File Input and Output

Computer Files

- Types of Storage Device:
  - **Volatile storage** is temporary. Volatile values (stored in variables) are lost when the computer loses its power. The Random Access Memory (RAM) is being used when a Java program stores a value in a variable.
  - **Non-volatile storage** is permanent. A Java program that is saved on a disk uses a non-volatile storage.
- A **computer file** is a collection of data stored on a non-volatile device.
- Categories of File:
  - A **text file** consists of data that can be read in a text editor. Data in a text file is encoded using a scheme. The most common schemes are ASCII and Unicode. Examples are program files and application files.
  - A **binary file** contains data that is not encoded as text. This file has contents in binary format, which means they cannot be understood by viewing them in a text editor. Examples are images, music, and the .class extension files which are created after compiling Java programs.
- The common characteristics of a text file and binary file are size, name, and date and time of creation.
- Permanent files are commonly stored in the **main directory** or the **root directory**.
- To organize stored files, **folders** or **directories** are used.
- Users may also create folders within folders. The complete list of the disk drive plus the hierarchy of directories in which the file is located is called **path**.
  Example of a complete path: **C:\Java\Chapter8\example.txt**
- In the Windows operating system, the backslash (\) is the **path delimiter** – the special character used to separate path components.

The Path and Files Classes

- The ***Path* class** creates objects that contain information about files and directories, such as sizes, locations, creation dates, and is used to check whether a file or directory exists.
- The ***Files* class** performs operations on files and directories, such as determining their attributes, creating input and output streams, and deleting them.
- To use both the *Path* and *Files* classes, add the following statement.
  ```
  import java.nio.file.*;
  ```
- To create and define a *Path*, use the *Paths* class and its *get()* method.
  Example: `Path filePath = Paths.get("C:\\Java\\Chapter8\\sample.txt");`
- An **absolute path** is a complete path; it does not require any other information to locate a file on a system.
  Example: **C:\Java\Chapter8\sample.txt**
- A **relative path** depends on other path information.
  Examples: **sample.txt**
  Chapter8\sample.txt
  Java\Chapter8
- *Path* Methods:

Method	Description
`String toString()`	Returns the *String* representation of the *Path*, eliminating double backslashes
`Path getFileName()`	Returns the file or directory denoted by this *Path*; this is the last item in the sequence of name elements.
`int getNameCount()`	Returns the number of name elements in the *Path*
`Path getName(int)`	Returns the name in the position of the *Path* specified by the integer parameter

Sample Program:

```
import java.nio.file.*;

public class PathSample
{
    public static void main(String[] args)
    {
        Path filePath =
            Paths.get("C:\\Java\\Chapter8\\sample.txt");
        int count = filePath.getNameCount();
        System.out.println("Path is " + filePath.toString());
        System.out.println("File name is " + filePath.getFileName());
        System.out.println("There are " + count +
            " elements in the file path");
        for(int x = 0; x < count; ++x)
            System.out.println("Element " + x + " is " +
                filePath.getName(x));
    }
}
```

Output:

```
General Output
--------------------Configuration: <Default>--
Path is C:\Java\Chapter8\sample.txt
File name is sample.txt
There are 3 elements in the file path
Element 0 is Java
Element 1 is Chapter8
Element 2 is sample.txt

Process completed.
```

- To convert a relative path to an absolute path, the ***toAbsolutePath()*** method is used.

Sample Program:

```
import java.util.Scanner;
import java.nio.file.*;

public class PathSample
{
    public static void main(String[] args)
    {
        String fileName;
        Scanner s = new Scanner(System.in);
        System.out.print("Enter a filename: ");
        fileName = s.nextLine();
        Path inputPath = Paths.get(fileName);
        Path fullPath = inputPath.toAbsolutePath();
        System.out.println("The full path is "
            + fullPath.toString());
        }
}
```

Output:

```
General Output
--------------------Configuration: <Default>--
Enter a filename: note.txt
The full path is C:\Java\note.txt

Process completed.
```

- To verify if a file exists and if a program can access it when needed, the ***checkAccess()*** method is used.

- Arguments of the *checkAccess()* Method:

Argument	Description
None	Checks whether the file exists
READ	Checks whether the file exists and whether the program has permission to read the file
WRITE	Checks whether the file exists and whether the program has permission to write to the file
EXECUTE	Checks whether the file exists and whether the program has permission to execute the file

- The ***delete()*** method of the *Files* class accepts a *Path* parameter and removes the last element (file or directory) in a path or throws an exception if the deletion is unsuccessful.
- Examples of Exceptions:
  - If there is an attempt to delete a file that does not exist, a ***NoSuchFileException*** is thrown.
  - If there is an attempt to delete a directory that has files, a ***DirectoryNotEmptyException*** is thrown.
  - If there is an attempt to delete a file without permission, a ***SecurityException*** is thrown.
  - Other input/output errors cause ***IOException***.
- The ***deleteIfExists()*** method can also be used to remove a file without encountering an exception if the file does not exist.
- To retrieve useful information about a file, the ***readAttributes()*** method of the *Files* class is used. This method takes two (2) arguments. These are *Path* object and *BasicFileAttributes.class*. The *readAttributes()* method returns an instance of the *BasicFileAttributes.class*.
  Example:

