

Building Java Programs

Chapter 6

Lecture 6-1: File Input with Scanner

reading: 6.1 - 6.2, 5.4

Input/output (I/O)

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

- Create a `File` object to get info about a file on your drive.
 - (This doesn't actually create a new file on the hard disk.)

```
File f = new File("example.txt");  
if (f.exists() && f.length() > 1000) {  
    f.delete();  
}
```

Method name	Description
<code>canRead()</code>	returns whether file is able to be read
<code>delete()</code>	removes file from disk
<code>exists()</code>	whether this file exists on disk
<code>getName()</code>	returns file's name
<code>length()</code>	returns number of bytes in file

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Reading files

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

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

- Example:

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

- or (shorter):

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

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File paths

- **absolute path:** specifies a drive or a top "/" folder

```
C:/Documents/smith/hw6/input/data.csv
```

- Windows can also use backslashes to separate folders.

- **relative path:** does not specify any top-level folder

```
names.dat  
input/kinglear.txt
```

- Assumed to be relative to the *current directory*:

```
Scanner input = new Scanner(new File("data/readme.txt"));
```

If our program is in `H:/hw6`, the Scanner will look for
`H:/hw6/data/readme.txt`

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Compiler error w/ files

```
import java.io.*;    // for File
import java.util.*; // for Scanner

public class ReadFile {
    public static void main(String[] args) {
        Scanner input = new Scanner(new File("data.txt"));
        String text = input.next();
        System.out.println(text);
    }
}
```

- The program fails to compile with the following error:

```
ReadFile.java:6: unreported exception java.io.FileNotFoundException;
must be caught or declared to be thrown
    Scanner input = new Scanner(new File("data.txt"));
                               ^
```

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Exceptions



- **exception:** An object representing a runtime error.
 - dividing an integer by 0
 - calling `substring` on a `String` and passing too large an index
 - trying to read the wrong type of value from a `Scanner`
 - trying to read a file that does not exist
- We say that a program with an error "*throws*" an exception.
- It is also possible to "*catch*" (handle or fix) an exception.
- **checked exception:** An error that must be handled by our program (otherwise it will not compile).
 - We must specify how our program will handle file I/O failures.

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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> (...) 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."*

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Input tokens

- **token:** A unit of user input, separated by whitespace.
 - A Scanner splits a file's contents into tokens.
- If an input file contains the following:

```
23  3.14  
"John Smith"
```

The Scanner can interpret the tokens as the following types:

<u>Token</u>	<u>Type(s)</u>
23	int, double, String
3.14	double, String
"John Smith"	String String

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Files and input cursor

- Consider a file `weather.txt` that contains this text:

```
16.2  23.5
      19.1 7.4  22.8

18.5  -1.8 14.9
```

- A `Scanner` views all input as a stream of characters:

```
16.2  23.5\n19.1 7.4  22.8\n\n18.5  -1.8 14.9\n
```

- **input cursor:** The current position of the `Scanner`.

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Consuming tokens

- **consuming input:** Reading input and advancing the cursor.
 - Calling `nextInt` etc. moves the cursor past the current token.

```
16.2  23.5\n19.1 7.4  22.8\n\n18.5  -1.8 14.9\n
```

```
double d = input.nextDouble(); // 16.2
```

```
16.2  23.5\n19.1 7.4  22.8\n\n18.5  -1.8 14.9\n
```

```
String s = input.next(); // "23.5"
```

```
16.2  23.5\n19.1 7.4  22.8\n\n18.5  -1.8 14.9\n
```

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File input question

- Recall the input file `weather.txt`:

```
16.2  23.5
      19.1 7.4  22.8
18.5  -1.8 14.9
```

- Write a program that prints the change in temperature between each pair of neighboring days.

```
16.2 to 23.5, change = 7.3
23.5 to 19.1, change = -4.4
19.1 to 7.4, change = -11.7
7.4 to 22.8, change = 15.4
22.8 to 18.5, change = -4.3
18.5 to -1.8, change = -20.3
-1.8 to 14.9, change = 16.7
```

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File input answer

```
// Displays changes in temperature from data in an input file.
import java.io.*;    // for File
import java.util.*; // for Scanner

public class Temperatures {
    public static void main(String[] args)
        throws FileNotFoundException {
        Scanner input = new Scanner(new File("weather.txt"));
        double prev = input.nextDouble(); // fencepost
        for (int i = 1; i <= 7; i++) {
            double next = input.nextDouble();
            System.out.println(prev + " to " + next +
                ", change = " + (next - prev));
            prev = next;
        }
    }
}
```

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Reading an entire file

- Suppose we want our program to work no matter how many numbers are in the file.
 - Currently, if the file has more numbers, they will not be read.
 - If the file has fewer numbers, what will happen?

