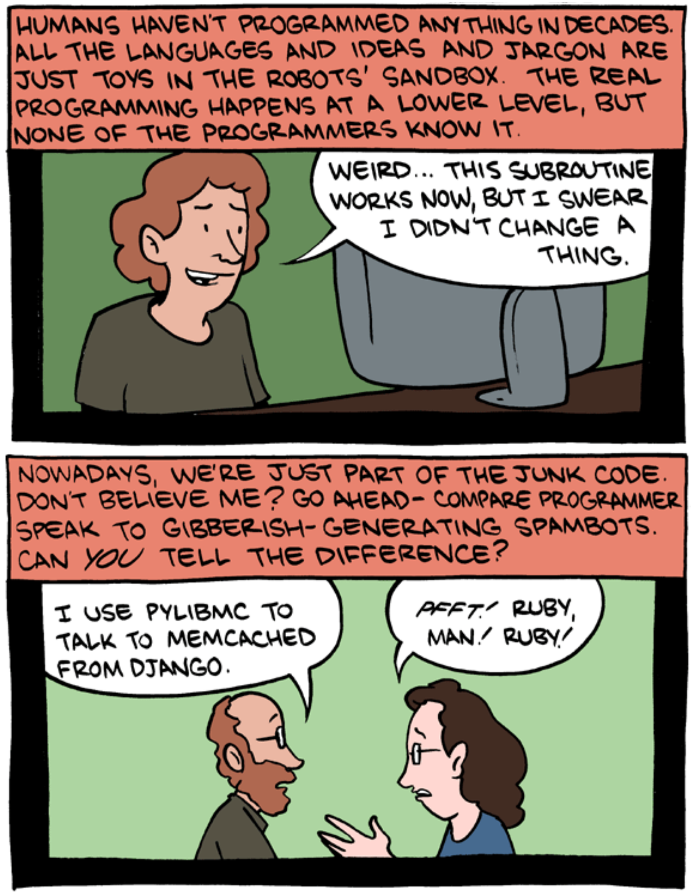
CSc 110, Autumn 2016

Lecture 22: Assertions

Adapted from slides by Marty Stepp and Stuart Reges


HUMANS HAVEN'T PROGRAMMED ANYTHING IN DECADES. ALL THE LANGUAGES AND IDEAS AND JARGON ARE JUST TOYS IN THE ROBOTS' SANDBOX. THE REAL PROGRAMMING HAPPENS AT A LOWER LEVEL, BUT NONE OF THE PROGRAMMERS KNOW IT.
WEIRD... THIS SUBROUTINE WORKS NOW, BUT I SWEAR I DIDN'T CHANGE A THING.
NOWADAYS, WE'RE JUST PART OF THE JUNK CODE. DON'T BELIEVE ME? GO AHEAD- COMPARE PROGRAMMER SPEAK TO GIBBERISH-GENERATING SPAMBOTS. CAN YOU TELL THE DIFFERENCE?
I USE PYLIBMC TO TALK TO MEMCACHED FROM DJANGO.
PFFT! RUBY, MAN! RUBY!

Punchline to a longer comic: http://www.smbc-comics.com/index.php?db=comics&id=2362#comic

Section attendance question

- Read a file of section attendance (*see next slide*):

```
yynyyynayayynyyyayanyyyaynayyayyanayyyanyayna
ayyanyyyyayanaayyanayyyananayayaynyayayynynya
yyayaynyyayyanynnyyyayyanayaynannnyyayyayayny
```

- And produce the following output:

```
Section 1
Student points: [20, 16, 17, 14, 11]
Student grades: [100.0, 80.0, 85.0, 70.0, 55.0]

Section 2
Student points: [16, 19, 14, 14, 8]
Student grades: [80.0, 95.0, 70.0, 70.0, 40.0]

Section 3
Student points: [16, 15, 16, 18, 14]
Student grades: [80.0, 75.0, 80.0, 90.0, 70.0]
```

  - Students earn 3 points for each section attended up to 20.

Section input file

```
student      123451234512345123451234512345123451234512345
week           1    2    3    4    5    6    7    8    9
section  1   yynyyynayayynyyyayanyyyaynayyayyanayyyanyayna
section  2   ayyanyyyyayanaayyanayyyananayayaynyayayynynya
section  3   yyayaynyyayyanynnyyyayyanayaynannnyyayyayayny
```

- Each line represents a section.
- A line consists of 9 weeks' worth of data.
  - Each week has 5 characters because there are 5 students.
- Within each week, each character represents one student.
  - `a` means the student was absent (+0 points)
  - `n` means they attended but didn't do the problems (+1 points)
  - `y` means they attended and did the problems (+3 points)

Logical assertions

- **assertion**: A statement that is either true or false.

