Assertions and Text I/O

Introduction to Programming and Computational Problem Solving - 2
CSE 8B
Lecture 13
Announcements

• Assignment 6 is due today, 11:59 PM
• Quiz 6 is Nov 11
• Assignment 7 will be released today
  – Due Nov 16, 11:59 PM
• Educational research study
  – Nov 11, weekly survey
• Reading
  – Programming with Assertions
    https://docs.oracle.com/javase/8/docs/technotes/guides/language/assert.html
  – Liang
    • Chapter 12
Exceptions

• Exceptions are runtime errors caused by your program and external circumstances
  – These errors can be caught and handled by your program
Exception handling

• Exception handling separates error-handling code from normal programming tasks
  – Makes programs easier to read and to modify
• The try block contains the code that is executed in normal circumstances
• The catch block contains the code that is executed in exceptional circumstances
• A method should throw an exception if the error needs to be handled by its caller
• Warning: exception handling usually requires more time and resources because it requires instantiating a new exception object, rolling back the call stack, and propagating the errors to the calling methods
Assertions

• An assertion is a Java statement that enables you to assert an assumption about your program
• An assertion contains a Boolean expression that should be true during program execution
• Assertions can be used to assure program correctness and avoid logic errors
Declaring assertions

• An assertion is declared using the Java keyword assert
  
  `assert assertion;`

or

  `assert assertion : detailMessage;`

where assertion is a Boolean expression and detailMessage is a primitive-type or an Object value
Executing assertions

• When an assertion statement is executed, Java evaluates the assertion
• If it is false, an AssertionError will be thrown
• The AssertionError class has a no-arg constructor and seven overloaded single-argument constructors of type int, long, float, double, boolean, char, and Object
Executing assertions

• For the first assert statement with no detail message, the no-arg constructor of AssertionError is used

• For the second assert statement with a detail message, an appropriate AssertionError constructor is used to match the data type of the message

• Since AssertionError is a subclass of Error, when an assertion becomes false, the program displays a message on the console and exits
Executing assertions example

```java
public class AssertionDemo {
    public static void main(String[] args) {
        int i;
        int sum = 0;
        for (i = 0; i < 10; i++) {
            sum += i;
        }
        assert i == 10;
        assert sum > 10 && sum < 5 * 10 : "sum is " + sum;
    }
}
```
Executing assertions example

• A best practice is to place assertions in a switch statement without a default case

  – Example

    switch (month) {
      case 1: ... ; break;
      case 2: ... ; break;
      ...
      case 12: ... ; break;
      default: assert false : "Invalid month: " + month
    }
Running programs with assertions

• By default, the assertions are disabled at runtime
• To enable them, use the switch `-enableassertions`, or `-ea` for short, as follows
  java -ea AssertionDemo
• Assertions can be selectively enabled or disabled at class level or package level
• The disable switch is `-disableassertions` or `-da` for short
• For example, the following command enables assertions in package `package1` and disables assertions in class `Class1`
  java -ea:package1 -da:Class1 AssertionDemo
Using exception handling or assertions

• **Assertions should not be used to replace exception handling**
• *Exception handling* deals with unusual circumstances during program execution
• **Assertions** are to assure the correctness of the program
• *Exception handling* addresses robustness
• **Assertions** address correctness
• Like exception handling, assertions are not used for normal tests, but for internal consistency and validity checks
• Assertions are checked at runtime and can be turned on or off at startup time
Using exception handling or assertions

• Do not use assertions for argument checking in public methods

• Valid arguments that may be passed to a public method are part of the method’s contract

• The contract must always be obeyed whether assertions are enabled or disabled

  – For example, the following code in the Circle class should be rewritten using exception handling

    ```java
    public void setRadius(double newRadius) {
      assert newRadius >= 0;
      radius = newRadius;
    }
    ```
Programming with assertions

