Lab 12 : Collections and Recursion

Topics covered 2d-array, collections and recursion

Exercise 1: The arrays we have been using so far have only held one column of data. But we often want to set up an array to hold more than one column. These arrays are called multi-dimensional arrays. We can think of a 2d-array as a matrix. For example, if we have a 2d-array named `arr`. Then row 0 consists of the elements `arr[0][0]`, `arr[0][1]`, `arr[0][2]`, etc. The column 0 is the elements `arr[0][0]`, `arr[1][0]`, `arr[2][0]`, `arr[3][0]` and so on.

	Column 0	Column 1	Column 2
Row 0	arr[0][0]	arr[0][1]	arr[0][2]
Row 1	arr[1][0]	arr[1][1]	arr[1][2]
Row 2	arr[2][0]	arr[2][1]	arr[2][2]
Row 3	arr[3][0]	arr[3][1]	arr[3][2]

Part 1. create a 2d-array with 4 rows and 3 columns of integers and assign some random value between 1 to 100 to each array element.

Part 2. Write a method that returns the sum of the elements in a given row of this 2d-array.

Part 3. Write a method that returns the sum of the elements in a given column of this 2d-array.

Part 4. Write a method that calculates the sum of each row and returns all row sums in this 2d-array.

Part 5. Write a method that returns the maximum value in this 2d-array.

Exercise 2: Revise the `Pet` class you created lab 7 to use `ArrayList` to store nicknames of a pet instead of using `Array`. You also need to revise all of the methods which using the "nicknames" attribute in the `Pet` class, e.g. addNickname(), hasNickname(), etc. Why it's better to use ArrayList rather than Array here?

```
public class Pet {

   private ArrayList<String> nicknames;

   ...
}
```

Exercise 3: Write a program which allow user to keep entering strings. The program will update and dispaly the cumulative occurence of each character in all previous strings user input. User can press `ctrl + d` in the terminal to terminate the program. You should use a `HashMap` to store relavent data.

```
$ java Occurance
Please input a string: Hello
{e=1, o=1, l=2, H=1}
Please input a string: Haha
{e=1, a=2, o=1, l=2, H=2, h=1}
Please input a string:
...
```

Exercise 4: In mathematics, the Fibonacci sequence are the numbers in the following integer sequence:

- 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, ...

By definition, the first two numbers in the Fibonacci sequence are 0 and 1, and each subsequent number is the sum of the previous two.

Write a class `Fibonacci` that takes a integer n from command line argument and print the nth Fibonacci number.

```
$ java Fibonacci 1
1
$ java Fibonacci 7
13
```

Extension 1: `Tower of Hanoi` is a puzzle invented by E. Lucas in 1883. It consists of three rods, and a number of disks of different sizes arranged from largest on the bottom to smallest on the top placed on a rod. The objective of the puzzle is to take minimum number of steps to move the entire stack to another rod with following rules:

- Only one disk can be moved at a time.
- Cannot place a larger disk onto a smaller disk.
- A disk can only be moved if it is the top of the stack.

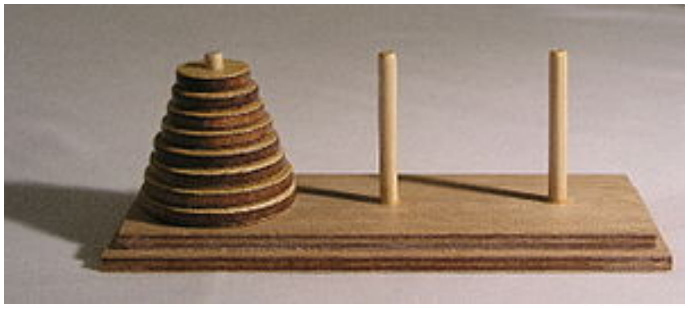

Figure 1: A model set of the Tower of Hanoi with 8 disks (source: Wikipedia)

Write a `Hanoi` class to move the given number (from command line argument) of disks from one rod to another using recursion.

```
$ java Hanoi 3
disk 1 from rod A to rod C
disk 2 from rod A to rod B
disk 1 from rod C to rod B
disk 3 from rod A to rod C
disk 1 from rod B to rod A
disk 2 from rod B to rod C
disk 1 from rod A to rod C
```