OOP with Java

Yuanbin Wu
cs@ecnu

OOP with Java

- 通知
  - Project 6: 5 月 24 日晚 9 点

- 复习
  - 异常处理
- 语法
  - 抛出异常 : throw
  - 处理异常 : try, catch
  - 异常对象 : Exception 类的子类
- 从方法中抛出异常
  - 方法的异常说明 :throws
  - 中断当前方法的执行，返回抛出的异常对象，在该方法的调用路径上寻找合适的 catch.

```java
class SimpleException extends Exception { }

public class InheritingExceptions {

    public static void main(String[] args) {
        try {
            System.out.println("Throw SimpleException from f()");
            throw new SimpleException();
        } catch(Exception e) {
            System.out.println("Caught it!");
            System.out.println(e);
            System.out.println(e.printStackTrace(System.out));
        }
    }
}
```

```
bar() throws Type1Exception, Type2Exception{
    …
    throw new Type1Exception ();
    …
    throw new Type2Exception ();
}
```

```
foo() {
    try{
        …
        bar();
    }
    catch (Type1Exception e){
        ...
    }
    catch (Type2Exception e){
        ...
    }
}
```

Quiz

```
class Main {
 public static void main(String args[]){
    final int i;
    i = 20;
    i = 30;
    System.out.println(i);
 }
}
```

Quiz

```java
abstract class demo
{
    public int a;
    demo() {
        a = 10;
    }
    abstract public void set();
    abstract final public void get();
}

class Test extends demo
{
    public void set(int a) {
        this.a = a;
    }
    final public void get() {
        System.out.println("a = " + a);
    }
    public static void main(String[] args) {
        Test obj = new Test();
        obj.set(20);
        obj.get();
    }
}
```

Quiz

```java
class Test {
    public static void main (String[] args) {
        try {
            int a = 0;
            System.out.println ("a = " + a + "\n");
            int b = 20 / a;
            System.out.println ("b = " + b);
        }
        catch(ArithmeticException e) {
            System.out.println ("Divide by zero error");
        }
        finally {
            System.out.println ("inside the finally block");
        }
    }
}
```

Quiz

```java
public class Test {
  private int x = 1;
  private int y = 2;
  private static int z = 3;

  public static void main(String[] args) {
    int x = 4;
    int y = 5;
    int z = 6;
    new Test().new Inner().init();
  }

  class Inner{
    void init(){
      System.out.println(x + " " + y + " " +z);
    }
  }
}
```

Quiz

1. 定义一个 LinkedList, 其中包含 String 对象 .
2. 编写方法遍历该 LinkedList.

I/O

- Introduction
- Path Object
- InputStream/OutputStream
- Reader/Writer
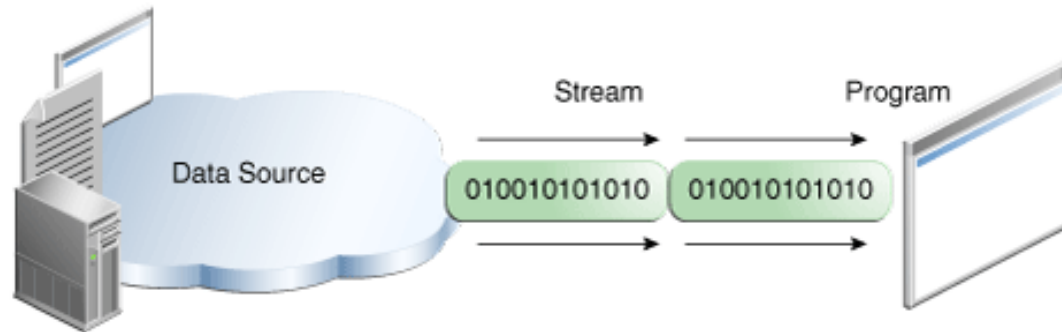- Typical usage of I/O streams
- Object Serialization

