Software 1

Java I/O

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The java.io package

- The java.io package provides:
  - Classes for reading input
  - Classes for writing output
  - Classes for manipulating files
  - Classes for serializing objects

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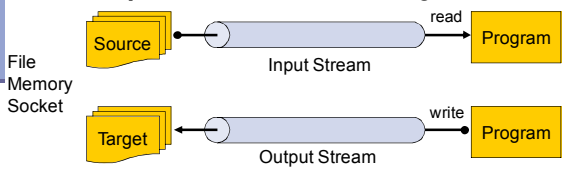
Streams

- A ***stream*** is a sequential flow of data
- Streams are one-way streets.
  - ***Input streams*** are for reading
  - ***Output streams*** are for writing



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Streams

- Usage Flow:

```
open a stream
while more information
    Read/write information
close the stream
```

- All streams are automatically opened when created.

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Streams

- There are two types of streams:
  - ***Byte streams*** for reading/writing raw bytes
  - ***Character streams*** for reading/writing text

- Class Name Suffix Convention:

	Byte	Character
Input	InputStream	Reader
Output	OutputStream	Writer

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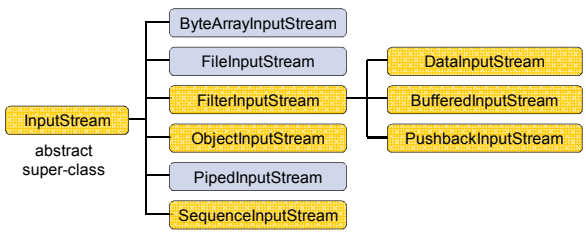
InputStreams



- read from data sinks
- perform some processing

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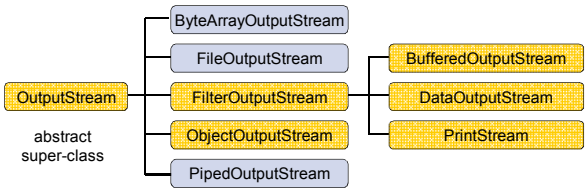
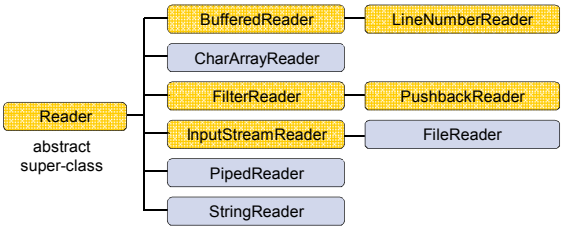
OutputStreams



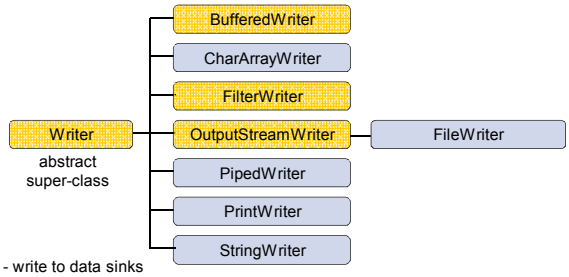
- write to data sinks
- perform some processing

Readers



- read from data sinks
- perform some processing

Writers



- write to data sinks
- perform some processing

Terminal I/O

- The System class provides references to the standard input, output and error streams:

```
InputStream stdin = System.in;
PrintStream stdout = System.out;
PrintStream stderr = System.err;
```


InputStream Example

- Reading a single byte from the standard input stream:

```
try {
    int value = System.in.read();
    ...
} catch (IOException e) {
    ...
}
```

an int with a byte information

is thrown in case of an error

returns -1 if a normal end of stream has been reached

InputStream Example

- Another implementation:

```
try {
   int value = System.in.read();
   if (value != -1) {
      byte bValue = (byte) value;
   }
   ...
} catch (IOException e) {...}
```

end-of-stream condition

casting

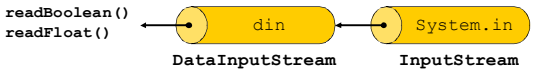
Character Stream Example

```
public static void main(String[] args) {

    try {
        FileReader in = new FileReader("in.txt");
        FileWriter out = new FileWriter("out.txt");

        int c;
        while ((c = in.read()) != -1) {
          out.write(c);
        }

        in.close();
        out.close();

    } catch (IOException e) {
        // Do something
    }
}
```


Stream Wrappers

- Some streams wrap others streams and add new features.
- A wrapper stream accepts another stream in its constructor:

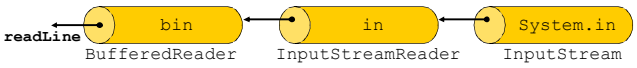
```
DataInputStream din =
    new DataInputStream(System.in);
double d = din.readDouble();
```



Stream Wrappers (cont.)

