Function in C++

A function is a block of code that performs a specific task.

Suppose we need to create a program to create a circle and color it. We can create two functions to solve this problem:

- A function to draw the circle
- A function to color the circle

Dividing a complex problem into smaller chunks makes our program easy to understand and reusable.

There are two types of function:

1. **Standard Library Functions:** Predefined in C++
   Built-in functions are also known as library functions. We need not to declare and define these functions as they are already written in the C++ libraries such as iostream, cmath etc. We can directly call them when we need.

2. **User-defined Function:** Created by users
   The functions that we declare and write in our programs are user-defined functions.

We will focus mostly on user-defined functions.

User-defined Function

C++ allows the programmer to define their own function. A user-defined function groups the code to perform a specific task and that group of code is given a name (identifier). When the function is invoked from any part of the program, it all executes the codes defined in the body of the function.

We need to understand the following about functions:

- Function Declaration
- Function Calling
- Function Parameters
- Function return type
- Function Prototype

Function Declaration

The syntax to declare a function is:

```
returnType functionName (parameter1, parameter2,...) {
    // function body
}
```

Here's an example of a function declaration.

```
// function declaration
void greet() {
    cout << "Hello World";
}
```

Here,

- the **name** of the function is `greet()`
- the **return type** of the function is `void`
- the empty **parentheses** mean it doesn't have any **parameters**
- the **function body** is written inside `{}`

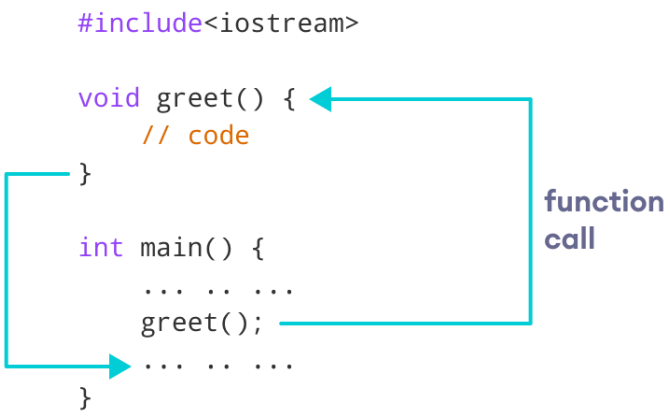
Note: We will learn about `returnType` and `parameters` later in this lecture.

Calling a Function

In the above program, we have declared a function named `greet()`. To use the `greet()` function, we need to call it.

Here's how we can call the above `greet()` function.

```
int main() {

    // calling a function
    greet();

}
```



Example 1: Display a Text

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

// declaring a function
void greet() {
    cout << "Hello there!";
}

int main() {

    // calling the function
    greet();

    return 0;
}
```

Output

```
Hello there!
```

Function Parameters

As mentioned above, a function can be declared with parameters (arguments). A parameter is a value that is passed when declaring a function.

For example, let us consider the function below:

```
void printNum(int num) {
    cout << num;
}
```

Here, the `int` variable *num* is the function parameter.

We pass a value to the function parameter while calling the function.

```
int main() {
    int n = 7;

    // calling the function
    // n is passed to the function as argument
    printNum(n);

    return 0;
}
```

Example 2: Function with Parameters

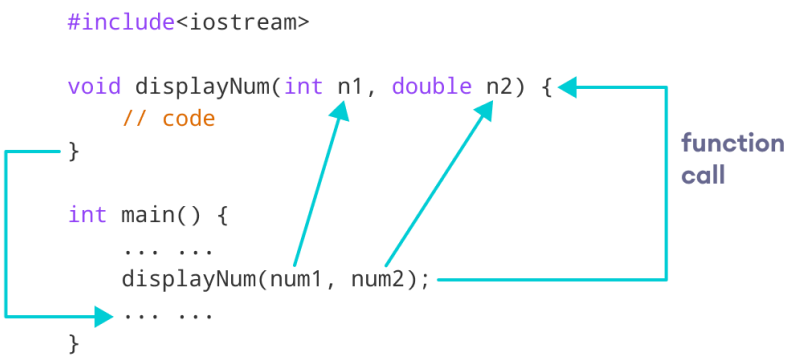
```
// program to print a text

