

Object Oriented Software Design

I/O subsystem API

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Outline

- 1 String
- 2 I/O and files
- 3 ArrayList
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Utilities for manipulating strings

- Since you will have to analyse strings to implement your program, let's have a closer look at class String
- The String class is immutable, so that once it is created a String object cannot be changed.
 - The String class has a number of methods that appear to modify strings. Since strings are immutable, what these methods really do is create and return a new string that contains the result of the operation.

Utilities for manipulating strings

- Usually, methods that are used to “read” the value of some property of a class are called **accessor** methods
 - method **length()** returns the number of characters in a string
 - To read the character at position **i**, we can call **charAt(i)**
 - You can copy a substring of a string into an array of characters as follows:

```
String mystring = "This is a lecture";  
char[] temp = new char[5];  
mystring.getChars(5, 10, temp, 0);
```

- It means: copy from the 5th character (included) to the 10th character (excluded) into **temp** starting at position 0
 - After the copy, temp contains "is a "
- If you want to obtain another string, it is possible to use substring:

```
String mystring = "This is a lecture";  
String sub = mystring.substring(5,10);
```

Concatenating strings

- The String class includes a method for concatenating two strings:

```
string1.concat(string2);
```

- This returns a new string that is string1 with string2 added to it at the end. You can also use the concat() method with string literals, as in:

```
"My name is ".concat("Rumplestiltskin");
```

- Strings are more commonly concatenated with the + operator, as in

```
"Hello," + " world" + "!"
```

Formatted printing

- In Java, you can output formatted printing using **System.out.printf()**, as follows:

```
System.out.printf("A float %f, and an integer %d", 3.754, 20);
```

- You can also use the **format()** method of class String:

```
String fs;  
fs = String.format("The value of the float variable is %f, " +  
                  "while the value of the integer variable " +  
                  "is %d, and the string is %s", floatVar, intVar,  
                  stringVar);  
System.out.println(fs);
```

Converting strings into numbers

- The **Number** subclasses that wrap primitive numeric types (Byte, Integer, Double, Float, Long, and Short) each provide a class method named `valueOf` that converts a string to an object of that type

```
public class ValueOfDemo {
    public static void main(String[] args) {
        if (args.length == 2) {
            Float a = Float.valueOf(args[0]);
            Float b = Float.valueOf(args[1]);

            float c = Float.parseFloat(args[0]);
            float d = Float.parseFloat(args[1]);

            System.out.printf("a = %f", a.floatValue());
            System.out.printf("b = %f", b.floatValue());
            System.out.printf("c = %f", c);
            System.out.printf("d = %f", d);
        } else {
            System.out.println("Insert two command-line arguments");
        }
    }
}
```

Other methods

- The `String` class has a large amount of different methods for manipulating strings:
 - searching character, replacing substrings, etc.
- Please refer to the Java 6 API to get a complete documentation for `String`

The File class

- The File class does not represent a file, but one or more file names.
 - It is used to get the list of files in a directory, as in `./examples/08.java` - `examples/DirList.java`
- Explanation:
 - the **list()** method of class File needs as argument an object of type **FilenameFilter**, which is a very simple interface:

```
public interface FilenameFilter {
    boolean accept(File dir, String name);
}
```
 - The **list()** will call the **accept()** on every file contained in the directory, to see if a file name is “acceptable”,
 - if **accept()** returns **true** the name is inserted in the list, otherwise it is not
- This technique is called **callback**

Making directories

- It is possible to use the File class to create directories, see if a file exist, get the file type, etc.
- `./examples/08.java` - `examples/MakeDirectories.java`

Input and output

- The Java library classes for I/O are divided by input and output
 - everything derived from the InputStream or Reader classes have basic methods called **read()** for reading a single byte or array of bytes
 - everything derived from OutputStream or Writer classes have basic methods called **write()** for writing a single byte or array of bytes
 - However, you won't generally use these methods; they exist so that other classes can use them - these other classes provide a more useful interface
 - Thus, you'll rarely create your stream object by using a single class, but instead will layer multiple objects together to provide your desired functionality.
 - The fact that you create more than one object to create a single resulting stream is the primary reason that Java's stream library is confusing.
- The rest of the slides are just descriptions of examples

Reading input by line

```
BufferedReader in = new BufferedReader(  
    new FileReader("IOStreamDemo.java"));  
String s, s2 = new String();  
while((s = in.readLine()) != null)  
    s2 += s + "\n";  
in.close();
```

