

Programowanie komputerów

Wykład 4: „Wejście/wyjście: strumienie Java”



dr inż. Walery Susłow
walery.suslow@ie.tu.koszalin.pl

Wejście/wyjście

- Podstawowy mechanizm wejścia-wyjścia znajduje się w Javie w pakiecie *java.io*.*
- Obejmuje on następujące obszary funkcjonalne:
 - reprezentacja plików i katalogów,
 - odczyt danych z pliku i zapis danych do pliku,
 - obsługa wyjątków związanych z wejściem-wyjściem.



java.io.* InputStream

Methods declared in supertypes are hidden in subtypes

```

InputStream
int available ()
void close ()
void mark (int readlimit)
boolean markSupported ()
int read ()
int read (byte b[])
int read (byte b[], int off, int len)
void reset ()
long skip (long n)
    
```

```

DataInput
boolean readBoolean ()
byte readByte ()
char readChar ()
double readDouble ()
float readFloat ()
void readFully (byte b[])
void readFully (byte b[], int off, int len)
int readInt ()
String readLine ()
long readLong ()
short readShort ()
String readUTF ()
int readUnsignedByte ()
int readUnsignedShort ()
int skipBytes (int n)
    
```

```

ObjectInput
int available ()
void close ()
int read ()
int read (byte b[])
int read (byte b[], int off, int len)
Object readObject ()
long skip (long n)
    
```

```

ObjectStreamConstants
    
```

```

FileInputStream
FileInputStream (String name)
FileInputStream (File file)
FileInputStream (FileDescriptor fdObj)

Accessors
FileChannel getChannel ()
FileDescriptor getFD ()

Object
# void finalize ()
    
```

```

ByteArrayInputStream
ByteArrayInputStream (byte buf[])
ByteArrayInputStream (byte buf[], int offset, int length)
    
```

```

PipedInputStream
PipedInputStream ()
PipedInputStream (PipedOutputStream src)

void connect (PipedOutputStream src)
# void receive (int b)
    
```

```

SequenceInputStream
SequenceInputStream (Enumeration e)
SequenceInputStream (InputStream s1, InputStream s2)
    
```

```

FilterInputStream
# FilterInputStream (InputStream in)
    
```

```

BufferedInputStream
BufferedInputStream (InputStream in)
BufferedInputStream (InputStream in, int size)
    
```

```

PushbackInputStream
PushbackInputStream (InputStream in)
PushbackInputStream (InputStream in, int size)

int read (byte[] b, int off, int len)
void unread (int b)
void unread (byte[] b)
void unread (byte[] b, int off, int len)
    
```

```

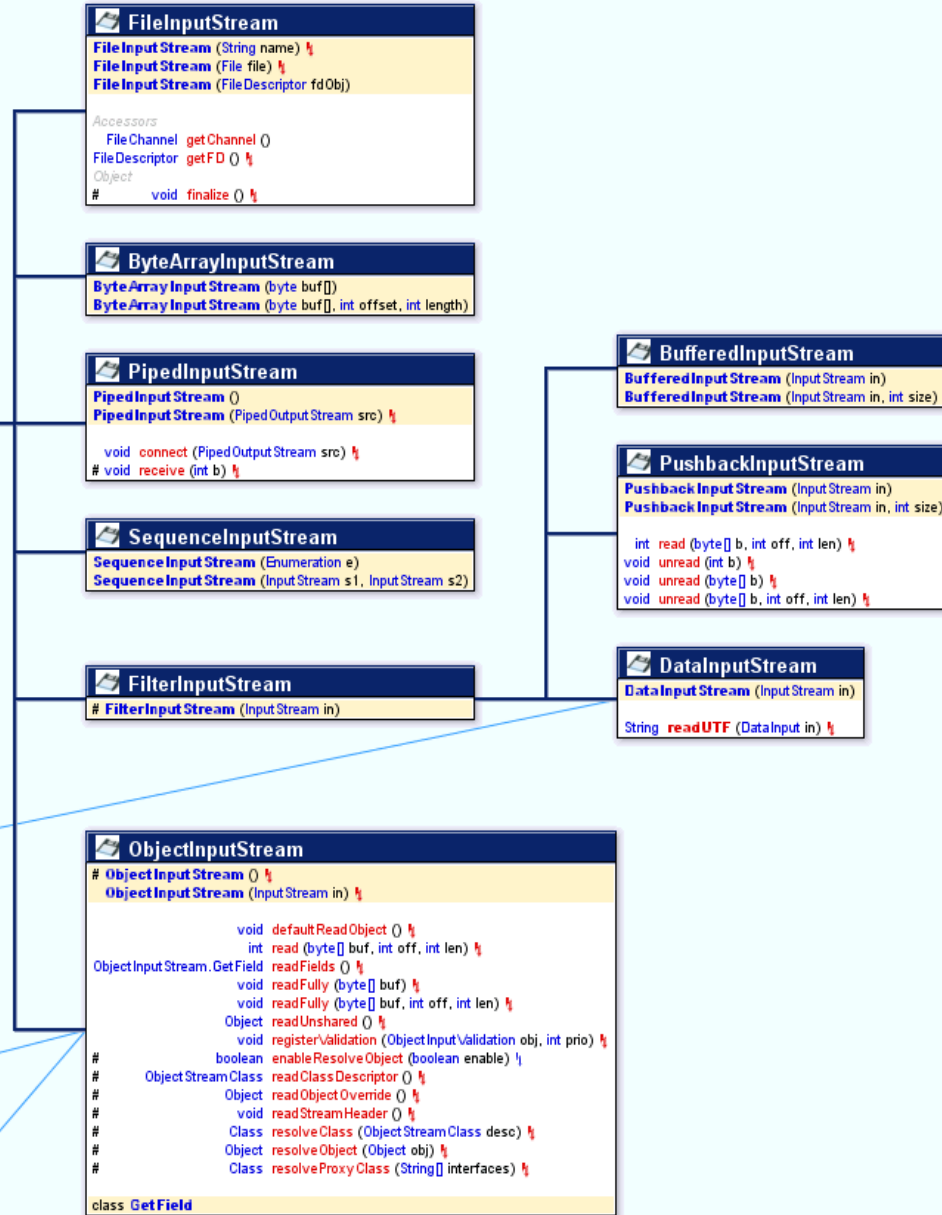
DataInputStream
DataInputStream (InputStream in)
String readUTF (DataInput in)
    
```

```

ObjectInputStream
# ObjectInputStream ()
ObjectInputStream (InputStream in)

void defaultReadObject ()
int read (byte[] buf, int off, int len)
ObjectInputStream.GetField readFields ()
void readFully (byte[] buf)
void readFully (byte[] buf, int off, int len)
Object readUnshared ()
void registerValidation (ObjectInputValidation obj, int prio)
# boolean enableResolveObject (boolean enable)
# ObjectStreamClass readClassDescriptor ()
# Object readObjectOverride ()
# void readStreamHeader ()
# Class resolveClass (ObjectStreamClass desc)
# Object resolveObject (Object obj)
# Class resolveProxyClass (String[] interfaces)

class GetField
    
```



