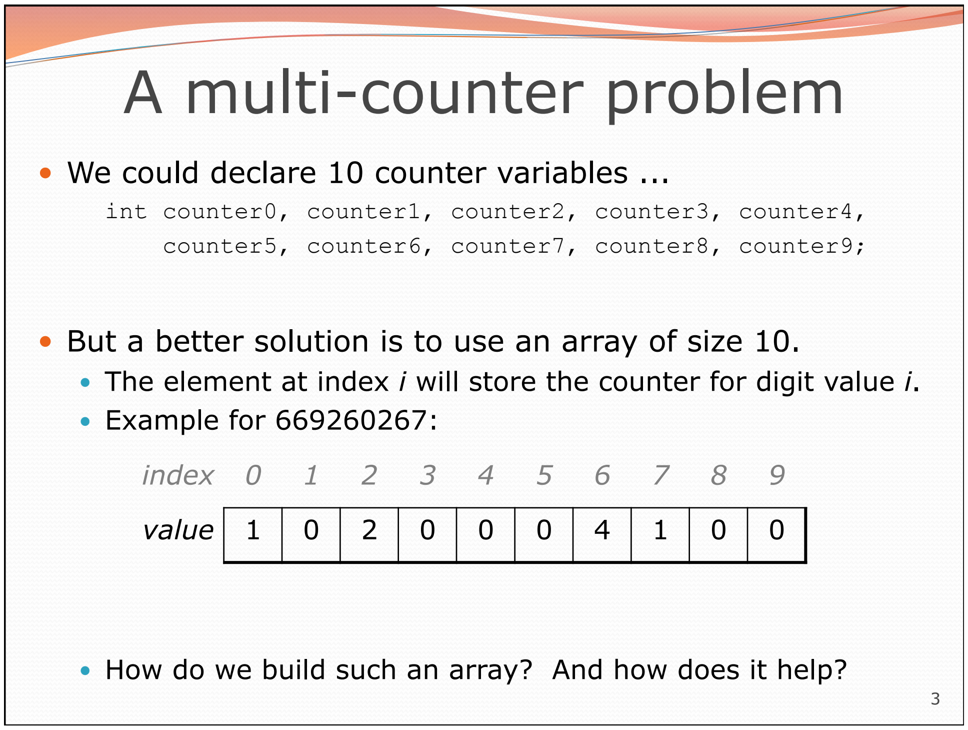
Building Java Programs

Chapter 7
Lecture 7-3: Arrays for Tallying; Text Processing

reading: 7.6, 4.3

A multi-counter problem

- Problem: Write a method `mostFrequentDigit` that returns the digit value that occurs most frequently in a number.
  - Example: The number 669260267 contains:
    one 0, two 2s, four 6es, one 7, and one 9.
    `mostFrequentDigit(669260267)` returns 6.
  - If there is a tie, return the digit with the lower value.
    `mostFrequentDigit(57135203)` returns 3.



A multi-counter problem

- We could declare 10 counter variables ...

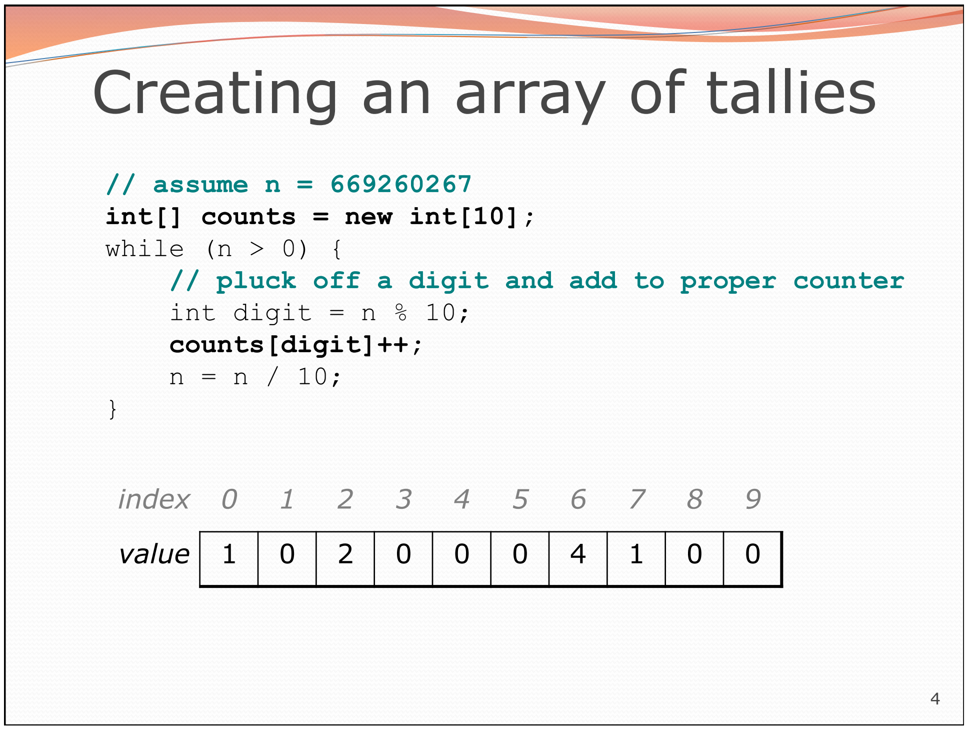
```
int counter0, counter1, counter2, counter3, counter4,
    counter5, counter6, counter7, counter8, counter9;
```

