Advanced Programming
CSE 201

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(Semester: Monsoon 2025)

Week 4 - Inner Classes and Exceptions/Exception Handling

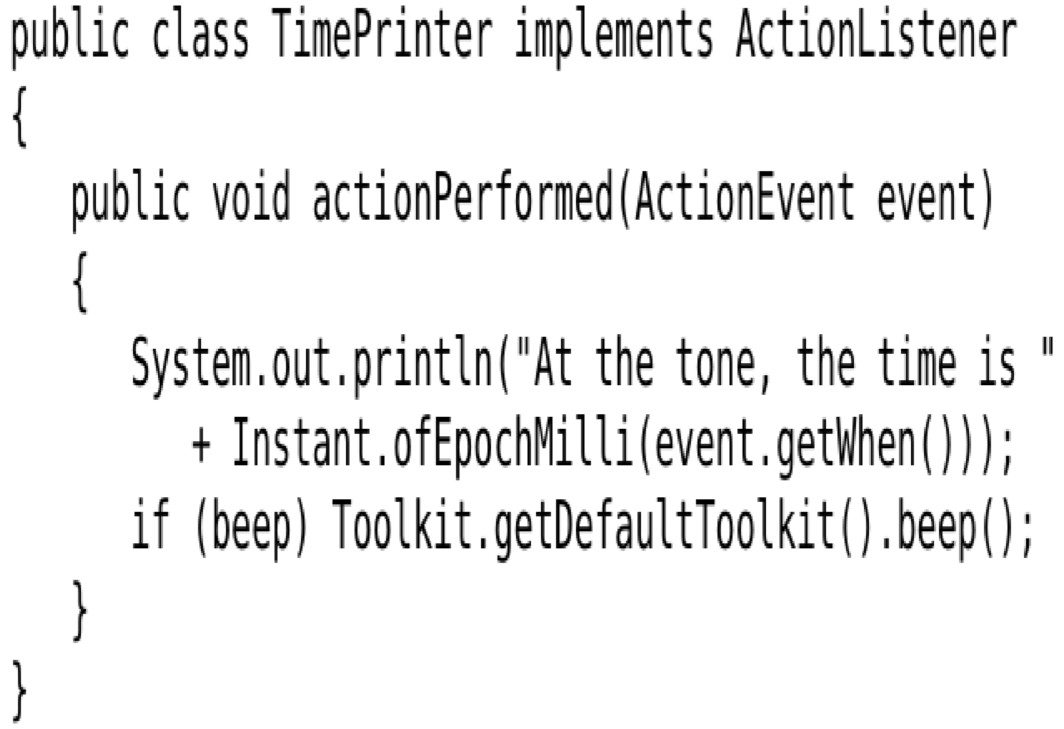
Inner Classes

```
public class TalkingClock
{
   private int interval;
   private boolean beep;

   public TalkingClock(int interval, boolean beep) { . . . }
   public void start() { . . . }

   public class TimePrinter implements ActionListener
      // an inner class
   {
      . . .
   }
}
```

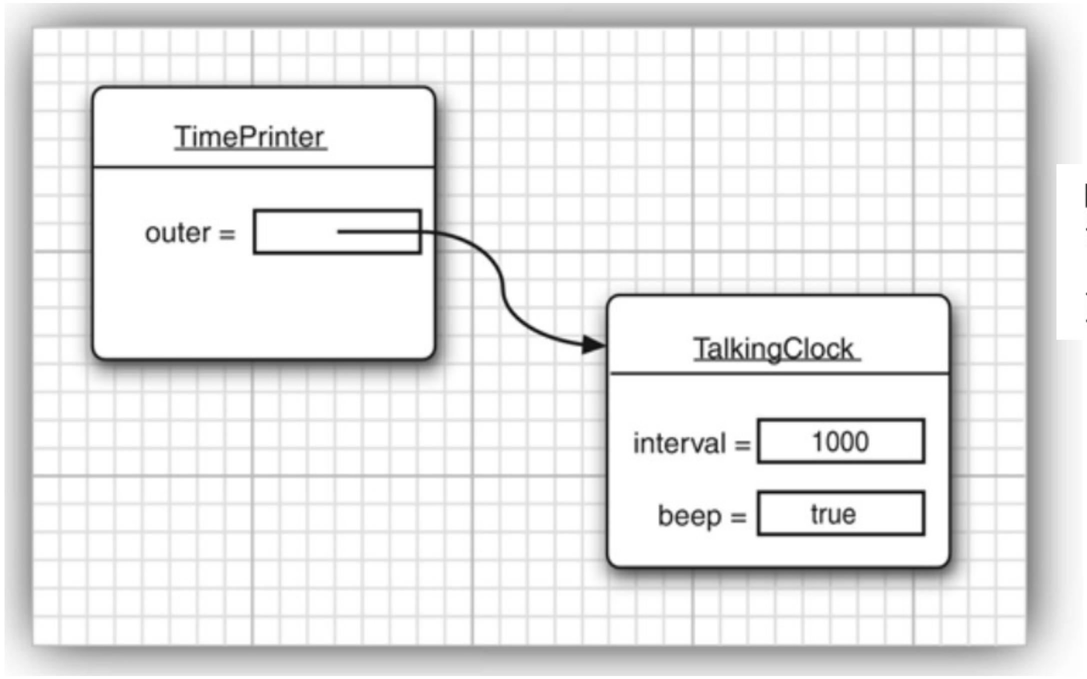
Inner Classes



```
public class TimePrinter implements ActionListener
{
   public void actionPerformed(ActionEvent event)
   {
      System.out.println("At the tone, the time is "
         + Instant.ofEpochMilli(event.getWhen()));
      if (beep) Toolkit.getDefaultToolkit().beep();
   }
}
```

