Principles of Software Construction: Objects, Design, and Concurrency

Design Case Study: Stream I/O Some answers…

Fall 2014

Charlie Garrod Jonathan Aldrich

School of Computer Science
institute for SOFTWARE RESEARCH

A challenge for you

- Identify the design patterns in this lecture
  - For each design pattern you recognize, write:
    - The class name
    - The design pattern
    - If you have time: At least one design goal or principle achieved by the pattern in this context
  - Hints:
    - Use the slides online to review the lecture
    - Design patterns include at least:
      - Adapter
      - Decorator
      - Iterator
      - Marker Interface
      - Template Method

The stream abstraction

- A sequence of **bytes**
- May read 8 bits at a time, and close

```
java.io.InputStream
   void          close();
   abstract int  read();
   int           read(byte[] b);
```

- May write, flush and close

```
java.io.OutputStream
   void          close();
   void          flush();
   abstract void write(int b);
   void          write(byte[] b);
```

The stream abstraction

- A sequence of **bytes**
- May read 8 bits at a time, and close

```
java.io.InputStream
   void           close();
   abstract int   read();
   int            read(byte[] b);
```

Template Method

Iterator?

- May write, flush and close

```
java.io.OutputStream
   void           close();
   void           flush();
   abstract void  write(int b);
   void           write(byte[] b);
```

Template Method

The reader/writer abstraction

- A sequence of **characters** in some encoding
- May read one character at a time and close

```
java.io.Reader
   void          close();
   abstract int  read();
   int           read(char[] c);
```

- May write, flush and close

```
java.io.Writer
   void          close();
   void          flush();
   abstract void write(int c);
   void          write(char[] b);
```

The reader/writer abstraction

- A sequence of **characters** in some encoding
- May read one character at a time and close

`java.io.Reader`

```
void          close();
abstract int  read();
int           read(char[] c);
```

Template Method

Iterator?

- May write, flush and close

`java.io.Writer`

```
void          close();
void          flush();
abstract void write(int c);
void          write(char[] b);
```

Template Method

Implementing streams

- `java.io.FileInputStream`
  - Reads from files, byte by byte
- `java.io.ByteArrayInputStream`
  - Provides a stream interface for a `byte[]`
- Many APIs provide streams for network connections, database connections, …
  - e.g., `java.lang.System.in`, `Socket.getInputStream()`, `Socket.getOutputStream()`, …

Implementing streams

- `java.io.FileInputStream`
  - Reads from files, byte by byte
- `java.io.ByteArrayInputStream`
  - Provides a stream interface for a `byte[]`
- Many APIs provide streams for network connections, database connections, …
  - e.g., `java.lang.System.in`, `Socket.getInputStream()`, `Socket.getOutputStream()`, …