- But a better solution is to use an array of size 10.
  - The element at index *i* will store the counter for digit value *i*.
  - Example for 669260267:

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

  - How do we build such an array? And how does it help?

3



Creating an array of tallies

```
// assume n = 669260267
int[] counts = new int[10];
while (n > 0) {
    // pluck off a digit and add to proper counter
    int digit = n % 10;
    counts[digit]++;
    n = n / 10;
}
```

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

4

Tally solution

```
// Returns the digit value that occurs most frequently in n.
// Breaks ties by choosing the smaller value.
public static int mostFrequentDigit(int n) {
    int[] counts = new int[10];
    while (n > 0) {
        int digit = n % 10;  // pluck off a digit and tally it
        counts[digit]++;
        n = n / 10;
    }
    // find the most frequently occurring digit
    int bestIndex = 0;
    for (int i = 1; i < counts.length; i++) {
        if (counts[i] > counts[bestIndex]) {
            bestIndex = i;
        }
    }
    return bestIndex;
}
```

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.

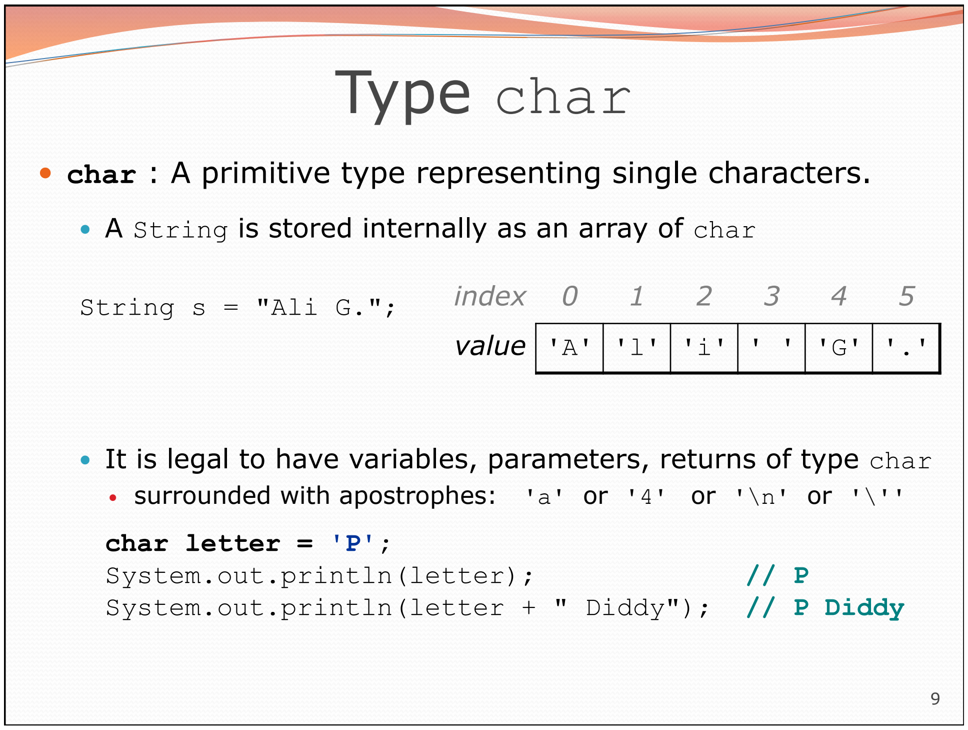
```
85: *****
86: ************
87: ***
88: *
91: ****
```

