C++ Overview & Basics

(CS 1002)

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History

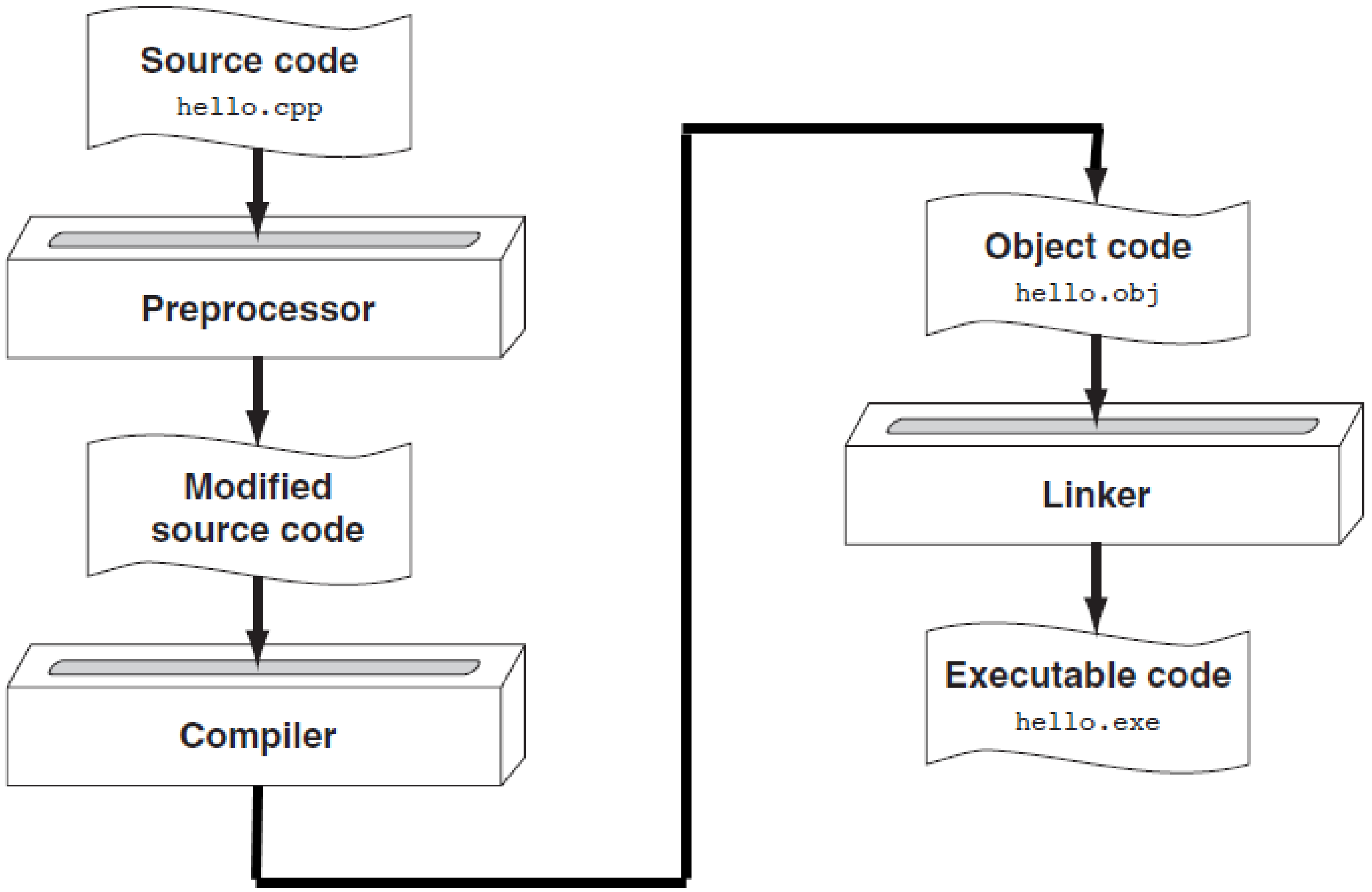
- **C** evolved from two languages (BCPL and B)
- 1980: "**C with Classes**"
- 1985: **C++ 1.0**
- 1995: **Draft standard**
- Developed by **Bjarne Stroustrup** at **Bell Labs**
- **Based** on **C**, added **Object-Oriented Programming concepts** (OOP) in C
- **Similar** program **performance** (**compared to C**)

