

# Building Java Programs

Chapter 5  
Lecture 11: `while` Loops,  
Fencepost Loops, and Sentinel Loops

**reading: 5.1 – 5.2**

(Slides adapted from Stuart Reges, H el ene Martin, and  
Marty Stepp)

```
while (mahself.stillAwake())  
{  
    sheep++;  
}
```



# Methods using `charAt`

- Write a method `printConsonants` that accepts a `String` as a parameter and prints out that `String` with all vowels removed

For example, the call:

```
printConsonants("atmosphere")
```

should print:

```
tmsphr
```

# A deceptive problem...

- Write a method `printLetters` that prints each letter from a word separated by commas.

For example, the call:

```
printLetters("Atmosphere")
```

should print:

```
A, t, m, o, s, p, h, e, r, e
```

# Flawed solutions

- ```
public static void printLetters(String word) {  
    for(int i = 0; i < word.length(); i++) {  
        System.out.print(word.charAt(i) + ", ");  
    }  
    System.out.println();    // end line  
}
```

- Output: A, t, m, o, s, p, h, e, r, e,

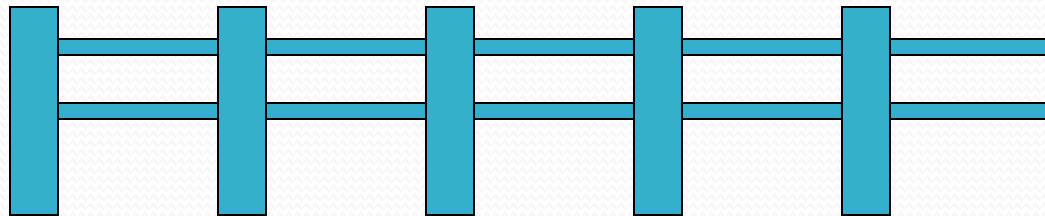
- ```
public static void printLetters(String word) {  
    for(int i = 0; i < word.length(); i++) {  
        System.out.print(", " + word.charAt(i));  
    }  
    System.out.println();    // end line  
}
```

- Output: , A, t, m, o, s, p, h, e, r, e

# Fence post analogy

- We print  $n$  letters but need only  $n - 1$  commas.
- Similar to building a fence with wires separated by posts:
  - If we use a flawed algorithm that repeatedly places a post + wire, the last post will have an extra dangling wire.

*for (length of fence) {  
    place a post.  
    place some wire.  
}*



# Fencepost loop

- Add a statement outside the loop to place the initial "post."
  - Also called a *fencepost loop* or a "loop-and-a-half" solution.

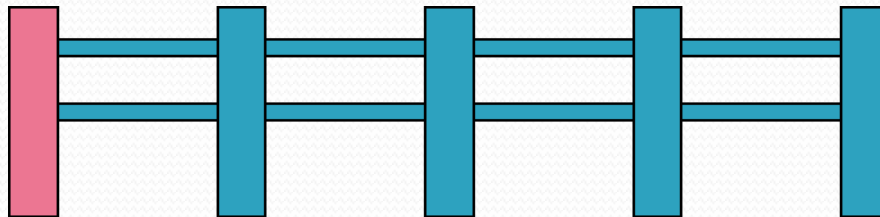
***place a post.***

*for (length of fence - **1**) {*

***place some wire.***

***place a post.***

*}*



# Fencepost method solution

- ```
public static void printLetters(String word) {  
    System.out.print(word.charAt(0));  
    for(int i = 1; i < word.length(); i++) {  
        System.out.print(", " + word.charAt(i));  
    }  
    System.out.println();    // end line  
}
```

- Alternate solution: Either first or last "post" can be taken out:

```
public static void printLetters(String word) {  
    for(int i = 0; i < word.length() - 1; i++) {  
        System.out.print(word.charAt(i) + ", ");  
    }  
    int last = word.length() - 1;  
    System.out.println(word.charAt(last)); // end line  
}
```



# Fencepost question

- Write a method `printPrimes` that prints all *prime* numbers up to a max.
  - Example: `printPrimes(50)` prints  
`2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47`
  - If the maximum is less than 2, print no output.
- To help you, write a method `countFactors` which returns the number of factors of a given integer.
  - `countFactors(20)` returns 6 due to factors 1, 2, 4, 5, 10, 20.