java.io.* OutputStream

Methods declared in supertypes are hidden in subtypes

```

DataOutput
void write (int b) ¶
void write (byte b[]) ¶
void write (byte b[], int off, int len) ¶
void writeBoolean (boolean v) ¶
void writeByte (int v) ¶
void writeBytes (String s) ¶
void writeChar (int v) ¶
void writeChars (String s) ¶
void writeDouble (double v) ¶
void writeFloat (float v) ¶
void writeInt (int v) ¶
void writeLong (long v) ¶
void writeShort (int v) ¶
void writeUTF (String str) ¶

```

```

OutputStream
void close () ¶
void flush () ¶
void write (int b) ¶
void write (byte b[]) ¶
void write (byte b[], int off, int len) ¶

```

```

ObjectOutput
void close () ¶
void flush () ¶
void write (int b) ¶
void write (byte b[]) ¶
void write (byte b[], int off, int len) ¶
void writeObject (Object obj) ¶

```

```

ObjectStreamConstants

```

```

FileOutputStream
FileOutput Stream (String name) ¶
FileOutput Stream (File file) ¶
FileOutput Stream (File Descriptor fdObj)
FileOutput Stream (String name, boolean append) ¶
FileOutput Stream (File file, boolean append) ¶

Accessors
FileChannel getChannel ()
FileDescriptor getFD () ¶
Object
# void finalize () ¶

```

```

ByteArrayOutputStream
Byte Array Output Stream ()
Byte Array Output Stream (int size)

Object
String toString ()
Other Public Methods
void reset ()
int size ()
byte[] toByteArray ()
String toString (String enc) ¶
void writeTo (Output Stream out) ¶

```

```

PipedOutputStream
Piped Output Stream ()
Piped Output Stream (PipedInput Stream snk) ¶

void connect (PipedInput Stream snk) ¶

```

```

FilterOutputStream
Filter Output Stream (Output Stream out)

```

```

ObjectOutputStream
# Object Output Stream () ¶
Object Output Stream (Output Stream out) ¶

Accessors
Object Output Stream.PutField putFields () ¶
Other Public Methods
void defaultWriteObject () ¶
void reset () ¶
void useProtocolVersion (int version) ¶
void write (byte[] buf) ¶
void write (byte[] buf, int off, int len) ¶
void writeFields () ¶
void writeUnshared (Object obj) ¶

Other Protected Methods
# void annotateClass (Class cl) ¶
# void annotateProxyClass (Class cl) ¶
# void drain () ¶
# boolean enableReplaceObject (boolean enable) ¶
# Object replaceObject (Object obj) ¶
# void writeClassDescriptor (Object Stream Class desc) ¶
# void writeObjectOverride (Object obj) ¶
# void writeStreamHeader () ¶

class PutField

```

```

PrintStream
Print Stream (Output Stream out)
Print Stream (Output Stream out, boolean autoFlush)
Print Stream (Output Stream out, boolean autoFlush, String encoding) ¶

Accessors
# void setError ()
Other Public Methods
boolean checkError ()
void print (boolean b)
void print (char c)
void print (int i)
void print (long l)
void print (float f)
void print (double d)
void print (char s[])
void print (String s)
void print (Object obj)
void println ()
void println (boolean x)
void println (char x)
void println (int x)
void println (long x)
void println (float x)
void println (double x)
void println (char x[])
void println (String x)
void println (Object x)

```

```

BufferedOutputStream
Buffered Output Stream (Output Stream out)
Buffered Output Stream (Output Stream out, int size)

```

```

DataOutputStream
Data Output Stream (Output Stream out)
int size ()

