CIS 110: Introduction to Computer Programming

Lecture 13

Indefinite Loops

(§ 5.1-5.2)

Outline

- Indefinite loops with while
- Fencepost and sentinel loops

Indefinite Loops

Indefinite Loop Bounds

- So far we've known the bounds of our loops *before we've executed the loop themselves.*
  - e.g., `for (int i = 0; i < 10; i++) { /* ... */ }`
- Many loops don't offer that luxury...

```
// while the user hasn't input "yes" yet
//     Ask the user for input
```

Problem: firstDivisor

- Problem: write a method `firstDivisor(x, y)` that returns the first number that divides x starting at y and going up.
  - Example: `firstDivisor(26, 10) = 13`
  - Indefinite behavior: the amount of numbers we'll check depends on x and y.

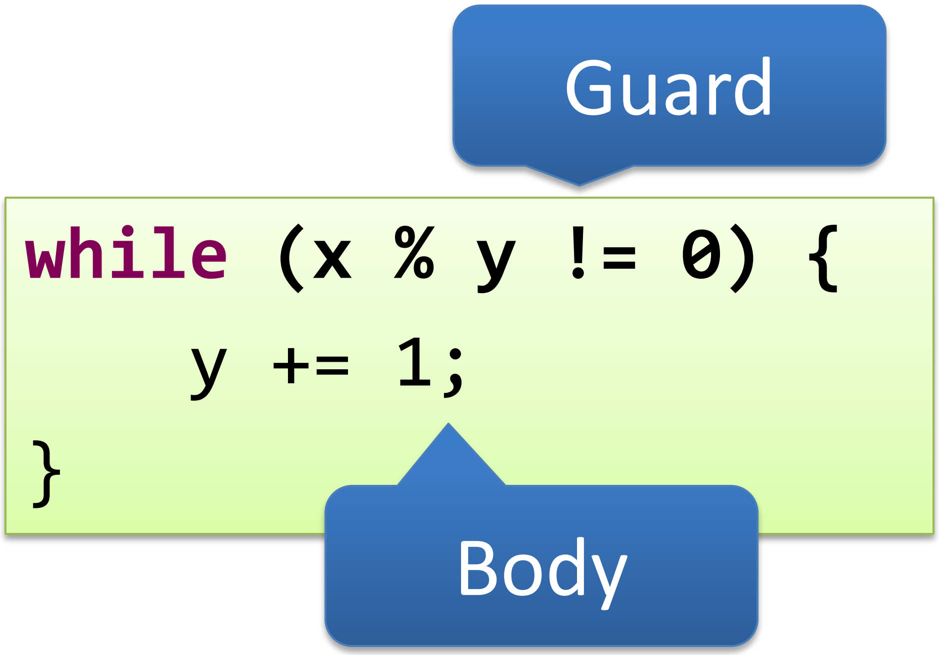
firstDivisor Solution

```java
public static int firstDivisor(int x, int y) {
  while (x % y != 0) {
    y += 1;
  }
  return y;
}

public static void main(String[] args) {
  // Output: 13
  System.out.println(firstDivisor(26, 10));
}
```

While loops

- "While the guard is true, execute the body".
  - Like an if-statement, but looping!



```
while (x % y != 0) {
    y += 1;
}
```

While Loops vs. For Loops

```java
for (int i = 0; i < 10; i++) {
  System.out.println(i);
}
```

```java
int i = 0;
while (i < 10) {
  System.out.println(i);
  i++;
}
```

- Can express the same kinds of loops.
- Some benefit to **`for`** over **`while`** (i.e., scoping).
- **`for`** is meant for *definite loops*: "loop *x* times".
- **`while`** is meant for *indefinite* loops: "loop until some condition is met".

The Random Object

```
Random rand = new Random();
double value = 0;
while(value <= 0.5) {
  System.out.printf("%.2f is less than or equal to 5.\n", value);
  // nextDouble returns a double between 0.0 and 1.0
  value = rand.nextDouble();
}
System.out.printf("%.2f is greater than 5!\n", value);
```

- Random objects to generate (pseudo)-random numbers
  - "Pseudo"-random because they are still the result of mathematical formula

Method calls of the Random object

```
Random rand = new Random();
// Prints a random integer betweem -2^31 to (2^31)-1
System.out.println(rand.nextInt());

// Prints a random integer between 0 and 9
System.out.println(rand.nextInt(10));

// Prints out a random double starting at 0.0 up to
// (but not including) 1.0
System.out.println(rand.nextDouble());

// Prints either true or false randomly
System.out.println(rand.nextBoolean());
```

Simulations and Games

- Application of indefinite loops.
  - Repeatedly executes until some condition is met.
  - E.g., simulating a *random walk*.

```
Random rand = new Random();
int position = 1;
while (position > 0) {
  System.out.println("I am currently at " + position);
  if (rand.nextBoolean()) {
    position += 1;
  } else {
    position -= 1;
  }
}
System.out.println("I am back home!");
```

Fencepost and Sentinel Loops

The fencepost problem

- Problem: write a method `fencepost(n)` that takes an integer and draws a fencepost of length n.
  - e.g., `fencepost(5)` prints `|=|=|=|=|`

Fencepost solution?

```
public static void fencepost(int n) {
  for (int i = 0; i < n; i++) {
    System.out.print("|=");
  }
  System.out.println();
}
```

- Not good enough!
  - Prints out an extra wire, e.g., |=|=|=|=|=

Hoisting is the solution!

```java
public static void fencepost(int n) {
  System.out.print("|");
  for (int i = 1; i < n; i++) {
    System.out.print("=|");
  }
  System.out.println();
}
```

- We *hoisted* part of the first iteration of the loop (i.e., the first post) and flipped the body.
  - Now the pattern works!
- *Loop-and-a-half* is a common pattern!

Sentinels

- *Sentinels* are values that designate when a loop should end.
- Problem: write a loop that sums up positive integers from the user until they enter -1 to end the process.
  - -1 is the *sentinel value* in this loop.

```
// while the user's input isn't -1
//    get an input from the user and add it to our running sum.
```

Sentinel solution?

```
Scanner in = new Scanner(System.in);
int sum = 0;
int input = 0;  // Prime loop so we enter it initially.
while (input != -1) {
  System.out.print("num? ");
  input = in.nextInt();
  sum += input;
}
System.out.println("sum = " + sum);
```

- Not good enough!
  - Prints out one less than the sum? Why?

Solution: hoist out some input!

```
Scanner in = new Scanner(System.in);
int sum = 0;
// Hoist out half of the loop!
System.out.print("num? ");
int input = in.nextInt();
while (input != -1) {
  sum += input;
  System.out.print("num? ");
  input = in.nextInt();
}
System.out.println("sum = " + sum);
```

- Now it works!
  - We hoisted out one prompt out of the loop and changed the order of summation and prompting.