Files and Streams

Using Streams, Files, Serialization

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#java-advanced

Table of Contents

1. Streams Basics
   - Opening a File Stream
   - Closing a File Stream
2. Types of Streams
   - Combining Streams
3. Files and Directories
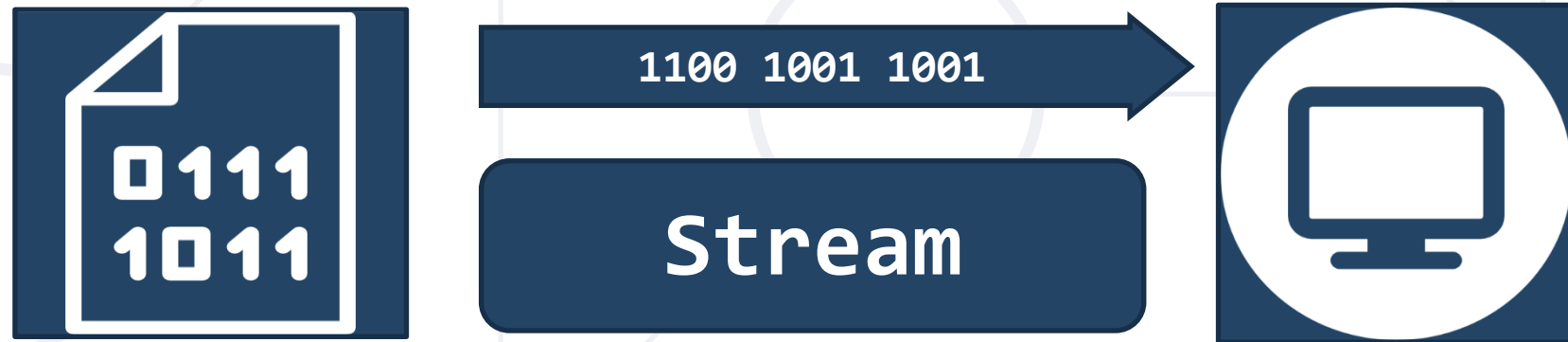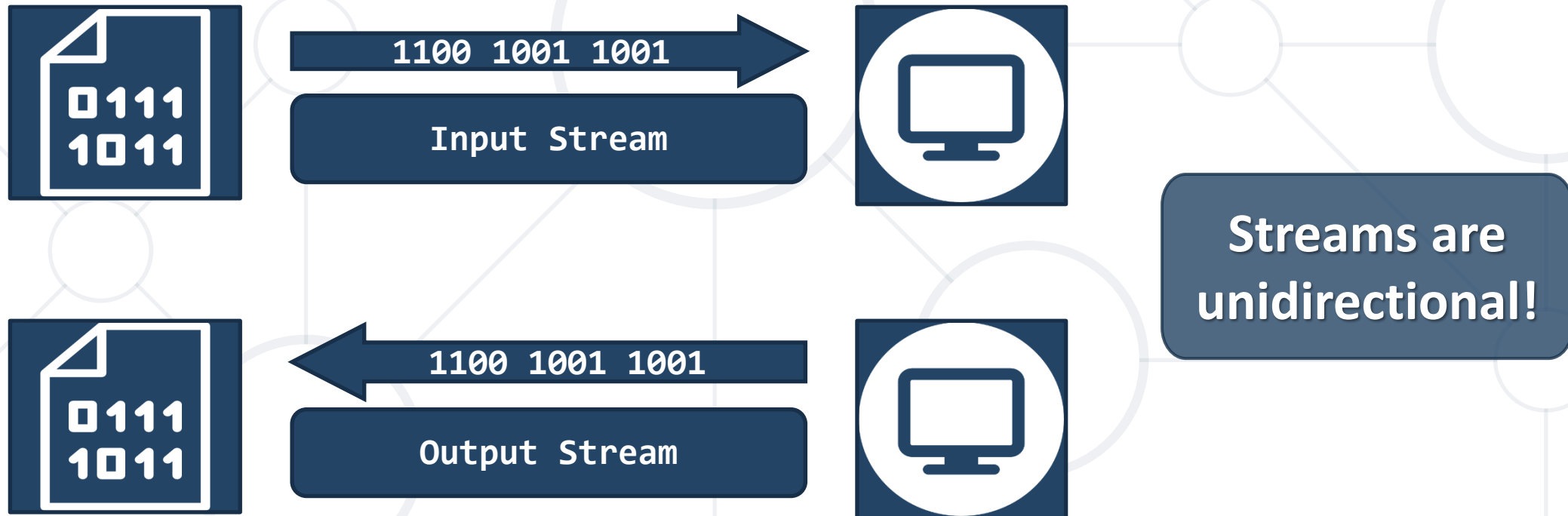4. Serialization

Streams

What is Stream?

