Object-oriented Programming in Java

Session: 6

New Features in File Handling

Objectives

- Describe the Console class
- Explain the DeflaterInputStream class
- Explain the InflaterOutputStream class
- Describe the java.nio Package
- Describe the file system

Introduction

- NIO in Java stands for New Input/Output operation.
- It is a collection of Java APIs that offers intensive I/O operations.
- The `java.nio.file` package provides comprehensive support for input and output operations.
- There are many classes present in the API, but in this session, only some of them will be discussed.
- The `java.nio` package mainly defines buffers which are containers for data.
- This API is easy to use.

Console Class [1-3]

- The `Console` class provides various methods to access character-based console device.
- These devices should be associated with the current virtual machine.
- Automatic invocation of virtual machine will not have a console associated with it.
- There are no public constructors for the `Console` class.
- To obtain an instance of the `Console` class, you need to invoke the `System.console()` method.
- The `System.console()` method returns the `Console` object if it is available; otherwise, it returns null.
- At present, the methods of `Console` class can be invoked only from the command line and not from Integrated Development Environments (IDEs), such as Eclipse, NetBeans, and so on.

Console Class [2-3]

- The following lists various methods available in the `Console` class:
  - format(String fmt, Object... args)
  - printf(String fmt, Object... args)
  - reader()
  - readLine()
  - readLine(String fmt, Object... args)
- The following Code Snippet shows the use of `Console` class methods:

Code Snippet

```
...
public static void main(String [] args) {
Console cons = System.console();
if (cons == null) {
    System.err.println("No console device is present!");
    return;
}
try {
     String username = cons.readLine("Enter your username: ");
```

Console Class [3-3]

Code Snippet

```
    char [] pwd = cons.readPassword("Enter your secret Password:
");
    System.out.println("Username = " + username);
    System.out.println("Password entered was = " + new
String(pwd));
    } catch(IOError ioe) {
       cons.printf("I/O problem: %s\n", ioe.getMessage());
    }
}
...
```

- The code accepts user name and password from the user through a console using the `readLine()` and `readPassword()` methods.
- The `System.console()` method returns a `Console` object if it is available that reads the username and password.

Classes in java.util.zip

Class Name	Description
`CheckedInputStream`	Maintains checksum of data that is being read.
`CheckedOutputStream`	Maintains checksum of data that is to be written.
`Deflater`	Performs data compression.
`DeflaterInputStream`	Reads source data and then compresses it in the 'deflate' compression format.
`DeflaterOutputStream`	Reads source data, compresses it in 'deflate' compression format, and then writes the compressed data to the output stream.
`Inflater`	Performs data decompression.
`InflaterInputStream`	Reads compressed data and then decompresses it in the 'deflate' compression format.
`InflaterOutputStream`	Reads compressed data, decompresses it in the 'deflate' compression format, and then writes the decompressed data in the output stream.
`ZipInputStream`	Implements an input stream filter to read files in the ZIP file format. It supports compressed and uncompressed entries.
`ZipOutputStream`	Reads the source data, compresses it in ZIP file format, and writes the data in the output stream.

Deflater Class [1-2]

- The `Deflater` class compresses the data present in an input stream. It compresses the data using the ZLIB compression library.
- The constructor of the `Deflater` class is used to create instances of the `Deflater` class.

Syntax

```
public Deflater()
```

- The following lists various methods available in the `Deflater` class:
  - `deflate(byte[] buffer)`
  - `deflate(byte[] buffer, int offset, int len)`
  - `setInput(byte[] buffer)`
  - `setInput(byte[] buffer, int offset, int len)`
  - `finish()`
  - `end()`

Deflater Class [2-2]

The following Code Snippet shows the use of methods in `Deflater` class:

Code Snippet

```
import java.util.zip.Deflater;
public class DeflaterApplication {
 public static void main(String[] args) throws Exception {
  // Encode a String into bytes
  String input = "The Deflater class compresses the data.";
  byte[] inputObj = input.getBytes("UTF-8");
  // Compress the bytes
  byte[] output = new byte[100];
  Deflater deflater = new Deflater();
  deflater.setInput(inputObj);
  deflater.finish();
  int compressDataLength = deflater.deflate(output);
  System.out.println(compressDataLength);
 }
}
```

Inflater Class [1-3]

- The `Inflater` class decompresses the compressed data.
- This class supports decompression using the ZLIB compression library.