- Reading a text string from the standard input:

```
try {
    InputStreamReader in =
                new InputStreamReader(System.in);

    BufferedReader bin = new BufferedReader(in);

    String text = bin.readLine();
    ...
} catch (IOException e) {...}
```



The File Class

- A utility class for file or directory properties (name, path, permissions, etc.)
- Performs basic file system operations:
  - removes a file: `delete()`
  - creates a new directory: `mkdir()`
  - checks if the file is writable: `canWrite()`
  - creates a new file: `createNewFile()`
- No direct access to file data
- Use file streams for reading and writing

The File Class
Constructors

- Using a full pathname:

```
File f = new File("/doc/foo.txt");
File dir = new File("/doc/tmp");
```

- Using a pathname relative to the current directory defined in `user.dir`:

```
File f = new File("foo.txt");
```

Note: Use `System.getProperty("user.dir")` to get the value of `user.dir`
(Usually the default is the current directory of the interpreter. In Eclipse it is the project's directory)

The File Class
Constructors (cont)

- `File f = new File("/doc","foo.txt");`
  - directory pathname
  - file name
- `File dir = new File("/doc");`
  `File f = new File(dir, "foo.txt");`
- A `File` object can be created for a non-existing file or directory
  - Use `exists()` to check if the file/dir exists

The File Class
Pathnames

- Pathnames are system-dependent
  - `"/doc/foo.txt"` (UNIX format)
  - `"D:\doc\foo.txt"` (Windows format)
- On Windows platform Java excepts path names either with `'/'` or `'\'`
- The system file separator is defined in:
  - `File.separator`
  - `File.separatorChar`

The File Class
Directory Listing

- Printing all files and directories under a given directory:

```
public static void main(String[] args) {
    File file = new File(args[0]);

    String[] files = file.list();
    for (int i=0 ; i< files.length ; i++) {
          System.out.println(files[i]);
    }
}
```


The File Class
Directory Listing (cont.)

- Printing all files and directories under a given directory with `".txt"` suffix:

```
public static void main(String[] args) {
    File file = new File(args[0]);
    FilenameFilter filter = new
              SuffixFileFilter(".txt");

    String[] files = file.list(filter);
    for (int i=0 ; i<files.length ; i++) {
          System.out.println(files[i]);
    }
}
```


The File Class
Directory Listing (cont.)

```
public class SuffixFileFilter
                implements FilenameFilter {

   private String suffix;

   public SuffixFileFilter(String suffix) {
      this.suffix = suffix;
   }

   public boolean accept(File dir, String name) {
      return name.endsWith(suffix);
   }
}
```


The Scanner Class

- Breaks its input into tokens using a delimiter pattern (matches whitespace by default)
- The resulting tokens may then be converted into values

```
try {
       Scanner s = new Scanner(System.in);
       int anInt = s.nextInt();
       float aFloat = s.nextfloat();
       String aString = s.next();
       String aLine = s.nextLine();

    } catch (IOException e) {
   // Do something
 }
```


The Scanner Class

- Works with any type of textual input
- We can change the delimiter and other options
- Another example:

```
String input = "1 fish 2 fish red fish blue fish";
Scanner s = new Scanner(input).useDelimiter("\\s*fish\\s*");
System.out.println(s.nextInt());
System.out.println(s.nextInt());
System.out.println(s.next());
System.out.println(s.next());
s.close();
```

Regular expression

Object Serialization

- A mechanism that enable objects to be:
  - saved and restored from byte streams
  - persistent (outlive the current process)
- Useful for:
  - persistent storage
  - sending an object to a remote computer

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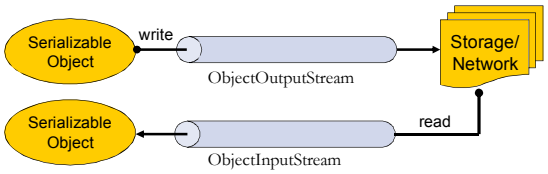
The Default Mechanism

- The default mechanism includes:
  - The Serializable interface
  - The ObjectOutputStream
  - The ObjectInputStream



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The Serializable Interface

- Objects to be serialized must implement the java.io.Serializable interface
- An empty interface
- Most objects are Serializable:
  - Primitives, Strings, GUI components etc.
- Subclasses of Serializable classes are also Serializable

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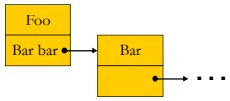
Recursive Serialization

- Can we serialize a Foo object?

```
public class Foo implements Serializable {
    private Bar bar;
    …
}

public class Bar {…}
```



- No, since Bar is not Serializable
- Solution:
  - Implement Bar as Serializable
  - Mark the bar field of Foo as transient

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Writing Objects

- Writing a `HashMap` object (`map`) to a file*:

```
try {

    FileOutputStream fileOut =
          new FileOutputStream("map.s");

    ObjectOutputStream out =
          new ObjectOutputStream(fileOut);

    out.writeObject(map);

} catch (Exception e) {...}
```

* HashMap is Serializable

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Reading Objects

```
try {

   FileInputStream fileIn =
          new FileInputStream("map.s");

   ObjectInputStream in =
          new ObjectInputStream(fileIn);

   Map h = (Map)in.readObject();

} catch (Exception e) {...}
```

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