COMP220 — Exam 4 (100 points)

Fall 2017

For this exam you will design elements of a complex number class. A brief description of complex numbers and some operations on them is given below. The next page contains exam questions. You are allowed to use any sources you wish, provided you cite them and following the academic honesty policies. **Due Thursday, 10/19 by the start of lab.**

Complex Numbers

Complex numbers are combinations of real and imaginary numbers. The imaginary number i is the number whose square root is -1. This means that $i^2 = -1$. Complex numbers are written as a sum of a real number and an imaginary numbers like so: $3 + 5i$, $0.2 + 15.3i$, $0 + i$, $1 + 0i$, $0 + 0i$, etc. Two complex numbers are equal only when their coefficients are equal.

Complex numbers can be represented abstractly in terms of a pair of real numbers made from their real and imaginary coefficients. For example, the complex number $2.5 - 3.7i$ corresponds to the pair $(2.5, -3.7)$ and in general $a + bi$ corresponds to the pair (a, b). Just like with Rational numbers, were able to build up the basic operations of complex numbers in terms of standard arithmetic involving these pairs.

Addition

To add complex numbers we simply add the appropriate coefficients.

$$(3 + 5i) + (-2 + 6i) = (1 + 11i)$$

In terms of abstracted pairs we have

$$(a, b) + (c, d) = (a + c, b + d)$$

Multiplication

Multiplying complex numbers requires a bit more work. We must multiply each coefficient with the other in the same way we'd multiply binomials. We can then use the fact that $i^2 = -1$ to simplify. For example:

$$\begin{aligned}(3 + 5i) * (-2 + 6i) &= -6 + 18i + -10i + 30i^2 \\ &= (-6 + -30) + (18 + -10)i \\ &= (-36 + 8i)\end{aligned}$$

For abstracted pairs this reduces down to

$$(a, b) * (c, d) = (ac - bd, ad + bc)$$

Conjugation

One more important operation on complex numbers is taking the conjugate. This simply means negating the imaginary coefficient such that (a, b) becomes $(a, -b)$.

Real, Imaginary, and Complex

The set of complex numbers contains all the real numbers, since real numbers are simply complex numbers with a zero-valued imaginary coefficient, i.e. $(a, 0)$ is real for all values of a. Likewise, imaginary numbers are those complex numbers with a zero real coefficient, i.e. $(0, b)$ is imaginary for all values of b. These two sets of numbers intersect in exactly one place: $(0, 0)$.

Exam Questions

All your code should work correctly in Code::Blocks. I should be able to open your project, compile without problems and run your tests. Submit via `handin` as assignment *exam4* by **Thursday, 10/19 at the start of lab**.

1. Design a Complex number class with the following components. Each component must include a basic declaration, a stub, and tests (but not documentation unless specified below).
   (a) A default constructor
   (b) A constructor to initialize the number directly from the real and imaginary coefficients
   (c) `operator==`
   (d) Basic Accessors (getters)
   (e) Basic Mutators (setters)
   (f) `operator+`
   (g) `operator*`
   (h) a conjugation method that acts as a mutator
   (i) predicate methods that determine if a complex number if zero, real, or imaginary
   (j) A `toString` method that writes (a, b) as $a + bi$.
2. Write documentation for the following:
   (a) Both constructors
   (b) `operator*`
   (c) the conjugation method
3. Fully implement the following along with any other methods required the make the tests for these methods pass:
   (a) Both constructors
   (b) `operator==`
   (c) `operator*`
   (d) the conjugation method