

CSCE 155 - Java

Lab 5.0 - Methods & Testing

Prior to Lab

Before attending this lab:

1. Read and familiarize yourself with this handout.
2. Read Chapters 5 and 29 of the [Computer Science I](#) textbook

Peer Programming Pair-Up

For students in the online section: you may complete the lab on your own if you wish or you may team up with a partner of your choosing, or, you may consult with a lab instructor to get teamed up online (via Zoom).

For students in the face-to-face section: your lab instructor will team you up with a partner.

To encourage collaboration and a team environment, labs are structured in a *peer programming* setup. At the start of each lab, you will be randomly paired up with another student (conflicts such as absences will be dealt with by the lab instructor). One of you will be designated the *driver* and the other the *navigator*.

The navigator will be responsible for reading the instructions and telling the driver what to do next. The driver will be in charge of the keyboard and workstation. Both driver and navigator are responsible for suggesting fixes and solutions together. Neither the navigator nor the driver is “in charge.” Beyond your immediate pairing, you are encouraged to help and interact with other pairs in the lab.

Each week you should alternate: if you were a driver last week, be a navigator next, etc. Resolve any issues (you were both drivers last week) within your pair. Ask the lab instructor to resolve issues only when you cannot come to a consensus.

Because of the peer programming setup of labs, it is absolutely essential that you complete any pre-lab activities and familiarize yourself with the handouts prior to coming to lab. Failure to do so will negatively impact your ability to collaborate and work with others which may mean that you will not be able to complete the lab.

1 Lab Objectives & Topics

At the end of this lab you should be familiar with the following:

- Understand how to design, document, write, and use methods in Java
- Design test cases and write informal unit tests

2 Background

Most programming languages allow you to define and use functions (or *methods*). Functions *encapsulate* functionality into a unit of code that can be reused. A function can be specified to take any number of inputs (called parameters or arguments) and return an output. Defining and using functions has several advantages. First, it facilitates code reuse. Rather than cutting and pasting a block of code, it can be encapsulated into a function and reused by calling the function anytime it needs to be executed.

Second, functions facilitate *procedural abstraction*. Often, we don't care or need to worry about the implementation details of a certain algorithm or procedure. By encapsulating the details in a function, we only need to know how to use it (what inputs to provide it and what output we can expect from it). We don't need to worry about *how* it computes its result. For example, up to now you've been using the standard math library's function to compute the square root of a number x , but you haven't had to worry about the details of how this computation actually takes place.

Finally, functions naturally define a *unit* of code that can be easily tested. Typically, unit tests are designed with *test cases* which are input/output combinations that are known to be correct. Unit testing involves feeding the input to a function and comparing the output to the *expected* output. If they match, we say the test case *passes*, if not, we say it *fails*. Unit testing gives a higher level of confidence that our function's implementation is correct.

When defining a function, it is necessary to define its *signature*. The signature of a function includes:

- The function's identifier – its name
- The return type – the type of variable the function returns
- The parameter list – the number of parameters the function takes (also called its

arity) along with their types

2.1 Methods in Java

In Java, functions (usually called methods) must be declared/defined within a class. This is done by declaring the method's signature and adding a block of code that specifies the instructions that will be executed when the method is invoked. In addition, there are two modifiers that can be applied to methods:

- `public` – this specifies that the method is publicly visible and can be invoked by any other method. Alternatives include `private` (the method is only visible within the class) and `protected` (the method is visible within the class and any subclasses)
- `static` – this specifies that the method belongs to the class and not to instances of the class.

3 Activities

We have provided partially completed programs for each of the following activities. Clone the lab's code from GitHub using the following URL: <https://github.com/cbourne/CSCE155-Java-Lab05>.

3.1 Writing Methods

Images are made up of individual *pixels*. Each pixel can be represented using an RGB (red-blue-green) color scheme. RGB is generally used in displays and models a color with three integer values in the range $[0, 255]$ corresponding to the red, green and blue “contribution” to the color. For example, the triple $(255, 255, 0)$ corresponds to a full red and green (additive) value which results in yellow.

Two common image filters are a black-and-white filter which transforms an image into an equivalent gray-scale image, and a sepia filter which transforms a photo to a reddish-brown monochrome to give it an old-timey look.

