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Building Java Programs

Chapter 5
Lecture 5-4: Assertions, do/while loops

reading: 5.4 - 5.5

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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.

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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?

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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)
```

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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  
        ...  
    }  
}
```

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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  
}
```

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"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.

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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

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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

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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

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while loop variations

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The do/while loop

- do/while loop:** Performs its test at the *end* of each repetition.
 - Guarantees that the loop's {} body will run at least once.

```
do {
    statement(s);
} while (test);
```

```
// Example: prompt until correct password is typed
String phrase;
do {
    System.out.print("Type your password: ");
    phrase = console.next();
} while (!phrase.equals("abracadabra"));
```

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do/while question

- Modify the previous Dice program to use do/while.

```
2 + 4 = 6
3 + 5 = 8
5 + 6 = 11
1 + 1 = 2
4 + 3 = 7
You won after 5 tries!
```

- Is do/while a good fit for our past Sentinel program?

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do/while answer

```
// Rolls two dice until a sum of 7 is reached.
import java.util.*;

public class Dice {
    public static void main(String[] args) {
        Random rand = new Random();
        int tries = 0;
        int sum;

        do {
            int roll1 = rand.nextInt(6) + 1; // one roll
            int roll2 = rand.nextInt(6) + 1;
            sum = roll1 + roll2;
            System.out.println(roll1 + " + " + roll2 + " = " + sum);
            tries++;
        } while (sum != 7);

        System.out.println("You won after " + tries + " tries!");
    }
}
```

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break

- **break statement:** Immediately exits a loop.
- Can be used to write a loop whose test is in the middle.
- The loop's test is often changed to true ("always repeat").

```
while (true) {
    statement(s);
    if (test) {
        break;
    }
    statement(s);
}
```

- break is considered to be bad style by some programmers.

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Sentinel loop with break

```
Scanner console = new Scanner(System.in);
int sum = 0;
while (true) {
    System.out.print("Enter a number (-1 to quit): ");
    int number = console.nextInt();
    if (number == -1) { // don't add -1 to sum
        break;
    }
    sum = sum + number; // number != -1 here
}
System.out.println("The total was " + sum);
```

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