

תוכנה 1

תרגיל מספר 3

הנחיות כלליות:

- קראו בעיון את קובץ נוהלי הגשת התרגילים אשר נמצא באתר הקורס.
 - הגשת התרגיל תעשה במערכת ה VirtualTAU בלבד (<http://virtual2002.tau.ac.il/>).
 - יש להגיש קובץ zip יחיד הנושא את שם המשתמש ומספר התרגיל (לדוגמא, עבור המשתמש zvainer יקרא הקובץ zvainer_hw3.zip) קובץ ה zip יכיל את קבצי ה-java של התוכניות אותם התבקשתם לממש
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שאלות:

בכל אחת משלוש השאלות הראשונות הינכם נדרשים לממש מתודה מסוימת. בנוסף יש לממש מתודת main המדגימה את השימוש במתודה שכתבתם (קוראת לה מספר פעמים עם ערכים שונים ומדפיסה את הערך המוחזר מכל קריאה).

Implement the methods described in the first 3 questions in a class called Func.

1. Implement the method **public static int maxSpan(int[] nums)**.
The method returns the maximal span found in a given array. (Efficiency is not a priority here).
Consider the leftmost and rightmost appearances of some value in an array. We'll say that the "span" is the number of elements between those extremities, inclusive. A single appearance has a span of 1.
For example: $\text{maxSpan}(\{1, 2, 1, 1, 3\}) \rightarrow 4$ (the span of 1)
 $\text{maxSpan}(\{1, 4, 2, 1, 4, 4, 4\}) \rightarrow 6$ (the span of 4)
2. Implement the method **public static int[] fix34(int[] nums)**.
The method accepts an integer array as its input and returns a **new array** which is a permutation of the input array. The method `fix34` rearranges the input array such that every 3 is immediately followed by a 4 (e.g. if there is a 3 at position i , there will be a 4 at position $i+1$). The method keeps the original positions of the 3s but may move any other number, moving the minimal amount of numbers.
Assumptions regarding the input:
 - The array contains the same number of 3's and 4's (for every 3 there is a 4)
 - There are no two consecutive 3s in the array
 - The matching 4 for a 3 at some position i is at position j where $j > i$ (after)
 - Examples: $\text{fix34}(\{1, 3, 1, 4\}) \rightarrow \{1, 3, 4, 1\}$
 $\text{fix34}(\{3, 2, 2, 4\}) \rightarrow \{3, 4, 2, 2\}$
3. Implement the method **public static String notReplace(String str)**.
The method takes a String as its input and returns a String in which every occurrence of the **lowercase word** "is" has been replaced with "is not". The word "is" should not

be immediately preceded or followed by a letter -- so for example the "is" in "this" should not be replaced. (Note: Character.isLetter(char) tests if a char is a letter.)

Examples: notReplace("is test") → "is not test"
 notReplace("is-is wise") → "is not-is not wise"

בשאלות הבאות נעשה שימוש בקבצי jar. כאשר הנכם נדרשים להוסיף קובץ jar (או zip) לפרויקט יש לעשות זאת ב Eclipse ע"י קליק ימני על הפרויקט, בחירה ב Build Path ואח"כ Add External Archives. יש לבחור את הקובץ אותו רוצים להוסיף לפרויקט. בנוסף, הקובץ hw3_resources.zip מכיל את הקבצים הנדרשים בשאלות אלו.

4. In this question you will write a program that draws a simple picture. You are not required to learn anything about graphics, instead you will use a Turtle class supplied by us that implements turtle graphics as described below.

Introduction - LOGO and Turtle Graphics

LOGO is a simple programming language that is often used to introduce programming concepts as well as planar geometry concepts to children. A LOGO environment consists of a window representing a plane and a turtle that lives in this plane. The turtle has a tail that can be up or down. If the turtle is walking while its tail is down, it leaves behind it a line. When it walks while its tail is up, no line is left behind. The purpose of LOGO is to be able to draw/define various figures by giving instructions to the turtle.