Implicit reference to object of outer class. However the correct way to use is to refer with object of the outer class.

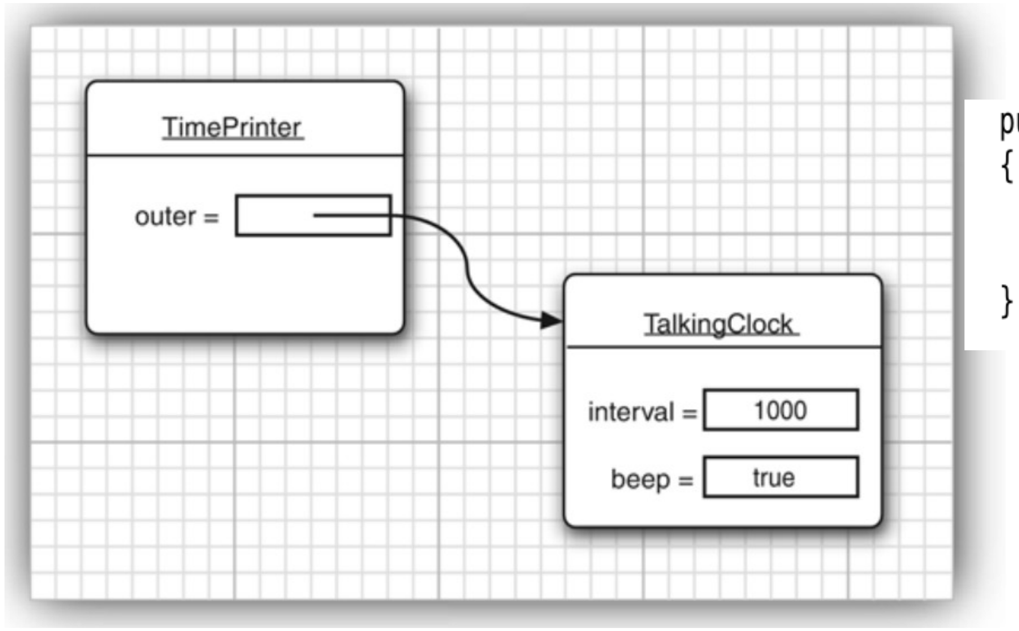
Inner Classes

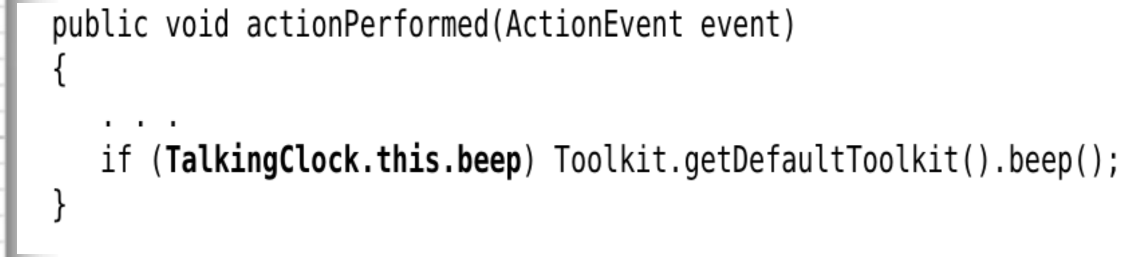


```
public TimePrinter(TalkingClock clock) // automatically generated code
{
   outer = clock;
}
```

Accessible with an object of the outer class in the inner.

