Building Java Programs

Chapter 5
Lecture 5-4: `do/while` loops, assertions

reading: 5.1, 5.5
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.

```java
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"));
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!
// 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!");
    }
}
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").

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

- **Break** is considered to be bad style by some programmers.
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);
Assertions

reading: 5.5
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.
- The capital of North Dakota is Bismarck.
- $x$ 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:

```java
if (x > 3) {
    // Point A
    x--; // Point A
} else {
    // Point B
    x++; // 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.

```java
System.out.print("Type a nonnegative number: ");
double number = console.nextDouble();

// Point A: is number < 0.0 here?  (SOMETIMES)
while (number < 0.0) {
    System.out.print("Negative; try again: ");
    number = console.nextDouble();
    // Point B: is number < 0.0 here?  (ALWAYS)
}

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

- In general you know nothing about parameters' values:
  ```java
  public static void mystery(int a, int b) {
    // is a == 10?  SOMETIMES
  }
  ```

- But inside an if, while, etc., you may know something:
  ```java
  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`:
  ```java
  while (y < 10) {
    // is y < 10? ALWAYS
    ...
  }
  ```

- After a loop, the loop's test must be `false`:
  ```java
  while (y < 10) {
    ...
  }
  // is y < 10? NEVER
  ```

- Inside a loop's body, the loop's test may become `false`:
  ```java
  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".
Assertion example 1

```java
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.

<table>
<thead>
<tr>
<th></th>
<th>x &lt; y</th>
<th>x == y</th>
<th>z == 0</th>
</tr>
</thead>
<tbody>
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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.

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</tr>
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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.

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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;
}
// 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.

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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.

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