- **Streams** are used to **transfer data**
- We **open a stream** to:
  - **Read** a file
  - **Write** to a file

Streams Basics

- Two fundamental types of streams:

1100 1001 1001

Input Stream

1100 1001 1001

Output Stream

Streams are unidirectional!

Opening a File Stream

```java
String path = "C:\\input.txt";

FileInputStream fileStream =
                new FileInputStream(path);

int oneByte = fileStream.read();
while (oneByte >= 0) {
    System.out.print(oneByte);
    oneByte = fileStream.read();
}
```

Returns -1 if empty

Closing a File Stream (1)

- Using **try-catch-finally**

```java
InputStream in = null;
try {
    in = new FileInputStream(path);
} catch (IOException e) {
    // TODO: handle exception
} finally {
    if (in != null) {
        in.close();
    }
}
```

Always free resources!

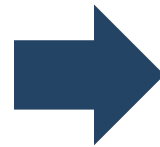**close()** can also throw an exception

- Using **try-with-resources**

```java
try (InputStream in = new FileInputStream(path)) {
    int oneByte = in.read();
    while (oneByte >= 0) {
        System.out.print(oneByte);
        oneByte = in.read();
    }
} catch (IOException e) {
    // TODO: handle exception
}
```

Problem: Read File

- You are given a file

- Read and print all of its contents **as a sequence of bytes**

- Submit in Judge **only the output** of the program

```
Two households, both
alike in dignity,
In fair Verona, where we
lay our scene,
```

→

```
1010100 1110111 1101111
100000 1101000 1101111
1110101 1110011 1100101
1101000…
```

Check your solution here: https://judge.softuni.bg/Contests/1493/Streams-Files-And-Directories-Lab

```java
String path = "D:\\input.txt";

try (InputStream in = new FileInputStream(path)) {
    int oneByte = in.read();
    while (oneByte >= 0) {
        System.out.printf("%s ",
            Integer.toBinaryString(oneByte));
        oneByte = in.read();
    }
}
catch (IOException e) {
    e.printStackTrace();
}
```
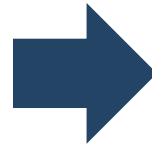
Problem: Write to File

- Read a file and write all its content while **skipping any punctuation** (skip '**,**', '**.**', '**!**', '**?**')

- Submit in Judge **only the output** of the program
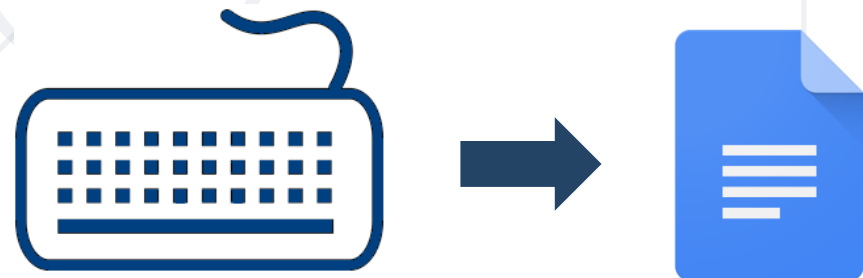
```
Two households, both
alike in dignity.
In fair Verona, where
we lay our scene.
```

➡

```
Two households both
alike in dignity
In fair Verona where
we lay our scene
```

Check your solution here: https://judge.softuni.bg/Contests/1493/Streams-Files-And-Directories-Lab

Solution: Write to File (1)

```java
String inputPath = "D:\\input.txt";
String outputPath = "D:\\output.txt";

List<Character> symbols = new ArrayList<>();
Collections.addAll(symbols, '.', ',', '!', '?');

// continues…
```

Check your solution here: https://judge.softuni.bg/Contests/1493/Streams-Files-And-Directories-Lab

Solution: Write to File (2)

```java
try (InputStream in = new FileInputStream(inputPath);
     OutputStream out = new FileOutputStream(outputPath))
{
  int oneByte = 0;
  while ((oneByte = in.read()) >= 0) {
    if (!symbols.contains((char)oneByte)) {
      out.write(oneByte);
    }
  }
} // TODO: handle exceptions
```

Check your solution here: https://judge.softuni.bg/Contests/1493/Streams-Files-And-Directories-Lab

