# Week 1

## Operators, Data Types & I/O

Gaddis: Chapters 1, 2, 3

CS 5301
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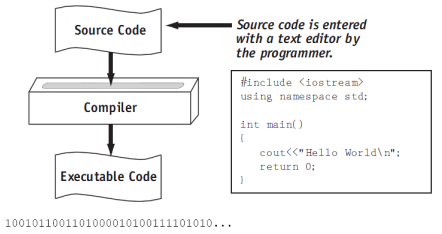
Jill Seaman



# 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.



# 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 ...
}
```



# 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;
```

# Integer types

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

| Data Type | Range |
|---|---|
| `short` | -32,768 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.



# 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` | ±3.4E-38 to ±3.4E38 |
| `double` | ±1.7E-308 to ±1.7E308 |
| `long double` | ±1.7E-308 to ±1.7E308 |

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



# 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;
```



# 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.

# 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++
```



# 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



# 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;
```



# 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
```

- `cout << fixed << setprecision(x);` print all floating point values using x digits after the decimal (put it at the beginning of the program):

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

```
3.14
20.00
```

# 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;
```



# 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.

Order of types:

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

- Explicit

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

or

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



# Math Library functions

- These require cmath header file
- These take double argument, return a double
- Commonly used functions:

```
pow     y = pow(x,d);   returns x raised to the power d
abs     y = abs(x);     returns absolute value of x
sort    y = sqrt(x);    returns square root of x
ceil    y = ceil(x);    returns the smallest integer >= x
sin     y = sin(x);     returns the sine of x (in radians)
etc.
```



# 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.