Array histogram answer

```
// Reads a file of test scores and shows a histogram of the score distribution.
import java.io.*;
import java.util.*;

public class Histogram {
    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();
            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();
            }
        }
    }
}
```

Text processing

reading: 4.3



Type char

- **char** : A primitive type representing single characters.
  - A String is stored internally as an array of char

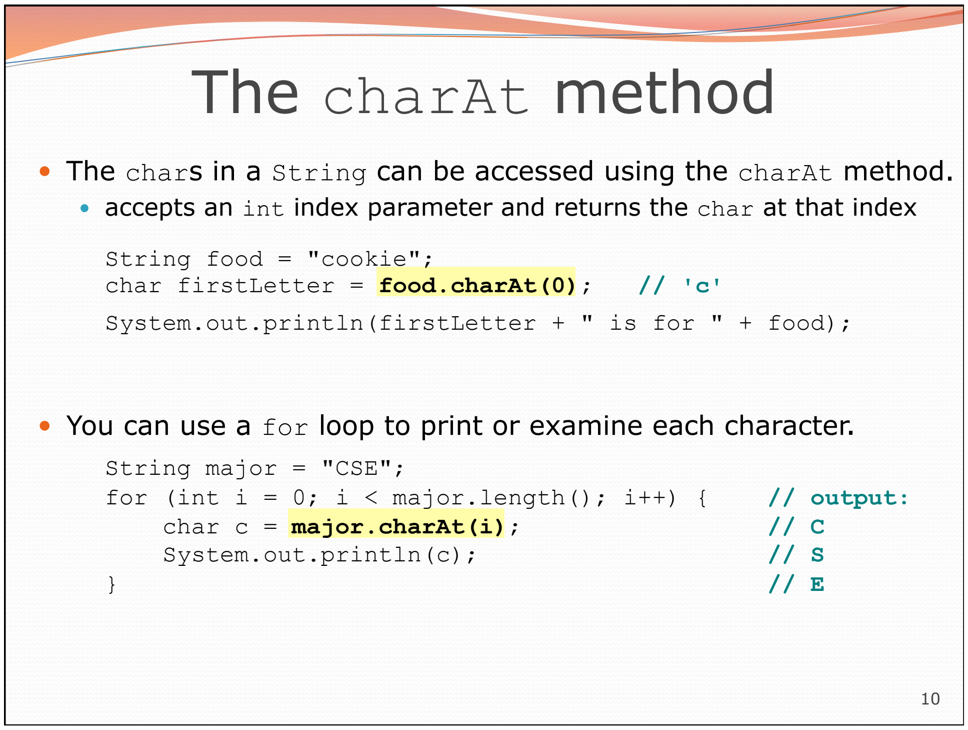
```
String s = "Ali G.";
```

index	0	1	2	3	4	5
value	'A'	'l'	'i'	' '	'G'	'.'

  - It is legal to have variables, parameters, returns of type char
    - surrounded with apostrophes: 'a' or '4' or '\n' or '\''

```
char letter = 'P';
System.out.println(letter);                 // P
System.out.println(letter + " Diddy");      // P Diddy
```

