CSE / ENGR 142 Programming I

Arithmetic Expressions

Assignment Statement Review

double area, radius;

*area = 3.14 * radius * radius;*

assignment statement — expression

Expressions

- Expressions are things that have values
  - A variable by itself is an expression: radius
  - A constant by itself is an expression: 3.14
- Often expressions are combinations of variables, constants, and operators.

  *area = 3.14 * radius * radius;*
- The overall value of the expression is based on the data and operators specified.
  - Data means the integer or floating-point constants and/or variables in the expression.
  - Operators are things like addition, multiplication, etc.

The Big Picture

- In an assignment statement,
  - the expression (right hand side) is first evaluated,
  - then its value is assigned to (stored in) the assignment variable (left hand side).
- How this happens depends on the data types in the expression, the operators, and the type of the assignment variable.

```
my_int = int1 + int2;
```

Unary and Binary

- Binary: operates on two things

  *3.0 * b*

  zebra + giraffe
- Unary: operates on one thing

  -23.4
- C operators are unary or binary
- Then what about expressions like *a+b+c*?

Expressions with *doubles*

REVIEW:

Doubles are floating-point values that represent real numbers within the computer.

Constants of type double:

0.0, 3.14, -2.1, 5.0, 6.02e23, 1.0e-3

not 0 or 17

Operators on doubles:

unary: -

binary: +, -, *, /

Expressions with *double*s: Examples

double height, base, radius, x, c1, c2 ;

Sample expressions (not statements):

*0.5 * height * base*

*(4.0 / 3.0) * 3.14 * radius * radius * radius*

*- 3.0 + c1 * x - c2 * x * x*

Expressions with *int*s

REVIEW:

An integer represents a whole number with no fractional part.

Constants of type *int*:

0, 1, -17, 42 not 0.0 or 1e3

Operators on *int*s:

unary: -

binary: +, -, *, /, %

int division and remainder

Integer operators include *integer division* and *integer remainder*.

```
  2
100 )299
  200
   99
```

/ is integer division: no remainder, no rounding

299 / 100 → 2 , 6 / 4 → 1 , 5 / 6 → 0

% is mod or remainder:

299 % 100 → 99 , 6 % 4 → 2 , 5 % 6 → 5

Expressions with *int*s: Examples

Given: total_minutes 359

Find: hours 5
minutes 59

Solution:

hours = total_minutes / 60 ;

minutes = total_minutes % 60 ;

A Cautionary Example

```
int radius;
double area;
.
.
.
area = ( 22 / 7 ) * radius * radius;
```


Why Use *int*s? Why Not *double*s Always?

- Sometimes only *int*s make sense
  - "give me the 15th spreadsheet cell"
  - "give me the (14.9999998387)th cell" ??
- *Double*s may be inaccurate representing "ints"
  - In mathematics 3 • 15 • (1/3) = 15
  - In computer arithmetic
    3.0 * 15.0 * (1.0 / 3.0) might be 14.999999997
- Last, *and least*
  - arithmetic with *double*s is often slower
  - *double*s often require more memory

Operator Precedence

Precedence determines the order of evaluation of operators.

Is *a + b * a - b* equal to *(a + b) * (a - b)* or *a + (b * a) - b* ??

And does it matter?

Try this:

*4 + 3 * 2 - 1*

*(4 + 3) * (2 - 1) =*

*4 + (3 * 2) - 1 =*

Operator Precedence

Precedence rules:

1. do ( )'s first, starting with innermost
2. then do unary minus (negation): -
3. then do multiplicative ops: *, /, %
4. lastly do additive ops: binary +, -

Associativity

Associativity determines the order among consecutive operators of **equal** precedence

Is *a / b * c* equal to *a / (b * c)* or *(a / b) * c* ??

Most C arithmetic operators are **"left associative"**, within the same precedence level

*a / b * c* equals *(a / b) * c*

a + b - c + d equals *((a + b) - c) + d*

C also has a few operators that are right associative.

The Full Story...

- C has about 50 operators & 18 precedence levels...
- A "Precedence Table" shows all the operators, their precedence and associativity.
  - Look on inside front cover of our textbook
  - Look in any C reference manual
- When in doubt: check the table
- When faced with an unknown operator: check the table

Precedence and Associativity: Example

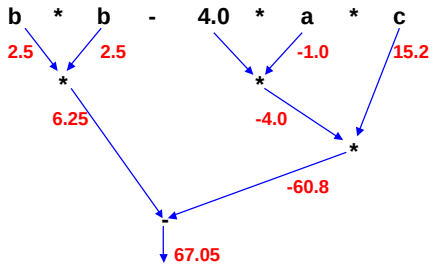
Mathematical formula:

$$\frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

C formula:

*(- b + sqrt (b * b - 4.0 * a * c)) / (2.0 * a)*

Expressions & Values



Mixed Type Expressions

What is *2 * 3.14* ?

Compiler will implicitly (automatically) convert *int* to *double* when they occur together:

int + double → *double + double* (likewise -, *, /)

2*3 * 3.14 → (2*3) * 3.14 → 6 * 3.14 → 6.0 * 3.14 → 18.84

2/3 * 3.14 → (2/3) * 3.14 → 0 * 3.14 → 0.0 * 3.14 → 0.0

We strongly recommend you avoid mixed types:
e.g., use 2.0 / 3.0 * 3.14 instead.

Conversions in Assignments

```
int total, count ;
double avg;
total = 97 ;    count = 10 ;
avg = total / count ;          /*avg is 9.0*/

total = avg;      /*BAD*/
```

implicit conversion to double

Explicit Conversions

(Section 7.1)

- To be explicit in the program, you can use a cast
  - convert the result of an expression to a different type.
- Format: *(type) expression*
- Examples:
  (double) myage
  (int) (balance + deposit)
- This does not change the rules for evaluating the expression (types, etc.)

Using Casts

```
int total, count ;
double avg;
total = 97 ;    count = 10 ;
avg = total / count ;                  /*avg is 9.0*/

avg = (double) total / (double) count ;
                                       /*avg is 9.7*/
avg = (double) (total / count) ;       /*avg is 9.0*/
```

implicit conversion to double

explicit conversion to double

C is "Strongly Typed"

- Every value has a type
- C cares a lot about what the type of each thing is
- Lots of cases where types have to match up
- Start now: be constantly aware of the type of everything in your programs!

Basic Lessons

- Write in the clearest way possible for the reader.
- Keep it simple; for very complex expressions, break them up into multiple statements.
- Use parentheses to indicate your desired precedence for operators where it may be ambiguous.
- Use explicit casts to avoid implicit conversions in mixed mode expressions and assignments.
- Be aware of types.