CSC1102
STRUCTURED AND OBJECT-ORIENTED PROGRAMMING

Course Outline

- **Module 1 (16 hours): Structured Programming**
  - Introduction to programming
  - Program structure
  - Branching and Iterations: Control flow statements
- Module 2 (16 hours): Data manipulation
  - Functions

Previously…

- Python program structure
- Python Syntax
- Variables and Constants

In this lecture

- Statements
- Expression evaluation
- Mathematical operators

Expressions in Python

- Example: total * TAXRATE
- Consists of a sequence of operators and operands
    - operands: total, TAXRATE
        - can be expressions themselves
    - operator: *
        - operation calculating a result based on the operand(s)

Some Expression Formats

- primary
  - expressions that directly map to a value
- unary
  - prefix: *operator operand*
  - postfix: *operand operator*
- binary
  - *operand1 operator operand2*
- ternary (operator in two parts)

Types for Operands

- Operators only apply to certain types
    - e.g., addition applies to numbers
- Each operand must be of the appropriate type
- Operators calculate a value
- Value can then be used as operands to other operators

Primary Expressions

- identifiers
  - variable
  - defined constant
- literal constants
  - operands can be values of the appropriate type
  - operator can have constant (e.g., 5, -34) as operand

Binary Expressions

expr1 op expr2

- arithmetic operators
  - + - binary addition (e.g., 5 + 3 result: 8)
  - - - binary subtraction (e.g., 5 - 3 result: 2)
  - * - multiplication (e.g., 5 * 3 result: 15)
  - / - division (e.g., 5 / 3 result: 1)
  - % - remainder (e.g., 5 % 3 result: 2)
- arithmetic operators apply to number types, result type depends on operand types

Arithmetic Operators

Two int operands -> int result

Two float operands -> float result

% - remainder operator, only works for int values

Mixed operands (float/int) - result produced is based on a “promotion” hierarchy, result cast to higher type in hierarchy

e.g., 5 / 3.0 produces 1.666666

Assignment Expression

varName = expr

- value of expr determined
- result of expression is the value of expr
- as a “side effect” the value calculated is also stored in the named variable (the current value stored in the variable is replaced)
- example:
  - current value of total is 5
  - total = 3
  - replaces the value 5 with the value 3 in the memory location corresponding to total

Shorthand Assignments

+=   -=   *=   /=   %=

example:

```
x += 3
```

is a shorthand for

```
x = x + 3
```

assuming x is 7 before x += 3 is calculated, the right-hand side x + 3 is calculated, producing 10, this value is then stored in x, and the result of the expression is 10

thus, these operators also have side effects

Unary Expressions

- Postfix

  fName(*arglist*) - function call

  subprogram is called (invoked) which performs some set of computations and returns a value (more later)

- Prefix

  type (*expr*) - expr can be any primary expression or the name of a type, operator returns num bytes used to represent type (int)

  + *expr* - unary plus (applies to numbers, no effect)

  - *expr* - unary minus (inverts sign of numbers)

Cast Operator (Unary Prefix Op)

TypeName(expression)

- conversion forces expression value from current type to the provided type
  - example: str(x)
- especially useful for mathematical operations

Complex Expressions

- Expressions can be composed to produce more complex expressions

  operand of expression can be an expression:

  total = totalSale + TAXRATE * totalSale

  three operators, =, +, *, how is this expression resolved??

  In Python, TAXRATE * totalSale is calculated, then totalSale is added to this value, then this value is stored in total

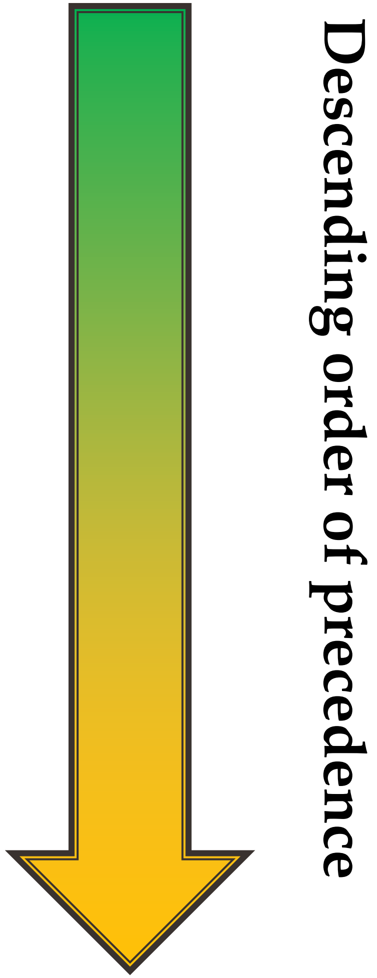
  But why??

