§2.3-2.4: Problem Solving, Documentation, Style

- *Quiz ch1 today*

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CMPT14x
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Quiz ch1

- Get out a blank sheet of paper
- In the top right corner, write
  - Your name
  - Student ID#
  - CMPT14x Quiz 1
  - Today's date (17 Sep 2007)
- Number your answers and provide short answers as best you can
- Closed book, closed notes, closed laptops/calcs

Quiz ch1 (20 points, 10 minutes)

- Copy this sentence and fill in the blanks: [4]
  - "Computers are t____, and computer scientists are t_____."
- What are the five steps of top-down problem solving?
  - (okay if you don't get exact words; write the concepts) [5]
- What's the difference between 7, 7.0, and "7"? [3] Explain.
- What does this evaluate to in Python: 15 / 4 [2]
- Name three examples of hardware for input and three examples of hardware for output. [6]

Quiz ch1: solutions (#1-2)

- "Computers are tools, and computer scientists are toolsmiths." (2) (2)
- Five steps of top-down problem solving: (5)
  - Write everything down
  - Apprehend the problem
  - Design a solution
  - Execute your plan
  - Scrutinize the results

Quiz ch1: solutions (#1-2)

- 7 vs. 7.0 vs. “7”:
  - Type: int vs. float vs. str
- 15 / 4:
  - 3 (not 3.75, not 4)
- Input hardware:
  - Keyboard, mouse, touchscreen, camera, microphone, game controller, laser rangefinder, ...
- Output hardware:
  - Monitor, printer, speaker, motor, etc.

What's on for today (§2.3-2.4)

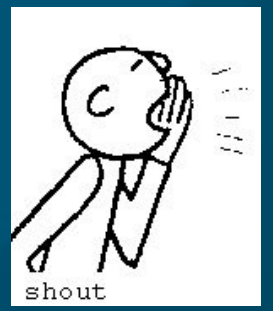
- Strong typing vs. weak typing
- Steps to problem solving: WADES in more detail
- Documentation
  - External documentation: design, manuals
  - Internal documentation: comments, docstrings
- Style guidelines

Strong typing vs. weak typing

- All variables have a type:
  - int, float, str, bool, etc.
- Some languages (e.g. C, M2, Java) are strongly-typed:
  - Must declare the type of the variable ahead of time:
    - x, y : REAL;
    - k : CARDINAL;
  - Can't change type or assign a value of different type:
    - x := “Hello World!”; (* won't work in M2 *)
- But Python is weakly-typed: variables can change type:
    - x = 5.0
    - x = True # okay in Python

Declaring vs. initializing

- This is only necessary for strongly-typed languages:
  - Declare a variable to tell the compiler the type of the variable:
    - VAR numApples : CARDINAL; (* M2 *)
  - Its value is undefined until it is initialized:
    - BEGIN
      - numApples := 5; (* M2 *)
- In a weakly-typed language like Python, just initialize the variable:
    - numApples = 5 # okay in Python



Keyboard input

- You know how to output using print()
- Use input() to get a value from the user:
  - balance = input("Opening balance? ")
  - The argument is the prompt string
  - Dynamic typing: Python interprets the user's response and determines its type
  - Just pressing Enter w/o input gives an error
- You can use raw_input() at the end of your program to wait for the user to press Enter before the program finishes

Documentation

- Document your thinking at every step,
  even the ideas that didn't work!
  - Programmer's diary: log of everything
- External documentation: outside the program
  - User manual:
    - What user input is required
    - What the user should expect the program to output
    - No details about program internals
- Internal documentation: within the program
  - Descriptive variable/module names
  - Comments in the code
  - Online help for the user

Examples of internal documentation

- Good variable names: numHashes
  - Bad variable names: x, num, i
- Comments: # in Python (to end of line)
  - **# loop numHashes times**
  - **while (counter < numHashes):**
    - **print "#", # no newline**
    - **counter = counter + 1**
- Online help:
  - "Enter 'h' for online help."

Comments

- Explain the "why", not the "what":
  - Bad: x = x + 1 # increment x
  - Good: x = x + 1 # do next hashmark
- Keep comments up-to-date!
  - Incorrect comments are worse than no comments
- Comments are no substitute for external documentation
  - Still need a separate design doc, pseudocode, user manual, etc.

Docstrings

- Python convention is to create a docstring at the top of every module, function, class, etc.:
  - ” ” ” Print a bunch of hashes.

