Building Java Programs

Chapter 7

Lecture 7-2: Tallying and Traversing Arrays

reading: 7.1

self-checks: #1-9

videos: Ch. 7 #4

A multi-counter problem

- Problem: Examine a large integer and count the number of occurrences of every digit from 0 through 9.
  - Example: The number 229231007 contains:

    two 0s, one 1, three 2s, one 7, and one 9.

- We could declare 10 counter variables for this...

```
int counter0, counter1, counter2, counter3, counter4,
    counter5, counter6, counter7, counter8, counter9;
```

  - Yuck!

A multi-counter problem

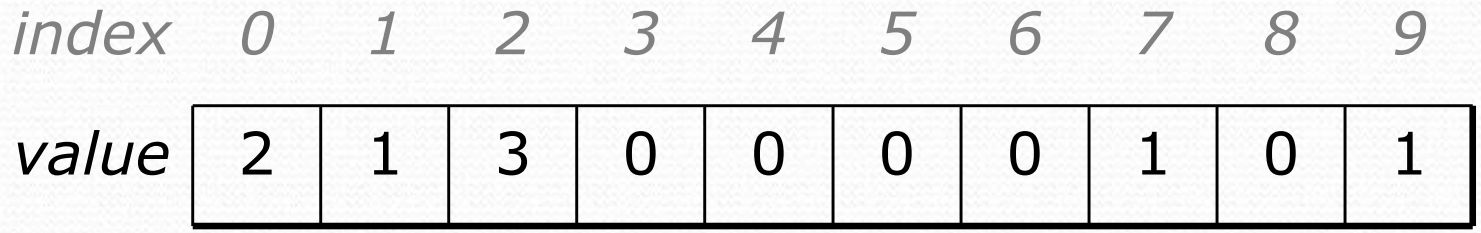
- A better solution is to use an array of size 10.
  - The element at index *i* will store the counter for digit value *i*.
  - for integer value 229231007, our array should store:

index	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
value	2	1	3	0	0	0	0	1	0	1

- The index at which a value is stored has meaning.
  - Sometimes it doesn't matter.
  - What about the weather case?

Creating an array of tallies

```
int num = 229231007;
int[] counts = new int[10];
while (num > 0) {
    // pluck off a digit and add to proper counter
    int digit = num % 10;
    counts[digit]++;
    num = num / 10;
}
```



Array histogram question

- Given a file of integer exam scores, such as:

```
82
66
79
63
83
```

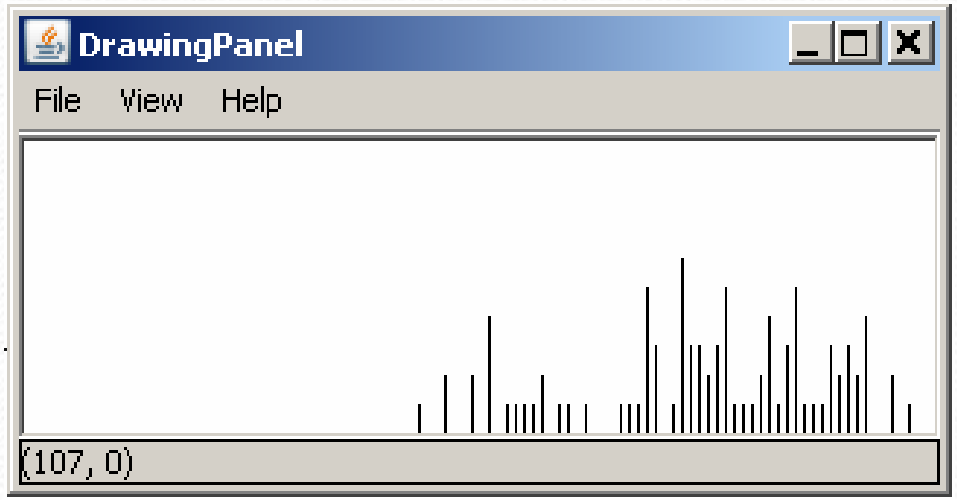
Write a program that will print a histogram of stars indicating the number of students who earned each unique exam score.

```
85: *****
86: ***********
87: ***
88: *
91: ****
```

Histogram variations

- Curve the scores; add a fixed number to each score.
  (But don't allow a curved score to exceed the max of 101.)