• Use assertions to reaffirm assumptions
• This gives you more confidence to assure correctness of the program
• A common use of assertions is to replace assumptions with assertions in the code
• A best practice is to use assertions liberally
• Assertions are checked at runtime and can be turned on or off at startup time, unlike exception handling
Text I/O

• In order to perform I/O, you need to create objects using appropriate Java I/O classes
  – The objects contain the methods for reading/writing data from/to a file
    File
    Scanner
    PrintWriter
Absolute file names

- Absolute file name includes full path
  - Unix
    
    /home/bochoa/cse8b/assignment7/Assignment7.java
  
  - Java string
    
    String pathname =
    "/home/bochoa/cse8b/assignment7/Assignment7.java";
  
  - Windows
    
    C:\cse8b\assignment7\Assignment7.java

  - Java string
    
    String pathname =
    "C:\cse8b\assignment7\Assignment7.java";
Relative file names

• Relative file name includes path relative to working directory
  – For example, if you are in directory cse8b
    • Unix
      assignment7/Assignment7.java
      – Java string
        String pathname = "assignment7/Assignment7.java"
    • Windows
      assignment7\Assignment7.java
      – Java string
        String pathname = "assignment7\\Assignment7.java"
The File class

• The File class is intended to provide an abstraction that deals with most of the machine-dependent complexities of files and path names in a machine-independent fashion

• The file name is a string

• The File class is a wrapper class for the file name and its directory path
The class `java.io.File` provides a way to handle file system paths and operations. Here are some of its methods and what they do:

- **`File(pathname: String)`**: Creates a `File` object for the specified path name. The path name may be a directory or a file.
- **`File(parent: String, child: String)`**: Creates a `File` object for the child under the directory parent. The child may be a file name or a subdirectory.
- **`File(parent: File, child: String)`**: Creates a `File` object for the child under the directory parent. The parent is a `File` object. In the preceding constructor, the parent is a string.
- **`exists(): boolean`**: Returns true if the file or the directory represented by the `File` object exists.
- **`canRead(): boolean`**: Returns true if the file represented by the `File` object exists and can be read.
- **`canWrite(): boolean`**: Returns true if the file represented by the `File` object exists and can be written.
- **`isDirectory(): boolean`**: Returns true if the `File` object represents a directory.
- **`isFile(): boolean`**: Returns true if the `File` object represents a file.
- **`isAbsolute(): boolean`**: Returns true if the `File` object is created using an absolute path name.
- **`isHidden(): boolean`**: Returns true if the file represented in the `File` object is hidden. The exact definition of hidden is system-dependent. On Windows, you can mark a file hidden in the File Properties dialog box. On Unix systems, a file is hidden if its name begins with a period(·) character.

The class also provides methods to get and set the absolute and canonical paths of the `File` object:

- **`getAbsolutePath(): String`**: Returns the complete absolute file or directory name represented by the `File` object.
- **`getCanonicalPath(): String`**: Returns the same as `getAbsolutePath()` except that it removes redundant names, such as `"."` and `".....", from the path name, resolves symbolic links (on Unix), and converts drive letters to standard uppercase (on Windows).

Methods to get the last name of the directory and file name:

- **`getName(): String`**: Returns the last name of the complete directory and file name represented by the `File` object. For example, `new File("c:\book\test.dat")`.getName() returns test.dat.

Methods to get the complete directory and file name:

- **`getPath(): String`**: Returns the complete directory and file name represented by the `File` object. For example, `new File("c:\book\test.dat")`.getPath() returns c:\book\test.dat.

Methods to get the complete parent directory:

- **`getParent(): String`**: Returns the complete parent directory of the current directory or the file represented by the `File` object. For example, `new File("c:\book\test.dat")`.getParent() returns c:\book.

Methods to get the last modified time:

- **`lastModified(): long`**: Returns the time that the file was last modified.

Methods to get the size of the file:

- **`length(): Long`**: Returns the size of the file, or 0 if it does not exist or if it is a directory.

Methods to list the files under a directory:

- **`listFiles(): File[]`**: Returns the files under the directory for a directory `File` object.

