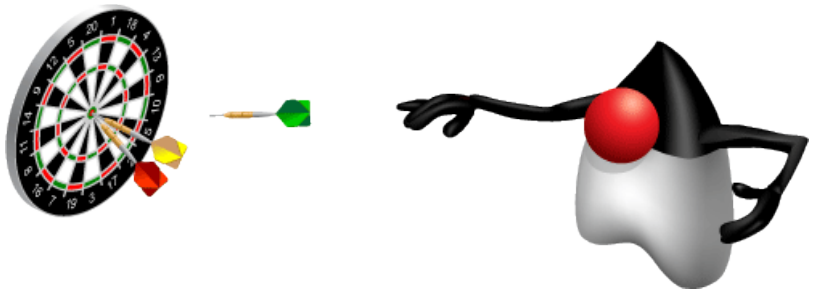
14

Java File I/O (NIO.2)

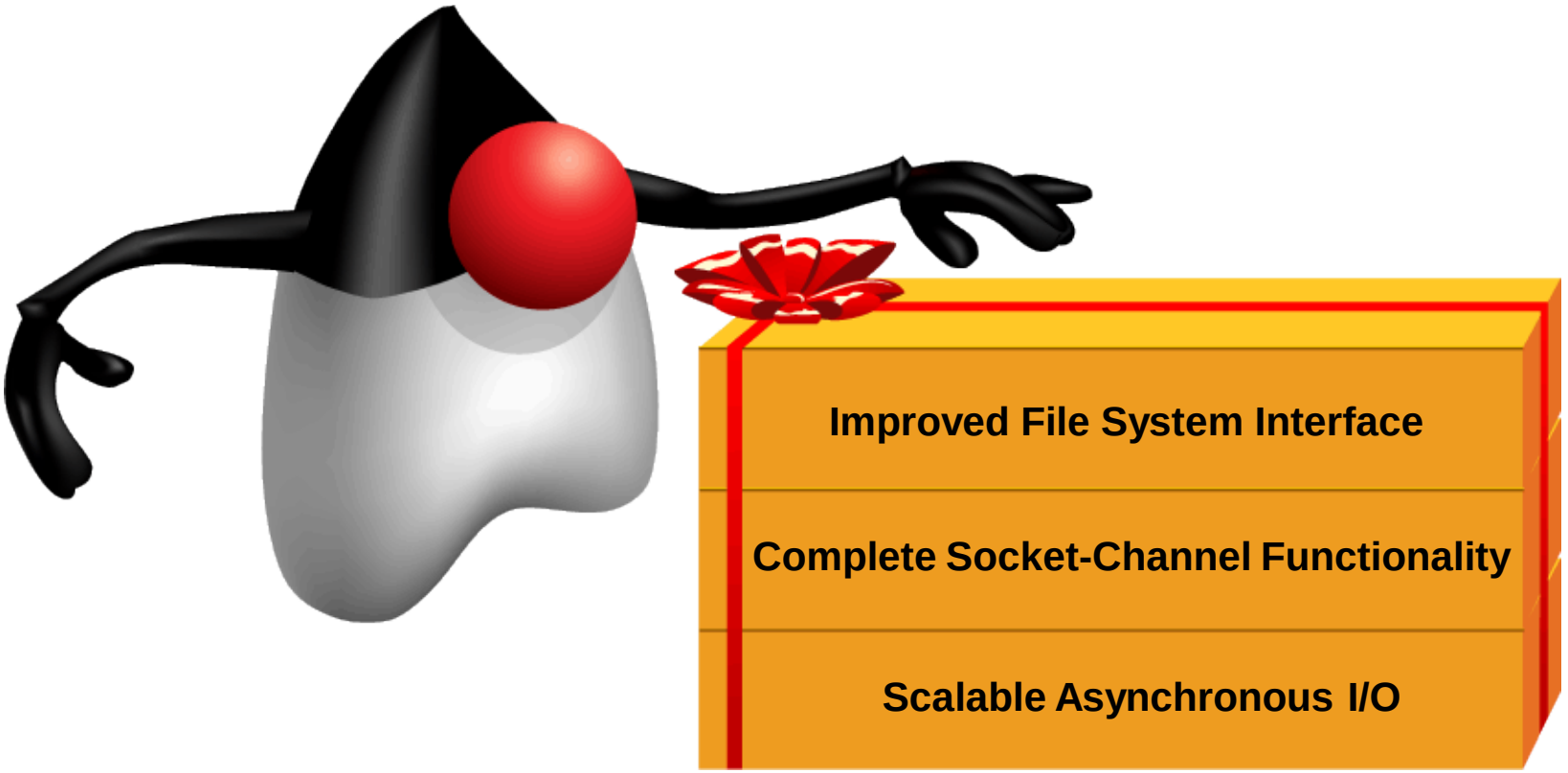
Objectives

After completing this lesson, you should be able to:

