异常

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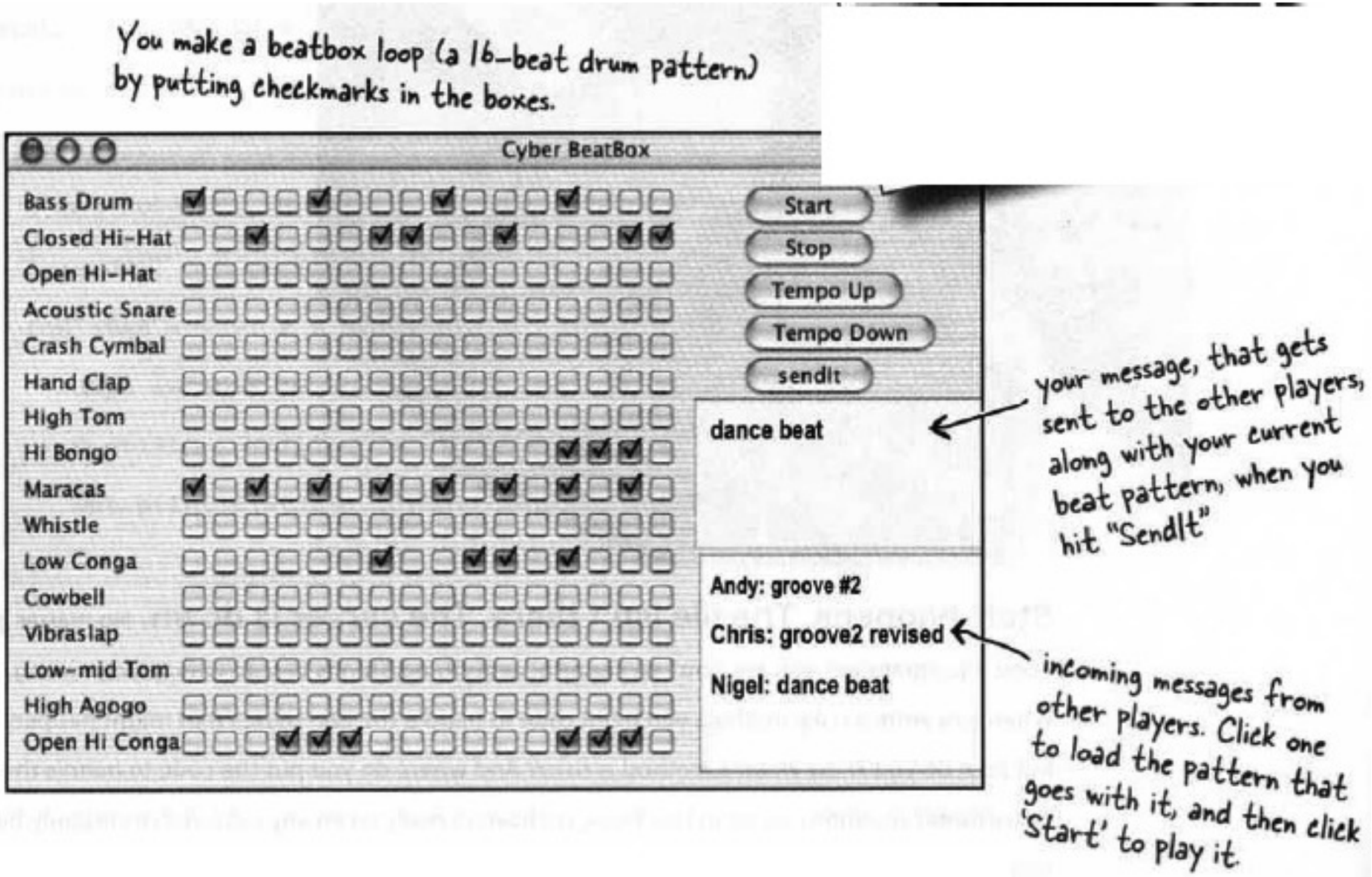
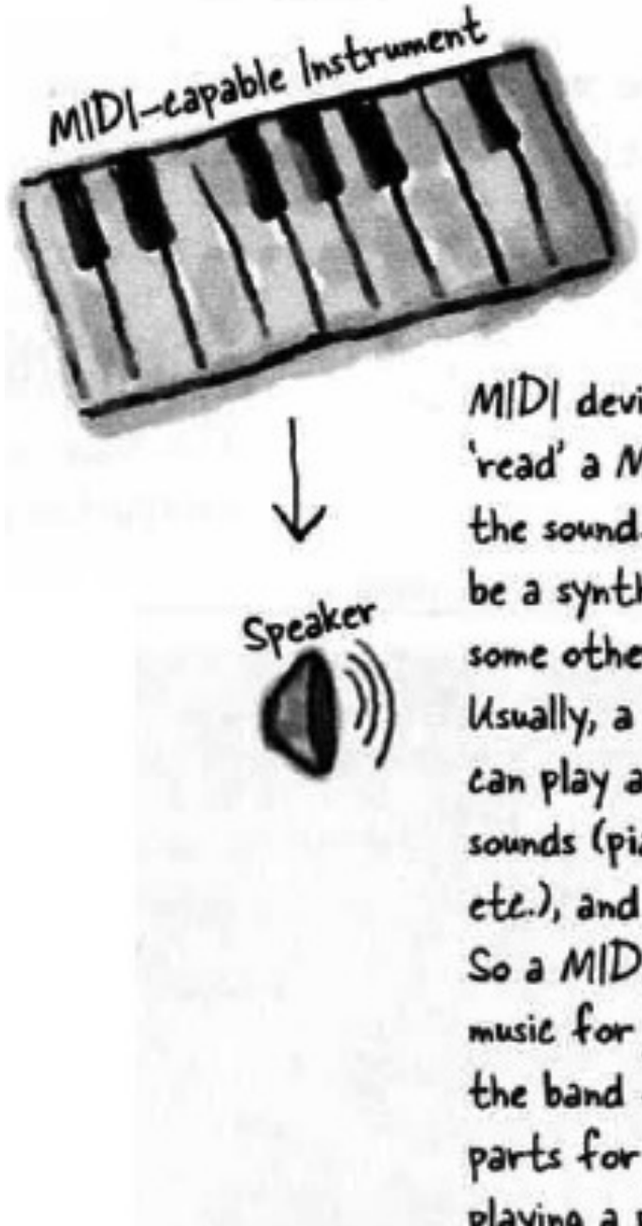
An example


You make a beatbox loop (a 16-beat drum pattern) by putting checkmarks in the boxes.
Cyber BeatBox
Bass Drum
Closed Hi-Hat
Open Hi-Hat
Acoustic Snare
Crash Cymbal
Hand Clap
High Tom
Hi Bongo
Maracas
Whistle
Low Conga
Cowbell
Vibraslap
Low-mid Tom
High Agogo
Open Hi Conga
Start
Stop
Tempo Up
Tempo Down
sendIt
dance beat
Andy: groove #2
Chris: groove2 revised
Nigel: dance beat
your message, that gets sent to the other players, along with your current beat pattern, when you hit "SendIt"
incoming messages from other players. Click one to load the pattern that goes with it, and then click 'Start' to play it.

the JavaSound API

- JavaSound is a collection of classes and interfaces added to Java starting with version 1.3. These aren‘t special add-ons, they’re part of the standard j2SE class library.
- MIDI stands for Musical instrument Digital Interface, and is a standard protocol for getting different kinds of electronic sound equipment to communicate.

MIDI file has information about how a song should be played, but it doesn't have any actual sound data. It's kind of like sheet music instructions for a player-piano.



MIDI device knows how to 'read' a MIDI file and play back the sound. The device might be a synthesizer keyboard or some other kind of instrument. Usually, a MIDI instrument can play a LOT of different sounds (piano, drums, violin, etc.), and all at the same time. So a MIDI file isn't like sheet music for just one musician in the band -- it can hold the parts for ALL the musicians playing a particular song.

