CS1 — Practical Session 7: Recursion

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In this 7th lab session you will probably struggle with the beautiful concept of recursion. (For the occasion, I will use a lot of (re-)*cursive* font.)

Exercise 1

(This is a repeat of the bonus exercise in session 4.)

It is known in mathematics that if you take any natural number n (i.e. 1, 2, 3), apply the following rules:

1. if n is even: divide n by 2
2. if n is odd: multiply by 3 and add 1

and continue to do this with the new number you obtain, you will at some point always reach the number 1.

Implement a Java Program that simulates this process, i.e. that reads in a integer number and then uses the rules listed above to build a sequence of numbers until it reaches the value 1. Your program should print out all the numbers that make up the sequence together with, at the end, the number of steps it took to reach the value 1.

Last time you were required to implement this with a while loop. For this session, of course you should build a recursive solution.

Exercise 2

Implement some of the "Simple Array Algorithms" we covered in class recursively. The algorithms to implement are:

- Finding the maximum/minimum
- Finding a value

Also the other algorithms can be implemented recursively. For example, implementing a recursive version of the binary search algorithm *is great exercise for the exam! In fact, it would be great exercise and constitute a big step towards passing this class, if you would implement all exercises on iteration from previous sessions recursively and all exercises from this session also iteratively. Be aware though that you should not consider this easy.*

Assignment!

From Wikipedia: *The Tower of Hanoi or Towers of Hanoi, also called the Tower of Brahma or Towers of Brahma, is a mathematical game or puzzle. It consists of three rods, and a number of disks of different sizes which can slide onto any rod. The puzzle starts with the disks in a neat stack in ascending order of size on one rod, the smallest at the top, thus making a conical shape.*

The objective of the puzzle is to move the entire stack to another rod, obeying the following rules:

1. *Only one disk may be moved at a time.*
2. *Each move consists of taking the upper disk from one of the rods and sliding it onto another rod, on top of the other disks that may already be present on that rod.*
3. *No disk may be placed on top of a smaller disk.*

Write a recursive methods that writes out all the steps necessary to solve the Towers of Hanoi problem. As an example, here is the output for a tower of height 2:

```
Give the tower height: 2
Move the top disc from the first stack to the second stack
Move the top disc from the first stack to the third stack
Move the top disc from the second stack to the third stack
You are done!
```

and for height 3:

```
wopr: java$ java HanoiTowers
Give the tower height: 3
Move the top disc from the first stack to the third stack
Move the top disc from the first stack to the second stack
Move the top disc from the third stack to the second stack
Move the top disc from the first stack to the third stack
Move the top disc from the second stack to the first stack
Move the top disc from the second stack to the third stack
Move the top disc from the first stack to the third stack
You are done!
```

Pay attention: The towers of Hanoi is a well known example of a recursive problem. As such, from the Wikipedia page on Towers of Hanoi, a recursive solution in Java is only 2 clicks away. It is very easy for you to copy that solution, send it to me and get credit for someone else's work. But remember that this exercise is supposed to teach you something, something that you will need to be able to do on the exam and that you will not learn from copy pasting code from a webpage. It is rumoured that sending in a copy-pasted solution to this exercise to get out of the attendance requirements for CS1, is the easiest and fastest way into the re-sit.

As usual, when it all works, **upload** your `.java` file to receive credit for your work.

Oh, and feel free to now also finish the MineSweeper game from last Monday's lab.