Inner Classes





```
public void actionPerformed(ActionEvent event)
{
   . . .
   if (TalkingClock.this.beep) Toolkit.getDefaultToolkit().beep();
}
```

Accessible without requiring in object. Outer class encapsulates the inner class as well.

Anonymous Class

```
new SuperType(construction parameters)
   {
      inner class methods and data
   }
```

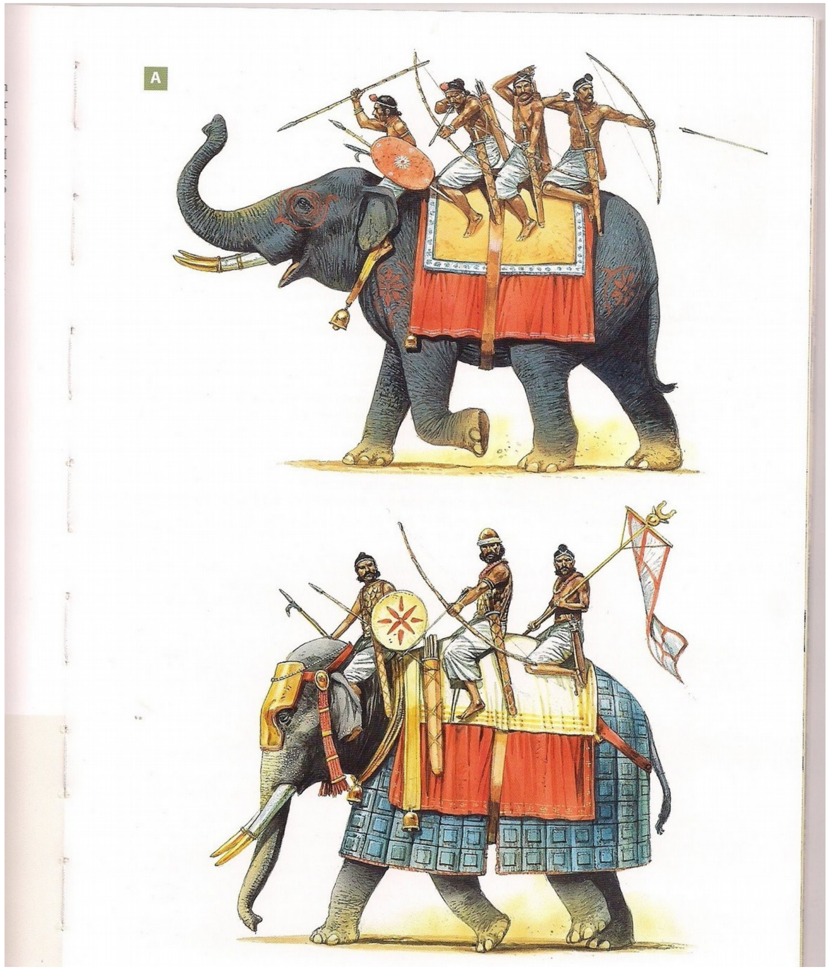
```
public void start(int interval, boolean beep)
{
   var listener = new ActionListener()
      {
         public void actionPerformed(ActionEvent event)
         {
            System.out.println("At the tone, the time is "
               + Instant.ofEpochMilli(event.getWhen()));
            if (beep) Toolkit.getDefaultToolkit().beep();
         }
      };
   var timer = new Timer(interval, listener);
   timer.start();
}
```

