

# Software and Programming I

## Lab 5: Fibonacci Sequence

# 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

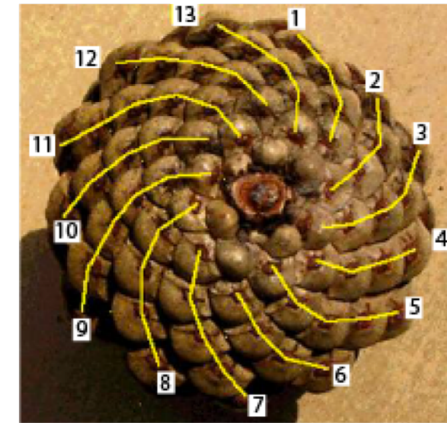
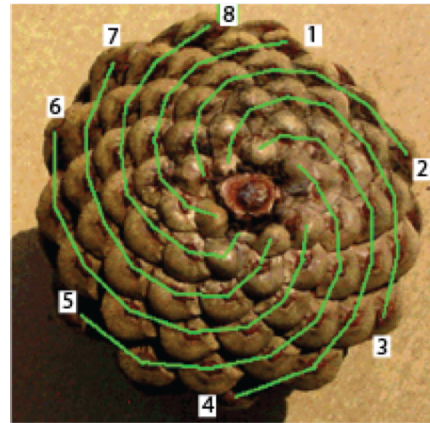


Figure 2 Pine cones with 8 and 13 whorls.  
(OU M269 course, Unit 4 Searching)

# Explanation of the Fibonacci sequence

- The Fibonacci series starts with the first two numbers being 1; then each subsequent number in the series is the sum of the previous two:

$$f_1 = 1, f_2 = 1 \quad (\text{one can also set } f_0 = 0)$$

$$f_n = f_{n-1} + f_{n-2}$$

giving the Fibonacci sequence

1, 1, 2, 3, 5, 8, 13, 21, 34, ...

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.

# Exercise 1: FibonacciNumbers

- The *Fibonacci numbers* are defined by the following sequence (see JFE, 2<sup>nd</sup> Ed, exercise P4.16 on p. 191)

$$f_1 = 1$$

$$f_2 = 1$$

$$f_n = f_{n-1} + f_{n-2}, \text{ for } n = 3, 4, 5, \dots$$

The above can be reformulated using **three variables** as follows:

```
fn1 = 1;
```

```
fn2 = 1;
```

```
fn = fn1 + fn2;    // line 3
```

After line 3, discard `fn2`, which is no longer needed, and set `fn2` to `fn1` and `fn1` to `fn`. Then work out the new value for `fn` using the same expression as given in line 3. Repeat this process for an appropriate number of times, using a for loop.

- The array version of the Fibonacci numbers was explained during Week 4 SP1 lecture on 6<sup>th</sup> Feb 2020.

# Exercise 1: FibonacciNumbers (2)

- Implement the program (i.e., the class `FibonacciNumbers`) that prompts the user for an integer `k` and prints the `k`th Fibonacci number, using the algorithm shown on slide 4.
- Your program consists of a `main` method that calls a helper method named `fibonacci` to work out the `k`th Fibonacci number.
- Method `main` does the following:
  1. Ask the user for an integer `k` (the program will then print out the `k`th Fibonacci number).
  2. Test the value entered
    - **if** `k` is zero or less, print an error message to the terminal and the program ends.
    - **else** `k` will be 1 or more, and the program calls the `fibonacci` method with the argument `k`. It then prints the result returned by the `fibonacci` method along with a suitable message.

# Exercise 1: FibonacciNumbers

## fibonacci method

- The `fibonacci` method should have one input parameter (named, say, `k`) of type `int` to receive the value entered by the user – this is sent in as an argument from the call in the `main` method.
- Pseudocode for the method body
  1. Check if `k` is 2 or less, then return 1 and terminate the method.
  2. Declare variables, `fn1`, `fn2` and `fn`, and assign an appropriate value or expression to each (see slide 4).
  3. Repeat the following (an appropriate number of times) using a for loop:
    - i. Assign suitable values to `fn1` and `fn2` using the algorithm on slide 4.
    - ii. Work out the new value for `fn` by adding `fn1` and `fn2`.
  4. The method should return `fn`.

# Exercise 1: FibonacciNumbers

## Code Template

<http://www.dcs.bbk.ac.uk/~roman/sp1/java/FibonacciNumbers.java>

```
1 import java.util.Scanner;
2 public class FibonacciNumbers
3 {
4     public static void main(String[] args)
5     {
6         System.out.println("Enter a number k to compute the kth Fibonacci number: ");
7         Scanner scanner = new Scanner(System.in);
8         int k = scanner.nextInt();
9         // INSERT YOUR CODE HERE
10        System.out.println("Invalid number");
11        // INSERT YOUR CODE HERE
12        System.out.println("The kth Fibonacci number is " + fibonacci(k));
13    }
14
15    public static int fibonacci(int k)
16    {
17        // INSERT YOUR CODE HERE
18    }
19 }
```

# Home Work

## Java for Everyone by C. Horstmann

Read Chapter 5 (Sections 5.1–5.8), which is available online from

<http://vufind.lib.bbk.ac.uk/vufind/Record/566484>

and complete the following exercises:

- Exercise R5.5
- Exercise R5.9
- Exercise R5.13
- Exercise R5.14
- Exercise P5.2
- Exercise P5.6
- Exercise P5.14