Syntax

```
public Inflater()
```

- The following lists various methods available in the `Inflater` class:
  - `inflate(byte[] buffer)`
  - `inflate(byte[] buffer, int offset, int len)`
  - `setInput(byte[] buffer)`
  - `setInput(byte[] buffer, int offset, int len)`
  - `end()`

Inflater Class [2-3]

The following Code Snippet shows the use of methods in `Inflater` class:

Code Snippet

```
public class DeflaterApplication {
 public static void main(String[] args) throws Exception {
  // Encode a String into bytes
  String input = "The Deflater class compresses the data.";
  byte[] inputObj = input.getBytes("UTF-8");
  // Compress the bytes
  byte[] output = new byte[100];
  Deflater deflaterObj = new Deflater();
  deflaterObj.setInput(inputObj);
  deflaterObj.finish();
  int compressDataLength = deflaterObj.deflate(output);
  System.out.println(compressDataLength);
  // Decompress the bytes
  Inflater inflaterObj = new Inflater();
  inflaterObj.setInput(output, 0, output.length);
```

Inflater Class [3-3]

```
  byte[] resultObj = new byte[100];
  int resultLength = inflaterObj.inflate(resultObj);
  inflaterObj.end();
  // Decode the bytes into a String
  String strOutput = new String(resultObj, 0, resultLength, "UTF-
8");
  System.out.println("Recovered string is: " + strOutput);
 }
}
```

DeflaterInputStream Class [1-5]

- The `DeflaterInputStream` class reads the source data from an input stream and then compresses it in the 'deflate' compression format.
- This class provides its own constructors and methods.
- The following lists various methods available in the `DeflaterInputStream` class:
  - `read()`
  - `read(byte[] buffer, int offset, int buffSize) throws IOException`
  - `close()`
  - `boolean markSupported()`
  - `int available()`
  - `long skip(long n)`

DeflaterInputStream Class [2-5]

The following Code Snippet shows the use of methods in `DeflaterInputStream` class:

Code Snippet

```
package javaioapplication;
import java.io.File;
import java.io.FileInputStream;
import java.io.FileNotFoundException;
import java.io.FileOutputStream;
import java.io.IOException;
import java.util.logging.Level;
import java.util.logging.Logger;
import java.util.zip.DeflaterInputStream;

public class DeflaterInputApplication {
 public static byte[] increaseArray(byte[] arrtemp) {
  byte[] temp = arrtemp;
```

DeflaterInputStream Class [3-5]

```
 arrtemp = new byte[arrtemp.length + 1];
 // backs up the data
 for (int itr = 0; itr < temp.length; itr++) {
  arrtemp[itr] = temp[itr];
 }
 return arrtemp;
}
public static void main(String args[]) throws IOException {
 FileOutputStream fos = null;
 try {
  File file = new File("C:/Java/Hello.txt");
  FileInputStream fis = new FileInputStream(file);
  DeflaterInputStream dis = new DeflaterInputStream(fis);
  // Creating byte array for deflating the data
```

DeflaterInputStream Class [4-5]

```
   byte input[] = new byte[0];
   int iindex = -1;
   // reads data from file
   int iread = 0;
   while ((iread = dis.read()) != -1) {
    input = increaseArray(input);
    input[++iindex] = (byte) iread;
   }
   fos = new FileOutputStream("C:/Java/DeflatedMain.dfl");
   fos.write(input, 0, input.length);
   fos.close();
System.out.println("File size after compression " +
input.length);
  } catch (FileNotFoundException ex) {
```

DeflaterInputStream Class [5-5]

```
    Logger.getLogger(DeflaterInputApplication.class.getName()).lo
g(Level. SEVERE, null, ex);
  } finally {
    try {
     fos.close();
    } catch (IOException ex) {
      Logger.getLogger(DeflaterInputApplication.class.getName()).l
og(Level. SEVERE, null, ex);
    }
   }
  }
}
```

DeflaterOutputStream Class [1-3]

- The `DeflaterOutputStream` class reads the source data, compresses it in the 'deflate' compression format, and then writes the compressed data to a predefined output stream.
- It also acts as the base for other types of compression filters, such as `GZIPOutputStream`.
- The following lists various methods available in `DeflaterOutputStreamclass`:
  - `write(int buffer)`
  - `write(byte[] buffer, int offset, int buffSize)`
  - `deflate()`
  - `close()`
  - `finish()`

DeflaterOutputStream Class [2-3]

The following Code Snippet shows the use of methods in `DeflaterOutputStream` class:

Code Snippet

```
package javaioapplication;
import java.io.File;
import java.io.FileInputStream;
import java.io.FileOutputStream;
import java.util.zip.DeflaterOutputStream;
public class DeflaterOutputApplication {
 public static void main(String args[]) {
  try {
      File filein = new File("C:/Java/Hello.txt");
      FileInputStream finRead = new FileInputStream(filein);

      File fileout = new File("C:/Java/DeflatedMain.dfl");
      FileOutputStream foutWrite = new FileOutputStream(fileout);
      DeflaterOutputStream deflWrite = new
DeflaterOutputStream(foutWrite);
```

DeflaterOutputStream Class [3-3]

```
        System.out.println("Original file size " +
filein.length());
        // Reading and writing the compressed data
        int bread = 0;
        while ((bread = finRead.read()) != -1) {
         deflWrite.write(bread);
        }
        // Closing objects
        deflWrite.close();
        finRead.close();
        System.out.println("File size after compression " +
fileout.length());
      } catch (Exception e) {
        e.printStackTrace();
      }
    }
  }
```

InflaterInputStream Class [1-3]

- The `InflaterInputStream` class reads the compressed data and decompresses it in the 'deflate' compression format.

Syntax

```
public InflaterInputStream(InputStream in)
```

The constructor creates an input stream of bytes to read the compressed data with a default decompressor and buffer size.

- The following lists various methods available in `InflaterInputStream` class:
  - `read()`
  - `read(byte[] buffer, int offset, int buffSize)`

InflaterInputStream Class [2-3]

The following Code Snippet shows the use of methods in `InflaterInputStream` class:

Code Snippet

```
...
public static void main(String args[]) {
try {
    File finf = new File("C:\\DeflatedMain.dfl");
    FileOutputStream foutWrite = new FileOutputStream(finf);
    File fout = new File("C:\\InflatedMain.java");
    FileInputStream finRead = new FileInputStream(fout);
    InflaterInputStream defRead = new
InflaterInputStream(finRead);
     System.out.println("File size before Inflation " +
fout.length());
 // Inflating the file to original size
    int bread = 0;
   while ((bread = defRead.read()) != -1) {
          foutWrite.write(bread);
   }
```

InflaterInputStream Class [3-3]

```
      foutWrite.close();
       System.out.println("File size after Inflation " +
finf.length());
    } catch (IOException ioe) {
          ioe.printStackTrace();
    }
}
...
```

- The code creates two File objects, `fout` and `finf` where, `fout` holds the location of compressed file and `finf` holds the location of decompressed file.
- The object, `fout` is passed as a reference to the `FileInputStream` and the object, `finf` is passed as a reference to the `FileOutputStream`.
- The `InflaterInputStream` object reads the data in the `FileInputStream` object, decompresses the compressed data, and then invokes the `write()` method to write the decompressed data to the output file named `InflatedMain.java`.

InflaterOutputStream Class [1-3]

- The `InflaterOutputStream` class reads the compressed data, decompresses the data stored in the deflate compression format, and then writes the decompressed data to an output stream.
- This class also serves as the base class for the decompression class named GZIPInputStream.

Syntax

```
public InflaterOutputStream(OutputStream out)
```

The constructor creates an output stream of bytes to write decompressed data with a default decompressor and buffer size.

- The following lists various methods available in the `InflaterOutputStream` class:
  - `write(int buffer)`
  - `write(byte[] buffer, int offset, int buffSize)`
  - `close()`
  - `finish()`

InflaterOutputStream Class [2-3]

The following Code Snippet shows decompression of data using the methods of `InflaterOutputStream` class:

Code Snippet

```
public class InflaterOutputStreamApplication {
 public static void main(String args[]) {
  try {
// Writing decompressed data
    File fin = new File("C:/Java/DeflatedMain.dfl");
    FileInputStream finWrite = new FileInputStream(fin);
    File fout = new File("C:/Java/InflatedMain.java");
    FileOutputStream foutWrite = new FileOutputStream(fout);
    InflaterOutputStream infWrite = new
InflaterOutputStream(foutWrite);
    System.out.println("Original file size " + fin.length());
// Reading and writing the decompressed data
   int bread = 0;
   while ((bread = finWrite.read()) != -1) {
```

InflaterOutputStream Class [3-3]

```
      infWrite.write(bread);
     }
// Inflating the file to original size
     infWrite.close();
     System.out.println("File size after Inflation " +
fout.length());
   } catch (IOException ioe) {
     ioe.printStackTrace();
   }
  }
}
```

java.nio Package

- NIO is platform dependent.
- Its ability to enhance application performance depends on the following:
  - OS
  - Specific JVM
  - Mass storage characteristics
  - Data
  - Host virtualization context

Central features of the NIO APIs:

- Charsets and their Associated Decoders and Encoders translate the data between bytes and Unicode characters. The charset API is defined in the `java.nio.charset` package.
- Buffers are containers for data. The buffer classes are defined in the `java.nio` package and are used by all NIO APIs.
- Channels of Various Types represent connections to entities that can perform I/O operations.
- Selectors and Selection Keys define a multiplexed, non-blocking I/O facility.

