OBJECT ORIENTED PROGRAMMING LAB

Lab # 01

Introduction to C++, Input and Output,

Variables, and Data Types

Instructor: Iqra Rehman

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Fast National University of Computer and Emerging Sciences, Peshawar

Department of Computer Science

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Basic Terminologies

Computer Program

- A computer program is a collection of instructions that performs a specific task when executed by a computer.
- Most computer devices require programs to function properly.
- A computer program is usually written by a computer programmer in a programming language.

Programming Language

- A programming language is a formal language, which comprises a set of instructions that produce various kinds of output. Programming languages are used in computer programming to implement algorithms.

C++ Introduction

- C++ pronounced as "See Plus Plus". It is a powerful computer programming language. It is the advance version of C language.
- The C is a procedural programming language while C++ is an Object-Oriented Programming language. Procedural means step by step process or step by step order.

C++ History

- In 1972 Dennis Ritche developed C language at Bell Laboratory.
- C language was an advanced version of B language.
- In 1980 C++ language was developed by "Bjarne Stroustrup" .
- C++ was an extension of C.

Writing a C++ program

- Extension of C++ program is cpp i.e. filename.cpp
- Text editor is required to write and edit C++ source code.
- C++ Compiler is required for compilation of source code into machine code. This machine code is called object code. It is stored in a new file with extension ***obj***. The object code is then linked to the libraries. After linking the object code to the libraries, an executable file with extension ***exe*** is created. The executable program is then run from operating system command line.
- For example, a source code of program in C++ is written and stored with first.cpp.

- After compilation, the object code is saved in file first.obj and executable code is stored in file first.exe.
- Before compilation code is called **source code.**
- After compilation code is called **object code.**

Structure of C++ program

- A C++ program consists of three main parts. These are:
  1. Preprocessor directives
  2. The main() function
  3. C++ statements

1. Preprocessor directives

- Provides instructions to the compiler before the beginning of the actual program. Also called compiler directives.
- The preprocessor directives consist of instructions for the compiler.
- The compiler adds special instructions or code from these directives into program at the time of compilation.
- The preprocessor directives normally start with a number sign (#) and the keyword “include” or “define”. For example preprocessor directives are used to include header files in the program.
- A program example is given below. The first statement of the program is a preprocessor directive. The preprocessor directive has been written to include the iostream.h header file.

```
#include <iostream>
int main()
 {
   cout << "Hello C++ Programming";
   return 0;
  }
```

Header File

- ❖ Header file is a C++ source file that contains definitions of library functions/objects.
- ❖ A header files are added into the program at the compilation of the program.
- ❖ A header file is added if the function/object defined in it is to be used the program.
- ❖ The preprocessor directive "**include**" is used to add a header file into the program. The name of the file is written in single brackets (<>) after "**include**" directive. The C++ has a large number of header files in which library functions are defined. The header file must be included in the program before calling its function in the program. A single header file may contain a large number of built-in library functions.
- ❖ For example the header file iostream.h has definitions of different built in input and output objects and functions. It is included in the above program because its object "cout" is used in the program.

Syntax is given by

    #include<name of the header file>

Eg: #include<iostream.h> input and output stream

#include<conio.h> console input and output (console means screen)

For example cout<< is defined in iostream.h and getch() is defined in conio.h.

2. The main() function

- ❖ The main() function indicates the beginning of C++ program.
- ❖ When we run a program first of all OS runs main function.
- ❖ Main function is built in function.
- ❖ It is automatically called.
- ❖ Without it programs is not executed.

Syntax

```
int main()

{

program statements…

}
```

3. C++ statements

The statements of the program are written under the main() function between the curly braces {}.

These statements are the body of the program. Each statement in C++ ends with semicolon (;).

C++ is case sensitive language. The C++ statements are normally written in lowercase letters but in some exceptional cases, these can also be written in upper case.

C++ Program Syntax

```
1.  #include <iostream>

2.  using namespace std;

3.

4.  int main() {

5.    cout << "Hello World!";

6.    return 0;

7.  }
```

Example explained

- **Line 1**: #include <iostream> is a header file library that lets us work with input and output objects, such as cout (used in line 5). Header files add functionality to C++ programs.
- **Line 2:** using namespace std means that we can use names for objects and variables from the standard library.
- Don't worry if you don't understand how #include <iostream> and using namespace std works. Just think of it as something that (almost) always appears in your program.
- **Line 3:** A blank line. C++ ignores white space.