C vs. C++

- **Advantages:**

1. Faster development time (code reuse)
2. Creating / using new data types is easier
3. Easier memory management
4. Stricter syntax & type checking => **less bugs**
5. Easier to implement Data hiding
6. Object Oriented concepts

C++ Program Compilation



From a High-level Program to an Executable File

a) **Create** **file** **containing** the **program** with a *text editor **(e.g., pico, gedit, etc.)**

b) **Run** **preprocessor** to **convert** **source file directives** to **source code program statements** **(#include lines).**

c) **Run** **compiler** to **convert** **source** program **statements** into **machine instructions** **(g++).**

***For more information: https://linuxhint.com/best-text-editors-for-ubuntu/**

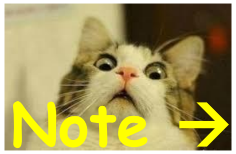
From a High-level Program to an Executable File

d) **Run** linker to **add/connect hardware-specific library code** to **machine instructions**, **producing** an **executable** file. **(g++)**

Steps: *b)* through *d)* are often performed by a single command or button click (such as **g++**).

Compiling a C++ program:

```
g++ -o first.exe hello.cpp
```



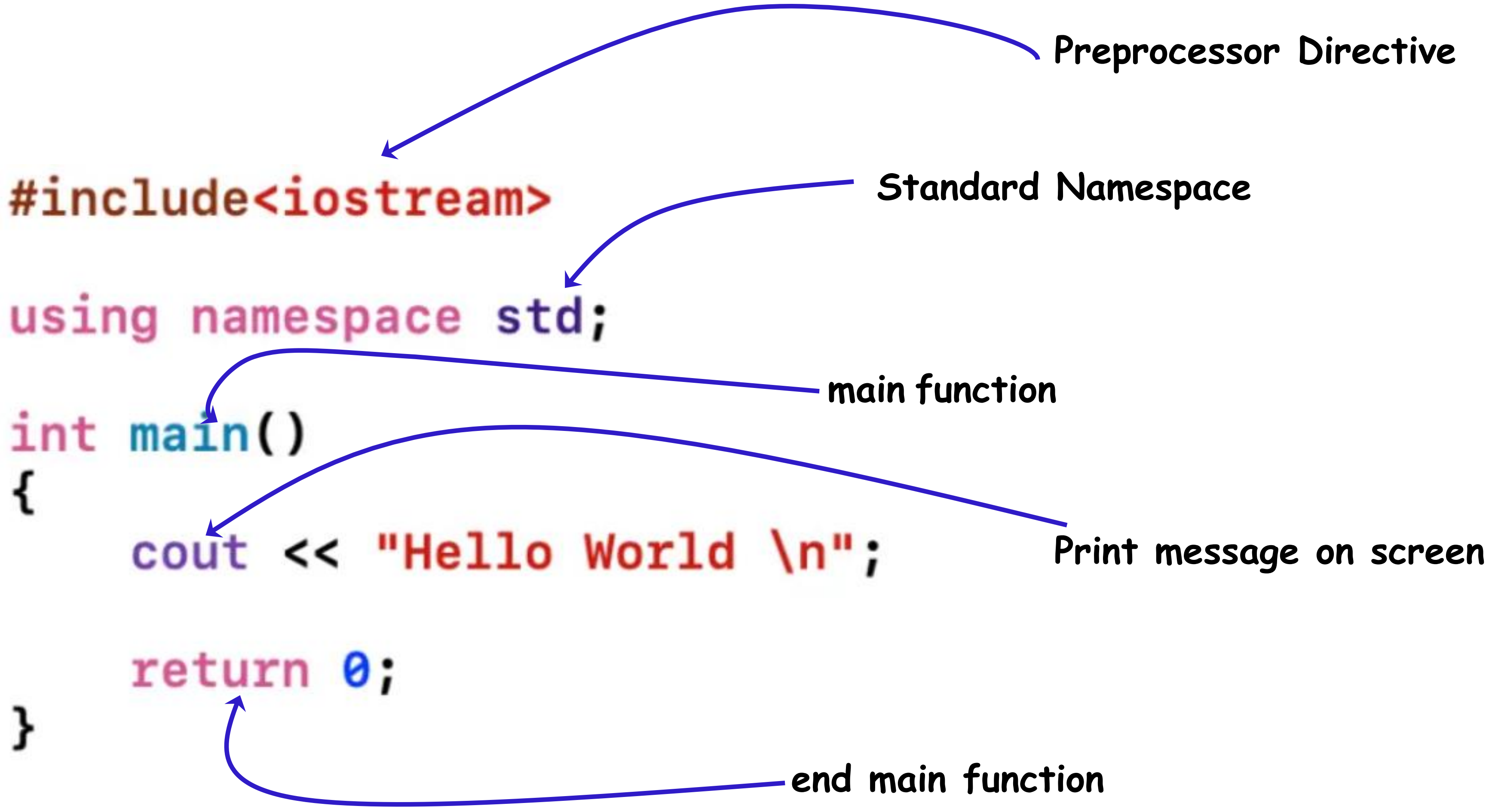
Errors occurring at any step will prevent execution of the step that follows.

