Lab 8
Implementation Plan

1. Download the sample code and test it. Create a new instance of `ImageViewer` and use it to load an image. Slide the "Brightness Levels" control all the way to the left. Then, move it slightly to the right by pressing the right arrow key several times. You should see clear changes in the image.

2. Create a new class named `Expander` that extends `ImageFilter`. The easiest part of this class is the constructor. It should take no parameters and do nothing. Like our `Quantizer` class, this class will inherit the `filter` and `layerFilter` methods from the `ImageFilter` class. Therefore, the main method you will have to define in this class is the `pixelFilter` method. The first thing to do in `pixelFilter` is determine the largest and smallest values in the pixel array. We suggest defining two private methods that will return the minimum and maximum values in a pixel array and invoking these methods from `filter`. Once it has the minimum and maximum values, your `pixelFilter` should process every value in the pixel array. If a particular element in the pixel array has value, `b`, you should replace it with

   ```
   ( b - minimum ) * 256/ (maximum - minimum + 1 )
   ```

3. Add an "Expand Range" button to your interface. Create a new `JPanel` to hold the button and add this `JPanel` to the `controlPane` right after the load button. This `JPanel` will eventually also hold the button that displays histograms.

4. Add code to the `buttonClicked` method to invoke the `filter` method of your `Expander` class when the "Expand Range" button is clicked. This code should apply the `filter` method to the image currently associated with the variable `displayed`. Then, both display the result `filter` returns and associates it with the variable `displayed`. Test this new functionality on the images from the `ExpandExamples` folder under the the `AllImages` folder (except for the RISD.png image which is damaged).

5. Create a `DualImageViewer` class that extends `GUIManager`. It should use a `BorderLayout` with two `ImageViewer`s in the `CENTER` and a `JPanel` holding the three control buttons in the `SOUTH`. The `Imageviewer`s should be placed in a `JPanel` that uses `GridLayout`. Add the three buttons now, even though they won't do anything for a while. Remove the `createWindow` call from `ImageViewer`. Test to ensure that each of your two image viewers appears correctly and can load images individually.

6. Add a `getPic` method to `ImageViewer` that returns the value of `displayed`. Use this new method together with the `setPic` method to implement the "Move Left -> Right" button. This will require adding a `buttonClicked` method to the `DualImageViewer` class.

7. Use the `Paster` class we provided to implement the "Insert Left -> Right" button's functionality.

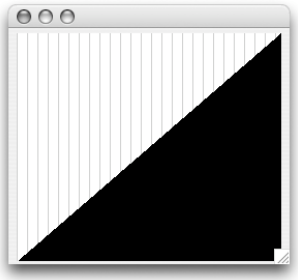
8. Modify the `buttonClicked` method in the `DualImageViewer` class so that the "Show Difference" button creates a new `ImageViewer`, tells the new `ImageViewer` to create a window, and sets the picture in the viewer to be the left image from the `DualImageViewer`. Test that this works.

9. Create and define the `Differencer` class. This class will extend `ImageViewer` like your `Expander` class, but its implementation will resemble the `Paster` class included with the starter project more than the `Expander` or `Quantizer` class. Its constructor will take an `SImage` as a parameter and associate it with an instance variable. It will include the definition of a `layerFilter` method that will take another `SImage` as a parameter. It will also take an `int` identifying a color level and extract the pixel arrays for that color level from both the image passed to the constructor and to `layerFilter`. It should return a pixel array that holds the absolute values of the differences between the two pixel arrays.

10. Modify the `buttonClicked` method in `DualImageViewer` to use the filter method of the `Differencer` class so that it displays the difference between the left and right images. Test this code by computing the difference between the two images in the `Difference` folder of `AllImages`.

11. Define the `DisplayHistogram` class. This class should extend `GUIManager`. In the handout, we suggested you should write a private method that draws a single line to simplify the implementation of this class. A good way to start therefore is to write this method and a simplified version of the constructor that will test it. This initial constructor will expect no parameter, create a 256 by 200 pixel array, use the private method to draw a few vertical lines of different sizes within the pixel array, create an `SImage` using the pixel array, and finally display this `SImage` in a `JLabel` in its window. If you include an invocation of `createWindow` in the constructor, you will be able to test this class and your line drawing method independently of the rest of your program.

12. Since you will need a working version of the `DisplayHistogram` class to tell if your Histogram class is really working, next define a trivial Histogram class that should cause your final `DisplayHistogram` class to display a window like this (actually, you are not required to draw the gray scale lines):

    To do this, define the `Histogram` method that is supposed to return the number of pixels of a given brightness so to instead return the brightness value itself. Define the method that is supposed to return the most frequently occurring brightness value to returns 255. Make the constructor should expect no parameters and do nothing.

13. Next, create one of your trivial `Histogram`s in the `DisplayHistogram` constructor and add a loop to the constructor to draw 256 lines based on the values returned by this `Histogram`. Test this until the result looks like the image above.

14. Now you are ready to work on the real `Histogram` class. First, change the constructor in the current version of the class to expect an `SImage` as a parameter. Next, change the `DisplayHistogram` constructor to expect a `Histogram` as a parameter. Finally, add a "Show Histogram" button to your `ImageViewer` class and modify its `buttonClicked` method so that it constructs and new `Histogram` using the image displayed and a new `DisplayHistogram` using this `Histogram`. Test this code. Since you did not modify the methods in the `Histogram` class, it should still display a triangle like the one shown above.

15. Write the real `Histogram` class. The constructor should create an array of 256 `int`s declared as an instance variable. It should then extract a pixel array of the gray levels of the `SImage` that was passed as a parameter. It should examine each value in the array, adding one to the corresponding position in the 256 element array as it does so. With this array, it should then be easy to define methods to return the most frequently occurring brightness value and the number of pixels of any brightness. Test the result on some of the images provided. You may find it interesting to look at the histograms of image differences.

16. Finally, you should complete the `Blocker` class. This class will extend `ImageFilter` and resemble `Quantizer` and `Expander` in its style of implementation. The key is to write two private methods to fill a block and to find the average brightness of a block. Since it is simpler, you might want to start by defining the method to fill a block with a particular value. You can test this method by defining a version of the `pixelFilter` method that fills each block with the brightness of the pixel in its upper left corner. Write this code and modify `ImageViewer` so that it displays and responds to the "Block size" slider. Test this code.

17. Once this is done, write the method to compute the average of a block and change `pixelFilter` to fill each block with its average rather than with the brightness of its upper left corner.

18. Check over all of your work before handing it in: formatting, comments, good variable names, vertical whitespace, and design. Consider what would happen to each of your methods if the input image data was not what you expected. Would your `expandRange` method work on an all-white image?