Introduction

- I/O
  - Input/output
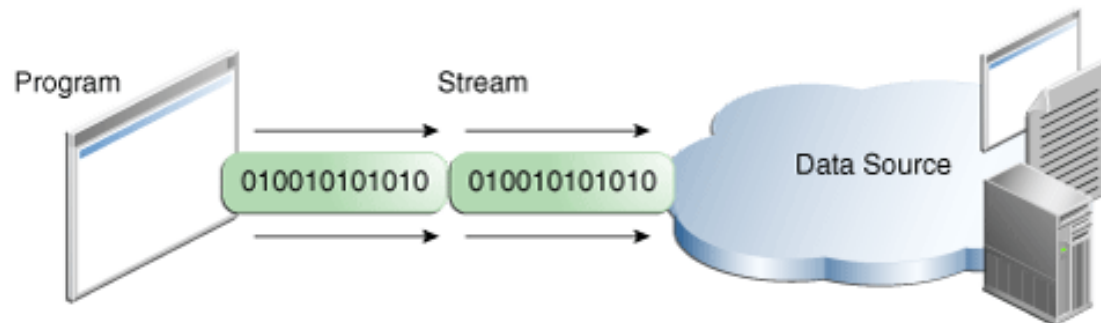 - 哪些行为有 I/O 操作？
- I/O 操作是复杂的
  - 多种交互的设备

Introduction

- I/O 过程的抽象
  - 流 (Stream)

Input

Output

Introduction

- 数据的来源 (In)，目的地 (Out)
  - 字节 (01 串): ByteArrayStream
  - 文件 : FileStream
  - 字符串 : StringStream
  - 对象 : ObjectStream

Introduction

- 最重要的 I/O Stream 操作
  - InputStream: read()
  - OutputStream: write()
  - close()
- 为生活带来便利的 I/O Stream 操作
  - 从文件读取一行 : readLine()
  - 读取一个基本类型 : readInt(), readDouble()…
  - 读取对象

```java
public static void fileOutput() throws IOException{
    String str = "hello world!";
    File file = new File("d:\\test2.txt");  // 创建文件
    if(!file.exists()){
        file.createNewFile();    // 如果文件不存在，则进行创建
    }
    FileOutputStream fOutput = new FileOutputStream(file);
    BufferedOutputStream bOutput = new BufferedOutputStream(fOutput);
    byte[] buffer = str.getBytes(); // 将字符串文本转换成字节数组
    bOutput.write(buffer);
    bOutput.close();
    fOutput.close();
}

public static void fileInput() throws IOException{
    File file = new File("d:\\test2.txt");    // 创建文件
    FileInputStream fIutput = new FileInputStream(file);
    BufferedInputStream bIutput = new BufferedInputStream(fIutput);
    int temp = 0;
    while((temp = bIutput.read())!= -1){    // 当 temp 为 -1 时，数据读取完毕
        System.out.print((char)temp);
    }
    bIutput.close();
    fIutput.close();
}
```
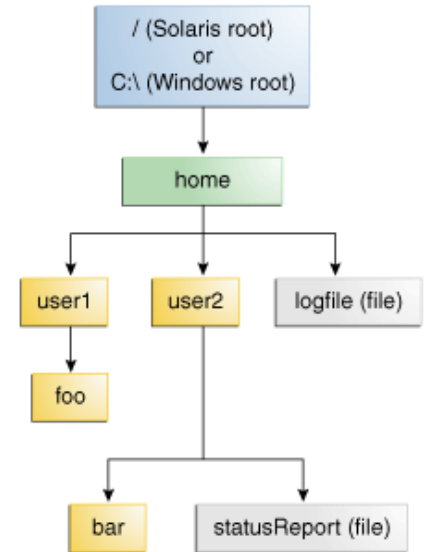
Path 接口

- File 类
  - Java 7 之前
- Path 接口
  - Java 7 引入, 用于替代 File 类
  - File 类对象可通过 toPath() 得到对应的 Path 对象

Path 接口

- 文件路径
  - 绝对路径
    - C:/Documents/tmp/Hello.java
  - 相对路径
    - ../../tmp/Hello.java

Path 接口

- Path 接口
  - java.nio.file
  - 提供对文件路径字符串的操作

Path 接口

- 创建 Path 类型的对象

```
Path p1 = Paths.get("C:/Document/tmp/Hello.java");

Path p2 = FileSystems.getDefault().getPath("C:/Document/tmp/Hello.java");
```

Path 接口

```
// Microsoft Windows syntax
Path path = Paths.get("C:\\home\\joe\\foo");

// Solaris syntax
// Path path = Paths.get("/home/joe/foo");

System.out.format("toString: %s%n", path.toString());           // C:\home\joe\foo
System.out.format("getFileName: %s%n", path.getFileName());     // foo
System.out.format("getName(0): %s%n", path.getName(0));         // home
System.out.format("getNameCount: %d%n", path.getNameCount());   // 3
System.out.format("subpath(0,2): %s%n", path.subpath(0,2));     // home\joe
System.out.format("getParent: %s%n", path.getParent());         // home\joe\
System.out.format("getRoot: %s%n", path.getRoot());             // C:\
```

Files 类

- 包含文件操作的静态方法
  - 文件是否存在
  - 创建文件
  - 删除文件
  - 拷贝 / 移动
  - 重命名
  - 列出目录下所有文件
  - ...