What Is a Program Made Of?

Common elements in **programming languages**:

- **Key/reserved words** (predefined meaning)
- **Programmer-defined identifiers** (rules apply)
- **Operators** (e.g., + for "add, * for multiply)
- **Punctuation** (symbols that organize, e.g., comma (,), semicolon(;), parentheses, etc.)
- **Syntax** (rules of "grammar")

First C++ Program



```
#include<iostream>

using namespace std;

int main()
{
      cout << "Hello World \n";

      return 0;
}
```

Preprocessor Directives

#include<iostream>

is a ***preprocessor directive***

- The **preprocessor** **runs before** the actual compiler and **prepares** your **program** for **compilation**.
- Lines starting with # are directives to preprocessor to perform certain tasks, e.g., ***"include"*** command instructs the preprocessor to add the *iostream* library in this program

main( ) function

- Every C++ program start executing **from main ( )**
- A function is a construct that contains/encapsulates statements in a block.
- Block starts from "**{**" and ends with "**}**" brace
- Every statement in the block must end with a semicolon (**;**)
- Examples…

Example Program 1

```
#include <iostream>
using namespace std;
int main()
{
    int num1 = 5, num2, sum;
    num2 = 12;

    sum = num1 + num2;
    cout << "The sum is " << sum;
    return 0;
}
```

Example Program 2

```
#include <iostream>
using namespace std;
int main()
{
      int num1 = 5, num2, sum;

       cout << “Enter second number: “;
       cin >> num2

       sum = num1 + num2;
       cout << “The sum is “ << sum;
       return 0;
}
```

Key Words

- Also known as **reserved words**
- Have a **special meaning** in **C++**
- **Can not be used for another purpose**
- **Written** using **lowercase letters**
- Examples in program (shown in **green**):

```
using namespace std;
int main()
```

Some C++ Reserve Words

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

Programmer-Defined Identifiers

- **Names** **made up** by the **programmer**
- **Not part** of the **C++ language**
- Used to **represent various things**, such as **variables** (*memory locations*)
- Example in program (**shown in green**):

```
 int num1;
```

Variables

- A **variable** is a **name for a cell** in **<u>computer memory</u>** (RAM) where a **value can be stored**.
- The **memory cell** (**variable**) **holds a data value**
- A **variable** must be **defined before it can be used**
- Example variable definition (declaration):

```
double num1;
```

Variables

- **Variables** are identifiers which represent some unknown, or variable-value.

- A **variable** is **named storage** (some memory address's contents)

```
x = a + b;
Speed_Limit = 90;
```

Declaring Variables

type <Variable Name> ;

Examples:

```
bool pass;
int marks;
double Pi;
int suM;
char grade;
```

- **NOTE:** Variable names are case sensitive in C++ ??