Adapter

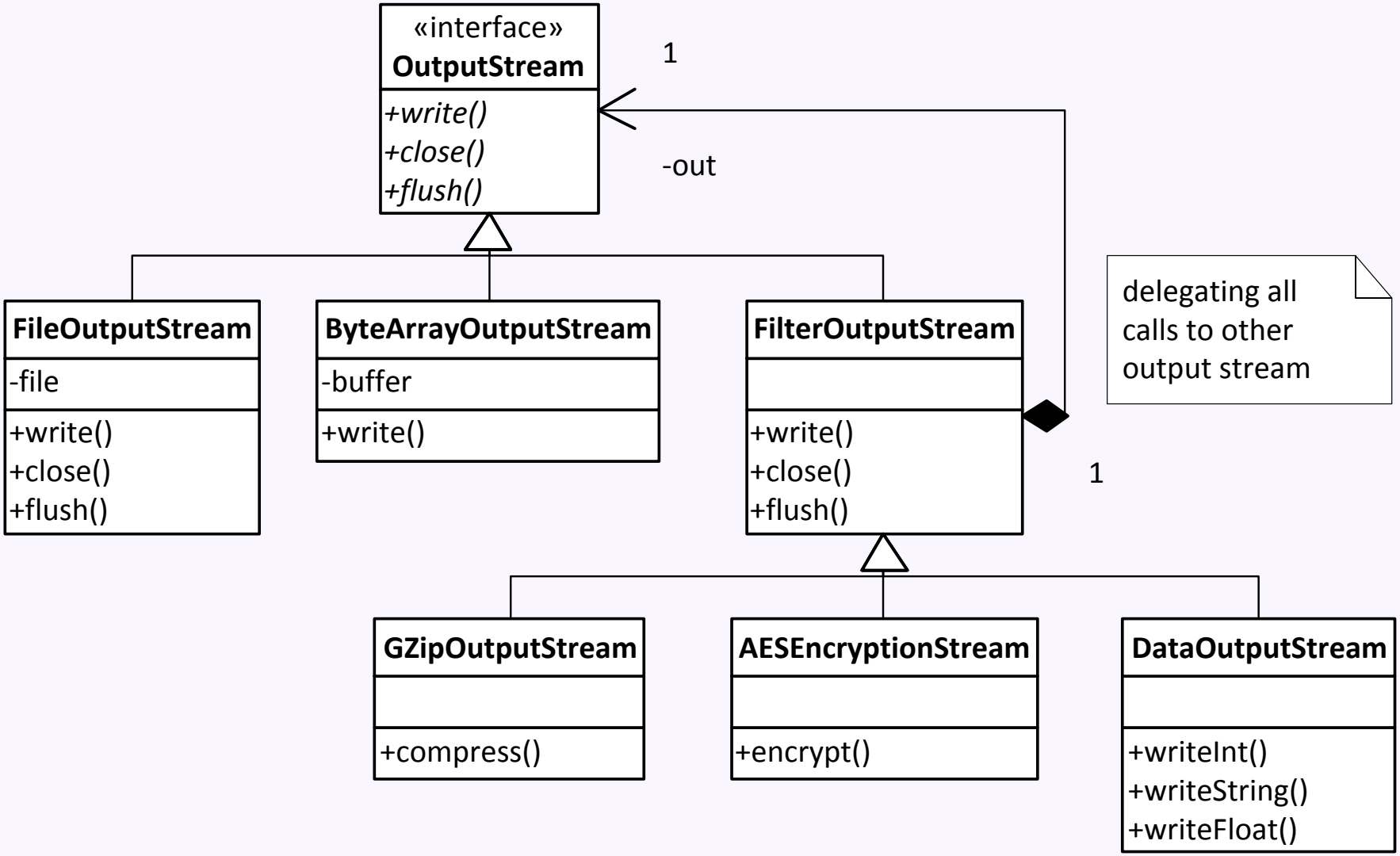
Implementing readers/writers

- `java.io.InputStreamReader`
  - Provides a `Reader` interface for any `InputStream`, adding additional functionality for the character encoding
    - Read characters from files/the network using corresponding streams
- `java.io.CharArrayReader`
  - Provides a `Reader` interface for a `char[]`
- Some convenience classes: `FileReader`, `StringReader`, …

