Streams and File I/O

Chapter 10

*JAVA: An Introduction to Problem Solving & Programming, 6*th Ed. By Walter Savitch
ISBN 0132162709

Objectives

- Describe the concept of an I/O stream
- Explain the difference between text and binary files
- Save data in a file
- Read data in a file

The Concept of a Stream

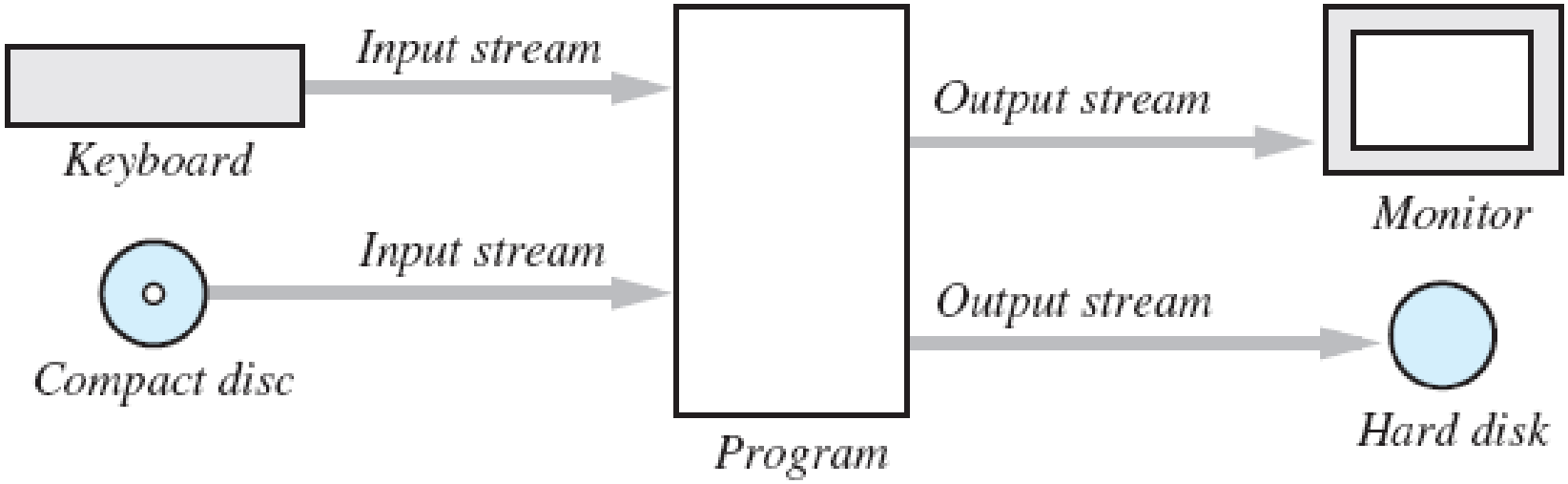
- Use of files
  - Store Java classes, programs
  - Store pictures, music, videos
  - Can also use files to store program I/O
- A *stream* is a flow of input or output data
  - Characters
  - Numbers
  - Bytes
- A stream is implemented as an object.

The Concept of a Stream

- Input streams take data from a source such as a file or the keyboard, and deliver it to a program.
  - *Data flowing into a program*
  - Used for **reading** data
  - Example: **`Scanner`**
- Output streams deliver data to a destination such as a file or the screen.
  - *Data flowing out of a program*
  - Used for **writing** data
  - Examples: **`System.out`**, **`System.err`**

The Concept of a Stream

- Figure 10.1 I/O Streams



Why Use Files for I/O

- Keyboard input, screen output deal with temporary data
  - When program ends, data is gone
- Data in a file remains after program ends
  - Can be used next time program runs
  - Can be used by another program

Text Files and Binary Files

- All data in files stored as binary digits
  - Long series of zeros and ones
- Files treated as sequence of characters called *text files*
  - Java program source code
  - Can be viewed, edited with text editor
- All other files are called *binary files*
  - Movie, music files
  - Access requires specialized program

Text-File I/O: Outlline

- Creating a Text File
- Appending to a text File
- Reading from a Text File
- Download from SavitchSrc link ch10
  - **`TextFileOutputDemo.java`**
  - **`AppendTextFile.java`**
  - **`TextFileInputDemo.java`**
  - **`TextFileInputDemo2.java`**

Creating a Text File

- Class **`PrintWriter`** defines methods needed to create and write to a text file
  - Must import package **`java.io`**
- To open the file
  - Declare *stream variable* for referencing the stream:
    ```
    PrintWriter outStream;
    ```
  - Invoke **`PrintWriter`** constructor, pass file name as argument:
    ```
    outStream = new PrintWriter(fileName);
    ```
  - Requires **`try`** and **`catch`** blocks

Creating a Text File

- File is empty initially
- May now be written to with methods `println` and `print` which work the same for writing text to a file than `System.out.println` and `System.out.print` works for writing to the screen:

```
outStream.println("Line 1");
outStream.print("Line 2");
```

Creating a Text File

- Data goes initially to memory buffer
  - When buffer full, goes to file

- Closing file empties buffer, disconnects from stream:

```
outStream.close();
```

Creating a Text File

- View **`TextFileOutputDemo.java`**

```
Enter three lines of text:
A tall tree
in a short forest is like
a big fish in a small pond.
Those lines were written to out.txt
```

Sample screen output

Resulting File

```
1 A tall tree
2 in a short forest is like
3 a big fish in a small pond.
```

You can use a text editor to read this file.