Declaring Variables

- C++ is **case sensitive**
  - Example:

    area

    Area

    AREA

    ArEa

  are all seen as **<u>different</u>** variables

Variable Names

<u>**Valid Names:**</u>

- Start with a letter
- Contains letters
- Contains digits
- Contains underscores

- cannot use C++ ***Reserve Words***
- cannot start variable name with a digit

Variable Names

- Choose meaningful names
  - Don't use abbreviations and acronyms: mtbf, TLA, myw, nbv

- Don't use overly long names
  - **Ok:**

    ```
    partial_sum
    element_count
    staple_partition
    ```

  - **Too long (valid but not good practice):**

    ```
    remaining_free_slots_in_the_symbol_table
    ```

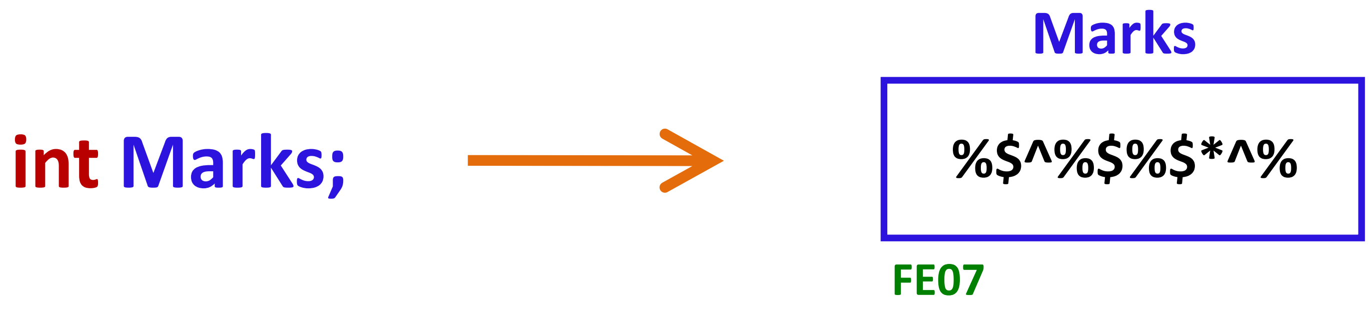
Which are valid variable names?

- AREA
- 2D
- Last Chance
- x_yt3
- Num-2
- Grade***
- area_under_the_curve
- _Marks
- #values
- areaoFCirCLe
- %done
- return
- Ifstatement

Declaring Variables…

- **When we declare a variable, what happens ?**
  - **Memory allocation**
    - How much memory (***data type***)

  - Memory associated with a name (variable name)
  - The allocated space has a unique **address**



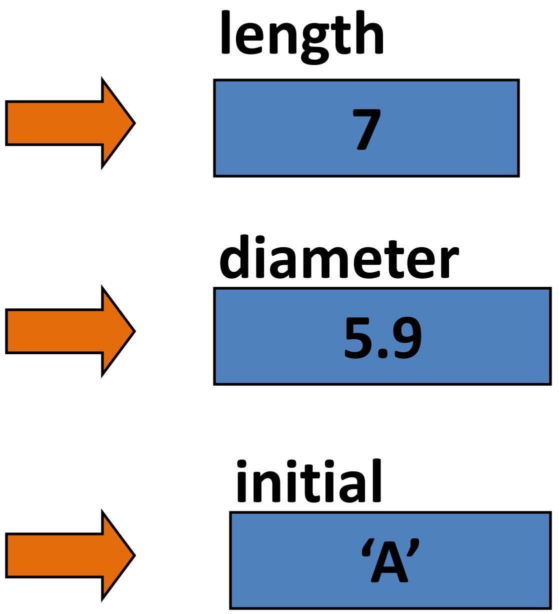
Variables Initialization

- Variables may be given initial values, or **initialized**, when declared. Examples:

```
int length = 7 ;

float diameter = 5.9 ;

char initial = 'A' ;
```



Operators

- **Used** to **perform operations** on **data**
- **Many types** of **operators**:
  - **Arithmetic**: `+, -, *, /`
  - **Assignment**: `=`
  - **Input**: **>>** - **Output: <<**

- **Examples in program** (**shown in blue**):

```
num2 = 12;
sum = num1 + num2;
cin >> num2;  cout << sum;
```

Punctuations

- **Characters** that **mark** the **end of a statement**, **separate items** in a **list**, and **separate elements** of a **statement**.

- Example in program (**shown in blue**):

```
int main ( )
{
   double num1, num2=3, num3;
   num1=5;
   cout << sqrt(num2);
}
```

Lines vs. Statements

In a source **(.cpp**) **file**,

- A line is **all of the characters** entered **before a carriage return** (**ENTER key**).
- Blank lines **improve** the **readability** of a program.