9



The charAt method

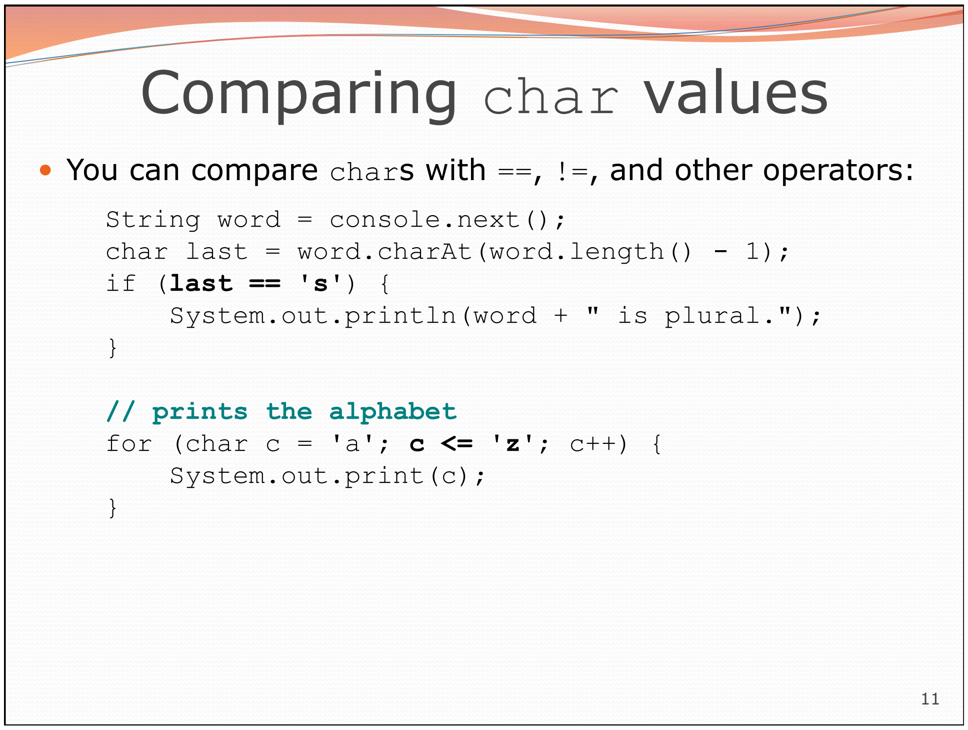
- The chars in a String can be accessed using the charAt method.
  - accepts an int index parameter and returns the char at that index

```
String food = "cookie";
char firstLetter = food.charAt(0);    // 'c'
System.out.println(firstLetter + " is for " + food);
```

- You can use a for loop to print or examine each character.

```
String major = "CSE";
for (int i = 0; i < major.length(); i++) {     // output:
    char c = major.charAt(i);                  // C
    System.out.println(c);                     // S
}                                              // E
```

