C++ BASIC INPUT/OUTPUT

The C++ standard libraries provide an extensive set of input/output capabilities which we will see in subsequent chapters. This chapter will discuss very basic and most common I/O operations required for C++ programming.

C++ I/O occurs in streams, which are sequences of bytes. If bytes flow from a device like a keyboard, a disk drive, or a network connection etc. to main memory, this is called **input operation** and if bytes flow from main memory to a device like a display screen, a printer, a disk drive, or a network connection, etc, this is called **output operation**.

I/O Library Header Files:

There are following header files important to C++ programs:

Header File	Function and Description
<iostream>	This file defines the **cin, cout, cerr** and **clog** objects, which correspond to the standard input stream, the standard output stream, the un-buffered standard error stream and the buffered standard error stream, respectively.
<iomanip>	This file declares services useful for performing formatted I/O with so-called parameterized stream manipulators, such as **setw** and **setprecision**.
<fstream>	This file declares services for user-controlled file processing. We will discuss about it in detail in File and Stream related chapter.

The standard output stream *cout*:

The predefined object **cout** is an instance of **ostream** class. The cout object is said to be "connected to" the standard output device, which usually is the display screen. The **cout** is used in conjunction with the stream insertion operator, which is written as << which are two less than signs as shown in the following example.

```
#include <iostream>

using namespace std;

int main( )
{
   char str[] = "Hello C++";

   cout << "Value of str is : " << str << endl;
}
```

When the above code is compiled and executed, it produces the following result:

```
Value of str is : Hello C++
```

The C++ compiler also determines the data type of variable to be output and selects the appropriate stream insertion operator to display the value. The << operator is overloaded to output data items of built-in types integer, float, double, strings and pointer values.

The insertion operator << may be used more than once in a single statement as shown above and **endl** is used to add a new-line at the end of the line.

The standard input stream *cin*:

The predefined object **cin** is an instance of **istream** class. The cin object is said to be attached to

the standard input device, which usually is the keyboard. The **cin** is used in conjunction with the stream extraction operator, which is written as >> which are two greater than signs as shown in the following example.

```
#include <iostream>

using namespace std;

int main( )
{
   char name[50];

   cout << "Please enter your name: ";
   cin >> name;
   cout << "Your name is: " << name << endl;

}
```

When the above code is compiled and executed, it will prompt you to enter a name. You enter a value and then hit enter to see the result something as follows:

```
Please enter your name: cplusplus
Your name is: cplusplus
```

The C++ compiler also determines the data type of the entered value and selects the appropriate stream extraction operator to extract the value and store it in the given variables.

The stream extraction operator >> may be used more than once in a single statement. To request more than one datum you can use the following:

```
cin >> name >> age;
```

This will be equivalent to the following two statements:

```
cin >> name;
cin >> age;
```

The standard error stream *cerr*:

The predefined object **cerr** is an instance of **ostream** class. The cerr object is said to be attached to the standard error device, which is also a display screen but the object **cerr** is un-buffered and each stream insertion to cerr causes its output to appear immediately.

The **cerr** is also used in conjunction with the stream insertion operator as shown in the following example.

```
#include <iostream>

using namespace std;

int main( )
{
   char str[] = "Unable to read....";

   cerr << "Error message : " << str << endl;
}
```

When the above code is compiled and executed, it produces the following result:

```
Error message : Unable to read....
```

The standard log stream *clog*:

The predefined object **clog** is an instance of **ostream** class. The clog object is said to be attached

to the standard error device, which is also a display screen but the object **clog** is buffered. This means that each insertion to clog could cause its output to be held in a buffer until the buffer is filled or until the buffer is flushed.

The **clog** is also used in conjunction with the stream insertion operator as shown in the following example.

```
#include <iostream>

using namespace std;

int main( )
{
   char str[] = "Unable to read....";

   clog << "Error message : " << str << endl;
}
```

When the above code is compiled and executed, it produces the following result:

```
Error message : Unable to read....
```

You would not be able to see any difference in cout, cerr and clog with these small examples, but while writing and executing big programs then difference becomes obvious. So this is good
Practice to display error messages using cerr stream and while displaying other log messages then clog should be used.