- Use the `Path` interface to operate on file and directory paths
- Use the `Files` class to check, delete, copy, or move a file or directory
- Use Stream API with NIO2



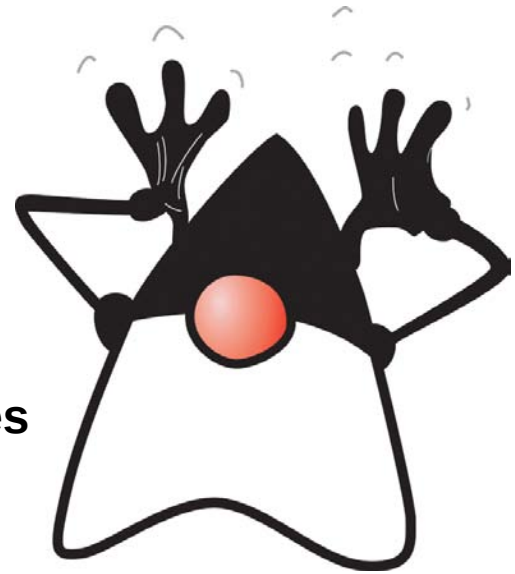
New File I/O API (NIO.2)



Limitations of `java.io.File`

Does not work well with symbolic links

Scalability issues



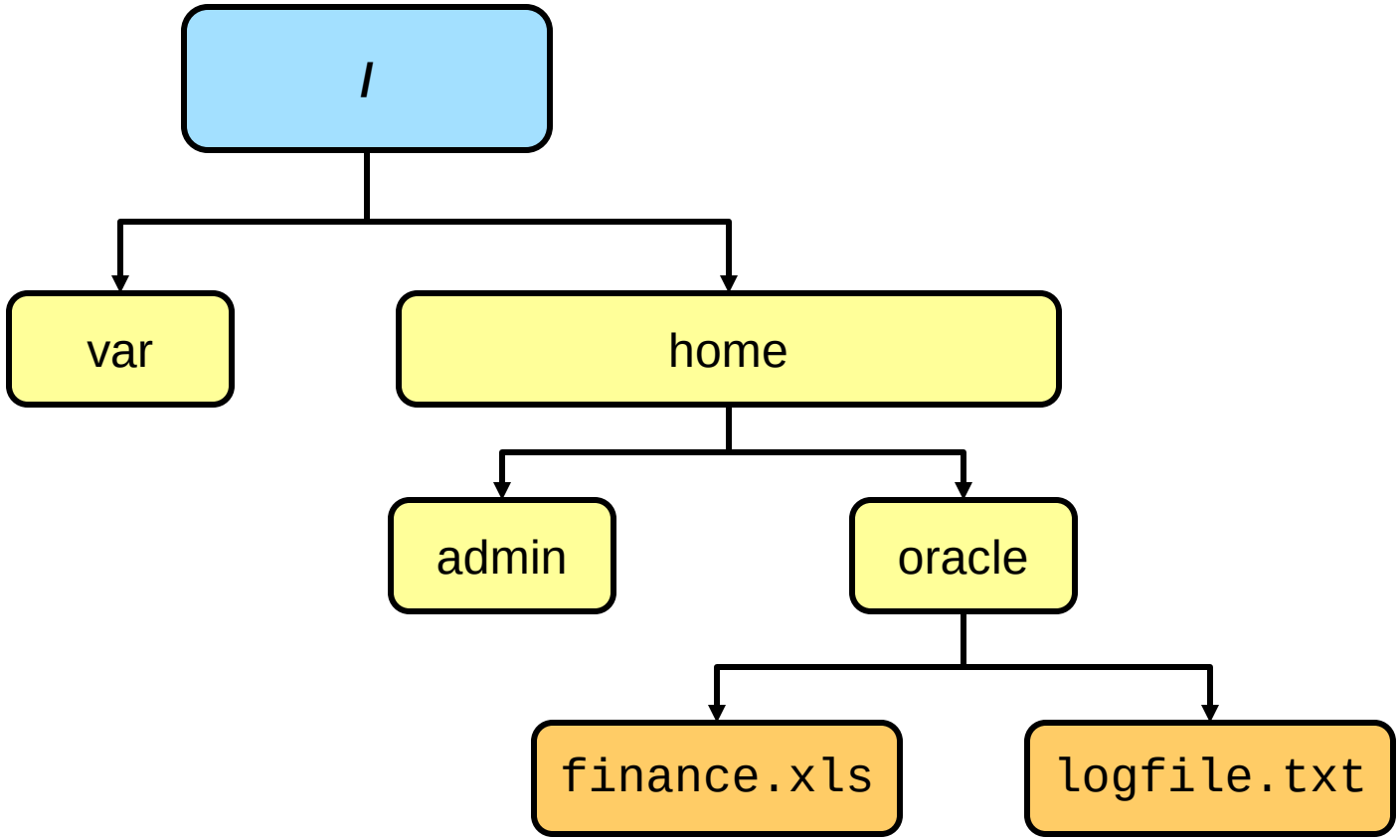
Performance issues

Very limited set of file attributes

Very basic file system access functionality

File Systems, Paths, Files

In NIO.2, both files and directories are represented by a path, which is the relative or absolute location of the file or directory.



Relative Path Versus Absolute Path

- A path is either *relative* or *absolute*.
- An absolute path always contains the root element and the complete directory list required to locate the file.
- Example:

```
...
/home/peter/statusReport
...
```

- A relative path must be combined with another path in order to access a file.
- Example:

```
...
clarence/foo
...
```

Java NIO.2 Concepts

Prior to JDK 7, the `java.io.File` class was the entry point for all file and directory operations. With NIO.2, there is a new package and classes:

- `java.nio.file.Path`: Locates a file or a directory by using a system-dependent path
- `java.nio.file.Files`: Using a `Path`, performs operations on files and directories
- `java.nio.file.FileSystem`: Provides an interface to a file system and a factory for creating a `Path` and other objects that access a file system
- All the methods that access the file system throw `IOException` or a subclass.

Path Interface

- The `java.nio.file.Path` interface provides the entry point for the NIO.2 file and directory manipulation.

```
FileSystem fs = FileSystems.getDefault();
Path p1 = fs.getPath (“/home/oracle/labs/resources/myFile.txt");
```

- To obtain a `Path` object, obtain an instance of the default file system, and then invoke the `getPath` method:

```
Path p1 = Paths.get(“/home/oracle/labs/resources/myFile.txt");
Path p2 = Paths.get(“/home/oracle", "labs", "resources", "myFile.txt");
```

`Path` Interface Features

The `Path` interface defines the methods used to locate a file or a directory in a file system. These methods include:

- To access the components of a path:
  - `getFileName`, `getParent`, `getRoot`, `getNameCount`
- To operate on a path:
  - `normalize`, `toUri`, `toAbsolutePath`, `subpath`, `resolve`, `relativize`
- To compare paths:
  - `startsWith`, `endsWith`, `equals`

Path: Example

```
1 public class PathTest
2     public static void main(String[] args) {
3          Path p1 = Paths.get(args[0]);
4          System.out.format("getFileName: %s%n", p1.getFileName());
5          System.out.format("getParent: %s%n", p1.getParent());
6          System.out.format("getNameCount: %d%n", p1.getNameCount());
7          System.out.format("getRoot: %s%n", p1.getRoot());
8          System.out.format("isAbsolute: %b%n", p1.isAbsolute());
9          System.out.format("toAbsolutePath: %s%n", p1.toAbsolutePath());
10         System.out.format("toURI: %s%n", p1.toUri());
11     }
12 }
```

```
java PathTest /home/oracle/file1.txt
getFileName: file1.txt
getParent: /home/oracle
getNameCount: 3
getRoot: /
isAbsolute: true
toAbsolutePath: /home/oracle/file1.txt
toURI: file:///home/oracle/file1.txt
```

Removing Redundancies from a `Path`

- Many file systems use "`.`" notation to denote the current directory and "`..`" to denote the parent directory.
- The following examples both include redundancies:

```
/home/./clarence/foo
/home/peter/../clarence/foo
```

- The `normalize` method removes any redundant elements, which includes any "`.`" or "`directory/..`" occurrences.
- Example:

```
Path p = Paths.get("/home/peter/../clarence/foo");
Path normalizedPath = p.normalize();
```

