Exceptions

CSC207 Fall 2016

What are exceptions?

Exceptions report exceptional conditions: unusual, strange, disturbing.

These conditions deserve exceptional treatment: not the usual go-to-the-next-step, plod-onwards approach.

Therefore, understanding exceptions requires thinking about a different model of program execution.

Exceptions in Java

To **"throw an exception"**:

```
throw Throwable;
```

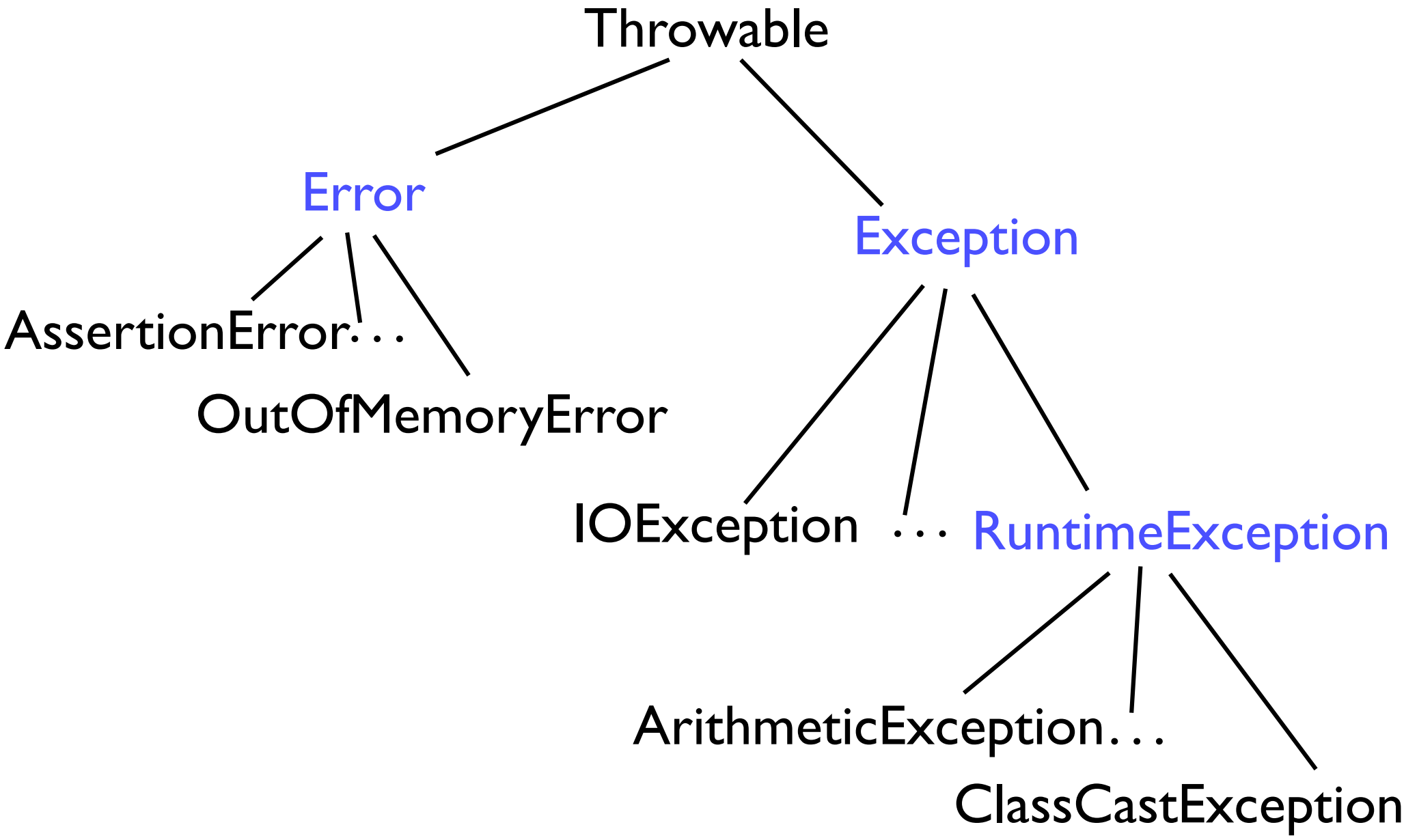
To **"catch an exception"** and deal with it:

```
try {
    statements
// The catch belongs to the try.
} catch (Throwable parameter) {
    statements
}
```

To say you aren't going to deal with exceptions (or may throw your own):

```
<accessMod> <returnType> <methodName> (<parameters>)
throws Throwable { ... }
```

The Hierarchy



Throwable

Constructors:

`Throwable(), Throwable(String message)`

Other useful methods:

`getMessage()`

`printStackTrace()`

`getStackTrace()`

What should you `throw`?

