Exceptions

CSC207 Summer 2018

What are exceptions?

In Java, an exception is an object.

Exceptions represent exceptional conditions: unusual, strange, disturbing. These conditions deserve exceptional treatment: not the usual go-to-the-next-step, plod-onwards approach.

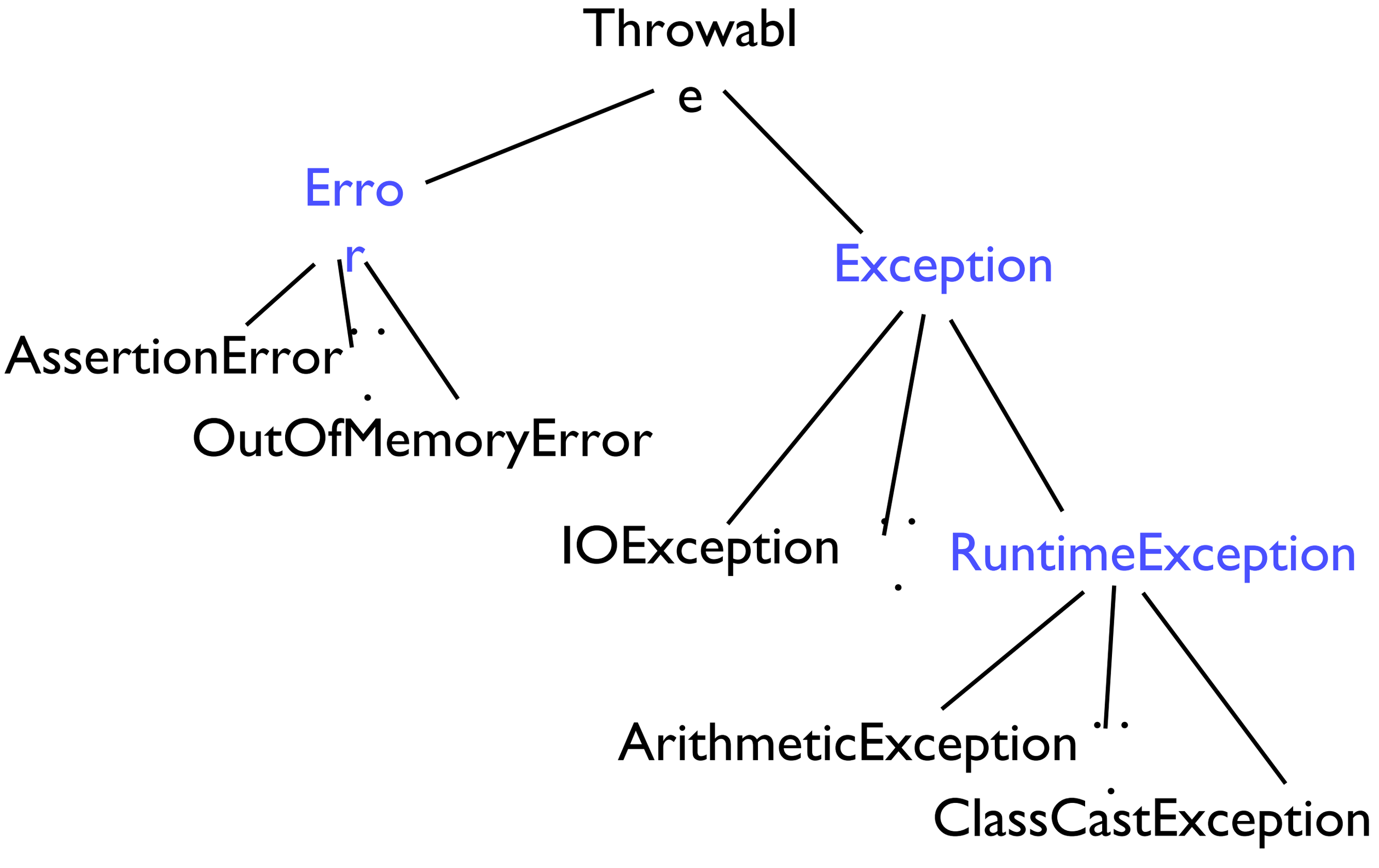
Exceptions have a different model of program execution.