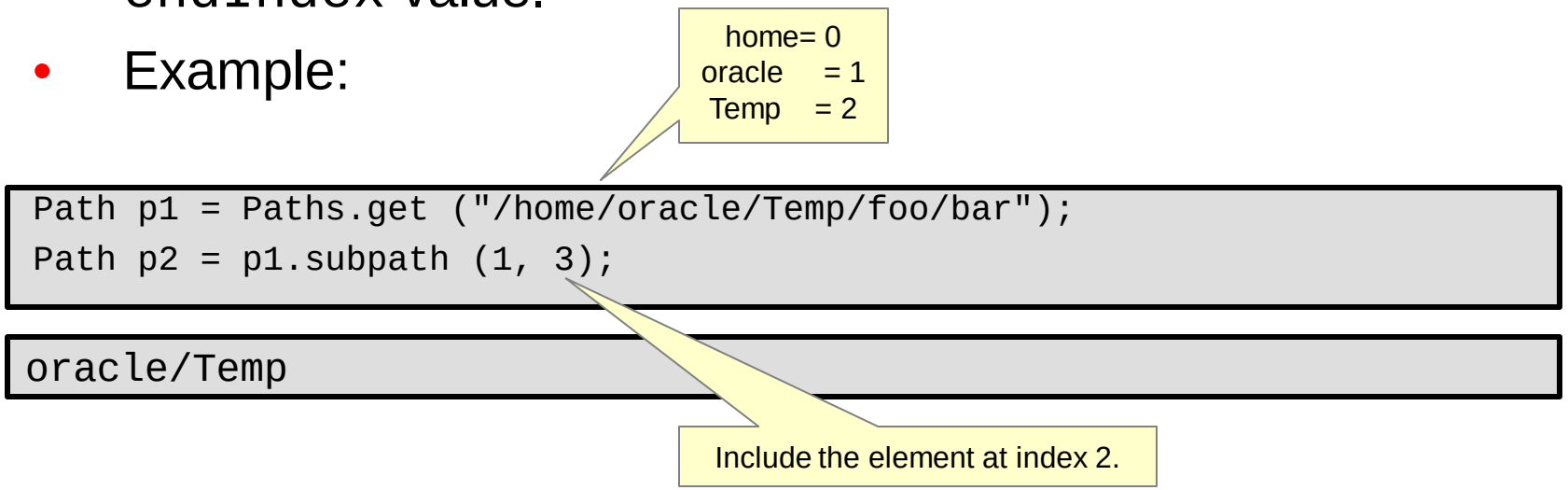
```
/home/clarence/foo
```

Creating a Subpath

- A portion of a path can be obtained by creating a subpath using the `subpath` method:

```
Path subpath(int beginIndex, int endIndex);
```

- The element returned by `endIndex` is one less that the `endIndex` value.
- Example:



Joining Two Paths

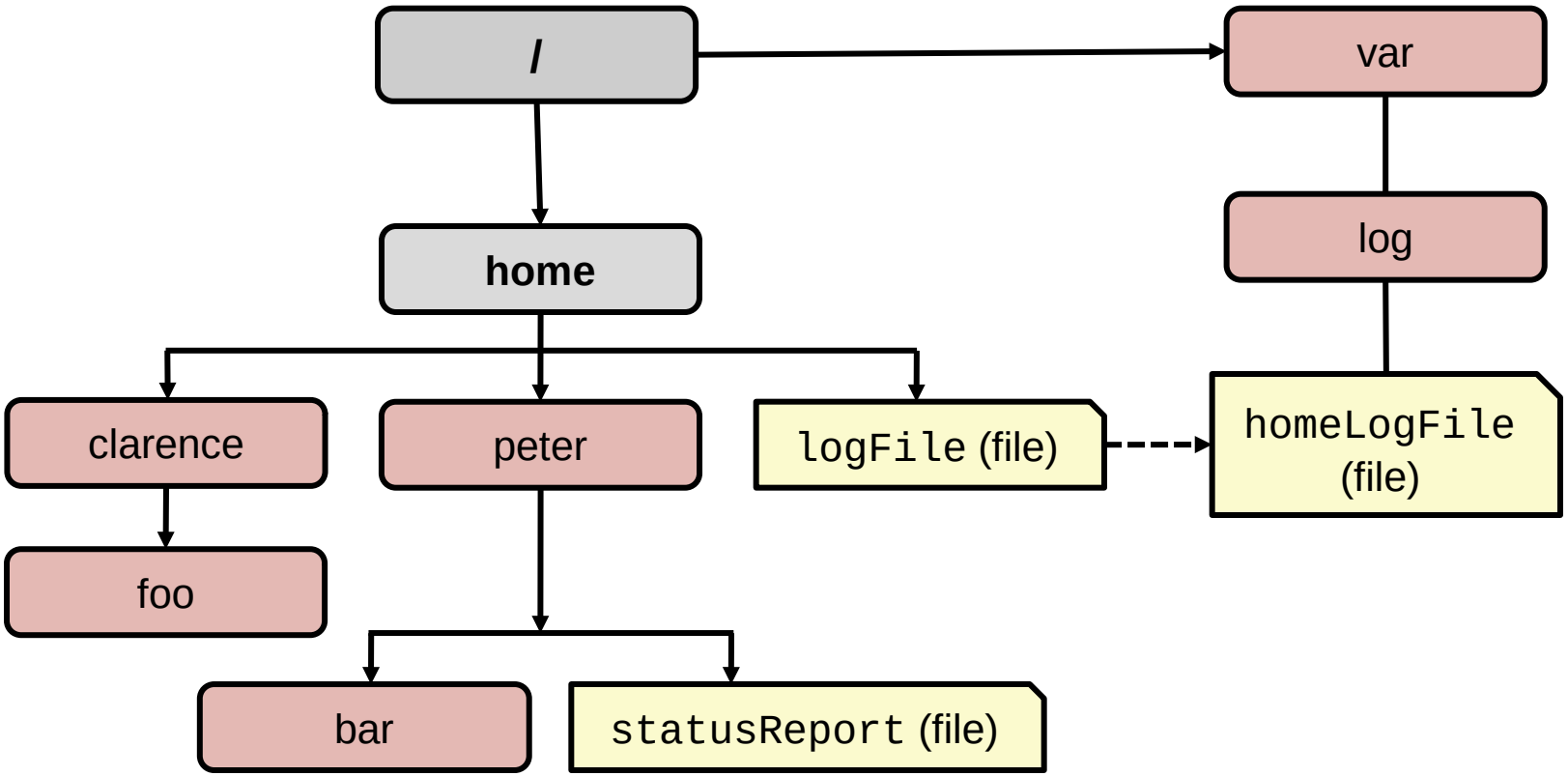
- The `resolve` method is used to combine two paths.
- Example:

```
Path p1 = Paths.get("/home/clarence/foo");
p1.resolve("bar");     // Returns /home/clarence/foo/bar
```