Basic Stream Types in Java

Byte and Character

Byte Stream

- Byte streams are the **lowest level streams**

    - Byte streams can read or write **one byte at a time**

    - All byte streams **descend** from **InputStream** and **OutputStream**
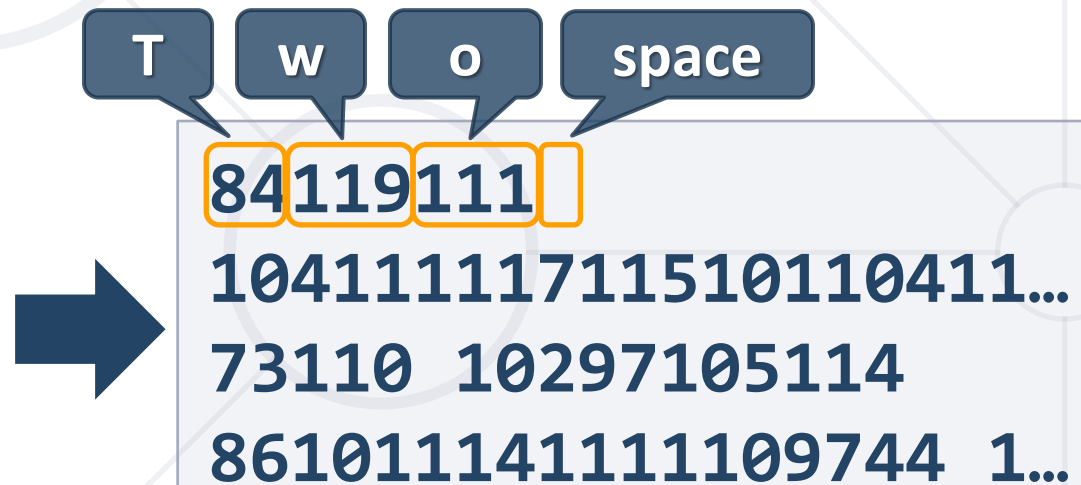
InputStream	100101	111111	100011	-1

OutputStream	100101	111111	100011	

- **Read a file** and **copy** its contents **to another text file**

- Write characters **as bytes** in decimal

- Write **every space or new line as it is**, e.g. as a space or new line

| T | w | o | space |

```
Two households, both
alike in dignity.
In fair Verona, where
we lay our scene.
```

→

```
84119111 
104111117115101101104111…
73110 10297105114
861011114111111109744 1…
```

Check your solution here: https://judge.softuni.bg/Contests/1493/Streams-Files-And-Directories-Lab

17

Solution: Copy Bytes

```java
// TODO: Open input and output streams
int oneByte = 0;
while ((oneByte = in.read()) >= 0) {
  if (oneByte == 10 || oneByte == 32) {
    out.write(oneByte);
  } else {
    String digits = String.valueOf(oneByte);
    for (int i = 0; i < digits.length(); i++)
      out.write(digits.charAt(i));
  }
} // TODO: handle exceptions
```

Check your solution here: https://judge.softuni.bg/Contests/1493/Streams-Files-And-Directories-Lab

Character Streams

- All character streams descend from **FileReader** and **FileWriter**

```
String path = "D:\\input.txt";

FileReader reader = new FileReader(path);
```

Combining Streams

- Character streams are often "**wrappers**" for byte streams
  - **FileReader** uses **FileInputStream**
  - **FileWriter** uses **FileOutputStream**

```
String path = "D:\\input.txt";

Scanner reader =
    new Scanner(new FileInputStream(path));
```

Wrapping a Stream

Problem: Extract Integers

- **Read a file** and **extracts all integers** in a separate file

- Get only numbers that are **not a part of a word**

- Submit in Judge **only the output** of the program

```
2 households, 22 alike
in 3nity,
In fair Verona, where
we lay our scene
```
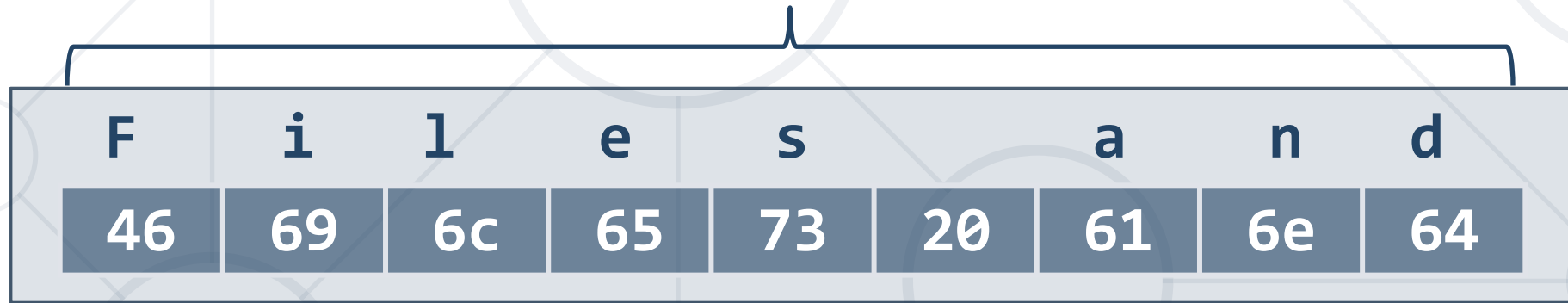
➡

```
2
22
```