10

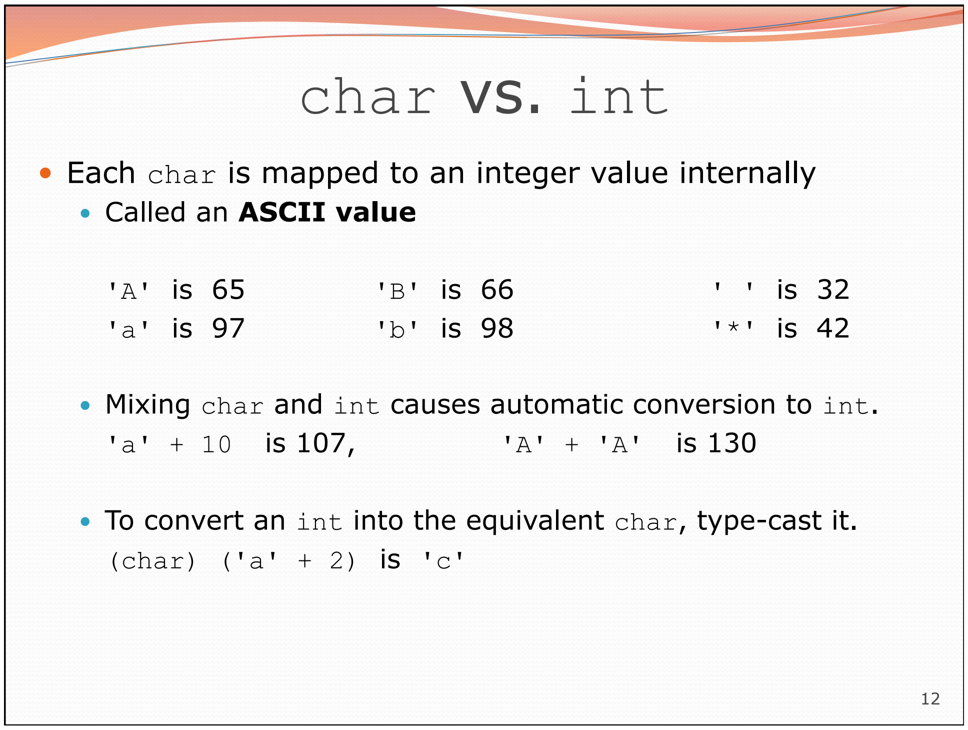


Comparing `char` values

- You can compare `char`s with `==`, `!=`, and other operators:

```
String word = console.next();
char last = word.charAt(word.length() - 1);
if (last == 's') {
    System.out.println(word + " is plural.");
}

// prints the alphabet
for (char c = 'a'; c <= 'z'; c++) {
    System.out.print(c);
}
```

11



`char` vs. `int`

- Each `char` is mapped to an integer value internally
  - Called an **ASCII value**

`'A'` is 65	`'B'` is 66	`' '` is 32
`'a'` is 97	`'b'` is 98	`'*'` is 42

  - Mixing `char` and `int` causes automatic conversion to `int`.

    `'a' + 10` is 107, `'A' + 'A'` is 130

  - To convert an `int` into the equivalent `char`, type-cast it.

    `(char) ('a' + 2)` is `'c'`

12

char vs. String

- "h" is a String, but 'h' is a char   (they are different)
- A String is an object; it contains methods.

```
String s = "h";
s = s.toUpperCase();         // "H"
int len = s.length();        //  1
char first = s.charAt(0);    // 'H'
```

- A char is primitive; you can't call methods on it.

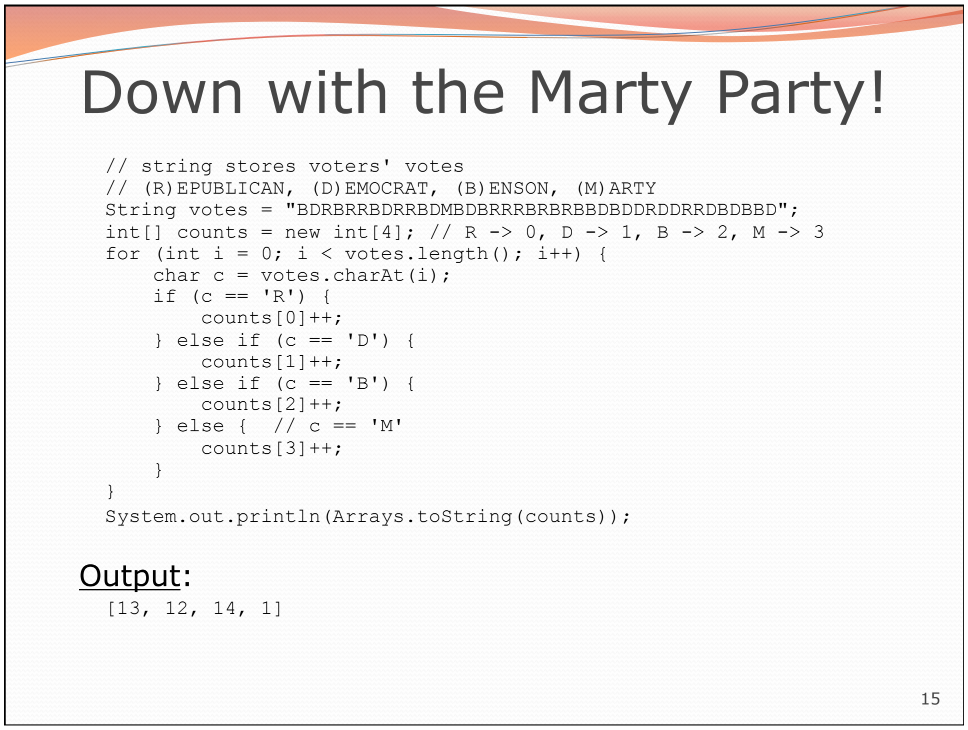
```
char c = 'h';
c = c.toUpperCase();                // ERROR
s = s.charAt(0).toUpperCase();      // ERROR
```

  - What is s + 1 ? What is c + 1 ?
  - What is s + s ? What is c + c ?