File Systems, Paths, and Files [1-2]

File Systems

- A file system stores and organizes files on media, typically hard drives.
- Typically, files are stored in a hierarchical structure, where there is a root node.
- Below this node exist files and directories.
- Each directory can contain files and subdirectories, which can contain files and subdirectories and so on.
- There is no limit to the hierarchical structure.
- File systems can have one or more root directories.
- File systems have different characteristics for path separators.

Path

- Every file is identified through its path.
- It starts from the root node.
- File system include different characteristics for path separators.

File Systems, Paths, and Files [2-2]

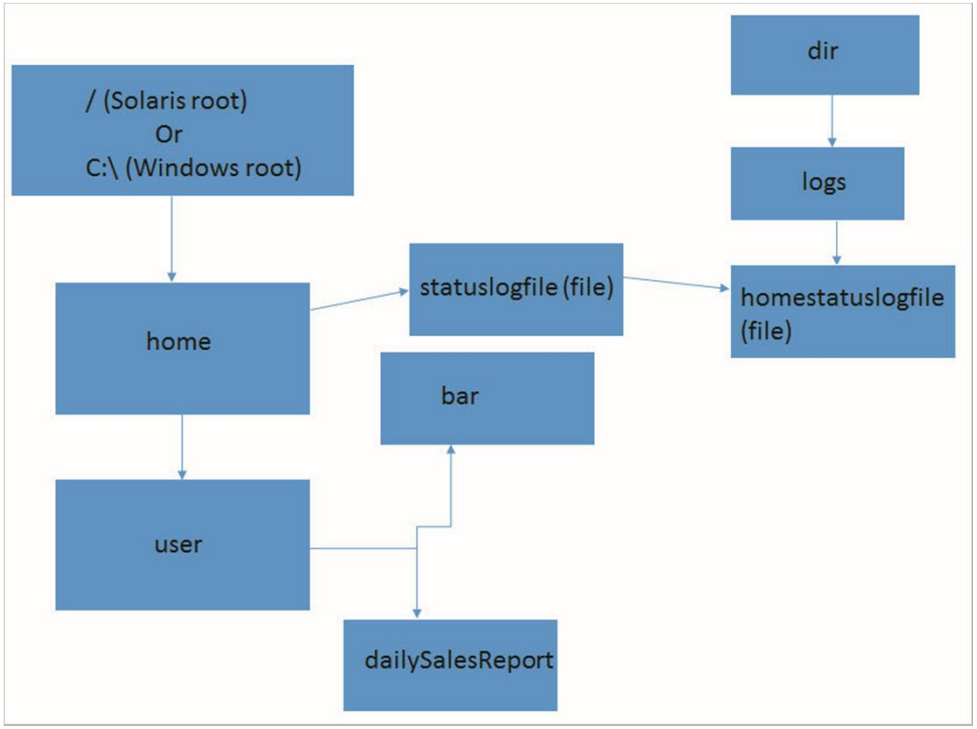
Files

NIO.2 includes the following new package and classes:

- `java.nio.file.Path`: This uses a system dependent path to locate a file or a directory.
- `Java.nio.file.Files`: This uses a Path object to perform operations on files and directories.
- `java.nio.file.FileSystem`: This provides an interface to a file system. This also helps to create a Path object and other objects to access a file system.

Symbolic Links

- A symbolic link is a reference to another file and is transparent to applications and users.
- Operations on symbolic links are automatically redirected to the target of the link.
- Here, the target is the file or directory that is pointed to.