C++ FUNCTIONS

A function is a group of statements that together perform a task. Every C++ program has at least one function, which is **main**, and all the most trivial programs can define additional functions.

You can divide up your code into separate functions. How you divide up your code among different functions is up to you, but logically the division usually is so each function performs a specific task.

A function **declaration** tells the compiler about a function's name, return type, and parameters. A function **definition** provides the actual body of the function.

The C++ standard library provides numerous built-in functions that your program can call. For example, function **strcat** to concatenate two strings, function **memcpy** to copy one memory location to another location and many more functions.

A function is knows as with various names like a method or a sub-routine or a procedure etc.

Defining a Function:

The general form of a C++ function definition is as follows:

```
return_type function_name( parameter list )
{
   body of the function
}
```

A C++ function definition consists of a function header and a function body. Here are all the parts of a function:

- **Return Type**: A function may return a value. The **return_type** is the data type of the value the function returns. Some functions perform the desired operations without returning a value. In this case, the return_type is the keyword **void**.
- **Function Name:** This is the actual name of the function. The function name and the parameter list together constitute the function signature.
- **Parameters:** A parameter is like a placeholder. When a function is invoked, you pass a value to the parameter. This value is referred to as actual parameter or argument. The parameter list refers to the type, order, and number of the parameters of a function. Parameters are optional; that is, a function may contain no parameters.
- **Function Body:** The function body contains a collection of statements that define what the function does.

Example:

Following is the source code for a function called **max**. This function takes two parameters num1 and num2 and returns the maximum between the two:

```
// function returning the max between two numbers

int max(int num1, int num2)
{
   // local variable declaration
   int result;

   if (num1 > num2)
      result = num1;
   else
      result = num2;

   return result;
}
```

Function Declarations:

A function **declaration** tells the compiler about a function name and how to call the function. The actual body of the function can be defined separately.

A function declaration has the following parts:

```
return_type function_name( parameter list );
```

For the above defined function max, following is the function declaration:

```
int max(int num1, int num2);
```

Parameter names are not importan in function declaration only their type is required, so following is also valid declaration:

```
int max(int, int);
```

Function declaration is required when you define a function in one source file and you call that function in another file. In such case, you should declare the function at the top of the file calling the function.

Calling a Function:

While creating a C++ function, you give a definition of what the function has to do. To use a function, you will have to call or invoke that function.

When a program calls a function, program control is transferred to the called function. A called function performs defined task and when its return statement is executed or when its function-ending closing brace is reached, it returns program control back to the main program.

To call a function, you simply need to pass the required parameters along with function name, and if function returns a value, then you can store returned value. For example:

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

// function declaration
int max(int num1, int num2);

int main ()
{
   // local variable declaration:
   int a = 100;
   int b = 200;
   int ret;

   // calling a function to get max value.
   ret = max(a, b);

   cout << "Max value is : " << ret << endl;

   return 0;
}

// function returning the max between two numbers
int max(int num1, int num2)
{
   // local variable declaration
   int result;

   if (num1 > num2)
      result = num1;
   else
      result = num2;
```

```
   return result;
}
```

I kept max function along with main function and compiled the source code. While running final executable, it would produce the following result:

```
Max value is : 200
```

Function Arguments:

If a function is to use arguments, it must declare variables that accept the values of the arguments. These variables are called the **formal parameters** of the function.

The formal parameters behave like other local variables inside the function and are created upon entry into the function and destroyed upon exit.

While calling a function, there are two ways that arguments can be passed to a function:

Call Type	Description
Callbyvalue	This method copies the actual value of an argument into the formal parameter of the function. In this case, changes made to the parameter inside the function have no effect on the argument.
Callbypointer	This method copies the address of an argument into the formal parameter. Inside the function, the address is used to access the actual argument used in the call. This means that changes made to the parameter affect the argument.
Callbyreference	This method copies the reference of an argument into the formal parameter. Inside the function, the reference is used to access the actual argument used in the call. This means that changes made to the parameter affect the argument.

By default, C++ uses **call by value** to pass arguments. In general, this means that code within a function cannot alter the arguments used to call the function and above mentioned example while calling max function used the same method.

Default Values for Parameters:

When you define a function, you can specify a default value for each of the last parameters. This value will be used if the corresponding argument is left blank when calling to the function.

This is done by using the assignment operator and assigning values for the arguments in the function definition. If a value for that parameter is not passed when the function is called, the default given value is used, but if a value is specified, this default value is ignored and the passed value is used instead. Consider the following example:

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

int sum(int a, int b=20)
{
  int result;

  result = a + b;

  return (result);
}

int main ()
{
   // local variable declaration:
```

```
   int a = 100;
   int b = 200;
   int result;

   // calling a function to add the values.
   result = sum(a, b);
   cout << "Total value is :" << result << endl;

   // calling a function again as follows.
   result = sum(a);
   cout << "Total value is :" << result << endl;

   return 0;
}
```

When the above code is compiled and executed, it produces the following result:

```
Total value is :300
Total value is :120
```

C++ POINTERS

C++ pointers are easy and fun to learn. Some C++ tasks are performed more easily with pointers, and other C++ tasks, such as dynamic memory allocation, cannot be performed without them.

As you know every variable is a memory location and every memory location has its address defined which can be accessed using ampersand & operator which denotes an address in memory. Consider the following which will print the address of the variables defined:

```
#include <iostream>

using namespace std;

int main ()
{
   int  var1;
   char var2[10];

   cout << "Address of var1 variable: ";
   cout << &var1 << endl;

   cout << "Address of var2 variable: ";
   cout << &var2 << endl;

   return 0;
}
```

When the above code is compiled and executed, it produces result something as follows:

```
Address of var1 variable: 0xbfebd5c0
Address of var2 variable: 0xbfebd5b6
```

What Are Pointers?

A **pointer** is a variable whose value is the address of another variable. Like any variable or constant, you must declare a pointer before you can work with it. The general form of a pointer variable declaration is:

```
type *var-name;
```

Here, **type** is the pointer's base type; it must be a valid C++ type and **var-name** is the name of the pointer variable. The asterisk you used to declare a pointer is the same asterisk that you use for multiplication. However, in this statement the asterisk is being used to designate a variable as a pointer. Following are the valid pointer declaration:

```
int    *ip;    // pointer to an integer
double *dp;    // pointer to a double
float  *fp;    // pointer to a float
char   *ch     // pointer to character
```

The actual data type of the value of all pointers, whether integer, float, character, or otherwise, is the same, a long hexadecimal number that represents a memory address. The only difference between pointers of different data types is the data type of the variable or constant that the pointer points to.

Using Pointers in C++:

There are few important operations, which we will do with the pointers very frequently. ***a*** we define a pointer variables ***b*** assign the address of a variable to a pointer and ***c*** finally access the value at the address available in the pointer variable. This is done by using unary operator * that returns the value of the variable located at the address specified by its operand. Following example makes

use of these operations:

```
#include <iostream>

using namespace std;

int main ()
{
   int  var = 20;   // actual variable declaration.
   int  *ip;        // pointer variable

   ip = &var;       // store address of var in pointer variable

   cout << "Value of var variable: ";
   cout << var << endl;

   // print the address stored in ip pointer variable
   cout << "Address stored in ip variable: ";
   cout << ip << endl;

   // access the value at the address available in pointer
   cout << "Value of *ip variable: ";
   cout << *ip << endl;

   return 0;
}
```

When the above code is compiled and executed, it produces result something as follows:

```
Value of var variable: 20
Address stored in ip variable: 0xbfc601ac
Value of *ip variable: 20
```