- **Line 4:** Another thing that always appear in a C++ program, is int main(). This is called a **function**. Any code inside its curly brackets {} will be executed.

- **Line 5:** cout (pronounced "see-out") is an **object** used together with the *insertion operator* (<<) to output/print text. In our example it will output "Hello World".

- **Note:** Every C++ statement ends with a semicolon ;.

- **Note:** The body of int main() could also been written as:
  int main () { cout << "Hello World! "; return 0; }

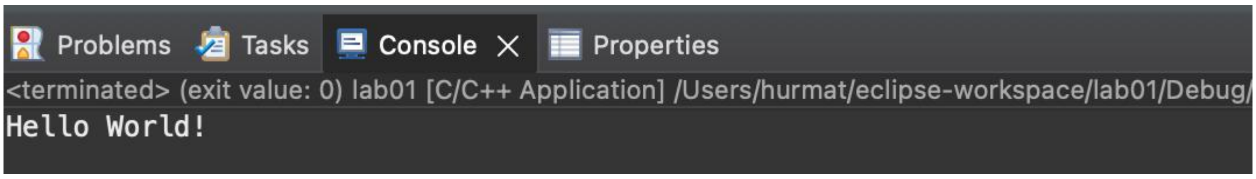
- **Remember:** The compiler ignores white spaces. However, multiple lines makes the code more readable.

- **Line 6:** return 0 ends the main function.
- **Line 7:** Do not forget to add the closing curly bracket } to actually end the main function.

C++ Output

The cout object, together with the *insertion operator* << operator, is used to output values/print text:

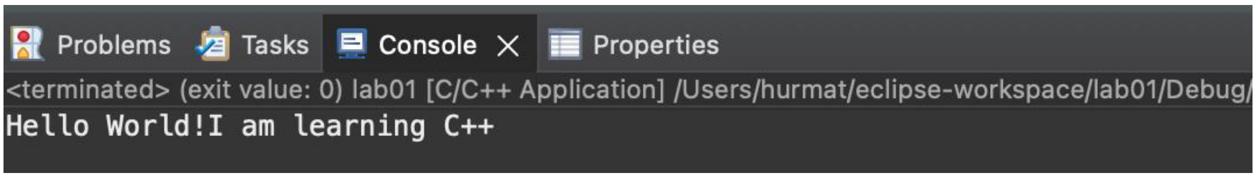
```
#include <iostream>
using namespace std;
int main() {
  cout << "Hello World!";
  return 0;
}
```



```
<terminated> (exit value: 0) lab01 [C/C++ Application] /Users/hurmat/eclipse-workspace/lab01/Debug/
Hello World!
```

- You can add as many cout objects as you want. However, note that it does not insert a new line at the end of the output:

```
#include <iostream>
using namespace std;
int main() {
 cout << "Hello World!";
 cout << "I am learning C++";
 return 0;
}
```

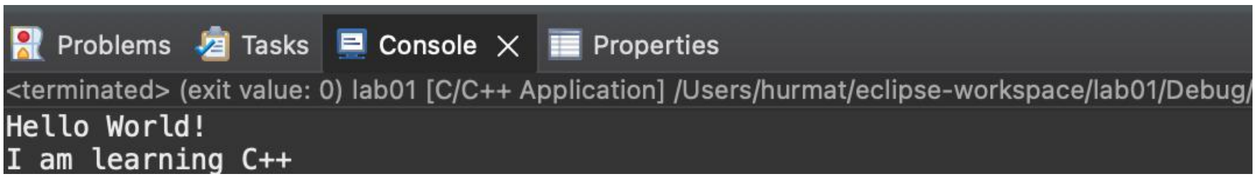


```
<terminated> (exit value: 0) lab01 [C/C++ Application] /Users/hurmat/eclipse-workspace/lab01/Debug/
Hello World!I am learning C++
```

C++ New Lines

To insert a new line, you can use the **\n** character:

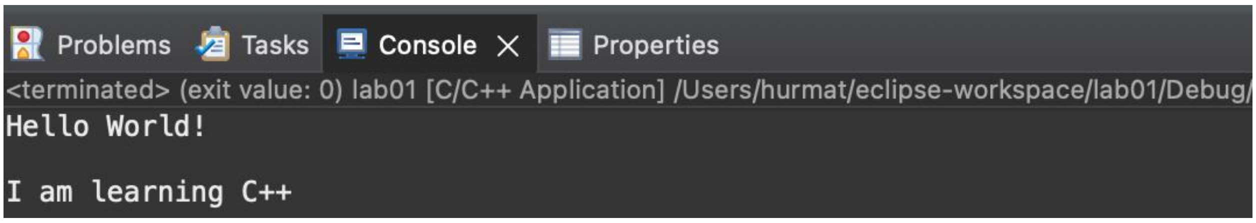
```
#include <iostream>
using namespace std;

int main() {
  cout << "Hello World! \n";
  cout << "I am learning C++";
  return 0;
}
```