We have already written a substantial program that processes an image file and applies one of these filters. However, you will need to write the functions responsible for transforming an RGB value into a gray-scale or sepia RGB value.

To convert an RGB value to gray-scale you can use one of several different techniques. Each technique “removes” the color value by setting all three RGB values to the same value but each technique does so in a slightly different way.

The first technique is to simply take the average of all three values:

$$\frac{r + g + b}{3}$$

The second technique, known as the “lightness” technique averages the most prominent and least prominent colors:

$$\frac{\max\{r, g, b\} + \min\{r, g, b\}}{2}$$

The luminosity technique uses a weighted average to account for a human perceptual preference toward green, setting all three values to:

$$0.21r + 0.72g + 0.07b$$

In all three cases, the integer values should be *rounded* rather than truncated.

A sepia filter sets different values to each of the three RGB components using the following formulas. Given a current (r, g, b) value, the sepia tone RGB value, (r', g', b') would be:

$$\begin{aligned} r' &= 0.393r + 0.769g + 0.189b \\ g' &= 0.349r + 0.686g + 0.168b \\ b' &= 0.272r + 0.534g + 0.131b \end{aligned}$$

As with the gray-scale techniques, values should be rounded. Moreover, if any of the values exceeds 255, they should be reset to 255 to stay within the valid RGB color range.

Instructions

In this exercise, you will design and write a “color utilities” library by implementing the methods described below. We’ve provided a class, `ColorUtils` with a few methods already completed for you. You’ll place your methods in the same class.

- Run the `ColorUtilsTester` file which contains several informal unit tests for the methods in `ColorUtils`. Observe that one of the tests will fail. Fix the `toGrayScaleAverage` method so that it passes the test. Use this as an opportunity to observe:
 - How to use the `RGB` class
 - How methods are defined in Java
 - How methods are documented in Java

Be sure to write doc-style documentation for all of the following methods.

- Write a helper method that returns the *minimum* of 3 integers. Name your function `min`.

- Write a method that takes an `RGB` value and uses the lightness technique to return the gray-scale `RGB` value. Name your method `toGrayScaleLightness`
- Write a method that takes an `RGB` value and uses the luminosity technique to return the gray-scale `RGB` value. Name your method `toGrayScaleLuminosity`
- Write a method that takes an `RGB` value and computes a sepia-tone `RGB` value. Name your method `toSepia`.
- Write doc-style documentation for all your functions.

3.2 Ad-Hoc Testing

We’ve provided an application interface (see `ImageDriver` that loads and saves images specified as *command line arguments*.

- You only need to specify the file names
- It is assumed the files are in the `images`
- The output file will be in the same directory, you may need to *refresh* your project in Eclipse if they do not show up automatically

The program uses your methods to convert the image and save it to a new file.

Do some *ad-hoc testing* using this application: convert the images provided as part of the project and view the results. You can also try converting some of your own images. If your functions are correct, the image conversion should look something like Figure 1.



Figure 1: Memorial Stadium. Original image (left) and Sepia-toned image (right).

3.3 Writing Tests

Testing is a fundamental step in software development. The most common types of tests are *unit tests* and the most common “unit” is a function. You may have already “tested”

your functions by running the project and viewing the resulting images. However, for your final activity, you will write (informal) *automated* unit tests to test your functions more rigorously.

Some starter unit testing code has already been provided in `ColorUtilsTester`. Each block of code calls a function with some inputs and compares the return value to the *expected* output. If they match, the test passes, if not it fails. A message is printed to the user and the total number of passed/failed test cases is reported.

Using this starter code as an example, add more test cases for the other functions. You should write at least 1 test case for *each* function you wrote.

4 Handin/Grader Instructions

1. Hand in your completed files:

- `ColorUtils.java`
- `ColorUtilsTester.java`

through the webhandin (<https://cse-apps.unl.edu/handin>) using your cse login and password.

2. Even if you worked with a partner, you *both* should turn in all files.
3. Verify your program by grading yourself through the webgrader (<https://cse.unl.edu/~cse155h/grade/>) using the same credentials.