תוכנה 1

תרגול 10: IO ועוד

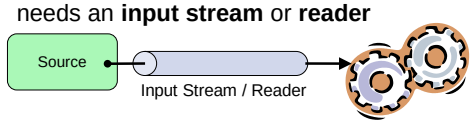
רובי בוים ומתי שמרת

Today

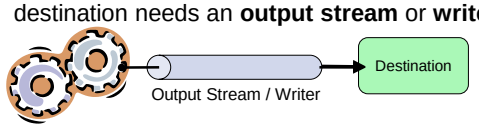
- IO
  - Class hierarchy
  - Exceptions
  - Serialization
- Demystifying Enums

Streams Reminder

- A program that needs to read data a source needs an **input stream** or **reader**



- A program that needs to write data to a destination needs an **output stream** or **writer**

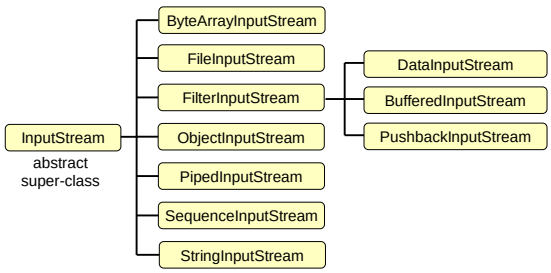


Streams

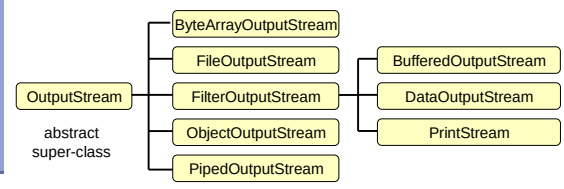
- There are two categories of streams:
  - ***Byte streams*** for reading/writing binary data
  - ***Character streams*** for reading/writing text
- Suffix Convention:

direction \ category	Byte	Character
Input	InputStream	Reader
Output	OutputStream	Writer

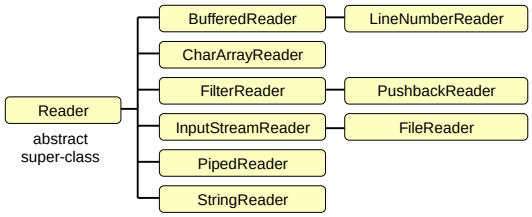
InputStream Class Hierarchy



OutputStream Class Hierarchy

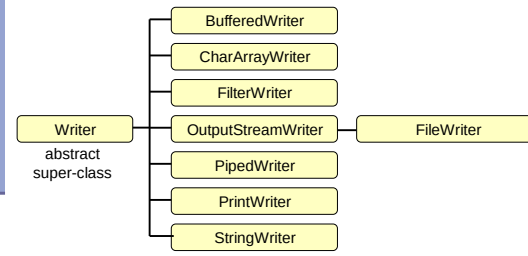


Reader Class Hierarchy



7

Writer Class Hierarchy



8

Handling Exceptions

- Handle exception
  - using a try-catch block
- Propagate the exception to the caller
  - Add throws declaration
- finally block is always executed at the end of the try block

9

Character Stream Example

```
public static void copy(String src, String dst)
    throws IOException {
    FileReader in = null;
    FileWriter out = null;

    try {
        in = new FileReader(src);
        out = new FileWriter(dst);

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

might throw an exception

might throw an exception

might throw an exception

10

Almost

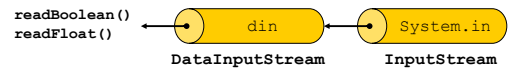
```
public static void copy(String src, String dst)
    throws IOException {
        // copy input to output
    } finally {
        closeIgnoringException(in);
        closeIgnoringException(out)
    }
}

private static void closeIgnoringException(Closeable c) {
    if (c != null) {
        try {
            c.close();
        } catch (IOException e) {
            // Deliberately left empty; There is nothing we
            // can do if close fails
        }
    }
}
```

11

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();
```



12

Stream Wrappers Example

- Reading a line of text from a file:

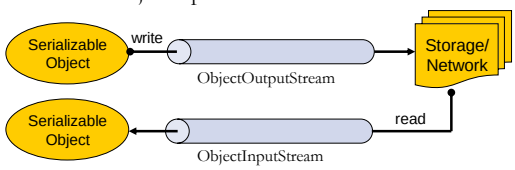
```
try {
    FileReader in =
        new FileReader("FileReaderDemo.java");

    BufferedReader bin = new BufferedReader(in);

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

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

The Default Mechanism

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



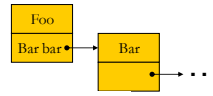
The Serializable Interface

- Objects to be serialized must implement the java.io.Serializable interface
- An empty interface
- Some types are Serializable:
  - Primitives, Strings, GUI components etc.
- Subtypes of Serializable types are also Serializable

Recursive Serialization

- Can we serialize a Foo object?

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

public class Bar implements Serializable {…}
```



- No, since Bar is not Serializable
- Solutions:
  1. Implement Bar as Serializable
  2. Mark the bar field of Foo as transient
  3. Customize the serialization process

HashMap Serialization

```
Map<Integer, String> map = new HashMap<…>();
...
ObjectOutputStream out = null;
try {
    out = new ObjectOutputStream(
                    new FileOutputStream("map.s"));
    out.writeObject(map);
} catch (IOException e) {
    ...
} finally  {
    ...
}
```

HashMap is Serializable, so are all the other **concrete** collection types we've seen

Reading Objects

```
ObjectInputStream in = null;
try {
    in = new ObjectInputStream(
             new FileInputStream("map.s"));
    Map<Integer, String> map =
        (Map<Integer, String>) in.readObject();
    System.out.println(map);
} catch (Exception e) {
    ...
} finally {
    ...
}
```


Demystifying Enums

- Enums are just syntactic sugar
- We could emulate an Enum with a class
  - This is what the compiler does

```
public enum Operation {
  PLUS("+") { public double apply(double x, double y) {return x + y;} },
  MINUS("-") { public double apply(double x, double y) {return x - y;} },
  TIMES("*") { public double apply(double x, double y) {return x * y;} },
  DIVIDE("/") { public double apply(double x, double y) {return x / y;} };

  private final String symbol;

  Operation(String symbol) { this.symbol = symbol; }
  public String toString() { return symbol; }

  public abstract double apply(double x, double y);
}
```


Disassembling Operation

```
public abstract class Operation extends Enum {
    private Operation(String s, int i, String symbol) {
        super(s, i);
        this.symbol = symbol;
    }

    public static Operation[] values() {
        Operation aoperation[];
        int i;
        Operation aoperation1[];
        System.arraycopy(aoperation = ENUM$VALUES, 0,
    aoperation1 = new Operation[i = aoperation.length], 0, i);
       return aoperation1;
    }

   ...
}
```

See the code on the course site.