```



java.io.* Reader

Methods declared in supertypes are hidden in subtypes

```

Reader
# Reader ()
# Reader (Object lock)

void close ()
void mark (int readAheadLimit)
boolean markSupported ()
int read ()
int read (char cbuf[])
int read (char cbuf[], int off, int len)
boolean ready ()
void reset ()
long skip (long n)
    
```

```

InputStreamReader
InputStreamReader (InputStream in)
InputStreamReader (InputStream in, String charsetName)
InputStreamReader (InputStream in, Charset cs)
InputStreamReader (InputStream in, CharsetDecoder dec)

String getEncoding ()
    
```

```

FileReader
FileReader (String fileName)
FileReader (File file)
FileReader (FileDescriptor fd)
    
```

```

CharArrayReader
CharArrayReader (char buf[])
CharArrayReader (char buf[], int offset, int length)
    
```

```

StringReader
StringReader (String s)
    
```

```

PipedReader
PipedReader ()
PipedReader (PipedWriter src)

void connect (PipedWriter src)
    
```

```

FilterReader
# FilterReader (Reader in)
    
```

```

PushbackReader
PushbackReader (Reader in)
PushbackReader (Reader in, int size)

void unread (int c)
void unread (char cbuf[])
void unread (char cbuf[], int off, int len)
    
```

```

BufferedReader
BufferedReader (Reader in)
BufferedReader (Reader in, int sz)

String readLine ()
    
```

```

LineNumberReader
LineNumberReader (Reader in)
LineNumberReader (Reader in, int sz)

Accessors
int get / setLineNumber ()

Other Public Methods
String readLine ()
    
```





java.io.* Writer

Methods declared in supertypes are hidden in subtypes

```

Writer
# Writer ()
# Writer (Object lock)

void close ()
void flush ()
void write (int c)
void write (char cbuf[])
void write (String str)
void write (char cbuf[], int off, int len)
void write (String str, int off, int len)
  
```

```

BufferedWriter
BufferedWriter (Writer out)
BufferedWriter (Writer out, int sz)

void newLine ()
  
```

```

CharArrayWriter
CharArrayWriter ()
CharArrayWriter (int initialSize)

Object
String toString ()
Other Public Methods
void reset ()
int size ()
char[] toCharArray ()
void writeTo (Writer out)
  
```

```

FilterWriter
# FilterWriter (Writer out)
  
```

```

PipedWriter
PipedWriter ()
PipedWriter (PipedReader snk)

void connect (PipedReader snk)
  
```

```

StringWriter
StringWriter ()
StringWriter (int initialSize)

Accessors
StringBuffer getBuffer ()
Object
String toString ()
  
```

```

OutputStreamWriter
OutputStreamWriter (OutputStream out)
OutputStreamWriter (OutputStream out, String charsetName)
OutputStreamWriter (OutputStream out, Charset cs)
OutputStreamWriter (OutputStream out, Charset Encoder enc)

String getEncoding ()
  
```

```

PrintWriter
PrintWriter (Writer out)
PrintWriter (OutputStream out)
PrintWriter (Writer out, boolean autoFlush)
PrintWriter (OutputStream out, boolean autoFlush)

Accessors
# void setError ()
Other Public Methods
boolean checkError ()
void print (boolean b)
void print (char c)
void print (int i)
void print (long l)
void print (float f)
void print (double d)
void print (char s[])
void print (String s)
void print (Object obj)
void println ()
void println (boolean x)
void println (char x)
void println (int x)
void println (long x)
void println (float x)
void println (double x)
void println (char x[])
void println (String x)
void println (Object x)
  
```

```

FileWriter
FileWriter (String fileName)
FileWriter (File file)
FileWriter (FileDescriptor fd)
FileWriter (String fileName, boolean append)
FileWriter (File file, boolean append)
  
```



java.io.*

Miscellaneous

Methods declared in supertypes are hidden in subtypes

StreamTokenizer

StreamTokenizer (Reader r)

Object

String toString ()

Other Public Methods

void commentChar (int ch)

void eolIsSignificant (boolean flag)

int lineno ()

void lowerCaseMode (boolean fl)

int nextToken ()

void ordinaryChar (int ch)

void ordinaryChars (int low, int hi)

void parseNumbers ()

void pushBack ()

void quoteChar (int ch)

void resetSyntax ()

void slashSlashComments (boolean flag)

void slashStarComments (boolean flag)

void whitespaceChars (int low, int hi)

void wordChars (int low, int hi)

int TT_EOF, TT_EOL, TT_NUMBER, TT_WORD

int ttype

String sval

double nval

FileFilter

boolean accept (File pathname)

FilenameFilter

boolean accept (File dir, String name)

DataInput

boolean readBoolean ()

byte readByte ()

char readChar ()

double readDouble ()

float readFloat ()

void readFully (byte b[])

void readFully (byte b[], int off, int len)

int readInt ()

String readLine ()

long readLong ()

short readShort ()

String readUTF ()

int readUnsignedByte ()

int readUnsignedShort ()

int skipBytes (int n)

DataOutput

void write (int b)

void write (byte b[])

void write (byte b[], int off, int len)

void writeBoolean (boolean v)

void writeByte (int v)

void writeBytes (String s)

void writeChar (int v)

void writeChars (String s)

void writeDouble (double v)

void writeFloat (float v)

void writeInt (int v)

void writeLong (long v)

void writeShort (int v)

void writeUTF (String str)

RandomAccessFile

RandomAccessFile (String name, String mode)

RandomAccessFile (File file, String mode)

Accessors

FileChannel getChannel ()

FileDescriptor getFD ()

long getFilePointer ()

void setLength (long newLength)

Other Public Methods

void close ()

long length ()

int read ()

int read (byte b[])

int read (byte b[], int off, int len)

void seek (long pos)

FileDescriptor

FileDescriptor ()

void sync ()

boolean valid ()

FileDescriptor in, out, err

Serializable

Externalizable

void readExternal (ObjectInput in)

void writeExternal (ObjectOutput out)

java.lang **Comparable**

int compareTo (Object o)

File

File (String pathname)

File (URI uri)

File (String parent, String child)

File (File parent, String child)

Static Methods

File createTempFile (String prefix, String suffix)

File createTempFile (String prefix, String suffix, File directory)

File[] listRoots ()

Accessors

File getAbsoluteFile ()

String getAbsolutePath ()

File getCanonicalFile ()

String getCanonicalPath ()

String getName ()

String getParent ()

