
WEEK EIGHT

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FILES

- Sequence of binary digits
 - May represent integers, text characters, etc.
- Files have many different types that define how to read the information inside
 - Text file: ASCII/UNICODE characters
 - Binary file: pretty much everything else

FILE I/O AND THE OS

- Operating System (OS) handles file operations for programs
 - Interacts with the storage device
 - Polices who can access/write to a file
 - Handles file properties (size, permissions, name)
- OS must open files so a program can use them
 - Programs use method calls to invoke OS routines
 - Create and open a new file to write to it (output)
 - Open an existing file to read it (input)
 - Open an existing file and write/append information to it (output)
 - Destroy an existing file
 - If the OS runs into a problem, it throws (creates) an exception

EXCEPTIONS

- Describes a problem that occurs in the code (or in this case with the OS)
- This allows the program to respond accordingly to an unexpected issue
- Some exceptions, (particularly file I/O exceptions) are **checked exceptions**
 - We must deal with these in some way, otherwise we will get an error
 - EX: `IOException`, `FileNotFoundException`
- When we encounter an exception, we must either:
 - Handle the exception (try/catch: we will discuss this later) OR
 - Pass the exception up a level
- To pass it up a level, we need to add a throw clause to the method header

```
public static void main (String[] args) throws Exception {
```

FILE BUFFERS

- Program calls a method to ask the OS to open the file
 - OS creates an area in memory (a buffer) that the program can access
 - OS provides the program with a reference to the buffer (a file handle)
 - OS checks if the program is permitted to receive the file handle
 - Permissions, is the file already open?
- Buffer improves performance
 - Memory is faster than accessing storage device where the file is stored
 - If file is opened, OS copies file contents into buffer
 - If file write occurs, change occurs in buffer
 - Eventually, OS will copy buffer back into the file
 - OS will flush the buffer and close the file
 - Open files are closed when program exits, thus we need to explicitly close files that are open

FILE POINTERS

- File pointer indicates where the next read or write operation will take place
- Each file is treated as a one-dimensional sequence of characters
 - Non-printing characters for newlines
- Read position indicates what characters are returned on the next read operation
 - Read position is updated to the next character each time a character is read
 - Most languages also provide methods to move the read pointer
 - EX: '1501 245'
 - `nextInt()` would read in '1501'
 - Read pointer is now on the white space between the two numbers
 - `nextLine()` would read in ' 245'

FILENAME CONVENTIONS

- Dependent on the OS
- Two different ways to reference file locations
 - Relative reference: specified from a default working directory (no absolute path)
 - `String filename = "Data.txt";`
 - Absolute reference: entire path specified from the root directory
 - `String filename = "C:\\Users\\ClarissaMilligan\\Documents\\FA24\\data.txt";`
 - Since '\\' is the escape character in ASCII/UNICODE, we must use '\\'
 - Unix-type OSs use forward slash '/'

THE PRINTWRITER CLASS

- Under the java.io library
- PrintWriter class allows for writing to files using `print` and `println` methods, like we use for the console
- Constructor takes in a filename (`String`) or file handle (`FileWriter`)
 - WARNING: If `PrintWriter` is just given a filename, it will always overwrite that file completely

```
import java.io.PrintWriter;

PrintWriter out = new PrintWriter("Names.txt");
out.println("Chris");
out.println("Kathryn");
out.println("Jean");
out.close();
```

The diagram illustrates the steps for using the `PrintWriter` class to write to a file. It consists of a code snippet with four lines, each preceded by a red arrow pointing to a label in a box:

- Open the file.** Points to the constructor call: `PrintWriter out = new PrintWriter("Names.txt");`
- Write data to the file.** Points to the three `println` statements: `out.println("Chris");`, `out.println("Kathryn");`, and `out.println("Jean");`
- Close the file.** Points to the `close()` statement: `out.close();`
- import java.io.PrintWriter;** Points to the import statement at the top.

THE FILEWRITER CLASS

- Also, in the java.io library
- FileWriter is used to avoid erasing an existing file
 - `FileWriter fwriter = new FileWriter("filename.txt", true);`
 - Boolean argument indicates whether or not we will be appending data to the file
 - If we choose true, buffer will be created in a way so output will be appended to the end of the file
- FileWriter object can be passed into a PrintWriter

THE FILE CLASS

- Also in the java.io library
- Used to create a file handle
 - `File fileHandle = new File("filename.txt");`
- Scanner object can be used to parse the associated buffer (read the contents)
 - `Scanner inputFile = new Scanner(fileHandle);`
- Data can then be read with the same methods we use for the console:
 - `nextLine()`, `nextInt()`, `nextDouble()`, etc.
 - `hasNextLine()`, `hasNextInt()`, `hasNextDouble()`, etc.

FILE CLASS METHODS

- Sanity checking methods
 - `exists()`, `canWrite()`, `canRead()`, `canExecute()`
- Other useful methods
 - `createNewFile()`, `delete()`, `getPath()`, `getAbsolutePath()`
- Set OS properties
 - `setExecutable()`, `setReadable()`, `setWritable()`,
`setLastModificationDate()`

HANDLING EXCEPTIONS

- Using a try/catch block allows us to handle issues without our program crashes
- Try block
 - Should surround any of the code that could generate an exception
 - Any code that is dependent on the code above also needs to be in the try block
 - Once an exception is thrown from the try block the execution halts and jumps to the corresponding catch block
- Catch block
 - Can be more than one for different exceptions
- Finally block
 - Executes last regardless of whether an exception is thrown

TRY/CATCH/FINALLY

```
try {  
    // code that can cause an exception  
} catch (Exception e) {  
    // code that happens if that exception occurs  
} finally {  
    // code that happens regardless of what happens above  
}
```

ACTIVITY

- Write code that:
 - Reads in 5 numbers from a file called “nums.txt”
 - Prints out the sum of the numbers
- File will look like this:

4

23

17

16.5

-8.3

FILEOUTPUTSTREAM

- Also, part of java.io
- FileOutputStream can be used in place of a FileWriter

```
FileOutputStream fileStream = new FileOutputStream("data.txt", true);  
PrintWriter fileOut = new PrintWriter(fileStream);  
  
fileOut.println("Hello File!");  
fileOut.close();  
fileStream.close();
```

FILEINPUTSTREAM

- Also, part of java.io
- FileInputStream can be used in place of File

```
FileInputStream fileByteStream = new FileInputStream("data.txt");
Scanner fileInput = new Scanner(fileByteStream);

while (fileInput.hasNextLine()) {
    System.out.println(fileInput.nextLine());
}

fileInput.close();
fileByteStream.close();
```