

Building Java Programs

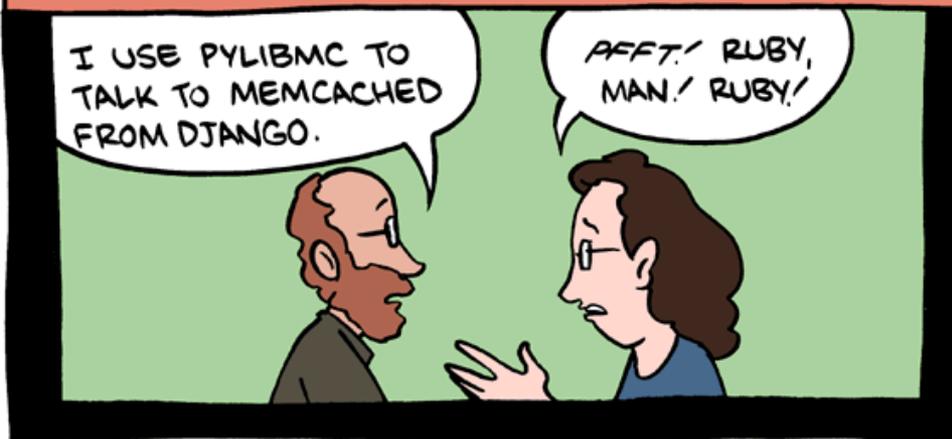
Chapter 5
Lecture 5-4: Assertions

reading: 5.5

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.



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?



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

Logical assertions

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

Examples:

- Java 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--;  
} else {  
    // Point B  
    x++;  
    // 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.

```
System.out.print("Type a nonnegative number: ");  
double number = console.nextDouble();  
// Point A: is number < 0.0 here? (SOMETIMES)
```

```
while (number < 0.0) {  
    // Point B: is number < 0.0 here? (ALWAYS)  
    System.out.print("Negative; try again: ");
```

```
    number = console.nextDouble();  
    // 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:

```
int x = 3;  
// is x > 0? ALWAYS
```

- In general you know nothing about parameters' values:

```
public static void mystery(int a, int b) {  
// is a == 10? SOMETIMES
```

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

```
public static void mystery(int a, int 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++;  
    // is y < 10?  SOMETIMES  
}
```

"Sometimes"

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

```
public static void mystery(int x, int y) {  
    int z = 0;
```

```
    // Point A
```

```
    while (x >= y) {  
        // Point B  
        x = x - y;  
        z++;
```

```
        if (x != y) {  
            // Point C  
            z = z * 2;  
        }
```

```
        // Point D
```

```
    }
```

```
    // Point E
```

```
    System.out.println(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

```
public static int mystery(Scanner console) {
    int prev = 0;
    int count = 0;
    int next = console.nextInt();

    // Point A
    while (next != 0) {
        // Point B
        if (next == prev) {
            // Point C
            count++;
        }
        prev = next;
        next = console.nextInt();

        // 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
public static int pow(int x, int y) {
    int 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--;
            // 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 |