CSci 127: Introduction to Computer Science

hunter.cuny.edu/csci

Today's Topics

- C++ and g++
- Hello World!
  - Libraries
  - Basic Input/Output (I/O)
- Datatypes
- Variables
- Assignment Statements
- Operators
- Decision Making

C++

- What is it?
  - Powerful programming language that gives you incredible speed and low-level access to memory and hardware!
- I heard about this language called `C`?
  - `C` is one of the most popular programming languages of all time. It can be used on almost every platform.
  - `C++` was created as an extension to the C programming language.
  - `C++` is like *C with Classes*.
    - Classes are a high-level programming construct that allows a program to be an interaction of objects.

C++ Continued

- C++ is a **compiled** not interpreted language.
  - **Compiler**: a program that understands a language and is used to create executable programs.
    - Translates all of the code once and allows the program to be executed many times thereafter.
  - **Interpreter**: a program that understands a language and is used to create programs.
    - Translates and executes the program line by line for each execution.
- Some examples:
  - Compiled languages: C/C++, Java, C#
  - Interpreted Languages: Python, Matlab, PHP
- Ok, so C++ is a compiled language...
  - But which compiler are we using?

g++

- What is it?
  - Compiler developed for the GNU operating system.
    - GNU: “**G**NU’s **N**ot **U**nix”
    - Supports C, C++, Objective-C, and more.
- How do we get it?
    - Cygwin: linux-like environment for windows.
    - Xcode: Mac programming package found on the OSX disc.
    - (Refer to lab12 for assistance)

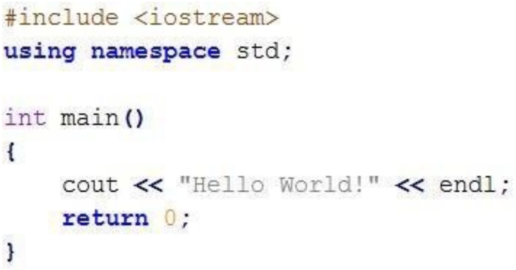
Getting Started

- C++ programs are stored in .cpp files.
  - Example: homework1**.cpp**, main**.cpp**, etc.
- Create the programs in Notepad (or Notepad++).
  - Mac users: you can use TextEdit.
- Compiling programs using g++:
  - Make sure the file is saved!

  - g++ homework1.cpp
    - Creates an executable (by default) called:
      - a.exe on Windows
      - a.out on Linux
    - Run the executable program with: **./**a.exe

Hello World!

- File: helloworld.cpp



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

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

Hello World Dissected

```
#include <iostream>
```

- `iostream` is a *library*.
  - **Library**: a collection of code that provides functionality to our programs.
- `iostream` provides us with basic input and output.
  - i.e., the ability to print and retrieve information to and from the console.
- We add this functionality to our program by referring to the library using the `#include` directive.

```
using namespace std;
```

- `std` is the standard C++ namespace.
- We're skipping this!
- Just include it in each of your programs!

Hello World Dissected

```
int main()
{}
```

- The main *function* of our program! Every C++ program needs this!
    - **Function**: grouping of code to solve a particular task.
- The `int` says that this function called main returns some integer.

```
cout << “Hello World!” << endl;
```

- `cout` is a C++ keyword that specifies that we should output to the standard console stream.
- The pair of arrow brackets << is a C++ operator that controls the reading (>>) or writing (<<).
- Endl is a keyword that behaves like a carriage return (newline).

```
return 0;
```

- The value 0 gets returned to signal the end of the program.

`cout`

- What is it?
  - A reserved keyword in C++ that allows us to output text, variables, and expressions to the screen/console.
- How do we use it?
  - Include the code that allows us to print to the screen.

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

  - Use the << operator!
- Examples:

```
cout << “Know anything besides Hello World?”;
cout << “We get the point already!”;
```

More coutStuff

- Breaking to a **new line**:
  - 2 ways
    - \n escape sequence
    - endl keyword
  - Examples:

```
cout << “Wow, a new line! \n”;
cout << “Wow another new line!” << endl;
```

Comments

- This is one of the most important topics!
  - And also the simplest!
- What is it?
  - A way to annotate code that is ignored by the compiler.
- Two types of comments:
  - Single line: `//This is a single-line comment!`
    - Everything (on the same line) after the `//` is ignored!
  - Multi-Line: Triggered by the `/*` and `*/` sequences.

```
/* <- This opens the comment block…
    Dude, there“s just too much to say!
This closes the comment block -> */
```

  - Rule: Use comments often to describe what your code is doing.

Datatypes

- C++ allows you to store and manipulate different types of data.
- Examples:

Type Name	Memory Used
`int`	4 bytes
`float`	4 bytes
`char`	1 byte
`bool`	1 byte

```
int number = 10001;
char middleInitial = ‘E’;   //Single Quotes
bool amIAwesome = true;
float teachingSalary = 0.50; //Cents!
```

- So we know the types of data that we can play around with. But how do we hold data in our program?

