Java I/O

Reading, Writing, and stuff – Pt II

Java I/O

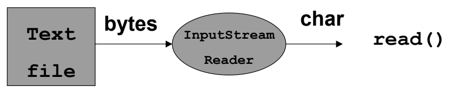
- For the next couple of classes we will be talking about Java I/O
  - Last class: basics and low level I/O
  - This class: "wrappers" and high level I/O
- All Java I/O classes are defined in the `java.io` package.

A question

- Byte -> character conversion
  - In order to support multiple languages (e.g. English, Japanese, etc), conversion from bytes to characters must be performed.

InputStreamReader

- Converts read bytes to characters



Bytes-> char

- Default encoding is defined by the Java System property `file.encoding`
  - `System.getProperty ("file.encoding")`
- This property is during Java installation
- You can override this when instantiating an InputStreamReader or OutputStreamWriter
  - `public InputStreamWriter (InputStream in, String enc)`

Bytes->Char

- Note that FileWriter and FileReader assume the default encoding
- See me if interested in reading/writing files that are not encoded using the default encoding.

Questions

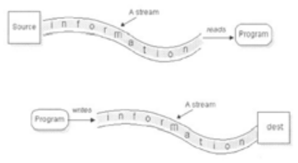
- Any other questions from last class?

Java I/O

- Low level vs high level
  - Low level: can only read/write a character or byte at a time
  - High level: can read/write strings that represent different data types
    - Ex. read/write an int, float,

Streams

- Basic low level mechanism for I/O in Java is the stream



Streams

- Reading from a stream
  - Open a stream
  - While more info
    - Read data
  - Close the stream
- Writing to a stream
  - Open a stream
  - While more info
    - Write data
  - Close the stream

Data and Streams

- Types of data that can be read from/written to streams
  - Bytes (8-bits / bytes)
    - Raw data
  - Characters (16-bits / bytes)
    - Text data
- Basic stream operations
  - Read
  - Write

The 4 base Java I/O classes

	READ	**WRITE**
CHAR	`Reader`	`Writer`
BYTE	`InputStream`	`OutputStream`

Each of these are abstract classes

Wrapper classes

- A class that takes a base class or data item and provides additional methods to manipulate it.
- The new class is said to act as a wrapper for the base class or data item.

Wrapper classes

```
• public class myWrapper {
    public myWrapper (WrappedClass C)

    // additional methods for manipulating
    // objects of type Wrapped Class
  }
```

Class being wrapped

Wrapper classes

- `Float, Integer, Double`, and `Long`
  - Are wrapper classes for the basic datatypes of `float, int, double`, and `long`.
  - Float F = new Float (5.4f);
    int i = F.intValue();
    System.out.println (F.toString())

Wrapper classes and I/O classes

- Many subclasses of the 4 base java.io classes are wrapper classes:
  - Add additional functionality
  - Convert from one format to another
  - Filter the data coming in or going out
- These wrapper subclasses wrap the base java.io classes.

Wrapper classes and I/O classes

- Classes wrap both extend base classes and wrap them.

```
public class PrintWriter extends Writer{

   public PrintWriter (Writer W) { … }
}
```

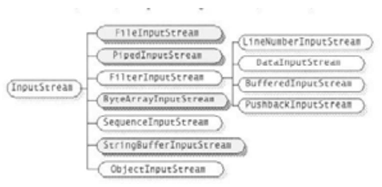
I/O Wrapper classes

- Added functionality
  - Buffering
  - Data Conversion
  - counting (I.e. line numbering)
  - Pushback

Why not use inheritance?

- Wrapper classes do not define a strict class hierarchy.
- Can use many wrappers dependent on what extra functionality you may need.

InputStream Wrappers



InputStream Wrappers

- BufferedInputStream
  - Buffers input as it reads.
  - Designed for efficiency
- DataInputStream
  - Allows binary data to be interpreted a basic data type.
- PushbackInputStream
  - Allows one to pushback (or *unread*) a byte after it's been read.

A look at DataInputStream

- `public DataInputStream extends InputStream{`

- `public DataInputStream (InputStream in)`
- `boolean readBoolean()throws IOException`
- `int readInt() throws IOException`
- `float readFloat() throws IOException`
- `double readDouble() throws IOException`
- `short readShort() throws IOException`
- `char readChar() throws IOException`

Creating wrapped streams

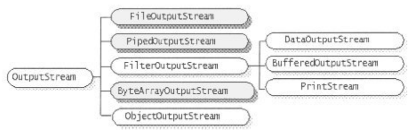
```
 try {
    // Binary data coming from a file
    InputStream in = new FileInputStream("filename");

    // Buffer the data for effiency
    BufferedInputStream bin = new BufferedInputStream (in);

    // Add "read-by-type" functionality
    DataInputStream din = new DataInputStream(bin);

    // read data by type
    double d = din.getDouble();
    int i = din.getInt();
}
catch (IOException E) { ... }
```

OutputStream Wrappers



OutputStream Wrappers

- BufferedOutputStream
  - Buffers output as it writes.
  - Designed for efficiency
- DataOutputStream
  - Allows basic data types to be written to the stream
- PrintStream
  - Allows character representation of basic data types to be written to the stream.

