Operators, Modifiers, and Math Functions

Hours 8 and 9

- Objectives
  - Operators: arithmetic, assignment, relational, logical, bitwise
  - Mathematical operators: +, -, *, /, %
  - Mathematical functions: sqrt, pow, etc.
- Modifiers: signed, unsigned, long, and short
- Logical operators: AND, OR, NOT
- Bitwise operators: AND, OR, XOR
- Conditional operator (?:)
- sizeof operator
- Math library

Logical Operators

Return true or false

- Left and right hand operands are boolean expressions
- && logical and
  
<table>
<thead>
<tr>
<th>E</th>
<th>E</th>
<th>E &amp;&amp; E</th>
</tr>
</thead>
<tbody>
<tr>
<td>f</td>
<td>f</td>
<td>f</td>
</tr>
<tr>
<td>f</td>
<td>t</td>
<td>f</td>
</tr>
<tr>
<td>t</td>
<td>f</td>
<td>f</td>
</tr>
<tr>
<td>t</td>
<td>t</td>
<td>t</td>
</tr>
</tbody>
</table>
- || logical or
  
| E | E | E || E |
|---|---|---------|
| f | f | f       |
| f | t | t       |
| t | f | t       |
| t | t | t       |
- ! logical not
  
<table>
<thead>
<tr>
<th>E</th>
<th>!E</th>
</tr>
</thead>
<tbody>
<tr>
<td>t</td>
<td>f</td>
</tr>
<tr>
<td>f</td>
<td>t</td>
</tr>
</tbody>
</table>

Variable Modifiers

C/C++ keywords

- signed: little used-turn unsigned char into signed char
- unsigned: often used-turns short, int, and long into unsigned (i.e., no negative values) type (doubles the magnitude; often used with bit-manipulation operators; unsigned arithmetic does not overflow)

True and False

An existential dilemma?

- False is 0
- Any value except 0 is true
- The result of a "boolean" expression is either 1 or 0
- C++ defines type bool with possible values: true & false
- Still implemented as 0 and not-0

```
if (n % 2)
  printf("n is odd\n");
else
  printf("n is even\n");
```

```
if (strcmp(s1, s2))
  printf("s1 & s2 differ\n");
else
  printf("s1 & s2 are equal\n");
```

Operator Examples

More unusual C operators

- ?:(conditional operator)
- sizeof: returns the size, measured in bytes, of variables or data types

Bit Operations

bitwise operations

- << (left shift)
- >> (right shift)
- & (bitwise and)
- | (bitwise or)
- ^ (exclusive or)
- ~ (complement)
Math Library Functions

Available in C and C++

- **Common Math Functions**
  - double sin(double x);
  - double cos(double x);
  - double tan(double x);
  - double asin(double x);
  - double acos(double x);
  - double atan(double x);
  - double atan2(double y, double x);
  - \( \tan^{-1}(y/x) \)
  - double exp(double x);
  - \( e^x \)
  - double log(double x);
  - double log10(double x);
  - double pow(double x, double y);

- **Using the math library**
  - #include <math.h>
  - link with Unix math library -lm (bigger than Windows/DOS)
  - included in Windows runtime
  - all angles are in radians

- **Math library also includes**
  - Hyperbolic functions
  - Bessel functions
  - Gamma functions
  - Absolute value functions
  - floor and ceiling
  - etc.