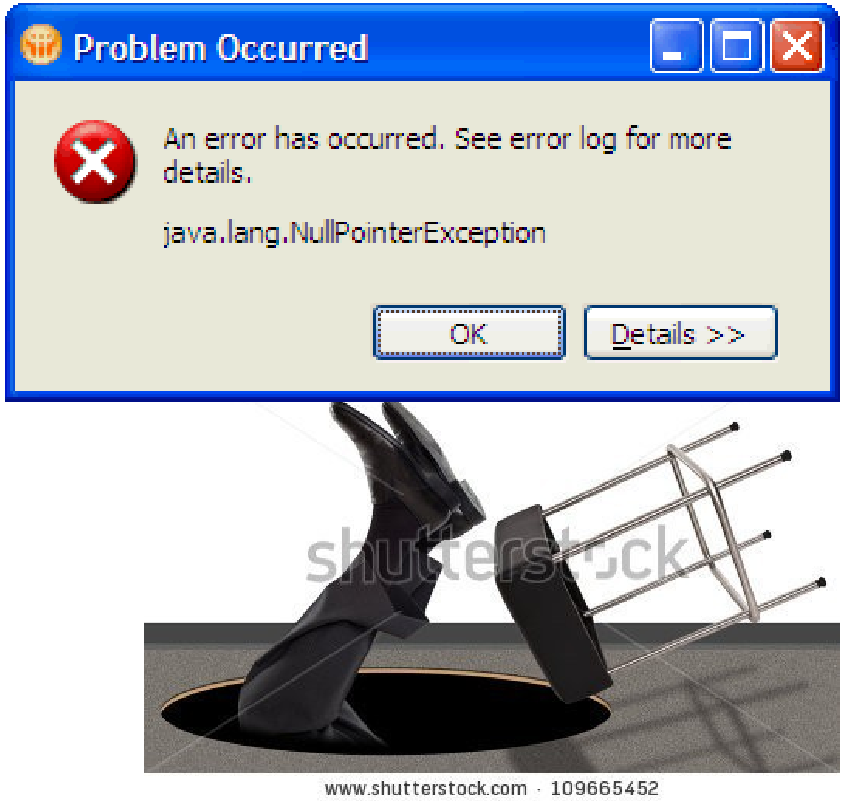
Exceptions and Exception Handling

OOP avatar of errors and error handling.

– Array out of bounds.
– IOException - e.g. File not found error.
– Mathematical exception - divide by zero error, NAN error, floating point exception *etc.*

Being Defensive is Important





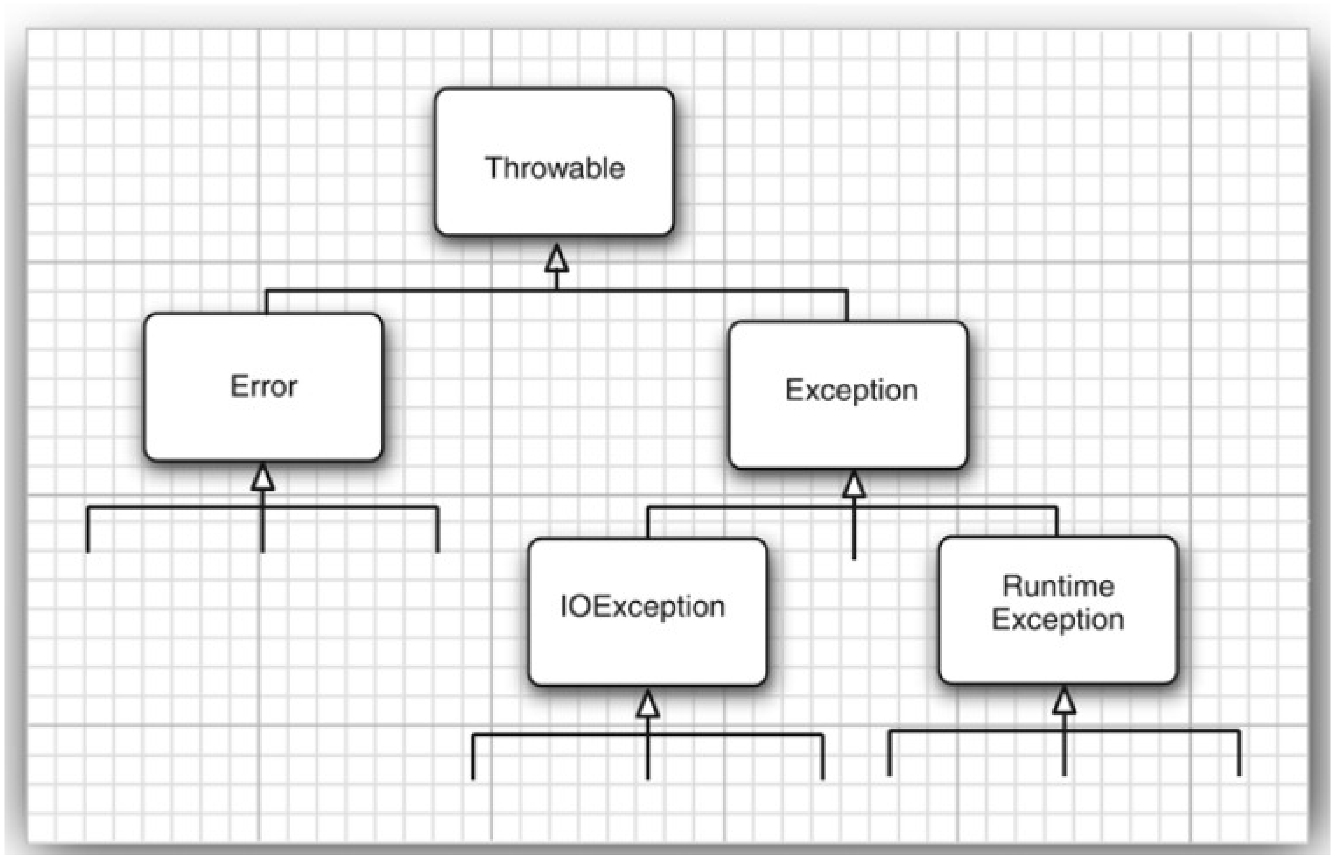
An error has occurred. See error log for more details.