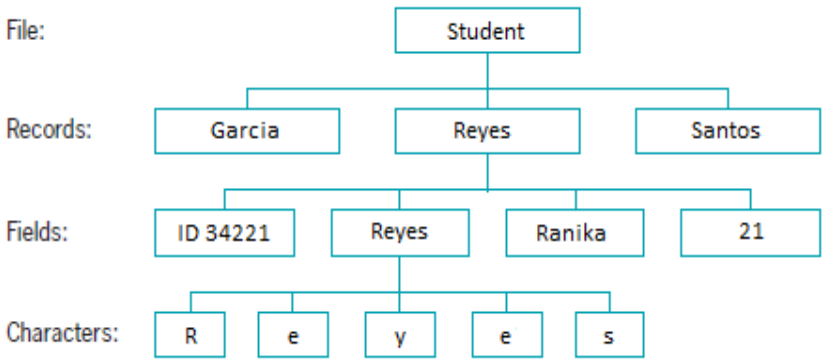
```
BasicFileAttributes fileAtt =
Files.readAttributes(filePath, BasicFileAttributes.class);
```

- *BasicFileAttributes* Methods:

Method	Description
`size()`	Returns the size of the file in bytes
`creationTime()`	Returns the date and time the file was created Format: `yyyy-mm-ddThh:mm:ss` *(T stands for Time)*
`lastModifiedTime()`	Returns the date and time the file was last edited *(Same format with `creationTime()`)*
`compareTo()`	Compares relationship between values retrieved from `creationTime()` or `lastModifiedTime()`

File Organization, Streams, and Buffers

- The smallest useful piece of data is the character. A **character** can be any letter, number, or other special symbol (such as punctuation mark) that makes up data.
- A **field** is a group of characters that has some meaning. Fields are grouped together to form records.
- A **record** is a collection of fields that contain data about an entity. Records are grouped to create files.
- A **file** consists of related records.



- When each record in a file is accessed one after another in the order in which it was stored, the data file is used as a **sequential access file**.
- A record's fields can be organized into a single line or can be separated by a character. Values in a record that are separated by commas are called **comma-separated values**.
- A **stream** is a flow of data. If the data is taken from a source (such as a file or the keyboard) and is delivered into a program, it is called an **input stream**. If the data is delivered from a program to a destination (such as a file or the screen), it is called an **output stream**.
- A **buffer** is a memory location into which you can write data, which you can read again later.
- **Flushing** clears any bytes that have been sent to a buffer for output but have not yet been displayed on a hardware device.

The IO Classes

- Input and Output Classes:

Class	Description
`InputStream`	Abstract class that contains method for performing input
`FileInputStream`	Provides the capability to read disk from files
`BufferedInputStream`	Handles input from a system's standard or default input device (usually the keyboard)
`OutputStream`	Abstract class that contains method for performing output
`FileOutputStream`	Provides the capability to write to disk files
`BufferedOutputStream`	Handles input from a system's standard or default output device (usually the monitor)
`PrintStream`	Contains methods for performing output that never throws an exception (`System.out` is a `PrintStream` object)
`Reader`	Abstract class for reading character streams; the only methods that a subclass must implement are `read(char[] int, int)` and `close()`
`BufferedReader`	Reads text from a character-input stream, buffering characters to provide for efficient reading of characters, arrays, and lines
`BufferedWriter`	Writes text to a character-output stream, buffering characters to provide for the efficient writing of characters, arrays, and lines

- Common Methods of the *OutputStream* Class:

`OutputStream` Method	Description
`void close()`	Closes the output stream and releases any system resources associated with the stream
`void flush()`	Flushes the output stream; if any bytes are buffered, they will be written
`void write(byte[] b)`	Writes all bytes to the output stream from the specified byte array
`void write(byte[] b, int off, int len)`	Writes bytes to the output stream from the specified byte array starting at offset position `off` for a length of `len` characters

- The *Files* class' ***newOutputStream()*** method is used to create a writeable file. A *Path* and a *StandardOpenOption* argument are passed to this method. This method creates a file if it hasn't existed yet, opens the file for writing, and returns an *OutputStream* that can be used to write bytes to the file.
- *StandardOpenOption* Arguments:

`StandardOpenOption`	Description
`WRITE`	Opens the file for writing
`APPEND`	Appends new data to the end of the file; use this option with `WRITE` or `CREATE`

TRUNCATE_EXISTING	Truncates the existing file to 0 byte so the file contents are replaced; use this option with the WRITE option
CREATE_NEW	Creates a new file only if it hasn't existed yet; it throws an exception if the file already exists
CREATE	Opens the file if it exists or creates a new file if it hasn't existed yet
DELETE_ON_CLOSE	Deletes the file when the stream is closed; it is used most often for temporary files that exist only for the duration of the program

- The ***newInputStream()*** method of the *Files* class is used to open a file for reading. This method accepts a *Path* parameter and returns a stream that can read bytes from a file.
- A ***BufferedReader*** object is declared to read a line of text from a character-input stream, buffering characters so reading is more efficient.
- Common Methods of the *BufferedReader* Class:

BufferedReader Method	**Description**
close()	Closes the stream and any resources associated with it
read()	Reads a single character
read(char[] buffer, int off, int len)	Reads characters into a portion of an array from position off for len characters
readLine()	Reads a line of text
skip(long n)	Skips the specified number of characters

Sequential Data Files

- The ***BufferedWriter*** class writes text to an output stream, buffering the characters.
- *BufferedWriter* Methods:

BufferedWriter Method	**Description**
close()	Closes the stream, flushing it first
flush()	Flushes the stream
newline()	Writes a line separator
write(String s, int off, int len)	Writes a String from position off for length len
write(char[] array, int off, int len)	Writes a character array from position off for length len
write(int c)	Writes a single character

References:

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