FUNCTIONS (created by professor Marina Tanasyuk)

In C++, a function is a group of statements that is given a name, and which can be called from some point of the program. The most common syntax to define a function is:

```
type name ( parameter1, parameter2, ...) { statements }
```

Where:

- `type` is the type of the value returned by the function.

- `name` is the identifier by which the function can be called.

- `parameters` (as many as needed): Each parameter consists of a type followed by an identifier, with each parameter being separated from the next by a comma. Each parameter looks very much like a regular variable declaration (for example: `int x`), and in fact acts within the function as a regular variable which is local to the function. The purpose of parameters is to allow passing arguments to the function from the location where it is called from.

- `statements` is the function's body. It is a block of statements surrounded by braces { } that specify what the function actually does.

Let's have a look at an example:

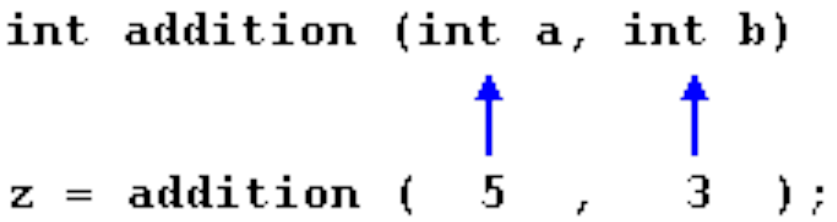
```
1  // function example
2  #include <iostream>
3  using namespace std;
4
5  int addition (int a, int b) {
6     int r;
7     r=a+b;
8     return r;
9  }
10
11 int main () {
12    int z;
13    z = addition (5,3);
14    cout << "The result is " << z;
15 }
16
17
```

```
The result is 8
```

This program is divided in two functions: `addition` and `main`.

Remember that no matter the order in which they are defined, a C++ program always starts by calling `main`. In fact, `main` is the only function called automatically, and the code in any other function is only executed if its function is called from `main` (directly or indirectly).

In the example above, `main` begins by declaring the variable `z` of type `int`, and right after that, it performs the first function call: it calls `addition`. The call to a function follows a structure very similar to its declaration. In the example above, the call to `addition` can be compared to its definition just a few lines earlier:



The parameters in the function declaration have a clear correspondence to the arguments passed in the function call. The call passes two values, `5` and `3`, to the function; these correspond to the parameters `a` and `b`, declared for function `addition`.

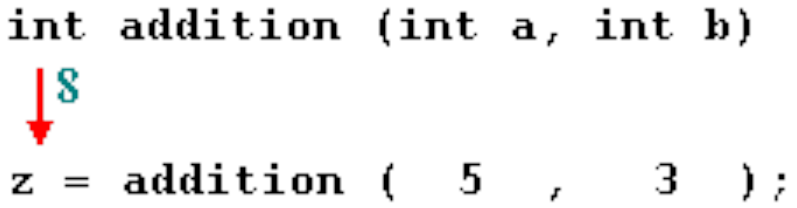
At the point at which the function is called from within main, the control is passed to function `addition`: here, execution of `main` is stopped, and will only resume once the `addition` function ends. At the moment of the function call, the value of both arguments (`5` and `3`) are copied to the local variables `int a` and `int b` within the function.

Then, inside `addition`, another local variable is declared (`int r`), and by means of the expression `r=a+b`, the result of `a` plus `b` is assigned to `r`; which, for this case, where `a` is 5 and `b` is 3, means that 8 is assigned to `r`.

The final statement within the function:

```
return r;
```

Ends function `addition`, and returns the control back to the point where the function was called; in this case: to function `main`. At this precise moment, the program resumes its course on `main` returning exactly at the same point at which it was interrupted by the call to `addition`. But additionally, because `addition` has a return type, the call is evaluated as having a value, and this value is the value specified in the return statement that ended `addition`: in this particular case, the value of the local variable `r`, which at the moment of the `return` statement had a value of 8.



Therefore, the call to `addition` is an expression with the value returned by the function, and in this case, that value, 8, is assigned to `z`. It is as if the entire function call (`addition(5,3)`) was replaced by the value it returns (i.e., 8).

Then main simply prints this value by calling:

```
cout << "The result is " << z;
```

A function can actually be called multiple times within a program, and its argument is naturally not limited just to literals:

```
1  // function example
2  #include <iostream>
3  using namespace std;
4  int subtraction (int a, int b) {
5     int r;
6     r=a-b;
7     return r;
8  }
9  int main () {
10    int x=5, y=3, z;
11    z = subtraction (7,2);
12    cout << "The first result is " << z << '\n';
13    cout << "The second result is " <<
14 subtraction (7,2) << '\n';
15    cout << "The third result is " << subtraction
16 (x,y) << '\n';
17    z = 4 + subtraction (x,y);
18    cout << "The fourth result is " << z << '\n';
19 }
20
21
```

```
The first
result is 5
The second
result is 5
The third
result is 2
The fourth
result is 6
```

Math functions

Header **<cmath>** declares a set of functions to compute common mathematical operations and transformations:

- **Trigonometric functions**
- **Exponential and logarithmic functions**
- **Power functions:**

  pow(base, power) -> pow(3, 2) = 3 ^ 2 = 9

  sqrt(value) -> sqrt(16) = 4
- **Rounding and remainder functions:**

  ceil(value) -> round up value -> ceil(2.3) = 3

  floor(value) -> round down value -> floor(2.8) = 2

  round(value) -> round to nearest -> round(2.3) = 2
- **Minimum, maximum, difference functions**
- **Other functions:**

  abs(value) -> abs(-4) = 4

rand() function

(included in <cstdlib> library)

Returns a pseudo-random integral number in the range between 0 and RAND_MAX.
RAND_MAX - this value is library-dependent, but is guaranteed to be at least 32767 on any standard library implementation.

A typical way to generate trivial pseudo-random numbers in a determined range using rand is to use the modulo of the returned value by the range span and add the initial value of the range:

rand() % v2 + v1
v1 is the starting point of the range, including (by default is 0)
v2 is how many numbers should be in the range

Examples:

```
v1 = rand() % 100;          // v1 in the range 0 to 99
v2 = rand() % 100 + 1;      // v2 in the range 1 to 100
v3 = rand() % 30 + 1985;    // v3 in the range 1985-2014
```