Session 13: Streams and Error Handling

Softwaretechnologie: Java I

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January 18, 2023

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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
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  - Read from files
  - Downloaded via network
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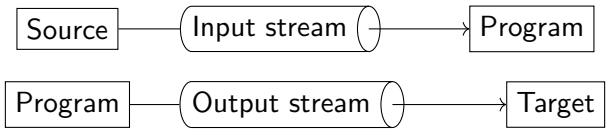
- Input/Output (IO)
  - Input to the program
  - Output from the program

Stream

- A channel through which bytes/characters are transmitted
  - Generic computer concept (not Java-specific)



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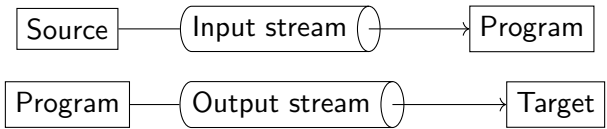

- Stream
  - Can provide a single unit only once (i.e., if something has been read from a stream, it's no longer in the stream)
  - Has an end (e.g., if the end of a file has been reached)
  - Has an order (i.e., after we have read something from a stream, we have to read the next unit)
  - Need to be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

Streams in Java

- Abstract class java.io.InputStream
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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?

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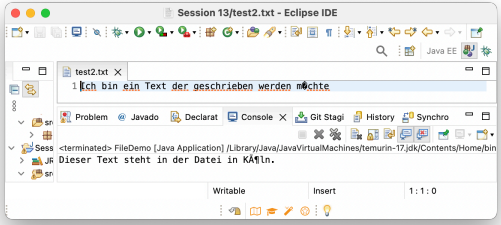
  - Because `byte` can distinguish 256 values, but we need 267 to signal the end of the stream
- Why not `short`?
  - Because `int` is actually faster than `short` ...
- The good news: `int` can be cast into a `char`, which is what we mostly really want

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 that can 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

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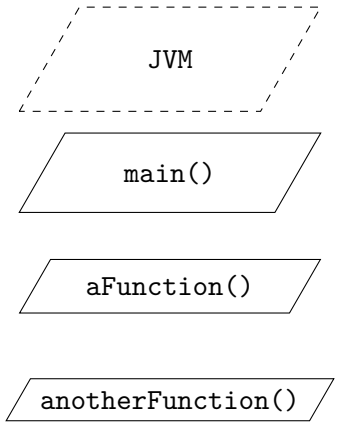
- An exception signals something unexpected that happened – usually an error of some kind
- Exceptions are thrown and can be caught
- But this happens beside to the usual program flow
- Exceptions are instances of the class `java.lang.Exception` (or one of its many subclasses)

Exception Handling Visualised



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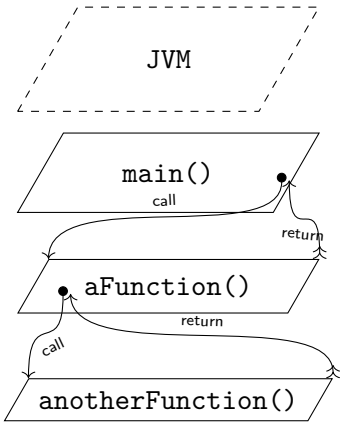

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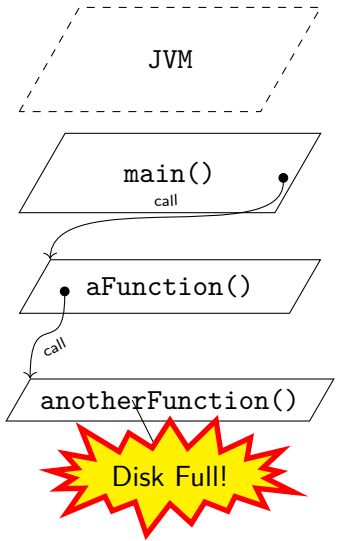

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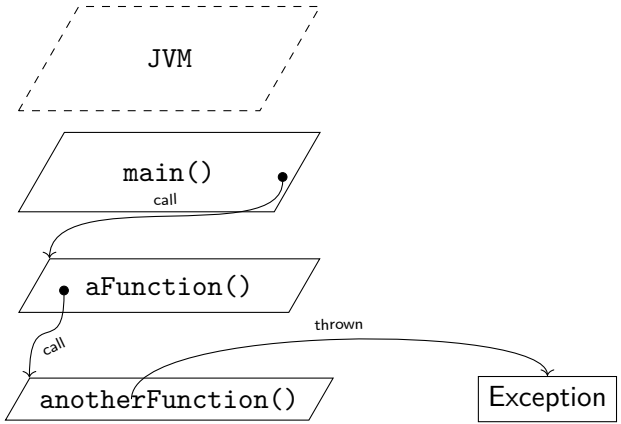