Resolving Complex Expressions

- Python has precedence, associativity rules it uses to determine the order operators are evaluated in
- Precedence: some operators are executed before others
- Associativity: when more than one operator in an expression has the same precedence then associativity rules are used to order

Operator Precedence

- Identifier, Constant, Parenthesized Expression
- Function call
- Postfix increment/decrement,
- Prefix increment/decrement, sizeof, unary +, unary -
- (Type) - cast operator
- * / %
- + -
- = += -= *= /= %=



Descending order of precedence

Using Operator Precedence

Example:

total = totalSale + TAXRATE * totalSale

* has highest precedence, so TAXRATE * totalSale is calculated first

+ has next highest precedence, so the result of TAXRATE * totalSale is added to totalSale

= has the lowest precedence, so the value calculated in the previous operations is stored in total

Parenthesized Expressions

- What if the precedence order is not what you want?

  example: sale1 + sale2 * TAXRATE

  in this case the multiplication would happen first, but you might want the addition first

  answer: parenthesize the expressions you want to happen first

  result: (sale1 + sale2) * TAXRATE

  parenthesized expressions have highest precedence

Programming Tip: Parenthesizing

- Does not hurt to include parentheses for all expressions
- Thus you can guarantee the order of evaluation

  Example:

  ```
  total = totalSale + TAXRATE * totalSale
  ```

  becomes

  ```
  total = (totalSale + (TAXRATE * totalSale))
  ```

Associativity

Rules determining how to evaluate expressions containing more than one operator with the same precedence

- example: is 5 - 4 - 3 = ((5 - 4) - 3) or (5 - (4 - 3))
- its important because the values may differ (e.g., -2 or 4 for the above possibilities)

Left associativity: operators are evaluated left to right

Right associativity: evaluated right to left

Operator Associativity

Identifier, Constant, Parenthesized Expression, Function call *(LEFT)*

Postfix increment/decrement *(LEFT)*

Prefix increment/decrement, unary +, unary - *(RIGHT)*

(Type) - cast operator *(RIGHT)*

* / % *(LEFT)*

+ - *(LEFT)*

= += -= *= /= %= *(RIGHT)*

Using Operator Associativity

- Evaluate operators by precedence
- When evaluating operators with the same precedence, consult associativity rules

  example: 5 - 4 - 3, two - operators, so associativity (left) is used

  5 - 4 - 3 evaluates to ((5 - 4) - 3) or -2
- Again, use parentheses to make sure things are evaluated the way you expect

Composing Assignments

Example:

- x = y = 3   (x = (y = 3)) with Right associativity
- Ok to do, but better to avoid

Example:

- x is 4, what is the result of   x = y = x + 3 ?
- x + 3 evaluated (producing 7), this value stored to y, then the result stored back to x

Statements

- Programs consist of sequences of statements
- Expressions can be used as part of various types of statements
- Expressions can also be used as stand-alone statements
    - generally assignment expressions are issued as separate statements

Expression Statements

Format: *Expression* ;

- When the statement is reached in the program the expression is evaluated
- Assignment statements cause side effects (change the value of variables)
- Print and input are actually functions that we call (and produce values), so these are expression statements

Compound Statements

- A block of code containing zero or more statements
- Example: Block of statements treated as a unit

```
def my_function():
    statement1
    statement2
    statement3
```

block

Compound Statements (cont)

- Local declarations exist during the execution of the block/compound statement
- Declarations are made one at a time
- Statements are executed from the first to the last
- Declarations go away once the statements in the block are executed