Symbolic Link

Path Interface [1-3]

- The `java.nio.file.Path` interface object can help to locate a file in a file system.
- Typically, the interface represents a system dependent file path.
- A Path is hierarchical.
- It includes a sequence of directory and file name elements.
- These are separated by a delimiter.
- Following are the features of a Path:
  - There could be a root component. This represents a file system hierarchy.
  - The name of a file or directory is the name element that is extreme far from the root of the directory hierarchy.
  - The other name elements include directory names.
- A Path can represent the following:
  - A root
  - A root and a sequence of names
  - One or more name elements

Path Interface [2-3]

- Following are some of the methods of the Path interface that can be grouped based on their common functionalities:
  - To access the path components or a subsequence of its name elements, the `getFileName()`, `getParent()`, `getRoot()`, and `subpath()` methods can be used.
  - To combine paths, the Path interface defines `resolve()` and `resolveSibling()` methods can be used.
  - To construct a relative path between two paths, the `relativize()` method can be used.
  - To compare and test paths, the `startsWith()` and `endWith()` methods can be used.
- To obtain a Path object, obtain an instance of the default file system. Next, invoke the `getPath()` method.

Code Snippet

```
FileSystem fs = FileSystem.getDeafult();
Path pathObj = fsObj.getPath("C:/Java/Hello.txt");
```

Path Interface [3-3]

The following Code Snippet displays the use of the Path interface:

Code Snippet

```
package javaioapplication;
import java.nio.file.Path;
import java.nio.file.Paths;
public class PathApplication {
public static void main(String[] args){
  Path pathObj = Paths.get("C:/Java/Hello.txt");
  System.out.printf("FileName is: %s%n", pathObj.getFileName());
  System.out.printf("Parent is: %s%n", pathObj.getParent());
  System.out.printf("Name count is: %d%n",
pathObj.getNameCount());
  System.out.printf("Root directory is: %s%n",
pathObj.getRoot());
  System.out.printf("Is Absolute: %s%n", pathObj.isAbsolute());
  }
}
```

Working with Links

- Path interface is link aware and every method either detects what to do or provides an option to configure the behavior when a symbolic link is encountered.
- While certain file systems support symbolic link, certain support hard links.
- Hard links differ from symbolic links.
- The following defines a hard link:
  - It is not allowed on directories and not allowed to cross partitions or volumes.
  - It is hard to find as it behaves like a regular file.
  - It should include the target of the link.

Tracking File System and Directory Changes [1-17]

- Static methods in the `java.nio.file.Files` class perform primary functions for the Path objects.
- The methods in the class can identify and automatically manage symbolic links.
- Following are the various `File` operations:
  - Copying a file or directory
  - Moving a file or directory
  - Checking a file or directory
  - Deleting a file or directory
  - Listing a Directory's Content
  - Creating and Reading Directories
  - Reading and Writing from Files
  - Reading a File by Using Buffered Stream I/O
  - Accessing a File Randomly

Copying a file or directory

- To do so, the `copy(Path, Path, CopyOption...)` method can be used.
- The following Code Snippet shows how to use the `copy()` method:

Code Snippet

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

Tracking File System and Directory Changes [3-17]

Moving a file or directory

- To do so, use the `move(Path, Path, CopyOption...)` method.
- If the target file exists, the `REPLACE_EXISTING` option should be used.
- Otherwise, the move fails.
- The method takes a varargs argument.
- The following Syntax shows how to use the `move()` method:

Syntax

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

Tracking File System and Directory Changes [4-17]

Checking a file or directory

- To do so, the file system should be accessed using the `Files` methods to determine if a particular Path exists.
- The methods in the `Path` class operate on the Path instance.
- Following are the `Files` methods for checking the existence of `Path` instance:
  - `exists(Path, LinkOption...opt)`: These check if the file exists. By default, it uses symbolic links.
  - `notExists(Path, LinkOption...)`: These check if the file does not exist.
  - `Files.exists(path)` is not equivalent to `Files.notExists(path)`.
- When testing a file's existence, one of the following is the possible outcome:
  - The file is verified to not exist.
  - The file is verified to exist.
  - The existence of the file cannot be verified.
  - The file's status is unknown.

Tracking File System and Directory Changes [5-17]

Deleting a file or directory

- The `delete(Path)` method can be used to delete a file, directories, or links.
- The deletion will fail if the directory is not empty.
- The method throws an exception if the deletion fails.
- If the file does not exist, a `NoSuchFileException` is thrown.

