



ASSIGNMENT 3

GENERAL INFORMATION

This assignment is made public on Friday, February 21, 2003. The assignment is due on
 Friday, February 28, 1 PM.

Hand in your assignment to the teaching assistant running your lab session.
 The first page of your (written) assignment has to contain at least the following information:

- the course name (Introduction to Programming - Concepts and Tools)
- your name and your student number
- name and student number of the fellow student if you submit in pairs
- assignment number

Please staple your assignment!

You will get back the graded assignment one week after submission deadline.

QUESTIONS

1. (*Recursion*)

Consider the sequence of numbers defined by recursion as follows:

$$mc(0) = 1, \quad mc(1) = 1, \quad mc(n) = 1 + mc(n-1) + mc(n-2) \text{ for all } n \geq 2.$$

- (a) Implement a method of signature

```
int mc(int)
```

that will take as parameter a number n and return $mc(n)$. The method has to be recursive.

- (b) Write a program that will test your implementation. For example, you could print out the first 10 numbers and compare them with the actual values.
- (c) When calling the method $mc(n)$, how many function calls are actually executed?
- (d) Argue whether or not the above recursive method is effective in calculating $mc(n)$. To answer this question you may want to draw trees showing how $mc(n)$ calls recursively itself (i.e., $mc(n-1)$ and $mc(n-2)$, and how $mc(n-1)$ calls $mc(n-2)$ and $mc(n-3)$, ...).

2. (*Binomial coefficients*)

The binomial coefficients $\binom{n}{k}$, (pronounced n choose k) for natural numbers n and k , give the number of different ways of picking a collection of k elements from a collection of n elements. The binomial coefficients play an important role in many parts of computer science and are, for example, used in algorithm analysis and simulation of networks. It is possible to calculate the value of $\binom{n}{k}$ recursively, as given below.

- (a) Write a method of signature

```
long binom(long, long)
```

that will calculate the binomial coefficients defined recursively by

$$\binom{n}{k} = \begin{cases} 1 & \text{if } k = 0, n, \\ \binom{n-1}{k-1} + \binom{n-1}{k} & \text{if } 0 < k < n, \\ 0 & \text{else.} \end{cases}$$

- (b) Write a program that will test your method.
- (c) Give a recursive definition of the number of method calls that are made once `binom(n,k)` is called.

3. (*Strings*)

Suppose you are given three methods of signatures

- `int length(String)`
- `String first(String)`
- `String substring(String)`

of which you know the following: The first method will take a string as argument and return its length, i.e., the number of letters making up the string. If the string is empty the method will return 0. The second method takes a string and returns as a string the first letter the argument, or the empty string if the parameter is of length zero. Finally, the third method takes a string as argument, and returns the string with the first letter chopped off.

- (a) Write a method of signature

`String reversalIt(String)`

which will take as argument a string and will return its reversal (where for example the reversal of the string “qwert” is the string “trewq”). Design an algorithm that is iterative, i.e., that uses a loop. (You have to call one or more of the methods given above to solve this problem.)

- (b) Write a method of signature

`String reversalRec(String)`

which will take as argument a string and will return its reversal, using this time a recursive algorithm. (Again you have to call one or more of the methods above.)

- (c) To test you methods implement them and write a program that will ask the user to input a string and that will output the string in reverse order.

To do so your program should contain the line `import java.lang.*;` before or after the line `import tio.*;`, and you should use the following implementations¹ of the three methods above:

```
static String first(String s){
    return ""+s.charAt(0);}

static String substring(String s){
    return s.substring(1);}

static int length(String s){
    return s.length();}
```

To read a string from the keyboard use the method `Console.in.readLine()` which will return the string keyed in by the user of your program.

¹The methods we need are pre-implemented as `charAt(int)`, `substring(int)` and `length()`, and are made available by importing `java.lang.*`. The methods are called in a different way than you have seen, so I wrapped them for easy use.