משימה 3# בקורס תוכנה 1

הוראות הגשה:

1. קראו בעיון את קובץ נוהלי הגשת התרגילים אשר נמצא באתר הקורס.
2. הגשת התרגיל תעשה ע"י המערכת VirtualTAU (http://virtual.tau.ac.il).
3. הגשת התרגיל תתבצע ע"י יצירת קובץ zip שנושא את שם המשתמש. לדוגמא, עבור המשתמש zvainer יקרא הקובץ zvainer.zip.
   קובץ ה zip יכיל:
   א. קובץ פרטים אישיים בשם details.txt המכיל את שמכם ומספר ת.ז. הזהות שלכם.
   ב. קבצי ה-java. של התכניות שהתבקשתם לכתוב.
   ג. קובץ טקסט עם העתק של כל קבצי ה Java.

שאלות:

בכל אחת מ שלוש השאלות ה ראשונות 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.

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).
   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 two, inclusive. A single value has a span of 1.
   For example: maxSpan({1, 2, 1, 1, 3}) → 4 (the span of 1)
   maxSpan({1, 4, 2, 1, 4, 1, 4}) → 6 (the span of 4)
   maxSpan({1, 4, 2, 1, 4, 4, 4}) → 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.
   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
   - Examples: fix34({1, 3, 1, 4}) → {1, 3, 4, 1}
     fix34({3, 2, 2, 4}) → {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 occurance 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") → "is not-is not"
   notReplace("This is right") → "This is not right"

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.

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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.

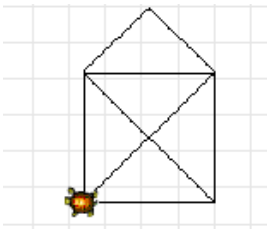
`moveForward(x)`	advance x units forwards
`moveBackward(x)`	move x units backwards
`turnLeft(x)`	turn x degrees counter-clockwise
`turnRight(x)`	turn x degrees clockwise
`tailUp()`	lifts the turtle's tail
`tailDown()`	lowers the turtle's tail

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).

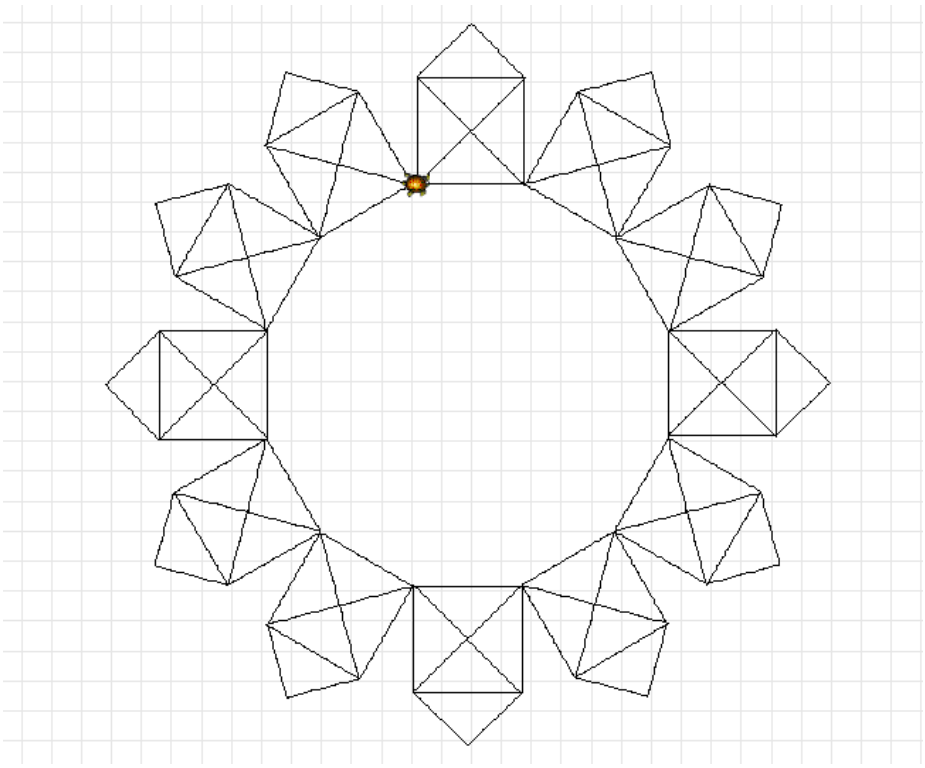
```
class Pentagon {

    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
        // ...
    }
}
```

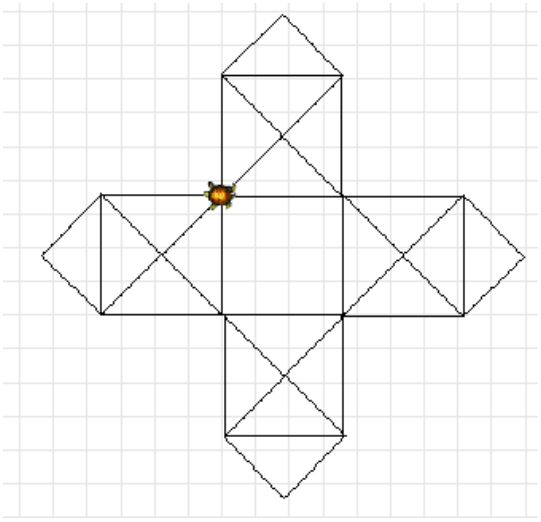
Recall that an Euler drawing is a drawing that can be done without lifting the pencil from the paper. In other words it is a figure that is drawn without going over any line twice. This is an example of an Euler drawing with our turtle.



