

Tutorial n°1

1 Hello world on different platforms

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:

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

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:

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

with $\varphi = \frac{1+\sqrt{5}}{2} \approx 1.61803\dots$

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 $\|r - \varphi\| > \epsilon$. 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:

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

Declare and implement a function 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 exercise:

```

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 exercise, 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

```

1 #include <iostream>
   using namespace std;
3
5 int main(int argc, char* argv[])
   {
7     cout << "argc = " << argc << endl;
9     for (int i = 0; i < argc; i++)
       cout << "argv[" << i << "] = " << argv[i] << endl;
11
   return 0;
13 }
```

ExampleMain.cpp

5.1.3 ...and L^AT_EX 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 undoubtedly L^AT_EX. However, if you are not yet familiar with it, it is time to start practicing! You can use L^AT_EX with 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/>.