First we need a Sequencer

Before we can get any sound to play, we need a Sequencer object. The sequencer is the object that takes all the MIDI data and sends it to the right instruments. It's the thing that *plays* the music. A sequencer can do a lot of different things, but in this book, we're using it strictly as a playback device. Like a CD-player on your stereo, but with a few added features. The Sequencer class is in the javax.sound.midi package (part of the standard Java library as of version 1.3). So let's start by making sure we can make (or get) a Sequencer object.

```
import javax.sound.midi.*;

public class MusicTest1 {

    public void play() {
        Sequencer sequencer = MidiSystem.getSequencer();

        System.out.println("We got a sequencer");
    } // close play

    public static void main(String[] args) {
        MusicTest1 mt = new MusicTest1();
        mt.play();
    } // close main
} // close class
```

import the javax.sound.midi package

We need a Sequencer object. It's the main part of the MIDI device/instrument we're using. It's the thing that, well, sequences all the MIDI information into a 'song'. But we don't make a brand new one ourselves -- we have to ask the MidiSystem to give us one.

Something's wrong!

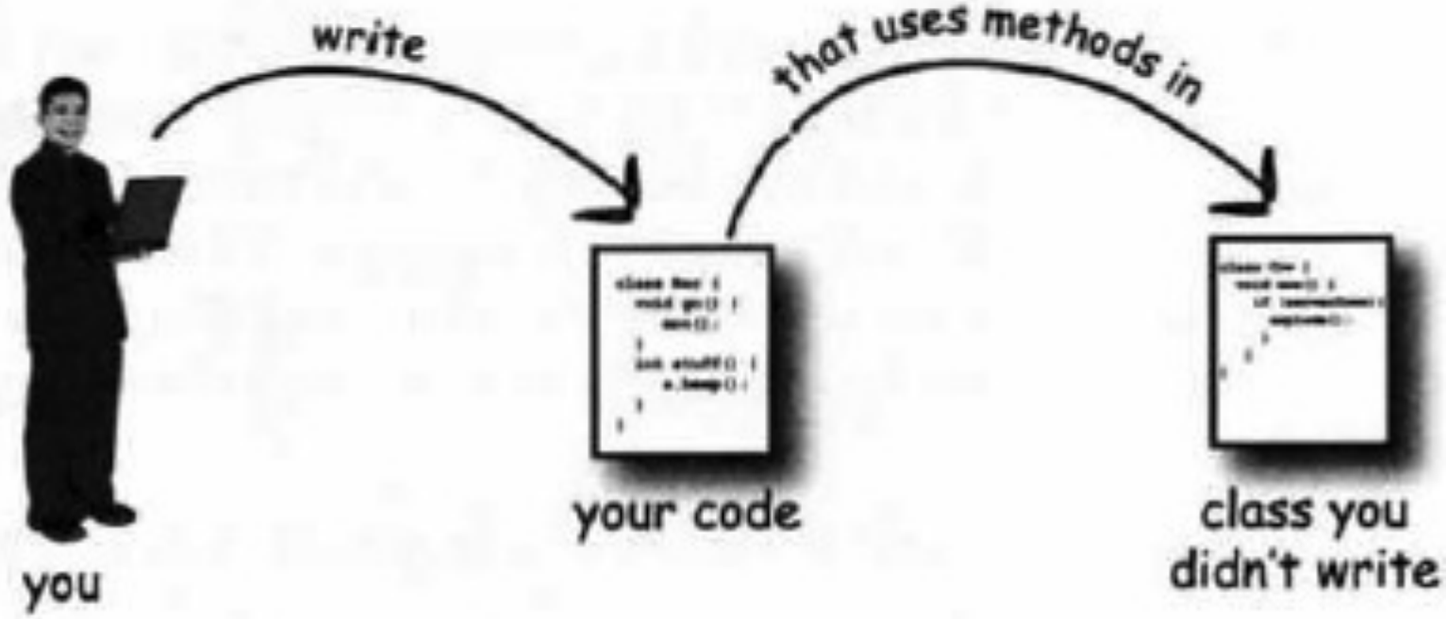
This code won't compile! The compiler says there's an 'unreported exception' that must be caught or declared.

File Edit Window Help SayWhat?

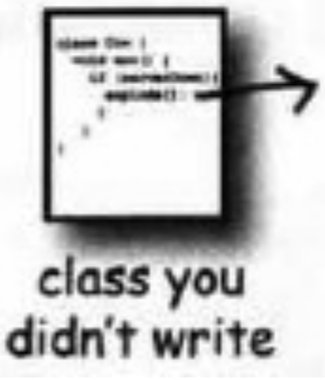
```
% javac MusicTest1.java
MusicTest1.java:13: unreported exception javax.sound.midi.
MidiUnavailableException; must be caught or declared to be
thrown
    Sequencer sequencer = MidiSystem.getSequencer();
                                     ^
1 errors
```

What happens when a method you want to call (probably in a class you didn't write) is risky?

1. **Let's say you want to call a method in a class that you didn't write.**

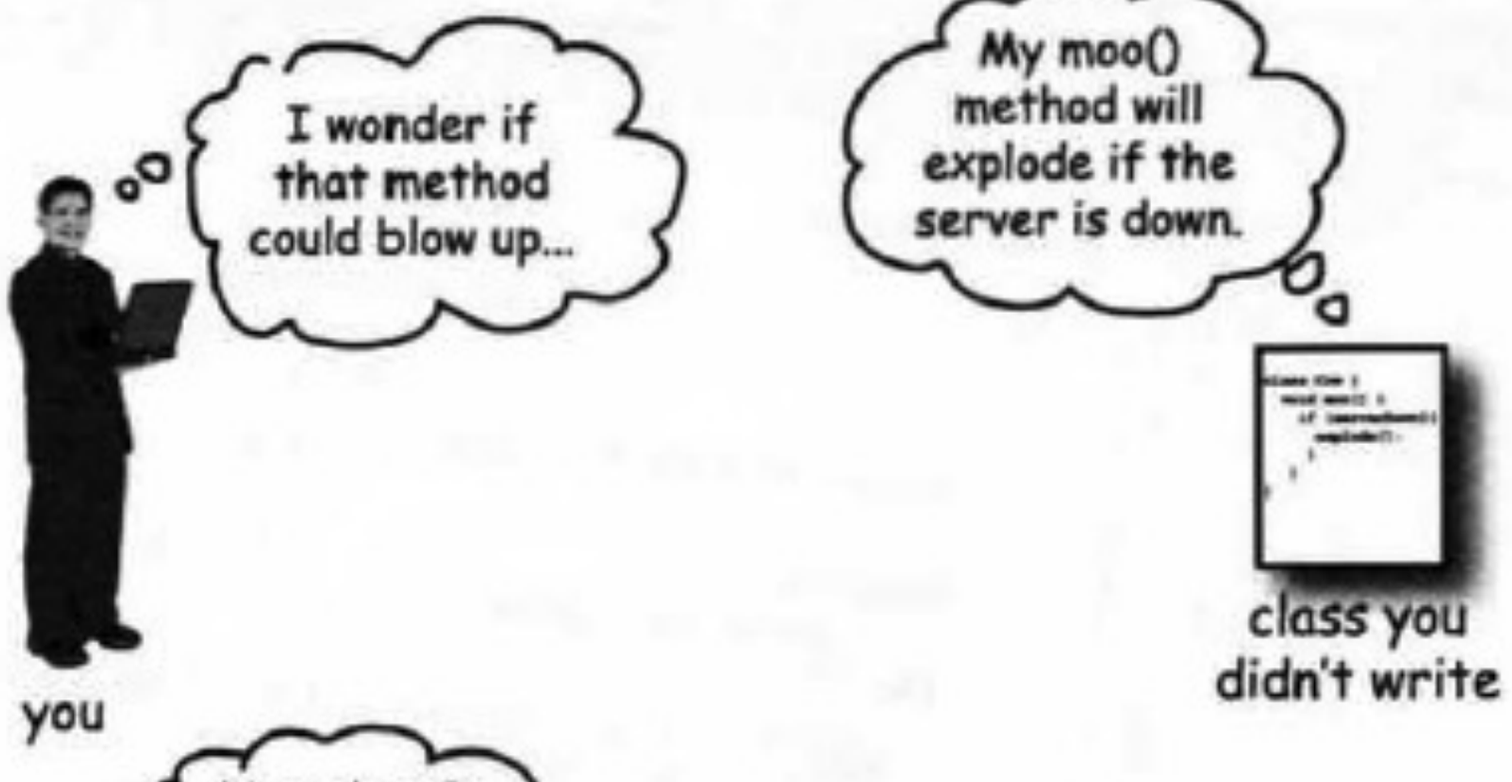


2. **That method does something risky, something that might not work at runtime.**




```
void moo() {
    if (serverDown) {
      explode();
    }
}
```

3. **You need to *know* that the method you're calling is risky.**



4. **You then write code that can handle the failure if it *does* happen. You need to be prepared, just in case.**

Methods in Java use exceptions to tell the calling code, "Something Bad Happened. I failed."