Solution: Extract Integers

```java
Scanner scanner =
    new Scanner(new FileInputStream(inputPath));

PrintWriter out =
    new PrintWriter(new FileOutputStream(outputPath));

while (scanner.hasNext()) {
   if (scanner.hasNextInt())
     out.println(scanner.nextInt());

   scanner.next();
}
out.close();
```

Check your solution here: https://judge.softuni.bg/Contests/1493/Streams-Files-And-Directories-Lab

Buffered Streams

- Reading the information in **chunks**

- Significantly **boost performance**

Length = 9

F	i	l	e	s		a	n	d
46	69	6c	65	73	20	61	6e	64

Position ⬆

Buffer

46	69

6c	65

73	20

61	6e

64	

Problem: Write Every Third Line

- Read a file and **write all lines which number is divisible by 3** in a separate file

- Line numbers start from **one**

```
Two households, both
alike in dignity,
In fair Verona, where
we lay our scene,
From ancient grudge
break to new mutiny...
```

Check your solution here: https://judge.softuni.bg/Contests/1493/Streams-Files-And-Directories-Lab
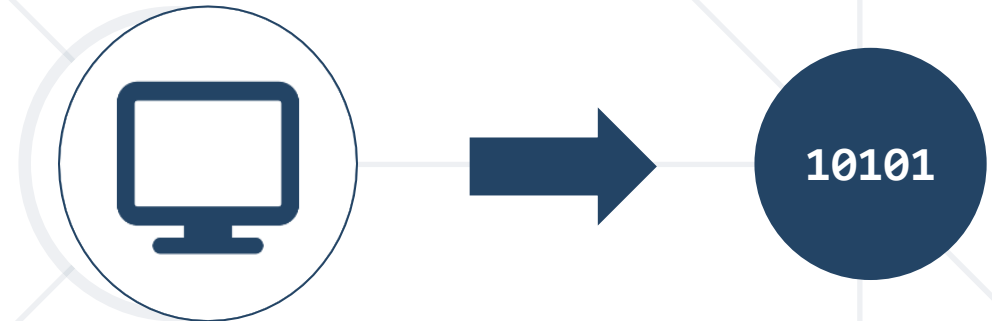
Solution: Write Every Third Line

```java
try (BufferedReader in =
        new BufferedReader(new FileReader(inputPath));
        PrintWriter out =
        new PrintWriter(new FileWriter(outputPath))) {
    int counter = 1;
    String line = in.readLine();
    while (line != null) {
        if (counter % 3 == 0)
            out.println(line);
        counter++;
        line = in.readLine();
    }
} // TODO: handle exceptions
```
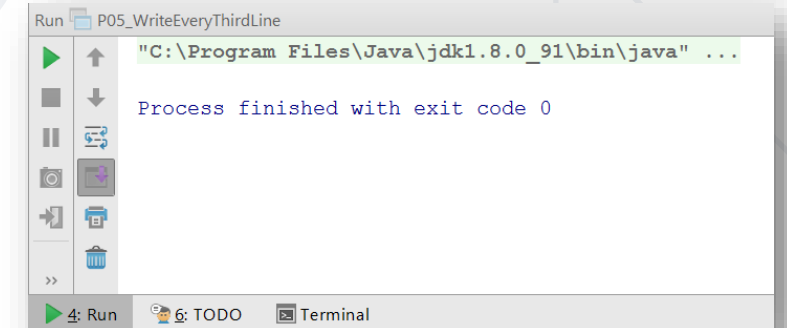
Check your solution here: https://judge.softuni.bg/Contests/1493/Streams-Files-And-Directories-Lab

Command Line I/O (1)

- Standard Input - **System.in**

- Standard Output - **System.out**

- Standard Error - **System.err**

Input Stream

```
Scanner scanner = new Scanner(System.in);
String line = scanner.nextLine();
System.out.println(line);
```

Output Stream

Run P05_WriteEveryThirdLine

"C:\Program Files\Java\jdk1.8.0_91\bin\java" ...