String traversals

- We can write algorithms to traverse strings to compute information.
- What useful information might the following string have?

```
"BDRBRRBDRRBDMBDBRRRBRBRBBDBDDRDDRRDBDBBD"
```



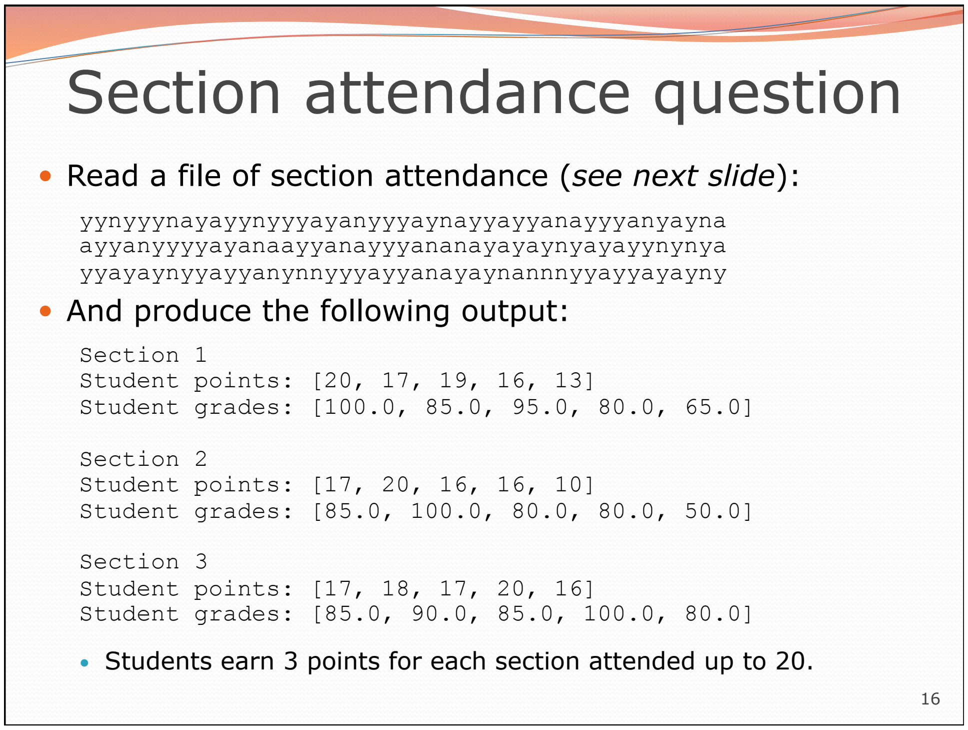
Down with the Marty Party!

```
// string stores voters' votes
// (R)EPUBLICAN, (D)EMOCRAT, (B)ENSON, (M)ARTY
String votes = "BDRBRRBDRRBDMBDBRRRBRBRBBDBDDRDDRRDBDBBD";
int[] counts = new int[4]; // R -> 0, D -> 1, B -> 2, M -> 3
for (int i = 0; i < votes.length(); i++) {
    char c = votes.charAt(i);
    if (c == 'R') {
        counts[0]++;
    } else if (c == 'D') {
        counts[1]++;
    } else if (c == 'B') {
        counts[2]++;
    } else {  // c == 'M'
        counts[3]++;
    }
}
System.out.println(Arrays.toString(counts));
```

Output:

```
[13, 12, 14, 1]
```

15



Section attendance question

- Read a file of section attendance (*see next slide*):