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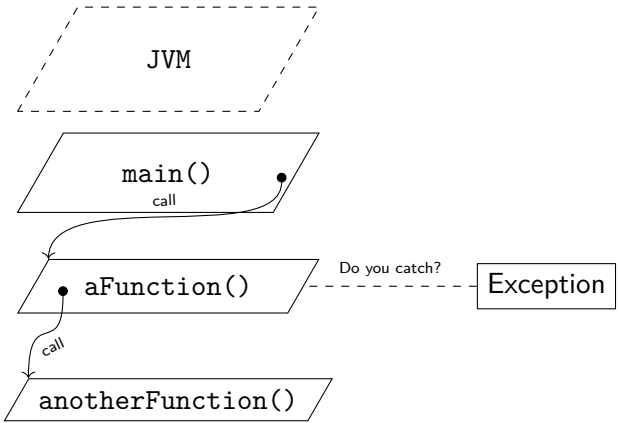

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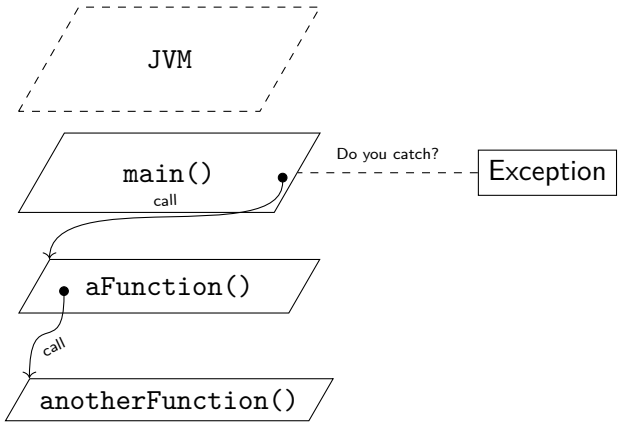

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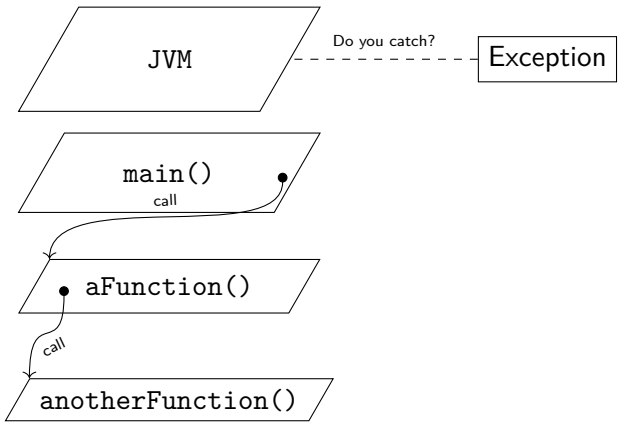

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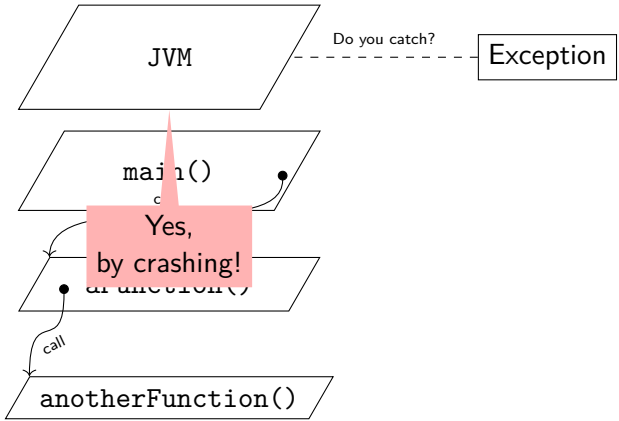

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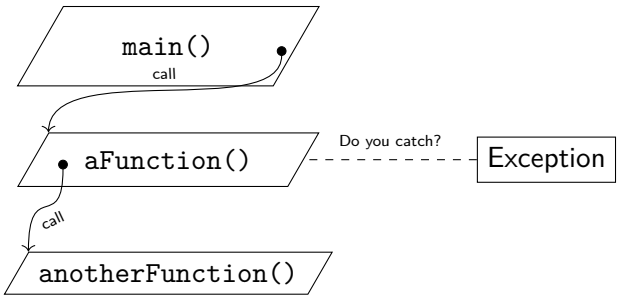

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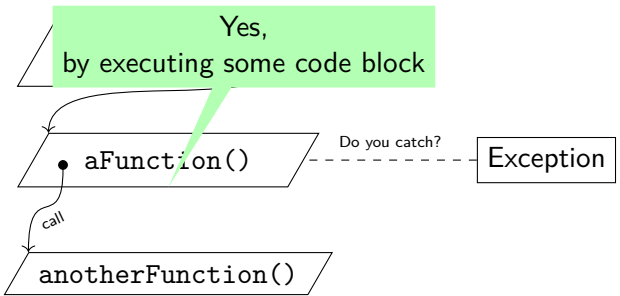

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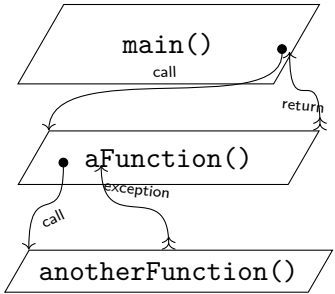

Implementation in Java

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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