Files 类

- 判断文件是否存在

```
Path p = Paths.get("C:/Document/tmp/Hello.java");
System.out.println(Files.exists(p));
```

- 判断文件是否可读 / 可写 / 可执行

```
Path p = Paths.get("C:/Document/tmp/Hello.java");
System.out.println(Files.isReadable(p));
System.out.println(Files.isWritable(p));
System.out.println(Files.isExecutable(p));
```

Files 类

- 删除文件

```
try {
    Files.delete(path);
} catch (NoSuchFileException x) {
    System.out.format("%s: no such" + " file or directory%n", path);
} catch (DirectoryNotEmptyException x) {
    System.out.format("%s not empty%n", path);
} catch (IOException x) {
    // File permission problems are caught here.
    System.out.println(x);
}
```

Files 类

- 获得文件相关的信息

```
size(Path)
isDirectory(Path, LinkOption)
isRegularFile(Path, LinkOption...)
isSymbolicLink(Path)
getLastModifiedTime(Path, LinkOption...)
setLastModifiedTime(Path, FileTime)
getOwner(Path, LinkOption...)
setOwner(Path, UserPrincipal)
```

Stream

- I/O 流
  - InputStream 类
    - 抽象类
    - read() (抽象方法)
    - close()
  - OutputStream 类
    - 抽象类
    - write() (抽象方法)
    - close()
  - 每次读入 / 写出一个字节

InputStream

- 从不同的源头产生输入
  - Byte arrays
  - String objects
  - files
  - …
- 对应于不同的 InputStream 子类

InputStream

- ByteArrayInputStream
- StringBufferInputStream
- FileInputStream
- ...

OutputStream

- 输出到不同的目的地
  - Byte arrays
  - String objects
  - files
  - …
- 对应于不同的 OutputStream 子类

OutputStream

- ByteArrayOutputStream
- FileOutputStream
- ...

Stream

InputStream

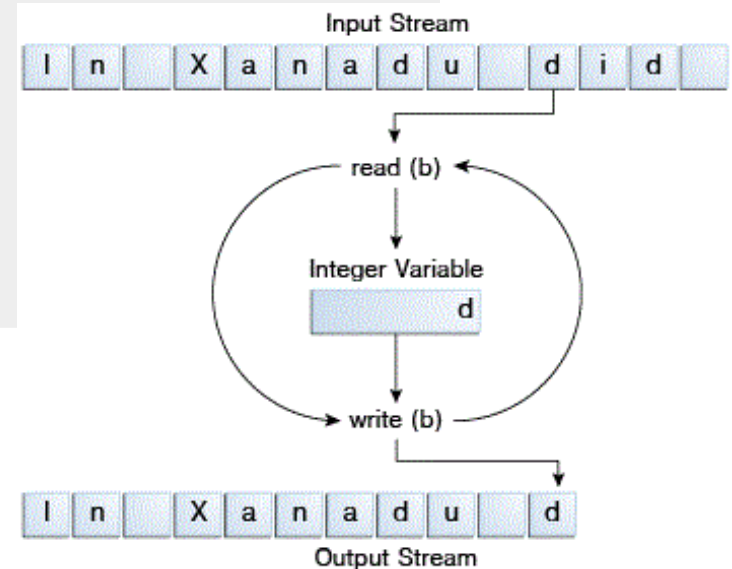ByteArrayInputStream
StringBufferInputStream
FileInputStream
...