C++ Pointers in Detail:

Pointers have many but easy concepts and they are very important to C++ programming. There are following few important pointer concepts which should be clear to a C++ programmer:

Concept	Description
C++NullPointers	C++ supports null pointer, which is a constant with a value of zero defined in several standard libraries.
C++pointerarithmetic	There are four arithmetic operators that can be used on pointers: ++, --, +, -
C++pointersvsarrays	There is a close relationship between pointers and arrays. Let us check how?
C++arrayofpointers	You can define arrays to hold a number of pointers.
C++pointertopointer	C++ allows you to have pointer on a pointer and so on.
Passingpointerstofunctions	Passing an argument by reference or by address both enable the passed argument to be changed in the calling function by the called function.
Returnpointerfromfunctions	C++ allows a function to return a pointer to local variable, static variable and dynamically allocated memory as well.

C++ IF...ELSE STATEMENT

An **if** statement can be followed by an optional **else** statement, which executes when the boolean expression is false.

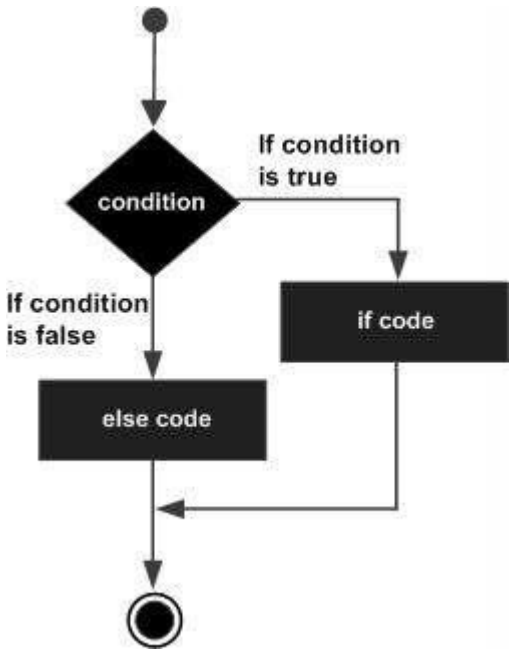
Syntax:

The syntax of an if...else statement in C++ is:

```
if(boolean_expression)
{
   // statement(s) will execute if the boolean expression is true
}
else
{
  // statement(s) will execute if the boolean expression is false
}
```

If the boolean expression evaluates to **true**, then the **if block** of code will be executed, otherwise **else block** of code will be executed.

Flow Diagram:



Example:

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

int main ()
{
   // local variable declaration:
   int a = 100;

   // check the boolean condition
   if( a < 20 )
   {
       // if condition is true then print the following
       cout << "a is less than 20;" << endl;
   }
   else
   {
```

```
        // if condition is false then print the following
        cout << "a is not less than 20;" << endl;
    }
    cout << "value of a is : " << a << endl;

    return 0;
}
```

When the above code is compiled and executed, it produces the following result:

```
a is not less than 20;
value of a is : 100
```

The if...else if...else Statement:

An **if** statement can be followed by an optional **else if...else** statement, which is very usefull to test various conditions using single if...else if statement.

When using if , else if , else statements there are few points to keep in mind.

- An if can have zero or one else's and it must come after any else if's.
- An if can have zero to many else if's and they must come before the else.
- Once an else if succeeds, none of he remaining else if's or else's will be tested.

Syntax:

The syntax of an if...else if...else statement in C++ is:

```
if(boolean_expression 1)
{
   // Executes when the boolean expression 1 is true
}
else if( boolean_expression 2)
{
   // Executes when the boolean expression 2 is true
}
else if( boolean_expression 3)
{
   // Executes when the boolean expression 3 is true
}
else
{
   // executes when the none of the above condition is true.
}
```

Example:

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

int main ()
{
   // local variable declaration:
   int a = 100;

   // check the boolean condition
   if( a == 10 )
   {
       // if condition is true then print the following
       cout << "Value of a is 10" << endl;
   }
   else if( a == 20 )
   {
       // if else if condition is true
       cout << "Value of a is 20" << endl;
```

```
   }
   else if( a == 30 )
   {
       // if else if condition is true
       cout << "Value of a is 30" << endl;
   }
   else
   {
       // if none of the conditions is true
       cout << "Value of a is not matching" << endl;
   }
   cout << "Exact value of a is : " << a << endl;

   return 0;
}
```

