COMP 110/L Lecture 17

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Some slides adapted from Dr. Kyle Dewey

Outline

- `Strings`
- `String.length`
- `String.split`
- Multidimensional arrays

Strings

- A string is an ordered sequence of characters.
- However, because of the String class, we never directly interact with this representation.
- Java provides many methods as part of the String class that can be used to process and manipulate strings.
- These methods do not change the strings since strings in Java are immutable.

Basics

- Declare and assign using regular assignment operator

```
String firstName = “Denise";

String lastName = "Ritchie";

 //we can also reassign values

firstName = "Tom";
```

- Note that the reassignment in the last line in the example does not change the original string.
- It just makes the variable firstName point to a new string

`String` methods

Method name	Description
`indexOf(`**`str`**`)`	index where the start of the given string appears in this string (-1 if it is not there)
`length()`	number of characters in this string

`substring(`**`index1`**`,`**`index2`**`)`
or
`substring(`**`index1`**`)`
	the characters in this string from *index1* (inclusive) to *index2* (exclusive);
	if *index2* omitted, grabs till end of string

`toLowerCase()`	a new string with all lowercase letters
`toUpperCase()`	a new string with all uppercase letters

- These methods are called using the dot notation:

```
String gangsta = "Dr. Dre";
System.out.println(gangsta.length());    // 7
```

Modifying strings

- Methods like `substring`, `toLowerCase`, etc. create/return a new string, rather than modifying the current string.

```
String s = "lil bow wow";
s.toUpperCase();
System.out.println(s);   // lil bow wow
```

- To modify a variable, you must reassign it:

```
String s = "lil bow wow";
s = s.toUpperCase();
System.out.println(s);   // LIL BOW WOW
```

Comparing strings

- Relational operators such as < and == fail on objects.

```
Scanner console = new Scanner(System.in);
System.out.print("What is your name? ");
String name = console.next();
if (name == "Barney") {
    System.out.println("I love you, you love me,");
    System.out.println("We're a happy family!");
}
```

- This code will compile, but it will not print the song.

- == compares objects by *references* (seen later), so it often gives `false` even when two `String`s have the same letters.

The `equals` method

- Objects are compared using a method named `equals`.

```
Scanner console = new Scanner(System.in);
System.out.print("What is your name? ");
String name = console.next();
if (name.equals("Barney")) {
    System.out.println("I love you, you love me,");
    System.out.println("We're a happy family!");
}
```

- Technically this is a method that returns a value of type `boolean`, the type used in logical tests.

`String` test methods

Method	Description
`equals(`**str**`)`	whether two strings contain the same characters
`equalsIgnoreCase(`**str**`)`	whether two strings contain the same characters, ignoring upper vs. lower case
`startsWith(`**str**`)`	whether one contains other's characters at start
`endsWith(`**str**`)`	whether one contains other's characters at end
`contains(`**str**`)`	whether the given string is found within this one

```
String name = console.next();
if (name.startsWith("Dr.")) {
    System.out.println("Are you single?");
} else if (name.equalsIgnoreCase("LUMBERG")) {
    System.out.println("I need your TPS reports.");
}
```

Type `char`

- `char` : A primitive type representing single characters.
  - Each character inside a `String` is stored as a `char` value.
  - Literal `char` values are surrounded with apostrophe (single-quote) marks, such as `'a'` or `'4'` or `'\n'` or `'\''`

  - It is legal to have variables, parameters, returns of type `char`

```
char letter = 'S';
System.out.println(letter);                    // S
```

- `char` values can be concatenated with strings.

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

The `charAt` method

- The `char`s in a `String` can be accessed using the `charAt` method.

```
String food = "cookie";
char firstLetter = food.charAt(0);   // 'c'

System.out.println(firstLetter + " is for " + food);
System.out.println("That's good enough for me!");
```

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

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

Output:

```
C
S
E
```

`char` **vs.** `String`

- `"h"` is a `String`
  `'h'` is a `char` (the two behave differently)

- `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'
```

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

```
char c = 'h';
c = c.toUpperCase();    // ERROR: "cannot be dereferenced"
```

Comparing `char` values

- You can compare `char` values with relational operators:

```
'a' < 'b'   and   'X' == 'X'   and   'Q' != 'q'
```

  - An example that prints the alphabet:

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

- You can test the value of a string's character:

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

Formatting Output

Use the `printf` statement.

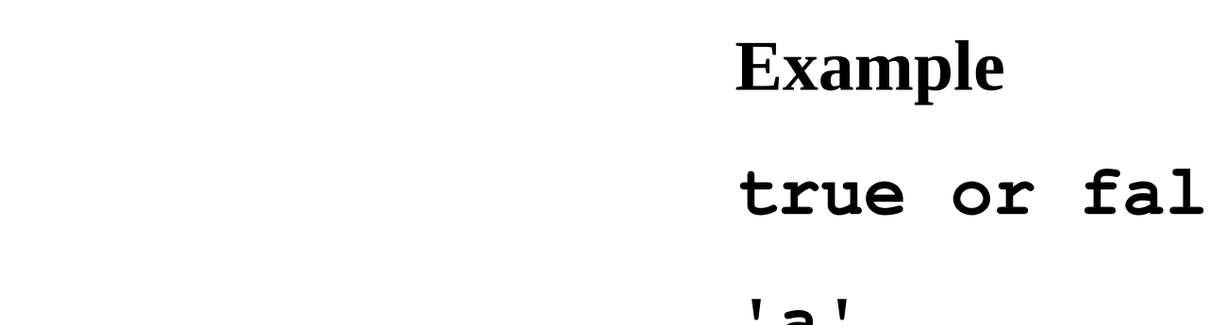
```
System.out.printf(format, items);
```

Where format is a string that may consist of substrings and format specifiers. A format specifier specifies how an item should be displayed. An item may be a numeric value, character, boolean value, or a string. Each specifier begins with a percent sign.

Frequently-Used Specifiers

Specifier	Output	Example
%b	a boolean value	true or false
%c	a character	'a'
%d	a decimal integer	200
%f	a floating-point number	45.460000
%e	a number in standard scientific notation	4.556000e+01
%s	a string	"Java is cool"

```
int count = 5;
double amount = 45.56;
System.out.printf("count is %d and amount is %f", count, amount);
```



display count is 5 and amount is 45.560000

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`"".length()`

0

Example:

StringLength.java

String.split

Tokenizing

- It is common to store different pieces of data as a string such that each individual piece of data is demarcated by some delimiter.

```
Smith,Joe,12345678,1985-09-08
```

- Often we need to process such strings to extract each individual piece of data.
- Processing such strings is usually referred to as *parsing*.
- In particular, a string is "split" into a collection of individual strings called tokens (thus the process is also sometimes referred to as tokenizing).

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```
new String[]{"foo", "bar"}
```

Example:

SplitOnComma.java

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`"foo.bar".split("\\.")`

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`"foo.bar".split(".")`

`"."`: matches **any** single character

`"foo.bar".split("\\.")`

`"\\."`: matches a period (backslash followed by a period)

Example:

SplitOnAnything.java

Multidimensional Arrays

Recap - Arrays

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```
new char[]{'a', 'b', 'c'}

new int[]{1, 2, 3}

new String[]{"foo", "bar"}

new double[]{1.2, 3.4}
```

Motivations

Thus far, you have used one-dimensional arrays to model linear collections of elements. You can use a two-dimensional array to represent a matrix or a table. For example, the following table that describes the distances between the cities can be represented using a two-dimensional array.

Distance Table (in miles)

	Chicago	Boston	New York	Atlanta	Miami	Dallas	Houston
Chicago	0	983	787	714	1375	967	1087
Boston	983	0	214	1102	1763	1723	1842
New York	787	214	0	888	1549	1548	1627
Atlanta	714	1102	888	0	661	781	810
Miami	1375	1763	1549	661	0	1426	1187
Dallas	967	1723	1548	781	1426	0	239
Houston	1087	1842	1627	810	1187	239	0

Motivations

```
double[][] distances = {
    {0, 983, 787, 714, 1375, 967, 1087},
    {983, 0, 214, 1102, 1763, 1723, 1842},
    {787, 214, 0, 888, 1549, 1548, 1627},
    {714, 1102, 888, 0, 661, 781, 810},
    {1375, 1763, 1549, 661, 0, 1426, 1187},
    {967, 1723, 1548, 781, 1426, 0, 239},
    {1087, 1842, 1627, 810, 1187, 239, 0},
};
```

Multidimensional Arrays

Java also allows us to make arrays of *arrays*.

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new int[][]{ new int[]{1, 2, 3},
             new int[]{4, 5},
             new int[]{6},
             new int[0],
             new int[]{7, 8, 9}
             }
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             }
```

Corresponding type: `int[][]`

Multidimensional Array Utility

Commonly used for representing tables

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```

Accessing Rows

One row of a two-dimensional array is an array...