- Chart the data with a `DrawingPanel`.
  - window is 100px tall
  - 2px between each bar
  - 10px tall bar for each student who earned that score



Array histogram answer

```
// Reads an input file of test scores (integers) and displays a
// graphical histogram of the score distribution.
import java.awt.*;
import java.io.*;
import java.util.*;

public class Histogram {
    public static final int CURVE = 5;   // adjustment to each exam score

    public static void main(String[] args) throws FileNotFoundException {
        Scanner input = new Scanner(new File("midterm.txt"));
        int[] counts = new int[101];     // counters of test scores 0 - 100

        while (input.hasNextInt()) {     // read file into counts array
            int score = input.nextInt();
            score = Math.min(score + CURVE, 100);    // curve the exam score
            counts[score]++;             // if score is 87, then counts[87]++
        }

        for (int i = 0; i < counts.length; i++) {    // print star histogram
            if (counts[i] > 0) {
                System.out.print(i + ": ");
                for (int j = 0; j < counts[i]; j++) {
                    System.out.print("*");
                }
                System.out.println();
            }
        }
```

Array histogram solution 2

```
        ...

        // use a DrawingPanel to draw the histogram
        DrawingPanel p = new DrawingPanel(counts.length * 3 + 6, 200);
        Graphics g = p.getGraphics();
        g.setColor(Color.BLACK);
        for (int i = 0; i < counts.length; i++) {
            g.drawLine(i * 3 + 3, 175, i * 3 + 3, 175 - 5 * counts[i]);
        }
    }
}
```

Array traversals, text processing

reading: 7.1, 4.4

self-check: Ch. 7 #8, Ch. 4 #19-23

Array traversals

- **traversal**: An examination of each element of an array.

```
for (int i = 0; i < array.length; i++) {
    do something with array[i];
}
```

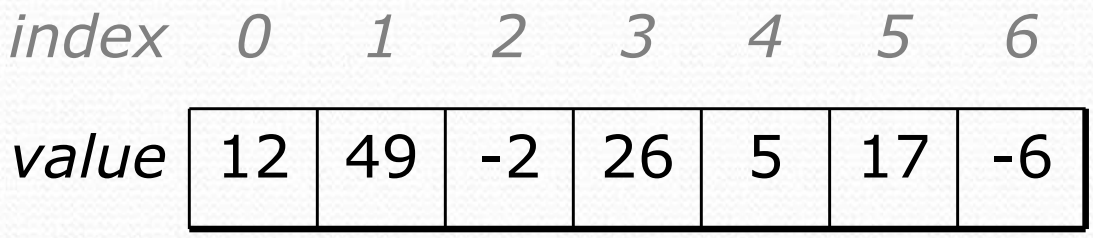
- Examples:
  - printing the elements
  - searching for a specific value
  - rearranging the elements
  - computing the sum, product, etc.

Quick array initialization

type[] **name** = {**value**, **value**, … **value**};

- Example:

```
int[] numbers = {12, 49, -2, 26, 5, 17, -6};
```



- Useful when you know what the array's elements will be
- The compiler figures out the size by counting the values

"Array mystery" problem

- What element values are stored in the following array?

```
int[] a = {1, 7, 5, 6, 4, 14, 11};
for (int i = 0; i < a.length - 1; i++) {
    if (a[i] > a[i + 1]) {
        a[i + 1] = a[i + 1] * 2;
    }
}
```