#include <iostream>
using namespace std;

// display a number
void displayNum(int n1, float n2) {
    cout << "The int number is " << n1;
    cout << "The double number is " << n2;
}

int main() {

     int num1 = 5;
     double num2 = 5.5;

    // calling the function
    displayNum(num1, num2);

    return 0;
}
```

Output

```
The int number is 5
The double number is 5.5
```

In the above program, we have used a function that has one `int` parameter and one `double` parameter.

We then pass *num1* and *num2* as arguments. These values are stored by the function parameters *n1* and *n2* respectively.



Note: The type of the arguments passed while calling the function must match with the corresponding parameters defined in the function declaration.

Return Statement

In the above programs, we have used void in the function declaration. For example,

```
void displayNumber() {
    // code
}
```

This means the function is not returning any value.

It's also possible to return a value from a function. For this, we need to specify the `returnType` of the function during function declaration.

Then, the `return` statement can be used to return a value from a function.

For example,

```
int add (int a, int b) {
    int c;
    c = a + b;
    return (c);
}
```

Here, we have the data type `int` instead of `void`. This means that the function returns an `int` value.

The code `return (a + b);` returns the sum of the two parameters as the function value.

The `return` statement denotes that the function has ended. Any code after `return` inside the function is not executed.

Example 3: Add Two Numbers

```
// program to add two numbers using a function

#include <iostream>

using namespace std;

// declaring a function
int add(int a, int b) {
    return (a + b);
}

int main() {

    int sum;

    // calling the function and storing the returned value in sum
    sum = add(100, 78);

    cout << "100 + 78 = " << sum << endl;

    return 0;
}
```

Output

```
100 + 78 = 178
```

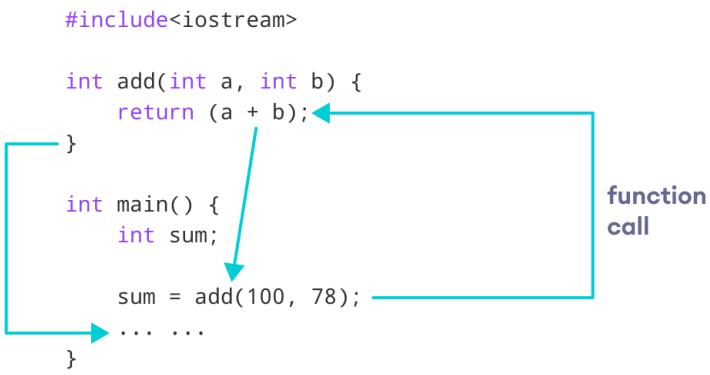
In the above program, the `add()` function is used to find the sum of two numbers.

We pass two `int` literals `100` and `78` while calling the function.

We store the returned value of the function in the variable *sum*, and then we print it.

Working of C++ Function with return statement

Notice that *sum* is a variable of `int` type. This is because the return value of `add()` is of `int` type.



Function Prototype

In C++, the code of function declaration should be before the function call. However, if we want to define a function after the function call, we need to use the function prototype. For example,

```
// function prototype
void add(int, int);

int main() {
    // calling the function before declaration.
    add(5, 3);
    return 0;
}

// function definition
void add(int a, int b) {
    cout << (a + b);
}
```

In the above code, the function prototype is:

```
void add(int, int);
```

This provides the compiler with information about the function name and its parameters. That's why we can use the code to call a function before the function has been defined.

The syntax of a function prototype is:

```
returnType functionName(dataType1, dataType2, ...);
```

Example 4: C++ Function Prototype

```
// using function definition after main() function
// function prototype is declared before main()

#include <iostream>

using namespace std;

// function prototype
int add(int, int);

int main() {
    int sum;