The turtle has a location and a direction. You can give the turtle instructions to change its location and direction causing it to draw some figures along the way. For example, the instruction 'forward 30' tells the turtle to advance 30 units forward in the direction it is looking at. The instruction 'left 45' tells the turtle to turn 45 degrees counter-clockwise (i.e., change its direction by 45 degrees).

Here is a representative list of instructions you can give the turtle of LOGO:

forward x	advance x units forwards
backwards x	move x units backwards
left x	turn x degrees counter-clockwise
right x	turn x degrees clockwise
tail up	lifts the turtle's tail
tail down	lowers the turtle's tail

What You Should Implement

You are not expected to implement the emulation of LOGO by yourself. For this purpose we give you a Java class [Turtle](#). Recall that this class defines all the behaviors of a LOGO turtle. Your program should only create a turtle object and give it instructions by invoking methods on it. The table below lists the methods of a Turtle object. You are encouraged to look at the [API documentation of class Turtle](#).

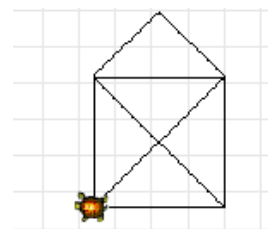
<code>moveForward(x)</code>	advance x units forwards
<code>moveBackward(x)</code>	move x units backwards
<code>turnLeft(x)</code>	turn x degrees counter-clockwise
<code>turnRight(x)</code>	turn x degrees clockwise
<code>tailUp()</code>	lifts the turtle's tail
<code>tailDown()</code>	lowers the turtle's tail

[Pentagon.java](#) is an example of a program that uses class Turtle to draw a 'pentagon' figure (Below is the skeleton of the program with some additional comments).

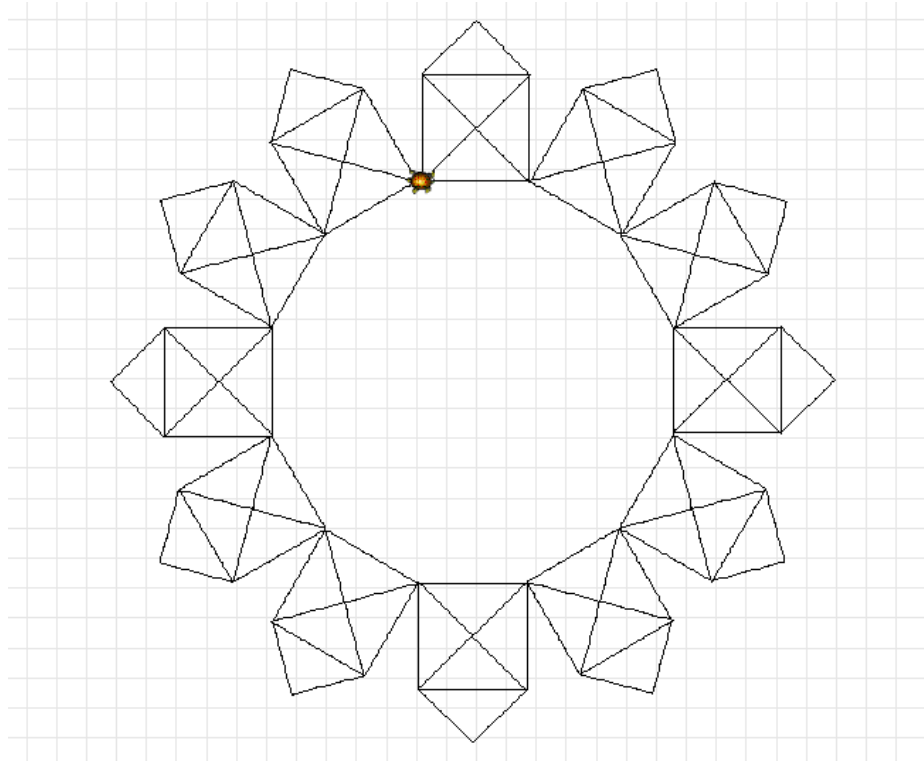
```
class Pentagon {

    public static void main(String[] args) {
        Turtle leonardo = new Turtle(); // Creates the turtle
        leonardo.tailDown();             // Start painting
        leonardo.moveForward(100);        // Advances the turtle
                                         // forward by 100 units
        // ...
    }
}
```

