# 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 12
- Assignment 7 will be released today
  - Due Nov 17, 11:59 PM
- Educational research study
  - Nov 12, 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

```
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

```
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/hw7/Assignment7.java`

    - Java string

      ```
      String pathname = "/home/bochoa/cse8b/hw7/Assignment7.java"
      ```

  - Windows

    `C:\cse8b\hw7\Assignment7.java`

    - Java string

      ```
      String pathname = "C:\\cse8b\\hw7\\Assignment7.java"
      ```

# Relative file names

- Relative file name includes path relative to working directory
  - For example, if you are in directory `cse8b`
    - Unix

      `hw7/Assignment7.java`

      - Java string

        ```
        String pathname = "hw7/Assignment7.java"
        ```

    - Windows

      `hw7\Assignment7.java`

      - Java string

        ```
        String pathname = "hw7\\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

| java.io.File | |
|---|---|
| `+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. |
| `+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). |
| `+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`. |
| `+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`. |
| `+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`. |
| `+lastModified(): long` | Returns the time that the file was last modified. |
| `+length(): long` | Returns the size of the file, or 0 if it does not exist or if it is a directory. |
| `+listFile(): File[]` | Returns the files under the directory for a directory `File` object. |
| `+delete(): boolean` | Deletes the file or directory represented by this `File` object.The method returns true if the deletion succeeds. |
| `+renameTo(dest: File): 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. |
| `+mkdir(): boolean` | Creates a directory represented in this `File` object. Returns true if the the directory is created successfully. |
| `+mkdirs(): boolean` | Same as `mkdir()` except that it creates directory along with its parent directories if the parent directories do not exist. |

# The `File` class example

```
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()));
  }
}
```

# File text I/O

- 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

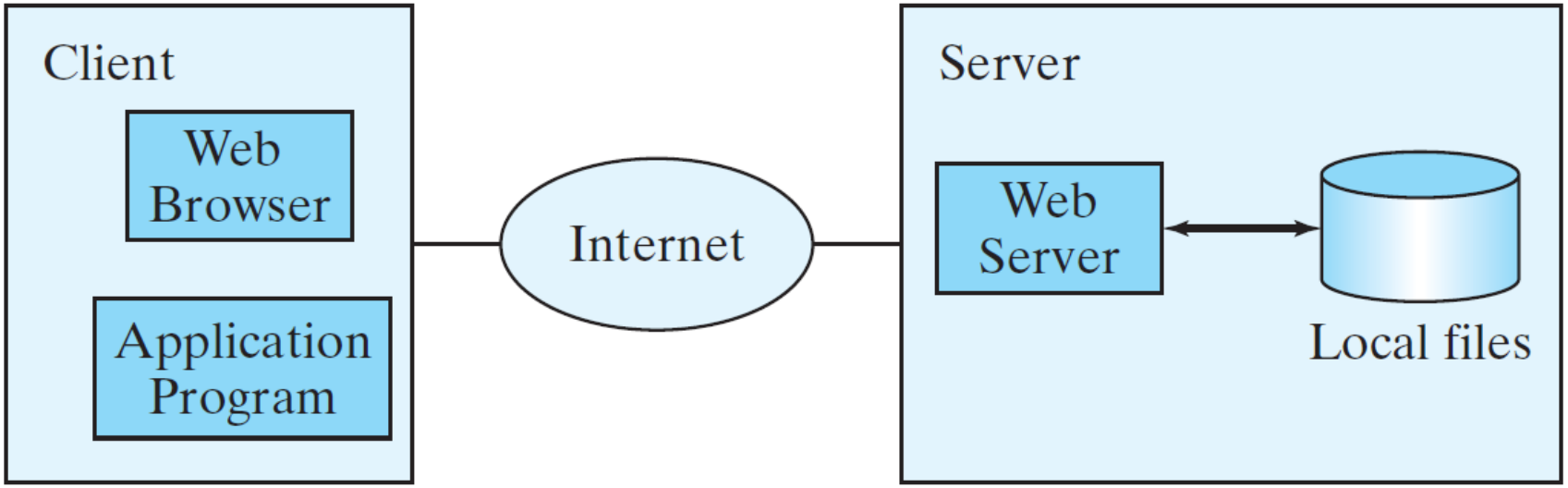
| java.util.Scanner | |
|---|---|
| +Scanner(source: File) | Creates a Scanner object to read data from the specified file. |
| +Scanner(source: String) | Creates a Scanner object to read data from the specified string. |
| +close() | Closes this scanner. |
| +hasNext(): boolean | Returns true if this scanner has another token in its input. |
| +next(): String | Returns next token as a string. |
| +nextByte(): byte | Returns next token as a byte. |
| +nextShort(): short | Returns next token as a short. |
| +nextInt(): int | Returns next token as an int. |
| +nextLong(): long | Returns next token as a long. |
| +nextFloat(): float | Returns next token as a float. |
| +nextDouble(): double | Returns next token as a double. |
| +useDelimiter(pattern: String): Scanner | Sets this scanner's delimiting pattern. |

# Reading data from a file

```
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



# Reading data from 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`

| java.io.PrintWriter | |
|---|---|
| +PrintWriter(filename: String) | Creates a PrintWriter for the specified file. |
| +print(s: String): void | Writes a string. |
| +print(c: char): void | Writes a character. |
| +print(cArray: char[]): void | Writes an array of character. |
| +print(i: int): void | Writes an int value. |
| +print(l: long): void | Writes a long value. |
| +print(f: float): void | Writes a float value. |
| +print(d: double): void | Writes a double value. |
| +print(b: boolean): void | Writes a boolean value. |
| Also contains the overloaded println methods. | 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 \r\n on Windows and \n on Unix. |
| Also contains the overloaded printf methods. | The printf method was introduced in §4.6, "Formatting Console Output and Strings." |

# Writing data to a file

```
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

```
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);
    }
```

# File I/O example

```
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);
      }
    }
  }
}
```

# Next Lecture

- Abstract classes
- Reading
  - Liang
    - Chapter 13