Problems Tasks Console Properties

```
<terminated> (exit value: 0) lab01 [C/C++ Application] /Users/hurmat/eclipse-workspace/lab01/Debug/
Hello World!
I am learning C++
```

Tip: Two \n \n characters after each other will create a blank line:

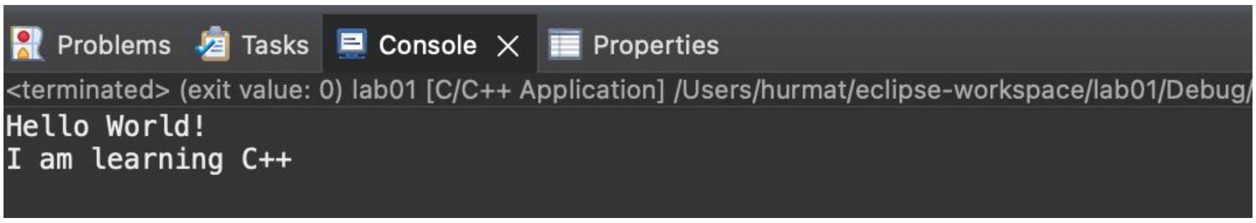
```
#include <iostream>
using namespace std;
int main() {
  cout << "Hello World! \n\n";
  cout << "I am learning C++";
  return 0;
}
```


Problems Tasks Console Properties

```
<terminated> (exit value: 0) lab01 [C/C++ Application] /Users/hurmat/eclipse-workspace/lab01/Debug/
Hello World!

I am learning C++
```

Another way to insert a new line, is with the **endl** manipulator:

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

int main() {
  cout << "Hello World!" << endl;
  cout << "I am learning C++";
  return 0;
}
```


Problems Tasks Console Properties

```
<terminated> (exit value: 0) lab01 [C/C++ Application] /Users/hurmat/eclipse-workspace/lab01/Debug/
Hello World!
I am learning C++
```

C++ Comments

A well-documented program is a good practice as a programmer. It makes a program more readable and error finding become easier. One important part of good documentation is Comments.

- In computer programming, a comment is a programmer-readable explanation or annotation in the source code of a computer program
- Comments are statements that are not executed by the compiler and interpreter.

Types of comments

1. Single line comment
2. Multi-line comment

1. Single line Comment

Represented as **//** double forward slash. It is used to denote single line comment. It applies comment to a single line only. It is refereed as C++-style comments as it is originally part of C++ programming.

Example

```
#include<iostream>
int main()
{
    // Single line Welcome user comment
    cout<<"Welcome to PFlab";
    return 0;
}

/*
Output
Welcome to PFlab
*/
```

2. Multi-line Comment

Represented as /* any text */. Start with forward slash and asterisk (/*) and end with asterisk and forward slash (*/). It is used to denote multi-line comment. It can apply comment to more than a single line. It is referred as C-Style comment as it was introduced in C programming.

```
#include<iostream>
int main()
{
    /* Multi-line Welcome user comment
    written to demonstrate comments
    in C/C++ */
cout<<"Welcome to PF lab";
    return 0;
}

/*
Output
Welcome to PFlab
*/
```

Single or multi-line comments?

It is up to you which you want to use. Normally, we use // for short comments, and /* */ for longer.

C++ Keywords

The words that are used by the language for special purpose are called keywords. These are also called reserved words. For example, in a C++ the word main is used to indicate the starting of program, include is used to add header files, int is used to declare integer type variable. All these words are keywords of C++. The reserved words cannot be used as variable names in a program.

A list of 32 Keywords in C++ Language which are also available in C language are given below.

auto	break	case	char	const	continue	default	do
double	else	enum	extern	float	For	goto	if
int	long	register	return	short	signed	sizeof	static
struct	switch	typedef	union	unsigned	Void	volatile	while

asm	dynamic_cast	namespace	reinterpret_cast	bool
explicit	new	static_cast	False	catch
operator	template	friend	Private	class
this	inline	public	Throw	const_cast
delete	mutable	protected	True	try
typeid	typename	using	Virtual	wchar_t

Tokens

A program statement consists of variable names, keywords, constants, punctuations marks, operators etc. In C++ these elements of a statement are called tokens. In the following program segment:

```
main()

{

        int a, b;

}
```

main, {, }, int , a, b and punctuation marks (,) and (;) are tokens of the program.

Variables

- ❖ A named memory location where data is stored is called variable.
- ❖ A quantity whose value may change during execution of the program is called variable. It is represented by a symbol or name.
- ❖ **Variable** is name of *reserved area allocated in memory*. In other words, it is a *name of memory location*.
- ❖ It is a combination of "vary + able" that means its value can be changed.
- ❖ **int** data=10;   // Here data is variable

Rules for Naming/Writing Variables

1. The first character of variable must be an alphabetic character.
2. Underscore can be used as first character of variable name.
3. Blank spaces are not allowed in a variable name.
4. Special character such as arithmetic operators, #, ^, cannot be used in a variable name.
5. The maximum length of a variable name depends upon the compiler of C++.
6. A variable name declared for one data type cannot be used to declare another data type.

C++ is a case sensitive language. Thus, variable name with the same spellings but different cases are treated as different variable names. For example, variable "Pay" And "pay" are two different variables.

- C++ is a case sensitive language: number is different from Number or nUmber

Valid identifiers:

- Int abc, char aBc, int first_var, float first

Invalid identifiers:

Int 3bc, int a*b, int #a, int void

camelCase variable names:

number, firstName, dateOfBirth

PascalCase variable names

Number, FirstName, DateOfBirth

Rule of Thumb

Use camelCasefor variable names

Use PascalCasefor advanced naming e.g. Classes, functions

```
int firstNumber;
char gender = 'm';
float piValue= 3.14;
int myAge, int countryName;
int a, b, c;
```

C++ Data Types

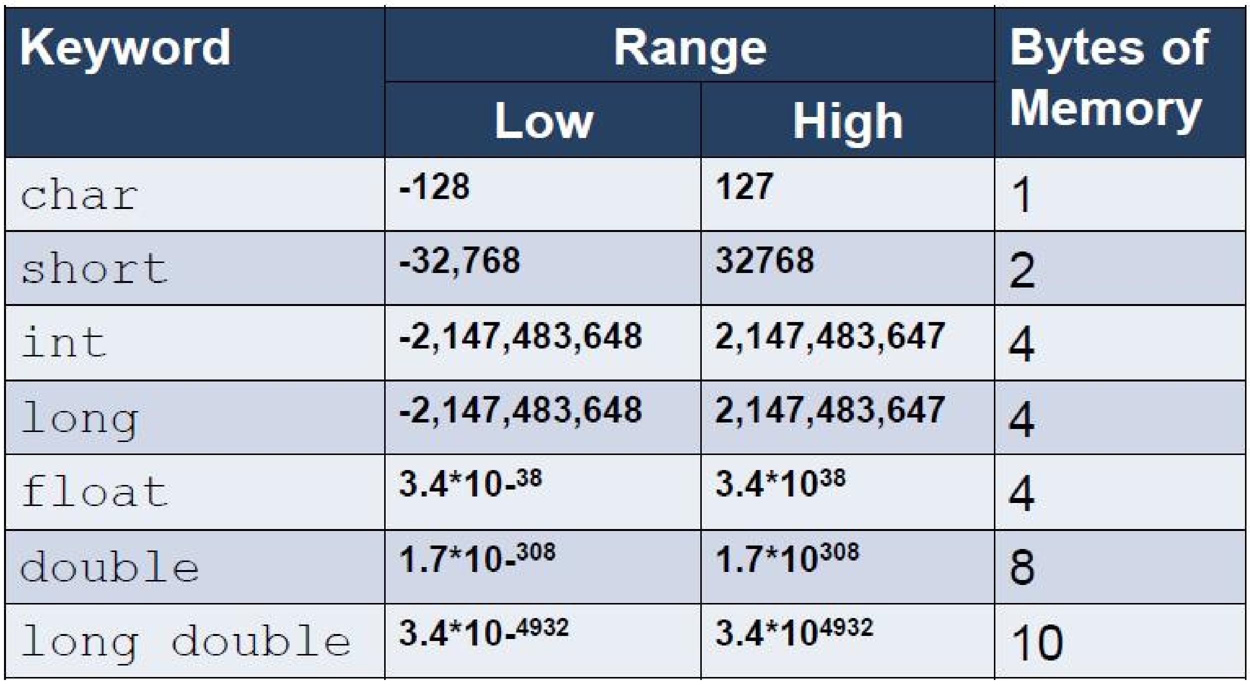
Data types specify the different sizes and values that can be stored in the variable.

Data Types tell us:

i) Type of data.

ii) Memory reserved (amount of memory).

iii) Range of value.



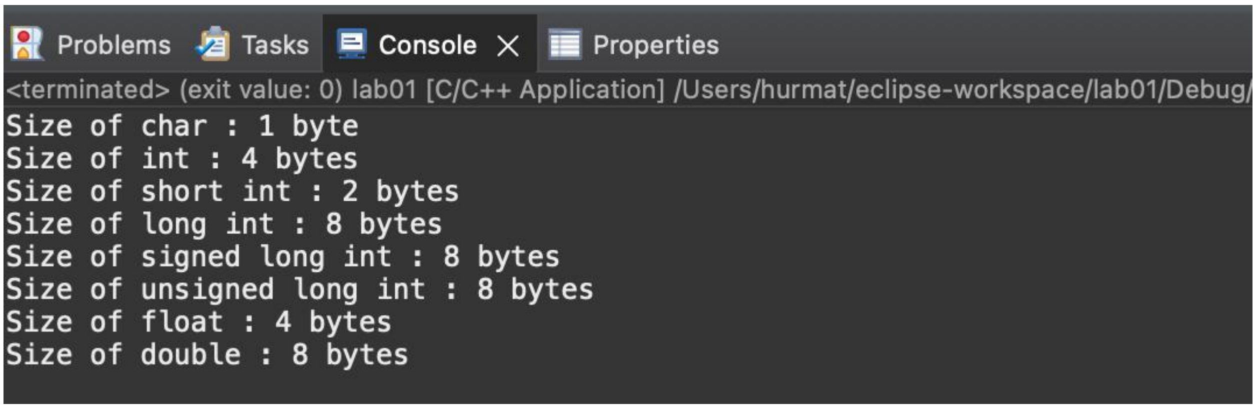
Keyword	Range		Bytes of Memory
	Low	High	
char	-128	127	1
short	-32,768	32768	2
int	-2,147,483,648	2,147,483,647	4
long	-2,147,483,648	2,147,483,647	4
float	$3.4*10-^{38}$	$3.4*10^{38}$	4
double	$1.7*10-^{308}$	$1.7*10^{308}$	8
long double	$3.4*10-^{4932}$	$3.4*10^{4932}$	10

sizeof() Data Type

sizeof() function is used to find size (bytes) of data type

e.g: sizeof(char)