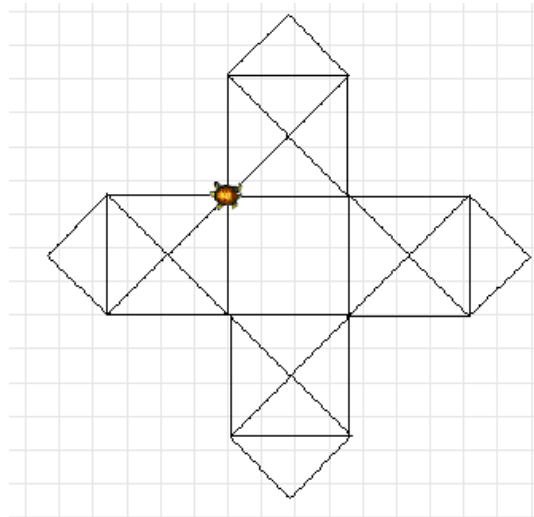
Recall that an Euler drawing is a drawing that can be done without lifting the pencil from the paper. In other words it is a figure that is drawn without going over any line twice. This is an example of an Euler drawing with our turtle.



Write a class named **TurtleDrawing** that draws the above figure n times, where n is provided by the user (see below). After each figure is drawn the turtle rotates so that at the end it will complete a full cycle. You may assume user input is correct. In order to receive input from the user use the [LineInput](#) class (located in the `simpleio.jar` file). For example, below is the output of `TurtleDrawing` when called with $n == 12$.



And this is how the output would look for $n=4$:



Once the program finished drawing, hide the turtle using the method [hide\(\)](#).

Technical Details

In order to use the Turtle and LineInput classes you will need to include [logo_turtle.jar](#) and [simpleio.jar](#) on your project as explained above.

5. In this section you will implement utilities for image processing. The methods you'll implement will rotate, flip and modify gray scales of a displayed image. Since reading an image file and displaying it is out of the scope of this course, we supply you with a JAR file that loads images and triggers the image processing methods.

What You Should Do

You are given a skeleton for the class [ImageProcessing](#). You should implement all the defined methods in the class (except main). The documentation for the class is given [here](#).

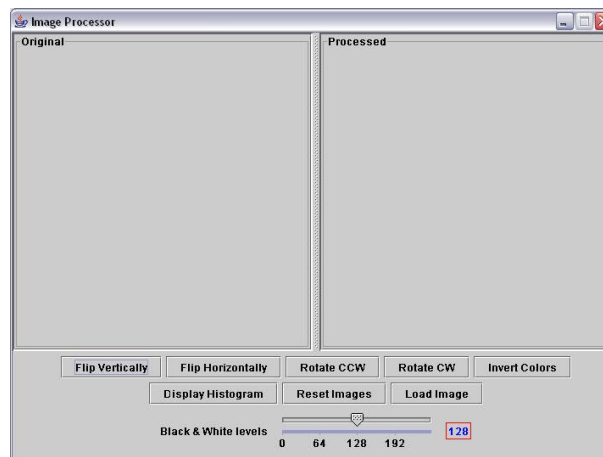
Each of the static methods in this class receives as an input a two dimensional array of image data. To simplify things we define that only gray scaled images are supported in our program, thus the image data contains values between 0 and 255, and where 0 is **black**, 255 is **white** and anything in between is a gray level. The graphical interface we supply invokes the **ImageProcessing** methods by sending the image data as a two-dimensional int array, receiving the results of the operation (your implementation) and displaying the produced image in the 'Processed' frame. Every cell in the array is actually the gray level of the pixel (picture element) at its corresponding image position.

Technical Details

- Download the [image_processor.jar](#), and make sure to include it on your build path as described above.