You can throw an instance of `Throwable` or any subclass of it (whether an already defined subclass, or a subclass you define).

Don't throw an instance of `Error` or any subclass of it: these are for unrecoverable circumstances. (e.g., `OutOfMemoryError`).

Don't throw an instance of `Exception`: throw something more specific.

It's okay to throw instances of:

- specific subclasses of `Exception` that are already defined, e.g., `UnsupportedOperationException`
- specific subclasses of `Exception` that you define.

These do not need to be handled

`Error`:

"Indicates serious problems that a reasonable application should not try to catch."

Do not have to handle these errors because they "are abnormal conditions that should never occur."

`RuntimeException`:

These are called **unchecked** because you do not have to handle them.

but have to correct them; runtime exception indicative of bug/misuage of API

Checked vs. Unchecked Exceptions

When defining an `Exception` subclass, we need to decide whether to extend `RunTimeException` (unchecked) or `Exception` (checked).

```
public class MyException extends RuntimeException {...}
class MyClass {
    public void m()  /* No "throws", but it compiles! */  {...
        if (...) throw new MyException("oops!") {...}
  }
}

public class MyException extends Exception {...}
class MyClass {
    public void m() throws MyException { ...
    if (...) throw new MyException("oops!") {...}
  }
}
```

What does the Java API say?

`Exception`:

> "The class `Exception` and its subclasses are a form of `Throwable` that indicates conditions that a reasonable application might want to catch."

`RunTimeException` (unchecked):

> "`RuntimeException` is the superclass of those exceptions that can be thrown during the normal operation of the Java Virtual Machine."
>
> Examples: `ArithmeticException`, `IndexOutOfBoundsException`, `NoSuchElementException`, `NullPointerException`

non-`RuntimeException` (checked):

> Examples: `IOException`, `NoSuchMethodException`

Guideline for which to use

"Use **checked exceptions** for conditions from which the caller can reasonably be expected to recover."

"Avoid unnecessary use of **checked exceptions**."

> If the user didn't use the API properly or if there is nothing to be done, then make it a RunTimeException.

"Use **run-time exceptions** to indicate programming errors. The great majority of run-time exceptions indicate precondition violations."

can be improved by fixing the code

> Example: Suppose method getItem(int i) returns an item at a particular index in a collection and requires that i be in some valid range.
>
> The programmer can check that before they call o.getItem(x).
>
> So sending an invalid index should not cause a checked exception to be thrown.

We can have cascading catches

Much like an if with a series of else if clauses, a try can have a series of catch clauses.

After the last catch clause, you can have a clause:

```
finally { ... }
```

But finally is not like a last else on an if statement:
The finally clause is always executed, whether an exception was thrown or not, and whether or not the thrown exception was caught.

as long as try block is executed

Example of a good use for this: close open files as a clean-up step.

An example of multiple catches

Suppose `ExSup` is the parent of `ExSubA` and `ExSubB`.

```
try {
    ...
} catch (ExSubA e) {
    // We do this if an ExSubA is thrown.
} catch (ExSup e) {
    // We do this if any ExSup that's not an ExSubA is thrown.
} catch (ExSubB e) {
    // We never do this, even if an ExSubB is thrown.
} finally {
    // We always do this, even if no exception is thrown.
}
```

`finally` vs. code after `try/catch`

```
try {
  // do something
} catch(MyException e) {
  // handle exception
} finally {
  cleanUp();
}
```

```
try {
  // do something
} catch(MyException e) {
  // handle exception
}
cleanUp();
```

Even if there are `return` statements or exceptions in the `try` or `catch` blocks, the code in `finally` be executed. That isn't the case with the code on the right-hand side.

Documenting Exceptions

```
/**
 * Return the mness of this object up to mlimit.
 * @param mlimit The max mity to be checked.
 * @return int The mness up to mlimit.
 * @throws MyException If the local alphabet has no m.
 */
public void m(int mlimit) throws MyException { ...
    if (...) throw new MyException ("oops!") { ...
    }
}
```

You need both:

- the Javadoc comment is for human readers, and
- the `throws` is for the compiler.

Both the reader and the compiler are checking that caller and callee have consistent interfaces.