Creating a Text File

- When creating a file
  - Inform the user of ongoing I/O events, program should not be "silent"
- A file has two names in the program
  - File name used by the operating system
  - The stream name variable
- Opening and writing to file overwrites pre-existing file in directory

Appending to a Text File

- Opening a file new begins with an empty file
  - If already exists, will be overwritten
- Some situations require appending data to existing file
- Command could be

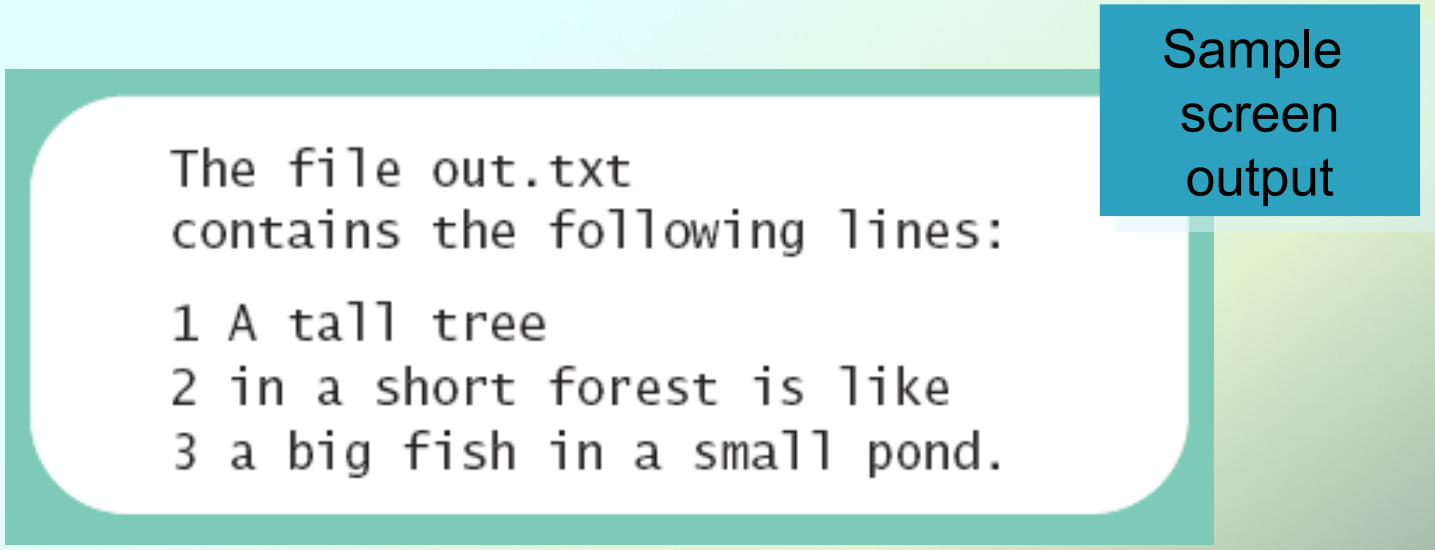
```
outputStream = new PrintWriter(
    new FileOutputstream(fileName, true));
```

- Methods **`println`** and **`print`** would append data at the end
- View **`AppendTextFile.java`**

Reading from a Text File

- View **`TextFileInputDemo.java`**
- Reads text from file, displays on screen
- Note
  - Statement which opens the file
  - Use of **`Scanner`** object
  - Boolean statement which reads the file and terminates reading loop
- Prints file created by **`TextFileOutputDemo.java`**

Reading from a Text File



Reading from a Text File

- Figure 10.3 Additional methods in class **`Scanner`**

Scannner_Object_Name`.hasNext()` Returns true if more input data is available to be read by the method `next`.
Scannner_Object_Name`.hasNextDouble()` Returns true if more input data is available to be read by the method `nextDouble`.
Scannner_Object_Name`.hasNextInt()` Returns true if more input data is available to be read by the method `nextInt`.
Scannner_Object_Name`.hasNextLine()` Returns true if more input data is available to be read by the method `nextLine`.

