DUE DATE: **By the end of your lab session**

CSE-271: Object-Oriented Programming

Exercise #10

Max Points: 20

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For your own convenient reference – You should first save/rename this document using the naming convention `MUid_Exercise10.docx` (example: `raodm_Exercise10.docx`) prior to proceeding with this exercise.

Objectives: The objectives of this exercise are to:

1. Review concepts of text vs. binary files
2. Review skills associated with relative and absolute path
3. Experiment with working with binary files
4. Work with random-access files

Fill in answers to all of the questions. For some of the questions you can simply copy-paste appropriate text from Eclipse output into this document. You may discuss the questions or seek help from your neighbor, TA, and/or your instructor.

Part #0: One time setup of Eclipse (IDE) – Only if needed

We already configured `Eclipse`'s source formatter and Checkstyle plug-in as part of Lab #1. If your `Eclipse` is not configured (because you are using a different computer) then use the instructions from Lab #1 to configure `Eclipse`.

Part #1: Relative and absolute paths

Estimate time: < 15 minutes

> **Without a good understanding of paths, you will eventually be lost.**
> *- Yours truly*

Background: Files are stored in a hierarchical manner using directories and sub-directories. The sequence of directories that need to be traversed in order to access a file is called the path. Path (to a file or directory) can be classified into the following 2 categories:

- **Absolute path**: Paths that start with a / (forward slash or just slash, *i.e.*, the division sign) or C:\ (Windows) are absolute paths. Example: `/home/raodm`, `~/`, or `C:\Users\raodm`.
- **Relative path**: Paths that **do not start** with a / are relative paths. Relative paths indicate directory and file structures with respect to `pwd` (present working directory). Examples: `../cse271` or `../` or `../../courses/cse174/exercises` or just `test.txt`, etc.

Exercise: Briefly (2-to-3 sentences each) respond to the following questions regarding generic concepts of file paths.

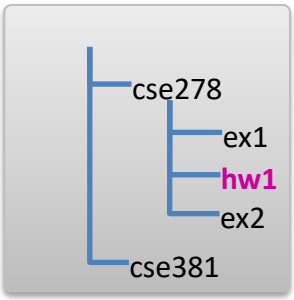
1. When we develop programs using files, we typically prefer to use relative paths. Why?

Relative paths are preferred over absolute because relative paths can be accessed by anyone while absolute paths are on a user-by-user basis.

2. Complete the following table to illustrate some of the general relative paths using a suitable sequence of `./` or `../`:

Description	Relative path
Present working directory (pwd)	`./`
The parent directory	`../`
The grandparent directory	`../../`
The great-grandparent directory	`../../../`
A subdirectory called `sub` under pwd	`./sub`

3. Now, let's practice a few path-related questions (similar to exam questions in this course) using the directory hierarchy shown in the adjacent figure. **Note that the absolute paths are not known (so you will need to use only relative paths)**.



   a. Assume the present working directory in `hw1`. Complete the following Java statement to open a file named `hello.txt` that exists in `ex2` directory.

```
FileInputStream fis = new FileInputStream(" ../ex2/hello.txt ");
```

   b. Assume the present working directory in `hw1`. Assume you have to call the following copy method:

```
class FileUtils {
    /**
     * Copies contents of a given source file to given destination file.
     * @param srcFile The source file to be copied.
     * @param destFile The duplicate file to be created.
     */
     public static void copy(String srcPath, String destPath);
}
```

   Illustrate a call to the above `copy` method to copy a file named `main.dat` from the `cse278` directory to a file named `main_copy.dat` in the `cse381` directory.

```
copy(../main.dat, ../../cse31/main_copy.dat);
```

Part #2: Text and binary file concepts

Estimated time: < 20 minutes

Background: Files are used to store different types of data on a storage medium. The contents of a file are classified into two main categories, namely text files and binary files. Binary files store bytes (a byte is 8-bits) of data while text files operate with characters. In Java a byte can have the

value -128–+127. In Java, a character occupies 2-to-4 bytes, depending on the encoding of characters. Text files, typically contain bytes with the value in the range 32–127, also called as 7-bit ASCII characters.

Exercise: In this part of the exercise, we will be reviewing some of the basic concepts of text and binary files.

1. What is a byte? What is the difference between a byte and a character?

   A byte consists of 8-bits and stores 256 values (-128 ⟵0 ⟶+127)

   A character uses 1-or-more bytes

2. State two advantages of binary files (when compared to text files)

   1. They are easier for a machine to read and write
   2. They operate using sequences of bytes

3. State two disadvantages of binary files

   1. They require custom software dependent on the contents
   2. May not be able to use them across different operating systems

4. When would a binary file also be a ASCII-text file?

   If all the bytes in a Binary file are in the range +32 to +127, then the binary file is a ACSII file

5. What is the difference between a binary file and a Random-access file?

   A random-access file is a sequence of fixed sized data that can be read or written in a random order. Binary files are a sequence of bytes/objects that must be read or written in a serial manner.