Java's exception-handling mechanism is a clean, well-lighted way to handle "exceptional situations" that pop up at runtime; it lets you put all your error-handling code in one easy-to-read place. It's based on you *knowing* that the method you're calling is risky (i.e. that the method *might* generate an exception), so that you can write code to deal with that possibility. If you *know* you might get an exception when you call a particular method, you can be *prepared* for—possibly even *recover* from—the problem that caused the exception.

So, how *do* you know if a method throws an exception? You find a **`throws`** clause in the risky method's declaration.

The `getSequencer()` method takes a risk. It can fail at runtime. So it must 'declare' the risk *you* take when you call it.

MidiSystem (Java 2 Platform SE v1.4.0)

Back Forward Stop Refresh Home AutoFill Print Mail

Address http://java.sun.com/j2se/1.4/docs/api/index.html

Live Home Page Apple Apple Support Apple Store iTools Mac OS X Microsoft MacTopia

javax.sound.midi
javax.sound.midi.s
javax.sound.sampl
javax.sound.sampl

MidiMessage
MidiSystem
Patch
Sequence
Sequencer.SyncMo
ShortMessage
SoundbankResourc
SysexMessage
Track
VoiceStatus

Exceptions
InvalidMidiDataExc
MidiUnavailableExc

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getSequencer

```
public static Sequencer getSequencer()
                              throws MidiUnavailableException
```

Obtains the default sequencer.

Returns:
the default sequencer
Throws:
MidiUnavailableException - if the sequencer is not available due to resource restrictions

Internet zone

The API does tell you that getSequencer() can throw an exception: MidiUnavailableException. A method has to declare the exceptions it might throw.

This part tells you WHEN you might get that exception -- in this case, because of resource restrictions (which could just means the sequencer is already being used).

The compiler needs to know that *YOU* know you're calling a risky method.

If you wrap the risky code in something called a **try/catch**, the compiler will relax.

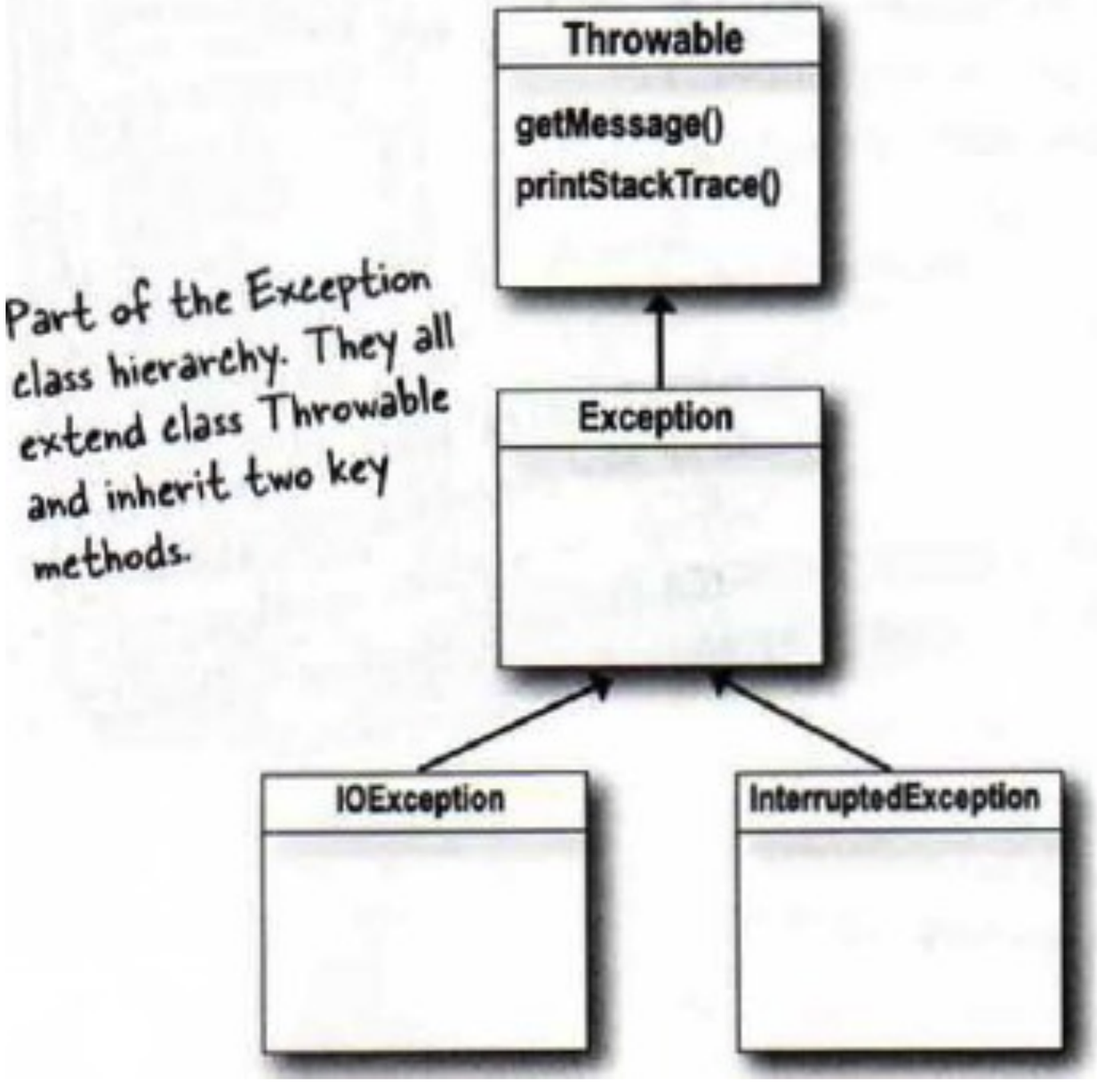
A try/catch block tells the compiler that you *know* an exceptional thing could happen in the method you're calling, and that you're prepared to handle it. That compiler doesn't care *how* you handle it; it cares only that you say you're taking care of it.

```
import javax.sound.midi.*;

public class MusicTest1 {
    public void play() {

        try {
            Sequencer sequencer = MidiSystem.getSequencer();
            System.out.println("Successfully got a sequencer");
        } catch(MidiUnavailableException ex) {
            System.out.println("Bummer");
        }
    } // close play

    public static void main(String[] args) {
        MusicTest1 mt = new MusicTest1();
        mt.play();
    } // close main
} // close class
```

put the risky thing in a 'try' block.

make a 'catch' block for what to do if the exceptional situation happens -- in other words, a MidiUnavailableException is thrown by the call to getSequencer().

An exception is an object... of type Exception.




```
try {
    // do risky thing
} catch(Exception ex) {
    // try to recover
}
```

it's just like declaring a method argument

This code only runs if an Exception is thrown.

What you write in a catch block depends on the exception that was thrown. For example, if a server is down you might use the catch block to try another server. If the file isn't there, you might ask the user for help finding it.

If it's *your* code that catches the exception, then whose code throws it?

- You'll spend much more of your Java coding time *handling* exceptions than you'll spend creating and throwing them yourself.
- For now, just know that when your code *calls a risky method*—*a method* that declares an exception, it's the risky method that throws the exception back to you, the caller.

① Risky, exception-throwing code:

this method MUST tell the world (by declaring) that it throws a BadException

```
public void takeRisk() throws BadException {
    if (abandonAllHope) {
      throw new BadException();
    }
}
```

create a new Exception object and throw it.

One method will catch what another method throws. An exception is always thrown back to the caller.

The method that throws has to declare that it might throw the exception.

② Your code that *calls* the risky method:

```
public void crossFingers() {
    try {
      anObject.takeRisk();
    } catch (BadException ex) {
      System.out.println("Aaargh!");
      ex.printStackTrace();
}
```

If you can't recover from the exception, at LEAST get a stack trace using the printStackTrace() method that all exceptions inherit.