OutputStream

ByteArrayOutputStream

FileOutputStream
...

```java
import java.io.FileInputStream;
import java.io.FileOutputStream;
import java.io.IOException;
public class CopyBytes {
    public static void main(String[] args) throws IOException {
        FileInputStream in = null;
        FileOutputStream out = null;
        try {
            in = new FileInputStream("xanadu.txt");
            out = new FileOutputStream("outagain.txt");
            int c;
            while ((c = in.read()) != -1)
                out.write(c);
        } finally {
            if (in != null)
                in.close();
            if (out != null)
                out.close();
        }
    }
}
```


Input Stream

| I | n | | X | a | n | a | d | u | | d | i | d | |

read (b)

Integer Variable
d

write (b)

| I | n | | X | a | n | a | d | u | | d |

Output Stream

Stream

- 是否有效
  - InputStream/OutputStream 每次读/写一个字节
  - 缓冲区 (buffer) 可以帮助提高效率
- 是否易用
  - 有时需要读入/写出一个基本类型，而不是字节
  - readInt(), readDouble()
- 是否易读
  - 需要格式化的输出
  - println(), print(), printf(),..

Stream

- 希望：对每一种输入输出流都可以
  - 选择是否带缓冲
  - 选择读入字节还是基本类型
  - 提供格式化的输出
- How?

Stream

- 如何实现带缓冲的输入 / 输出流？
- 方案 1:
  - read() 方法增加参数
  - read(byte[ ], int off, int len)
- 缺点
  - buffer 长度需要用户指定
  - 用户需要知道更多实现细节

Stream

- 如何实现带缓冲的输入/输出流？
- 方案2
  - 继承
  - BufferedByteArrayInputStream, BufferedByteArrayOutputStream
  - BufferedStringBufferInputStream, BufferedStringBufferOutputStream
  - BufferedFileInputStream, BufferedFileOutputStream
  - …
- 缺点
  - 类过多
  - 无法动态加载

Stream

- 如何实现带缓冲的输入 / 输出流？
- 方案 3
  - 组合
  - 定义 BufferedInputStream 类
  - 包含一个 InputStream 对象作为成员
  - 调用该 InputStream 对象的 read(byte[], int off, int len) 实现缓冲
  - 该调用在不同系统上有不同的优化，并且被封装

```
FileInputStream fin = new FileInputStream("xanadu.txt");
BufferedInputStream bf = new BufferedInputStream(fin);
bf.read(); // buffered read
```

```
FileOutputStream fout = new FileOutputStream("xanadu.txt");
BufferedOutputStream bf = new BufferedOutputStream(fout);
bf.write(1); // buffered write
```

```
ByteArrayInputStream bin = new ByteArrayInputStream("xanadu.txt".getBytes());
BufferedInputStream bf = new BufferedInputStream(bin);
bf.read(); // buffered read
```

```
ByteArrayOutputStream bout = new ByteArrayOutputStream("xanadu.txt".getBytes());
BufferedOutputStream bf = new BufferedOutputStream(bout);
bf.write(1); // buffered read
```

Stream

- 添加缓冲功能
  - BufferedInputStream
- 添加读取基本类型功能
  - DataInputStream
    - readInt(), readDouble(), readFloat(), ...

```java
FileInputStream fin = new FileInputStream("xanadu.txt");
DataInputStream din = new DataInputStream(fin);
din.read();  din.readInt();  din.readDouble();
```

```java
FileOutputStream fout = new FileOutputStream("xanadu.txt");
DataOutputStream dout = new DataOutputStream(fout);
dout.write(1); dout.writeInt(10), dout.writeDouble(3.14);
```

```java
ByteArrayInputStream bin = new ByteArrayInputStream("xanadu.txt".getBytes());
DataInputStream din = new DataInputStream(bin);
din.read(); din.readInt();  din.readDouble();
```

```java
ByteArrayOutputStream bout = new ByteArrayOutputStream("xanadu.txt".getBytes());
DataOutputStream bout = new DataOutputStream(bout);
bout.write(1); bout.writeInt(10), bout.writeDouble(3.14);
```

Stream

- 添加缓冲功能
  - BufferedInputStream

- 添加读取基本类型功能
  - DataInputStream
    - readInt(), readDouble(), readFloat(), ...