```
#include<iostream>
using namespace std;
int main()
{
    // your code here

    return 0;
}
```

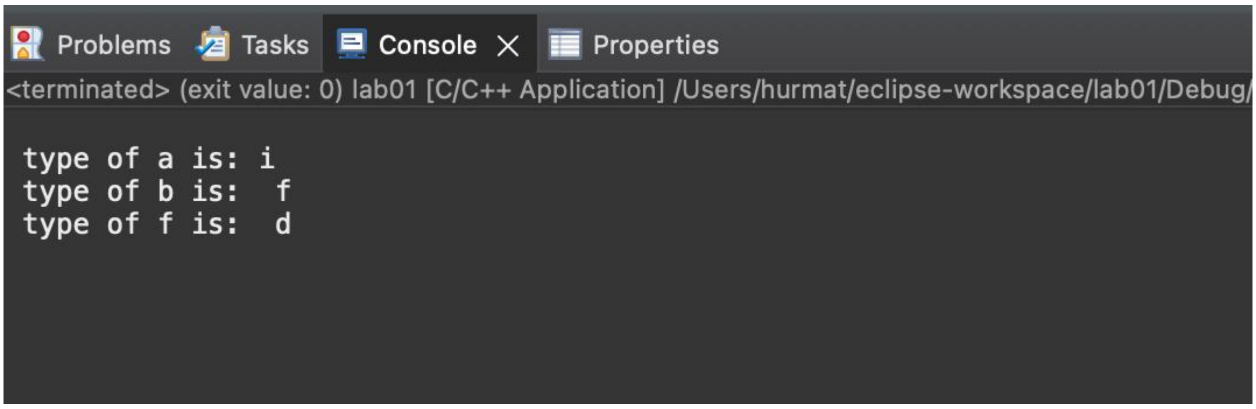


```
<terminated> (exit value: 0) lab01 [C/C++ Application] /Users/hurmat/eclipse-workspace/lab01/Debug/
Size of char : 1 byte
Size of int : 4 bytes
Size of short int : 2 bytes
Size of long int : 8 bytes
Size of signed long int : 8 bytes
Size of unsigned long int : 8 bytes
Size of float : 4 bytes
Size of double : 8 bytes
```

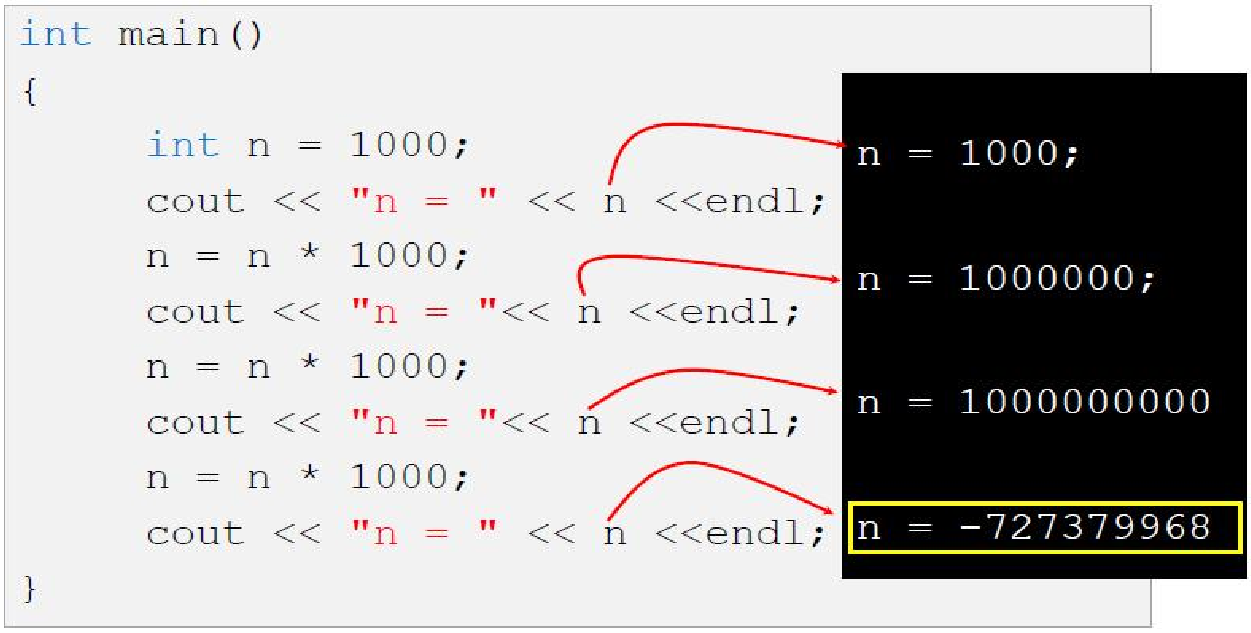
How to get the type of a variable in C++ ?

We will use typeid for getting the type of the variables. typeid is an operator which is used where dynamic type of an object need to be known.

typeid(x).name() return shorthand name of the data type of x, for example, it return i for integers, d for doubles, Pi for the pointer to integer etc. But actual name returned is mostly compiler dependent.



```