java.lang.NullPointerException

Exception Handling Syntax

- *Process for handling exceptions*
  - `try` some code, catch exception thrown by tried code, finally, “clean up” if necessary
  - `try`, `catch`, and `finally` are reserved words
- `try` denotes code that may throw an exception
  - place questionable code within a `try` block
  - a `try` block must be immediately followed by a `catch` block unlike an if w/o else thus,
  - `try-catch` blocks always occurs as pairs
- `catch` exception thrown in `try` block and write special code to handle it
  - catch blocks distinguished by type of exception
  - can have several ***catch blocks***, each specifying a particular type of exception Once an
  - exception is handled, execution continues after the catch block
- `finally` (optional)
  - special block of code that is executed whether or not an exception is thrown
  - follows *catch block*

Exceptions and Exception Handling



Exceptions are *also* classes

Exceptions Handling by JVM

- *Any method invocdation is represented as a "***stack frame***" on the Java "***stack***"*
- **Callee–Caller** *relationship: If method A calls method B then A is* **caller** *and B is* **callee**
- *Each frame stores local variables, input parameters, return values and intermediate calculations*
  - *In addition, each frame also stores an "***exception table***"*
  - *This exception table stores information on each try/catch/finally block, i.e. the instruction offset where the catch/finally blocks are defined.*

  How JVM handles exceptons:

  1. Look for exception handler in current stack frame (method)

  2. If not found, then terminate the execution of current method and go to the callee method and repeat step 1 by looking into callee's exception table

  3. If no matching handler is found in any stack frame, then JVM finally terminates by throwing the stack trace (printStackTrace method)

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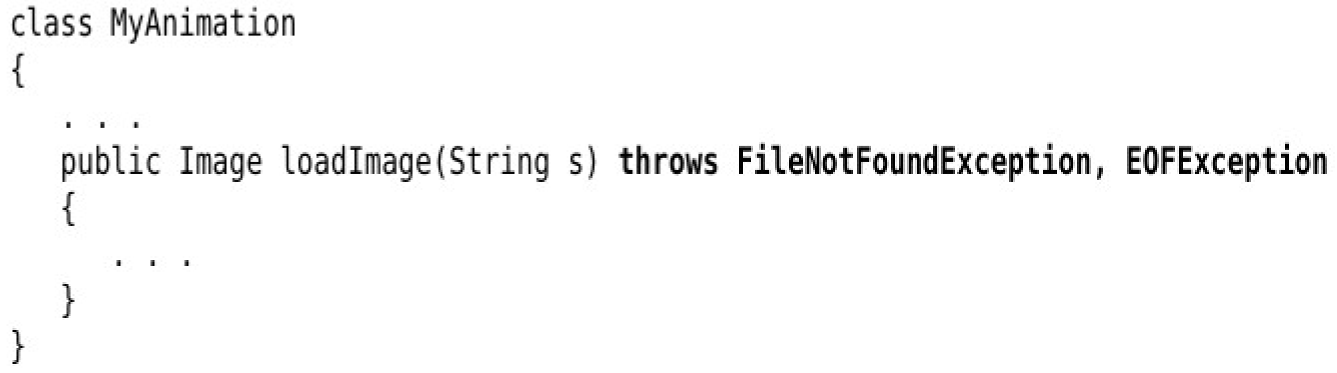
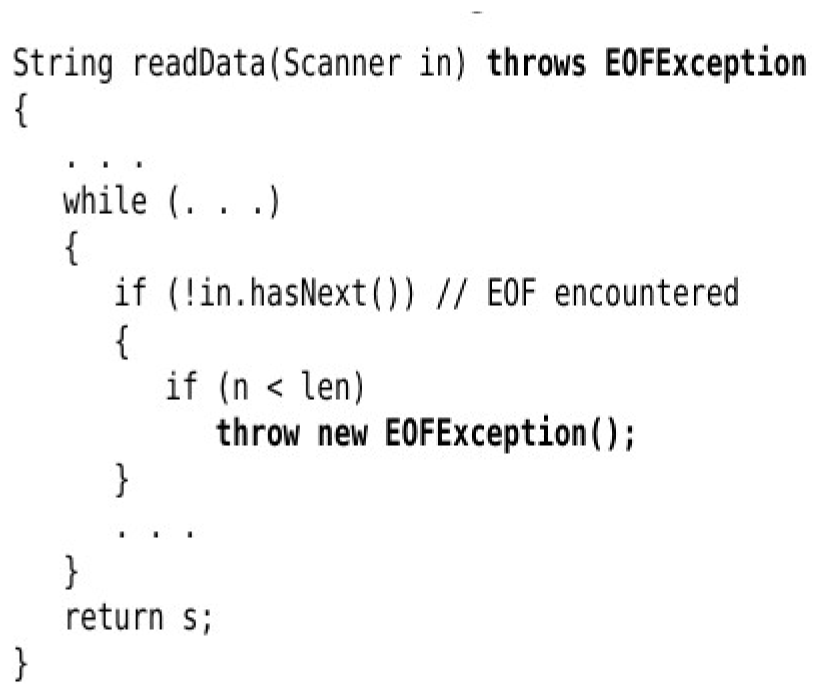
Exceptions and Exception Handling