When an exception might occur while your method is running, you have two choices:

1. Write a *catch block* for each kind of exception that might happen, and code to deal with the exceptional situation.

2. Let your method crash (!) and force the method that called yours to deal with it.

The Java exception type hierarchy



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 (like else and if)
} catch (ExceptionType1 parameter) {
statements
} catch (ExceptionType2 parameter) {
statements
} …
finally { // This is optional
}
```

Throwable

Constructors:

`Throwable(), Throwable(String message)`

Other useful methods you can use once you catch an exception:

`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 (for example, `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 (for example, `UnsupportedOperationException`)
- specific subclasses of `Exception` that you define.

Things you do not need to handle

`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`:

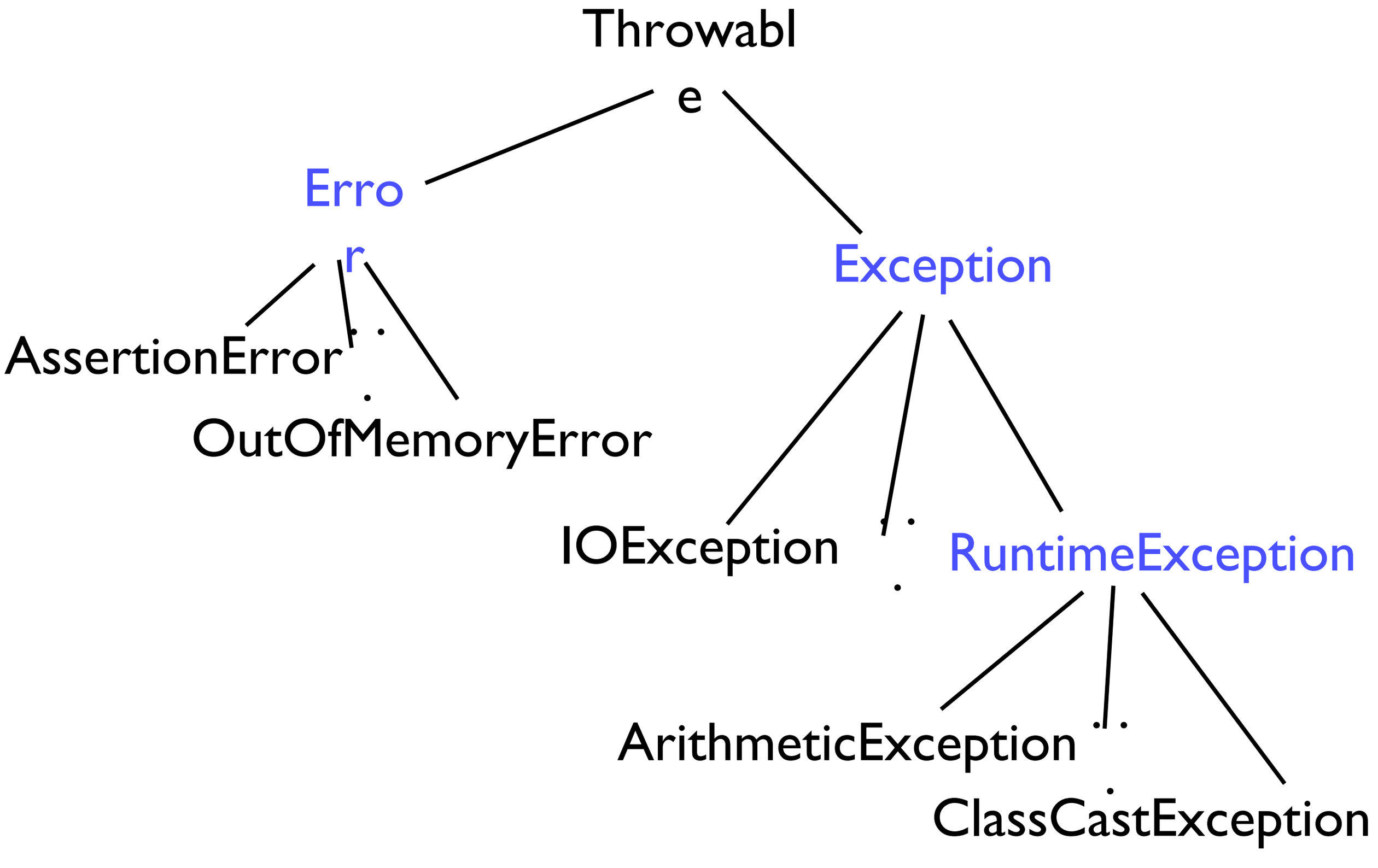
These are called *unchecked* because you do not have to handle them.

Defining your own exception

You will sometimes want to define your own exception class.

- You get to choose a meaningful name so that it fits in the problem domain.
- You get to decide where in the exception hierarchy it belongs.
- You get to decide how it fits into your regular code.

Reminder: the Java exception hierarchy



Checked vs. Unchecked Exceptions

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

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

`RuntimeException` vs. non-`RuntimeException`?

Java API: "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."

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.

Another guideline for which to use

Your exception will often be thrown by code you write. Programmers calling your methods need to be aware of this.

If an exceptional situation is *predictable* by a programmer using your code (they can write an `if` statement to check, or otherwise ensure they're avoiding the exceptional situation), make the exception a `RuntimeException` subclass.

If an exceptional situation is not predictable by a programmer using your code, make the exception a plain `Exception` subclass.

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 `finally` 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.

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 thrown in the `try` or `catch` blocks, the code in `finally` will 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 and for humans.

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

Let’s see in action...