File getParentFile ()

String getPath ()

boolean isAbsolute ()

boolean isDirectory ()

boolean isFile ()

boolean isHidden ()

boolean setLastModified (long time)

boolean setReadOnly ()

Collectors

boolean delete ()

void deleteOnExit ()

Object

boolean equals (Object obj)

int hashCode ()

String toString ()

Other Public Methods

boolean canRead ()

boolean canWrite ()

int compareTo (File pathname)

int compareTo (Object o)

boolean createNewFile ()

boolean exists ()

long lastModified ()

long length ()

String[] list ()

String[] list (FilenameFilter filter)

File[] listFiles ()

File[] listFiles (FilenameFilter filter)

File[] listFiles (FileFilter filter)

boolean mkdir ()

boolean mkdirs ()

boolean renameTo (File dest)

URI toURI ()

URL toURL ()

char separatorChar, pathSeparatorChar

String separator, pathSeparator



java.io.* Exceptions

Methods declared in supertypes are hidden in subtypes

Serializable

java.lang.Throwable

Throwable ()
Throwable (String message)
Throwable (Throwable cause)
Throwable (String message, Throwable cause)

Accessors

Throwable getCause ()
String getLocalizedMessage ()
String getMessage ()
StackTraceElement[] get / setStackTrace ()

Object

String toString ()

Other Public Methods

Throwable fillInStackTrace ()
Throwable initCause (Throwable cause)
void printStackTrace ()
void printStackTrace (PrintStream s)
void printStackTrace (PrintWriter s)

java.lang.Exception

IOException

InterruptedException

InterruptedException ()
InterruptedException (String s)

int bytesTransferred

CharConversionException

EOFException

FileNotFoundException

ObjectStreamException

InvalidObjectException

NotActiveException

NotSerializableException

StreamCorruptedException

InvalidClassException

InvalidClassException (String reason)
InvalidClassException (String cname, String reason)

String classname

OptionalDataException

int length
boolean eof

WriteAbortedException

SyncFailedException

UTFDataFormatException

UnsupportedEncodingException



Klasa `java.io.File`

- Obiekty klasy `java.io.File` reprezentują ścieżkę do pliku albo katalogu (niezależnie od tego, czy one istnieją)
- Stanowią one punkt wejścia dla wszystkich operacji zapisu i odczytu danych, ale za ich pomocą nie można bezpośrednio dokonywać tych czynności

```
File plik = new File("c:/dane.txt"); //utwórz uchwyt do pliku  
File katalog = new File("c:/moje dokumenty"); //do folderu  
File plik2 = new File(katalog, "nowy plik.txt")
```



Wybrane metody klasy *java.io.File*

- *String getName()* – zwraca nazwę pliku
- *String getAbsolutePath()* – zwraca pełną ścieżkę pliku
- *boolean exists()* – czy plik istnieje?
- *boolean canWrite()* – możliwość zapisu
- *boolean canRead()* – możliwość odczytu
- *boolean isFile()* – czy jest plikiem?
- *boolean isDirectory()* – czy jest katalogiem
- *int length()* – rozmiar pliku



Wybrane metody klasy *java.io.File*

- *String[] list()* – zwraca tablicę z nazwami plików znajdujących się w katalogu
- *boolean renameTo(File nowy)* – zmiana nazwy
- *boolean mkdirs()* – utworzenie hierarchii katalogów opisanych w konstruktorze
- *boolean delete()* – kasowanie pliku
- *boolean createNewFile()* – utworzenie nowego pliku



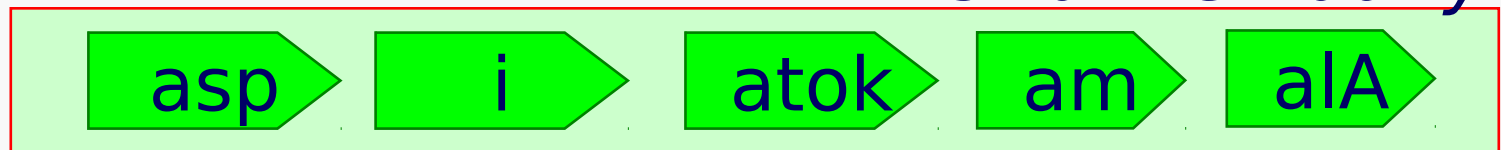
Strumienie



Strumienie

- W Javie mechanizm wejścia-wyjścia opiera się na pojęciu *strumienia* (ang. *stream*)
- *Strumień* to tor komunikacyjny pomiędzy dowolnym źródłem i miejscem przeznaczenia danych.
- Zasadniczo strumienie są jednokierunkowe, tzn. z jednego końca przyjmują dane (można do nich pisać), a z drugiego wysyłają (można z nich czytać).

strumień danych



Strumienie

- Wszystkie nowoczesne konstrukcje I/O opierają się na strumieniu. Strumień jest to połączenie do źródła danych lub do docelowego miejsca przechowywania danych.
- Plik jest ograniczonym obszarem danych wejściowych, klawiatura nie ma zdefiniowanego końca danych.
- Rzeby obsłużyć wejście/wyjście:

```
import java.io.*;
```

```
... // Open the stream - otwórz
```

```
... // Use the stream (read, write) - wykorzystaj
```

```
... // Close the stream - zamknij
```



Rodzaje strumieni

Plikowe, tekstowe, buforowane...

