Week 1
Operators, Data Types & I/O
Gaddis: Chapters 1, 2, 3

CS 5301
Fall 2014
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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.

Structure of a C++ Program
• Hello world:

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

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

• In general:

```cpp
//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**
  ```
<table>
<thead>
<tr>
<th align="right">short</th>
<th align="right">float</th>
<th align="right">bool</th>
</tr>
</thead>
<tbody>
<tr>
<td align="right"></td>
<td align="right"></td>
<td align="right"></td>
</tr>
<tr>
<td align="right">int</td>
<td align="right">double</td>
<td align="right">char</td>
</tr>
<tr>
<td align="right"></td>
<td align="right"></td>
<td align="right"></td>
</tr>
<tr>
<td align="right">long</td>
<td align="right">long double</td>
<td align="right"></td>
</tr>
</tbody>
</table>
  ```

• **Variable Declaration** statement

```cpp
datatype identifier;
```

• **Variable Initialization** statement

```
datatype identifier = constant;
```
Integer types

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

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>short</td>
<td>-23,768 to 32,767</td>
</tr>
<tr>
<td>int</td>
<td>-2,147,483,648 to 2,147,483,647</td>
</tr>
<tr>
<td>long</td>
<td>-2,147,483,648 to 2,147,483,647</td>
</tr>
</tbody>
</table>

- 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.

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>float</td>
<td>±3.4E-38 to ±3.4E38</td>
</tr>
<tr>
<td>double</td>
<td>±1.7E-308 to ±1.7E308</td>
</tr>
<tr>
<td>long double</td>
<td>±1.7E-308 to ±1.7E308</td>
</tr>
</tbody>
</table>

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

Constants

- Literals (specific value of a given type)

<table>
<thead>
<tr>
<th>Value</th>
<th>Literal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>75</td>
<td>12.45</td>
</tr>
<tr>
<td>-2</td>
<td>-3.8</td>
</tr>
<tr>
<td>6.25e-5</td>
<td>true</td>
</tr>
<tr>
<td>'A'</td>
<td>'9'</td>
</tr>
</tbody>
</table>

- Named Constants:
  variable whose value cannot be changed

  ```c
  const datatype identifier = constant;
  const double TAX_RATE = 0.0675;
  ```

Assignment statement, expressions

- To change the value of a variable:

  ```c
  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)

- **Integer division:**

<table>
<thead>
<tr>
<th>Expression</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>$14 \div 3$</td>
<td>$4$ r. $2$ (because $3 \times 4 + 2 = 14$)</td>
</tr>
<tr>
<td>$14/3$</td>
<td>$4$ in C++</td>
</tr>
<tr>
<td>$14%3$</td>
<td>$2$ in C++</td>
</tr>
<tr>
<td>$14.0/3.0$</td>
<td>$4.6666667$ in C++</td>
</tr>
</tbody>
</table>

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;
  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;
  ```

- **fixed:** always use decimal notation (not scientific)

  ```
  cout << fixed << setprecision(2);
  ```

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

  ```
  cout << x << endl;
  ```

  ```
  float x = 20;
  cout << x << endl;
  ```
The string class

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

- To define string variables:
  
  ```cpp
  string firstName, lastName;
  string name;
  name = "George";
  cout << name.size() << " ";
  cout << name[2] << endl;
  ```

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

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Type conversions

- **Implicit**
  - assignment:
    ```cpp
    int x;
    double d = 3.1415;
    x = d;
    cout << x << endl;
    ```
  - binary operations:
    ```cpp
    int x = 10;
    double d = 2.3;
    cout << x + d << endl;
    ```

- **Explicit**
  ```cpp
  int x, y;
  ...
  float avg = static_cast<float>(x)/y;
  ```
  ```cpp
  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**
  ```cpp
  // this text is ignored, to end of line
  ```

- **Multi-Line Comments**
  ```cpp
  /* 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++.

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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.