Escape Sequences

- Triggered by a backslash \
- The most common escape sequences are:

Sequence	Meaning
\n	Break the output to a new line. This is also achieved with the `endl`keyword!
\\	Allows you to put a backslash in the output.
\”	Allows you to put a double quote in the output.

- Examples:

```
cout << “This is awesome!\n”;
cout << “A\\S\\L” << endl;
cout << “He said \“FAIL\”\n”;
```

Variables

- What are they?
  - – A facility for storing and manipulating data in a computer program.
- Examples:

  `temp, windSpeed, position, weight, height, eyeColor`
- Basic Rules:
  - – **Must be declared** prior to use!
  - – Case sensitive: `num` is not the same as `Num`
  - – Don’t start with a number! `1stTemp` is illegal!

- – No spaces! `wind Speed` is illegal!
- – No *reserved words*!
  - **Reserved word**: variable name with a predefined meaning in C++.

Statements

- What is it?
  - A line of code that indicates an action or performs some purpose.
- Examples:

```
num = 4;   x = y;  windspeed = 0.55;
```

- You might have noticed this semicolon business!
  - **Rule**: Statements in C++ are always terminated by a semicolon!
  - What does it do?
    - The semicolon indicates where the end of the statement lies.
    - Without the semicolon, we don’t know where one statement begins and another one ends.
- Semicolons ruin lives!

- Let’s see the most common type of statement!

Assignment Statements

- Syntax:

```
datatype variable = expression;
```

- Examples:

```
float rate = 0.05;
float time = 1.0;
float distance = rate * time;
int count = count + 2;
```

- How does it work?
  - Expression on the right of the equal sign gets evaluated.
  - Then the result is stored in the variable on the left of the equal sign.

Assignment Compatibility

- Variables need to have a datatype when declared!
- Rule: Store the proper type of data in that variable!
- Example:

```
int number = 0.665;  //What gets stored in num?
//The number 0 gets stored in num!
//An integer is a whole number (positive or negative).
//We‟re basically truncating the fractional part!
//Solution: Declare the variable as a float!
```

- Some datatypes can be automatically converted to another form.
  - Integers to floats: 1 to 1.0
  - Integers to bools: 1 to true; 0 to false
  - Chars to integers: ‘a’ to 97

Operators

- Arithmetic: Order of operations! PEMDAS!
  - Addition: `z = x + y;`
  - Subtraction: `z = x - y;`
  - Multiplication: `z = x * y;`
  - Division: `z = x / y;`
- Two types of division:
  - Integer (whole number): 1/2 = 0, 2/1 = 2, etc.
  - Floating point: 1.0/2 = 0.5, 1.0/3 = 0.3333, etc.
  - **Rule**: If both numbers are integers, then integer division is triggered. If either of the number is a floating point, then floating point division occurs!
- Integer division ruins lives!

More Operators

- Similar to division, we have the **modulus** operator!
  - The modulus operator `%` gives the remainder of the division.

```
3  % 4=  3;      //  3/4  = 0  so  R = 3

4  % 1=  0;      //  4/1  = 4  so  R = 0

2  % 2=  0;      //  2/2  = 1  so  R = 0
```

- C++ has a bunch of nice math operators, but no exponentiation operator!
  - We can't easily express x^2!
  - To solve this, we can use a function known as `pow()`.

```
float xSquared = pow(x, 2); // x to the power of 2
```

  - We'll see function usage later...

Combined Operators

- We know how to do simple arithmetic operations.
- We can combine operations acting on a variable:
  - If we have these types of statements

```
x  =  x  +  10;

y  =  y  -  5;

x  =  x  /  2;

y  =  y  *  2;
```

  - We can rewrite these statements using combined operators:

```
x += 10
y -= 5
etc..
```

Increment Operator

+1

- What it is?
  - A concise way of adding one to a variable.
- Why do we use it?

– Two ways to basically say `x = x + 1`

```
y = x++;              //Increment x after  storing

y = ++x;              //Increment x first  then

                                           store
```

- Who cares?
  - Used a lot!
    - We'll see specific uses (looping) later on.
- Understand the difference between the two ways!

Decrement Operator

-1

- What is it?
  - A cool way of subtracting one from a variable.
- Why do we use it?

  - Two ways to basically say `x = x - 1`

```
y = x--;        //Decrement x  after storing

y = --x;        //Decrement x  first then

                               store
```

- Who cares?
  - It’s the same argument as increment!
- Some languages do not have increment and decrement operators, and they get used quite often!