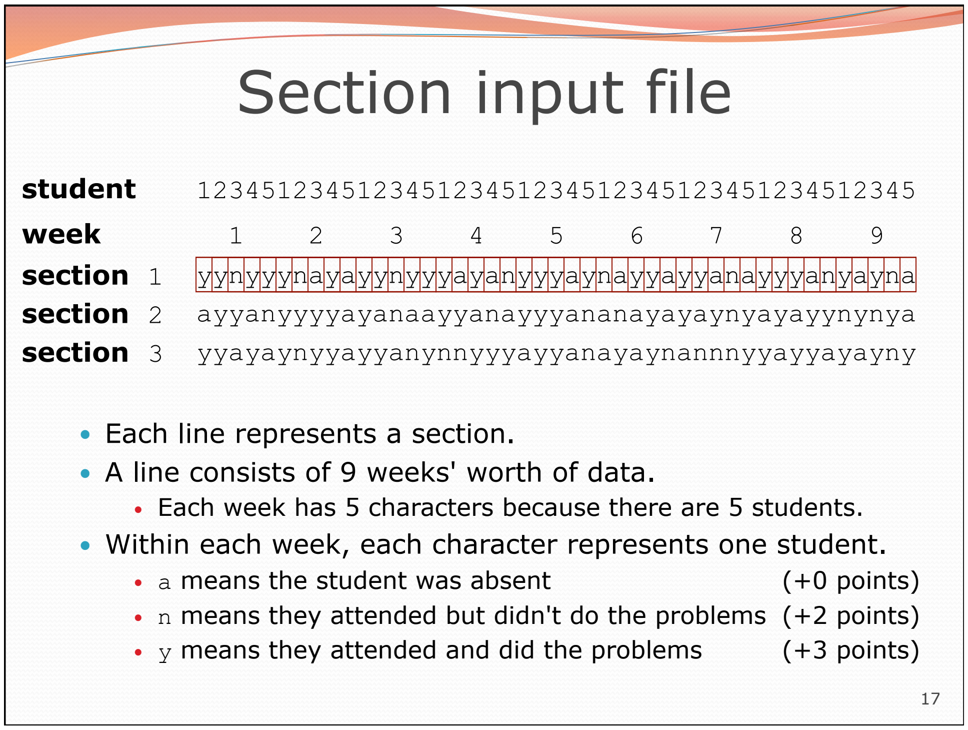
```
yynyyynayayynyyyayanyyyaynayyayyanayyyanyayna
ayyanyyyyayanaayyanayyyananayayaynyayayyynynya
yyayaynyyayyanynnyyyayyanayaynannnyyayyayayny
```

- And produce the following output:

```
Section 1
Student points: [20, 17, 19, 16, 13]
Student grades: [100.0, 85.0, 95.0, 80.0, 65.0]

Section 2
Student points: [17, 20, 16, 16, 10]
Student grades: [85.0, 100.0, 80.0, 80.0, 50.0]

Section 3
Student points: [17, 18, 17, 20, 16]
Student grades: [85.0, 90.0, 85.0, 100.0, 80.0]
```

  - Students earn 3 points for each section attended up to 20.