A crash! Example output from a file with just 3 numbers:

```
16.2 to 23.5, change = 7.3
23.5 to 19.1, change = -4.4
```

```
Exception in thread "main" java.util.NoSuchElementException
    at java.util.Scanner.throwFor(Scanner.java:838)
    at java.util.Scanner.next(Scanner.java:1347)
    at Temperatures.main(Temperatures.java:12)
```

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Scanner exceptions

- NoSuchElementException
 - You read past the end of the input.
- InputMismatchException
 - You read the wrong type of token (e.g. read "hi" as an int).
- Finding and fixing these exceptions:
 - Read the exception text for line numbers in your code (the first line that mentions your file; often near the bottom):

```
Exception in thread "main" java.util.NoSuchElementException
    at java.util.Scanner.throwFor(Scanner.java:838)
    at java.util.Scanner.next(Scanner.java:1347)
    at MyProgram.myMethodName(MyProgram.java:19)
    at MyProgram.main(MyProgram.java:6)
```

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Scanner tests for valid input

Method	Description
<code>hasNext()</code>	returns <code>true</code> if there is a next token
<code>hasNextInt()</code>	returns <code>true</code> if there is a next token and it can be read as an <code>int</code>
<code>hasNextDouble()</code>	returns <code>true</code> if there is a next token and it can be read as a <code>double</code>

- These methods of the `Scanner` do not consume input; they just give information about what the next token will be.
 - Useful to see what input is coming, and to avoid crashes.
 - These methods can be used with a console `Scanner`, as well.
 - When called on the console, they sometimes pause waiting for input.

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Using hasNext 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);
}
```

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File input question 2

- Modify the temperature program to process the entire file, regardless of how many numbers it contains.
 - Example: If a ninth day's data is added, output might be:

```
16.2 to 23.5, change = 7.3
23.5 to 19.1, change = -4.4
19.1 to 7.4, change = -11.7
7.4 to 22.8, change = 15.4
22.8 to 18.5, change = -4.3
18.5 to -1.8, change = -20.3
-1.8 to 14.9, change = 16.7
14.9 to 16.1, change = 1.2
```

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File input answer 2

```
// Displays changes in temperature from data in an input file.
import java.io.*;    // for File
import java.util.*; // for Scanner

public class Temperatures {
    public static void main(String[] args)
        throws FileNotFoundException {
        Scanner input = new Scanner(new File("weather.txt"));
        double prev = input.nextDouble(); // fencepost
        while (input.hasNextDouble()) {
            double next = input.nextDouble();
            System.out.println(prev + " to " + next +
                ", change = " + (next - prev));
            prev = next;
        }
    }
}
```

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File input question 3

- Modify the temperature program to handle files that contain non-numeric tokens (by skipping them).
- For example, it should produce the same output as before when given this input file, `weather2.txt`:

```
16.2  23.5
Tuesday 19.1  Wed 7.4  THURS. TEMP: 22.8

18.5  -1.8  <-- Marty here is my data!  --Kim
14.9  :-)
```

- You may assume that the file begins with a real number.

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File input answer 3

```
// Displays changes in temperature from data in an input file.
import java.io.*;    // for File
import java.util.*; // for Scanner

public class Temperatures2 {
    public static void main(String[] args)
        throws FileNotFoundException {
        Scanner input = new Scanner(new File("weather.txt"));
        double prev = input.nextDouble(); // fencepost
        while (input.hasNext()) {
            if (input.hasNextDouble()) {
                double next = input.nextDouble();
                System.out.println(prev + " to " + next +
                    ", change = " + (next - prev));
                prev = next;
            } else {
                input.next(); // throw away unwanted token
            }
        }
    }
}
```

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