Komunikacja z pamięcią operacyjną

- *CharArrayReader, CharArrayWriter, ByteArrayInputStream, ByteArrayOutputStream, StringReader, StringWriter, StringBufferInputStream*

Komunikacja z plikiem

- *FileReader, FileWriter, FileInputStream, FileOutputStream*

Potokowe przetwarzanie danych

- *PipedReader, PipedWriter, PipedInputStream, PipedOutputStream*

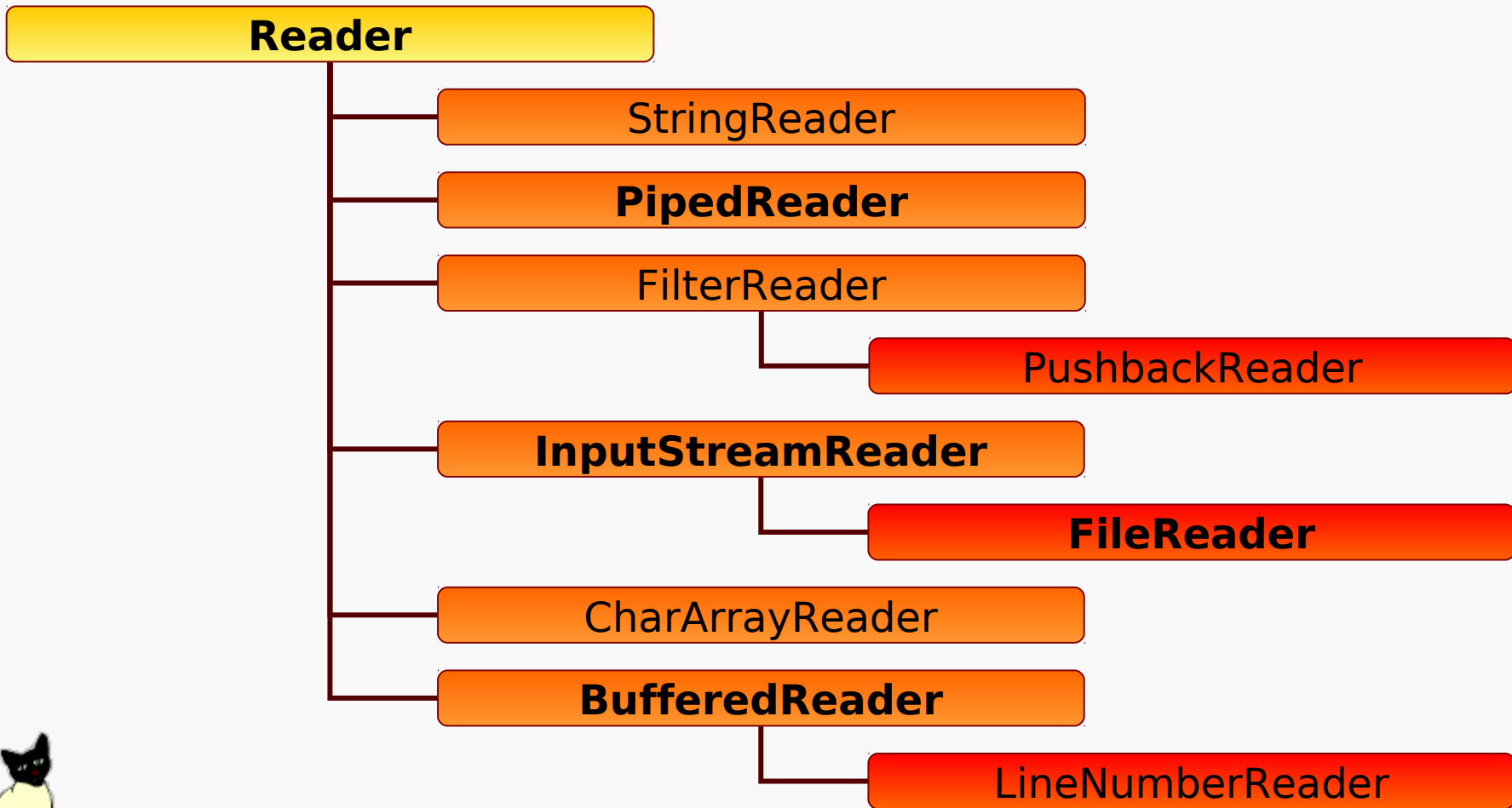


Akcje za pomocą strumieni

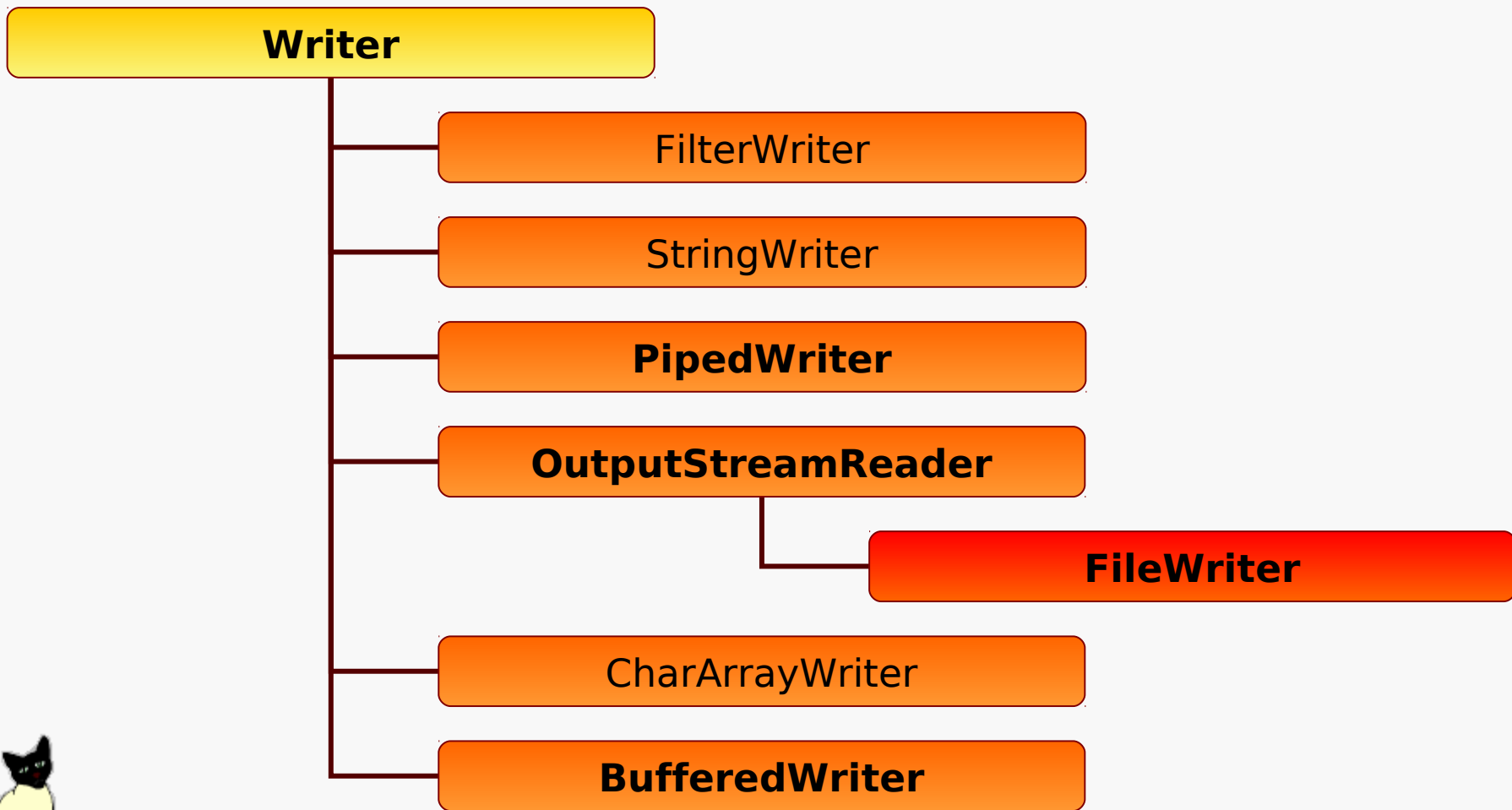
- Łączenie (concatenation): *SequenceInputStream*
- Serializacja: *ObjectInputStream, ObjectOutputStream*