16

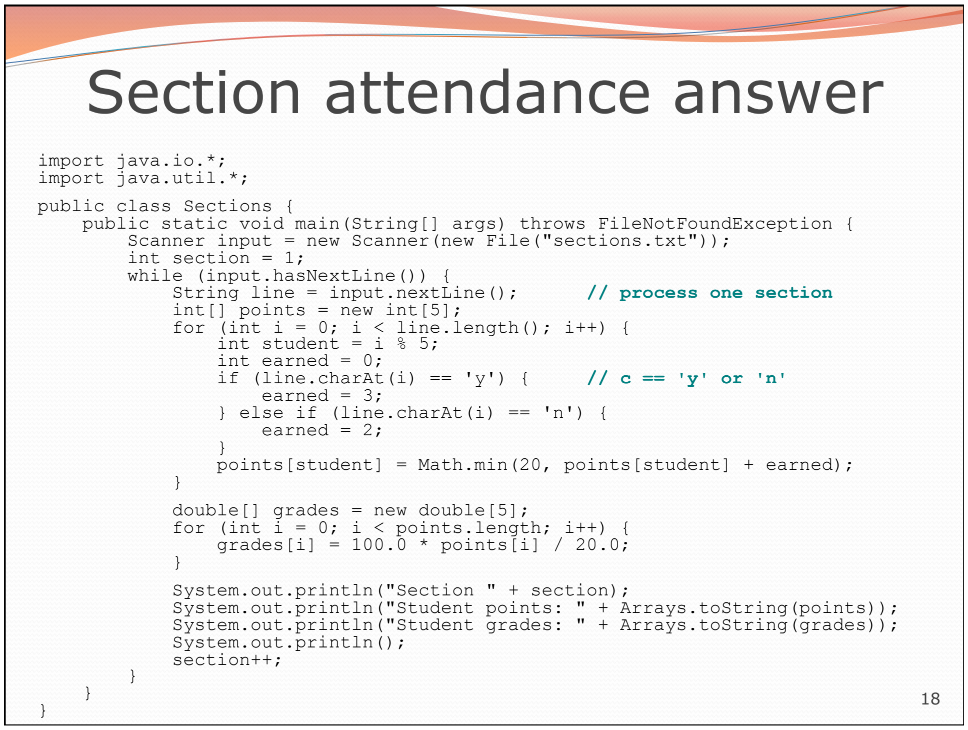


Section input file

```
student      123451234512345123451234512345123451234512345
week           1    2    3    4    5    6    7    8    9
section  1   yynyyynayayynyyyayanyyyaynayyayyanayyyanyayna
section  2   ayyanyyyyayanaayyanayyyananayayaynyayayyynynya
section  3   yyayaynyyayyanynnyyyayyanayaynannnyyayyayayny
```

- Each line represents a section.
- A line consists of 9 weeks' worth of data.
  - Each week has 5 characters because there are 5 students.
- Within each week, each character represents one student.
  - `a` means the student was absent (+0 points)
  - `n` means they attended but didn't do the problems (+2 points)
  - `y` means they attended and did the problems (+3 points)

17



Section attendance answer

```java
import java.io.*;
import java.util.*;

public class Sections {
    public static void main(String[] args) throws FileNotFoundException {
        Scanner input = new Scanner(new File("sections.txt"));
        int section = 1;
        while (input.hasNextLine()) {
            String line = input.nextLine();      // process one section
            int[] points = new int[5];
            for (int i = 0; i < line.length(); i++) {
                int student = i % 5;
                int earned = 0;
                if (line.charAt(i) == 'y') {     // c == 'y' or 'n'
                    earned = 3;
                } else if (line.charAt(i) == 'n') {
                    earned = 2;
                }
                points[student] = Math.min(20, points[student] + earned);
            }

            double[] grades = new double[5];
            for (int i = 0; i < points.length; i++) {
                grades[i] = 100.0 * points[i] / 20.0;
            }

            System.out.println("Section " + section);
            System.out.println("Student points: " + Arrays.toString(points));
            System.out.println("Student grades: " + Arrays.toString(grades));
            System.out.println();
            section++;
        }
    }
}
```

18

Data transformations

- In many problems we transform data between forms.
  - Example: digits → count of each digit → most frequent digit
  - Often each transformation is computed/stored as an array.
  - For structure, a transformation is often put in its own method.

- Sometimes we map between data and array indexes.
  - by position (store the *i* th value we read at index *i*)
  - tally (if input value is *i*, store it at array index *i*)
  - explicit mapping (count `'J'` at index 0, count `'X'` at index 1)

- *Exercise:* Modify our Sections program to use static methods that use arrays as parameters and returns.

Array param/return answer

```
// This program reads a file representing which students attended
// which discussion sections and produces output of the students'
// section attendance and scores.

import java.io.*;
import java.util.*;

public class Sections2 {
    public static void main(String[] args) throws FileNotFoundException {
        Scanner input = new Scanner(new File("sections.txt"));
        int section = 1;
        while (input.hasNextLine()) {
            // process one section
            String line = input.nextLine();
            int[] points = countPoints(line);
            double[] grades = computeGrades(points);
            results(section, points, grades);
            section++;
        }
    }

    // Produces all output about a particular section.
    public static void results(int section, int[] points, double[] grades) {
        System.out.println("Section " + section);
        System.out.println("Student scores: " + Arrays.toString(points));
        System.out.println("Student grades: " + Arrays.toString(grades));
        System.out.println();
    }

    ...
```

Array param/return answer

```
    ...
    // Computes the points earned for each student for a particular section.
    public static int[] countPoints(String line) {
        int[] points = new int[5];
        for (int i = 0; i < line.length(); i++) {
            int student = i % 5;
            int earned = 0;
            if (line.charAt(i) == 'y') {      // c == 'y'  or  c == 'n'
                earned = 3;
            } else if (line.charAt(i) == 'n') {
                earned = 2;
            }
            points[student] = Math.min(20, points[student] + earned);
        }
        return points;
    }

    // Computes the percentage for each student for a particular section.
    public static double[] computeGrades(int[] points) {
        double[] grades = new double[5];
        for (int i = 0; i < points.length; i++) {
            grades[i] = 100.0 * points[i] / 20.0;
        }
        return grades;
    }
}
```