Types, Expressions, and Pseudocode

16 Sep 2009
CMPT140
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Data types

- Certainly atomic vs. compound data are different types
- But even for atomic data there are types: e.g.
  - Cardinals (unsigned whole numbers; naturals): 0, 1, 2, 3, 4, 5, …
  - Integers (signed whole): -27, 0, 5, 247
  - Reals / Floats: 5.0, -23.0, 3x10^{8}
  - Booleans: True, False
  - Characters: 'a', 'H', '5', '='
  - Strings: “Hello World!”, “5”

Types in Python

- Python has many built-in types; here are some:
    - int: e.g., 2, -5, 0
    - float: e.g., 2.3, -42e6, 0.
    - str: e.g., 'hello', “world”, '!', ''
    - bool: True, False
    - tuple: e.g, (2, -1, 'hi'), ()
- You can find the type of an expression with:
    - type(2.3)
- A complete list of types is at http://docs.python.org/ref/types.html

Operators care about type

- Operators work on operands:
  - e.g. 3+4: operator is "+"; operands: 3, 4
- Cardinal type: e.g., +, -, *, /, *print*, etc.
- Character type: e.g., *capitalize*, *print*, etc.
  - 'b' / '4' doesn't make sense
- String type: e.g., *reverse*, *print*, etc.
  - *reverse*(1.3) doesn't make sense
- Array-of-strings type: e.g.,
  - Reverse each string in the array
  - Reverse the order of the array

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Abstract Data Types

- An Abstract Data Type (ADT) is a set of items w/ common properties and operations
  - e.g., Real ADT: reals w/ +, -, *, /, ...

- Implementation of an ADT:
  - Real-world implementations of ADTs on actual computers have limitations
  - e.g. Can't represent integers bigger than 2,147,483,647 (on a 32-bit machine)
  - e.g. Real (floating-point) numbers can be represented only up to a certain number of significant figures: 1.9999999999 ≠ 2

Variables and constants

- A constant's value remains fixed: e.g., π, e, 2
- A variable's value may change: x, numApples
- We can assign new values to variables
  - numApples = 12
  - numApples = numApples – 1
- But not to constants
  - π = 3.0 (don't want to do this!)
- In Python, can't force a name to be constant
  - Convention: use ALLCAPS for names that are intended to be constant

Expressions

- A combination of data items with appropriate operators is called an expression
- Expressions are evaluated to obtain a single numeric result
    - 15 + 9 + 11 + 2 ------evaluation--->>> 37
- Operators may evaluate to a different type than their operands:
    - 22.1 > 15.0:
      What is the type of the operands?
      What is the type of the result?

Logical operators

- Logical operators take bool operands:
  - GodLovesMe = True
  - ILoveGod = False
- not: flips True to False and vice-versa
  - not GodLovesMe >>> False
- and: is True if both operands are True
  - GodLovesMe and ILoveGod >>> False
- or: is True if at least one operand is True
  - GodLovesMe or ILoveGod >>> True

Operator Precedence

- How would you evaluate this?
  - 5 + 4 * 2
  - (5 + 4) * 2 >>> 18: Addition first
  - 5 + (4 * 2) >>> 13: Multiplication first
- Precedence is a convention for which operators get evaluated first (higher precedence)
  - Usually multiplication has higher precedence than addition
- When in doubt, use parentheses!

Expression compatibility

- 5 + True is nonsensical: incompatible types
- What about 5(int) + 2.3(float)?
    - Works because the two types are expression compatible
- The "+" operator is overloaded:
    - Works for multiple types: int and float
- It turns out that in Python, 5+True does work:
    - 5+True >>> 6
      (interprets True as 1 and False as 0)

Control abstractions

- Sequence: first do this; then do that
- Selection (branch): IF … THEN … ELSE …
- Repetition (loop): WHILE … DO ….
- Composition (subroutine): call a function
- Parallelism: do all these at the same time

