Week 1: Introduction to C++

Gaddis: Chapter 2
(excluding 2.1, 2.11, 2.14)

CS 1428
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Literals

- A literal represents a constant value used in a program statement.
- Numbers: 0, 34, 3.14159, -1.8e12, etc.
- Characters: 'A', 'z', '!', '5', etc.
- Strings (sequence of characters):
  - "Hello", "This is a string"
  - "100 years", "100", "Y", etc.
- NOTE: These are all different: 5, '5', "5"

Special characters

- Newline: '\n'
- Double quote: '\"'.
- These can occur in strings:
  - "Hello\nthere"
  - "she said \"boo\" very quietly"
- See textbook for more
- It's a backslash ('\'), not a slash ('/)

2.2 The cout Object

- cout: short for "console output"
  - a stream object: represents the contents of the screen
- <<: the stream insertion operator
  - use it to send data to cout (to be output to the screen)
    cout << "This is an example."
- when this instruction is executed, the console (screen) looks like this:
  This is an example.
The `endl` manipulator

- `endl`: short for "end line"
  - send it to `cout` when you want to start a new line of output.
    ```cpp
cout << "Hello " << endl << "there!";
```
  - or you can use the newline character: `\n`
    ```cpp
cout << "Hello \nthere!";
```
  - Either way the output to the screen is:
    ```
Hello
there!
```

more examples

```cpp
cout << "Hello " << "there!";
```

```cpp
Hello there!
```

```cpp
cout << "Hello ";
cout << "there!";
```

```cpp
Hello there!
```

```cpp
cout << "The best selling book on Amazon\n is "The Help";"
```

```cpp
The best selling book on Amazon is "The Help"
```

2.5 Identifiers

- An identifier is a name for some program element (like a variable).
- Rules:
  - May not be a keyword (see Table 2.4 in the book)
  - First character must be a letter or underscore
  - Following characters must be letters, numbers or underscores.
- Identifiers are case-sensitive:
  - `myVariable` is not the same as `MyVariable`

2.4 Variables (and Literals)

- Variable: named location in main memory
- Has a name and a datatype
  - `<datatype> <identifier>`
  - The data type indicates the kind of data it can contain.
- A variable must be defined before it can be used!!
- Examples:
  - `int someNumber;`
  - `char firstLetter;`
2.12 Variable Assignments and Initialization

- An **assignment statement** uses the = operator to store a value in an already defined variable.
  - `someNumber = 12;`
- When this statement is executed, the computer stores the value 12 in memory, in the location named “someNumber”.
- The variable receiving the value must be on the left side of the = (the following does NOT work):
  - `12 = someNumber;` //This is an ERROR

Example program using a variable

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

int main() {
    int number;

    number = 100;
    cout << "The value of the number is " << number << endl;
    return 0;
}
```

Output screen: The value of the number is 100

Variable Initialization

- To initialize a variable means to assign it a value when it is defined:
  - `int length = 12;`
- You can define and initialize multiple variables at once (and change them later):
  ```cpp
  int length = 12, width = 5, area;
  area = 35;
  length = 10;
  area = 40;
  ```

Data Types

- Variables are classified according to their data type.
- The data type determines the kind of information that may be stored in the variable.
- A data type is a set of values.
- Generally two main (types of) data types:
  - Numeric
  - Character-based
C++ Data Types

- int, short, long
  - whole numbers (integers)
- float, double
  - real numbers (with fractional amounts, decimal points)
- bool
  - logical values: true and false
- char
  - a single character
- string
  - any text, a sequence of characters

2.6 Integer Data Types

- Whole numbers such as 12, 7, and -99
- Typical ranges (may vary on different systems):

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Range of values:</th>
</tr>
</thead>
<tbody>
<tr>
<td>short</td>
<td>-32,768 to 32,767</td>
</tr>
<tr>
<td>unsigned short</td>
<td>0 to 65,535</td>
</tr>
<tr>
<td>int</td>
<td>-2,147,483,648 to 2,147,483,647</td>
</tr>
<tr>
<td>unsigned int</td>
<td>0 to 4,294,967,295</td>
</tr>
<tr>
<td>long</td>
<td>-2,147,483,648 to 2,147,483,647</td>
</tr>
<tr>
<td>unsigned long</td>
<td>0 to 4,294,967,295</td>
</tr>
</tbody>
</table>