Process finished with exit code 0

4: Run   6: TODO   Terminal

```java
public static void main(String[] args) throws IOException {
    BufferedReader reader =
        new BufferedReader(new InputStreamReader(System.in));

    String hello = reader.readLine(); // Hello BufferedReader
    System.out.println(hello);        // Hello BufferedReader
}
```
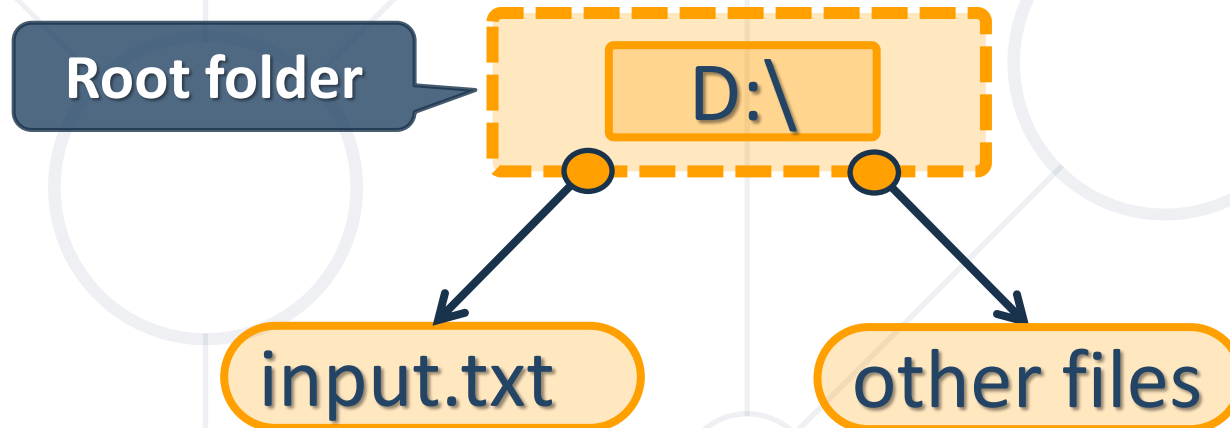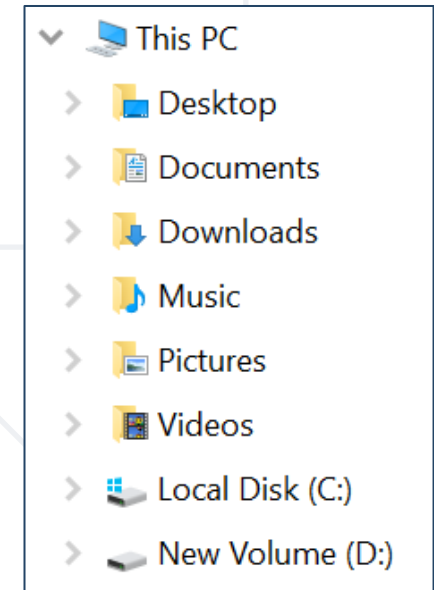
Files and Paths

Easily Working With Files

Paths

- The location of a file in the file system

  `D:\input.txt`

- Represented in Java by the Path class

  `Path path = Paths.get("D:\\input.txt");`

Root folder → D:\ → input.txt, other files

Files (1)

- Provides **static methods** for **creating streams**

```java
Path path = Paths.get("D:\\input.txt");

try (BufferedReader reader =
        Files.newBufferedReader(path)) {
    // TODO: work with file
} catch (IOException e) {
    // TODO: handle exception
}
```
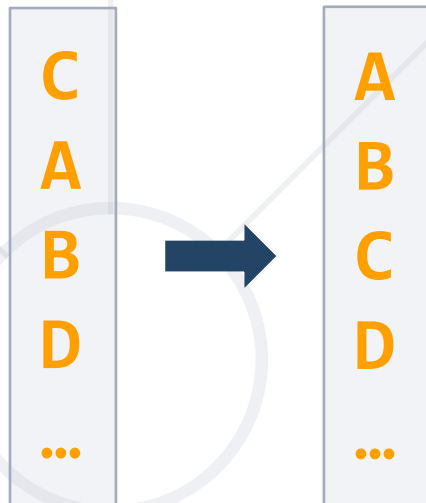
Files (2)

- Provides **utility** methods for easy file manipulation

```java
Path inPath = Paths.get("D:\\input.txt");
Path outPath = Paths.get("D:\\output.txt");

List<String> lines = Files.readAllLines(inPath);
Files.write(outPath, lines);

// TODO: handle exceptions
```

Problem: Sort Lines

- **Read** a text **file** and **sort all lines**

- **Write** the result to another text **file**

- Use Paths and Files classes

```
C        A
A        B
B   →    C
D        D
...      ...
```

32

Solution: Sort Lines

```java
Path path = Paths.get("D:\\input.txt");
Path output = Paths.get("D:\\output.txt");

try {
    List<String> lines = Files.readAllLines(path);
    lines = lines.stream().filter(l ->
            !l.isBlank()).collect(Collectors.toList());
    Collections.sort(lines);
    Files.write(output, lines);
} catch (IOException e) {
    e.printStackTrace();
}
```