    Nellie Hacker, CMPT140
    ” ” ”
    numHashes = input(“How many hashes? ”)
    . . .
- Triple-quotes: this is a string, not a comment
- First line is a short summary
- Second line is blank, then detailed description
- Automated Python tools read docstrings to help you organize your code
  - More info: http://www.python.org/dev/peps/pep-0257/

Style conventions

- Not hard-and-fast rules, but flexible conventions that make code easier to read and understand
- Variable names: numHashes
  - Flexible, but I prefer no underscores, and capitalize each word ("CamelCase")
  - First letter is lowercase
- File/module names: helloworld.py
  - Short, all lowercase, no underscores
- Function names: print_hashes()
  - lowercase, command predicate, underscores
- More details: http://www.python.org/dev/peps/pep-0008/

Expressions

- An expression is a combination of
  - Literals, constants, and variables,
  - Using appropriate operations (by type)

    12 – 7

    numApples * 4
- A few operators we'll look at:
  - Binary: + - * / % // **
  - Comparison: == < > <= => != <> is
  - Boolean: and or not (shortcut)

Binary arithmetic operators

- + , –, *: addition, subtraction, multiplication
- **: power: 2**4 == 16
- /: division: 7.0 / 2 == 3.5
  - On two ints, returns an int (floor): 7 / 2 == 3
  - A note about float arithmetic: 7.2 / 2 ≠ 3.6
- //: floor division
  - Same as / for ints: 7 // 2 == 3
  - On floats, returns floor of quotient: 7.0 // 2 == 3.0
- %: modulo (remainder): 8 % 3 == 2
  - 8 % 0 => ZeroDivisionError

Comparison operators

- Test for quantitative equality: 2 + 3 == 5
- Test for inequality: 2 + 3 != 4
  - Can also use <>
- Comparison: <, >, <= , >=
- Test for identity: is, is not
  - (2, 3) == ((2, 3)), but
  - (2, 3) is not ((2, 3))

Boolean operators: shortcut

- Boolean operators: and or not
  - In C/C++/Java: && || !
- Python's boolean operators have shortcut semantics:
  - Second operand is only evaluated if necessary
    - (7 / 0) and False => ZeroDivisionError
    - False and (7 / 0) == False
      - Doesn't raise ZeroDivisionError
    - True or (7 / 0) == True
      - Same thing

Type conversions

- Python is dynamically typed, so operators can do implicit type conversions to their operands:
  - 2 (int) + 3.5 (float) == 5.5 (float)
    - Plus (+) operator converts 2 (int) to 2.0 (float)
- You can manually convert types:
  - int(2.7) == 2
  - int(True) == 1
  - Better alternative to input():
    - ageString = raw_input("Age? ")
    - age = int(ageString)

Precedence

- Of the operators we've learned, the precedence order from highest (evaluated first) to lowest (evaluated last) is
  - **
  - **Unary +, -**
  - *, /, %, //
  - **Binary +, -**
  - ==, !=, <>, <, >, <=, >=
  - **Is, is not**
  - **Not**
  - **And**
  - **or**
- Complete precedence rules at http://docs.python.org/ref/summary.html

Formatted output: print with %

- The built-in function print can accept a format string:
  - print “You have %d apples.” % 7
    - Output: “You have 7 apples.”
  - It can take multiple arguments:
    - print “%d apples and %d oranges.” % 7, 10
      - Output: “7 apples and 10 oranges.”
  - Format codes:
    - %d: integer
    - %f: float
    - %s: string

Formatting: %d, %f

- You can specify the field width:
  - print "%3d apples" % 5
    - Output: " 5 apples" (note two leading spaces)
  - print "%-3d apples" % 5
    - Output: "5 apples" (left-aligned: two trailing spaces)
  - print "%03d apples" % 5
    - Output: "005 apples" (padded with zeros)
  - print "%4.1f apples" % 5.273
    - Output: " 5.3 apples"
    - 4 is the total field width, including the decimal
    - 1 is the number of digits after the decimal

Review of today (§2.3-2.4)

- Steps to problem solving: WADES in more detail
- Documentation
  - External documentation: design, manuals
  - Internal documentation:
    - Comments
    - Docstrings
- Style guidelines

- (see bankinterest.py example)

TODO items

- Lab01 due Wed by midnight
  - myCourses electronic turn-in should be working
  - If it doesn't work, just email your lab to me as an attachment
- HW02 due Fri:
  - 2.14 # 7 (interpret it in Python), 11, 13