- Passing an absolute path to the `resolve` method returns the passed-in path.

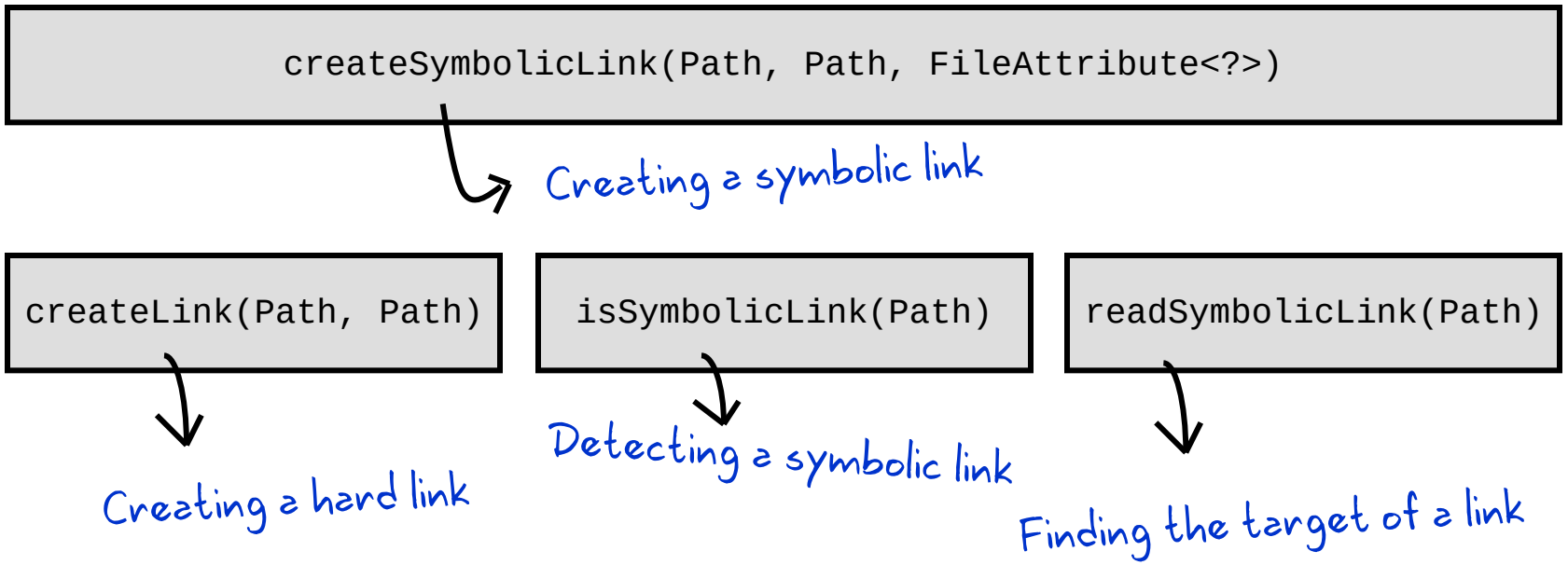
```
Paths.get("foo").resolve("/home/clarence"); // Returns /home/clarence
```