# Fencepost answer

```
// Prints all prime numbers up to the given max.
```

```
public static void printPrimes(int max) {  
    if (max >= 2) {  
        System.out.print("2");  
        for (int i = 3; i <= max; i++) {  
            if (countFactors(i) == 2) {  
                System.out.print(", " + i);  
            }  
        }  
        System.out.println();  
    }  
}
```

```
// Returns how many factors the given number has.
```

```
public static int countFactors(int number) {  
    int count = 0;  
    for (int i = 1; i <= number; i++) {  
        if (number % i == 0) {  
            count++; // i is a factor of number  
        }  
    }  
    return count;  
}
```

# while loops

**reading: 5.1**

# Categories of loops

- **definite loop:** Executes a known number of times.
  - The `for` loops we have seen are definite loops.
    - Print "hello" 10 times.
    - Find all the prime numbers up to an integer  $n$ .
    - Print each odd number between 5 and 127.
- **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 typed "q" to quit.

# The while loop

- **while loop:** Repeatedly executes its body as long as a logical test is true.

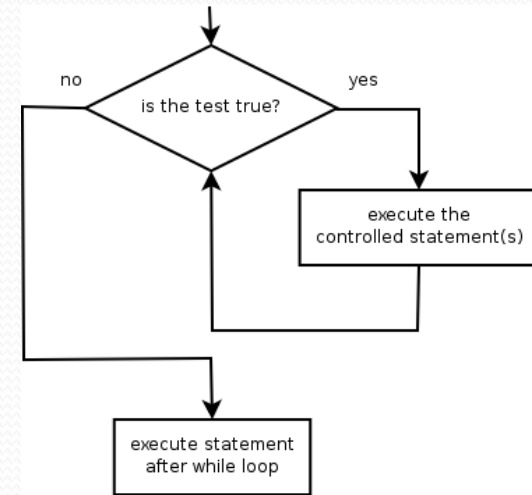
```
while (test) {  
    statement(s);  
}
```

- Example:

```
int num = 1;  
while (num <= 200) {  
    System.out.print(num + " ");  
    num = num * 2;  
}
```

```
// output: 1 2 4 8 16 32 64 128
```

```
// initialization  
// test  
  
// update
```



# Example while loop

```
// finds the first factor of 91, other than 1
int n = 91;
int factor = 2;
while (n % factor != 0) {
    factor++;
}
System.out.println("First factor is " + factor);
// output: First factor is 7
```

- `while` is better than `for` because we don't know how many times we will need to increment to find the factor.

# Sentinel values

- **sentinel**: A value that signals the end of user input.
  - **sentinel loop**: Repeats until a sentinel value is seen.
- Example: Write a program that prompts the user for text until the user types "quit", then output the total number of characters typed.
  - (In this case, "quit" is the sentinel value.)

```
Type a word (or "quit" to exit): hello  
Type a word (or "quit" to exit): yay  
Type a word (or "quit" to exit): quit  
You typed a total of 8 characters.
```

# Solution?

```
Scanner console = new Scanner(System.in);
int sum = 0;
String response = "dummy"; // "dummy" value, anything but "quit"

while (!response.equals("quit")) {
    System.out.print("Type a word (or \"quit\" to exit): ");
    response = console.next();
    sum += response.length();
}

System.out.println("You typed a total of " + sum + " characters.");
```

- This solution produces the wrong output. Why?  
You typed a total of 12 characters.



# The problem with our code

- Our code uses a pattern like this:

```
sum = 0.  
while (input is not the sentinel) {  
    prompt for input; read input.  
    add input length to the sum.  
}
```

- On the last pass, the sentinel's length (4) is added to the sum:

```
prompt for input; read input ("quit").  
add input length (4) to the sum.
```

- This is a fencepost problem.
  - Must read  $N$  lines, but only sum the lengths of the first  $N-1$ .

# A fencepost solution

```
sum = 0.  
prompt for input; read input.           // place a "post"  
  
while (input is not the sentinel) {  
    add input length to the sum.         // place a "wire"  
    prompt for input; read input.       // place a "post"  
}
```

- Sentinel loops often utilize a fencepost "loop-and-a-half" style solution by pulling some code out of the loop.

# Correct code

```
Scanner console = new Scanner(System.in);
int sum = 0;

// pull one prompt/read ("post") out of the loop
System.out.print("Type a word (or \"quit\" to exit): ");
String response = console.next();

while (!response.equals("quit")) {
    sum += response.length();    // moved to top of loop
    System.out.print("Type a word (or \"quit\" to exit): ");
    response = console.next();
}

System.out.println("You typed a total of " + sum + " characters.");
```

# Sentinel as a constant

```
public static final String SENTINEL = "quit";  
...
```

```
Scanner console = new Scanner(System.in);  
int sum = 0;
```

```
// pull one prompt/read ("post") out of the loop
```

```
System.out.print("Type a word (or \" + SENTINEL + "\" to exit): ");  
String response = console.next();
```

```
while (!response.equals(SENTINEL)) {  
    sum += response.length();    // moved to top of loop  
    System.out.print("Type a word (or \" + SENTINEL + "\" to exit): ");  
    response = console.next();  
}
```

```
System.out.println("You typed a total of " + sum + " characters.");
```