File I/O - Chapter 10

- A Java stream is a sequence of bytes.
- An InputStream can read from
  - a file
  - the console (System.in)
  - a network socket
  - an array of bytes in memory
  - a StringBuffer
  - a pipe, which is an OutputStream
- An OutputStream can write to
  - a file, etc.

Many Stream Classes

- Java has many different stream classes.
- The classes differ in the methods they provide for converting "regular" Java values to/from sequences of bytes.
- The classes also differ in how they are constructed. For example, can you specify the name of a file as a String when constructing a particular stream class.

Text Files vs Binary Files

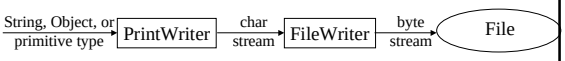
- text files contain "text", usually in ASCII
- everything else is a binary file
- 1234 vs "1234"

byte 0	byte 1	byte 2	byte 3
00000000	00000000	00000100	11010010
0	0	4	210
49	50	51	52

Writing Text Files

```
import java.io.*;

class HelloFile {
  public static void main(String[] args)
        throws java.io.IOException
  {
    PrintWriter out =
     new PrintWriter(new FileWriter("hello.txt"));
    out.println("Hello, file system!");
    out.close();
  }
}
```



Reading Text Files

```
import tio.*;

class FileReadInput {
  public static void main(String[] args)
  {
    ReadInput in = new ReadInput("sample.txt");
    int x = in.readInt();
    double y = in.readDouble();
    String s = in.readWord();
    System.out.println("x = "+x);
    System.out.println("y = "+y);
    System.out.println("s = "+s);
  }
}
```


EOF with hasMoreElements()

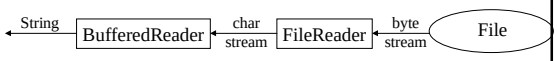
```
//WordCount.java - count the words in a file
import tio.*;

class WordCount {
  public static void main(String[] args)
  {
    ReadInput in = new ReadInput("sample.txt");
    int count = 0;
    while (in.hasMoreElements()){
      String word = in.readWord();
      count++;
    }
    System.out.println("There were "+count+" words.");
  }
}
```

Reading Text Files without tio

```
import java.io.*;

class HelloFileRead2 {
  public static void main(String[] args)
        throws IOException
  {
    BufferedReader in = new BufferedReader(
                  new FileReader("hello.txt"));
    System.out.println(in.readLine());
  }
}
```



7

Formatting Text Output

- C uses printf(…)
- C++ uses streams
  `cout << setw(10) << i<< j << k`
- For tio we followed the C++ model

8

```
//FormattedOutput.java - demo of formatted text output
import tio.*;
class FormattedOutput {
  public static void main(String[] args)
        throws java.io.IOException
  {
    int x = 1, y = 22;
    double z = 4.5678E-20;
    FormattedWriter out = new FormattedWriter(System.out);
    out.setWidth(10);
    out.setDigits(2);
    out.printf("col1");
    out.printf("col2");
    out.printfln("col3");
    out.printf(x);
    out.printf(y);
    out.printfln(z);
  }
}
```

9

```
package tio;
import java.io.*;
import java.text.*;

public class FormattedWriter extends PrintWriter {
  // constants for specifying justification
  public static final int LEFT = 1;
  public static final int RIGHT = 2;

  public FormattedWriter(OutputStream os) {
    super(os, true); // make default auto-flushing
  }
  public FormattedWriter(FileWriter writer) {
    super(writer, true);
  }
  public FormattedWriter(String filename)
    throws java.io.IOException
  {
    this(new FileWriter(filename));
  }
```

10

```
  public void setWidth(int width) {
    if (width < 0)
      this.width = 0;
    else if (width > MAX_WIDTH)
      this.width = MAX_WIDTH;
    else
      this.width = width;
  }

  public void setDigits(int places) {
    decimalPlaces = places;
    form.setMaximumFractionDigits(decimalPlaces);
  }
```

11

```
  public void setJustify(int leftOrRight) {
    if (leftOrRight != LEFT && leftOrRight != RIGHT)
      throw new IllegalArgumentException(
        "use FormattedWriter.LEFT or" +
        " FormattedWriter.RIGHT");
    justify = leftOrRight;
  }

  public void setPadChar(char pad) {
    if (pad == ' ')
      padding = spaces;
    else if (pad == '0')
      padding = zeros;
    else
      padding = buildPadding(MAX_WIDTH, pad);
  }
```

12

```
 public void printf(String s) {
   if (s.length() >= width)
     super.print(s);
   else if (justify == LEFT)
     super.print(s +
         padding.substring(0, width - s.length()));
   else
     super.print(
         padding.substring(0, width - s.length()) + s);
 }

 public void printf(boolean value) {
   printf(String.valueOf(value));
 }

 . . .
```

13

Binary I/O

- DataInputStream/DataOutputStream
- readBoolean(), readInt(), readFloat(),…, readUTF()
- NOT the same as readInt() from tio which reads TEXT and parses it into an int.