Symbolic Links



Working with Links

- `Path` interface is "link aware."
- Every `Path` method either:
  - Detects what to do when a symbolic link is encountered, or
  - Provides an option enabling you to configure the behavior when a symbolic link is encountered



`File` Operations

- Checking a File or Directory
- Deleting a File or Directory
- Copying a File or Directory
- Moving a File or Directory
- Managing Metadata
- Reading, Writing, and Creating Files
- Random Access Files
- Creating and Reading Directories

Checking a File or Directory

A `Path` object represents the concept of a file or a directory location. Before you can access a file or directory, you should first access the file system to determine whether it exists using the following `Files` methods:

- `exists(Path p, LinkOption... option)`
  Tests to see whether a file exists. By default, symbolic links are followed.
- `notExists(Path p, LinkOption... option)`
  Tests to see whether a file does not exist. By default, symbolic links are followed.
- Example:

```
Path p = Paths.get(args[0]);
System.out.format("Path %s exists: %b%n", p,
                  Files.exists(p, LinkOption.NOFOLLOW_LINKS));
```

Optional argument

Checking a File or Directory

To verify that a file can be accessed, the `Files` class provides the following `boolean` methods.

- `isReadable(Path)`
- `isWritable(Path)`
- `isExecutable(Path)`

Note that these tests are not atomic with respect to other file system operations. Therefore, the results of these tests may not be reliable once the methods complete.

- The `isSameFile (Path, Path)` method tests to see whether two paths point to the same file. This is particularly useful in file systems that support symbolic links.

Creating Files and Directories

Files and directories can be created using one of the following methods:

```
Files.createFile (Path dir);
Files.createDirectory (Path dir);
```

- The `createDirectories` method can be used to create directories that do not exist, from top to bottom:

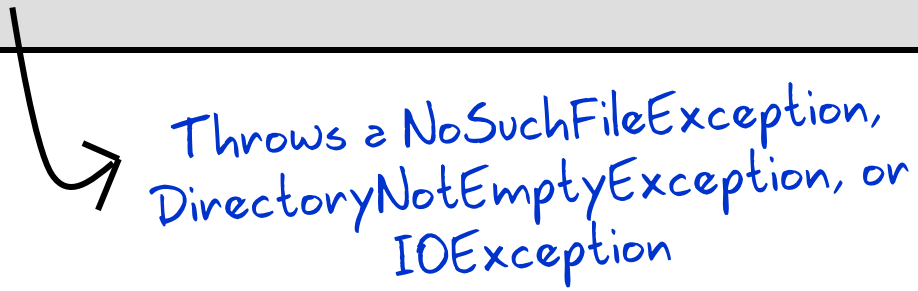
```
Files.createDirectories(Paths.get("/home/oracle/Temp/foo/bar/example"));
```

Deleting a File or Directory

You can delete files, directories, or links. The `Files` class provides two methods:

- `delete(Path)`
- `deleteIfExists(Path)`

```
//...
Files.delete(path);
//...
```




```
//...
Files.deleteIfExists(Path)
//...
```

No exception thrown

Copying a File or Directory

- You can copy a file or directory by using the `copy(Path, Path, CopyOption...)` method.
- When directories are copied, the files inside the directory are not copied.

StandardCopyOption parameters

```
//...
copy(Path, Path, CopyOption...)
//...
```

REPLACE_EXISTING
COPY_ATTRIBUTES
NOFOLLOW_LINKS

- Example:

```
import static java.nio.file.StandardCopyOption.*;
//...
Files.copy(source, target, REPLACE_EXISTING, NOFOLLOW_LINKS);
```

Moving a File or Directory

- You can move a file or directory by using the `move(Path, Path, CopyOption...)` method.
- Moving a directory will not move the contents of the directory.

StandardCopyOption parameters

```
//...
move(Path, Path, CopyOption...)
//...
```

REPLACE_EXISTING
ATOMIC_MOVE

- Example:

```
import static java.nio.file.StandardCopyOption.*;
//...
Files.move(source, target, REPLACE_EXISTING);
```

List the Contents of a Directory

To get a list of the files in the current directory, use the `Files.list()` method.

```
public class FileList {

  public static void main(String[] args) {

    try(Stream<Path> files = Files.list(Paths.get("."))){

      files
          .forEach(line -> System.out.println(line));

    } catch (IOException e){
      System.out.println("Message: " + e.getMessage());
    }
  }
}
```

Walk the Directory Structure

The `Files.walk()` method walks a directory structure.

```
public class A11FileWalk {

  public static void main(String[] args) {

    try(Stream<Path> files = Files.walk(Paths.get("."))){

      files
        .forEach(line -> System.out.println(line));

    } catch (Exception e){
      System.out.println("Message: " + e.getMessage());
    }
  }
}
```