<terminated> (exit value: 0) lab01 [C/C++ Application] /Users/hurmat/eclipse-workspace/lab01/Debug/

 type of a is: i
 type of b is:  f
 type of f is:  d
```



```
int main()
{
        int n = 1000;
        cout << "n = " << n <<endl;
        n = n * 1000;
        cout << "n = "<< n <<endl;
        n = n * 1000;
        cout << "n = "<< n <<endl;
        n = n * 1000;
        cout << "n = " << n <<endl;
}
```

```
n = 1000;
n = 1000000;
n = 1000000000
n = -727379968
```

Integer Overflow

C++ Constant

When you do not want others (or yourself) to override existing variable values, use the const keyword (this will declare the variable as "constant", which means unchangeable and read-only)

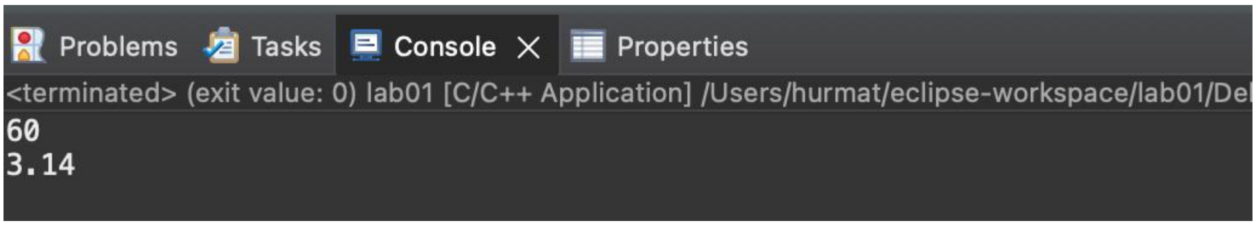
Example

const int myNum = 15; // myNum will always be 15
myNum = 10; // error: assignment of read-only variable 'myNum'

You should always declare the variable as constant when you have values that are unlikely to change:

```
#include <iostream>
using namespace std;
int main() {
  const int minutesPerHour = 60;
  const float PI = 3.14;
  cout << minutesPerHour << “\n";
  cout << PI;
  return 0;
```

Output:



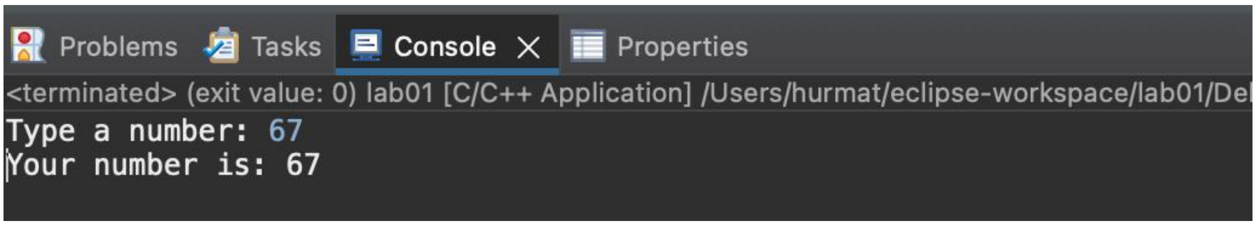
```
<terminated> (exit value: 0) lab01 [C/C++ Application] /Users/hurmat/eclipse-workspace/lab01/De
60
3.14
```

C++ Input

- You have already learned that cout is used to output (print) values. Now we will use cin to get user input.
- cin is a predefined variable that reads data from the keyboard with the extraction operator (>>).
- In the following example, the user can input a number, which is stored in the variable x. Then we print the value of x:

```
#include <iostream>
using namespace std;
int main() {
  int x;
  cout << "Type a number: "; // Type a number and press enter
  cin >> x; // Get user input from the keyboard
  cout << "Your number is: " << x;
  return 0;
}
```

Output



```
<terminated> (exit value: 0) lab01 [C/C++ Application] /Users/hurmat/eclipse-workspace/lab01/De
Type a number: 67
Your number is: 67
```

Good To Know

- cout is pronounced "see-out". Used for output, and uses the insertion operator (<<)
- cin is pronounced "see-in". Used for input, and uses the extraction operator (>>)

Creating a Simple Calculator

```
#include <iostream>
using namespace std;
int main() {
  int x, y;
  int sum;
  cout << "Type a number: ";
  cin >> x;
  cout << "Type another number: ";
  cin >> y;
  sum = x + y;
  cout << "Sum is: " << sum;
  return 0;
}

/*
Output
Type a number:2
Type another number: 4
Sum is: 6
*/
```

Character Data Type

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

int main() {
    char x;
    x='a';
    cout<<"The character is :"<<x<<endl;
}
```

Output:

The character is :a

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

int main() {
    char x;
    cout<<"Enter any character: ";
    cin>>x;
    cout<<"The character you entered is :"<<x<<endl;
}
```

Output:

```
Enter any character: A
The character you entered is :A
```

C++ Type Conversion or Type Casting

C++ allows us to convert data of one type to that of another. This is known as type conversion.

There are two types of type conversion in C++.

1. Implicit Conversion
2. Explicit Conversion (also known as Type Casting)

1) Implicit Type Conversion

- ❖ The type conversion that is done automatically done by the compiler is known as implicit type conversion.
- ❖ This type of conversion is also known as automatic conversion.
- ❖ Let us look at two examples of implicit type conversion.

Example 1: Conversion from int to double

```
#include <iostream>
using namespace std;
int main() {
   // assigning an int value to num_int
   int num_int = 9;

   // declaring a double type variable
   double num_double;