Methods to delete files or directories:

- **`delete(): boolean`**: Deletes the file or directory represented by this `File` object. The method returns true if the deletion succeeds.

Methods to create directories:

- **`mkdir(): boolean`**: Renames the file or directory represented by this `File` object to the specified name represented in dest. The method returns true if the operation succeeds.

- **`mkdirs(): boolean`**: Creates a directory represented in this `File` object. Returns true if the directory is created successfully.

   Same as `mkdir()` except that it creates directory along with its parent directories if the parent directories do not exist.
public class TestFileClass {
    public static void main(String[] args) {
        java.io.File file = new java.io.File("image/us.gif");
        System.out.println("Does it exist? " + file.exists());
        System.out.println("The file has " + file.length() + " bytes");
        System.out.println("Can it be read? " + file.canRead());
        System.out.println("Can it be written? " + file.canWrite());
        System.out.println("Is it a directory? " + file.isDirectory());
        System.out.println("Is it a file? " + file.isFile());
        System.out.println("Is it absolute? " + file.isAbsolute());
        System.out.println("Is it hidden? " + file.isHidden());
        System.out.println("Absolute path is " +
                file.getAbsolutePath());
        System.out.println("Last modified on " +
                new java.util.Date(file.lastModified()));
    }
}
A File object encapsulates the properties of a file or a path, but does not contain the methods for reading/writing data from/to a file.

In order to perform I/O, you need to create objects using appropriate Java I/O classes:

- The objects contain the methods for reading/writing data from/to a file.

Use the Scanner class for reading text data from a file.

Use the PrintWriter class for writing text data to a file.
Reading data from the console

• Create a Scanner object
  Scanner input = new Scanner(System.in);
  – Example
    System.out.print("Enter a double value: ");
    Scanner input = new Scanner(System.in);
    double d = input.nextDouble();
Reading data using Scanner

• Reading data from the console
  Scanner input = new Scanner(System.in);

• Reading data from a file
  Scanner input = new Scanner(new File(filename));
# Reading data using Scanner

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>+Scanner(source: File)</td>
<td>Creates a Scanner object to read data from the specified file.</td>
</tr>
<tr>
<td>+Scanner(source: String)</td>
<td>Creates a Scanner object to read data from the specified string.</td>
</tr>
<tr>
<td>close()</td>
<td>Closes this scanner.</td>
</tr>
<tr>
<td>hasNext(): boolean</td>
<td>Returns true if this scanner has another token in its input.</td>
</tr>
<tr>
<td>next(): String</td>
<td>Returns next token as a string.</td>
</tr>
<tr>
<td>nextByte(): byte</td>
<td>Returns next token as a byte.</td>
</tr>
<tr>
<td>nextShort(): short</td>
<td>Returns next token as a short.</td>
</tr>
<tr>
<td>nextInt(): int</td>
<td>Returns next token as an int.</td>
</tr>
<tr>
<td>nextLong(): long</td>
<td>Returns next token as a long.</td>
</tr>
<tr>
<td>nextFloat(): float</td>
<td>Returns next token as a float.</td>
</tr>
<tr>
<td>nextDouble(): double</td>
<td>Returns next token as a double.</td>
</tr>
<tr>
<td>useDelimiter(pattern: String): Scanner</td>
<td>Sets this scanner’s delimiting pattern.</td>
</tr>
</tbody>
</table>
public class ReadData {
    public static void main(String[] args) throws Exception {
        // Create a File instance
        java.io.File file = new java.io.File("scores.txt");

        // Create a Scanner for the file
        Scanner input = new Scanner(file);

        // Read data from a file
        while (input.hasNext()) {
            String firstName = input.next();
            String mi = input.next();
            String lastName = input.next();
            int score = input.nextInt();
            System.out.println(firstName + " " + mi + " " + lastName + " " + score);
        }