Tracking File System and Directory Changes [6-17]

To determine the reason for the failure, the following exception can be caught as shown in the Code Snippet:

Code Snippet

```
try {
 Files.delete(path);
} catch (NoSuchFileException x) {
  System.err.format("%s: no such" + " file or directory%n",
path);
} catch (DirectoryNotEmptyException x) {
  System.err.format("%s not empty%n", path);
} catch (IOException x) {
  // File permission problems are caught here.
  System.err.println(x);
}
```

Listing a Directory's Content

- To do so, use the `DirectoryStream` class that iterates over all the files and directories from any `Path` directory.
- Consider the following:
  - `DirectoryIteratorException` is thrown if there is an I/O error while iterating over the entries in the specified directory.
  - `PatternSyntaxException` is thrown when the pattern is invalid.
- The following Code Snippet displays the use of `DirectoryStream` class:

Code Snippet

```
import java.io.IOException;
import java.nio.file.DirectoryIteratorException;
import java.nio.file.DirectoryStream;
import java.nio.file.Files;
import java.nio.file.Path;
import java.nio.file.Paths;
```

Tracking File System and Directory Changes [8-17]

```
import java.util.Iterator;
public class ListDirApplication {
 public static void main(String[] args) {
  Path pathObj = Paths.get("D:/resources");
  try (DirectoryStream<Path> dirStreamObj =
Files.newDirectoryStream(path Obj, "*.java")) {
  for (Iterator<Path> itrObj = dirStreamObj.iterator(); itrObj.
hasNext();) {
   Path fileObj = itrObj.next();
   System.out.println(fileObj.getFileName());
  }
 } catch (IOException | DirectoryIteratorException ex) {
// IOException can never be thrown by the iteration.
// In this snippet, itObj can only be thrown by
newDirectoryStream.
System.err.println(ex.getMessage());
  }
 }
}
```

Creating and Reading Directories

- The `createDirectory(Path dir)` method is used to create a new directory.
- The `createDirectories()` method can be used to create directories from top to bottom.
- The following Code Snippet illustrates this:

Code Snippet

```
Files.createDirectories(Paths.get("C:/Java/test/example"));
```

Reading and Writing from Files

- To read from files, use the `readAllBytes` or `ReadAllLines` methods that will read the entire content of the file.
- The following Code Snippet shows the use of `ReadAllLines` method:

Code Snippet

```
Files.createDirectories(Paths.get("C:/Java/test/example"));
```

Reading a File by Using Buffered Stream I/O

- The `newBufferedReader(Path, Charset)` method opens a file for reading.
- This returns a `BufferedReader` object that helps to read text from a file efficiently.
- The following Code Snippet demonstrates the use of `newBufferedReader()` method:

Code Snippet

```
Import java.io.BufferedReader;
import java.io.IOException;
import java.nio.charset.Charset;
import java.nio.file.Files;
import java.nio.file.Path;
import java.nio.file.Paths;
public class BufferedIOApplication {
```

Tracking File System and Directory Changes [12-17]

```
 public static void main(String[] args) {
   Path pathObj = Paths.get("C:/Java/Hello.txt");
   Charset charset = Charset.forName("US-ASCII");
 try (BufferedReader buffReadObj =
Files.newBufferedReader(pathObj, charset)) {
      String lineObj = null;
while ((lineObj = buffReadObj.readLine()) != null) {
       System.out.println(lineObj);
      }
  } catch (IOException e) {
    System.err.format("IOException: %s%n", e);
  }
 }
}
```

Accessing a File Randomly

- Files can be nonsequentially or randomly accessed using the `SeekableByteChannel` interface.
- To randomly access a file, perform the following:
  - Open the file.
  - Find the particular location.
  - Read from the file or write to the file.
- The `SeekableByteChannel` interface extends channel I/O and includes various methods to set the position.
- The data can then be read from the location or written to it.
- The interface includes the following methods:
  - read(ByteBuffer)
  - write(ByteBuffer)
  - truncate(long)

Tracking File System and Directory Changes [14-17]

- position
- position(long)

- The following Code Snippet displays the use of the methods of random access file:

Code Snippet

```
import java.io.FileNotFoundException;
import java.io.IOException;
import java.nio.ByteBuffer;
import java.nio.channels.FileChannel;
import java.nio.file.Path;
import java.nio.file.Paths;
import static java.nio.file.StandardOpenOption.*;
public class RandomAccessApplication {
```

Tracking File System and Directory Changes [15-17]

```
public static void main(String[] args) throws
FileNotFoundException {
 String strObj = "I love Java programming!\n";
 byte byteDataObj[] = strObj.getBytes();
 ByteBuffer bufObj = ByteBuffer.wrap(byteDataObj);


 ByteBuffer bufCopyObj = ByteBuffer.allocate(20);
 Path pathObj = Paths.get("C:/Java/NewHello.txt");
 //creates a new file if it is not existing
 try (FileChannel fcObj = (FileChannel.open(pathObj, CREATE,
READ, WRITE))) {
//reads the first 20 bytes of the file
  int nreadChar;
  do {
  nreadChar = fcObj.read(bufCopyObj);
    System.out.println(nreadChar);
  } while (nreadChar != -1 && bufCopyObj.hasRemaining());
```

