Problem Set 4 Exercise #07: Complex Numbers

Reference: Lecture 10 Unit 2 notes

Learning objective: Object-oriented programming

Estimated completion time: 45 minutes

Problem statement:

In mathematics, A **complex number** has the form **`a + bi`** where **`a`** is the real part, **`b`** is the imaginary part and **`i = sqrt(-1)`**.

Complex numbers are a field, and thus have addition, subtraction, multiplication and division operations as listed below:

- Addition: **`(a + bi) + (c + di) = (a + c) + (b + d)i`**
- Subtraction: **`(a + bi) - (c + di) = (a - c) + (b - d)i`**
- Multiplication: **`(a + bi) * (c + di) = (a*c – b*d) + (b*c + a*d)i`**
- Division: **`(a + bi) / (c + di) = ( (a*c + b*d)/(c*c + d*d) ) +`**
  `( (b*c - a*d)/(c*c + d*d) )i`

Write a complex number class that has two attributes: *real* (real part) and *imag* (imaginary part), both are integers. This class should support the following operations:

- **`Complex(int inReal, int inImag) // create a complex number`**
- **`void add(Complex another)       // this = this + another`**
- **`void minus(Complex another)     // this = this - another`**
- **`void multiply(Complex another)  // this = this * another`**
- **`void divide(Complex another)    // this = this / another`**
- **`String toString()   // return e.g. "(3 + 4i)"`**

You may assume that division operation is always valid (i.e., **`c*c + d*d != 0`**).

In addition, write a user program **PS4_Ex07_TestComplex.java** that reads a complex number from user input. After that, it reads a series of commands (each with another complex number), and performs corresponding arithmetic calculations as defined above and reports the result. Once "q" is inputted, your program should terminate.

For example, in the sample run #1 next page, a complex number **`8+9i`** is first inputted, it is then subtracted (-) by the second inputted complex number **`4+4i`** which gives the result of **`4+5i`**.

Sample run #1:

```
8 9
Complex number (8 + 9i) created
- 4 4
After subtraction: (4 + 5i)
q
```

Sample run #2:

```
4 5
Complex number (4 + 5i) created
+ 4 5
After addition: (8 + 10i)
- 4 5
After subtraction: (4 + 5i)
* 4 5
After multiplication: (-9 + 40i)
/ 4 5
After division: (4 + 5i)
q
```

Sample run #3:

```
4 5
Complex number (4 + 5i) created
+ 1 2
After addition: (5 + 7i)
- 3 4
After subtraction: (2 + 3i)
* 5 6
After multiplication: (-8 + 27i)
/ 7 8
After division: (1 + 2i)
q
```

Sample run #4:

```
0 0
Complex number (0 + 0i) created
* 2 3
After multiplication: (0 + 0i)
/ 4 5
After division: (0 + 0i)
+ 2 5
After addition: (2 + 5i)
q
```