- Konwersja: *DataInputStream, DataOutputStream*
- Zliczanie: *LineNumberReader, LineNumberInputStream*
- Podglądanie: *PushbackReader, PushbackInputStream*
- Drukowanie: *PrintWriter, PrintStream*
- Buforowanie: *BufferedReader, BufferedWriter, BufferedInputStream, BufferedOutputStream*
- Filtrowanie: *FilterReader, FilterWriter, FilterInputStream, FilterOutputStream*
- Zamiana bajt-znak: *InputStreamReader, OutputStreamWriter*



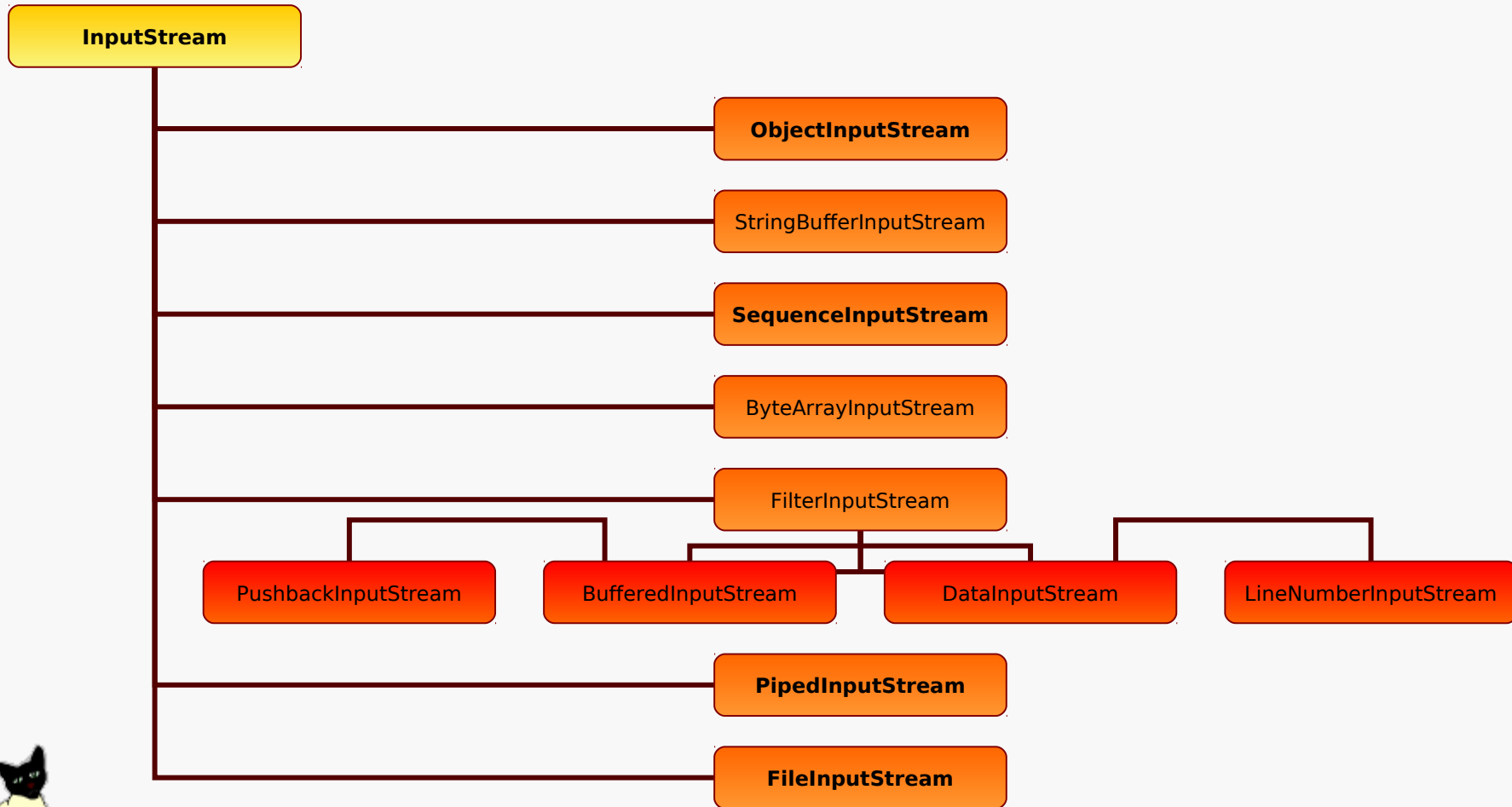
Strumienie znaków (Character streams)



