Building Java Programs

Strings, File I/O

reading: 3.3, 4.3-4.4, 5.4, 6.1 – 6.5

Strings

- **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;
```

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

```
String name = "Ultimate";
```

index	0	1	2	3	4	5	6	7
character	U	l	t	i	m	a	t	e

  - First character's index : 0
  - Last character's index : 1 less than the string's length
  - The individual characters are values of type `char` (seen later)

`String` methods

Method name	Description
`indexOf(`**`str`**`)`	index where the start of the given string appears in this string (-1 if not found)
`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* is 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 starz = "Yeezy & Hova";
System.out.println(starz.length());   // 12
```

Modifying strings

- Methods like `substring` and `toLowerCase` build and return a new string, rather than modifying the current string.

```
String s = "Aceyalone";
s.toUpperCase();
System.out.println(s);   // Aceyalone
```

- To modify a variable's value, you must reassign it:

```
String s = "Aceyalone";
s = s.toUpperCase();
System.out.println(s);   // ACEYALONE
```

`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.endsWith("Kweli")) {
   System.out.println("Pay attention, you gotta listen to hear.");
} else if(name.equalsIgnoreCase("NaS")) {
   System.out.println("I never sleep 'cause sleep is the cousin of
                       death.");
}
```

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
```

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"
```

File input

Reading files

- To read a file, pass a `File` when constructing a `Scanner`.

```
Scanner name = new Scanner(new File("file name"));
```

  - Example:

```
File file = new File("mydata.txt");
Scanner input = new Scanner(file);
```

  - or (shorter):

```
Scanner input = new Scanner(new File("mydata.txt"));
```

- To access `File`: `import java.io.*;`

Using `Scanner` methods

- Avoiding type mismatches:

```
Scanner console = new Scanner(System.in);
System.out.print("How old are you? ");
if (console.hasNextInt()) {
    int age = console.nextInt();   // will not crash!
    System.out.println("Wow, " + age + " is old!");
} else {
    System.out.println("You didn't type an integer.");
}
```

- Avoiding reading past the end of a file:

```
Scanner input = new Scanner(new File("example.txt"));
if (input.hasNext()) {
    String token = input.next();   // will not crash!
    System.out.println("next token is " + token);
}
```

Hours question

- Given a file `hours.txt` with the following contents:

```
123 Ben 12.5 8.1 7.6 3.2
456 Greg 4.0 11.6 6.5 2.7 12
789 Victoria 8.0 8.0 8.0 8.0 7.5
```

  - Consider the task of computing hours worked by each person:

```
Ben (ID#123) worked 31.4 hours (7.85 hours/day)
Greg (ID#456) worked 36.8 hours (7.36 hours/day)
Victoria (ID#789) worked 39.5 hours (7.90 hours/day)
```

The `throws` clause

- **`throws` clause**: Keywords on a method's header that state that it may generate an exception (and will not handle it).

- Syntax:

```
public static type name(params) throws type {
```

  - Example:

```
public class ReadFile {
    public static void main(String[] args)
            throws FileNotFoundException {
```

  - Like saying, *"I hereby announce that this method might throw an exception, and I accept the consequences if this happens."*

Hours answer (flawed)

```
// This solution does not work!
import java.io.*;                   // for File
import java.util.*;                 // for Scanner

public class HoursWorked {
    public static void main(String[] args)
            throws FileNotFoundException {
        Scanner input = new Scanner(new File("hours.txt"));
        while (input.hasNext()) {
            // process one person
            int id = input.nextInt();
            String name = input.next();
            double totalHours = 0.0;
            int days = 0;
            while (input.hasNextDouble()) {
                totalHours += input.nextDouble();
                days++;
            }
            System.out.println(name + " (ID#" + id +
                    ") worked " + totalHours + " hours (" +
                    (totalHours / days) + " hours/day)");
        }
    }
}
```

Flawed output

```
Ben (ID#123) worked 487.4 hours (97.48 hours/day)
Exception in thread "main"
java.util.InputMismatchException
        at java.util.Scanner.throwFor(Scanner.java:840)
        at java.util.Scanner.next(Scanner.java:1461)
        at java.util.Scanner.nextInt(Scanner.java:2091)
        at HoursWorked.main(HoursBad.java:9)
```

- The inner `while` loop is grabbing the next person's ID.
- We want to process the tokens, but we also care about the line breaks (they mark the end of a person's data).

- A better solution is a hybrid approach:
  - First, break the overall input into lines.
  - Then break each line into tokens.

Line-based `Scanner` methods

Method	Description
`nextLine()`	returns next entire line of input (from cursor to `\n`)
`hasNextLine()`	returns `true` if there are any more lines of input to read (always true for console input)

```
Scanner input = new Scanner(new File("<filename>"));
while (input.hasNextLine()) {
    String line = input.nextLine();
    <process this line>;
}
```

Scanners on Strings

- A `Scanner` can tokenize the contents of a `String`:

```
Scanner <name> = new Scanner(<String>);
```

  - Example:

```
String text = "15  3.2 hello   9  27.5";
Scanner scan = new Scanner(text);

int num = scan.nextInt();
System.out.println(num);              // 15

double num2 = scan.nextDouble();
System.out.println(num2);             // 3.2

String word = scan.next();
System.out.println(word);             // "hello"
```

Mixing lines and tokens

Input file `input.txt`:	Output to console:
`The quick brown fox jumps over` `the lazy dog.`	`Line has 6 words` `Line has 3 words`

```
// Counts the words on each line of a file
Scanner input = new Scanner(new File("input.txt"));
while (input.hasNextLine()) {
    String line = input.nextLine();
    Scanner lineScan = new Scanner(line);

    // process the contents of this line
    int count = 0;
    while (lineScan.hasNext()) {
        String word = lineScan.next();
        count++;
    }
    System.out.println("Line has " + count + " words");
}
```

Hours question

- Fix the `Hours` program to read the input file properly:

```
123 Ben 12.5 8.1 7.6 3.2
456 Greg 4.0 11.6 6.5 2.7 12
789 Victoria 8.0 8.0 8.0 8.0 7.5
```

  - Recall, it should produce the following output:

```
Ben (ID#123) worked 31.4 hours (7.85 hours/day)
Greg (ID#456) worked 36.8 hours (7.36 hours/day)
Victoria (ID#789) worked 39.5 hours (7.90 hours/day)
```

Hours answer, corrected

```
// Processes an employee input file and outputs each employee's hours.
import java.io.*;    // for File
import java.util.*;  // for Scanner

public class Hours {
    public static void main(String[] args) throws FileNotFoundException {
        Scanner input = new Scanner(new File("hours.txt"));
        while (input.hasNextLine()) {
            String line = input.nextLine();
            processEmployee(line);
        }
    }

    public static void processEmployee(String line) {
        Scanner lineScan = new Scanner(line);
        int id = lineScan.nextInt();           // e.g. 456
        String name = lineScan.next();         // e.g. "Greg"
        double sum = 0.0;
        int count = 0;
        while (lineScan.hasNextDouble()) {
            sum = sum + lineScan.nextDouble();
            count++;
        }

        double average = sum / count;
        System.out.println(name + " (ID#" + id + ") worked " +
            sum + " hours (" + average + " hours/day)");
    }
}
```

File output

reading: 6.4 - 6.5

Output to files

- **`PrintStream`**: An object in the `java.io` package that lets you print output to a destination such as a file.
  - Any methods you have used on `System.out` (such as `print`, `println`) will work on a `PrintStream`.

- Syntax:

```
PrintStream <name> = new PrintStream(new File("<filename>"));
```

Example:

```
PrintStream output = new PrintStream(new File("out.txt"));
output.println("Hello, file!");
output.println("This is a second line of output.");
```

Details about `PrintStream`

```
PrintStream <name> = new PrintStream(new File("<filename>"));
```

- If the given file does not exist, it is created.
- If the given file already exists, it is overwritten.

- The output you print appears in a file, not on the console. You will have to open the file with an editor to see it.

- Do not open the same file for both reading (`Scanner`) and writing (`PrintStream`) at the same time.
  - You will overwrite your input file with an empty file (0 bytes).

`PrintStream` question

- Modify our previous Hours program to use a `PrintStream` to send its output to the file `hours_out.txt`.
  - The program will produce no console output.
  - But the file `hours_out.txt` will be created with the text:

```
Ben (ID#123) worked 31.4 hours (7.85 hours/day)
Greg (ID#456) worked 36.8 hours (7.36 hours/day)
Victoria (ID#789) worked 39.5 hours (7.9 hours/day)
```

PrintStream answer

```
// Processes an employee input file and outputs each employee's hours.
import java.io.*;    // for File
import java.util.*;  // for Scanner

public class Hours2 {
    public static void main(String[] args) throws FileNotFoundException {
        Scanner input = new Scanner(new File("hours.txt"));
        PrintStream out = new PrintStream(new File("hours_out.txt"));
        while (input.hasNextLine()) {
            String line = input.nextLine();
            processEmployee(out, line);
        }
    }

    public static void processEmployee(PrintStream out, String line) {
        Scanner lineScan = new Scanner(line);
        int id = lineScan.nextInt();          // e.g. 456
        String name = lineScan.next();        // e.g. "Greg"
        double sum = 0.0;
        int count = 0;
        while (lineScan.hasNextDouble()) {
            sum = sum + lineScan.nextDouble();
            count++;
        }

        double average = sum / count;
        out.println(name + " (ID#" + id + ") worked " +
                    sum + " hours (" + average + " hours/day)");
    }
}
```