Methods tells Java compiler that what kind of errors it can throw.



```
class MyAnimation
{
   . . .
   public Image loadImage(String s) throws FileNotFoundException, EOFException
   {
      . . .
   }
}
```

Throwing an Exception



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

Creating and Throwing Exception Class

```java
class FileFormatException extends IOException
{
   public FileFormatException() {}
   public FileFormatException(String gripe)
   {
      super(gripe);
   }
}
```

```java
String readData(Scanner in) throws FileFormatException
{
   . . .
   while (. . .)
   {
      if (ch == -1) // EOF encountered
      {
         if (n < len)
            throw new FileFormatException();
      }
      . . .
   }
   return s;
}
```

Catching What Was Thrown

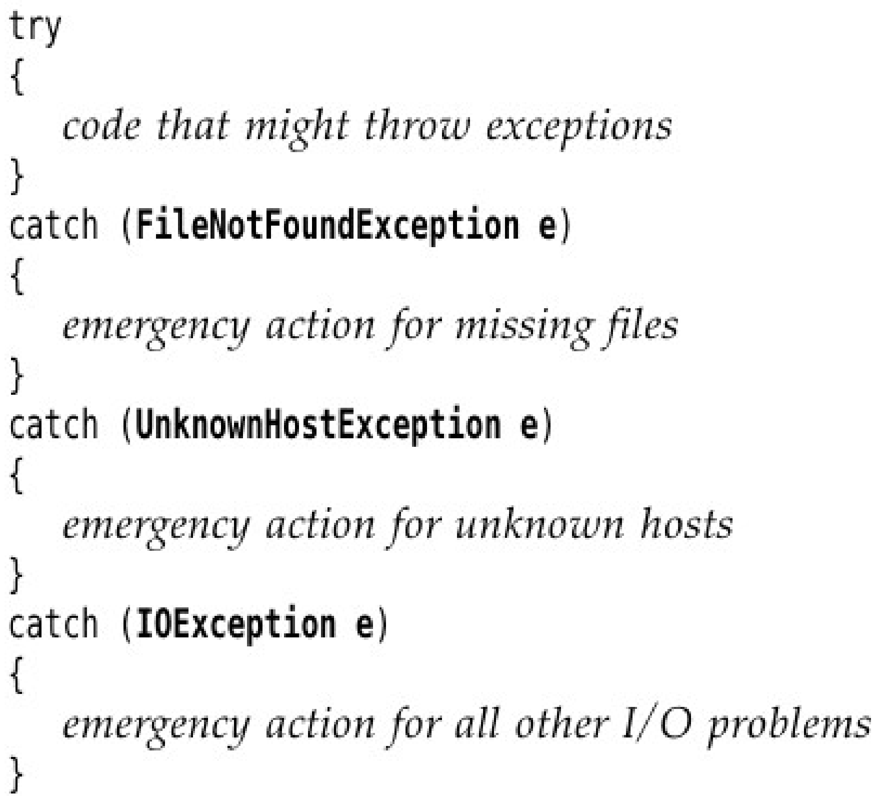
```
try
{
    code
    more code
    more code
}
catch (ExceptionType e)
{
    handler for this type
}
```

In try {} code after the throw is skipped.