Don't use for large files

Check your solution here: https://judge.softuni.bg/Contests/1493/Streams-Files-And-Directories-Lab

File Class in Java

Easily Working With Files
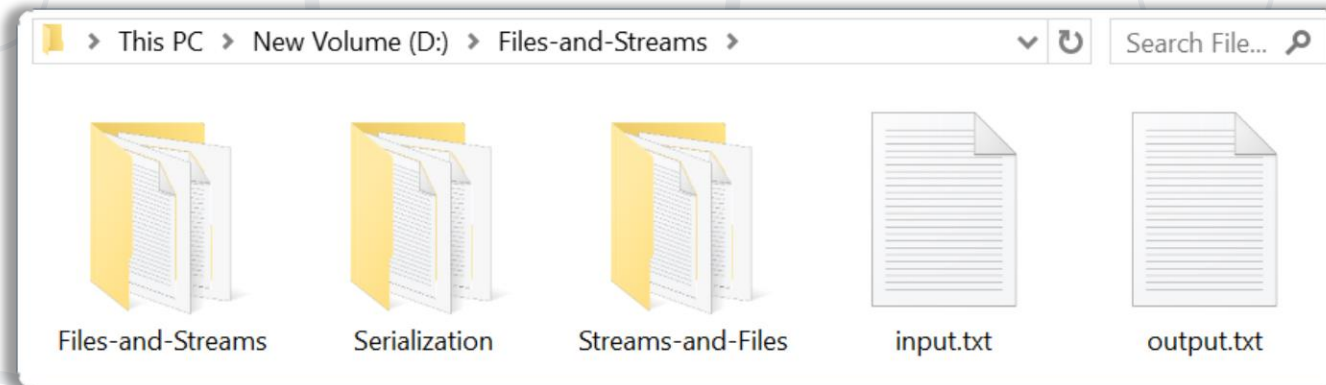
File Class in Java

- Provides methods for quick and easy manipulation of files

```java
import java.io.File;

File file = new File("D:\\input.txt");

boolean isExisting = file.exists();
long length = file.length();
boolean isDirectory = file.isDirectory();
File[] files = file.listFiles();
```

Problem: List Files

- **Print names and sizes** of all files in "Files-and-Streams" directory

- Skip **child** directories


```
input.txt: [size in bytes]
output.txt: [size in bytes]
```

Check your solution here: https://judge.softuni.bg/Contests/1493/Streams-Files-And-Directories-Lab

```java
if (file.exists()) {
  if (file.isDirectory()) {
    File[] files = file.listFiles();
    for (File f : files) {
      if (!f.isDirectory()) {
        System.out.printf("%s: [%s]%n",
                          f.getName(), f.length());
      }
    }
  }
}
```

Problem: Nested Folders

- You are **given** a folder named "Files-and-Streams"

- **List all folder names**, starting with the root

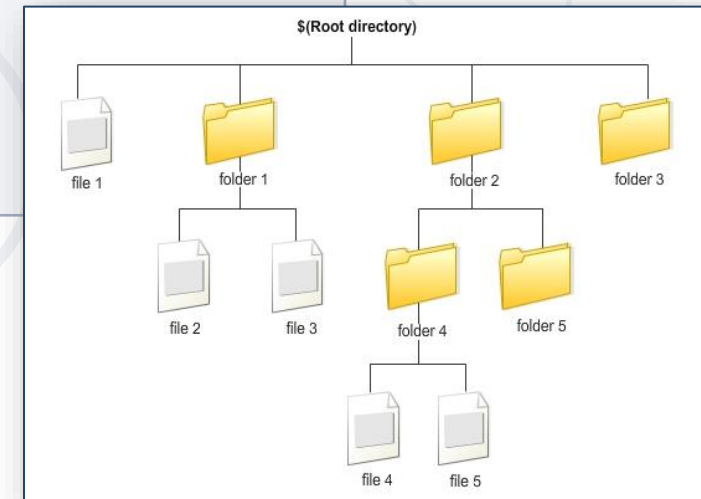- **Print folder count** on the last line (including the root)
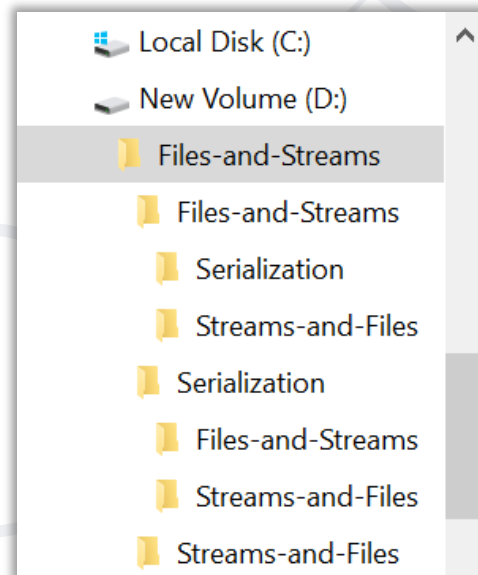
```
...
Streams-and-Files
Serialization
Streams-and-Files
[count] folders
```

```java
String path = "D:\\Files-and-Streams";
File root = new File(path);

Deque<File> dirs = new ArrayDeque<>();
dirs.offer(root);

// continue…
```