- Example variable definitions:
  
  ```
  short dayOfWeek;
  unsigned long distance;
  int xCoordinate;
  ```

2.9 Floating-Point Data Types

- Real numbers such as 12.45, and -3.8
- Typical ranges (may vary on different systems):

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Range of values:</th>
</tr>
</thead>
<tbody>
<tr>
<td>float</td>
<td>+/- 3.4e +/- 38 (~7 digits of precision)</td>
</tr>
<tr>
<td>double</td>
<td>+/- 1.7e +/- 308 (~15 digits of precision)</td>
</tr>
<tr>
<td>long double</td>
<td>+/- 1.7e +/- 308 (~15 digits of precision)</td>
</tr>
</tbody>
</table>

- Floating-point literals can be represented in
  - Fixed point (decimal) notation:
    ```
    31.4159 0.0000625
    ```
  - E (scientific) notation:
    ```
    3.14159E1 6.25e-5
    ```

Example program using floating-point data types

```cpp
// This program uses floating point data types.
#include <iostream>
using namespace std;

int main()
{
  float distance;
  double mass;

  distance = 1.495979E11;
  mass = 1.989E30;
  cout << "The Sun is " << distance << " meters away.\n";
  cout << "The Sun's mass is " << mass << " kilograms.\n";
  return 0;
}
```

Output screen:

```
The Sun is 1.49598e+11 meters away.
The Sun's mass is 1.989e+30 kilograms.
```
2.10 The bool Data Type

- The values true and false.
- Literal values: `true`, `false`
- (false is equivalent to 0, true is equivalent to 1)

```cpp
int main() {
    bool boolValue;
    boolValue = true;
    cout << boolValue << endl; // output: 1
    boolValue = false;
    cout << boolValue << endl; // output: 0
    return 0;
}
```

2.7 The char Data Type

- All the keyboard and printable symbols.
- Literal values: `'A` `'5` `'?` `'b`
  - see also: slides 2 and 3.
- Numeric value of character from the ASCII character set is stored in memory:

```cpp
// CODE:
char letter;
letter = 'C';
cout << letter << endl; // OUTPUT: C
```

Appendix B shows the ASCII code values

2.8 The C++ string class

- Sequences of characters
- Requires the string header file: `#include <string>`
- To define string variables in programs:
  ```cpp
  string firstName, lastName;
  ```
- To assign literals to variables:
  ```cpp
  firstName = "George";
  lastName = "Washington";
  ```
- To display via `cout`
  ```cpp
  cout << firstName << " " << lastName;
  ```

  See slides 2 and 3 for more examples of string literals.

  OUTPUT: George Washington

2.13 Scope

- The scope of a variable is the part of the program in which the variable can be accessed.
- A variable cannot be used before it is defined.

```cpp
// This program can't find its variable.
#include <iostream>
using namespace std;

int main() {
    cout << value; // ERROR! value not defined yet!
    int value = 100;
    return 0;
}
```
2.15 Comments

- Used to document parts of the program
- Intended for humans reading the source code of the program:
  - Indicate the purpose of the program
  - Describe the use of variables
  - Explain complex sections of code
- Are ignored by the compiler

2.16 Named Constants

- Named constant: variable whose value cannot be changed during program execution
- Used for representing constant values with descriptive names:
  ```
  const double TAX_RATE = 0.0675;
  const int NUM_STATES = 50;
  ```
- Often named in uppercase letters (see style guidelines)

2.17 Programming Style

- The visual organization of the source code
- Includes the use of spaces, tabs, and blank lines
- Includes naming of variables, constants.
- Includes where to use comments.
- Purpose: improve the readability of the source code

Example:

```cpp
int length = 12; // length in inches
int width = 15;  // width in inches
int area;        // calculated area
// calculate rectangle area
area = length * width;

/* this is a multi-line comment */
int area; /* calculated area */
```
Programming Style

Common elements to improve readability:

- Braces `{ }` aligned vertically
- Indentation of statements within a set of braces
- Blank lines between declaration and other statements
- Long statements wrapped over multiple lines with aligned operators

See the Style Guidelines on the class website. You must follow these in your programming assignments.