Finding Code Responsible for Behavior

Due date: by the end of the recitation session

Introduction

- Have you ever run a program and wondered why it does what it does?
- Have you ever run your own code and wondered why it does not do what you expected it to do?
- Have you ever accidentally wrote a line of code that turned out to be correct, but you were not sure why it worked?

In this activity you will learn and practice some techniques that may be used to demystify such situations.

Here is a simple program. You might have seen similar programs in the previous course.

```java
import java.util.ArrayList;

public class PrintlnMistery {
    public static void main( String[] args ) {

        ArrayList<Integer> list = new ArrayList<Integer> ();

        list.add(1);
        list.add(2);
        list.add(3);
        list.add(4);
        list.add(5);

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

When we run it, it produces a single line of output:
```
[1, 2, 3, 4, 5]
```

How does it work? How does `println` function know what to do? Where do the commas and the square brackets come from? And what is `System.out` to begin with? (Yes, you probably have used `System.out` a thousand times, but have you ever stopped to think about what it actually is. Is it a class, object, something else? Where is it defined? What other things you can do with it?)

Worksheet: **https://goo.gl/yFBRNc**

Part 1

Java API comes with thorough documentation. You can browse through it starting at the main page at https://docs.oracle.com/javase/8/docs/api/, or you can just google the name of a particular class that you are interested in. Note that the search often returns documentation pages for older versions of Java (version 7 still seems to be dominant). In some cases it does not matter. But when you need documentation for a specific version, just replace the number in the URL by the version number that you want.

- Read at the documentation for the **System** class.
- Find the class in which the **println** function is defined and look at the detailed description(s) of this function. It says there that it uses **valueOf** function defined in another class. Look at the documentation for that function.
- Finally, the documentation for the appropriate **valueOf** function claims to use yet another function (don't worry, this is the end of this chain). Look at the documentation for that function.

Answer the questions in Part 1 on the worksheet (they are here just as a reference for all group members):
1. What does **System.out** represent? What is it with respect to the **System** class? What is its type?
2. Is **println()** function defined in the **System** class? If not, what class is it defined in?
3. There are several **println** functions. How do they differ? Which function is called/used in the above program (on the last line of the code)?
4. **println** calls **valueOf** function while it executes. What class is this function defined in?
5. There are several **valueOf** functions. Which function is used in the above program?
6. **valueOf** function calls another function. In which class is that function defined?
7. Reading all the documentation, were you able to figure out where the square brackets and the commas in the output come from? If so, what is the answer?

Part 2

OpenJDK (Open Java Development Kit) is a free and open source implementation of the Java programming language. You should have downloaded the source code for OpenJDK from the course website prior to this class. If you do not already have it downloaded, you can try to do it now (but be warned that the file is large and sometimes the WiFi interrupts the download process) or after the class.

Try to find out where you can find the source code for Java 8 on the web (other that from the course website).

Look at the sub-directory structure in the source code that you downloaded.

Open any of the source code files (the ones with .java extension). Take a look at the top 24 or so lines. The text talks about *GNU General Public License, version 2*. Find a website that describes what that is.

Answer the questions in Part 2 on the worksheet (they are here just as a reference for all group members):
1. Were you able to find a place on the web to download the source code of OpenJDK? If so, tells us where you found it (describe your search process and/or specify the URL).
2. How does the sub-directory structure in the source code relates to package/import statements that you include at the top of many of your programs? (For example the first line in the program above.)
3. What are the top lines of each source code file? Why do you think they are there?
4. Are you allowed to modify and redistribute the source code of OpenJDK?

Part 3

Locate and open the Java source code for the class that you determined contains the **toString** function executed to produce the output with square brackets and the commas for the **ArrayList** object.

Looking at the implementation of the **toString** function you will discover several things that you may not have encountered before. Don't worry about those lines. You should have enough intuition (given the comments above the method and what you observed in practice) to figure out what the method does even without understanding each line of code.

<u>Answer the questions in Part 3</u> on the worksheet (they are here just as a reference for all group members):
1. Name some parts in the source code of the toString function (the one responsible for putting together string representation of an **ArrayList** object) that are unfamiliar/strange.
2. Indicate the line of code that produces the open square bracket "[" (specify the line number and copy the line here).
3. Indicate the line of code that produces the close square bracket "]" (specify the line number and copy the line here).
4. Indicate the line of code that places the comma and space between the elements in the ArrayList (specify the line number and copy the line here).