COMP 110
Introduction to Programming

Fall 2015
Time: TR 9:30 – 10:45
Room: AR 121 (Hanes Art Center)

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Previous Class

• What did we discuss?
Today

• Announcements
  • Lab 1 will be announced later today
  • Lab1: due Tue, Sep 8 at 11:55 PM

• More on variables and operators
• Binary representation
• Keyboard input

More Operators – Increment and Decrement

• Increment (++)
  – adds 1 to any integer or floating point
  count++;
  count = count + 1;

• Decrement (--) 
  – subtracts 1 from any integer or floating point
  count--;
  count = count - 1;
Increment and Decrement

- **Prefix** \((++\text{count} \text{ or } --\text{count})\)
  - value used in a larger expression is the new value of \text{count} (after the increment/decrement)

- **Postfix** \((\text{count}++ \text{ or } \text{count}--)\)
  - value used in a larger expression is the original value of \text{count} (before the increment/decrement)
  - increment/decrement is the last operation performed (even after assignment)

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If \text{count} currently contains 45, then the statement

\[
\text{total} = \text{count}++; \\
\text{total} = \text{count} += 1;
\]

assigns 45 to \text{total} and 46 to \text{count}

If \text{count} currently contains 45, then the statement

\[
\text{total} = ++\text{count}; \\
\text{total} = \text{count} += 1;
\]

assigns the value 46 to both \text{total} and \text{count}
Questions

• What is stored in total and count in the following statements?

```java
double total = 15.5;
total++;
total = total + count++;
int total = 20, count = 3;
total = total / --count;
```

<table>
<thead>
<tr>
<th>total</th>
<th>count</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.5</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
</tr>
</tbody>
</table>

Input and Output

• Normally, a computer receives two kinds of input:
  – The program
  – The data needed by the program.

• The output is the result(s) produced by following the instructions in the program.
Running a Program

- Sometimes the computer and the program are considered to be one unit.
  - Programmers typically find this view to be more convenient.

It’s all About Data

- Software is data
  - numbers, characters
  - instructions, programs

- Hardware stores and processes data
  - read, write
  - add, subtract, multiply, divide
Representing Text Digitally

- All information in a computer is *digitized*, broken down and represented as numbers.

    Hi, Heather.

    72 105 44 32 72 101 97 116 104 101 114 46

*Corresponding upper and lower case letters are separate characters.*

Language of a Computer

- **Machine language**: the most basic language of a computer

  - A sequence of 0s and 1s
    - binary digit, or *bit*
    - sequence of 8 bits is called a *byte*

  - Every computer directly understands its own machine language
    - why can't Windows programs run on Apple computers?
Bit Permutations

<table>
<thead>
<tr>
<th>1 bit</th>
<th>2 bits</th>
<th>3 bits</th>
<th>4 bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>00</td>
<td>000</td>
<td>0000</td>
</tr>
<tr>
<td>1</td>
<td>01</td>
<td>001</td>
<td>0001</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>010</td>
<td>0100</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>011</td>
<td>0110</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>0100</td>
<td>1100</td>
</tr>
<tr>
<td></td>
<td>101</td>
<td>0101</td>
<td>1101</td>
</tr>
<tr>
<td></td>
<td>110</td>
<td>0110</td>
<td>1110</td>
</tr>
<tr>
<td></td>
<td>111</td>
<td>0111</td>
<td>1111</td>
</tr>
</tbody>
</table>

Each additional bit doubles the number of possible permutations

Bit Permutations

- Each permutation can represent a particular item
- There are $2^N$ permutations of $N$ bits
  - $N$ bits are needed to represent $2^N$ unique items

How many items can be represented by

- 1 bit? $2^1 = 2$ items
- 2 bits? $2^2 = 4$ items
- 3 bits? $2^3 = 8$ items
- 4 bits? $2^4 = 16$ items
- 5 bits? $2^5 = 32$ items
Binary Numbers

- $N$ bits to represent $2^N$ values
- $N$ bits represent values 0 to $2^N-1$
- Example: 5 bits
  - 32 unique values (0-31)
  - 00000 = 0
  - 11111 = 31

\[
\begin{align*}
2^4 & \quad 2^3 & \quad 2^2 & \quad 2^1 & \quad 2^0 \\
16 & + & 8 & + & 4 & + & 2 & + & 1 \\
\end{align*}
\]

Decimal to Binary

<table>
<thead>
<tr>
<th>Number</th>
<th>Place Value</th>
<th>Digit</th>
</tr>
</thead>
<tbody>
<tr>
<td>114</td>
<td>$2^6 = 64$</td>
<td>1</td>
</tr>
<tr>
<td>50</td>
<td>$2^5 = 32$</td>
<td>1</td>
</tr>
<tr>
<td>18</td>
<td>$2^4 = 16$</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>$2^3 = 8$</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>$2^2 = 4$</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>$2^1 = 2$</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>$2^0 = 1$</td>
<td>0</td>
</tr>
</tbody>
</table>
Questions: Binary Numbers

• What’s the maximum value a 6-bit number can represent? **63**

• What’s the decimal representation of 111010? **58 = 32+16+8+2**

• What’s the binary representation of 35? **100011**

Teaching Assistants and Office hours

http://comp110.com/team

http://comp110.com/support
Keyboard Input

- Java has reasonable facilities for handling keyboard input.
- These facilities are provided by the `Scanner` class in the `java.util` package.
  - A `package` is a library of classes.

Simple Input

- Data can be entered from the keyboard using
  ```java
  Scanner keyboard = new Scanner(System.in);
  ```
  followed, for example, by
  ```java
  eggsPerBasket = keyboard.nextInt();
  ```
  which reads one `int` value from the keyboard and assigns it to `eggsPerBasket`. 
Simple Screen Output

```
System.out.println("The count is " + count);
```

- Outputs the string literal "the count is 
- Followed by the current value of the variable count.

Using the Scanner Class

- Near the beginning of your program, insert
  ```java
  import java.util.Scanner;
  ```
- Create an object of the Scanner class
  ```java
  Scanner keyboard =
      new Scanner (System.in)
  ```
- Read data (an int or a double, for example)
  ```java
  int n1 = keyboard.nextInt();
  double d1 = keyboard.nextDouble();
  ```
Next class (Tue, Sep 1)

- Binary representation
- More programming in class

→ Reading Assignment: Chapter 1