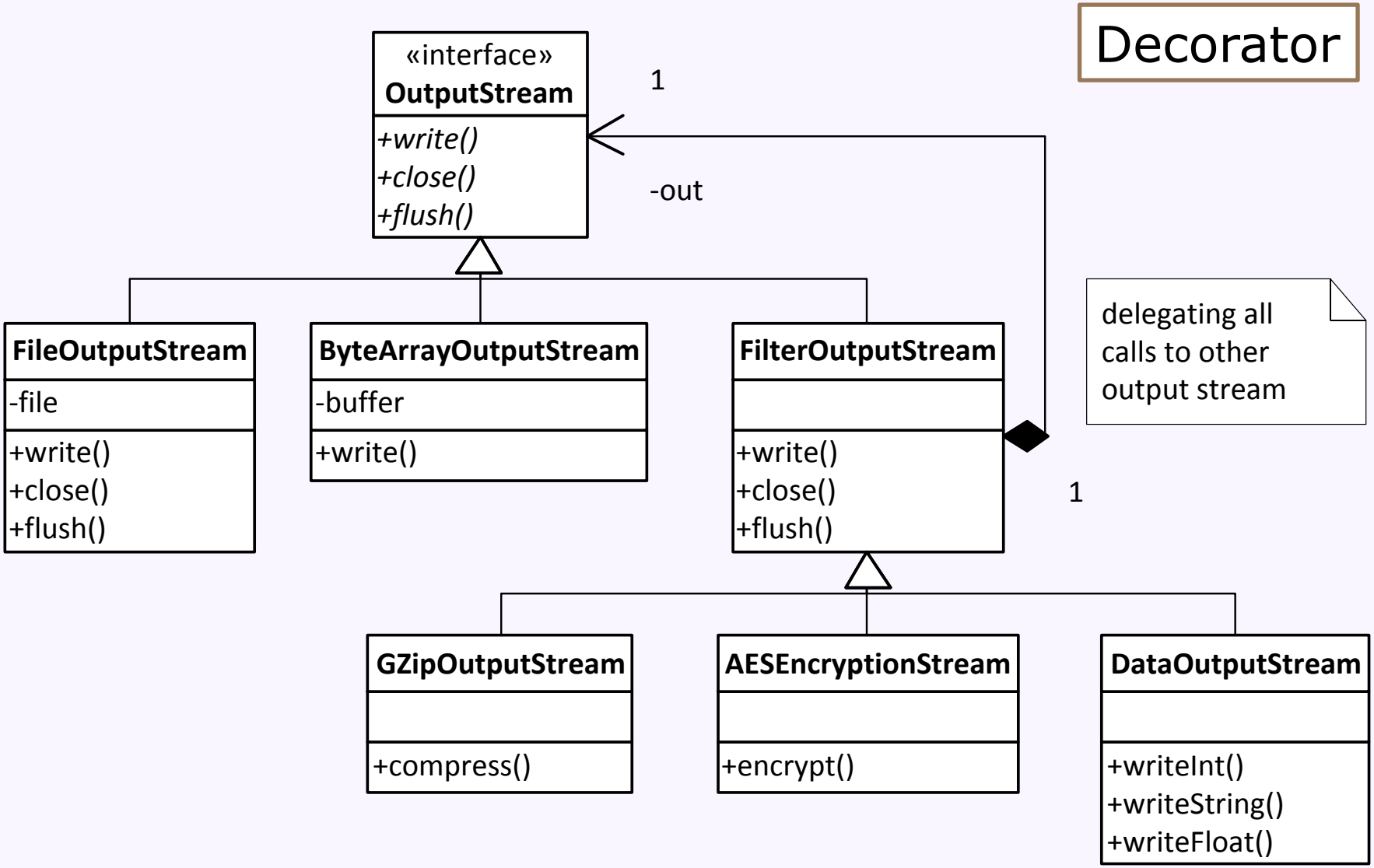
Implementing readers/writers

- `java.io.InputStreamReader` — Adapter
  - Provides a `Reader` interface for any `InputStream`, adding additional functionality for the character encoding
    - Read characters from files/the network using corresponding streams
- `java.io.CharArrayReader` — Adapter
  - Provides a `Reader` interface for a `char[]`
- Some convenience classes: `FileReader`, `StringReader`, … — Adapter

A better design to add functionality to streams



A better design to add functionality to streams



To read and write arbitrary objects

- Your object must implement the `java.io.Serializable` interface
  - Methods: none
- If all of your data fields are themselves `Serializable`, Java can automatically serialize your class
  - If not, will get runtime `NotSerializableException`
- Can customize serialization by overriding special methods

See QABean.java and FileObjectExample.java

To read and write arbitrary objects

- Your object must implement the `java.io.Serializable` interface
  - Methods: none

Marker Interface

- If all of your data fields are themselves `Serializable`, Java can automatically serialize your class
  - If not, will get runtime `NotSerializableException`
- Can customize serialization by overriding special methods

See QABean.java and FileObjectExample.java

The java.util.Scanner

- Provides convenient methods for reading from a stream

java.util.Scanner:

```
Scanner(InputStream source);
Scanner(File source);
void    close();
boolean hasNextInt();
int     nextInt();
boolean hasNextDouble();
double  nextDouble();
boolean hasNextLine();
String  nextLine();
boolean hasNext(Pattern p);
String  next(Pattern p);
…
```

The java.util.Scanner

- Provides convenient methods for reading from a stream

java.util.Scanner:

```
Scanner(InputStream source);
Scanner(File source);
void    close();
boolean hasNextInt();
int     nextInt();
boolean hasNextDouble();
double  nextDouble();
boolean hasNextLine();
String  nextLine();
boolean hasNext(Pattern p);
String  next(Pattern p);
…
```

Iterator