Handling errors

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Programming Language Concepts

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When things go wrong

- Our code could encounter many types of errors
    - *User input* — enter invalid filenames or URLs
    - *Device errors* — printer jam, network connection drops
    - *Resource limitations* — disk full
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- Signalling errors
  - Return an invalid value: -1 at end of file, `null`
  - What if there is no obvious invalid value?

Exception handling

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- Declare if a method can throw an exception
  - Compiler can check whether calling code has made a provision to handle the exception

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- Checked exceptions
  - Typically user-defined, code assumptions violated
    - In a list of orders, quantities should be positive integers

Catching and handling exceptions

- **try**–**catch**
    - Enclose code that may generate exception in a **try** block
    - Exception handler in **catch** block
    - Similar to Python

```
try {
  ...
  call a function that may
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catch (ExceptionType e){
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  examine e and handle it
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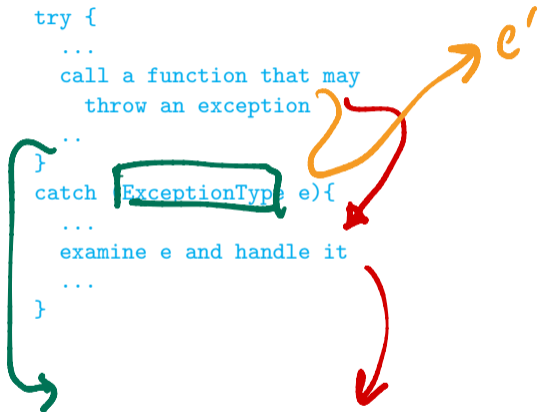
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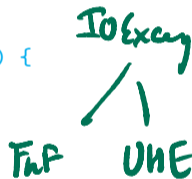
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- Top level uncaught exception — program crash

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try {
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  handle missing files
}
catch (UnknownHostException e) {
  handle unknown hosts
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catch (IOException e) {
  handle all other I/O issues
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- Order `catch` blocks by argument type, more specific to less specific
  - `IOException` would intercept `FileNotFoundException`

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- Your code detects an error and generates an exception
  - `throw` a checked exception

Notifying checked exceptions

- Example: you write a method `readData()`
    - Header line provides length of data
        - `Content-Length: 2048`
    - Actual data read is less than promised length

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    - `EOFException`, subtype of `IOException`
    - "Signals that EOF has been reached unexpectedly during input"
- Create an object of exception type and `throw` it

    `throw new EOFException();`

- Can also pass a diagnostic message when constructing exception object

    `String errormsg = "Content-Length:" + contentlen + ", Received: " + rcvdlen;`
    `throw new EOFException(errormsg);`

- How does caller know that `readData()` generates `EOFException`?

Throwing exceptions . . .

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- Declare exceptions thrown in header

```
String readData(Scanner in)
    throws EOFException {
  ...
  while (...) {
    if (!in.hasNext()) {
      // EOF encountered
      if (n < len) {
        String errmsg = ...
        throw new EOFException(errmsg);
      }
      ...
    }
  }
  return(s);
}
```

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- Can throw multiple types of exceptions

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String readFile(String filename)
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           EOFException { ... }
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```

- Can throw any subtype of declared exception type

```
String readFile(String filename)
    throws IOException { ... }
```

  - Can throw `FileNotFoundException`, `EOFException`, both subclasses of `IOException`

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- If you call such a method, you must handle it

- ... or pass it on; your method should advertise that it throws the same exception — *Your function should have throws ... in its head...*

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- Should not normally generate `RunTimeException`
  - Fix the error or report suitable checked exception

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Customized exceptions

- Don't want negative numbers in
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- Define a new class extending `Exception`

```java
public class NegativeException extends Exception{

  private int error_value;
   // Negative value that generated exception

  public NegativeException(String message, int i){
    super(message);  // Appeal to superclass
    error_value = i; // constructor to set message
  }

  public int report_error_value(){
    return error_value;
  }
}
```

Customized exceptions

- Don't want negative numbers in a `LinearList`

- Define a new class extending `Exception`

- Throw this from `LinearList`
  - Note that `add` advertises the fact that it throws a `NegativeException`

```
public class NegativeException extends Exception{
   ...
}

public class LinearList{
  ...
  public add(int i) throws NegativeException{
    ...
    if (i < 0){
      throw new NegativeException("Negative input",i);
    }
    ...
  }
}
```

More on catching exceptions

- Can extract information about the exception

```
try {
  ...
  call a function that may
    throw an exception
  ..
}
catch (ExceptionType e){
  ...
  String errormsg = e.getMessage();
  ...
}
```

More on catching exceptions

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- Chaining exceptions
  - Process and throw a new exception from `catch`

```
try {
  ...
  access database
  ..
}
catch (SQLException e){
  ...
  String errormsg =
    "database error" + e.getMessage();
  throw new ServletException(errormsg);
  ...
}
```

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- `Throwable` has additional methods to track chain of exceptions
  - `getCause()`, `initCause()`

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- `Throwable` has additional methods to track chain of exceptions
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- Add information when you chain exceptions

- Retrieve information when you catch exception

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try {
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catch (ServletException e){
  ...
  Throwable original = e.getCause();
  ...
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- Add a block labelled `finally`

```
try{
    ...
  }

catch (ExceptionType1 e){...}

catch (ExceptionType2 e){...}

finally{
    ...
  // Always executed, whether try
  // terminates normally or
  // exceptionally. Use for clean up.
}
```

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- Different scenarios

```
FileInputStream in =
  new FileInputStream(...);
try {
  // 1
  code that might throw exceptions
  // 2
}
catch (IOException e) {
  // 3
  show error message
  // 4
}
finally {
  // 5
  in.close();
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// 6
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  - `IOException` in `try`, chained exception in `catch` — 1,3,5

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$e_2.getName \rightarrow e_1$

f

$e_2.initName(e_1)$

e_2

g

e_1

h

i