), remove(), peek(), size(), and isEmpty().
- Do not use an enhanced for loop (aka for-each loop).

```java
public static boolean contains(Deque<String> stack, String e) {
















}
```

**Question 6 (10 points)**

Suppose that a deque is implemented using a circular array, aka a ring buffer. Assume that the deque starts with capacity **5** and that it **doubles** its capacity when an element is added to a full deque. Assume that when an element is removed from the deque, the array element where it resided is set to null.

At each of the points indicated below,

- Write the state of the deque's internal array.
- State the values of indexOfFirst and indexOfLast.

```java
Deque<Integer> deque = new ArrayDeque<>();
deque.addLast(10);
deque.addFirst(20);
deque.addFirst(30);
deque.addLast(40);
deque.addLast(50);
// Point A:






deque.addFirst(60);
deque.addFirst(70);
// Point B:






for (int i = 0; i < 6; i++) {
    deque.removeLast();
}
// Point C:
```

**Question 7 (8 points)**

Draw a diagram illustrating the internal state of the HashMap immediately after the following code runs.

```
Map<Integer, Integer> map = new HashMap<>();
map.put(13, 10);
map.put(15, 10);
map.put(13, 5);
map.put(18, 15);
map.put(23, 6);
map.put(-3, 7);
map.remove(6);
map.remove(15);
```

Additionally, write the final size, capacity, and load factor.

Assume that the initial capacity is **5**. Assume that we increase the capacity when the load factor is $> \mathbf{0.5}$, and that we **double** the capacity (not 2 * capacity + 1). Note: the order of the entries within each "bucket" doesn't matter.

Assume that the hash function takes a key and returns `Math.abs(key) % capacity`.

**Question 8 (6 points)**

Consider the following method:

```
public static void mystery(SequencedMap<String, Integer> map) {
    SequencedSet<Integer> set = new LinkedHashSet<>();

    for (String s : map.keySet()) {
        set.add(map.get(s));
    }

    System.out.println(set);
}
```

(a) Write the method's running time in big-Oh notation.

(b) Suppose the method is passed the following map:

```
{f=30, d=20, c=40, e=30, b=30, a=20}
```

Write the method's output in this case.

**Question 9 (6 points)**

Consider the following method:

```
public static void mystery(int n) {
    SequencedSet<Integer> set = new LinkedHashSet<>();

    for (int i = 2; i <= n * 2; i++) {
        set.add(i);
    }

    for (Iterator<Integer> iter = set.iterator(); iter.hasNext(); ) {
        System.out.print(iter.next() + " ");

        if (iter.hasNext()) {
            iter.next();
        }
    }
}
```

(a) Write the method's running time in big-Oh notation.

(b) Suppose the method is passed the value 6. Write the method's output in this case.

**Question 10 (12 points)**

Complete the following method. The method should return the maximum frequency among the elements in the provided collection. For example, the call

```
maxFrequency(List.of("c", "a", "b", "a", "a"))
```

should return 3, since the element with the highest frequency, namely `"a"`, occurs three times. (If `"b"` would also occur 3 times, the result would still be 3.)

Your method must run in $O(n)$ time. Tip: use a Map.

```
public static int maxFrequency(Collection<String> collection) {













}
```

**Question 11 (8 points)**

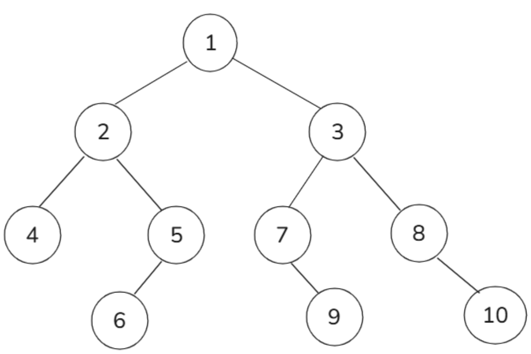
Suppose we have the following class:

```java
public class BinaryTreeNode<E> {
    public E data;
    public BinaryTreeNode<E> left, right;
}
```

Complete the following method. The method should return the number of elements in the tree rooted at the given node that are equal to e. You may assume that no element is null and that e isn't null.

```java
public static <E> int count(BinaryTreeNode<E> root, E e) {









}
```

**Question 12 (8 points)**




For the above tree, write the following traversals:

(a) preorder

(b) inorder

(c) postorder

(d) level-order