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...and columns are individual elements of rows.

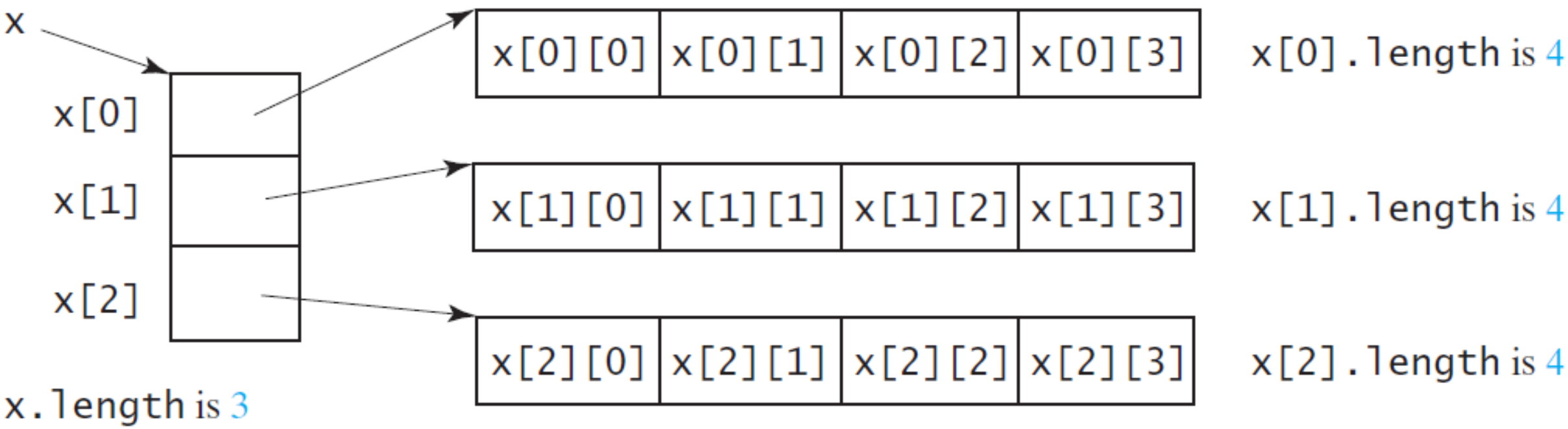
```
int[][] array = ...;
int[] row = array[0];
int columnElement = row[5];
```

```
int[][] array = ...;
int columnElement = array[0][5];
```

	Column 0	Column 1	Column 2
Row 0	x[0][0]	x[0][1]	x[0][2]
Row 1	x[1][0]	x[1][1]	x[1][2]
Row 2	x[2][0]	x[2][1]	x[2][2]

Lengths of Two-dimensional Arrays

```
int[][] x = new int[3][4];
```



Lengths of Two-dimensional Arrays, cont.

```
int[][] array = {
                    {1, 2, 3},
                    {4, 5, 6},
                    {7, 8, 9},
                    {10, 11, 12}
                };
```

array.length

array[0].length

array[1].length

array[2].length

array[3].length

array[4].length ArrayIndexOutOfBoundsException

Ragged Arrays

Each row in a two-dimensional array is itself an array. So, the rows can have different lengths. Such an array is known as *a ragged array*.

For example,

```
int[][] matrix = {
  {1, 2, 3, 4, 5},
  {2, 3, 4, 5},
  {3, 4, 5},
  {4, 5},
  {5}
};
```

matrix.length is 5
matrix[0].length is 5
matrix[1].length is 4
matrix[2].length is 3
matrix[3].length is 2
matrix[4].length is 1

Example:

`AccessTwoDimensionalElement.java`

More 2D Array Examples

- `PrintRow2D.java`
- `PrintCol2D.java`