Write a class called **TurtleDrawing** that draws the above figure *n* times, where *n* is provided by the user. After each figure is drawn the turtle rotates so that at the end it will complete a full cycle. In order to receive input from the user you should use the LineInput class (located in the simple_io.zip file). For example below is the output of TurtleDrawing when it is called to draw 12 figures.



And this is how the output would look for 4 figures:



After finshing drawing, hide the turtle using the method hide().

Technical Details

In order to use our Turtle class and the LineInput class you should include both logo_turtle.jar and simple_io.zip on your project as explained above. Note that Turtle is defined in the default package, hence you have to write your code in the default package as well.

5. In this exercise, you will get the code of the class Circle. Notice that the instance variables of class Circle include the radius, and two double values x0 and y0 which represent the center coordinate of the circle. We wish to change the implementation of class Circle so that instead of these two variables, we will have an instance of class Point as a member instance variable representing the center (download Point.java).

   Remember that changing the implementation details should not affect the API of the class! This means that this change should not be noticed by outside users of class Circle. In particular you are not allowed to modify any of the method signatures. In practice you will surely need to change the implementation of some of the methods. Use the Circle.java file given to you and modify it to implement your solution.

   To test your modified Circle class, we supply you with a class CircleViewer which you can use to display your circles. CircleTest.java is a simple program that uses CircleViewer. This program creates two circles and a CircleViewer object, and adds both circles to the viewer, using the method addCircle() of the viewer.

   The CircleViewer "remembers" the circles it should display (by storing a reference to it), and whenever the update() method is called on it, it uses the Circle interface to retrieve the state of all the circles it should display (i.e., calls getCenter(), getRadius()), and draws them appropriately. To use the CircleViewer class, download shapes.zip and include it in your project as explained above.

   Write your own simple program called SimpleCircleTest that tests your circle implementation class. Remember to test all the methods in the class, and use the CircleViewer class.

6. In this section you will implement a utility class for image processing. Your class will be able to 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

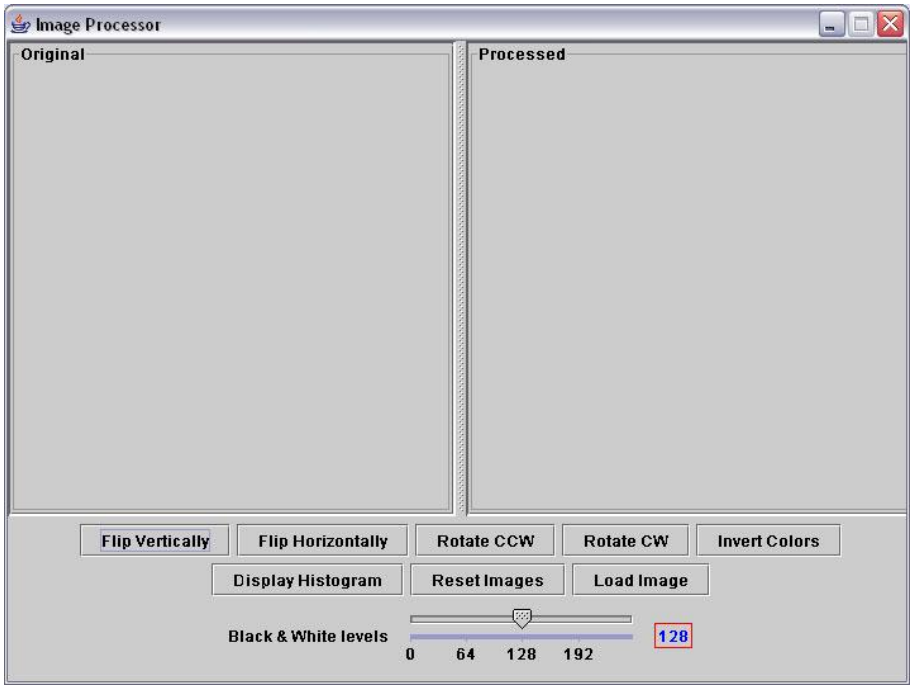
   Implement the class **`ImageProcessing`** according to its API.
   Each of the static methods in this class receives as an input a two dimensional array of image data. To simplify things we define that only gray-scaled images are supported in our program, thus the image data contains values between 0 and 255, where 0 symbols the **black**, 255 symbols the **white** and anything in between symbols a level of gray.
   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 explained above.
- At any stage of your work you can test your methods by executing the graphical interface we supplied.
  You can do so by creating a main class that will contain the following main method and placing it in the working directory:

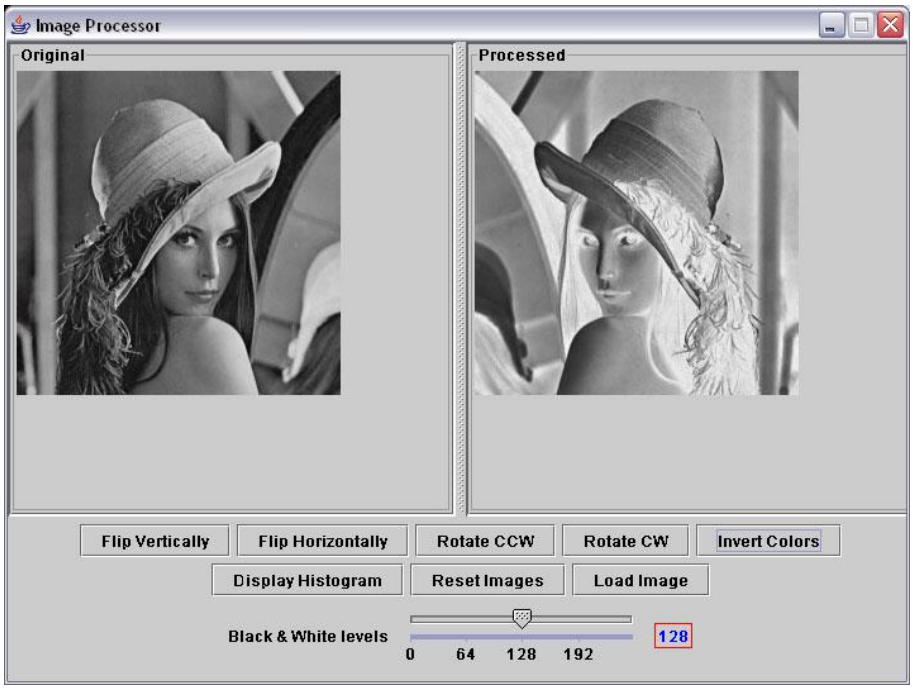
```
public static void main(String[] args) {
      ImageProcessorUI processorUI =
            new ImageProcessorUI("Image Processor");
}
```

  Executing the main will display the application's screen:

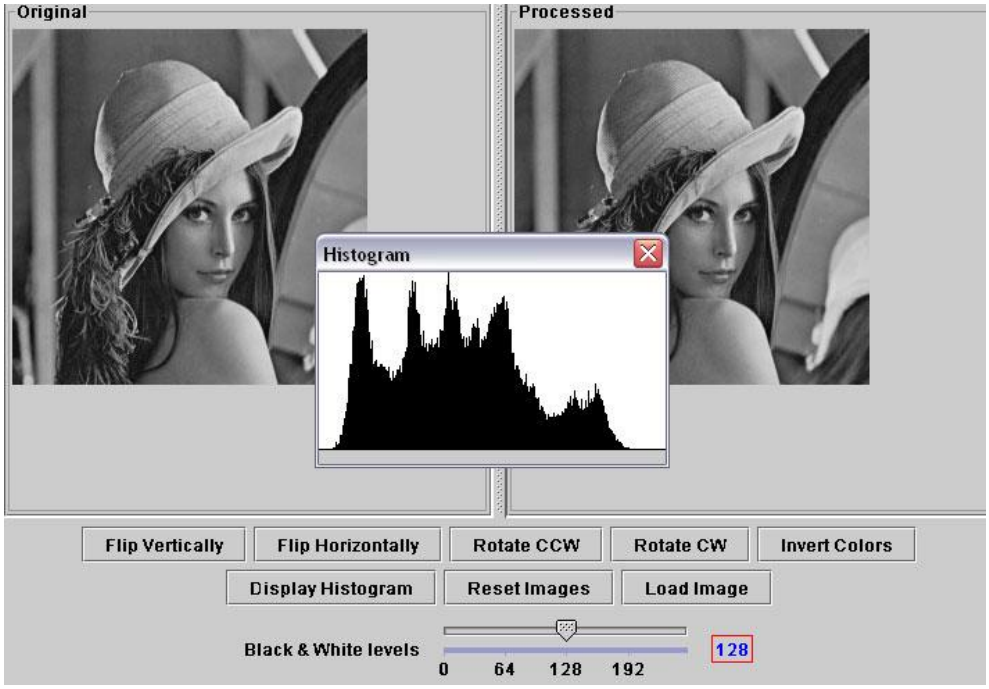


  Note: DO NOT submit this main.

- Load an image by clicking 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 play with.
  For example, loading the 'lena.jpg', flipping it and inverting it will yield the image below:



- 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 `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.