- 添加格式化输出功能
  - PrintStream
    - println(), print(),

```
FileOutputStream fout = new FileOutputStream("xanadu.txt");
PrintStream ps = new PrintStream(fout);
ps.write(1); ps.println("hello"); ps.print("world");
```
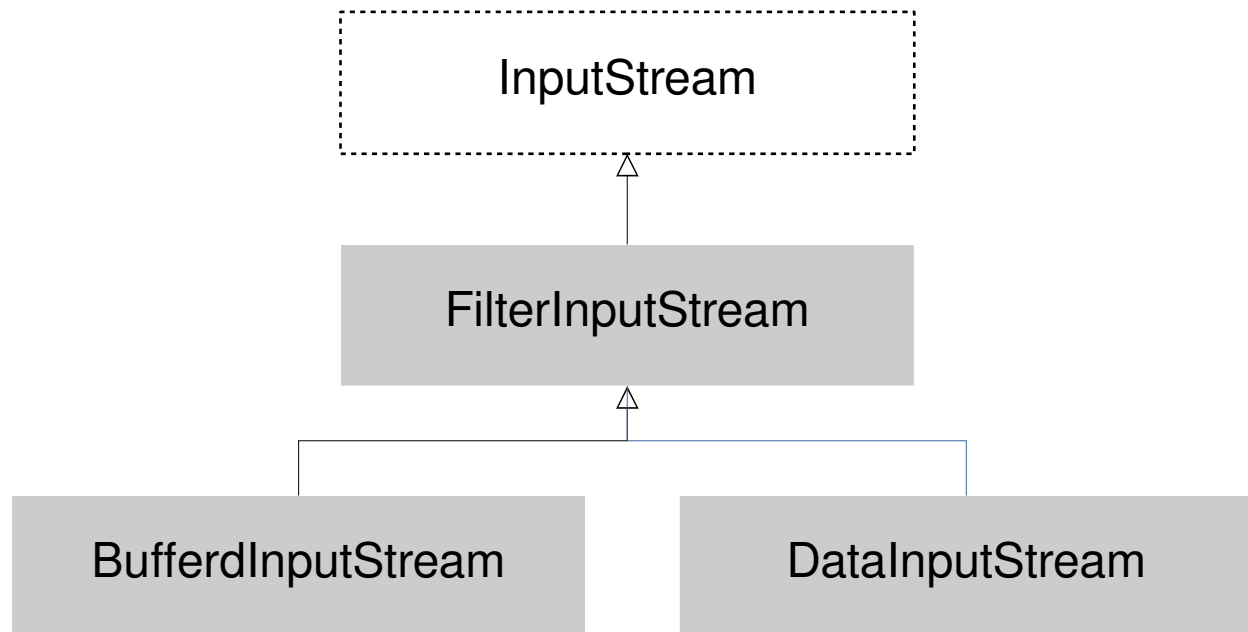
```
ByteArrayOutputStream bout = new ByteArrayOutputStream("xanadu.txt".getBytes());
PrintStream ps = new PrintStream(bout);
ps.write(1); ps.println("hello"); ps.print("world");
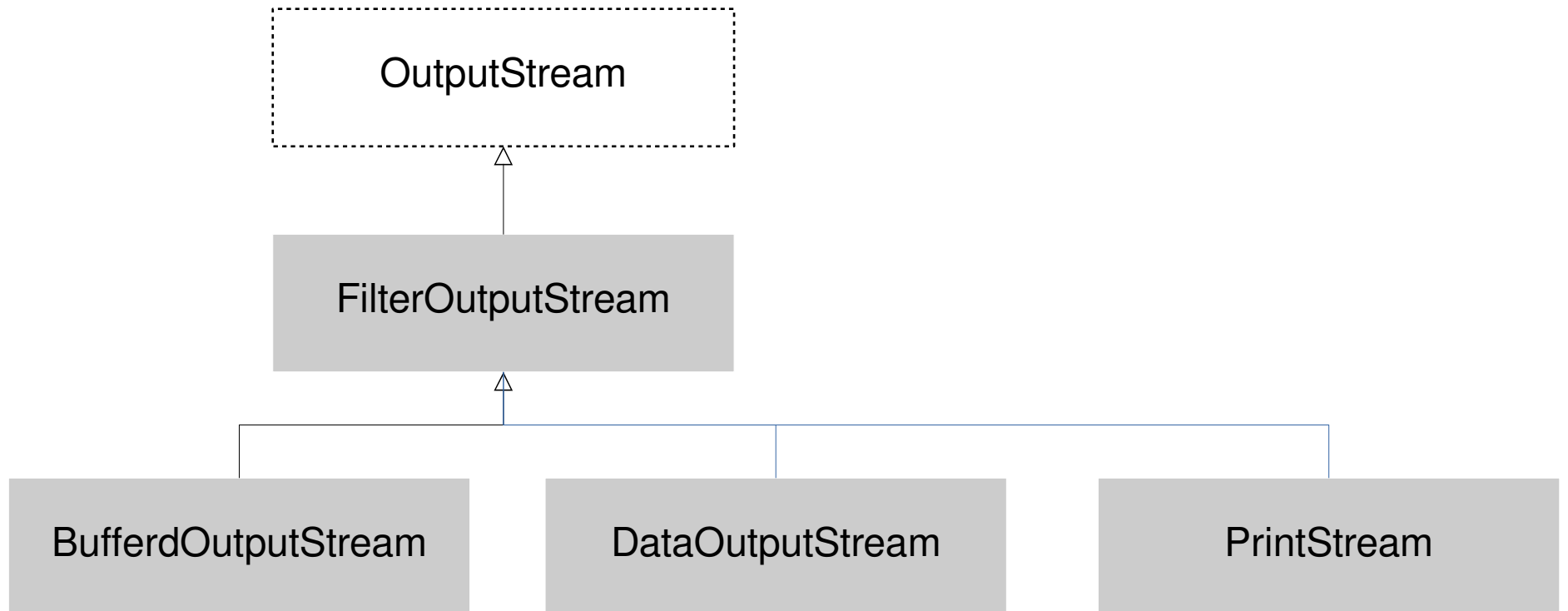```

# FilterInputStream

- 抽象类
- 特点
  - BufferedInputStream, DataInputStream
  - 为 InputStream 的子类
  - 具有 InputStream 所有的类的子类接口

# FilterInputStream

- 构造函数：
  - FilterInputStream(InputStream in)
  - protected