Techniques for Any File: Outline

- The Class `File`
- Programming Example: Reading a File Name from the Keyboard
- Using Path Names
- Methods of the Class `File`
- Defining a Method to Open a Stream

The Class `File`

- Class provides a way to represent file names in a general way
  - A `File` object represents the name of a file
- The object

  ```
  new File ("treasure.txt")
  ```

  is not simply a string
  - It is an object that *knows* it is supposed to name a file

Programming Example

- Reading a file name from the keyboard
- View **`TextFileInputDemo2.java`**

```
Enter file name: out.txt
The file out.txt
contains the following lines:

1 A tall tree
2 in a short forest is like
3 a big fish in a small pond.
```

Sample screen output

Using Path Names

- Files opened in our examples assumed to be in same folder as where program is being run
- Possible to specify path names
  - Full path name:
    `"D:/homework/hw1/data.txt"`
  - Relative path name
    `"../data.txt"`

Using Path Names

- Be aware of differences of pathname styles in different operating systems

```
"/home/username/hw/hw1/data.txt”
"D:/homework/hw1/data.txt"
```

- Safest to always use Unix-style pathnames, even under Windows:

```
Scanner fileScan = new Scanner(
      new
  File("D:/homework/hw1/data.txt"));
```

Methods of the Class File

- Recall that a **`File`** object is a system-independent abstraction of file's path name
- Class **`File`** has methods to access information about a path and the files in it
  - Whether the file exists
  - Whether it is specified as readable or not
  - Etc.
- View **`FileClassDemo.java`**

Methods of the Class File

- Figure 10.4 Some methods in class **`File`**

`public boolean canRead()` Tests whether the program can read from the file.
`public boolean canWrite()` Tests whether the program can write to the file.
`public boolean delete()` Tries to delete the file. Returns true if it was able to delete the file.
`public boolean exists()` Tests whether an existing file has the name used as an argument to the constructor when the `File` object was created.
`public String getName()` Returns the name of the file. (Note that this name is not a path name, just a simple file name.)
`public String getPath()` Returns the path name of the file.
`public long length()` Returns the length of the file, in bytes.

Examples: File I/O

- **`Scanner`** is very slow
  - not appropriate for reading large data sets
- Use **`PrintWriter`** and **`BufferedReader`** instead
- Download source files from **Examples/File I/O**
  - **`UTF8FileInputDemo.java`**
  - **`UTF8FileOutputDemo.java`**
  - **`UTF8CopyFile.java`**

Arguments to a Java Program

- **`UTF8FileInputDemo`** expects one argument:

```
public static void main(String[] args) {
   // make sure number of arguments is correct
   if (args.length != 1) {
      System.out.println("Usage: java " +
                         UTF8FileInputDemo <filename>");
      System.exit(0);
   }
   ...
```

- Call the programm with an argument (filename) behind the class name – e.g. on command line:

```
java UTF8FileInputDemo file.txt
```

FileUtils.java

- When writing a file, best to have control over encoding and overwrite/append options
- Download **FileUtils.java** from **Examples/File I/O**
- **FileUtils.java** has static methods for creating **PrintWriter** and **BufferedReader** objects with various parameters
- Also see **UTF8CopyFile2.java**

Methods in **FileUtils.java**

```
PrintWriter openPrintWriter(String fileName)
PrintWriter openPrintWriter(File aFile)
PrintWriter openPrintWriter(String fileName, boolean
append)
PrintWriter openPrintWriter(File aFile, boolean append)

BufferedReader openBufferedReader(String fileName)
BufferedReader openBufferedReader(File aFile)
BufferedReader openBufferedReader(String fName, String
encoding)
BufferedReader openBufferedReader(File aFile, String
encoding)
```

Using **PrintWriter**

```
PrintWriter dest;
String text = "Hi Mom!";
int num = 42;

try {
    dest = FileUtils.openPrintWriter("tmp.txt");
    dest.println(text + " My favorite number is " + num);
    dest.close(); // must close file
} catch (UnsupportedEncodingException e) {
    System.out.println("Bad encoding. " + e.getMessage());
    System.exit(0);
} catch (FileNotFoundException e) {
    System.out.println(e.getMessage());
    System.exit(0);
}
```

Using **BufferedReader**

```
BufferedReader src;
String line;
String[] fields;

try {
    src = FileUtils.openBufferedReader("input.txt");
    while ((line = src.readLine()) != null) {
        line = line.trim(); // must trim before splitting
        fields = line.split("\\s+");
        // process fields
    }
    src.close(); // must close file
} catch (UnsupportedEncodingException e) {
    System.out.println("Bad encoding. " + e.getMessage());
    System.exit(0);
} catch (FileNotFoundException e) {
    System.out.println(e.getMessage());
    System.exit(0);
} catch (IOException e) {
    System.out.println(e.getMessage());
    System.exit(0);
}
```

Case Study
Processing a CSV File

- A comma-separated values or CSV file is a simple text format used to store a list of records
- Example from log of a cash register's transactions for the day:

```
SKU,Quantity,Price,Description
4039,50,0.99,SODA
9100,5,9.50,T-SHIRT
1949,30,110.00,JAVA PROGRAMMING TEXTBOOK
5199,25,1.50,COOKIE
```

Example Processing a CSV File

- View **`TransactionReader.java`**
- Uses the **`split`** method which puts strings separated by a delimiter into an array

```
String line = "4039,50,0.99,SODA"
String[] ary = line.split(",");
System.out.println(ary[0]);          // Outputs 4039
System.out.println(ary[1]);          // Outputs 50
System.out.println(ary[2]);          // Outputs 0.99
System.out.println(ary[3]);          // Outputs SODA
```