  Examples:
  - Python was created in 1995.
  - The sky is purple.
  - 23 is a prime number.
  - 10 is greater than 20.
  - x divided by 2 equals 7. *(depends on the value of x)*

- An assertion might be false ("The sky is purple" above), but it is still an assertion because it is a true/false statement.

Reasoning about assertions

- Suppose you have the following code:

```
if (x >= 3):
    # Point A
    x -= 1
else:
    # Point B
    x += 1
    # Point C
# Point D
```

- What do you know about `x`'s value at the three points?
  - Is `x > 3`? Always? Sometimes? Never?

Assertions in code

- We can make assertions about our code and ask whether they are true at various points in the code.
  - Valid answers are ALWAYS, NEVER, or SOMETIMES.

```
number = input("Type a nonnegative number: ")
# Point A: is number < 0.0 here?               (SOMETIMES)

while (number < 0.0):                          (ALWAYS)
    # Point B: is number < 0.0 here?
    number = input("Negative; try again: ")

    # Point C: is number < 0.0 here?           (SOMETIMES)

# Point D: is number < 0.0 here?               (NEVER)
```

Reasoning about assertions

- Right after a variable is initialized, its value is known:

```
x = 3
# is x > 0?  ALWAYS
```

- In general you know nothing about parameters' values:

```
def mystery(a, b):
# is a == 10?  SOMETIMES
```

- But inside an `if`, `while`, etc., you may know something:

```
def mystery(a, b):
    if (a < 0):
        # is a == 10?  NEVER
        ...
```

Assertions and loops

- At the start of a loop's body, the loop's test must be `True`:

```
while (y < 10):
    # is y < 10?  ALWAYS
    ...
```

- After a loop, the loop's test must be `False`:

```
while (y < 10):
    ...

# is y < 10?  NEVER
```

- Inside a loop's body, the loop's test may become `False`:

```
while (y < 10):
    y += 1
    # is y < 10?  SOMETIMES
```

"Sometimes"

- Things that cause a variable's value to be unknown (often leads to "sometimes" answers):
  - reading from `input`
  - reading a number from a `random` object
  - a parameter's initial value to a function

- If you can reach a part of the program both with the answer being "yes" and the answer being "no", then the correct answer is "sometimes".
  - If you're unsure, "Sometimes" is a good guess.

Assertion example 1

```
def mystery(x, y):
    z = 0
    # Point A

    while (x >= y):
        # Point B
        x = x - y
        z += 1

        if (x != y):
            # Point C
            z = z * 2
        # Point D
    # Point E
    print(z)
```

Which of the following assertions are true at which point(s) in the code? Choose ALWAYS, NEVER, or SOMETIMES.

	x < y	x == y	z == 0
Point A	SOMETIMES	SOMETIMES	ALWAYS
Point B	NEVER	SOMETIMES	SOMETIMES
Point C	SOMETIMES	NEVER	NEVER
Point D	SOMETIMES	SOMETIMES	NEVER
Point E	ALWAYS	NEVER	SOMETIMES

Assertion example 2

```
def mystery():
    prev = 0
    count = 0
    next = input()
    # Point A

    while (next != 0):
        # Point B

        if (next == prev):
            # Point C
            count += 1

        prev = next
        next = input()
        # Point D
    # Point E
    return count
```

Which of the following assertions are true at which point(s) in the code? Choose ALWAYS, NEVER, or SOMETIMES.

	`next == 0`	`prev == 0`	`next == prev`
Point A	SOMETIMES	ALWAYS	SOMETIMES
Point B	NEVER	SOMETIMES	SOMETIMES
Point C	NEVER	NEVER	ALWAYS
Point D	SOMETIMES	NEVER	SOMETIMES
Point E	ALWAYS	SOMETIMES	SOMETIMES

Assertion example 3

```
# Assumes y >= 0, and returns x^y
def pow(x, y):
    prod = 1

    # Point A
    while (y > 0):
        # Point B
        if (y % 2 == 0):
            # Point C
            x = x * x
            y = y // 2
            # Point D
        else:
            # Point E
            prod = prod * x
            y -= 1
            # Point F
    # Point G
    return prod
```

Which of the following assertions are true at which point(s) in the code? Choose ALWAYS, NEVER, or SOMETIMES.

	`y > 0`	`y % 2 == 0`
Point A	SOMETIMES	SOMETIMES
Point B	ALWAYS	SOMETIMES
Point C	ALWAYS	ALWAYS
Point D	ALWAYS	SOMETIMES
Point E	ALWAYS	NEVER
Point F	SOMETIMES	ALWAYS
Point G	NEVER	ALWAYS