```
            ┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐
            |        InputStream        |
            └ ─ ─ ─ ─ ─ ─ ─ △ ─ ─ ─ ─ ─ ┘
                            │
            ┌───────────────────────────┐
            │      FilterInputStream     │
            └───────────────△───────────┘
                    ┌───────┴────────┐
    ┌───────────────────────┐  ┌───────────────────────┐
    │   BufferdInputStream   │  │    DataInputStream     │
    └───────────────────────┘  └───────────────────────┘
```

FilterOutputStream
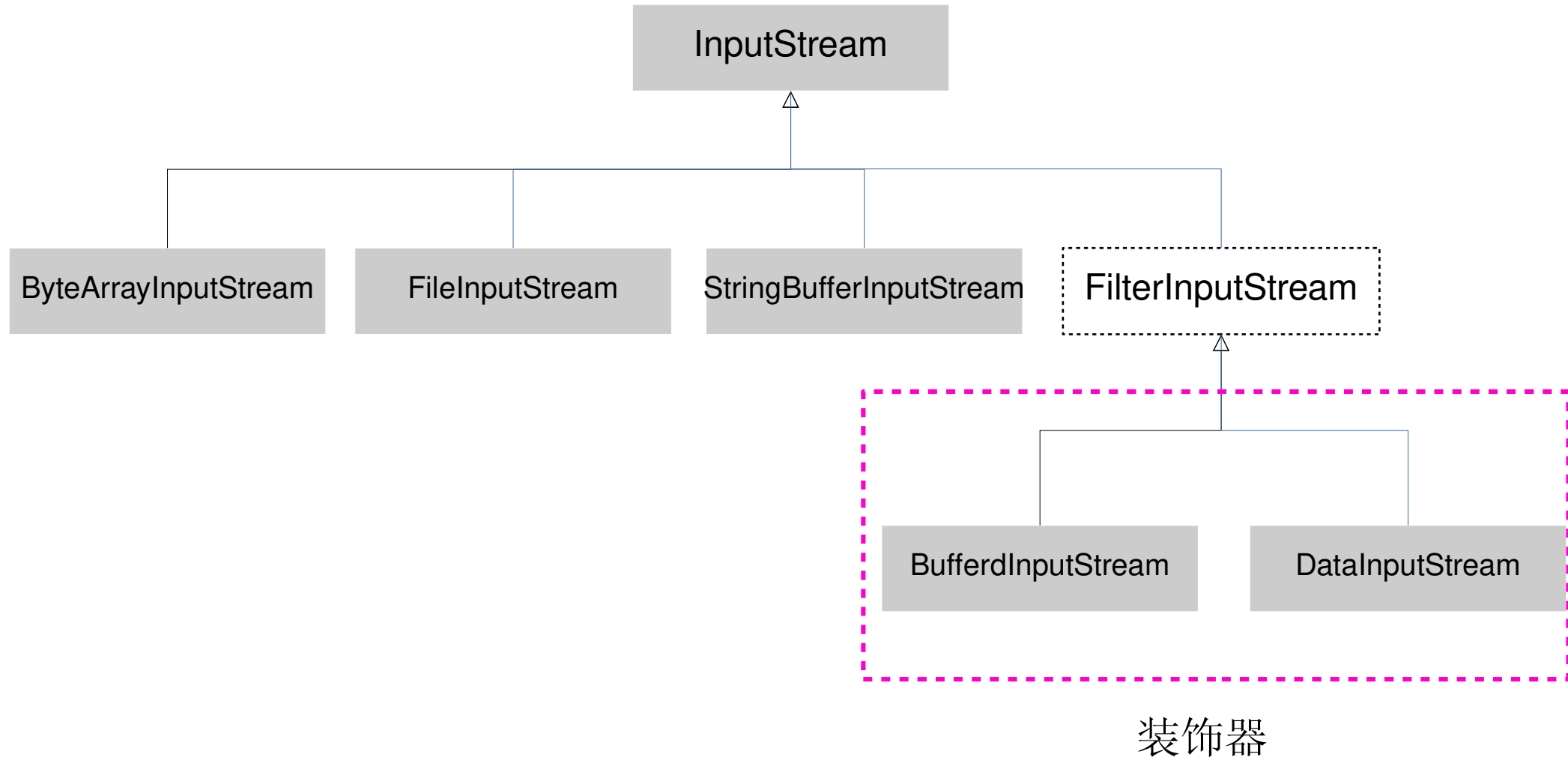
FilterInputStream

- 特点
  - 为 InputStream 的子类
  - 需要被继承（构造函数是 protected)
    - BufferedInputStream, DataInputStream

FilterInputStream 的对象 可以作为 **FilterInputStream** 的参数！

