

Recap

- ▶ Abstract classes
 - ▶ A class that cannot be instantiated
 - ▶ Other classes can inherit from it
- ▶ Abstract methods
 - ▶ A method without an implementation
 - ▶ If a class has an abstract method the class must be abstract as well
 - ▶ Inheritors of the class must implement the method
- ▶ Interfaces
 - ▶ Something like a class, but all methods are abstract
 - ▶ Used to define the behaviour of a class, without actually implementing it

Superclass vs. Interface

- ▶ It depends on your application
- ▶ Main/secondary categories
 - ▶ Some categories are more important than others
 - ▶ Important categories as super classes, others as interfaces
- ▶ Amount of code
 - ▶ Use as superclass what defines the more methods
- ▶ Can do / is a
 - ▶ Interface signifies what an object can do
 - ▶ Superclass signifies what an object is
- ▶ Change frequency
 - ▶ If we expect it to change often, make an interface



Session 11: Input/Output and Error Handling

Softwaretechnologie: Java 1

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Section 1

Input and Output

Introduction

- ▶ So far: All data is defined within our programs
- ▶ Reality: Data is external to our program
 - ▶ Read from files
 - ▶ Downloaded via network
 - ▶ Recorded from microphone

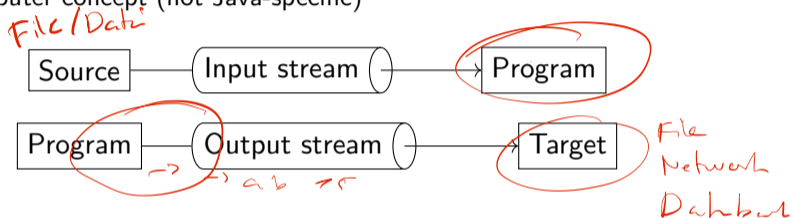
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- ▶ Reality: Data is external to our program
 - ▶ Read from files
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- ▶ Input/Output (IO)
 - ▶ Input to the program
 - ▶ Output from the program

System.out.println()

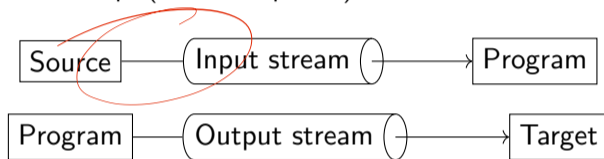
Stream

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- ▶ Stream
 - ▶ Can provide a single unit only once (i.e., if something has been read from a stream, it's no longer in the stream)
 - ▶ Has an end (e.g., if the end of a file has been reached)
 - ▶ Has an order (i.e., after we have read something from a stream, we have to read the next unit)
 - ▶ Need to be closed after use

Streams in Java

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- ▶ Implementations
 - ▶ `java.io.FileInputStream` / `java.io.FileOutputStream` – for reading/writing from files
 - ▶ `java.io.ObjectInputStream` / `java.io.ObjectOutputStream` – to read/write objects from/into other streams
 - ▶ ... for many other use cases

demo

What's with int and byte?

- ▶ `InputStream.read()` returns an `int`
 - ▶ “The value byte is returned as an int in the range 0 to 255. If no byte is available because the end of the stream has been reached, the value `-1` is returned.”

What's with int and byte?

- ▶ `InputStream.read()` returns an `int`
 - ▶ “The value byte is returned as an int in the range 0 to 255. If no byte is available because the end of the stream has been reached, the value -1 is returned.”
- ▶ Why not the data type `byte`?
 - ▶ Because `byte` can distinguish 256 values, but we need 267 to signal the end of the stream

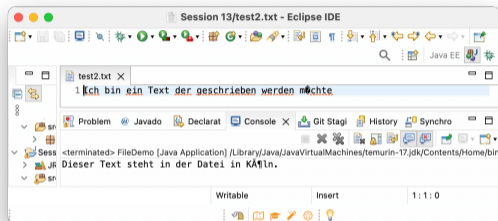
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- ▶ Why not `short`?
 - ▶ Because `int` is actually faster than `short` ...
- ▶ The good news: `int` can be cast into a `char`, which is what we mostly really want

Why are some characters broken?



- ▶ Some characters are represented as more than one byte
 - ▶ E.g., “ö”:

1	1	0	0	0	0	1	1	1	0	1	1	0	1	1	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
 - ▶ It's an interpretation step to convert 1100001110110110 into an ö
- ▶ Readers are an abstraction layer on top of streams to handle this

Readers

▶ `java.io.InputStreamReader`

▶ `int read()` – Reads a single character

▶ `java.io.OutputStreamWriter`

▶ `void write(int ch)` – Writes a single character

```
1 InputStream fis = new FileInputStream("path/to/file");
2 InputStreamReader isr = new InputStreamReader(fis, "UTF-8");
3 char ch = isr.read();
4 isr.close();
5
6 OutputStream os = new FileOutputStream("path/to/file");
7 OutputStreamWriter osw = new OutputStreamWriter(os, "UTF-8");
8 osw.write('a');
9 osw.flush();
10 osw.close();
```

