

Computer Architecture

Recitation 2

The purpose of this recitation is to train you in the programming language C. You should compile and test all the programs with the option `-Wall` without producing any warning.

Exercise 1 (getting started)

§1 Write a C program which waits for an integer n on the keyboard and then writes « well done » when the value of the integer is 42 and « lost » otherwise.

Exercise 2 (simple loops)

§2.a Write a C program which waits for an integer n on the keyboard and then writes its factorial:

$$n! = \prod_{k=1}^n i = 1 \times 2 \times \cdots \times n$$

§2.b Write a C program which outputs the first ten factorial numbers:

```
1! = 1
2! = 2
3! = 6
4! = 24
5! = 120
6! = 720
7! = 5040
8! = 40320
9! = 362880
10! = 3628800
```

§2.c Adapt the previous C program in order to output the first twenty factorial numbers. It is quite likely that you see a series of somewhat unexpected answers in your list. If this is the case, can you explain what happened?

§2.d Correct your C program in §2.c in order to output the correct list of twenty first factorial numbers. Check in particular that the factorial of 20 is equal to

$$20! = 2432902008176640000$$

Exercise 3 (random numbers)

Random numbers in C are computed using a random number generator (or seed) which needs to be initialized. Here follows a typical piece of C code which initializes a random seed, computes two random numbers between 1 and 10 and prints them:

```
srand((unsigned)time(NULL));
printf("%d\n", rand() % 10 + 1);
printf("%d\n", rand() % 10 + 1);
```

§3.a Complete the previous fragment of code in order to make it compile. Always remember in this situation that the command `man` provides a very safe guide. Beware that you will need to go to page `rand(3)` rather than to the page `rand(1)` by typing the command `man 3 rand` rather than simply `man rand`. Similarly, you will need to get to the page `time(3)` rather than to the page `time(1)`.

§3.b Write a C program which prints 10 random numbers picked between 1 and 6 and which then inserts a paragraph break to the next line.

```
6 2 3 6 3 2 1 1 4 4
```

§3.c Write a C program which prints 100 random numbers picked between 1 and 6 as a 10×10 matrix:

```
1 6 4 2 1 3 5 1 6 2
6 2 2 2 3 5 4 5 2 3
...
```

§3.d Slightly modify the previous C program in such a way that it prints in the end the number of 6's in the matrix.

Exercise 4 (Fibonacci)

Leonardo di Pisa (also known as Leonardi Bonacci) was born around 1170 the son of a wealthy italian merchant. He had the opportunity to travel throughout

the Mediterranean world, and to learn mathematics with the leading Arabic mathematicians of his time. Based on this precious knowledge, he wrote in 1202 the *Liber Abaci* which introduced and popularized the Hindu-Arabic numeral system in Europe. In this book, he described and solved a problem involving the growth of a population of rabbits, based on two quite idealized assumptions:

- every year, every mature rabbit produces an immature rabbit,
- it then takes a year for each immature rabbit to become mature,
- no rabbit ever dies.

Starting from the year 0 with one immature rabbit leads to the famous Fibonacci sequence defined by the following recursion:

$$\begin{aligned} f_0 &= 1 ; \\ f_1 &= 1 ; \\ f_n &= f_{n-1} + f_{n-2} \quad \text{for } n \geq 2. \end{aligned}$$

Write an iterative program which reads an integer n and then prints the first n long integers of the Fibonacci sequence. An additional constraint will be to write a program which executes in constant space (that is, with a constant number of variables) and thus does not use any array.

References and acknowledgments: among all the introductory exercises in C which I encountered in the literature, I most enjoyed this series of exercises designed by my friend and colleague Juliusz Chroboczek back in Paris — which I thus decided to adapt here from French to English, with only a few minor alterations or improvements.