Check your solution here: https://judge.softuni.bg/Contests/1493/Streams-Files-And-Directories-Lab

```java
int count = 0;
while (!dirs.isEmpty()) {
    File current = dirs.poll();
    File[] nestedFiles = current.listFiles();
    for (File nestedFile : nestedFiles)
        if (nestedFile.isDirectory())
            dirs.offer(nestedFile);
    count++;
    System.out.println(current.getName());
}
System.out.println(count + " folders");
```

Check your solution here: https://judge.softuni.bg/Contests/1493/Streams-Files-And-Directories-Lab

Serialization

Serializing and Deserializing Objects

Serialization

- **Save** objects to a file

```
List<String> names = new ArrayList<>();
Collections.addAll(names, "Mimi", "Gosho");

FileOutputStream fos = new FileOutputStream(path);
ObjectOutputStream oos =
          new ObjectOutputStream(fos);


oos.writeObject(names);

// TODO: handle exceptions
```

> Save objects to .ser file

Deserialization

- **Load** objects from a file

```java
FileInputStream fis =
    new FileInputStream(path);
ObjectInputStream oos =
    new ObjectInputStream(fis);

List<String> names =
    (List<String>) oos.readObject();

// TODO: handle exceptions
```
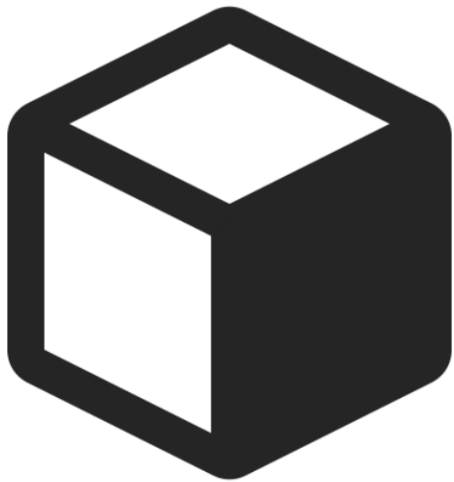
Serialization of Custom Objects

- Custom objects should **implement** the **Serializable** interface

```java
class Cube implements Serializable {
    String color;
    double width;
    double height;
    double depth;
}
```

Problem: Serialize Custom Object

- Create a **Cube class** with color, width, height and depth

- Create a cube – **color: "green", w: 15.3, h: 12.4** and **d: 3**

Check your solution here: https://judge.softuni.bg/Contests/1493/Streams-Files-And-Directories-Lab

Solution: Serialize Custom Object (1)

```java
class Cube implements Serializable {
    String color;
    double width;
    double height;
    double depth;
}
```

Check your solution here: https://judge.softuni.bg/Contests/1493/Streams-Files-And-Directories-Lab

Solution: Serialize Custom Object (2)

```java
//TODO: Create Cube object

String path = "D:\\save.ser";
try (ObjectOutputStream oos = new ObjectOutputStream(
                new FileOutputStream(path))) {
    oos.writeObject(cube);
} catch (IOException e) {
    e.printStackTrace();
}
```

Check your solution here: https://judge.softuni.bg/Contests/1493/Streams-Files-And-Directories-Lab

Summary

- **Streams** are used to **transfer data**
- **Two** main **types** of streams
    - **Input** Streams
    - **Output** Streams
- **Buffered** streams boost **performance**
- Streams **can be chained together**
- You can **save objects** state into a file