Here are four sample lines. Line 3 is blank:

```
double num1 = 5, num2, sum;
num2 = 12;

sum = num1 + num2;
```

Lines vs. Statements

- **A statement** is an **instruction** to the **computer to perform an action**.
- A **statement** may **contain keywords**, **operators**, **programmer-defined identifiers**, and **punctuation**.
- A **statement may fit on one line**, or it **may occupy multiple lines**.

Here is a **single statement that uses two lines**:

```
double num1 = 5,
            num2, sum;
```

Comments

- **Two types of comments**
  1. **Single line comment:** **//** *my program*
  2. **Multi-line** (paragraph) **comment:**

```
/*   my
     Program  */
```

- The **compiler ignores** all the **comment** related **text**

Omitting std:: prefix

- *using* directive brings namespaces or its sub-items into current scope

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

int main()
{
      cout<<"Hello World!"<<endl;
      cout<<"Bye!";
     return 0;
}
```

Namespaces

- **Namespace pollution**
  - Occurs **when building large systems** from **pieces**
  - ***Identical globally-visible names clash***
  - **How many programs** have a “**print**” **function**?
  - Very **difficult to fix**

```
using namespace std;
cout<<“Hello World”;
```

std is a **standard C++ namespace**,

You can define your own namespaces too (we see this in future)

rvalue and lvalue

Assignment Rule: On the **left side** of an **assignment** there must be a ***lvalue***[1] or a **variable** (**address** of **memory location**)

```
int i, j;
i = 7;
7 = i;
j * 4 = 7;
```

[1] *locator/location value*

rvalue and lvalue

- ***Are the two occurrences of "a" in this expression the same?***

  a = a + 1;

  - ➢One on the ***left*** : **location** of the **variable** (whose **name** is **a**, or **address**);
  - ➢One on the ***right***: **value** of the **variable** (whose **name** is **a**);

- **Two attributes** of **variables** ***lvalue*** and ***rvalue***
  - The ***lvalue*** of a variable is **its address**
  - The ***rvalue*** of a variable is **its value**

Using iostream

- **Standard iostream objects**:

  cout - **object** providing a **connection** to the **monitor**

  cin - **object** providing a **connection** to the **keyboard**

The Insertion Operator (<<)

- To **send output** to the **screen** we use the **insertion operator (i.e., <<)** on the **object cout**

```
cout << age;
```

- **Different type of objects** can be **printed**:

```
cout << 7;   // Outputs 7
cout << 3.6; // Outputs 3.6
cout << "String"; // Outputs String
cout << '\n'; // Outputs a newline
```

The Extraction Operator (>>)

- To **get input** from the **keyboard** we use the **extraction operator** and the object **cin**

```
cin >> Variable;
```

- **Multiple uses** of the **insertion** and **extraction operator** can be ***chained*** together:

```
cout << E1 << E2 << E3 << … ;
cin >> V1 >> V2 >> V3 >> …;
```

- Example:

  cout << “Total sales are $” << sales << ‘\n’;

  cin >> Sales1 >> Sales2 >> Sales3;

The >> Operator

- **Values** must be **separated** by **whitespace** (***space***, ***tab***, ***end-of-line*** [ENTER], ***end-of-file***).
- **Multiple values need not all be of the same type**

The >> Operator

- **When ENTER** key **pressed**, **keyboard input goes** to the **input buffer** (where it is stored as characters)

```
_ 1 2 3 _ T O M _ B R O W N _ 7 2 . 5 eol
1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 10 ← position
```

>> extracts characters from the **input buffer** and **converts** them **into** the **data type** of the **variable**

```
int count;
cout << "How may chairs in the room? ";
cin  >> count;
```

- **String "123"** converted to **whole number (int) 123** and **stored into variable count**. Next, >> starts at pos 5 (space)

String input (Variables)

```
// Read first and second name
#include<iostream>
#include<string>
int main() {
  string first;
  string second;
  cout << “Enter your first and second names:";
  cin >> first >> second;
  cout << "Hello “ << first << “ “ << second;
  return 0;
}
```

Any Questions