    // calling the function and storing
    // the returned value in sum
    sum = add(100, 78);

    cout << "100 + 78 = " << sum << endl;

    return 0;
}

// function definition
int add(int a, int b) {
    return (a + b);
}
```

Output

```
100 + 78 = 178
```

The above program is nearly identical to **Example 3**. The only difference is that here, the function is defined **after** the function call.

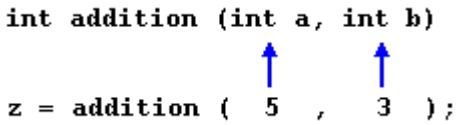
That's why we have used a function prototype in this example.

Arguments passed by value and by reference

In the functions seen earlier, arguments have always been passed by value. This means that, when calling a function, what is passed to the function are the values of these arguments on the moment of the call, which are copied into the variables represented by the function parameters. For example, take:

```
int x=5, y=3, z;
z = addition ( x, y );
```

In this case, function addition is passed 5 and 3, which are copies of the values of x and y, respectively. These values (5 and 3) are used to initialize the variables set as parameters in the function's definition, but any modification of these variables within the function has no effect on the values of the variables x and y outside it, because x and y were themselves not passed to the function on the call, but only copies of their values at that moment.

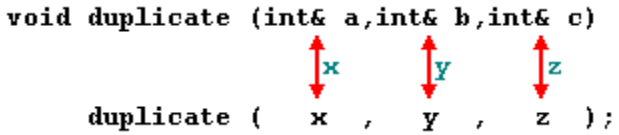


In certain cases, though, it may be useful to access an external variable from within a function. To do that, arguments can be passed by reference, instead of by value. For example, the function duplicate in this code duplicates the value of its three arguments, causing the variables used as arguments to actually be modified by the call:

```
// passing parameters by reference
#include <iostream>
using namespace std;

void duplicate (int& a, int& b, int& c)
{
  a*=2;
  b*=2;
  c*=2;
}

int main ()
{
  int x=1, y=3, z=7;
  duplicate (x, y, z);
  cout << "x=" << x << ", y=" << y << ",
z=" << z;
  return 0;
}
```

To gain access to its arguments, the function declares its parameters as *references*. In C++, references are indicated with an ampersand (&) following the parameter type, as in the parameters taken by duplicate in the example above.

When a variable is passed *by reference*, what is passed is no longer a copy, but the variable itself, the variable identified by the function parameter, becomes somehow associated with the argument passed to the function, and any modification on their corresponding local variables within the function are reflected in the variables passed as arguments in the call.



In fact, a, b, and c become aliases of the arguments passed on the function call (x, y, and z) and any change on a within the function is actually modifying variable x outside the function. Any change on b modifies y, and any change on c modifies z. That is why when, in the example, function duplicate modifies the values of variables a, b, and c, the values of x, y, and z are affected.

If instead of defining duplicate as:

```
void duplicate (int& a, int& b, int& c)
```

Was it to be defined without the ampersand signs as:

```
void duplicate (int a, int b, int c)
```

The variables would not be passed *by reference*, but *by value*, creating instead copies of their values. In this case, the output of the program would have been the values of x, y, and z without being modified (i.e., 1, 3, and 7).

C++ Library Functions

Library functions are the built-in functions in C++ programming. Programmers can use library functions by invoking the functions directly; they don't need to write the functions themselves.

Some common library functions in C++ are `sqrt()`, `abs()`, `isdigit()`, etc.

In order to use library functions, we usually need to include the header file in which these library functions are defined.

For instance, in order to use mathematical functions such as `sqrt()` and `abs()`, we need to include the header file `cmath`.

Example 5: C++ Program to Find the Square Root of a Number

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

int main() {
    double number, squareRoot;

    number = 25.0;

    // sqrt() is a library function to calculate the square root
    squareRoot = sqrt(number);

    cout << "Square root of " << number << " = " << squareRoot;

    return 0;
}
```

Output

```
Square root of 25 = 5
```

In this program, the `sqrt()` library function is used to calculate the square root of a number.

The function declaration of `sqrt()` is defined in the `cmath` header file. That's why we need to use the code `#include <cmath>` to use the `sqrt()` function.