14

```
import java.io.*;

class BinIOTest {
  public static void main(String[] args)
           throws IOException
  {
    DataOutputStream out = new DataOutputStream(
                    new FileOutputStream("test.bin"));
    double x = 1.0;
    int count = 10;
    out.writeInt(count);
    for (int i = 0; i < count; i++){
      out.writeDouble(x);
      x = x / 3.0;
    }
    out.close();
```

15

```
     DataInputStream in = new DataInputStream(
                    new FileInputStream("test.bin"));
    count = in.readInt();
    for (int i = 0; i < count; i++){
      System.out.println(in.readDouble());
    }
  }
}
```

16

```
import java.io.*;

class ObjectIO {
  public static void main(String[] args)
      throws Exception
  {
    int[] someArray = {1,2,3};
    Stack stack = new Stack();
    stack.push(new Integer(1));
    stack.push("two");
    stack.push(someArray);

    ObjectOutputStream out =
      new ObjectOutputStream(new FileOutputStream("outfile"));
    out.writeObject(stack);
    out.close();
```

17

```
    stack = null;
    someArray = null;
    ObjectInputStream in = new
      ObjectInputStream(new FileInputStream("outfile"));
    stack = (Stack)(in.readObject());
    someArray = (int[])stack.pop();
    System.out.println(someArray[1]);
    System.out.println(stack.pop());
    System.out.println(stack.pop());
  }
}
```

18

```
//Stack.java - a generic stack
class Stack implements java.io.Serializable {
  Object top() {
    . . .
  }
  void push(Object value) {
    . . .
  }
  Object pop() {
    . . .
  }
  boolean empty() { return top == null; }
  private ListElement top = null;
}
```



```
//ListElement.java - a generic list element
class ListElement implements java.io.Serializable {
  ListElement(Object value) {
    data = value;
  }
  ListElement next;
  Object data;
}
```


EOF

- input method returns a special value
- input method throws an exception
- special method used to check for more input

EOF Summary

Class	Method	EOF detected by
tio.ReadInput	all	hasMoreElements()
	readLine()	returns null
	readChar()	returns -1
java.io.DataInputStream	readPrimitive()	EOFException
	readLine()	returns null
	read()	returns -1
java.io.BufferedReader	readLine()	returns null
	read()	returns -1

Another Example of ObjectIO

- The following example reinforces that an ObjectOutputStream can handle recursive data structures.


```
import java.io.*;
import java.util.Vector;

class Graph implements Serializable {
  Node root;
  void print() {
    root.print();
    root.reset();
  }
}
```

```
class Node implements Serializable {
  int value;
  boolean visited;
  Vector children = new Vector();
  Node(int v) { value = v;}
  void print() {
    if (visited)
      return;
    System.out.print(value + ":");
    for (int i = 0; i < children.size(); i++)
      System.out.print(
         ((Node)(children.elementAt(i))).value + " ");
    System.out.println();
    visited = true;
    for (int i = 0; i < children.size(); i++)
      ((Node)(children.elementAt(i))).print();
  }
```

25

```
  void reset() {
    if (!visited)
      return;
    visited = false;
    for (int i = 0; i < children.size(); i++)
      ((Node)(children.elementAt(i))).reset();

  }
}
```

26

```
class GraphTest {
  public static void main(String[] args)
       throws IOException, ClassNotFoundException
  {
    Graph theGraph = new Graph();
    Node node1 = new Node(1);
    Node node2 = new Node(2);
    Node node3 = new Node(3);
    Node node4 = new Node(4);

    theGraph.root = node1;
    node1.children.add(node2);
    node1.children.add(node3);
    node2.children.add(node4);
    node3.children.add(node4);
    node4.children.add(node1);
    theGraph.print();
```

27

```
    ObjectOutputStream out = new ObjectOutputStream(
                new FileOutputStream("outfile"));
    out.writeObject(theGraph);
    out.close();
  }
}
```

28

```
class GraphRestore {
  public static void main(String[] args)
       throws IOException, ClassNotFoundException
  {
    Graph theGraph;

    ObjectInputStream in = new
      ObjectInputStream(new FileInputStream("outfile"));
    theGraph = (Graph)(in.readObject());
    System.out.println("resurrected");
    theGraph.print();
  }
}
```

29

More about Serializable

- So what can't be serialized automatically?
- There are many things. One example is an open file stream.
- In general, anything that involves state that is outside of the Java Virtual Machine, such as the file system state for an open file stream.

30

Special Handling of Objects

- If you want to serialize an object that requires special handling, have the class implement

```
private void
writeObject(java.io.ObjectOutputStream out)
     throws IOException;
```

and

```
private void
readObject(java.io.ObjectInputStream in)
     throws IOException, ClassNotFoundException;
```

31

```
class Graph implements Serializable {
  Node root;
  void print() {
    root.print();
    root.reset();
  }
  private void writeObject(ObjectOutputStream out)
    throws IOException
  {
    System.out.println("Writing");
    out.defaultWriteObject();
  }
  private void readObject(ObjectInputStream in)
    throws IOException, ClassNotFoundException
  {
    System.out.println("reading");
    in.defaultReadObject();
  }
```

32