Lab 00: Recursion Warmup
COSC 290 - Fall ’22

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<tr>
<th>Starter File(s)</th>
<th>L00_starter.zip (2 .java files)</th>
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<td>Submission</td>
<td>Upload only the following file(s) to Moodle:</td>
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<td></td>
<td>• Lab00.java</td>
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<td>• Lab00Tester.java</td>
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<td>Due Date</td>
<td>Mon, Sept 5th at 10PM for all lab sections</td>
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Welcome! Our goals for this initial warmup lab are the following:

• setup and test your Java working environment (JDK and editor)
• refresh your Java syntax knowledge and coding skills
• practice working with recursion, a programmatic design we will be utilizing very often this semester

1 Initial Setup

The steps below will refresh you on compiling and running Java code, while also showing you how you will submit your work. Before you begin, you want to make sure you have the following:

• an installation of the Java runtime and development kit (JDK)
• an editor to help you with writing (and, ideally, also compiling and running) Java code. Either JEdit or VSCode are recommended.

Tutorials for installing the Java runtime/JDK on Mac and Windows, as well as the VSCode editor are available on your lab Moodle page

With the above completed, follow the below steps to verify your Java installation:

• download the provided Lab00.zip and extract its contents, the two files: Lab00.java and Lab00Tester.java
• attempt to compile (using the javac command) the provided files. They should compile with no errors.
• attempt to run (using the java command) the provided file. It all goes well, you should see:

```
Exception in thread "main" java.lang.UnsupportedOperationException: implement me!
at Lab00Tester.main(Lab00Tester.java:11)
```

• You will be seeing a lot of the above exception in our future labs – these exceptions will be inserted into provided code to indicate what you need to implement!

2 Overview: Thinking Recursively

As mentioned previously, the goal of the programming portion of this lab is to help you get back in the mindset of writing recursive code. As a refresher, a recursive function is a function which has one or more calls to itself.

Below is a general strategy for designing a recursive solution to a problem:

1. Start with your base case – what sort of argument could be passed to this function where no recursion is necessary? In other words, you know exactly what you need to return without the use of any recursive calls. Remember - sometimes we need multiple base cases!
2. Next, move on to the recursive case(s). Remember, these recursive calls need to eventually stop, otherwise you will have infinite recursion. This means that, whatever argument you pass in to your recursive call should be incrementally working towards your base case(s).
3. When determining how to design your recursive call and what to do with its result, try the **black-box strategy**!

Let’s treat our recursive call as a *black box* – in other words, assume that your recursive function works perfectly and gives you exactly what you intend. Given the argument you are passing to the recursive call, what will it return? What do you need to do with this result to get what you want overall given the original argument?

For example, imagine I’m writing a function `public int arraySum(int[] arr)` which returns the sum of all ints in an argument array, and I have the following:

- a **base case** saying if the length `arr` is 0, to return 0.
- a **recursive case** which recursively calls `arraySum` and passes it the argument `slicedArr`, which is a copy of `arr` with the first index removed.

If we just pretend my recursive case works exactly as I intended, what does it return to me? The sum of all ints in `slicedArr`, which is the sum of all ints in `arr` minus the first index. Thus, to get my overall result, I need to add the first index to the sum returned from my recursive call.

My recursive call would end up looking something like this:

```java
int[] slicedArr = ... // a copy of arr with the first index removed
return arr[0] + arraySum(slicedArr);
```

### 3 Your Task

Your task for this lab is to implement the following functions. Declarations (and, in some cases, some initial code) for each of the below functions are written for you in the provided `Lab00.java`.

To best flex our recursive muscles, your implementations **must adhere** to the following:

- each function should have at least one recursive call
- don’t create/use any global (*i.e. instance or class*) variables
- don’t modify or add any additional arguments
- don’t create any additional helper functions

#### 3.1 Reverse String

Write the implementation for the function `reverseString(String str)` which accepts a `String` argument `str`, and returns the String reversed. A null argument can simply return null.

Example:

- `reverseString("cat")` should return "tac"

#### 3.2 Mirror String

Similar to above, write the implementation for the function `mirrorString(String str)` which accepts a `String` argument `str`, and returns the String mirrored, meaning the String is repeated backwards. A null argument can simply return null.

Example:

- `mirrorString("cat")` should return "catac"
3.3 Find Smallest Int

Write the implementation for the function `findSmallestInt(Stack<Integer> s)` which accepts a Stack argument s containing Integers, and returns the smallest integer that appears on the Stack.

This argument Stack must not be changed upon completion of this function. In other words, its ok to pop things off the argument Stack, but you must ultimately put everything back in its original order before the function is done. If the argument Stack is empty or null, this function should throw an IllegalArgumentException.

Example (imagine below Stack as being portrayed bottom to top):
- 4 => 7 => 3 => 6 => 5 would return 3

3.4 Remove Odd Indices

Write the implementation for the function `removeOddIndices(LinkedList<E> myLL)` which accepts a LinkedList argument myLL containing objects of generic type E, and removes all the odd numbered indices from the list.

This function modifies the state of the argument myLL directly; remember that objects are passed by reference in Java. If the argument Queue is null, this function should throw an IllegalArgumentException. The zero-th index is not considered odd and thus not eliminated. An empty list should remain unmodified.

Example (imagine below Queues as being portrayed front to back):
- {"cat": "dog", "bird": "frog"} would become {"cat": "bird"}
  ...the index 1 ("dog") and 3 ("frog") values are removed

3.5 Invert Map

Write the implementation for the function `invertMap(HashMap<String, String> hm)` which accepts a HashMap argument hm where both its keys and values are Strings, and inverts it so that the values are now keys and the keys values. If null is passed as an argument, this function returns null.

This function modifies the state of the argument hm directly. If the argument HashMap is null, this function should throw an IllegalArgumentException. Additionally, since keys are unique but values are not for HashMaps, if the argument contains duplicate value(s) across its various keys, this function should also throw an IllegalArgumentException.

Hint: take a look at the provided helper function `getOneKey`, it will be useful in your implementation.

Example:
- {"cat":"Mittens", "dog":"Brownie", "parrot":"Polly"} should return{"Mittens":"cat", "Brownie":
  "dog", "Polly":"parrot"}

4 Submission

See the top of this document for the lab’s due date and time. Don’t forget, you will be evaluated on the quality of the test cases provided in your Lab00Tester.java.

When uploading your submission to Moodle submit only the files listed below – please do not upload a .zip or any .class/.java~ files:
- Lab00.java
- Lab00Tester.java