- Comment
 - **in** represents the file handle, we open file IOStreamDemo.java
 - we read one string at time, and append all strings in **s2**.
 - The reading is done using buffering
 - i.e. a block of data is read in an internal buffer, and then we read line by line from the buffer
 - This technique is called **decorator pattern** or **wrapper pattern**

Reading from std input

```
BufferedReader stdin = new BufferedReader(  
    new InputStreamReader(System.in));  
System.out.print("Enter a line:");  
System.out.println(stdin.readLine());
```

- Comment:
 - In this case, we read one line from the standard input (the keyboard), represented by object **System.in**
 - This same code can be used in the assignment

Reading from a string

```
StringReader in2 = new StringReader(s2);  
int c;  
while((c = in2.read()) != -1)  
    System.out.print((char)c);
```

- It is possible to treat a string as a file
 - In the example, we read one character at time from the string
- It is also possible to “unread” one character, as follows:

```
String s = "This is a string!";  
PushbackReader r = new PushbackReader(new StringReader(s));  
char c = (char)r.read();    // read character 'T'  
r.unread('P');  
System.out.println((char)r.read()); // prints 'P'
```

- In some cases, this may be useful for low-level parsing of strings

Writing onto a file

```
try {
    BufferedReader in4 = new BufferedReader(
        new StringReader(s2));
    PrintWriter out1 = new PrintWriter(
        new BufferedWriter(new FileWriter("IODemo.out")));
    int lineCount = 1;
    while((s = in4.readLine()) != null )
        out1.println(lineCount++ + ": " + s);
    out1.close();
} catch (EOFException e) {
    System.err.println("End of stream");
}
```

- The previous example reads one line at time from a string, and writes on a output file
 - **PrintWriter** is used to output text files, it wraps a **BufferedWriter** which wraps an output file writer
 - If you need to write a binary file, you only need to remove the **PrintWriter** class, and only use the **BufferedWriter**.
 - The explicit **close()** for **out1** is needed otherwise the buffers don't get flushed, so they're incomplete

Arrays

- We have seen arrays
 - Arrays have fixed length: once you create an array, it is not possible to add further elements to it
- Variable-length arrays are supported by class **ArrayList**
 - Three constructors:
 - default constructor (an empty array),
 - a constructor that takes an integer (the initial capacity, but the array is still empty)
 - a constructor that takes a **Collection** of object
 - **ArrayList** may only contain references to Objects
 - API:
<http://download.oracle.com/javase/1.4.2/docs/api/java/ut>

Example

ArrayListExample.java

```
import java.util.*;

class ArrayListExample {
    public static void main(String args[]) {
        ArrayList al = new ArrayList();
        for (int i=0; i<args.length; i++) al.add(args[i]);

        System.out.println("al.size() = " + al.size());
        for (int i=0; i < al.size(); i++) {
            System.out.println(al.get(i));
        }
        al.add("This is the last one");
        al.add(0, "this is the first one");
        System.out.println("al.size() = " + al.size());
        for (int i=0; i < al.size(); i++) {
            System.out.println(al.get(i));
        }
    }
}
```

Exercises

● Parenthesis matching

- Write a class that provides a static method to find matching parenthesis in a String
- The method takes as input a string, and the position of the first open parenthesis and returns the position of the closing parenthesis

```
String s = "5 * (4 + 2) / 2";
Parenthesis.get(s, 4);    // returns 10
```

In fact:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
5		*		(	4		+		2	)		/		2

- Pay attention to nested parenthesis:

```
String s = "5 * (4 / (2 - 1) - 2) / 2";
Parenthesis.get(s, 4);    // returns 20, not 15
```

- The function must:
 - raise an exception called **UnmatchedParenthesisException** if it cannot find a matching closing parenthesis
 - raise an exception called **NotAParenthesisException** if the initial position does not contain a left parenthesis symbol "("
- Write the function a set of at least 5 tests that check the correctness of your implementation
 - Two tests must check that the exceptions are correctly raised
 - One test checks for simple parenthesis
 - Another one checks for 3 levels of parenthesis nesting
 - The last one checks for a matching parenthesis as last character

Use your utility

- Now you should use your utility on a text file
 - Read the file line by line
 - For every line:
 - Print the line on screen
 - below, the number of outer groups of parenthesis, and for every group, and the number of contained groups
 - If there is an error, prints the line number and the error message, and continues with the next line
- Example:

```
(a + (b+c) + (a + (g+h)))  
>>> 1 groups "a + (b+c) + (a + (g+h))"  
>>> 2 groups "b+c", "a + (g+h)"  
>>> 0 groups  
>>> 1 group "g+h"  
>>> 0 groups
```