Tracking File System and Directory Changes [16-17]

```
// writes the string at the beginning of the file.
fcObj.position(0);
while (bufObj.hasRemaining()) {
fcObj.write(bufObj);
}
bufObj.rewind();

// Moves to the end of the file and copies the first 20 bytes to
// the end of the file.
long length = fcObj.size();
fcObj.position(length - 1);
//flips the buffer and sets the limit to the current position
bufCopyObj.flip();
while (bufCopyObj.hasRemaining()) {
fcObj.write(bufCopyObj);
}
```

Tracking File System and Directory Changes [17-17]

```
  while (bufObj.hasRemaining()) {
   fcObj.write(bufObj);
  }
 } catch (IOException ex) {
  System.out.println("I/O Exception: " + ex.getMessage());
 }
}
}
```

Tracking File System Using WatchService and PathMatcher

- The `FileSystem` class provides an interface to a file system and is the factory for objects to access files and other objects in the file system.
- It includes several types of objects.
- Following are some of the objects:
  - `getUserPrincipalLookupService()`
  - `newWatchService()`
  - `getPath()`
  - `getPathMatcher()`
  - `getFileStores()`
- A file system can have a single hierarchy of files or several distinct file hierarchies.
- A single hierarchy of files includes one top-level root directory.
- A file system can include one or more `file-stores`.

WatchService

- A WatchService watches registered objects for changes and events.
- Multiple concurrent consumers can use a WatchService.
- A file manager can use a WatchService to check a directory for changes such as when files are created or deleted.
- The `register()` method is invoked to register a `Watchable` object with a WatchService.
- This method returns a `WatchKey` to represent the registration.
- When a change or event for an object occurs, the key is signaled or queued to the WatchService.
- After the events are processed, the consumer invokes the key's `reset()` method.
- This resets the key. The key is then signaled and re-queued with further events.
- To cancel a registration with a WatchService, the key's `cancel()` method is invoked.

PathMatcher Interface [1-6]

- To locate a file one would search directory.
- One could use a search tool or the `PathMatcher` interface which has a match method that determines whether a Path object matches a specified string.
- The `PathMatcher` interface is implemented by objects to match operations on paths.
- The following is the syntax for the `syntaxAndPattern` string:

Syntax

```
Syntax:pattern
```

- The following lists certain patterns:
  - `.*.{java,class}`
  - `Client.?`
  - `C:\\*`
  - `*.java`
  - `*.*`

PathMatcher Interface [2-6]

- To find a file, the user will search a directory recursively.
- The `java.nio.PathMatcher` interface has a match method to determine whether a Path object matches the specified search string.
- The `FileSystem` factory methods can be used to retrieve the `PathMatcher` instance.
- To walk a file tree, the `FileVisitor` interface needs to be implemented.
- This interface specifies the behavior in traversal process.
- The key points in the traversal process includes when a file is visited, before accessing a directory, after accessing a directory, or when a failure happens.
- The methods corresponding to these situations are as follows:
  - `preVisitDirectory()` – invoked before visiting a directory
  - `postVisitDirectory()` – invoked after all entries in a directory is visited
  - `visitFile()` – invoked when a file is visited
  - `visitFileFailed()` – invoked when a file cannot be accessed

PathMatcher Interface [3-6]

- The `SimpleFileVisitor` class implements the `FileVisitor` interface and overrides all the methods of this class.
- This class visits all the files and when it encounters an error, it throws an IOError.
- This class can be extended and only the required methods is required to be overridden.
- The Code Snippet displays the use of `PatternMatcher` and the `SimpleFileVisitor` class to search for a file based on a pattern:

Code Snippet

```
import java.io.IOException;
import java.nio.file.FileSystems;
import java.nio.file.Files;
import java.nio.file.Path;
import java.nio.file.PathMatcher;
import java.nio.file.Paths;
import java.nio.file.SimpleFileVisitor;
import static java.nio.file.FileVisitResult.*;
```

PathMatcher Interface [4-6]

```
import java.nio.file.FileVisitResult;
import java.nio.file.attribute.BasicFileAttributes;
class Finder extends SimpleFileVisitor<Path> {

 private Path file;
 private PathMatcher matcher;
 private int num;

 public Finder(Path path, PathMatcher matcher) {
  file = path;
  this.matcher = matcher;
 }
 private void find(Path file) {
  Path name = file.getFileName();
  if (name != null && matcher.matches(name)) {
   num++;
   System.out.println(file);
  }
 }
```