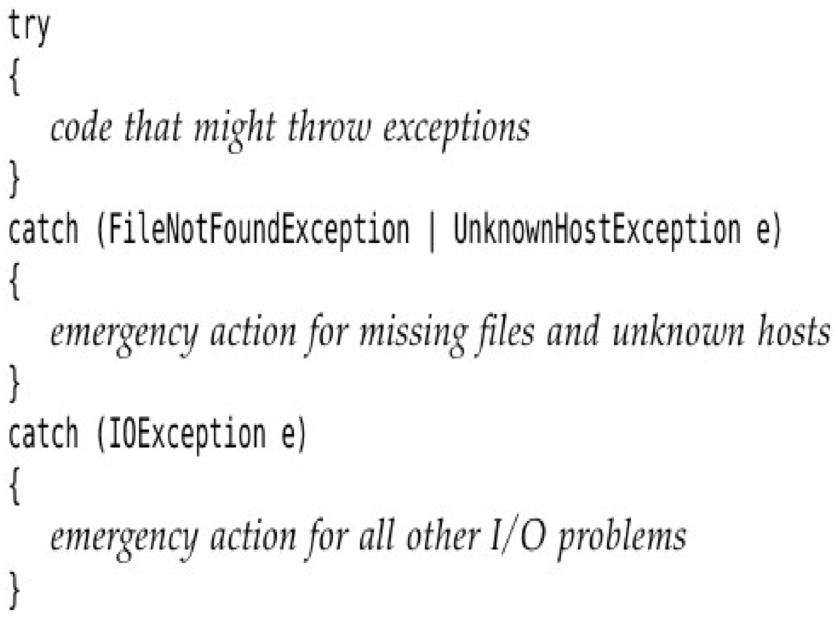
The program jumps to the catch() handler.

If no appropriate handler, then JRE handles it and show it on stdout

Catching What Was Thrown



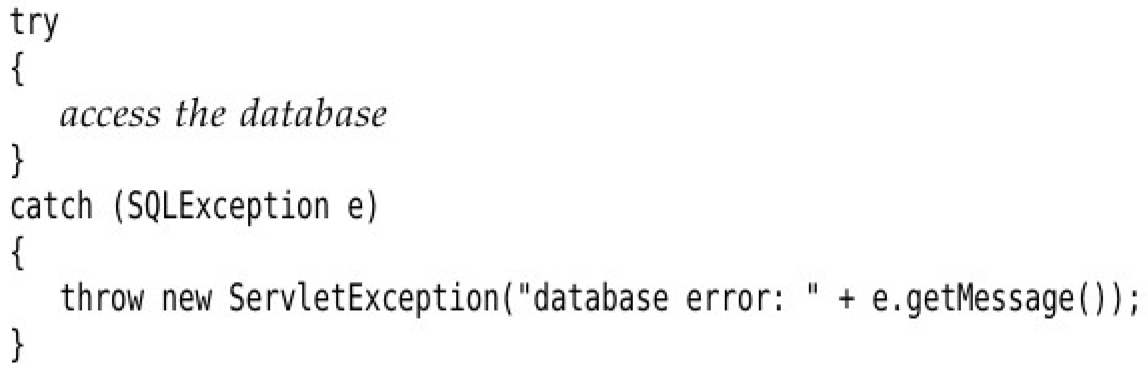
```
try
{
   code that might throw exceptions
}
catch (FileNotFoundException e)
{
   emergency action for missing files
}
catch (UnknownHostException e)
{
   emergency action for unknown hosts
}
catch (IOException e)
{
   emergency action for all other I/O problems
}
```



```
try
{
   code that might throw exceptions
}
catch (FileNotFoundException | UnknownHostException e)
{
   emergency action for missing files and unknown hosts
}
catch (IOException e)
{
   emergency action for all other I/O problems
}
```