A look at DataOutputStream

- `public DataOutputStream extends OutputStream{`

- `public DataOutputStream (OutputStream out)`
- `void writeBoolean(boolean b)throws IOException`
- `void writeInt(int i) throws IOException`
- `void writeFloat(float f) throws IOException`
- `void writeDouble(double d) throws IOException`
- `void writeShort(short s) throws IOException`
- `void writeChar(char c) throws IOException`

A look at PrintOutputStream

- `public PrintWriter extends OutputStream{`

- `void print (boolean b)`
- `void print (int i)`
- `void print (float f)`
- `void print (char c)`
- `void print (char[] c)`
- `void print (double d)`
- `void print (String S)`
- `void print (Object O)`
- `void print (long l)`

A look at PrintOutputStream

✓ `void println (boolean b)`
✓ `void println (int i)`
✓ `void println (float f)`
✓ `void println (char c)`
✓ `void println (char[] c)`
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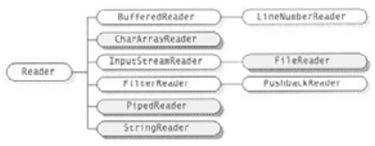
Reader Wrappers



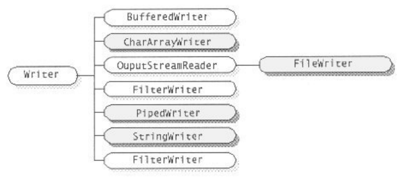
Reader Wrappers

- BufferedReader
  - Buffers input as it reads.
  - Designed for efficiency
- LineNumberReader
  - Keeps track of number of lines read
  - Allows you to read text a line at a time
- PushbackReader
  - Allows one to pushback (or *unread*) a character after it's been read.

Reader Wrappers

- Why there isn’t a DataReader?
  - Actually, I don’t know…a DataReader would be nice
  - However, you can always convert text to a basic data type by using valueOf methods:
    - `float Float.valueOf (String S)`
    - `int Integer.valueOf (String S)`
    - `double Double.valueOf (String S)`
    - `boolean Boolean.valueOf (String S)`

Writer Wrappers



Writer Wrappers

- BufferedWriter
  - Buffers output as it writes.
  - Designed for efficiency
- PrintWriter
  - Allows character representation of basic data types to be written to the stream.
- Why is there no DataWriter?

PrintWriter - constructors

- `public PrintWriter(Writer out)`
- `public PrintWriter(OutputStream out)`
  - Supplied for convenience
  - Includes a OutputStreamWriter to convert text data to binary

A look at PrintWriter

- `public PrintWriter extends Writer{`

- `void print (boolean b)`
- `void print (int i)`
- `void print (float f)`
- `void print (char c)`
- `void print (char[] c)`
- `void print (double d)`
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A look at PrintWriter

✓ `void println (boolean b)`
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✓ `void println (Object O)`
✓ `void println (long l)`

Mixing low level I/O with high level I/O

- Since PrintWriter extends as well as wraps Writer, you can use it to do both low and high level I/O:

```
try {
    PrintWriter P = new PrintWriter
        (new FileWriter (“filename”));
   int i = 7;
   char c = ‘a’;
   P.println (i);
   P.write (c);
}
catch (IOException E) { … }
```

Standard in, out, error

- System.in
  - Defined as a static InputStream
  - Standard input stream
- System.out
  - Defined as a static PrintStream
  - Standard output stream
- System.err
  - Defined as a static PrintStream
  - Standard error stream

Reading lines of text from System.in

```
// System.in is an InputStream, we want
// read characters, not bytes
InputStreamReader ir = new InputStreamReader
  (System.in);

// We’ll need the ability to read text
// lines at a time
BufferedReader br = new BufferedReader (ir);

// Now we can read lines of text
String curline = br.readLine();
```

Summary

- Wrapper classes
- Uses for wrapper classes
  - High level data I/O
- Wrappers available for Reader, Writer, InputStream, OutputStream
- System.in, System.out, System.err

Something to think about for next time

```
 /**
  * A test program for the Payroll Class
  */
static public void main (String args[])
{
   // Create a payroll
   Payroll pay = new Payroll();

   // Create some actors, define the number of
   // performances for each then add them to the payroll
   Actor A = new Actor ("Nathan Lane");
   A.perform (8);
   pay.addPerformer (A);
   ...

   // Calculate and print out the total weekly pay
   System.out.println ("The total weekly pay for this week is " +
                pay.calculateTotalPay());
 }
```

Something to think about for next time

- Change the Payroll app testing function so that Performers are read in from a text file or from standard input:
  - Format of input (1 line for each):
    - Name
    - Type (A for actor, G for Guitarist, D for Drummer)
    - # of performance

Something to think about for next time

- Usage:
  - `java Payroll`
    - will take input from standard in
  - `Java Payroll infile`
    - Will take input from input file `infile`

Questions?