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- ▶ When writing to a file
 - ▶ Directory isn't there
 - ▶ File is already there
 - ▶ Directory is there and file isn't, but we have no (write) access
 - ▶ Disk becomes full during writing

Section 2

Exception Handling

Introduction

- ▶ Exceptions can appear in various places and for many reasons
- ▶ An exception signals something unexpected that happened – usually an error of some kind

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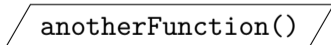
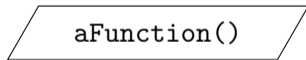
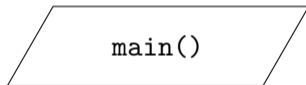
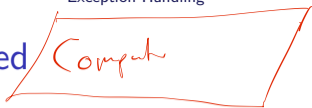
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- ▶ But this happens beside to the usual program flow

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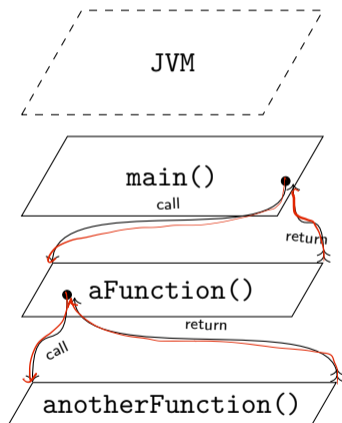
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- ▶ An exception signals something unexpected that happened – usually an error of some kind
- ▶ Exceptions are thrown and can be caught
- ▶ But this happens beside to the usual program flow
- ▶ Exceptions are instances of the class `java.lang.Exception` (or one of its many subclasses)

