Arrays
(Savitch, Chapter 7.1-7.2)

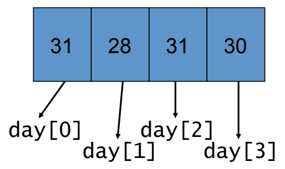
TOPICS

• Array Basics
• Array Loops
• Array Programming

Arrays

- An array is a set of variables *of the same type* accessed by their index

```
int[] day = new int[4];
```



Arrays (cont'd)

- The previous example creates 4 integers.
  - They are just accessed by their position
    - day[0], day[1], day[2], day[3]
  - Each integer has its own value
  - What happens with day[-1], day[4], day[1000]?
- Arrays can be of any type
  - int, double, char, boolean, String, class
  - Every element of an array has the same type

Arrays (cont'd)

- Arrays are declared using square brackets:
  - type [] name; *or*
  - type name[];
- using the new keyword
  - type[] name = new type[size];
  - The new command allocates a block of memory
- The length field (instance variable) of an array tells you how many elements it has
  - day.length == 4.

Loops + arrays: challenge problem

- Task: read words from input until the word ‘quit’ appears. Then print out how many times each lowercase letter appeared.
- Question: where do you start? How do you approach this problem?

Step 1: Decomposition

- What has to be done?
- Initialize counters! – another loop
  - Read strings from terminal
  - For each string,
    - For each character,
      - Increment counter for that character

    } Nested loops
  - Print out counts per character } Another loop

Steps 2-4:

- Tackle each step individually
  - Initialize counters
    - Declare the counters first
    - But there are 26 of them…
    - … so use an array!

```
int[] alphaCounters = new int[26];
```

Step 2 (continued)

- Still initializing counters…
  - The counters count how often each letter appears
  - So we need to initialize all 26 of them to zero!
  - So we use a for loop with 26 iterations

```
for(int i=0; i < 26; i++) {
   alphaCounters[i] = 0;
}
```

Step 2 (yet again)

- So putting it together, we need to declare and initialize a counter for every letter in the alphabet:

```
int[] alphaCounters = new int[26];
for(int i=0; i < 26; i++) {
   alphaCounters[i] = 0;
}
```

Step 2 (one more time!)

- Actually, hard-coding '26' is a bad idea
  - What if we want to include capitals later?
  - What if we want to re-use this code?
- We want to initialize the array, and nothing more:

```
int[] alphaCounters = new int[26];
for (int i=0;
     i < alphaCounters.length;
     i++) {
   alphaCounters[i] = 0;
}
```

Does it work?

- Did we declare and initialize the counters correctly?
  - Never assume something is correct
  - Test each step before moving on
- How?
  - Method #1: Use the debugger
    - Run the code (so far) step-by-step
    - Check that the array has 26 elements
    - Check that each is set to zero
  - Method #2: Write the code to print counters
    - Test it before you start counting letters

Printing the Counters

- So printing the counters is another loop:
  - Why the trailing println()?

```
for(int i=0; i < 26; i++) {
   System.out.print(alphaCounters[i]+”,”);
}
System.out.println();
```

Your First Test Code

- What should this print?

```
// Declare & Initialize Counters
int[] alphaCounters = new int[26];
for(int i=0; i < 26; i++) {
   alphaCounters[i] = 0;
}

// Print Counters
for(int i=0; i < 26; i++) {
   System.out.print(alphaCounters[i]+”,”);
}
System.out.println();
```

Running Your First Test

```
public static void main(String[] args) {
  // Declare and initialize counters
  int[] alphaCounters = new int[26];
  for(int i=0; i < 26; i++) {
     alphaCounters[i] = 0;
  }
  // Print Counters
  for(int i=0; i < 26; i++) {
     System.out.print(alphaCounters[i]+”,”);
  }
  System.out.println();
}
```

Reading Strings & Counting Letters

- The next step has two parts:
  - Read strings (until “quit”)
  - Increment letter counters
- Decompose the (sub)problem
  - Either read strings…
    - Assuming you can count letters once you have them
  - Or count letter instances
    - Given a string (assume you can get strings somehow)

Don’t try to do two things at once!