Type Casting

- We spoke about the automatic changing (**casting**) of data types:
  - `float` to `int`, `int` to `float`, `char` to `int`, etc...
- We can explicitly cast variables to different types:

```
float x = 5.34;
int y = (int) x;
```

Constants

- What are they?
  - Variables that can’t change value!
- Why do we use them?
  - Sometimes you want to make sure that a variable retains the same value.
    - We’ll get a compiler error if we try to change a constant!
- Syntax:
  - *`const datatype variable = Constant;`*
  - *Note*: We usually capitalize the variable name!
- Examples:
  - `const float PI = 3.14159265;`
  - `const float NYC_TAX = 8.875;`

cin

- What is it?
  - Another reserved keyword (part of `iostream` and the `std` namespace) in C++ that allows us to grab user input from the screen/console.
- When do we use it?
  - Basically, whenever we expect some input from the user.
  - Note, the opposite direction of the arrow operator >>.
- Examples:

```
int age;
cout << “Please enter your age: ”;
cin >> age;
```

- Cool Stuff
  - `cin` take input in the type specified by the holder variable.
  - Example, in `cin >> age`, the input is automatically captured as an `int`!

DECISION MAKING

- Relational Operators
- `if` Statement
- `if/else` Statement

Relational Operators

- In C++ we have statements that evaluate to a boolean (truth) value. Known as *conditions*.
  - Statements that test for:

Equality	`A == B //is A equal to B?`
Not Equal	`A != B`
Greater Than	`A > B`
Greater or Equal	`A >= B`
Less Than	`A < B`
Less or Equal	`A <= B`

- Example:

```
int A = 4, B = 5;
bool isEqual = A == B; //Remember double equal signs!
bool isGreater = A > B;
```

Boolean Expressions

- We can combine relational statements into complicated expressions.
  - Boolean operators!
    - AND = `&&`
    - OR = `||`
    - NOT = `!`
- Format:

  (*Boolean_Exp_1*) **&&** (*Boolean_Exp_2*)

  (*Boolean_Exp_1*) **||** (*Boolean_Exp_2*)

  (**!***Boolean_Exp_1*)

AND

- What is it?
  - A boolean operation that evaluates to true only when all parts of the expression are true.
- Format:

  (*Boolean_Exp_1*) && (*Boolean_Exp_2*)
- Example:

```
int timeFree;
cin >> timeFree;
if(timeFree >= 9 && timeFree <= 12)
   cout << “Dude, you’re a bum!\n”;
```

AND if it helps…

A	B	A && B
0	0	0
0	1	0
1	0	0
1	1	1

- Look at this *truth table* for `&&`.
- Both A and B are boolean expressions.
- Imagine that 0 is `false` and 1 is `true`.
- How to make sense of the table:
  - Line 1: If A is false and B is false, then A && B is false.
  - Line 2: If A is false and B is true, then A && B is false.
  - Line 3: If A is true and B is false, then A && B is false.
  - Line 4: If A is true and B is true, then A && B is true.

OR

- What is it?
  - A boolean operation that evaluates to true when **any** part of the expression is true!
- Format:

  (*Boolean_Exp_1*) || (*Boolean_Exp_2*)
- Example:

```
if(hoursHome >= 10 || status == “Hacker”)
   cout << “Get Outside!\n”;
```

OR if it helps…

A	B	A || B
0	0	0
0	1	1
1	0	1
1	1	1

- Look at this *truth table* for `||`.
- Both A and B are boolean expressions.
- Imagine that 0 is `false` and 1 is `true`.
- How to make sense of the table:
  - Line 1: If A is false and B is false, then A || B is false.
  - Line 2: If A is false and B is true, then A || B is true.
  - Line 3: If A is true and B is false, then A || B is true.
  - Line 4: If A is true and B is true, then A || B is true.

NOT

A	!A
0	1
1	0

- What is it?
  - A boolean expression that evaluates to `true` only when the expression is `false`.
  - It’s the opposite of the expression’s truth value.
- How do we use it?
  - `!Boolean_Exp`
- Examples:

```
if(!(status == “PhD Student”))
    cout << “You’ve got more money than Joel!\n”;
```

`if` Statement

- What is it?
  - A branching construct whereby a set of code is executed based on the truth value of a condition.
- Syntax:

```
if (condition == true)
{
    //Do the code in here!
}
```

- What does it mean?
  - If the boolean condition/expression is true, then we execute the instructions within the curly braces.
    - The branching condition can be any statement that evaluates to a boolean value.
  - Otherwise, we skip all of the code between the curly braces.
- Example:

```
int x = 15;
if(x < 20)
   cout << “Yay!\n”;
```

`if…else` Statement

- We need to understand how the code gets executed.
  - Each if statement gets visited regardless of whether or not its body gets executed…
  - But what if we have 20 consecutive if statements in our program?
    - If the first condition evaluated to true, then we would still check the conditions for the other 19…
  - Isn’t there a way to skip all other conditions once we have a true condition?
- If/Else Statements to the rescue!

`if`…`else`continued!

- Easy Example:

```
if(x == y)
{
    cout << x << “ is equal to “ << y << endl;
}
else
{
    cout << x << “ is not equal to “ << y << endl;
}
```

- More involved example: Combining Else and If

```
if(x == y)
{
    cout << x << “ is equal to “ << y << endl;
}
else if (x != y)
{
    cout << x << “ is not equal to “ << y << endl;
}
```