Unit 4: Iteration For Loops

Adapted from:

- 1) Building Java Programs: A Back to Basics Approach
- by Stuart Reges and Marty Stepp
- 2) Runestone CSAwesome Curriculum

Categories of loops

indefinite loop: One where the number of times its body repeats is not known in advance.

- Prompt the user until they type a non-negative number.
- Print random numbers until a prime number is printed.
- Repeat until the user has types "q" to quit.

The **while loop** is usually used for indefinite loops.

Categories of loops

definite loop: Executes a known number of times.

- Print "hello" 10 times.
- Find all the prime numbers up to an integer n.
- Print each odd number between 5 and 127.

In this lecture, we will see that a for loop is often used to implement a definite loop.

Repetition with for loops

• So far, repeating a statement is redundant:

```
System.out.println("Homer says:");
System.out.println("I am so smart");
System.out.println("S-M-R-T... I mean S-M-A-R-T");
```

• Java's for loop statement performs a task many times.

for loop syntax

```
for (initialization; test; update) {
    statement;
    statement;
    ...
    statement;
}
```

- Perform **initialization** once.
- Repeat the following:
 - Check if the **test** is true. If not, stop.
 - Execute the statements.
 - Perform the update.

Initialization

```
for (int i = 1; i <= 6; i++) {
    System.out.println("I am so smart");
}</pre>
```

- Tells Java what variable to use in the loop
 - Performed once as the loop begins
 - The variable is called a *loop counter*
 - can use any name, not just i
 - can start at any value, not just 1

Test

```
for (int i = 1; i <= 6; i++) {
     System.out.println("I am so smart");
}</pre>
```

- Tests the loop counter variable against a limit
 - Uses comparison operators:
 - < less than
 - <= less than or equal to</pre>
 - > greater than
 - >= greater than or equal to

Repetition over a range

Use a for loop to print:

```
System.out.println("1 squared = " + 1 * 1);
System.out.println("2 squared = " + 2 * 2);
System.out.println("3 squared = " + 3 * 3);
System.out.println("4 squared = " + 4 * 4);
System.out.println("5 squared = " + 5 * 5);
System.out.println("6 squared = " + 6 * 6);
```

- Intuition: "I want to print a line for each number from 1 to 6"

Answer

```
for (int i = 1; i <= 6; i++) {
    System.out.println(i + " squared = " + i * i);
}
System.out.println("Whoo!");</pre>
```

Output:

```
1 squared = 1
2 squared = 4
3 squared = 9
4 squared = 16
5 squared = 25
6 squared = 36
Whoo!
```

Example

Write a for loop to print: 5 9 13 17 21 25

Answer:

Counting down

- The update can use -- to make the loop count down.
 - The **test** must say > instead of <</p>

```
System.out.print("T-minus ");
for (int i = 10; i >= 1; i--) {
         System.out.print(i + ", ");
}
System.out.println("blastoff!");
System.out.println("The end.");
```

– Output:

```
T-minus 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, blastoff! The end.
```

For Loop in Movies

```
Groundhog Day (1993); Bill Murray.
Looper (2010); Bruce Willis and Joseph
 Gordon-Levitt, Emily Blunt.
Edge of Tomorrow (2014); Tom Cruise,
 Emily Blunt.
Happy Death Day (2017).
TV-Shows:
Russian Doll (Netflix, Emmy-nominated)
```

isPrime

```
public static boolean isPrime(int n) {
    int factors = 0;
    for (int i = 1; i <= n; i++) {
        if (n % i == 0) {
            factors++;
    if (factors == 2) {
        return true;
    } else {
        return false;
```

• Calls to methods returning boolean can be used as tests:

```
if (isPrime(57)) {
    ...
}
```

isPrime method

The condition below is verbose. Can we simplify it? Replace it with one statement!

```
public static boolean isPrime(int n) {
    int factors = 0;
    for (int i = 1; i <= n; i++) {
        if (n % i == 0) {
            factors++;
    if(factors == 2)
          return true;
    else
         return false;
```

Improved isPrime method

The following version utilizes Boolean Zen:

```
public static boolean isPrime(int n) {
   int factors = 0;
   for (int i = 1; i <= n; i++) {
      if (n % i == 0) {
        factors++;
      }
   }
   return factors == 2; // if n has 2 factors, true
}</pre>
```

For vs While

Write a loop to compute the sum:

```
1 + 2 + 3 + ... + 99 + 100
```

```
int sum = 0;
int number = 1;
while(number <= 100) {</pre>
    sum += number;
    number++;
int sum = 0;
for (int i = 1; i \le 100; i++) {
    sum += i;
```

Both for and while loops can be used to solve this problem.

For vs. While

Although for and while loop can generally be interchangeable. It is best practice to use a for loop as a definite loop where the beginning and termination of the loop is well defined.

```
for(int i = 1; i <= 100; i++) {
         System.out.println(i);
}</pre>
```

This for loop executes 100 times. It is a definite loop. It is usually better to use a for loop as a definite loop.

For vs. While

If the termination condition of a loop is less well defined, use a while loop. For example, suppose you require a positive integer input from the user. The following will loop until a positive number is entered.

This while loop executes an unknown number of times since you don't know when the user will enter a positive number. It is a indefinite loop. It is better to use a while loop here.

String Algorithms: For Loops

Loops allow us to do String traversals. Suppose we want to know the number of spaces in a String.

String Algorithms: For Loops

Assume that a given String is a sequence of words separated by spaces, return the number of words. Use countSpaces.

```
public static int numOfWords(String str) {
    return countSpaces(str) + 1;
}
```

String Algorithms: While Loops

Given a string, return the string with all of its spaces removed. For loop or while loop?

One way to do this is to use a while loop with indexOf.

```
public static String removeSpaces(String str) {
    while(str.indexOf(" ") != -1) {
        int indexSpace = str.indexOf(" ");
        String first = str.substring(0, indexSpace);
        String second = str.substring(indexSpace + 1);
        str = first + second; // first space removed
    }
    return str;
}
```

Palindrome

Given a string, return whether the string is a palindrome(reads the same forward as backwards).

Can we make the code slightly more efficient?

Improved Palindrome

We can go just to the middle of the String.

Lab 1

On replit classroom, please do For Loops: 19 - 33 (some of the numbers are skipped, total of 11 problems)

Lab 2

Write a static method named printTwoDigit that accepts an integer n as a parameter and that prints a series of n randomly generated numbers. The method should use Math.random() to select numbers in the range of 10 to 19 inclusive where each number is equally likely to be chosen.

After displaying each number that was produced, the method should indicate whether the number 13 was ever selected ("we saw a 13!") or not ("no 13 was seen."). You may assume that the value of *n* passed is at least 0.

You should an output similar to below. (see next slide)

Lab 2

Call	<pre>printTwoDigit(4);</pre>	<pre>printTwoDigit(7);</pre>
Output	<pre>next = 12 next = 10 next = 16 next = 11 no 13 was seen.</pre>	<pre>next = 12 next = 19 next = 12 next = 13 next = 11 next = 16 next = 13 we saw a 13!</pre>
		_

References

- Building Java Programs: A Back to Basics Approach by Stuart Reges and Marty Stepp
- 2) Runestone CSAwesome Curriculum:

https://runestone.academy/runestone/books/published/csawesome/index.html

For more tutorials/lecture notes in Java, Python, game programming, artificial intelligence with neural networks:

https://longbaonguyen.github.io