When the above code is compiled and executed, it produces the following result:

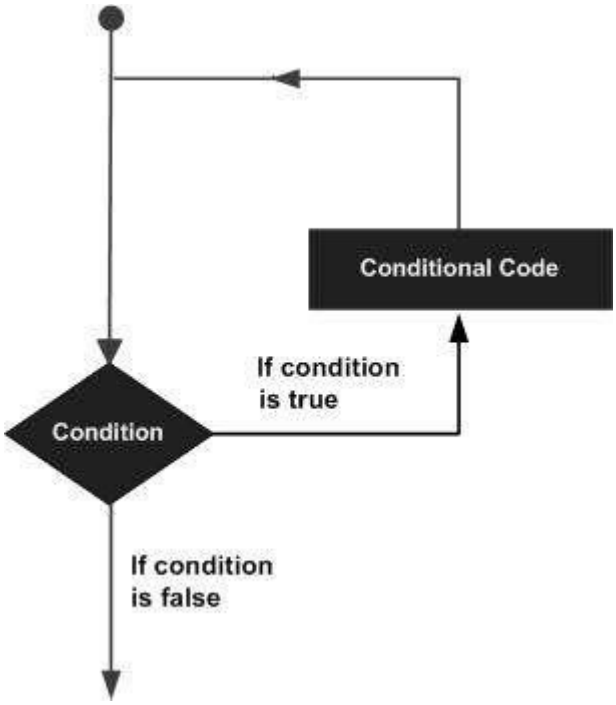
```
Value of a is not matching
Exact value of a is : 100
```

C++ LOOP TYPES

There may be a situation, when you need to execute a block of code several number of times. In general statements are executed sequentially: The first statement in a function is executed first, followed by the second, and so on.

Programming languages provide various control structures that allow for more complicated execution paths.

A loop statement allows us to execute a statement or group of statements multiple times and following is the general from of a loop statement in most of the programming languages:



C++ programming language provides the following types of loop to handle looping requirements. Click the following links to check their detail.

Loop Type	Description
whileloop	Repeats a statement or group of statements while a given condition is true. It tests the condition before executing the loop body.
for loop	Execute a sequence of statements multiple times and abbreviates the code that manages the loop variable.
do...whileloop	Like a while statement, except that it tests the condition at the end of the loop body
nestedloops	You can use one or more loop inside any another while, for or do..while loop.

Loop Control Statements:

Loop control statements change execution from its normal sequence. When execution leaves a scope, all automatic objects that were created in that scope are destroyed.

C++ supports the following control statements. Click the following links to check their detail.

Control Statement	Description
breakstatement	Terminates the **loop** or **switch** statement and transfers execution to the statement immediately following the loop or switch.
continuestatement	Causes the loop to skip the remainder of its body and immediately retest its condition prior to reiterating.
gotostatement	Transfers control to the labeled statement. Though it is not advised to use goto statement in your program.

The Infinite Loop:

A loop becomes infinite loop if a condition never becomes false. The **for** loop is traditionally used for this purpose. Since none of the three expressions that form the for loop are required, you can make an endless loop by leaving the conditional expression empty.

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

int main ()
{

   for( ; ; )
   {
      printf("This loop will run forever.\n");
   }

   return 0;
}
```

When the conditional expression is absent, it is assumed to be true. You may have an initialization and increment expression, but C++ programmers more commonly use the for; ; construct to signify an infinite loop.

NOTE: You can terminate an infinite loop by pressing Ctrl + C keys.