```java
FileInputStream fin = new FileInputStream("xanadu.txt");
BufferedInputStream bf = new BufferedInputStream(fin);
DataInputStream din = new DataInputStream(bf);

din.read();  din.readInt();  din.readDouble();
```

```java
FileOutputStream fout = new FileOutputStream("xanadu.txt");
BufferedOutputStream bf = new BufferedOutputStream(fout);
DataOutputStream dout = new DataOutputStream(bf);

dout.write(1);  dout.writeInt(10);  dout.writeDouble(3.14);
```

Decorator pattern

InputStream

ByteArrayInputStream   FileInputStream   StringBufferInputStream   FilterInputStream

BufferdInputStream   DataInputStream

装饰器

总结

- Stream
  - InputStream, OutputStream
- 根据数据源的不同，分为
  - FileInputStream, ByteArrayInputStream …
  - FileOutputStream, ByteArrayOutputStream…
- 可以有不同的装饰器
  - BufferedInputStream, DataInputStream
  - PrintStream

```java
public static void fileOutput() throws IOException{
    String str = "hello world!";
    File file = new File("d:\\test2.txt");  // 创建文件
    if(!file.exists()){
        file.createNewFile();    // 如果文件不存在，则进行创建
    }
    FileOutputStream fOutput = new FileOutputStream(file);
    BufferedOutputStream bOutput = new BufferedOutputStream(fOutput);
    byte[] buffer = str.getBytes(); // 将字符串文本转换成字节数组
    bOutput.write(buffer);
    bOutput.close();
    fOutput.close();
}