BufferedReader File Stream

The new `lines()` method converts a `BufferedReader` into a stream.

```
public class BufferedRead {
  public static void main(String[] args) {
    try(BufferedReader bReader =
      new BufferedReader(new FileReader("tempest.txt"))){

      bReader.lines()
        .forEach(line ->
            System.out.println("Line: " + line));

    } catch (IOException e){
        System.out.println("Message: " + e.getMessage());
    }
  }
}
```

NIO File Stream

The `lines()` method can be called using NIO classes

```
public class ReadNio {

  public static void main(String[] args) {

    try(Stream<String> lines =
        Files.lines(Paths.get("tempest.txt"))){

      lines.forEach(line ->
        System.out.println("Line: " + line));

    } catch (IOException e){
      System.out.println("Error: " + e.getMessage());
    }
  }
}
```

Read File into `ArrayList`

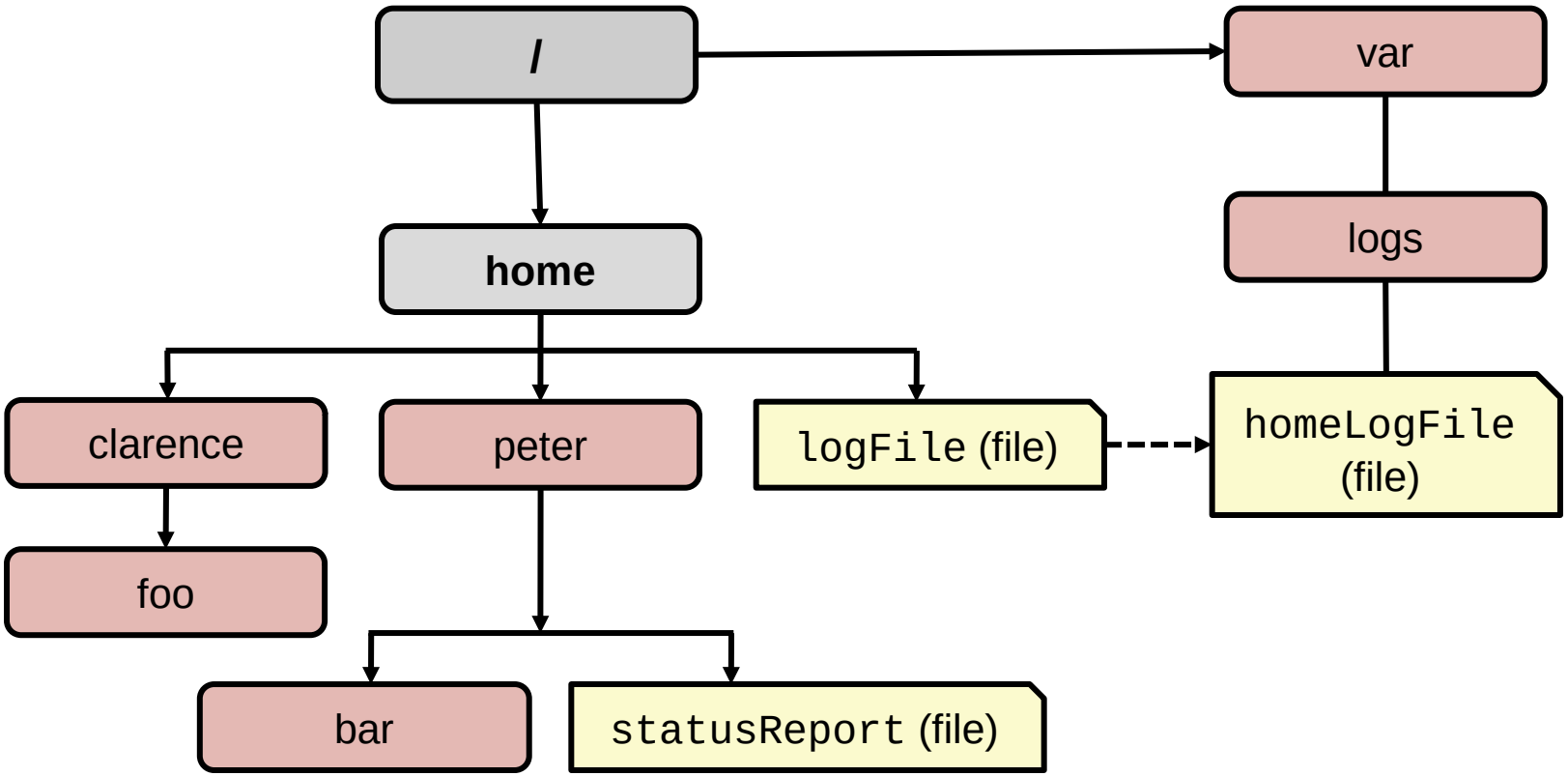
Use `readAllLines()` to load a file into an `ArrayList`.

```
public class ReadAllNio {
  public static void main(String[] args) {
    Path file = Paths.get("tempest.txt");
    List<String> fileArr;

    try{

      fileArr = Files.readAllLines(file);

      fileArr.stream()
        .filter(line -> line.contains("PROSPERO"))
        .forEach(line -> System.out.println(line));

    } catch (IOException e){
      System.out.println("Message: " + e.getMessage());
    }
  }
}
```