6. Consider the adjacent `Dog` class

```
class Dog {
    String name = "Fido";
    String breed = "Labradoodle";
}
```

   a. Copy-paste the Dog class into the space below. Next, suitably modify the Java class such that `Dog` objects can be written and read using `ObjectOutputStream` and `ObjectInputStream`.

```
Class Dog implements Serialize {
    Private static final long serialVersionUID = 0L;

    Private String name = "Fido";
    Private String breed = "Labradoodle";
}
```

b. Write a method `public void outputDog(Dog pet, String zooName)` that writes `pet` into file with name specified by `zooName` using a suitable binary stream. The method must catch all exceptions.

```
 Void outputDog(Dog pet, String zooName) {
    Try {
        ObjectOutputStream    oos    =    new    ObjectOutoutStrea(new
FileOutputStream(zooName));
    Oos.writeObject(pet);
    } catch (Exception e) {
        e.printStackTrace();
    }
}
```

c. Write a method `public Dog inputDog(String zooName)` that reads a `Dog` object from file with name specified by `zooName` using a suitable binary stream. The method must catch all exceptions.

```
Dog inputDog(String zooName) {
    Dog pet = null;
    try {
        ObjectInputStream    ois    =    new    ObjectInputStream(new
FileInputStream(zooName));
        pet = (Dog) ois.readObject();
    } catch (Exception e) {
        e.printStackTrace();
    }
    return pet;
}
```

7. The following problem is loosely-inspired by paths (*i.e.*, nested directories represented as a binary tree) but is more focused on recursion.

A strategy game contains a randomly generated maze that consist of a series of *paths* that either end at an exit or at a dead end as shown in the adjacent figure. The maze has been represented using a series of `Path` objects show in the code fragment. Paths that have an exit have the `isExit` variable set to `true`. Paths that dead end have both `leftPath` and `rightPath` set to `null`. Complete the following method that searches the maze starting from a given `Path` and returns a `Path` object that has `isExit` set to `true`. If no such object is found, then this method must return `null`.

```
public class Path {
  public Path leftPath;
  public Path rightPath;
  public boolean isExit;
  // Reset not shown
}
```

```
static Path findExit(Path start) {

if (start == null || start.isExit) {
    return start;
}
Path exit = findPath(start.leftPath);
if (exit == null) {
    exit = findPath(start.rightPath);
}
return exit;
}
```

Part #3: Text & object binary files

Estimated time: < 30 minutes

Background: Recollect that, binary files are not human-readable and require a special program to create and manipulate binary files. Hence, binary files are typically created from text data that is either entered by the user or read from a file. This would be the case immaterial of whether a GUI is used. A similar approach is used for binary files associated with databases or even spreadsheets.

Exercise: Complete this part of the exercise in the following manner:

1. Create a new Java project in Eclipse
2. Download the supplied starter code `employee.txt`, `Employee.java` and `EmployeeTester.java` to your new Eclipse project.
3. Do not modify `EmployeeTester.java`
4. Follow the Javadoc comments and instructions in `Employee.java` to suitably implement the methods.
5. Once you have correctly implemented the methods, run the `main` method in `EmployeeTester` for testing.

Expected output:

```
Data loaded from text file:
 1, John Smith     ,  35535
 5, Mary Jones     ,  75355
 3, Chen Wang      ,  63535
 7, Manish Patel   ,  47535
 2, Li Chyou       ,  55000
 6, Akari Nokomoto ,  42750
 4, Ren Koyo       ,  59750
 8, Hakim Mandela  ,  67500

Writing data to binary file...
Done.

Data loaded from binary file:
 1, John Smith     ,  35535
 5, Mary Jones     ,  75355
 7, Manish Patel   ,  47535
 2, Li Chyou       ,  55000
 4, Ren Koyo       ,  59750
 8, Hakim Mandela  ,  67500
```

Part #4: Programming with random-access files

Estimated time: < 30 minutes

Background: Recollect that, random access files enable reading and writing data at any offset within a given file. Random access gives us the advantage of being able to read data without having to read previous information. However, this advantage is effectively realized only when fixed-size records are used to read and write data. Accomplishing fixed-size records has its own inherent limitations as well.

Exercise: Complete this part of the exercise in the following manner:

1. Create a new Java project in Eclipse
2. Download the supplied starter code `simple_db.dat`, `SimpleDB.java` and `SimpleDBTester.java` to your new Eclipse project.
3. Do not modify `SimpleDBTester.java`
4. Follow the Javadoc comments and instructions in `SimpleDB.java` to suitably implement the methods.
5. Once you have correctly implemented the methods, run the `main` method in `SimpleDBTester` for testing.

Expected output:

```
Record #4:  4, Ren Koyo       ,  59750
Record #2:  7, Manish Patel   ,  47535

Testing swap method
Record #5:  5, Mary Jones     ,  75355
Record #7:  3, Chen Wang      ,  63535

Sorting & printing
 1, John Smith     ,  35535
 6, Akari Nokomoto ,  42750
 7, Manish Patel   ,  47535
 2, Li Chyou       ,  55000
 4, Ren Koyo       ,  59750
 3, Chen Wang      ,  63535
 8, Hakim Mandela  ,  67500
 5, Mary Jones     ,  75355
```

Part #5: Submit to Canvas via CODE plug-in

Estimated time: < 5 minutes

Exercise: You will be submitting the following files via the Canvas CODE plug-in:

1. This MS-Word document saved as a PDF file – **Only submit PDF file**.
2. The Java source file `Employee.java`, `SimpleDB.java` that you modified in this exercise.

Ensure you actually complete the submission on Canvas by verifying your submission (after you submit)