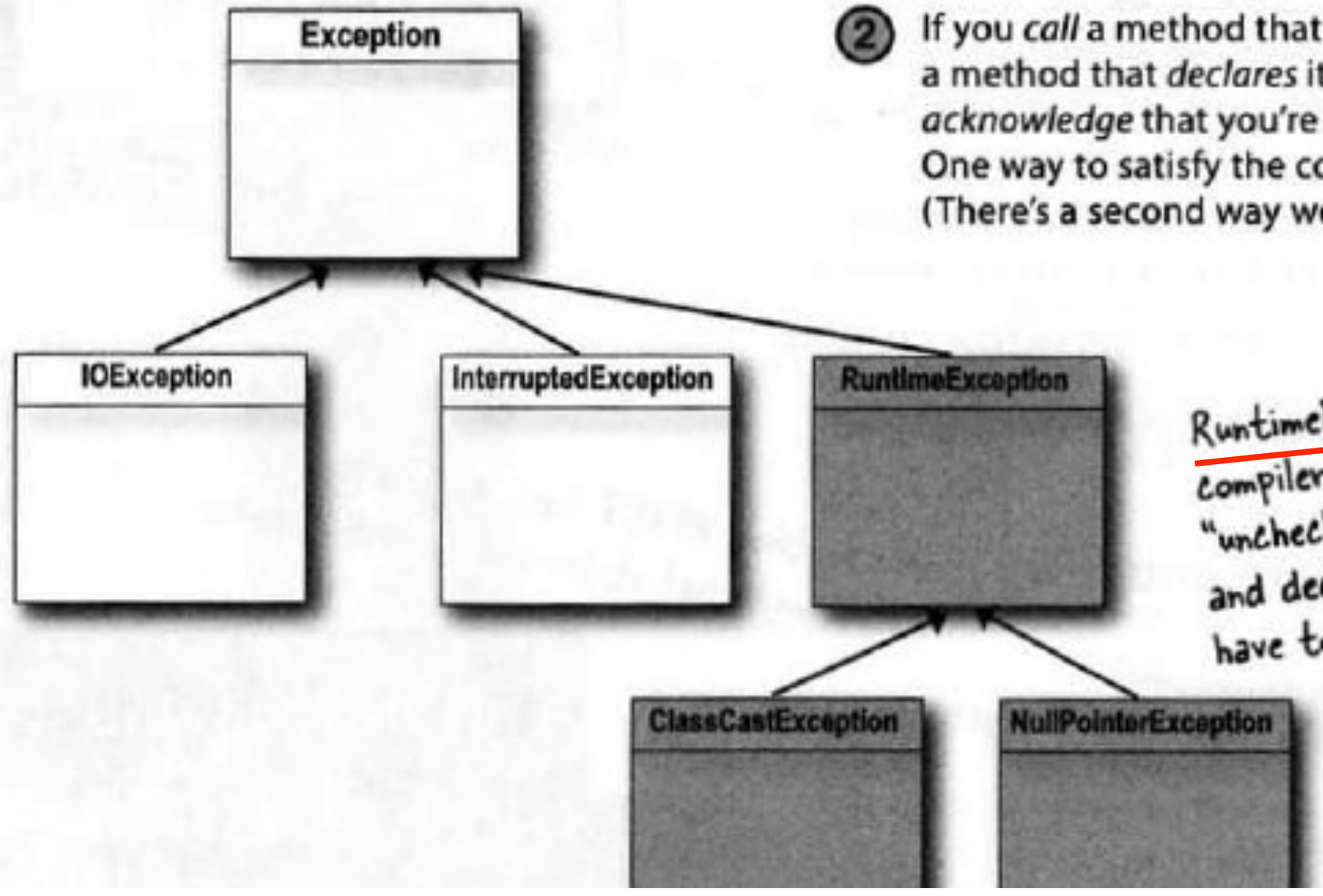
The compiler checks for everything except RuntimeExceptions.

The compiler guarantees:

1. If you *throw* an exception in your code you *must* declare it using the *throws* keyword in your method declaration.

2. If you *call* a method that throws an exception (in other words, a method that *declares* it throws an exception), you must *acknowledge* that you're aware of the exception possibility. One way to satisfy the compiler is to wrap the call in a try/catch. (There's a second way we'll look at a little later in this chapter.)

Exceptions that are *NOT* subclasses of RuntimeException are checked for by the compiler. They're called "checked exceptions"



RuntimeExceptions are NOT checked by the compiler. They're known as (big surprise here) "unchecked exceptions". You can throw, catch, and declare RuntimeExceptions, but you don't have to, and the compiler won't check.

Q: Wait just a minute! How come this is the FIRST time we've had to try/catch an Exception? What about the exceptions I've already gotten like NullPointerException and the exception for DivideByZero. I even got a NumberFormatException from the Integer.parseInt() method. How come we didn't have to catch those?

A: The compiler cares about all subclasses of Exception, *unless* they are a special type, RuntimeException. Any exception class that extends RuntimeException gets a free pass. RuntimeExceptions can be thrown anywhere, with or without throws declarations or try/catch blocks. The compiler doesn't bother checking whether a method declares that it throws a RuntimeException, or whether the caller acknowledges that they might get that exception at runtime.

Q: I'll bite. WHY doesn't the compiler care about those runtime exceptions? Aren't they just as likely to bring the whole show to a stop?

A: Most RuntimeExceptions come from a problem in your code logic, rather than a condition that fails at runtime in ways that you cannot predict or prevent. You *cannot* guarantee the file is there. You *cannot* guarantee the server is up. But you *can* make sure your code doesn't index off the end of an array (that's what the .length attribute is for).

You WANT RuntimeExceptions to happen at development and testing time. You don't want to code in a try/catch, for example, and have the overhead that goes with it, to catch something that shouldn't happen in the first place.

A try/catch is for handling exceptional situations, not flaws *in your code. Use your catch blocks to try to recover from* situations you can't guarantee will succeed. Or at the very least, print out a message to the user and a stack trace, so somebody can figure out what happened.

- A method can throw an exception when something fails at runtime.
- An exception is always an object of type Exception. (Which, as you remember from the polymorphism chapters means the object is from a class that has Exception somewhere up its inheritance tree.)
- The compiler does NOT pay attention to exceptions that are of type **RuntimeException**. A RuntimeException does not have to be declared or wrapped in a try/catch (although you're free to do either or both of those things)
- All Exceptions the compiler cares about are called 'checked exceptions' which really means *compiler*-checked exceptions. Only RuntimeExceptions are excluded from compiler checking. All other exceptions must be acknowledged in your code, according to the rules.
- A method throws an exception with the keyword **`throw`**, followed by a new exception object:

```
throw new NoCaffeineException();
```

- Methods that *might* throw a checked exception ***must*** announce it with a **`throws Exception`** declaration.
- If your code calls a checked-exception-throwing method, it must reassure the compiler that precautions have been taken.
- If you're prepared to handle the exception, wrap the call in a try/catch, and put your exception handling/recovery code in the catch block.
- If you're not prepared to handle the exception, you can still make the compiler happy by officially 'ducking' the exception. We'll talk about ducking a little later in this chapter.

Flow control in try/catch blocks

If the try succeeds

(doRiskyThing() does *not* throw an exception)

```
try {
① Foo f = x.doRiskyThing();
  int b = f.getNum();

} catch (Exception ex) {
    System.out.println("failed");
}
② System.out.println("We made it!");
```

First the try block runs, then the code below the catch runs.

The code in the catch block never runs.

```
File Edit Window Help RiskAll
%java Tester
We made it!
```

If the try **fails**

(because doRiskyThing() *does* throw an exception)

The try block runs, but the call to doRiskyThing() throws an exception, so the rest of the try block doesn't run.

