Software and Programming 1

Lab 2:
Step-by-step execution of programs using a Debugger
Exercise 1: Step-by-step execution

- Launch BlueJ - begin with the Start icon in the lower left corner of the screen. Select the options in the order shown:

  Start -> All Programs -> ApplicationsA-B -> BlueJ

- Create a new Project on your disk space.
  1. Select Project then followed by New Project.
  2. Select a directory in your disk space and a suitable name for your project, e.g. hello. After entering hello in the BlueJ window, a new BlueJ window will appear for the project hello.

- Create a new class by clicking on button New Class ... in the new BlueJ window. Enter the name HelloWorld for the new class and click on OK.
Structure of HelloWorld Program

```java
public class HelloWorld {
    public static void main(String[] args) {
        // insert a sequence of Java statements inside the curly braces for the method main.
    }
}
```
Exercise 1: Step-by-step execution (2)

How many times does each of the following fragments of code print "Hello, world!". Why?
Use the debugger for step-by-step execution.

1. for (int i = 1; i <= 11; i++)
   System.out.println("Hello, world!");

2. for (int i = 10; i >= 0; i--)
   System.out.println("Hello, world!");

3. for (int i = 12; i >= 0; i++)
   System.out.println("Hello, world!");
Exercise 1: Step-by-step execution (3)

4. for (int i = -2; i < 12; i = i + 2)
   System.out.println("Hello, world!");

5. for (int i = 1; i < 22; i = i * 2)
   System.out.println("Hello, world!");
2. Write a program that reads a word and prints the word in reverse (see JFE, 2nd Ed, exercise P4.9 on p. 189). For example if the user provides the input "Harry", the program prints `yrraH`

```java
import java.util.Scanner;

public class ReverseWord {
    public static void main(String[] args) {
        // Write code to create an object `in` of type Scanner.
        // Create a BlueJ terminal window using `print`
        // or `println` statement for input from keyboard.
        // Read a word which is typed at the keyboard using
        // the method `in.next()`.
        // Store the word in a variable.
        // Use a `for` loop to print the word in reverse
    }
}
```
3. Write a program that prints all powers of 2 from $2^0$ up to $2^{20}$ (and execute it step-by-step). See JFE, 2nd Ed, exercise P4.13 on p. 190.

Hints:
(i) Firstly, use a `for` loop and then multiply with a variable to store the “current” value inside the loop.

(ii) Next, use the `Math.pow` method instead of the previous solution.
Challenging Exercise (attempt this only if time permits in the tutorial)

4. The *Fibonacci numbers* are defined by the sequence (see JFE, 2nd Ed, exercise P4.16 on p. 191)
   \[ f_1 = 1 \]
   \[ f_2 = 1 \]
   \[ f_n = f_{n-1} + f_{n-2} \]

Reformulate that as
   \[ \text{fold1} = 1; \]
   \[ \text{fold2} = 1; \]
   \[ \text{fnew} = \text{fold1} + \text{fold2}; \]

After that, discard `fold2`, which is no longer needed, and set `fold2` to `fold1` and `fold1` to `fnew`. Repeat an appropriate number of times. (Hint: use a for loop.)

Implement a program that prompts the user for an integer `n` and prints the `n`th Fibonacci number, using the above algorithm.

Use the debugger for step-by-step execution.
Explain of the Fibonacci sequence

• The Fibonacci series starts with the numbers 0 and 1; and then each subsequent number in the series is the sum of the previous two:

\[ f_0 = 0, \quad f_1 = 1 \]
\[ f_n = f_{n-1} + f_{n-2} \]

giving the Fibonacci sequence

\[ 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, \ldots \]

So, the next number is found by adding up the two numbers before it. For example,

– The ‘2’ is found by adding the two numbers before it (i.e. 1+1)
– Similarly, the ‘3’ is found by adding the two numbers before it (i.e. 1+2).
– And so on.
Why is the Fibonacci sequence interesting?

• “Fibonacci numbers are not only of interest to mathematicians. They seem to show up almost everywhere in nature, from the sequences of spirals in spiral galaxies (see Figure 1) to the whorls on pine cones (see Figure 2), where the number of spirals in each direction is a Fibonacci number.” (OU M269 course, Unit 4 Searching, 2013)

Figure 1 A spiral galaxy
Figure 2 Pine cones with 8 and 13 whorls. (OU M269 course, Unit 4 Searching)