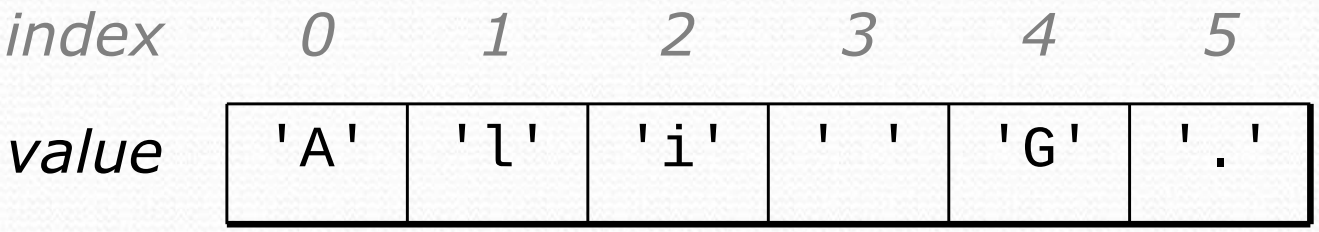
index	*0*	*1*	*2*	*3*	*4*	*5*	*6*
value	1	7	10	12	8	14	22

Text processing

- **text processing**: Examining, editing, formatting text.
  - Often involves `for` loops to examine each letter of a `String`.
    - Count the number of times the letter 's' occurs in a file.
    - Find which letter is most common in a file.
    - Count A, C, T and Gs in `Strings` representing DNA strands.

- `Strings` are represented internally as arrays of `char`.

```
String str = "Ali G.";
```



Recall: type char

- **`char`**: A primitive type representing a single character.
  - Values are surrounded with apostrophes: `'a'` or `'4'` or `'\n'`

- Access a string's characters with its `charAt` method.

```
String word = console.next();
char firstLetter = word.charAt(0);
if (firstLetter == 'c') {
    System.out.println("That's good enough for me!");
}
```

- Use `for` loops to examine each character.

```
String coolMajor = "CSE";
for (int i = 0; i < coolMajor.length(); i++) {
    System.out.println(coolMajor.charAt(i));
}
```

Text processing question

- Write a method `tallyVotes` that accepts a `String` parameter and prints the number of McCain, Obama and independent voters.

```
// (M)cCain, (O)bama, (I)ndependent
String voteText = "MOOOOOOMMMMMOOOOOOMOMMIMOMMIMOMMIO";
tallyVotes(voteText);
```

  - Output:

```
Votes: [16, 14, 3]
```

Arrays.toString

- `Arrays.toString` accepts an array as a parameter and returns a `String` representation of its elements.

```
int[] e = {0, 2, 4, 6, 8};
e[1] = e[3] + e[4];
System.out.println("e is " + Arrays.toString(e));
```

Output:

```
e is [0, 14, 4, 6, 8]
```

- Must `import java.util.*;`

The `Arrays` class

- Class `Arrays` in package `java.util` has useful static methods for manipulating arrays:

Method name	Description
`binarySearch(`**`array`**`, `**`value`**`)`	returns the index of the given value in a sorted array (< 0 if not found)
`equals(`**`array1`**`, `**`array2`**`)`	returns `true` if the two arrays contain the same elements in the same order
`fill(`**`array`**`, `**`value`**`)`	sets every element in the array to have the given value
`sort(`**`array`**`)`	arranges the elements in the array into ascending order
`toString(`**`array`**`)`	returns a string representing the array, such as `"[10, 30, 17]"`

Text processing answer

```
public static int[] tallyVotes(String votes) {
    int[] tallies = new int[3];   // M -> 0, O -> 1, I -> 2

    for(int i = 0; i < votes.length(); i++) {
        if(votes.charAt(i) == 'M') {
            tallies[0]++;
        } else if(votes.charAt(i) == 'O') {
            tallies[1]++;
        } else {                        // votes.charAt(i) == 'I'
            tallies[2]++;
        }
    }

    System.out.println("Votes: " + Arrays.toString(tally));;
}
```