Tutorial n°1

1 Hello world on different plateforms

You can use any IDE and compiler you want, as long as you write C++. In practice, we strongly recommend you to consider Qt or CodeBlocks rather than Visual Studio (not standard C++ with infamous microsoft standards...) with GCC as compiler. Depending on the installed IDE on the computers, please consider the following 3 exercices to get familiar with various IDEs.

1.1 CodeBlocks

Open the CodeBlocks software, create a new project (Win32 application) and display a Hello world.

1.2 Visual C++ 20XX Express

Open the Visual C++ 20XX Express software, create a new project (Win32 application) and display a Hello world.

1.3 Qt

Open Qt Creator, create a new Qt project (console application) and display a Hello world.

2 Variables

Choose one of the Development Environment for the rest of this tutorial.

2.1 Global and other variables

Explain what is a local variable and what is a global variable. Illustrate the differences on an example of your choice.

2.1.1 Elementary functions: Mean, Min, and Max

1. Declare and implement a function which computes the maximum of two variables.

2. Declare and implement a function which computes the minimum of two variables.

3. Declare and implement a function which computes the mean of two variables.

3 Combination

3.1 Factorial

1. Declare a variable to represent a integer and ask the user to enter a value to initialize it.

2. Verify that the value entered is an integer superior or equal to zero, and if not, ask the user to enter a new value until the value is correct (not only once).

3. Declare and implement a function to compute the factorial of the value entered by the user.
   Reminder: The factorial is formally defined by: $\forall n \in \mathbb{N}^*$, $n! = \prod_{k=1}^{n} k$.

3.2   Number of combinations from a set

The number of k-combinations (each of size k) from a set S with n elements is the binomial coefficient:

$$C_k^n = \binom{n}{k} = \frac{n!}{k!\,(n-k)!}, \; if \; 0 \le k \le n.$$

Declare and implement a function to compute and display the number of combination of a lottery game (49 different numbers), where the player must choose 6 different numbers.

3.3   Number of combinations with repetitions

The number of combinations with repetitions can be calculated as:

$$\binom{n+k-1}{n-1} = \frac{(n+k-1)!}{k!\,(n-1)!} = \binom{n+k-1}{k}.$$

Declare and implement a function to compute and display the number of possible combinations of the Yathzee game, where the player rolls 5D6.

3.4   Permutations

The number of permutation can be calculated as:

$$P_k^n = P(n,k) = \frac{n!}{(n-k)!}.$$

In a set of 54 cards, what is the number of permutation if you choose 5 cards (poker)? Declare and implement a function to answer such question.

4   List of Fibonacci numbers and its relation with the golden ratio

4.1   List of Fibonacci

In mathematical terms, the sequence F_n of Fibonacci numbers is defined by the recursive relation:

$$\begin{cases} F_0 = 0 \\ F_1 = 1 \\ F_n = F_{n-1} + F_{n-2}. \end{cases}$$

Declare and implement a function to compute and display the n first numbers of the Fibonacci's list, where n is provided by the user.

4.2   Approximation of the golden ratio

Johannes Kepler observed that the ratio of consecutive Fibonacci numbers converges to:

$$\lim_{n \to \infty} \frac{F(n+1)}{F(n)} = \varphi,$$

with $\varphi = \frac{1+\sqrt{5}}{2} \approx 1.61803\ldots$
Create a constant global variable called φ and initialize it to the value defined in the previous equation. Declare and implement a function which computes the ratio of consecutive Fibonacci numbers r while $\|r - \phi\| > \varepsilon$. Display the result and the number of iterations for various values of ε: try at least 1.10^{-6}, 1.10^{-9}, 1.10^{-12}, and 1.10^{-15}. Any comment on the impact of the format (float vs double)?

5   Pascal's triangle

Pascal's triangle is a geometric arrangement of binomial coefficients in a triangle. Pascal demonstrated that:

$$\forall n \in \mathbb{N}^*, \forall k \in [\![0,n]\!], \ (x+y)^n = \sum_{k=0}^{n} C_k^n x^{n-k} y^k$$

Declare and implement a fucntion to compute and display the *n* first rows of the Pascal's triangle in the form using previously defined functions. Arrays are not allowed for this exercice:

```
1
1   1
1   2    1
1   3    3    1
1   4    6    4    1
1   5    10   10   5    1
⋮   …    …    …    …    …
```

5.1   Few other things to know

5.1.1   working with strings

The standard library offers powerful features to work with strings. Naturally, one can always reinvent the wheel and recreate a new home-made class, which is a very sure way to waste time and energy for nothing... In this exercice, have a look at the standard string class in C++: http://www.cplusplus.com/reference/string/string/string/.

Illustrate some of its most common functions and operators, such as + , =, append(), c_str(),<< , insert(), length(), and getline(), at the least.

5.1.2   Understanding `int main ( int argc, char** argv)`…

Try and adapt the following code. Guess what are the parameters argc and what they correspond to

```cpp
#include <iostream>
using namespace std;


int main(int argc, char* argv[])
{
  cout << "argc = " << argc << endl;

  for (int i = 0; i<argc; i++)
  cout << "argv[i] = " << argv[i]<<endl;

return 0;
}
```

ExampleMain.cpp

5.1.3   ...and LATEX to generate nice pdf files

Last but not least, you will be obliged, soon or later, to write reports. The most efficient tool to do so is undoubtfully LATEX. However, if you are not yet familiar with it, it is time to start practicing! You can use LATEXwith various editors: Lyx http://www.lyx.org/ and Texniccenter (windows only) http://www.texniccenter.org/ are among the most popular ones. For instance, this document has been created using Texniccenter. For further information, please see http://www.latex-project.org/.