        // Close the file
        input.close();
    }
}
Reading data from the internet

• Just like you can read data from a file on the computer, you can read data from a file on the internet
public class ReadFileFromURL {
    public static void main(String[] args) {
        System.out.print("Enter a URL: ");
        String URLString = new Scanner(System.in).next();

        try {
            java.net.URL url = new java.net.URL(URLString);
            int count = 0;
            Scanner input = new Scanner(url.openStream());
            while (input.hasNext()) {
                String line = input.nextLine();
                count += line.length();
            }

            System.out.println("The file size is " + count + " characters");
        }
        catch (java.net.MalformedURLException ex) {
            System.out.println("Invalid URL");
        }
        catch (java.io.IOException ex) {
            System.out.println("IO Errors");
        }
    }
}
Writing data using PrintWriter

<table>
<thead>
<tr>
<th>java.io.PrintWriter</th>
<th>Creates a PrintWriter for the specified file.</th>
</tr>
</thead>
<tbody>
<tr>
<td>+PrintWriter(filename: String)</td>
<td>Writes a string.</td>
</tr>
<tr>
<td>+print(s: String): void</td>
<td>Writes a character.</td>
</tr>
<tr>
<td>+print(c: char): void</td>
<td>Writes an array of character.</td>
</tr>
<tr>
<td>+print(cArray: char[]): void</td>
<td>Writes an int value.</td>
</tr>
<tr>
<td>+print(i: int): void</td>
<td>Writes a long value.</td>
</tr>
<tr>
<td>+print(l: long): void</td>
<td>Writes a float value.</td>
</tr>
<tr>
<td>+print(f: float): void</td>
<td>Writes a double value.</td>
</tr>
<tr>
<td>+print(d: double): void</td>
<td>Writes a boolean value.</td>
</tr>
<tr>
<td>+print(b: boolean): void</td>
<td>A println method acts like a print method; additionally it prints a line separator. The line separator string is defined by the system. It is \n on Windows and \n on Unix. The printf method was introduced in §4.6, “Formatting Console Output and Strings.”</td>
</tr>
</tbody>
</table>

Also contains the overloaded println methods.

Also contains the overloaded printf methods.
public class WriteData {
    public static void main(String[] args) throws java.io.IOException {
        java.io.File file = new java.io.File("scores.txt");
        if (file.exists()) {
            System.out.println("File already exists");
            System.exit(0);
        }

        // Create a file
        java.io.PrintWriter output = new java.io.PrintWriter(file);

        // Write formatted output to the file
        output.print("John T Smith ");
        output.println(90);
        output.print("Eric K Jones ");
        output.println(85);

        // Close the file
        output.close();
    }
}
Use try-with-resources syntax

• When reading or writing programmers often forget to close the file
• The try-with-resources syntax automatically closes the files
  – Write file example

```java
try {
    // Create a file
    java.io.PrintWriter output = new java.io.PrintWriter(file);

    // Write formatted output to the file
    output.print("John T Smith ");
    output.println(90);
    output.print("Eric K Jones ");
    output.println(85);
}
```
public class ReplaceText {
    public static void main(String[] args) throws Exception {
        // Check command line parameter usage
        if (args.length != 4) {
            System.out.println(
                "Usage: java ReplaceText sourceFile targetFile oldStr newStr");
            System.exit(1);
        }

        // Check if source file exists
        File sourceFile = new File(args[0]);
        if (!sourceFile.exists()) {
            System.out.println("Source file " + args[0] + " does not exist");
            System.exit(2);
        }

        // Check if target file exists
        File targetFile = new File(args[1]);
        if (targetFile.exists()) {
            System.out.println("Target file " + args[1] + " already exists");
            System.exit(3);
        }

        try {
            // Create input and output files
            Scanner input = new Scanner(sourceFile);
            PrintWriter output = new PrintWriter(targetFile);
            while (input.hasNext()) {
                String s1 = input.nextLine();
                String s2 = s1.replaceAll(args[2], args[3]);
                output.println(s2);
            }
        }
    }
}

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Next Lecture

• Abstract classes
• Reading
  – Liang
    • Chapter 13