

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

- The class `String` represents objects that store text.
- **string**: An object storing a sequence of text characters.
 - Unlike most other objects, a `String` is not created with `new`.

```
String name = "text";
```

```
String name = expression;
```

- Examples:

```
String name = "Marla Singer";
```

```
int x = 3;
```

```
int y = 5;
```

```
String point = "(" + x + ", " + y + ")";
```

Indexes

- Characters of a string are numbered with 0-based *indexes*:

```
String name = "P. Diddy";
```

index	0	1	2	3	4	5	6	7
char	P	.		D	i	d	d	y

- The first character's index is always 0
- The last character's index is 1 less than the string's length
- The individual characters are values of type `char` (seen later)

String methods

Method name	Description
<code>indexOf(str)</code>	index where the start of the given string appears in this string (-1 if it is not there)
<code>length()</code>	number of characters in this string
<code>substring(index1, index2)</code> or <code>substring(index1)</code>	the characters in this string from <i>index1</i> (inclusive) to <i>index2</i> (<u>exclusive</u>); if <i>index2</i> omitted, grabs till end of string
<code>toLowerCase()</code>	a new string with all lowercase letters
<code>toUpperCase()</code>	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
```

String method examples

```
//      index 012345678901
String s1 = "Stuart Reges";
String s2 = "Marty Stepp";
System.out.println(s1.length());           // 12
System.out.println(s1.indexOf("e"));       // 8
System.out.println(s1.substring(7, 10))    // "Reg"

String s3 = s2.substring(2, 8);
System.out.println(s3.toLowerCase());     // "rty st"
```

- Given the following string:

```
//      index 0123456789012345678901
String book = "Building Java Programs";
```

- How would you extract the word "Java" ?
- How would you extract the first word from any string?

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
```

Strings as parameters

```
public class StringParameters {  
    public static void main(String[] args) {  
        sayHello("Marty");  
  
        String teacher = "Helene";  
        sayHello(teacher);  
    }  
  
    public static void sayHello(String name) {  
        System.out.println("Welcome, " + name);  
    }  
}
```

Output:

```
Welcome, Marty  
Welcome, Helene
```


Strings as user input

- Scanner's next method reads a word of input as a String.

```
Scanner console = new Scanner(System.in);
System.out.print("What is your name? ");
String name = console.next();
name = name.toUpperCase();
System.out.println(name + " has " + name.length() +
    " letters and starts with " + name.substring(0, 1));
```

Output:

```
What is your name? Madonna
MADONNA has 7 letters and starts with M
```

- The nextLine method reads a line of input as a String.

```
System.out.print("What is your address? ");
String address = console.nextLine();
```

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
<code>equals(str)</code>	whether two strings contain the same characters
<code>equalsIgnoreCase(str)</code>	whether two strings contain the same characters, ignoring upper vs. lower case
<code>startsWith(str)</code>	whether one contains other's characters at start
<code>endsWith(str)</code>	whether one contains other's characters at end
<code>contains(str)</code>	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 chars 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
<code>%b</code>	a boolean value	true or false
<code>%c</code>	a character	'a'
<code>%d</code>	a decimal integer	200
<code>%f</code>	a floating-point number	45.460000
<code>%e</code>	a number in standard scientific notation	4.556000e+01
<code>%s</code>	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

String.length

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```
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```

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Example:

`StringLength.java`


```
String.split
```

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Returns an array of `Strings` (`String[]`).

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Returns an array of `Strings` (`String[]`).

```
"foo,bar".split(",")  
new String[]{"foo", "bar"}
```

Example:

`SplitOnComma.java`

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`split` takes a *regular expression*.

Regular expressions describe different string patterns.

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

`","`: matches only one pattern: a comma

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

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

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

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

Example:

`SplitOnAnything.java`

Regular Expressions

- Super popular for extracting values from `String` inputs
- Could easily spend a week on them
- Covered in later courses

Multidimensional Arrays

Recap - Arrays

Arrays are fixed-length sequences of elements of the same type.

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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*.

These are often called *multidimensional* 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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              new int[0],  
              new int[] {7, 8, 9}  
            }
```

Corresponding type: `int[][]`

Multidimensional Array Utility

Commonly used for representing tables

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13	12	19
64	89	247
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```
new int[][] { new int[] {13, 12, 19},  
              new int[] {64, 89, 247},  
              new int[] {78, 57, 21} }
```

Accessing Rows

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

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int[][] array = ...;  
int[] row = array[0];
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Accessing Columns

...and columns are individual elements of rows.

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

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

Accessing Columns

...and columns are individual elements of rows.

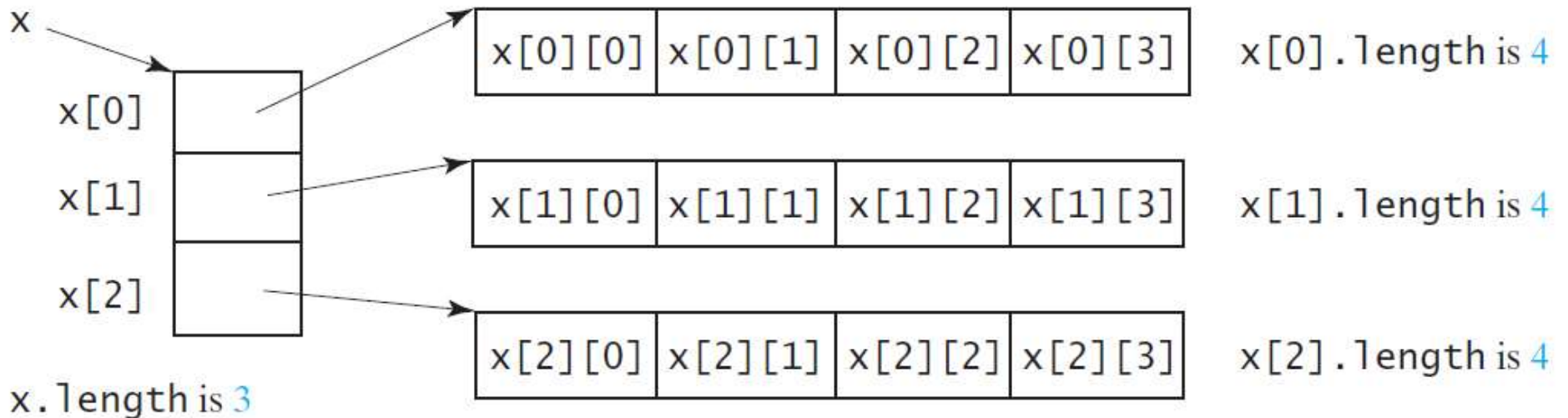
```
int[][] array = ...;  
int[] row = array[0];  
int columnElement = row[5];
```

```
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`