One approach…

- We’ve already written a loop to read until “quit”
  - Remember the Echo program?
- So let us start with that:

```
Scanner in = new Scanner(System.in);
while (true) {
   String s = in.next();
   if (s.equals(“quit”)) break;
   System.out.println(s);  // Replace with counting
}
```

Wait! Stop! Test this First!

- How?
  - Use a print statement to make sure you are getting the right strings, or…
  - Use the debugger!

Counting Letters

- Given a string, we need to increment a counter for every letter.
  - Nested loop inside the get string loop

```
for(int i=0; i < s.length(); i++)
{
   char letter = s.charAt(i);
   OK, increment letter count here…
}
```

Counting Letters (II)

- Now increment the appropriate counter

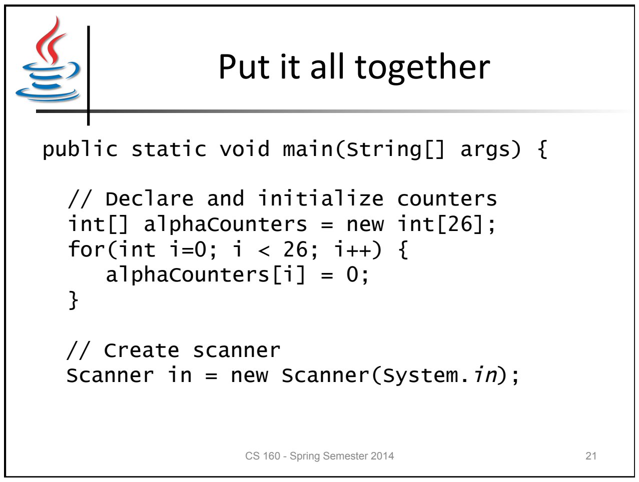
```
for(int i=0; i < s.length(); i++)
{
   char letter = s.charAt(i);
   switch(letter) {
   case 'a': alphaCounters[0]++; break;
   case 'b': alphaCounters[1]++; break;
   case 'c': alphaCounters[2]++; break;
   // 23 more cases…
}
```

Counting Letters (alt)

- The previous code is clean but long.
- Java supports ASCII char subtraction

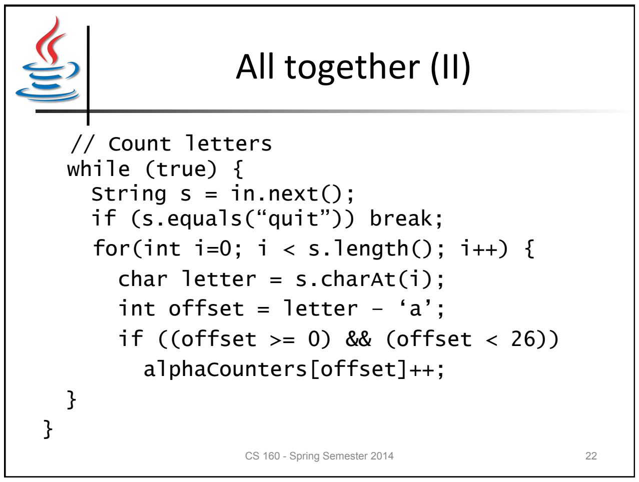
```
char first_char = 'a';
char second_char = 'b';
int offset = second_char - first_char; // 1
```

```
for(int i=0; i < s.length(); i++)
{
   char letter = s.charAt(i);
   int offset = letter - 'a';
   if ((offset >= 0) && (offset < 26)) {
      alphaCounters[offset]++;
   }
}
```