Combining exceptions

Rethrowing Exceptions



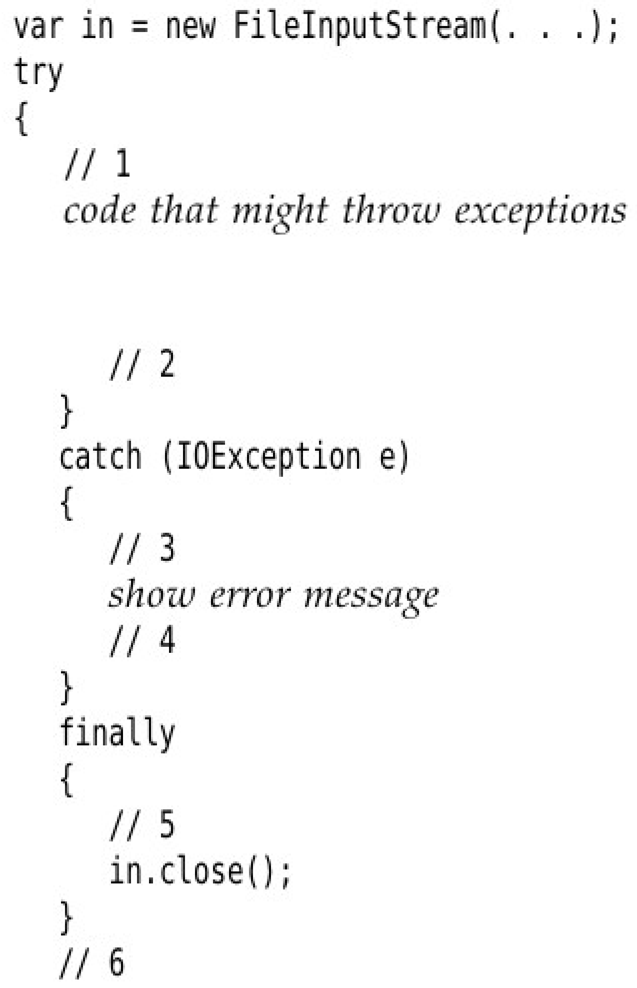
```
try
{
   access the database
}
catch (SQLException e)
{
   throw new ServletException("database error: " + e.getMessage());
}
```

Finally Clause

- Executed at the end of all try{} catch{} blocks.

- Last set of instructions to be called before the program terminates. Usually used for resource release and clearup operations.

Finally Clause



```
var in = new FileInputStream(. . .);
try
{
   // 1
   code that might throw exceptions



      // 2
   }
   catch (IOException e)
   {
      // 3
      show error message
      // 4
   }
   finally
   {
      // 5
      in.close();
   }
   // 6
```

Using Assertions

- Idiomatic tools for defensive programming.
- Faster execution than throwing exceptions.
- Not to be used for everyday programs.
- Irrecoverable.
- Usually program terminates.

```
assert <condition>;

assert <condition> : <expression> ;
```

[Check condition. If false then create an object with argument <experession> of type AssertionError - JVM catches it and prints the details presented in the <expression>]

Using Assertions

```
if (x > 0){
    ....
 }
Else {
   ...
}
```

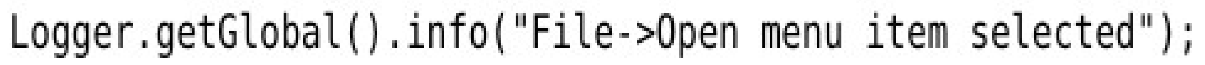
```
if (x > 0){
     throw new
exception(“myexception”) ;
 }

catch(Exception ep){
...
}
```

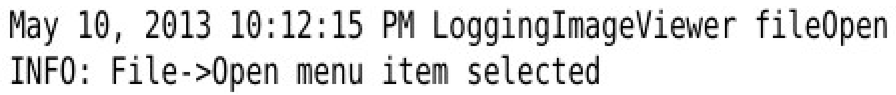
```
assert x>0 : new String(“x>0”);
```

Logging

- System.out.println() cannot be always used - makes things slow.
- Adding and removing them at all places can be cumbersome.
- Usually not used in production code.
- Logging can be collectively enabled or supressed.



```
Logger.getGlobal().info("File->Open menu item selected");
```



```
May 10, 2013 10:12:15 PM LoggingImageViewer fileOpen
INFO: File->Open menu item selected
```

Log Levels

SEVERE
WARNING
INFO
CONFIG
FINE
FINER
FINEST

Top -> Bottom levels of logging.

*If you log a bottom level,
then you log all levels above it.*

*SEVERE, WARNING and INFO
are always enable for every
Java program by default.*

```
logger.warning(msg);
logger.fine(msg);

logger.log(Level.<Levelna
me>, msg);
```

Logging Unexpected Exceptions

Two methods commonly used:

```
void throwing(String className, String methodName, Throwable t)
void log(Level l, String message, Throwable t)
```

```
        try
        {
            if (. . .)
            {
               var e = new IOException(". . .");
               logger.throwing("com.mycompany.mylib.Reader", "read", e);
               throw e;
            }

        }

          catch (IOException e)
          {
             Logger.getLogger("com.mycompany.myapp").log(Level.WARNING, "Reading image", e);
          }
```