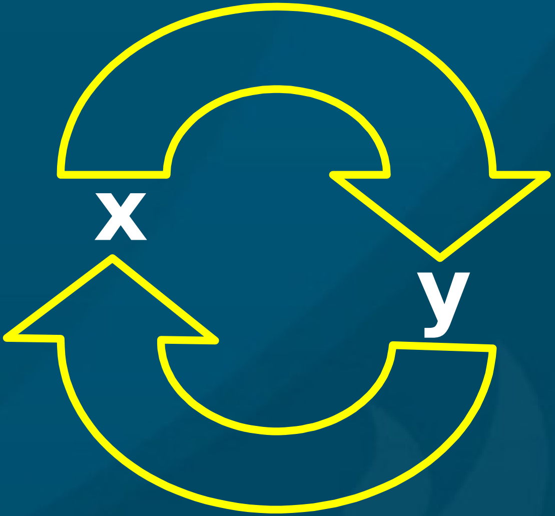
- These are the basic building blocks of program control and structure

Pseudocode

- Pseudocode is sketching out your design
    - General enough: not tangled in details
    - Specific enough: can translate into code
- Use the five control abstractions
- Usually several iterations of pseudocode, getting less abstract and closer to real code
- Don't worry on syntax; focus on semantics
    - e.g., repetition can be done with WHILE ... DO ..., or LOOP ... UNTIL ..., etc.
    - Similar semantics; different syntax

Example pseudocode: swap

- Problem: swap the values of x and y
- Initial solution:
  - x <--- y
  - y <--- x
- Will this work?
- Try again:
  - temp <--- x
  - x <--- y
  - y <--- temp



Example: add 1..20

- Problem: add the integers between 1 and 20
- Initial solution:
    - Initialize sum to 0
    - Initialize counter to 1
    - Repeat:
        - Add counter to sum
        - Add one to counter
    - Until counter = 20
- Will this work?

Example: add 1..20 (2nd *try)*

- Try again:
  - Initialize sum to 0
  - Initialize counter to 1
  - Repeat:
    - Add counter to sum
    - Add one to counter
  - Until counter = 21

- Alternate version:
  - Initialize sum to 0
  - Initialize counter to 1
  - While counter <21, repeat:
    - Add counter to sum
    - Add one to counter

- Same semantics, different syntax
- Top-of-loop test vs. bottom-of-loop test

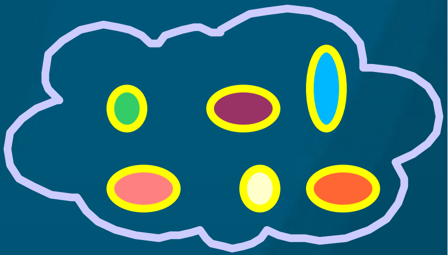
Pseudocode: you try (group effort!)

- Problem: print the largest of a sequence of numbers
    -

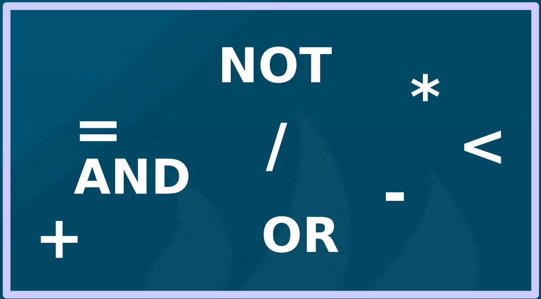
Writeups for Labs 1-2 *(L1 due next wk)*

- Short writeup (full writeups required starting with Lab3)
  - Design (10 marks)
    - Name, CMPT140, Lab 1, date
    - Statement of the problem
    - Discussion of solution strategy
  - Code (30 marks)
    - Name, etc. again in code header
    - Well-commented code, formatted and indented
    - Clear, well-chosen identifiers (variable names)
  - Output (10 marks)
    - A couple runs with different input

Review



- Data types (examples?)
    - Contrast: 5, 5.0, '5', “5”, (5), {5}
- Operators, operands, ADTs, implementations
- Variables vs. constants
- Logical operators: not, and, or
- Operator precedence
- Expression compatibility (what types?)
- Pseudocode



TODO items

- Sign up for a lab section
    - Wed/Ian, Thu/Andrew
- Do the Python/IDLE intro by Fri (nothing to turn in, not graded)
- Lab1 due next Wed/Thu 10pm, to myCourses