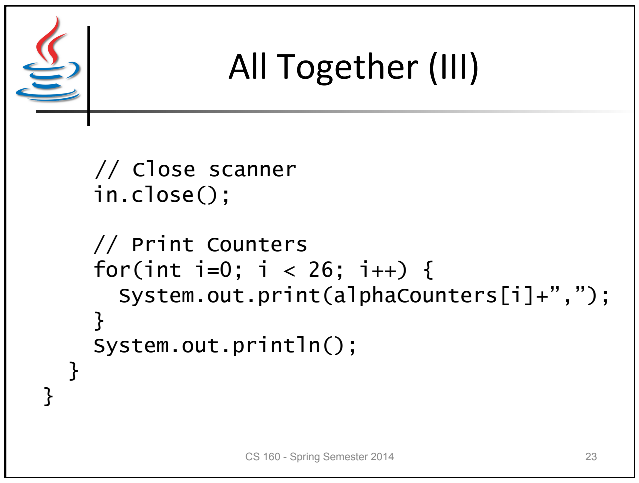
Put it all together

```
public static void main(String[] args) {

  // Declare and initialize counters
  int[] alphaCounters = new int[26];
  for(int i=0; i < 26; i++) {
     alphaCounters[i] = 0;
  }

  // Create scanner
  Scanner in = new Scanner(System.in);
```



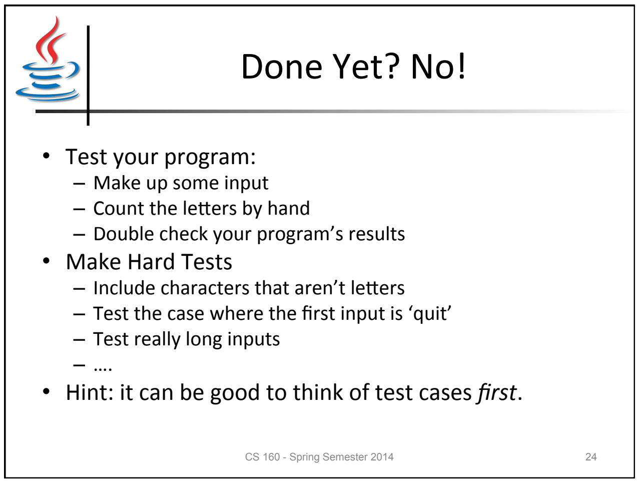
All together (II)

```
  // Count letters
  while (true) {
    String s = in.next();
    if (s.equals("quit")) break;
    for(int i=0; i < s.length(); i++) {
      char letter = s.charAt(i);
      int offset = letter - 'a';
      if ((offset >= 0) && (offset < 26))
        alphaCounters[offset]++;
  }
}
```



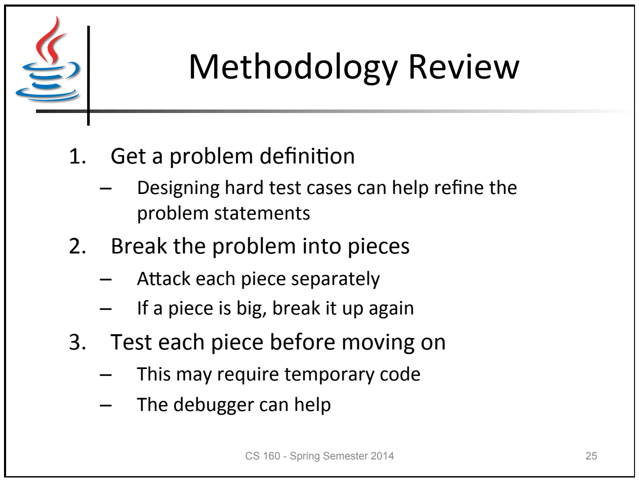
All Together (III)

```
    // Close scanner
    in.close();

    // Print Counters
    for(int i=0; i < 26; i++) {
      System.out.print(alphaCounters[i]+",");
    }
    System.out.println();
  }
}
```



Done Yet? No!

- Test your program:
  - Make up some input
  - Count the letters by hand
  - Double check your program's results
- Make Hard Tests
  - Include characters that aren't letters
  - Test the case where the first input is 'quit'
  - Test really long inputs
  - ….
- Hint: it can be good to think of test cases *first*.



Methodology Review

1. Get a problem definition
   - Designing hard test cases can help refine the problem statements
2. Break the problem into pieces
   - Attack each piece separately
   - If a piece is big, break it up again
3. Test each piece before moving on
   - This may require temporary code
   - The debugger can help