

# Week 1

## Operators, Data Types & I/O

Gaddis: Chapters 1, 2, 3

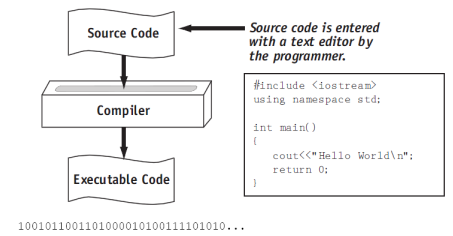
CS 5301  
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# Programming

- A program is a set of instructions that the computer follows to perform a task
- It must be translated from a programming language (C++) to machine code in order to run on the machine.



Tony Gaddis, Starting out with C++: From Control Structures Through Objects 7th ed.

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## Structure of a C++ Program

- Hello world:

```
//This program outputs a message to the screen
#include <iostream>
using namespace std;

int main() {
    cout << "Hello world!" << endl;
}
```

- In general:

```
//This is a comment
#include <includefile> ...
using namespace std;

int main() {
    statements ...
}
```

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## Variables, Data Types

- **Variable:** portion of memory that stores a value
- **Identifier:** name of a program element
- Fundamental data types

short	float	bool
int	double	char
long	long double	

- **Variable Declaration** statement

```
datatype identifier;
```

```
float hours;
```

- **Variable Initialization** statement:

```
datatype identifier = constant;
```

```
int count = 0;
```

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## Integer types

- Integers are whole numbers such as 12, 7, and -99

Data Type	Range
short	-23,768 to 32,767
int	-2,147,483,648 to 2,147,483,647
long	-2,147,483,648 to 2,147,483,647

- **char** type stores characters such as 'A', '@', and '9'
  - The ascii code value (an integer) of the character is stored in memory.

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## Floating-point types (and bool)

- Floating point types store real numbers such as 12.45 and -3.8
- They are stored using scientific notation.

Data Type	Range
float	$\pm 3.4E-38$ to $\pm 3.4E38$
double	$\pm 1.7E-308$ to $\pm 1.7E308$
long double	$\pm 1.7E-308$ to $\pm 1.7E308$

- **bool** type stores values that are true or false
  - false is 0, true is 1.

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## Constants

- **Literals** (specific value of a given type)

```
1
75
-2
```

```
12.45
-3.8
6.25e-5
```

```
true
false
```

```
'A'
'2'
```

- **Named Constants:**  
variable whose value cannot be changed

```
const datatype identifier = constant;
```

```
const double TAX_RATE = 0.0675;
```

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## Assignment statement, expressions

- To change the value of a variable:

```
variable = expression;
```

```
count = 10;
```

- \* **The lefthand side must be a variable**
- \* The righthand side is an expression of the right type
- What is an expression?
  - \* an expression has a type and evaluates to a value
    - ✦ literal
    - ✦ named constant
    - ✦ variable
    - ✦ arithmetic expression
    - ✦ etc.

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## Arithmetic Operations

- arithmetic operators:

+ addition  
- subtraction  
\* multiplication  
/ division  
% modulo (remainder)

```
x + 10
7 * 2
8 - 5 * 10
(3 * 10) / 2
```

- Integer division:

```
14 ÷ 3 = 4 r. 2 (because 4*3+2 = 14)
```

```
14/3 => 4 in C++
14%3 => 2 in C++
```

```
14.0/3.0 => 4.6666667 in C++
```

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## Operator precedence

- In an expression with multiple operators, which one happens first?

- Use this order for different operators:

+ - (unary)  
\* / %  
+ - (binary)  
<> <= >=  
== !=  
&&  
||

We will study relational and logical operators next week.

- Use this order for multiple occurrences of the same operator

- (unary negation) associates right to left

\*, /, %, +, - associate left to right

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## Basic Input/Output

- Output (cout and <<)

• sends data to the screen (console)

```
cout << expression;
cout << expr1 << expr2;
```

```
cout << "hello";
cout << "Count is: " << count << endl;
```

- Input (cin and >>)

• receives data typed in from the keyboard (stops at space)

```
cin >> variable;
cin >> var1 >> var2;
```

right hand side must be a variable!

```
cout << "Enter the height and width: ";
cin >> height >> width;
cout << "The height is " << height << endl;
```

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## Formatting output

- Goal: control how output displays for numeric data

• these require `#include<iomanip>`

• `setw(x)`: print next value in a field at least x spaces wide (right justified, padded with spaces).

```
cout << setw(6) << 1234 << setw(6) << 5 << endl;
cout << setw(6) << 5 << setw(6) << 1234 << endl;
```

```
1234 5
5 1234
```

• `fixed`: always use decimal notation (not scientific)

• `setprecision(x)`: when used with `fixed`, print floating point values using x digits after the decimal

```
cout << fixed << setprecision(2);
cout << 3.14159 << endl;
float x = 20;
cout << x << endl;
```

```
3.14
20.00
```

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## The string class

- string literals: represent sequences of chars, inside of double quotes: `cout << "Hello";`

- To define string variables:

```
string firstName, lastName;
```

- Operations include:

- = for assignment
- .size() function for length
- [n] to access one character in the nth position.

```
string name;  
name = "George";  
cout << name.size() << " ";  
cout << name[2] << endl;
```

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## Type conversions

- Implicit

- assignment:

```
int x;  
double d = 3.1415;  
x = d;  
cout << x << endl;
```

the type of expression on the right will be converted to type of variable on left, possibly losing information.

- binary operations:

```
int x = 10;  
double d = 2.3;  
cout << x + d << endl;
```

the operand with the lower ranking type is converted to the type of the other.

- Explicit

```
int x, y;  
...  
float avg = static_cast<float>(x)/y;
```

or

```
float avg = x/(float)y; //c-style notation
```

Order of types:

```
long double  
double  
float  
long  
int  
char
```

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## Comments

- Single-Line Comments

```
// this text is ignored, to end of line
```

- Multi-Line Comments

```
/* Anything occurring between a slash star and  
a star slash is ignored. Even when spanning  
multiple lines. */
```

- Use comments to explain your code to a human reader who knows C++.

## Programming Style

- The visual organization of the source code
- Purpose: improve the readability of the source code
- Includes the use of spaces, tabs, and blank lines
- Includes naming of variables, constants.
- Includes where to use comments.
- Common elements to improve readability:
  - Braces { } aligned vertically
  - Indentation of statements within a set of braces
  - Lines shorter than 80 characters.

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## Sample Problem

- Write a program that converts Celsius temperatures to Fahrenheit temperatures. The formula is

$$F = \frac{9}{5}C + 32$$

where F is the Fahrenheit temperature, and C is the Celsius temperature. Input the Celsius temperature from the user and output the temperature in Fahrenheit.