Managing Metadata

Method	Explanation
`size`	Returns the size of the specified file in bytes
`isDirectory`	Returns true if the specified `Path` locates a file that is a directory
`isRegularFile`	Returns true if the specified `Path` locates a file that is a regular file
`isSymbolicLink`	Returns true if the specified `Path` locates a file that is a symbolic link
`isHidden`	Returns true if the specified `Path` locates a file that is considered hidden by the file system
`getLastModifiedTime`	Returns or sets the specified file's last modified time
`setLastModifiedTime`	
`getAttribute`	Returns or sets the value of a file attribute
`setAttribute`	

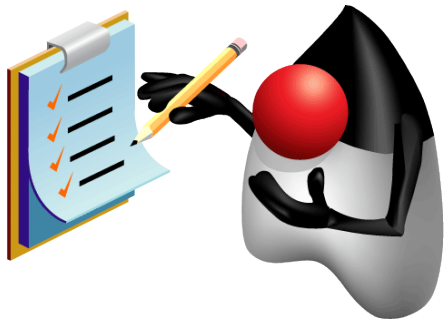
Symbolic Links



Summary

In this lesson, you should have learned how to:

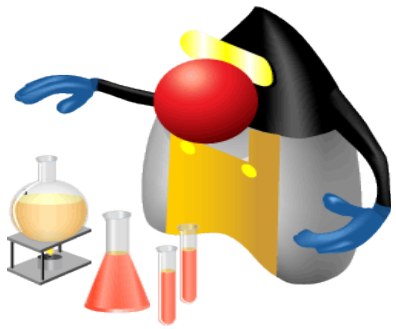
- Use the `Path` interface to operate on file and directory paths
- Use the `Files` class to check, delete, copy, or move a file or directory
- Use Stream API with NIO2



Practice Overview

Practice 14-1: Working with Files

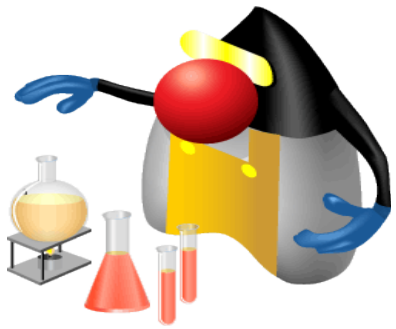
In this practice, read text files using new features in Java 8 and the lines method.



Practice Overview

Practice 14-2: Working with Directories

In this practice, list directories and files using new features found in Java 8.



Quiz

Given any starting directory path, which `FileVisitor` method(s) would you use to delete a file tree?

a. `preVisitDirectory()`
b. `postVisitDirectory()`
c. `visitFile()`
d. `visitDirectory()`

Quiz

Given a `Path` object with the following path:

```
/export/home/duke/../peter/./documents
```

What `Path` method would remove the redundant elements?

a. `normalize`
b. `relativize`
c. `resolve`
d. `toAbsolutePath`

Quiz

Given the following fragment:

```
Path p1 = Paths.get("/export/home/peter");
Path p2 = Paths.get("/export/home/peter2");
Files.move(p1, p2, StandardCopyOption.REPLACE_EXISTING);
```

If the `peter2` directory does not exist, and the `peter` directory is populated with subfolders and files, what is the result?

a. `DirectoryNotEmptyException`
b. `NotDirectoryException`
c. Directory `peter2` is created.
d. Directory `peter` is copied to `peter2`.
e. Directory `peter2` is created and populated with files and directories from `peter`.

Quiz

Given this fragment:

```
Path source = Paths.get(args[0]);
Path target = Paths.get(args[1]);
Files.copy(source, target);
```

Assuming `source` and `target` are not directories, how can you prevent this copy operation from generating `FileAlreadyExistsException`?

a. Delete the `target` file before the copy.
b. Use the `move` method instead.
c. Use the `copyExisting` method instead.
d. Add the `REPLACE_EXISTING` option to the method.

Quiz

To copy, move, or open a file or directory using NIO.2, you must first create an instance of:

a. `Path`
b. `Files`
c. `FileSystem`
d. `Channel`