Exception Handling Visualised

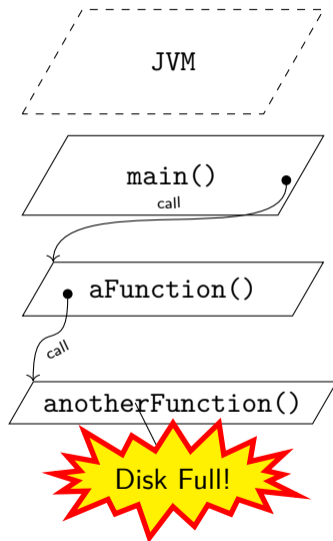
Exception Handling



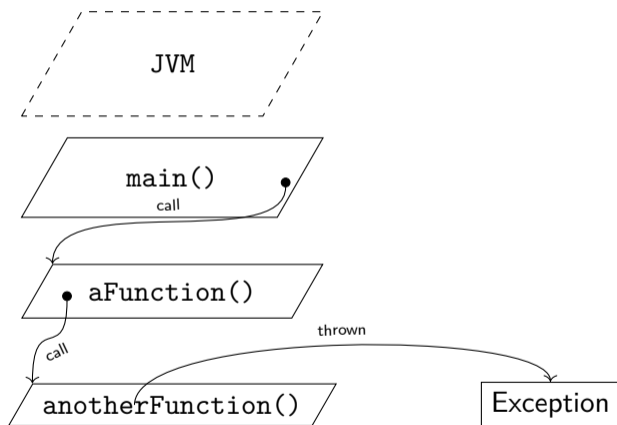
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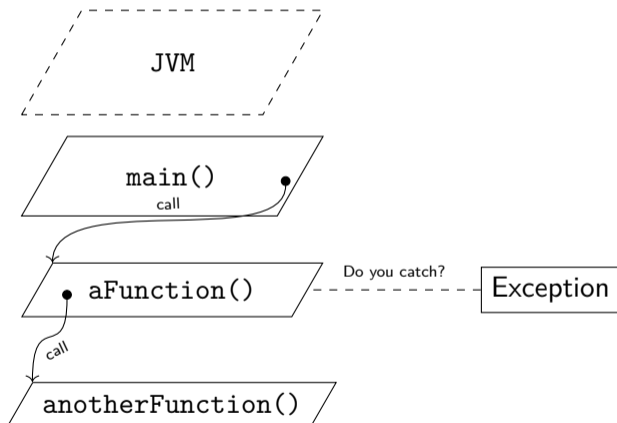
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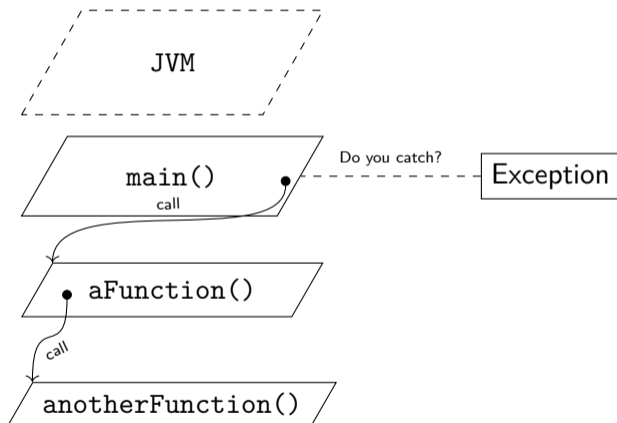
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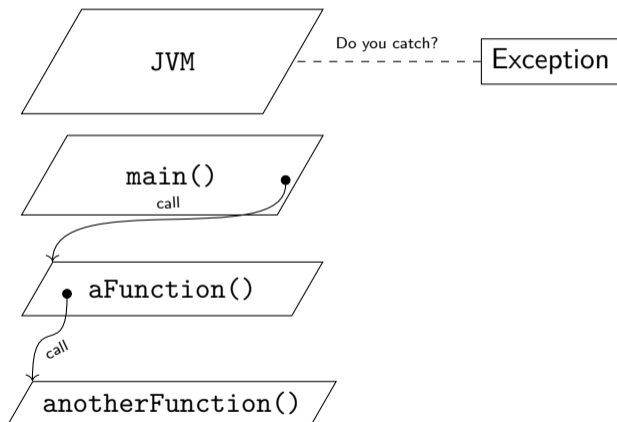
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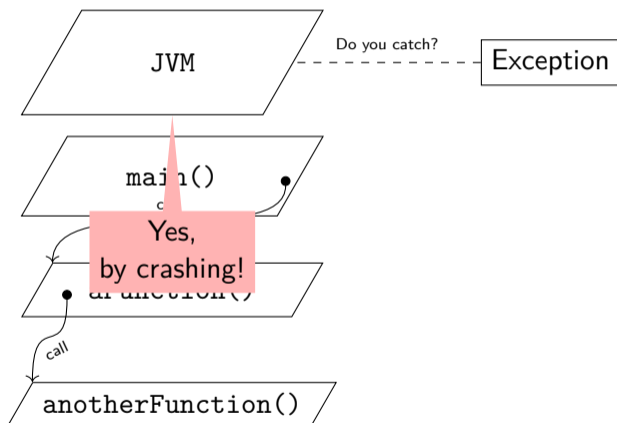
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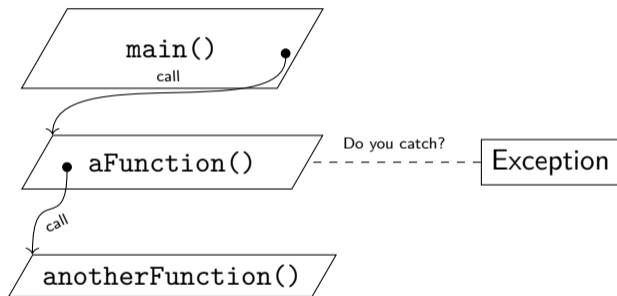
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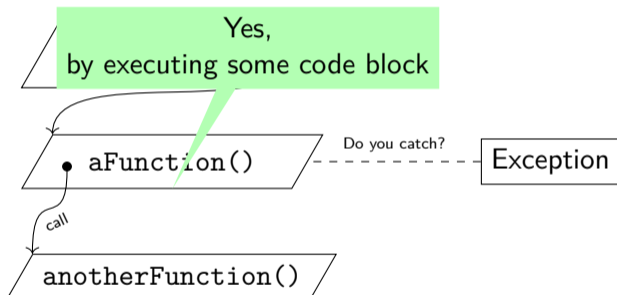
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Implementation in Java

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Kinds of exceptions

- ▶ Regular exceptions are objects of the class `java.lang.Exception`
- ▶ Runtime exceptions are objects of the class `java.lang.RuntimeException`
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I.e., we don't need step 1 from a above
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 - ▶ A runtime exception can happen anytime, anywhere
- ▶ We can define our own exceptions by creating sub classes of `java.lang.Exception`

Implementation in Java

Signal that an exception can be thrown

```
1 public void someMethod() throws Exception {  
2     // some code  
3 }
```

- ▶ New modifier for method declaration: `throws`
- ▶ Modifier followed by a class name
- ▶ Needs to match the type of exception

Implementation in Java

Throw an exception

```
1 public void someMethod() throws Exception {  
2     // some code ✓  
3     if (SOME TEST) {  
4         throw new Exception("some error occurred");  
5     }  
6     // some code —  
7 }
```

- ▶ New keyword `throws`
- ▶ Followed by an object of type `java.lang.Exception`
 - ▶ Regular rules for creating an object of a class
 - ▶ In 99% of the time, we create a new one with `new`

Implementation in Java

Catching an exception

```
1 // some code
2 try {
3     // some code
4     object.someMethod();
5     // some code
6 } catch (Exception e) {
7     // deal with the error
8     // if needed, access fields/methods of the exception with the variable e
9 }
10 // some code
```

- ▶ New statement kind: `try { ... } catch (TYPE VARIABLE) { ... }`
- ▶ If line 4 throws an exception, code in line 5 is not executed – but code in lines 7 and 8
- ▶ Program continues in line 10

demo

Section 3

Exercise