public static void fileInput() throws IOException{
    File file = new File("d:\\test2.txt");    // 创建文件
    FileInputStream fIutput = new FileInputStream(file);
    BufferedInputStream bIutput = new BufferedInputStream(fIutput);
    int temp = 0;
    while((temp = bIutput.read())!= -1){    // 当 temp 为 -1 时，数据读取完毕
        System.out.print((char)temp);
    }
    bIutput.close();
    fIutput.close();
}
```

Reader / Writer

- InputStream, OutputStream
  - 每次读入 / 写出一个字节
- Reader, Writer
  - 每次读入 / 写出一个字符
    - Utf-16
    - 每次读入 / 写出 16bit, 或者 32bit

Reader / Writer

读写字节	读写字符
InputStream	Reader
OutputStream	Writer
FileInputStream	FileReader
FileOutputStream	FileWriter
StringBufferInputStream	StringReader
(no corresponding class)	StringWriter
ByteArrayInputStream	CharArrayReader
ByteArrayOutputStream	CharArrayWriter

Reader / Writer decorators

读写字节	读写字符
FilterInputStream	FilterReader
FilterOutputStream	FilterWriter
BufferedInputStream	BufferedReader
BufferedOutputStream	BufferedWriter
DataInputStream	DataInputStream
DataOutputStream	DataOutputStream
PrintStream	PrintWriter

PrintWriter
可以用 OutputStream
作为参数

Typical uses of I/O streams

- 例子

```java
import java.io.*;
public class BufferedInputFile {
    // Throw exceptions to console:
    public static String read(String filename) throws IOException {
        // Reading input by lines:
        BufferedReader in = new BufferedReader(new FileReader(filename));
        String s;
        StringBuilder sb = new StringBuilder();
        while((s = in.readLine())!= null)
            sb.append(s + "\n");
        in.close();
        return sb.toString();
    }
    public static void main(String[] args) throws IOException {
        System.out.print(read("BufferedInputFile.java"));
    }
}
```

```java
import java.io.*;
public class MemoryInput {
    public static void main(String[] args) throws IOException {
        StringReader in = new StringReader(
                BufferedInputFile.read("MemoryInput.java"));
        int c;
        while((c = in.read()) != -1)
            System.out.print((char)c);
    }
}
```

```java
import java.io.*;
public class FormattedMemoryInput {
    public static void main(String[] args) throws IOException {
        try {
            DataInputStream in = new DataInputStream(
            new ByteArrayInputStream(
                BufferedInputFile.read(
                    "FormattedMemoryInput.java").getBytes()));
            while(true)
                System.out.print((char)in.readByte());
        } catch(EOFException e) {
            System.err.println("End of stream");
        }
    }
}
```

```java
import java.io.*;
public class TestEOF {
    public static void main(String[] args) throws IOException {
        DataInputStream in = new DataInputStream(
            new BufferedInputStream(
                new FileInputStream("TestEOF.java")));
        while(in.available() != 0)
            System.out.print((char)in.readByte());
    }
}
```

```java
import java.io.*;
public class BasicFileOutput {
    static String file = "BasicFileOutput.out";
    public static void main(String[] args) throws IOException {
        BufferedReader in = new BufferedReader(
            new StringReader(
            BufferedInputFile.read("BasicFileOutput.java")));
        PrintWriter out = new PrintWriter(
            new BufferedWriter(new FileWriter(file)));
        int lineCount = 1;
        String s;
        while((s = in.readLine()) != null )
            out.println(lineCount++ + ": " + s);
        out.close();
        // Show the stored file:
        System.out.println(BufferedInputFile.read(file));
    }
}
```

Short cut:
PrintWriter out = new PrinterWriter(file);

```java
import java.io.*;
public class StoringAndRecoveringData {
    public static void main(String[] args) throws IOException {
        DataOutputStream out = new DataOutputStream(
            new BufferedOutputStream(new FileOutputStream("Data.txt")));
        out.writeDouble(3.14159);
        out.writeUTF("That was pi");
        out.writeDouble(1.41413);
        out.writeUTF("Square root of 2");
        out.close();
        DataInputStream in = new DataInputStream(
            new BufferedInputStream(new FileInputStream("Data.txt")));
        System.out.println(in.readDouble());
        // Only readUTF() will recover the
        // Java-UTF String properly:
        System.out.println(in.readUTF());
        System.out.println(in.readDouble());
        System.out.println(in.readUTF());
    }
}
```

Standard I/O

- System.out
  - PrintStream
- System.err
  - PrintStream
- System.in
  - 需要一些预处理

```java
import java.io.*;
public class Echo {
    public static void main(String[] args) throws IOException {
        BufferedReader stdin = new BufferedReader(
            new InputStreamReader(System.in));
        String s;
        while((s = stdin.readLine()) != null && s.length()!= 0)
            System.out.println(s);
    }
}
```