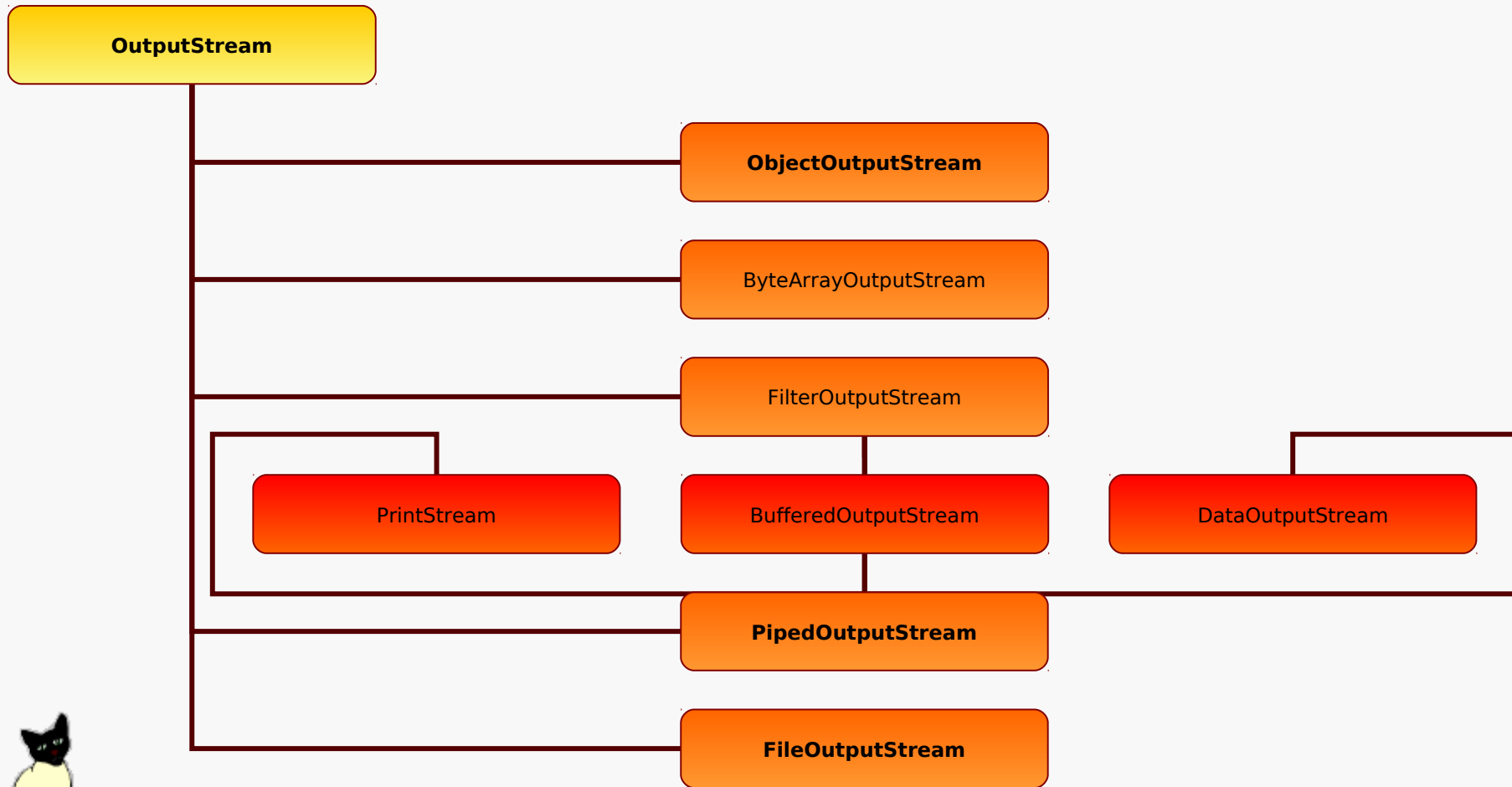
Strumienie znaków (Character streams)



Strumienie bajtowe



Strumienie bajtów (Byte streams)



Klasa File: obsługa katalogów

```
import java.io.*;
import java.util.*;

public class DirList {
    public static void main(String[] args) {
        File path = new File("..");
        String[] list;
        list = path.list();
        for (int i=0; i < list.length; i++)
            System.out.println(list[i]);
    }
}
```



Strumienie plikowe

FileReader – FileWriter

FileInputStream – FileOutputStream



Powtórzymy: otwórz - wykorzystaj - zamknij

Przykładowe otwieranie strumienia:

```
FileReader fileReader = new FileReader(fileName);  
// Nigdy nie stosujemy fileName póki działa fileReader
```

Przykładowe używanie strumienia

```
int ch;  
ch = fileReader.read( );  
// Znaczenie int zależy od kodowania pliku (ASCII, Unicode)
```

Pamiętajmy:

- Strumień jest „drogim” mechanizmem.
- Istnieje przedział ilości strumieni otwartych jednocześnie.
- Nie wolno stosować kilka strumieni do tego samego pliku.
- ZAWSZE zamykamy wykorzystane strumienie.



