Operators and Expressions

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Computer Science 106

Computing in Engineering and Science

February 9, 2006

California State University Northridge

Outline

- Review last class
- Assignment operator
- Definition of expressions
- Mathematical operators
- Operator precedence
- The remainder or mod (%) operator

True-False Review Quiz

- You do not have to declare a variable before using it in a program ***False***
- Declaring a variable is the same as assigning it an initial value ***False***
- You can declare a variable and assign it a value at the same time ***True***
- Subtracting one from the minimum short integer gives the maximum short ***True***

Another Review Quiz

- A program has the following declarations

  int k = 10, r = 58, j = 9;
- What is the result of the following divisions?

  r/k r/k = 58/10 = 5 after truncation

  j/k j/k = 9/10 = 0 after truncation

  r/j r/j = 58/9 = 6 after truncation

Assignment Operator

- Assignment operator is =

  <variable> = *<expression>*;
- An expression is a variable, a constant, or a combination of variables, constants, and operators
- Remember syntax for commands
  - `text entered as printed`
  - *<description of item>*

Assignment Operator II

- *<variable>* = *<expression>*; assigns value of expression to variable
  - myVar = 3; // assigns 3 to myVar
  - var2 = myVar ; // assigns 3 to var2
  - set = 10 + var2; // assigns 13 to set
- Can have multiple assignments
  - x = y = z = 0; sets x, y, and z to zero
- Look at C++ operators and the rules for their application: operator precedence

Operators

- Different types of operators
  - Arithmetic operators give usual arithmetic operations (+ – * /) and mod (%)
  - Relational operators give true or false results (> < >= <= == !=)
  - Logical operators and(&&) or(||) not(!)
- Operator precedence: rules for which operators are evaluated first in an expression with more than one operator

```
x = -y
x = y - z
```


Example of Precedence

- What is 4 + 2 * 3?
  - Depends on which operator (* or +) has precedence (is done first)
  - No fixed mathematical rules
  - Simple calculators often do expressions as entered giving (4 + 2 = 6) * 3 = 18
  - Programming languages (and scientific calculators) usually give precedence to multiplication giving 4 + (2 * 3 = 6) = 10

Arithmetic Operator Precedence

- Expressions scanned from left to right
- Operators with highest precedence are executed first
- Scan is repeated to execute operators with decreasing level of precedence
- Highest level is unary minus (-x)
- Next is multiply, divide and mod (%)
- Lowest is addition and subtraction

The mod Operator

- Operator % gives remainder
- Like long division before you learned about fractions and decimals
- 3 goes into 7 two times with a remainder of 1
- 7 % 3 = 1 (7/3 = 2 remainder 1)
- What is 3 % 4? 3 (3/4 = 0 remainder 3)
- What does it mean if N % 2 is zero?

N is an even number

Raising Numbers to a Power

- C++ does not have an exponentiation operator to evaluate x^n
- Use the pow function for this purpose
  - Requires #include <cmath>
  - `double result = pow(number, power);`
  - What is pow(3, 4)? pow(3, 4) = 3^4 = 81
  - What is pow(4, 3)? pow(4, 3) = 4^3 = 64
  - Note importance of order in function
- Can use multiplication, e.g. x * x for x^2

Overcoming Precedence

- Use parentheses to group operations to give desired results.
- Write code for these equations $w = \frac{u+v}{x+y}$ $w = \frac{\frac{ua}{b}+v}{x+\frac{y+a}{c}}$
- w = (u + v) / (x + y);
- What does u + v / x + y; give? $u + \frac{v}{x} + y$
- w = (a * u / b + v) / (x + (y + a) / c);
- Can use extra parentheses

Some Questions

- Write C++ expressions for the following:

$$u = \frac{x + yz^2}{w + \frac{x}{3y}} \qquad u = \frac{\frac{x}{yz} + r}{x + y - \frac{a}{b}}$$

```
u = (x + y * z * z)/(w + x / (3 * y) );

u = (x / y / z + r) / (x + y - a / b );
```


Type Conversion

- Can equate variable of one type to value of another type
  - Internal conversion rules apply
  - Assigning double variable an int value converts data and adds decimal point
  - Assigning int variable a double value loses decimal fraction
  - Declare: int x = 3; double y = 4.8;
  - What is result of x = y? of y = x?

x = 4 y = 3.0

Type Conversion II

- Type precedence for data types
  - See text for complete list
  - double is higher than int
- When two unlike data types are used in an operation the lower type is promoted to the higher type before the operation
  - For int x = 3; double y = 2;
  - What is result of x / 2? of x / y? of x / 2.0?

What is difference between 2 and 2.0?

x/2 is 1 x/y is 1.5 x/2.0 is 1.5

Type Conversion III

- Be careful in order of operations
- What are results of following examples?

```
double m = 10, v = 20;
double KE = (1/2) * m * v * v;
double KE = m * v * v / 2;
double KE = 0.5 * m * v * v;
double KE = 1 / 2 * m * v * v;
double KE = 1 / 2.0 * m * v * v;
```

0
2000
2000
0
2000

Type Conversion Functions

- static_cast<double>(***<expression>***) converts value of ***<expression>*** to type double
- static_cast<int>(***<expression>***) converts value of ***<expression>*** to type int
- Although the use of static_cast is the preferred operation in modern C++ an older method is simpler

Type Conversion Functions

- `double(` ***<expression>*** `)` converts value of ***<expression>*** to type double
- `int(` ***<expression>*** `)` converts value of ***<expression>*** to type int
- Example: to find average of type int data: int sum, number; double average = double(sum)/double(number);
  - Do we need both doubles in this statement?

No converting one to double will promote the other

More on Type Promotion

- Recall kinetic energy example

```
double KE = (1/2) * m * V * V;
```

- Result depends only on the two operands currently being considered
  - Does ***not*** depend on other variables in the expression
  - Does ***not*** depend on left-hand-side variable
- What does double x = 1/2; give for x?

California State University Northridge **It gives 0.0 for x** 19

Questions

- What values are stored in the variables by the following statements? (27/4 = 6.75)

```
double a;
int x = 27, y = 4, z;
z = x / y;                  z = 6
a = x / y;                  a = 6.0
a = double( x ) / y;        a = 6.75
z = double( x ) / y;        z = 6
```

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More Questions

- What values are stored in the variables by the following statements?

```
int a;  double x = 12, y =
        5, z = 3.3, w;
w = x / y;          w = 2.4
a = x / y;          a = 2
w = int( z / y);    w = 0
a = x / int( z );   a = 4
```

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