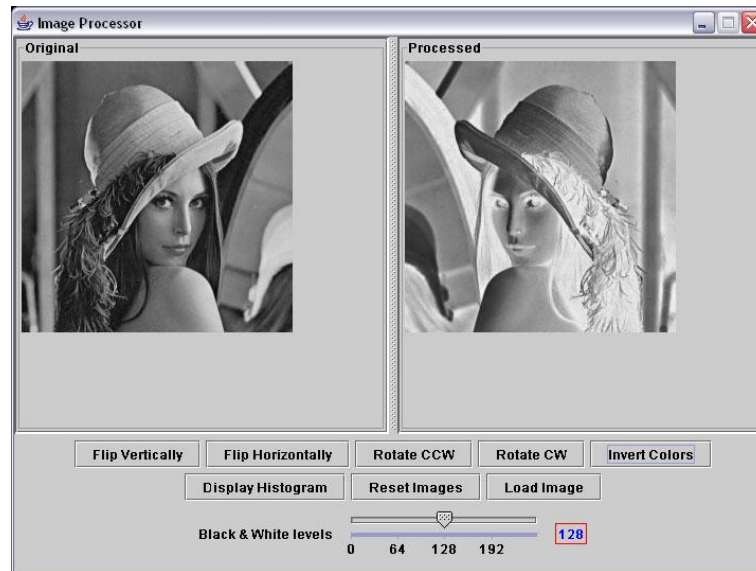
You can test your implementation at any point by simply running the skeleton program we provide. Running the program will display the application's graphic interface (see below).

Initially clicking the buttons will have no effect as each button invokes one of your methods (not implemented yet). As your implementation progresses you should be able to see the result of it, this will aid you in testing and debugging your implementation.

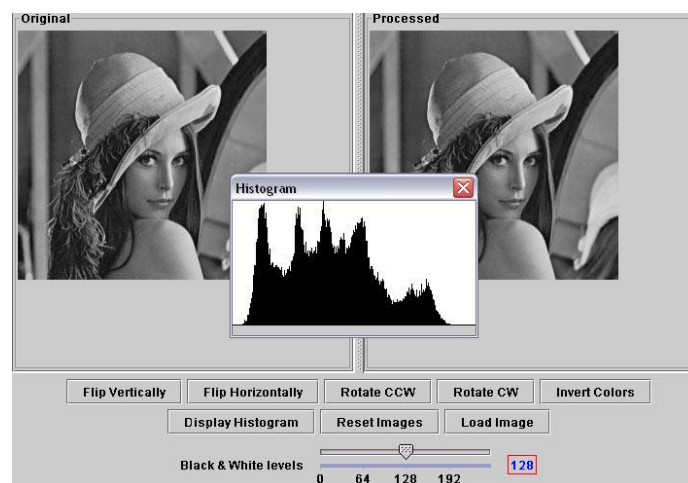


- To load an image click on the 'Load Image' button and select a gray-scaled image you wish to view. You can find [a zip file containing 2 images here](#) that you can use.

For example, loading the 'lena.jpg', flipping it (along the Y axis) and inverting it will yield the following result:



- The **histogram** method creates a histogram for the given image data. It returns a 256 cells array that holds the histogram representation. Each cell index in the array is referred as the *column height* for a given gray level that corresponds to the array's index number itself. For example, if the value 30 is in cell 0, that means we have 30 pixels with the value of 0 (black) in the loaded image. More generally: Cell i holds the number of image pixels with a gray level of i . Pressing the 'Display Histogram' button will display the loaded image histogram:



- The **invert** method changes the grayscale levels of the image so the 0 becomes 255, 1 becomes 254, 2 become 253 etc.
- The **toBW** method transforms the grayscale image into a black and white one. A pixel's value under a given threshold will become 0 otherwise it will become 255.
- The **flipX** method should perform a flip relative to the X axis - i.e. **vertical** flip, and the **flipY** should perform a **horizontal** flip. See [animation](#) for clarification.