Strumienie plikowe: kopiowanie znaków

```
import java.io.*;
public class Copy {
    public static void main(String[] args) throws IOException {
        File inputFile = new File("wejscie.txt");
        File outputFile = new File("wyjscie.txt");
        FileReader in = new FileReader(inputFile);
        FileWriter out = new FileWriter(outputFile);
        int c;
        while ((c = in.read()) != -1)
            out.write(c);
        in.close();
        out.close();
    }
}
```

Kodowanie 16bit → 8bit zgodnie z domyślnym:
System.getProperty("file.encoding")

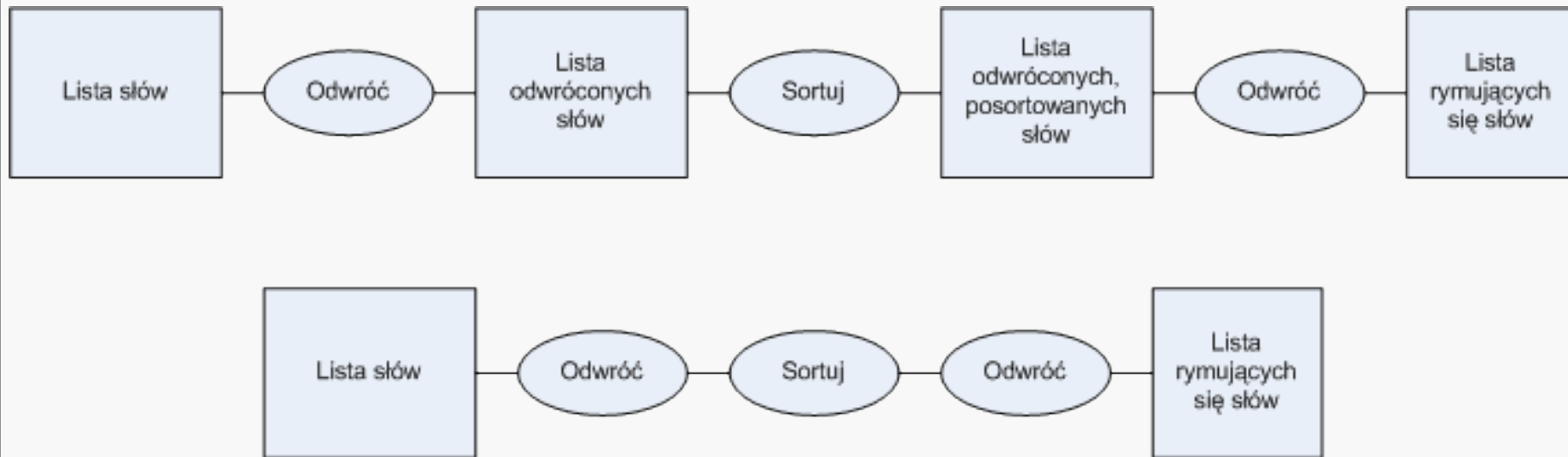


Strumienie plikowe: kopiowanie bajtów

```
import java.io.*;
public class CopyBytes {
    public static void main(String[] args) throws IOException {
        File inputFile = new File("wejscie.txt");
        File outputFile = new File("wyjscie.txt");
        FileInputStream in = new
FileInputStream(inputFile);
        FileOutputStream out = new
FileOutputStream(outputFile);
        int c;
        while ((c = in.read()) != -1) out.write(c);
        in.close();    out.close();
    }
}
```



Strumienie buforowane/potokowe



Strumienie buforowane

```
import java.io.*;

public class RhymingWords {
    public static void main(String[] args) throws IOException {
        FileReader words = new FileReader("slova.txt");
        Reader rhymedWords = reverse(sort(reverse(words)));
        BufferedReader in = new BufferedReader(rhymedWords);
        String input;
        while ((input = in.readLine()) != null)
            System.out.println(input);
        in.close();
    }
}
```



Strumienie potokowe (1)

```
public static Reader reverse(Reader source)  
throws IOException {
```

```
    BufferedReader in = new BufferedReader(source);  
    PipedWriter pipeOut = new PipedWriter();  
    PipedReader pipeIn = new PipedReader(pipeOut);  
    PrintWriter out = new PrintWriter(pipeOut);
```

```
    new ReverseThread(out, in).start();
```

```
    return pipeIn;
```

```
}
```



Strumienie potokowe (2)

```
public static Reader sort(Reader source) throws  
IOException {
```

```
    BufferedReader in = new BufferedReader(source);  
    PipedWriter pipeOut = new PipedWriter();  
    PipedReader pipeIn = new PipedReader(pipeOut);  
    PrintWriter out = new PrintWriter(pipeOut);
```

```
    new SortThread(out, in).start();
```

```
    return pipeIn;
```

```
}
```

```
}
```



Opakowanie strumieni

```
public static Reader sort(Reader source) throws  
IOException {
```

```
    BufferedReader in = new BufferedReader(source);
```

```
    PipedWriter pipeOut = new PipedWriter();
```

```
    PipedReader pipeIn = new PipedReader(pipeOut);
```

```
    PrintWriter out = new PrintWriter(pipeOut);
```

```
    new SortThread(out, in).start();
```

```
    return pipeIn;
```

```
}
```

