CS 61B Fall 2023

Arrays, Linked Lists

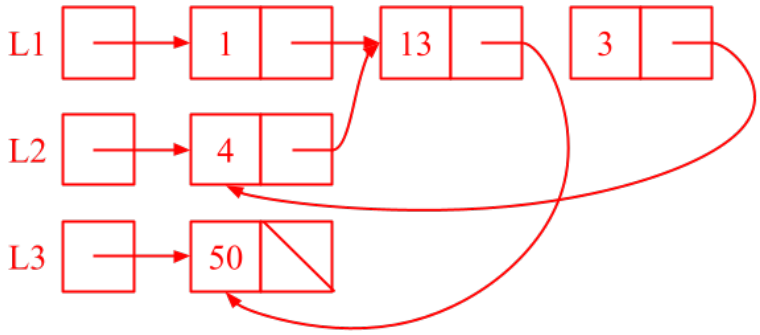
Exam-Level 3: September 4, 2023

1 Boxes and Pointers

Draw a box and pointer diagram to represent the IntLists `L1`, `L2`, and `L3` after each statement.

```
1 IntList L1 = IntList.list(1, 2, 3);
2 IntList L2 = new IntList(4, L1.rest);
3 L2.rest.first = 13;
4 L1.rest.rest.rest = L2;
5 IntList L3 = IntList.list(50);
6 L2.rest.rest = L3;
```

Solution:



2 Partition

Implement `partition`, which takes in an `IntList lst` and an integer `k`, and *destructively* partitions `lst` into `k IntLists` with the following properties:

- It is the **same** length as the other lists. You may assume the `IntList` is evenly divisible.
- Its ordering is consistent with the ordering of `lst`, i.e. items in earlier in `lst` must **precede** items that are later.

These lists should be put in an array of length `k`, and this array should be returned.
For instance, if `lst` contains the elements 6, 5, 4, 3, 2, 1, and `k = 2`, then a **possible** partition, is putting elements [6 4, 2] at index 0, and elements [5, 3, 1] at index 1.

You may assume you have the access to the method `reverse`, which destructively reverses the ordering of a given `IntList` and returns a pointer to the reversed `IntList`. **Hint:** Think about how to build up the IntList backward at each index, starting with `null`.

You may not create any `IntList` instances.

```
1  public static IntList[] partition(IntList lst, int k) {
2      IntList[] array = new IntList[k];
3      int index = 0;
4      IntList L = ____________________________________________
5      while (L != null) {
6
7          ____________________________________________________
8
9          ____________________________________________________
10
11         ____________________________________________________
12
13         ____________________________________________________
14
15         ____________________________________________________
16
17         ____________________________________________________
18
19         index = ____________________ % ____________________;
20     }
21     return array;
22 }
```

Solution: [Here] is a video walkthrough of the solution.

```
public static IntList[] partition(IntList lst, int k) {
    IntList[] array = new IntList[k];
    int index = 0;
    IntList L = reverse(lst);
    while (L != null) {
        IntList prevAtIndex = array[index];
        IntList next = L.rest;
        array[index] = L;
        array[index].rest = prevAtIndex;
        L = next;
        index = (index + 1) % array.length;
    }
    return array;
}
```

Explanation: We reverse our `IntList` so that we can build up each element of the `IntList[]` array backwards–in general, it is much easier to build an `IntList` backward than forward.
The general idea is to initialize each element in the array to `null`, then put an element of `L` inside the correct index by assigning `array[index] = L`. Then, we get whatever we've built up so far (`prevAtIndex`) and add it to the end of our `rest` element so that we have the entire IntList again with one element at the front.
Afterwards, we advance `L` to the next element and increment the index.

3 Remove Duplicates

Using the simplified `DLList` class defined on the next page, implement the `removeDuplicates` method.

`removeDuplicates` should remove all duplicate items from the **DLList**. For example, if our initial list is `[8, 4, 4, 6, 4, 10, 12, 12]`, our final list should be `[8, 4, 6, 10, 12]`. You may **not** assume that duplicate items are grouped together, or that the list is sorted!

```
public class DLList {
    Node sentinel;

    public DLList() {
        // ...
    }

    public class Node {
        int item;
        Node prev;
        Node next;
    }

    public void removeDuplicates() {

        Node ref = ____________________________________________________________;
        Node checker;

        while (_______________________________________________________________) {

            checker = _____________________________________________________________;

            while (_____________________________________________________________) {

                if (_____________________________________________________________) {

                    Node checkerPrev = checker.prev;
                    Node checkerNext = checker.next;

                    _____________________________________________________________;

                    _____________________________________________________________;

                    _____________________________________________________________;

                    checker = ____________________________________________________________;
                } else {

                    checker = ____________________________________________________________;
                }
            }

            ref = _____________________________________________________________;
        }
    }
}
```

Solution:

```
public void removeDuplicates() {
    Node ref = sentinel.next;
    Node checker;
    while (ref != sentinel) {
        checker = ref.next;
        while (checker != sentinel) {
            if (ref.item == checker.item) {
                Node checkerPrev = checker.prev;
                Node checkerNext = checker.next;
                checkerPrev.next = checker.next;
                checkerNext.prev = checker.prev;
                checker = checkerNext;
            } else {
                checker = checker.next;
            }
        }
        ref = ref.next;
    }
}
```