Project 4

CMPT220L
Due on Dec 4, 2020 by 11:59 PM
Points: 100

The Complex Class

Problem Description

A complex number is a number of the form $a+bi$, where a and b are real numbers and i is $\sqrt{-1}$. The numbers a and b are known as the real part and imaginary part of the complex number, respectively. You can perform addition, subtraction, multiplication, and division for complex numbers using the following formula:

$$a + bi + c + di = (a + c) + (b + d)i$$

$$a + bi - (c + di) = (a - c) + (b - d)i$$

$$(a + bi) * (c + di) = (ac - bd) + (bc + ad)i$$

$$(a + bi)/(c + di) = (ac + bd)/(c^2 + d^2) + (bc - ad)i/(c^2 + d^2)$$

You can also obtain the absolute value for a complex number using the following formula:

$$|a + bi| = \sqrt{a^2 + b^2}$$

Deliverables

1. Create a UML diagram of a class named `Complex` that extends the `Number` class for representing complex numbers. **15 Points**

2. Implement the class in Java (Complex.java) and add the following methods:

   (a) `add`, `subtract`, `multiply`, `divide`, `abs` for performing complex-number operations. **15 Points**

   (b) Override `toString` method for returning a string representation for a complex number. The `toString` method returns $a + bi$ as a string. If b is 0, it simply returns a. **15 Points**

3. Provide three constructors `Complex(a,b)`, `Complex(a)`, and `Complex()`. `Complex()` creates a `Complex` object for number 0 and `Complex(a)` creates a `Complex` object with 0 for b. **15 Points**

4. Provide the `getRealPart()` and `getImaginaryPart()` methods for returning the real and imaginary part of the complex number, respectively. **15 Points**

5. Implement the `Cloneable` and `Comparable` interfaces.

6. Create Java program called `Project4` that prompts the user to enter two complex numbers and display the result of their addition, subtraction, multiplication, and division. **15 Points**
   Here is a sample run:

```
Enter the first complex number: 3.5 5.5
Enter the second complex number: -3.5 1
(3.5 + 5.5i) + (-3.5 + 1.0i) = 0.0 + 6.5i
(3.5 + 5.5i) - (-3.5 + 1.0i) = 7.0 + 4.5i
```

```
(3.5 + 5.5i) * (-3.5 + 1.0i) = -17.75 + -15.75i
(3.5 + 5.5i) / (-3.5 + 1.0i) = -0.5094 + -1.7i
|3.5 + 5.5i| = 6.519202405202649
```

7. Comment your code. **10 Points**

Extra Credit (Optional) 30 points

If z_1, z_2, z_3 are three noncollinear points in the complex space, then the directed or signed area $A(z_1, z_2, z_3)$ of the triangle with these vertices is given by

$$A(z_1, z_2, z_3) = \frac{i}{4}\begin{vmatrix} z_1 & \overline{z}_1 & 1 \\ z_2 & \overline{z}_2 & 1 \\ z_3 & \overline{z}_3 & 1 \end{vmatrix} \tag{1}$$

Write a program that takes three points specified by their x and y coordinates and calculates the area using complex numbers. Assume that $z_n = x_n + y_n i$. Compare your result with the formula we used previously in class to calculate the area of a triangle. Call your program `Extra.java`. *Note:* Use `https://en.wikipedia.org/wiki/Determinant` to solve equation (1).

Submission

Submit the following items:

1. Create a PDF file with the UML diagram and submit to GitHub.
2. Compile, test, and submit your Java program to GitHub (you must submit the program regardless whether it's complete or incomplete, correct or incorrect)

Place your `.java` file under the corresponding folder in your local copy of the GitHub repository, commit and push it to the remote repository. Make sure that the professor has access to the repository (`jfac65-marist`).

```
cmpt220lastname\
   prj\
      4\
         Project4.pdf
         Project4.java
         Complex.java
```