Questions?
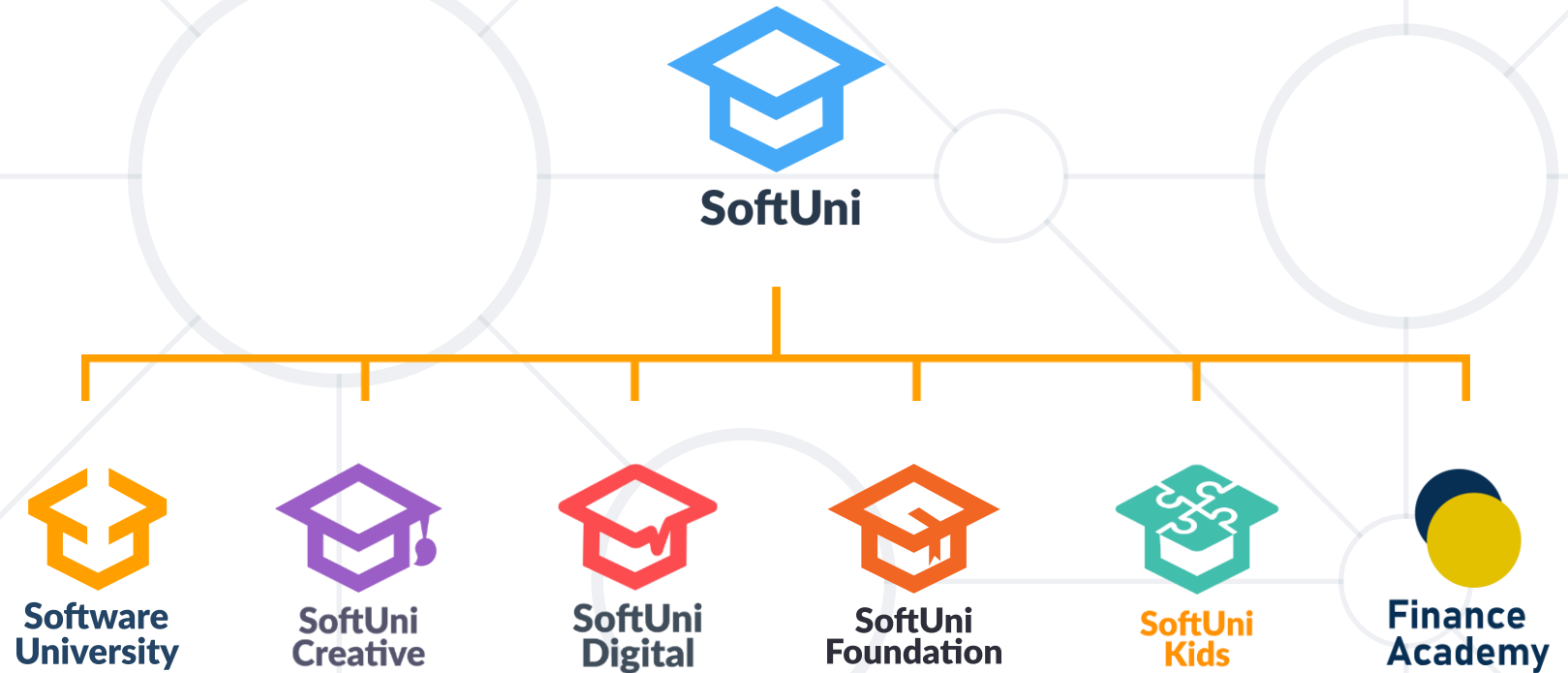
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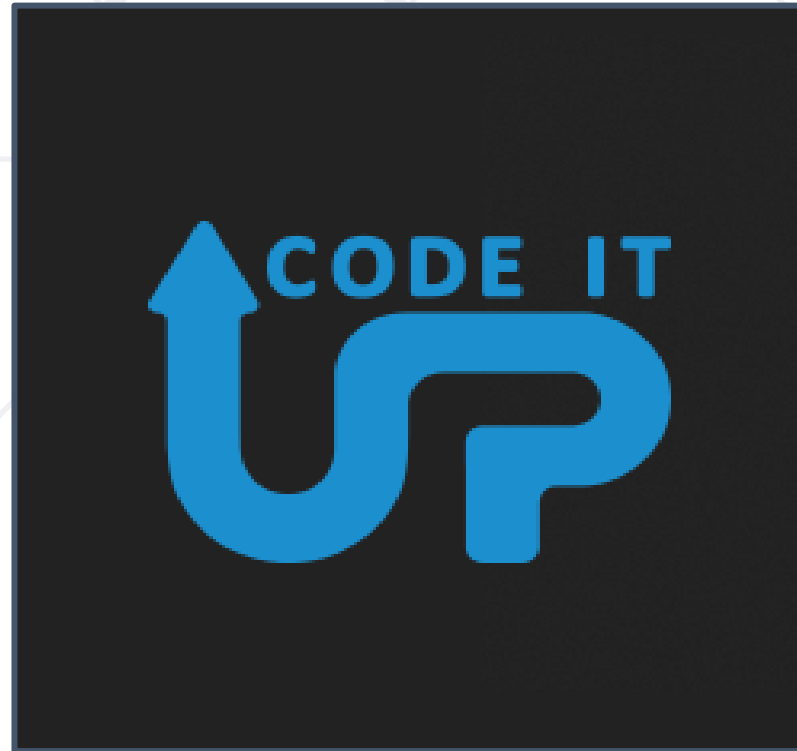
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