The catch block runs, then the method continues on.

```
try {
  1 Foo f = x.doRiskyThing();
    int b = f.getNum();

} catch (Exception ex) {
  2   System.out.println("failed");
  }
  3 System.out.println("We made it!");
```

The rest of the try block never runs, which is a Good Thing because the rest of the try depends on the success of the call to doRiskyThing().

```
File Edit Window Help RiskAll
%java Tester
failed
We made it!
```

Finally

A finally block is where you put code that must run *regardless* of an exception.

```
try {
    turnOvenOn();
    x.bake();
} catch (BakingException ex) {
        ex.printStackTrace();
} finally {
        turnOvenOff();
}
```

- Without finally, you have to put the turnOvenOff() in *both* the try and the catch because *you have to turn off the oven no matter what.* A finally block lets you put all your important cleanup code in *one* place instead of duplicating it like this:

```
try {
    turnOvenOn();
    x.bake();
    turnOvenOff();
} catch (BakingException ex) {
        ex.printStackTrace();
        turnOvenOff();
}
```

Multiple exceptions

Catching multiple exceptions

The compiler will make sure that you've handled *all* the checked exceptions thrown by the method you're calling. Stack the *catch* blocks under the *try*, one after the other. Sometimes the order in which you stack the catch blocks matters, but we'll get to that a little later.

```
public class Laundry {

    public void doLaundry() throws PantsException, LingerieException {
        // code that could throw either exception
    }
}
```

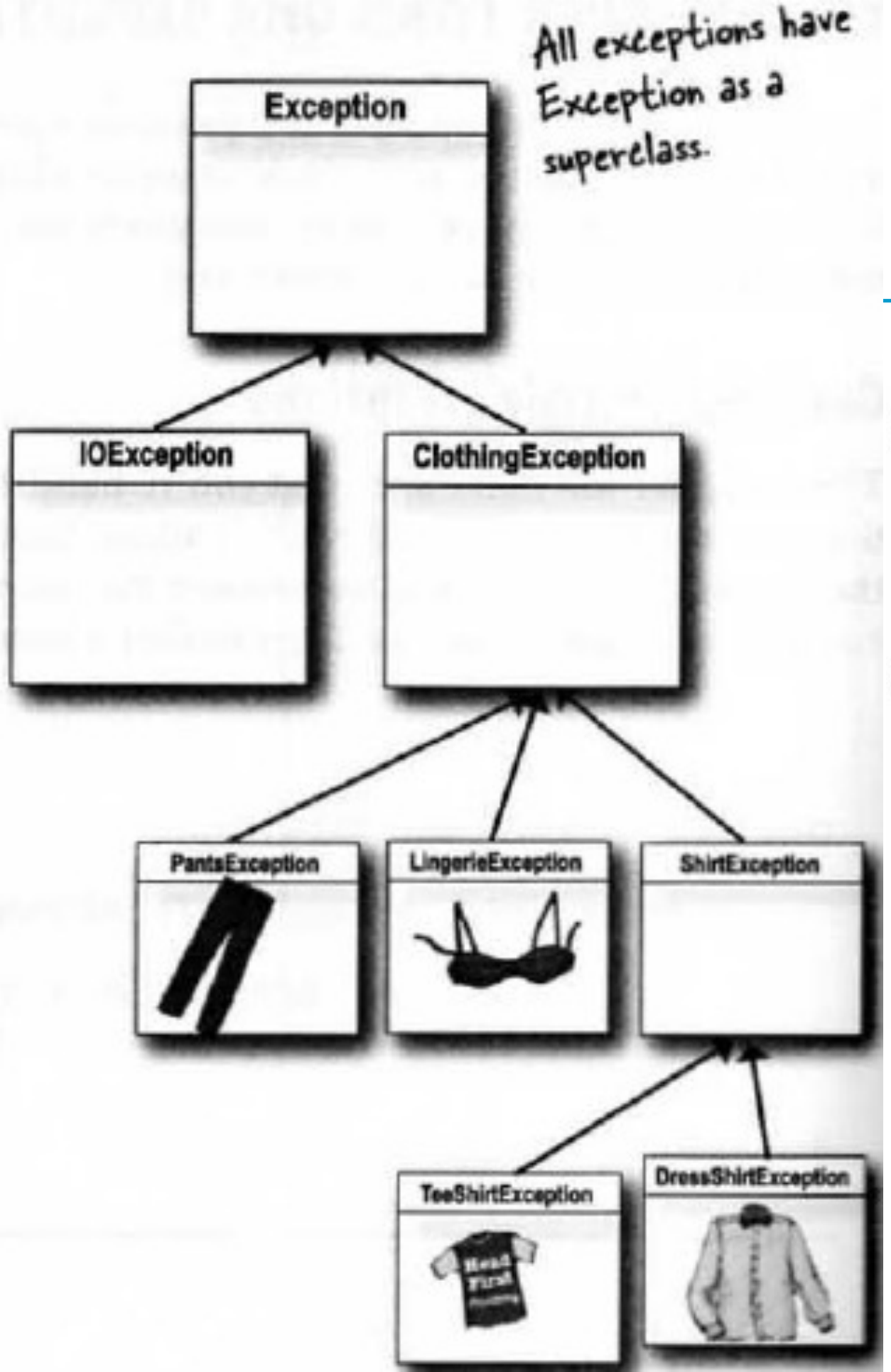
This method declares two, count 'em, TWO exceptions.

```
public class Foo {
    public void go() {
        Laundry laundry = new Laundry();
        try {
            laundry.doLaundry();
        } catch(PantsException pex) {
            // recovery code
        } catch(LingerieException lex) {
            // recovery code
        }
    }
}
```

if doLaundry() throws a PantsException, it lands in the PantsException catch block.

if doLaundry() throws a LingerieException, it lands in the LingerieException catch block.

Exceptions are polymorphic



1 You can DECLARE exceptions using a supertype of the exceptions you throw.

```
public void doLaundry() throws ClothingException {
```

Declaring a ClothingException lets you throw any subclass of ClothingException. That means doLaundry() can throw a PantsException, LingerieException, TeeShirtException, and DressShirtException without explicitly declaring them individually.

② You can CATCH exceptions using a supertype of the exception thrown.

```
try {
    laundry.doLaundry();
} catch(ClothingException cex) {
    // recovery code
}
```

can catch any ClothingException subclass

```
try {
    laundry.doLaundry();
} catch(ShirtException sex) {
    // recovery code
}
```

can catch only TeeShirtException and DressShirtException

Just because you CAN catch everything with one big super polymorphic catch, doesn't always mean you SHOULD.

You *could* write your exception-handling code so that you specify only *one* catch block, using the supertype Exception in the catch clause, so that you'll be able to catch *any* exception that might be thrown.

```
try {
    laundry.doLaundry();
} catch(Exception ex) {
    // recovery code...
}
```

Recovery from WHAT? This catch block will catch ANY and all exceptions, so you won't automatically know what went wrong.

Write a different catch block for each exception that you need to handle uniquely.