PathMatcher Interface [5-6]

```
 void done() {
System.out.println("Matched: " + num);
}
 @Override
 public FileVisitResult visitFile(Path file, BasicFileAttributes
attr) {
  find(file);
  return CONTINUE;
 }

 // Invoke the pattern matching
 // method on each directory.
 @Override
 public FileVisitResult preVisitDirectory(Path dir,
   BasicFileAttributes attrs) {
  find(dir);
  return CONTINUE;
 }
```

PathMatcher Interface [6-6]

```
 @Override
 public FileVisitResult visitFileFailed(Path file, IOException exc) {
        System.err.println(exc);
        return CONTINUE;
     }
}
public class PathMatcherApplication {
 public static void main(String[] args) throws IOException {
  Path pathObj;
pathObj = Paths.get("D:/resources");
PathMatcher matcherObj = FileSystems.getDefault().getPathMatcher("glob:" +
"*.java");
   Finder finder = new Finder(pathObj, matcherObj);
   try {
      Files.walkFileTree(pathObj, finder);
   } catch (IOException ex) {
       System.out.println(ex);
   }
 }
 }
```

File Class and File Attributes [1-2]

- In a file system, the files and directories include data.
- It is the metadata that tracks information about each object in the file system.
- Information can be such as the file creation date, the last file modified date, file owner, and so on.
- Metadata refers to file attributes of a file system.
- These file attributes can be achieved by the following methods of the `Files` class:
  - `isRegularFile(Path, LinkOption...)`
  - `isSymbolicLink(Path)`
  - `size(Path)`
  - `isDirectory(Path, LinkOption)`
  - `isHidden(Path)`
  - `getPosixFilePermissions (Path, LinkOption...)`
  - `setPosixFilePermissions(Path, Set<Pos ixFilePermission>)`
  - `getAttribute(Path, String, LinkOption...)`

File Class and File Attributes [2-2]

- `setAttribute(Path, String, Object, LinkOption...)`
- `getLastModifiedTime (Path, LinkOption...)`
- `setLastModifiedTime(Path, FileTime)`
- `getOwner(Path, LinkOption...)`
- `setOwner(Path, UserPrincipal)`

- To obtain a set of attributes, the `Files` class includes the following two `readAttributes()` methods to get a file's attributes in one bulk operation:
  - `readAttributes(Path p, Class<A> type, LinkOption... option)`
  - `readAttributes(Path p, String str, LinkOption... option)`
- The basic attributes of a file system includes the following time stamps:
  - `creationTime`
  - `lastModifiedTime`
  - `lastAccessTime`

DOS File Attributes [1-2]

- File systems other than DOS such as Samba also support DOS file attributes.
- The following Code Snippet shows the use of the methods of the `DosFileAttributes` class:

Code Snippet

```
import java.io.IOException;
import java.nio.file.Files;
import java.nio.file.Path;
import java.nio.file.Paths;
import java.nio.file.attribute.DosFileAttributes;
public class DOSFileAttriApplication {
  /**
  *
  * @param args
  * @throws IOException
  */
```

DOS File Attributes [2-2]

```
  public static void main(String[] args) throws IOException {
   Path pathObj;
pathObj = Paths.get("C:/Java/Hello.txt");
  try {
   DosFileAttributes attrObj =
     Files.readAttributes(pathObj, DosFileAttributes.class);
   System.out.println("Is ReadOnly: " + attrObj.isReadOnly());
   System.out.println("Is Hidden: " + attrObj.isHidden());
   System.out.println("Is Archive: " + attrObj.isArchive());
   System.out.println("Is System: " + attrObj.isSystem());
  } catch (UnsupportedOperationException ex) {
    System.err.println("DOS file" + " attributes not supported:"
+ ex);
  }
 }
}
```

Summary

- Java SE 6 has introduced the Console class to enhance and simplify command line applications.
- The Console class provides various methods to access character-based console device.
- Java in its java.util.zip package provides classes that can compress and decompress files.
- The Deflater and Inflater classes extend from the Object class.
- The DeflaterInputStream and DeflaterOutputStream classes are inherited from the FilterInputStream and FilterOutputStream classes respectively.
- The InflaterInputStream and InflaterOutputStream classes are inherited from the FilterInputStream and FilterOutputStream classes respectively.
- NIO is platform dependent. A file system stores and organizes files on media, typically hard drives.