   // implicit conversion
   // assigning int value to a double variable
   num_double = num_int;
   cout << "num_int = " << num_int << endl;
   cout << "num_double = " << num_double << endl;

   return 0;
}
/*
Output:
num_int = 9
num_double = 9 */
```

- In the program, we have assigned an int data to a double variable.
  num_double = num_int;

- Here, the int value is automatically converted to double by the compiler before it is assigned to the num_double variable.
- This is an example of implicit type conversion.

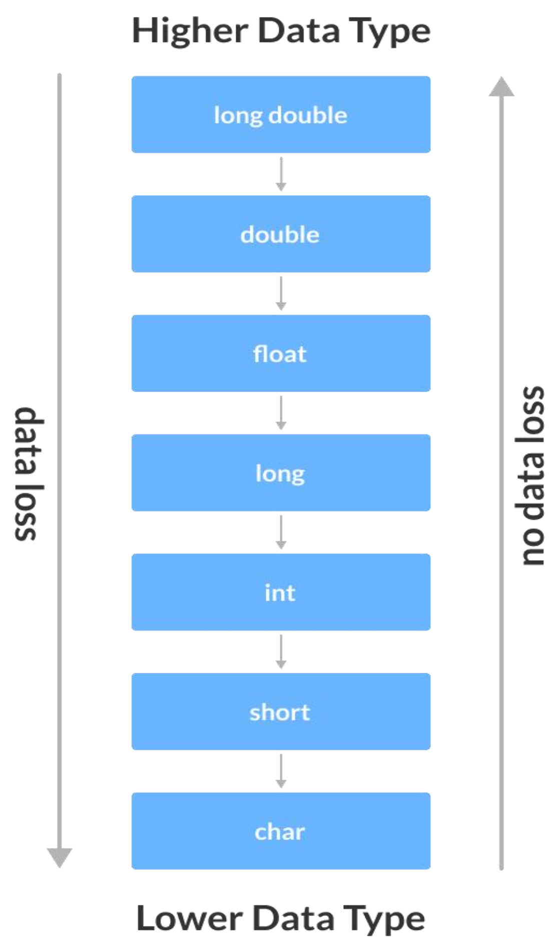
Example 2: Automatic Conversion from double to int

```
#include <iostream>
using namespace std;
int main() {
   int num_int;
   double num_double = 9.99;
   // implicit conversion
   // assigning a double value to an int variable
   num_int = num_double;

   cout << "num_int = " << num_int << endl;
   cout << "num_double = " << num_double << endl;
   return 0;
}
/*
Output:
num_int = 9
num_double = 9.99
*/
```

- In the program, we have assigned a double data to an int variable.
  - num_int = num_double;
- Here, the double value is automatically converted to int by the compiler before it is assigned to the num_int variable. This is also an example of implicit type conversion.
- **Note:** Since int cannot have a decimal part, the digits after the decimal point are truncated in the above example.

Data Loss During Conversion (Narrowing Conversion)

- As we have seen from the above example, conversion from one data type to another is prone (risk) to data loss. This happens when data of a larger type is converted to data of a smaller type.



2) C++ Explicit Conversion

When the user manually changes data from one type to another, this is known as explicit conversion. This type of conversion is also known as type casting.

There are three major ways in which we can use explicit conversion in C++. They are:

1. C-style type casting (also known as cast notation)
2. Function notation (also known as old C++ style type casting)
3. Type conversion operators

i) C-style Type Casting

As the name suggests, this type of casting is favored by the **C programming language**. It is also known as **cast notation**.

The syntax for this style is:

(data_type)expression;

```
// initializing int variable
int num_int = 26;

// declaring double variable
double num_double;

// converting from int to double
num_double = (double)num_int;
```

ii) Function-style Casting

We can also use the function like notation to cast data from one type to another.

The syntax for this style is:

data_type(expression);

```
#include <iostream>
int num_int = 26;

// declaring double variable
double num_double;

// converting from int to double
num_double = double(num_int);
```

Example 3: Type Casting

```
#include <iostream>
using namespace std;
int main() {
    // initializing a double variable
    double num_double = 3.56;
    cout << "num_double = " << num_double << endl;

    // C-style conversion from double to int
    int num_int1 = (int)num_double;
    cout << "num_int1   = " << num_int1 << endl;

    // function-style conversion from double to int
    int num_int2 = int(num_double);
    cout << "num_int2   = " << num_int2 << endl;

    return 0;
}
```

```
/*
Output:
num_double = 3.56
num_int1   = 3
num_int2   = 3
*/
```

- We used both the **C style type conversion** and the **function-style casting for type conversion** and displayed the results.
- Since they perform the same task, both give us the same output.

References

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