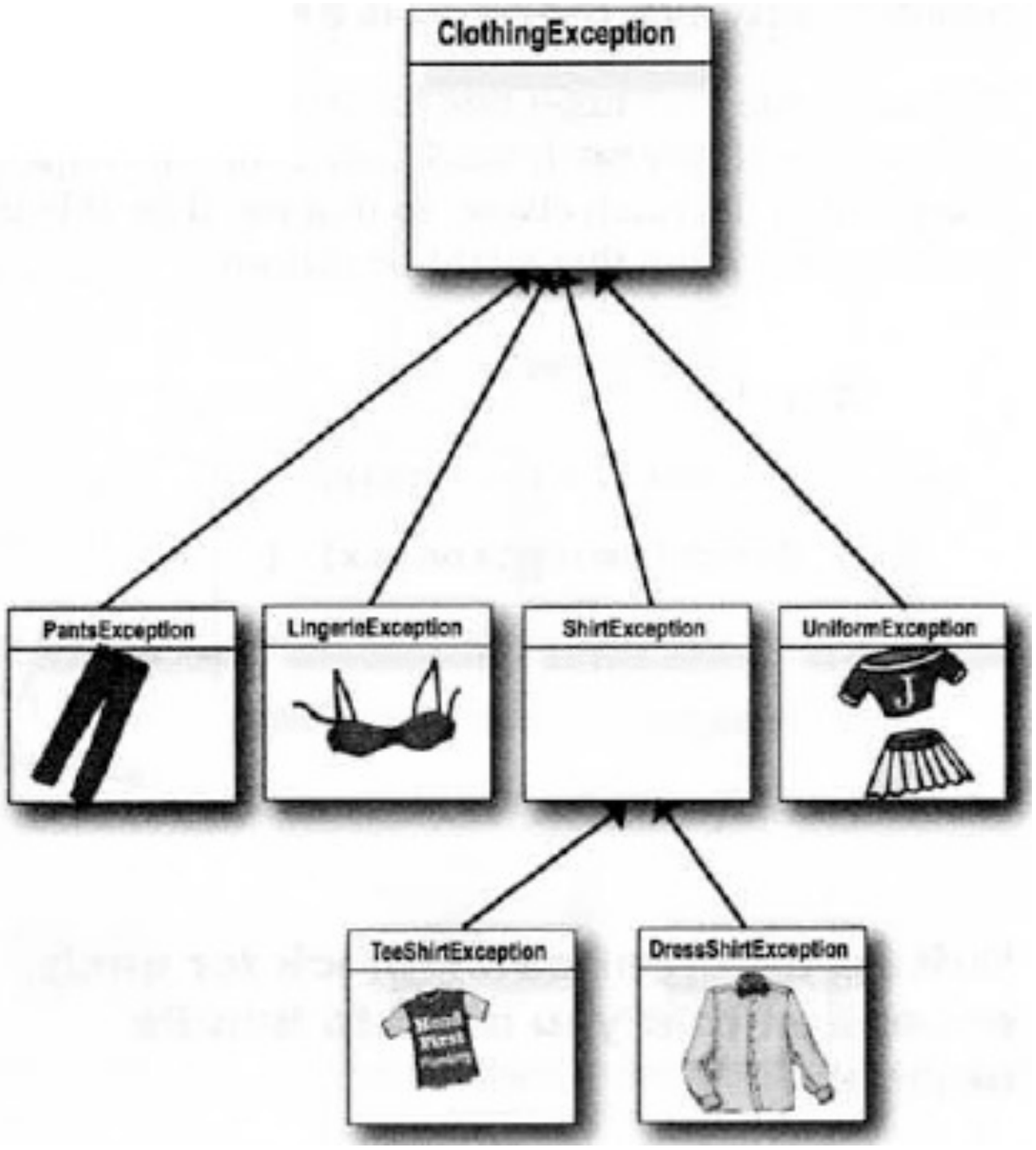
For example, if your code deals with (or recovers from) a TeeShirtException differently than it handles a LingerieException, write a catch block for each. But if you treat all other types of ClothingException in the same way, then add a ClothingException catch to handle the rest.

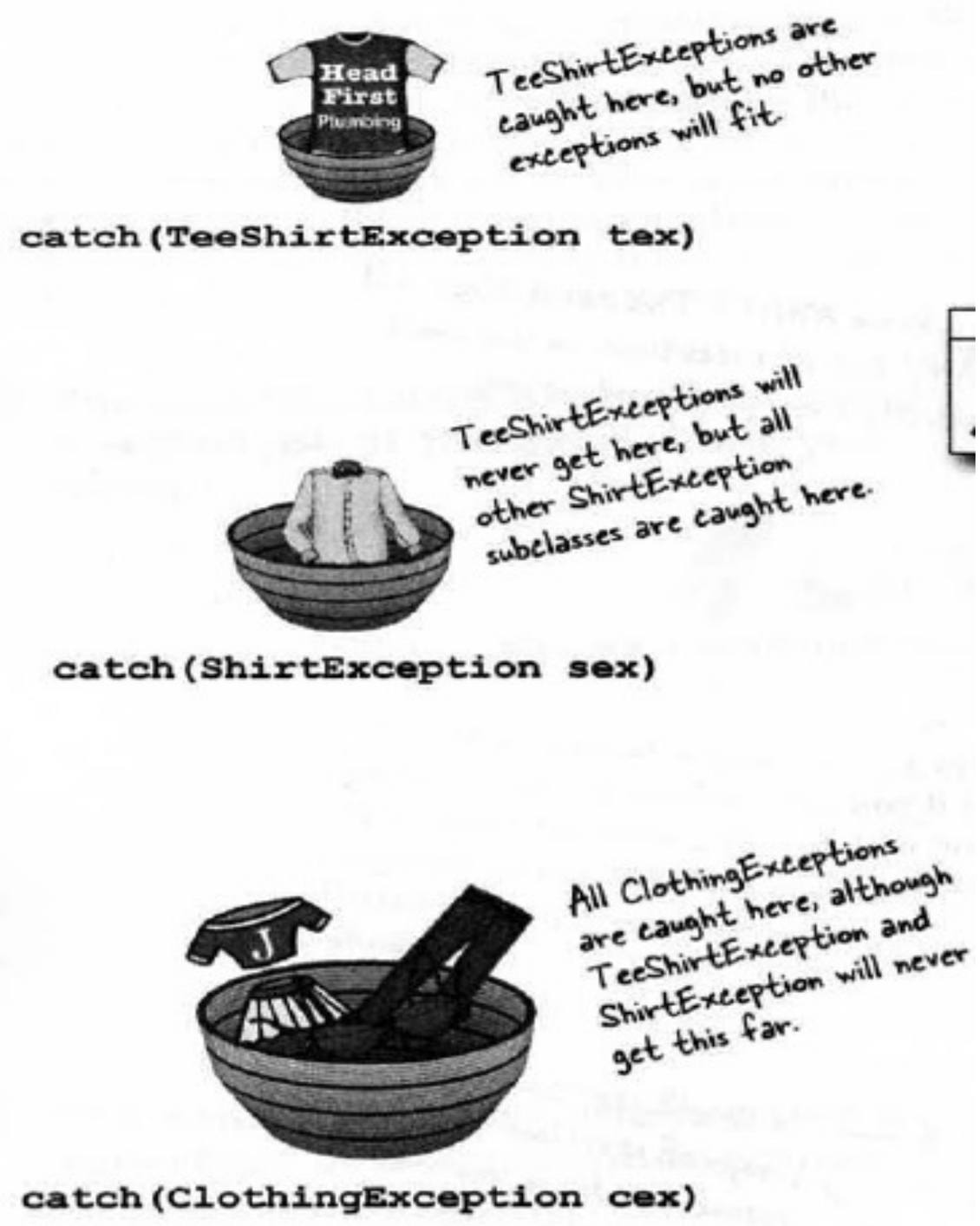
```
try {
    laundry.doLaundry();
} catch(TeeShirtException tex) {
    // recovery from TeeShirtException
} catch(LingerieException lex) {
    // recovery from LingerieException
} catch(ClothingException cex) {
    // recovery from all others
}
```

TeeShirtExceptions and LingerieExceptions need different recovery code, so you should use different catch blocks.

All other ClothingExceptions are caught here.

Multiple catch blocks must be ordered from smallest to biggest





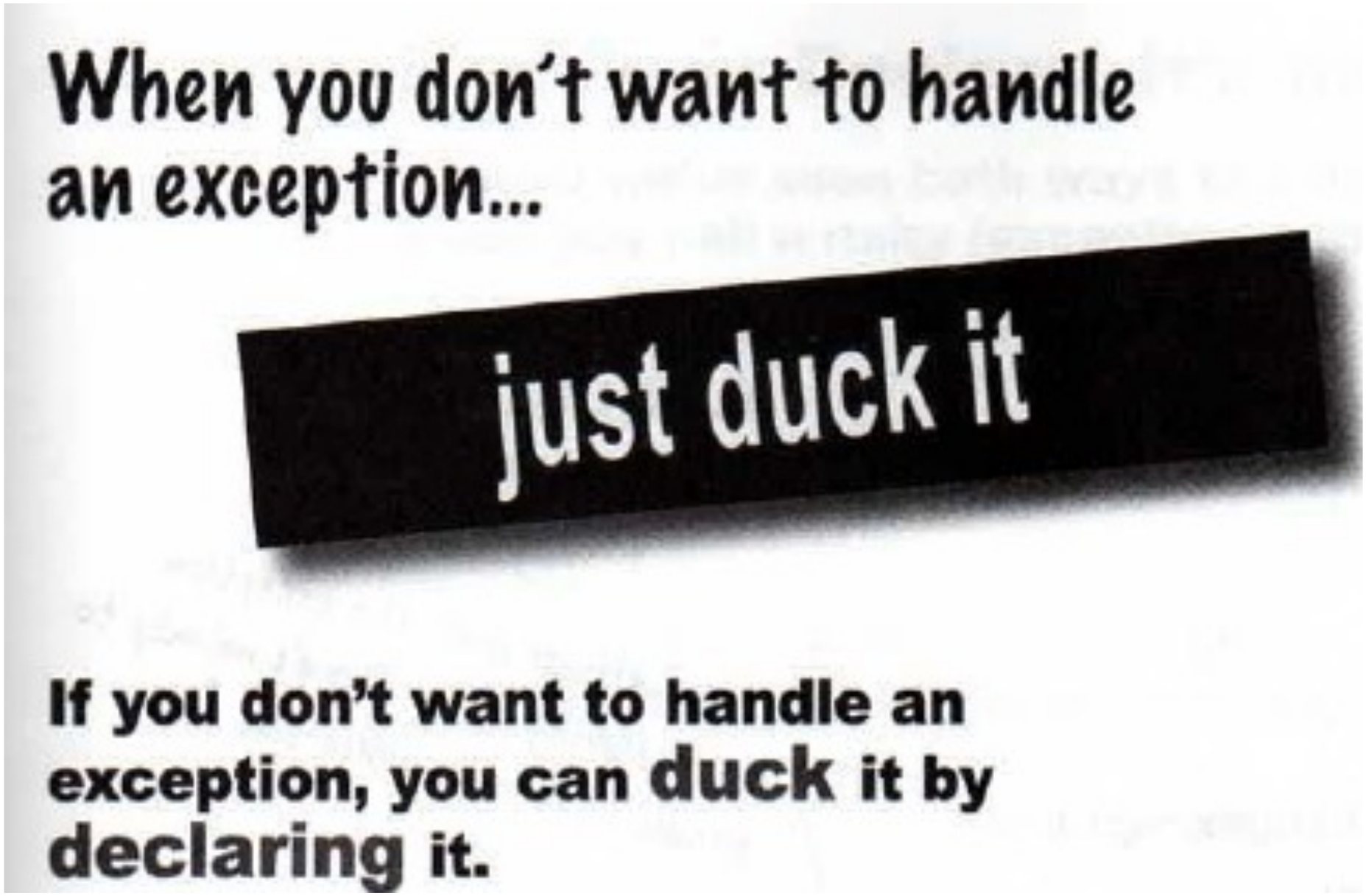
- The higher up the inheritance tree, the bigger the catch ‘basket’.
- The mother of all catch arguments is type Exception; it will catch any exception, including runtime (unchecked) exceptions, so you probably won’t use it outside of testing.

You can't put bigger baskets above smaller baskets.

Well, you *can* but it won't compile. Catch blocks are not like overloaded methods where the best match is picked. With catch blocks, the JVM simply starts at the first one and works its way down until it finds a catch that's broad enough (in other words, high enough on the inheritance tree) to handle the exception. If your first catch block is **`catch (Exception ex)`**, the compiler knows there's no point in adding any others—they'll never be reached.

Siblings can be in any order, because they can't catch one another's exceptions.

You could put ShirtException above LingerieException and nobody would mind. Because even though ShirtException is a bigger (broader) type because it can catch other classes (its own subclasses), ShirtException can't catch a LingerieException so there's no problem.


When you don't want to handle an exception...
just duck it
If you don't want to handle an exception, you can duck it by declaring it.

When a method throws an exception, that method is popped off the stack immediately, and the exception is thrown to the next method down the stack—the *caller*. But if the *caller* is a *ducker*, then there's no catch for it so the *caller* pops off the stack immediately, and the exception is thrown to the next method and so on... where does it end? You'll see a little later.

```
public void foo() throws ReallyBadException {
    // call risky method without a try/catch
    laundry.doLaundry();
}
```

You don't REALLY throw it, but since you don't have a try/catch for the risky method you call, YOU are now the "risky method". Because now, whoever calls YOU has to deal with the exception.

Ducking (by declaring) only delays the inevitable

Sooner or later, *somebody* has to deal with it. But what if *main()* ducks the exception?

```
public class Washer {
    Laundry laundry = new Laundry();

    public void foo() throws ClothingException {
        laundry.doLaundry();
    }

    public static void main (String[] args) throws ClothingException {
        Washer a = new Washer();
        a.foo();
    }
}
```

Both methods duck the exception (by declaring it) so there's nobody to handle it! This compiles just fine.

1 doLaundry() throws a ClothingException

main() calls foo()

foo() calls doLaundry()

doLaundry() is running and throws a ClothingException

2 foo() ducks the exception

doLaundry() pops off the stack immediately and the exception is thrown back to foo().

But foo() doesn't have a try/catch, so...

3 main() ducks the exception

foo() pops off the stack immediately and the exception is thrown back to... who? What? There's nobody left but the JVM, and it's thinking, "Don't expect ME to get you out of this."

4 The JVM shuts down

Handle or Declare. It's the law.

So now we've seen both ways to satisfy the compiler when you call a risky (exception-throwing) method.

1 HANDLE

Wrap the risky call in a try/catch

```
try {
    laundry.doLaundry();
} catch(ClothingException cex) {
      // recovery code
}
```

This had better be a big enough catch to handle all exceptions that doLaundry() might throw. Or else the compiler will still complain that you're not catching all of the exceptions.

2 DECLARE (duck it)

Declare that YOUR method throws the same exceptions as the risky method you're calling.

```
void foo() throws ClothingException {
    laundry.doLaundry();
}
```

The doLaundry() method throws a ClothingException, but by declaring the exception, the foo() method gets to duck the exception. No try/catch.

But now this means that whoever calls the foo() method has to follow the Handle or Declare law. If foo() ducks the exception (by declaring it), and main() calls foo(), then main() has to deal with the exception.

```
public class Washer {
    Laundry laundry = new Laundry();

    public void foo() throws ClothingException {
        laundry.doLaundry();
    }

    public static void main (String[] args) {
        Washer a = new Washer();
        a.foo();
    }
}
```

TROUBLE!!

Now main() won't compile, and we get an "unreported exception" error. As far as the compiler's concerned, the foo() method throws an exception.

Because the foo() method ducks the ClothingException thrown by doLaundry(), main() has to wrap a.foo() in a try/catch, or main() has to declare that it, too, throws ClothingException!

Getting back to our music code...

Now that you've completely forgotten, we started this chapter with a first look at some JavaSound code. We created a Sequencer object but it wouldn't compile because the method Midi.getSequencer() declares a checked exception (MidiUnavailableException). But we can fix that now by wrapping the call in a try/catch.

```
public void play() {
        try {

            Sequencer sequencer = MidiSystem.getSequencer();
            System.out.println("Successfully got a sequencer");

        } catch(MidiUnavailableException ex) {
            System.out.println("Bummer");
        }
} // close play
```

No problem calling getSequencer(), now that we've wrapped it in a try/catch block.

The catch parameter has to be the 'right' exception. If we said 'catch(FileNotFoundException f), the code would not compile, because polymorphically a MidiUnavilableException won't fit into a FileNotFoundException.

Remember it's not enough to have a catch block... you have to catch the thing being thrown!

Exception Rules

1 You cannot have a catch or finally without a try

```
void go() {
   Foo f = new Foo();
   f.foof();
   catch(FooException ex) { }
}
```

NOT LEGAL! Where's the try?

2 You cannot put code between the try and the catch

```
try {
   x.doStuff();
}
int y = 43;
} catch(Exception ex) { }
```

NOT LEGAL! You can't put code between the try and the catch.

3 A try MUST be followed by either a catch or a finally

```
try {
   x.doStuff();
} finally {
   // cleanup
}
```

LEGAL because you have a finally, even though there's no catch. But you cannot have a try by itself.

4 A try with only a finally (no catch) must still declare the exception.

```
void go() throws FooException {
   try {
      x.doStuff();
   } finally { }
}
```

A try without a catch doesn't satisfy the handle or declare law

当finally子句包含return 语句

```
public static int f(int n){
    try{
        int r = n*n;
        return r;
    }
    finally{
        if(n==2) return 0;
    }
}
```

使用异常机制的建议

- 异常的声明是API的一部分
- 异常处理不能代替简单的测试
- 不要过分地细化异常
- 利用异常层次结构
  - 不要只抛出RuntimeException异常，应该寻找更合适的子类或者创建自己的异常类
- 不要压制异常
- 在检测错误时，“苛刻”要比放任更好
  - 在出错的地方抛出一个EmptyStackException异常要比在后面抛出一个NullPointerException异常更好
- 不要羞于传递异常
  - 早抛出，晚捕获

创建自己的异常

- 精心设计异常的层次结构
- 异常类中包含足够的信息
- 异常与错误提示

代码清单 1-6 使用异常包装技术的示例

```
public class DataAccessGateway {
    public void load() throws DataAccessException {
        try {
            FileInputStream input = new FileInputStream("data.txt");

        }
        catch (IOException e) {
            throw new DataAccessException(e);
        }
    }
}
```

代码清单 1-7 支持国际化异常消息的异常类的基类

```
public abstract class LocalizedException extends Exception {
    private static final String DEFAULT_BASE_NAME = "com/java7book/chapter1/
        exception/java7/messages";
    private String baseName = DEFAULT_BASE_NAME;
    protected ResourceBundle resourceBundle;
    private String messageKey;
    public LocalizedException(String messageKey) {

        this.messageKey = messageKey;
        initResourceBundle();
    }
    public LocalizedException(String messageKey, String baseName) {
        this.messageKey = messageKey;
        this.baseName = baseName;
        initResourceBundle();
    }
    private void initResourceBundle() {
        resourceBundle = ResourceBundle.getBundle(baseName);
    }
    protected void setBaseName(String baseName) {
        this.baseName = baseName;
    }
    protected void setMessageKey(String key) {
        messageKey = key;
    }
    public abstract String getLocalizedMessage();
    public String getMessage() {
        return getLocalizedMessage();
    }
    protected String format(Object ... args) {
        String message = resourceBundle.getString(messageKey);
        return MessageFormat.format(message, args);
    }
}
```

代码清单 1-8　继承自支持国际化异常消息的异常类的子类

```
public class InsufficientBalanceException extends LocalizedException {
    private BigDecimal requested;
    private BigDecimal balance;
    private BigDecimal shortage;
    public InsufficientBalanceException(BigDecimal requested, BigDecimal balance) {
        super("INSUFFICIENT_BALANCE_EXCEPTION");
        this.requested = requested;
        this.balance = balance;
        this.shortage = requested.subtract(balance);
    }
    public String getLocalizedMessage() {
       return format(balance, requested, shortage);
    }
}
```

异常的消失

代码清单 1-9　异常消失的示例

```
public class DisappearedException {
    public void show() throws BaseException{
        try {
            Integer.parseInt("Hello");
        }
        catch (NumberFormatException nfe) {
            throw new BaseException(nfe);
        } finally {
            try {
                int result = 2 / 0;
            } catch (ArithmeticException ae) {
                throw new BaseException(ae);
            }
        }
    }
}
```

两种解决办法

- Solution 1
  - 抛出try语句块中阐述的原始异常，忽略在finally语句块中产生的异常
- Solution 2
  - 把产生的异常都记录下来

Solution 1

代码清单 1-10　抛出 try 语句块中产生的原始异常的示例

```
public class ReadFile {
    public void read(String filename) throws BaseException {
        FileInputStream input = null;
        IOException readException = null;
        try {
            input = new FileInputStream(filename);
        } catch (IOException ex) {
            readException = ex;
        } finally {
            if (input != null) {
                try {
                    input.close();
                } catch (IOException ex) {
                    if (readException == null) {
                        readException = ex;
                    }
                }
            }
            if (readException != null) {
                throw new BaseException(readException);
            }
        }
    }
}
```

Solution 2

代码清单 1-11　使用 addSuppressed 方法记录异常的示例

```
public class ReadFile {
    public void read(String filename) throws IOException {
        FileInputStream input = null;
        IOException readException = null;
        try {
            input = new FileInputStream(filename);
        } catch (IOException ex) {
            readException = ex;
        } finally {
            if (input != null) {
                try {
                    input.close();
                } catch (IOException ex) {
                    if (readException != null) {
                        readException.addSuppressed(ex);
                    }
                    else {
                        readException = ex;
                    }
                }
            }
            if (readException != null) {
                throw readException;
            }
        }
    }
}
```

Java 7的异常处理新特性

- 一个catch子句捕获多个异常
- 更加精确的异常抛出

代码清单 1-12　在 catch 子句中指定多种异常

```
public class ExceptionHandler {
    public void handle() {
        ExceptionThrower thrower = new ExceptionThrower();
        try {
            thrower.manyExceptions();
        } catch (ExceptionA | ExceptionB ab) {
        } catch (ExceptionC c) {
        }
    }
}
```

注意:
在 catch 子句中声明捕获的这些异常类中, 不能出现重复的类型, 也不允许其中的某个异常是另 外一个异常的子类, 否则会出现编译错误。如果在 catch 子句中声明了多个异常类, 那 么异常参数的具体类型是所有这些异常类型的最小上界。
关于一个 catch 子句中的异常类型不能出现其中一个是另外一个的子类的情况, 实 际上涉及捕获多个异常的内部实现方式。原因在于, 编译器的做法其实是把捕获多个异常的 catch 子句转换成了多个 catch 子 句, 在每个 catch 子句中捕获一个异常。

代码清单 1-17　精确的异常抛出的示例

```
public class PreciseThrowUse {
    public void testThrow() throws ExceptionA {
        try {
            throw new ExceptionASub2();
        }
        catch(ExceptionA e) {
            try {
                throw e;
            }
            catch (ExceptionASub1 e2) { // 编译错误

            }
        }
}
```

在上面的代码中，异常类 ExceptionASub1 和 ExceptionASub2 都是 ExceptionA 的子类, 而且这两者之间并没有继承关系。方法 testThrow 中首先抛出了 ExceptionASub2 异常, 通过第一个 catch 子句捕获之后重新抛出。在这里, Java 编译器可以准确知 道变量 e 表示的异常类型是 ExceptionASub2, 接下来的第二个 catch 子句试图捕获 ExceptionASub1 类型的异常, 这显然是不可能的, 因此会产生编译错误。上面的代码在 Java 6 编译器上是可以通过编译的。对于 Java 6 编译器来说, 第二个 try 子句中抛出的 异常类型是前一个 catch 子句中声明的 ExceptionA 类型, 因此在第二个 catch 子句中尝 试捕获 ExceptionA 的子类型 ExceptionASub1 是合法的。

Java 7中引入try-with-resources语句

代码清单 1-18　读取磁盘文件内容的示例

```
public class ResourceBasicUsage {
    public String readFile(String path) throws IOException {
        try (BufferedReader reader = new BufferedReader(new FileReader(path))) {
            StringBuilder builder = new StringBuilder();
            String line = null;
            while ((line = reader.readLine()) != null) {
                builder.append(line);
                builder.append(String.format("%n"));
            }
            return builder.toString();
        }
    }
}
```

代码清单 1-19　自定义资源使用 AutoCloseable 接口的示例

```
public class CustomResource implements AutoCloseable {
    public void close() throws Exception {
        System.out.println("进行资源释放。");
    }

    public void useCustomResource() throws Exception {
        try (CustomResource resource = new CustomResource())  {
            System.out.println("使用资源。");
        }
    }
}
```

能够被 try 语句所管理的资源需要满足一个条件, 那就是其 Java 类要实现 java.lang.AutoCloseable 接口, 否则会出现编译错误。当需要释放资源的时候, 该接口的 close 方 法会被自动调用。Java 类库中已有不少接口或类继承或实现了这个接口, 使得它们可 以用在 try 语句中。在这些已有的常见接口或类中, 最常用的就是与 I/O 操作和数据库 相关的接口。与 I/O 相关的 java.io.Closeable 继承了 AutoCloseable, 而与数据库相关的 java.sql.Connection、java.sql.ResultSet 和 java.sql.Statement 也继承了该接口。如果希望 自己开发的类也能利用 try 语句的自动化资源管理, 只需要实现 AutoCloseable 接口即 可。

代码清单 1-20　使用 try-with-resources 语句管理两个资源的示例

```
public class MultipleResourcesUsage {
    public void copyFile(String fromPath, String toPath) throws IOException {
        try (InputStream input = new FileInputStream(fromPath);
                OutputStream output = new FileOutputStream(toPath)) {
            byte[] buffer = new byte[8192];
            int len = -1;
            while ((len = input.read(buffer)) != -1) {
                output.write(buffer, 0, len);
            }
        }
    }
}
```