Complex Numbers in Java

John Brophy
Visual Numerics
www.vni.com

Complex Arithmetic

- Class com.imsl.math.Complex.
- Double precision only.
- Complex objects are immutable.

Complex objects are immutable

- Complex objects have reference semantics, not value semantics
  - Difference between value and reference semantics is minimized for immutable objects
- Normally use x.equals(y) instead of x == y
  - Same as for String
  - == means same instance, equals mean equal value

If Complex were mutable

Initial

double x 1.2

double y 3.4

After

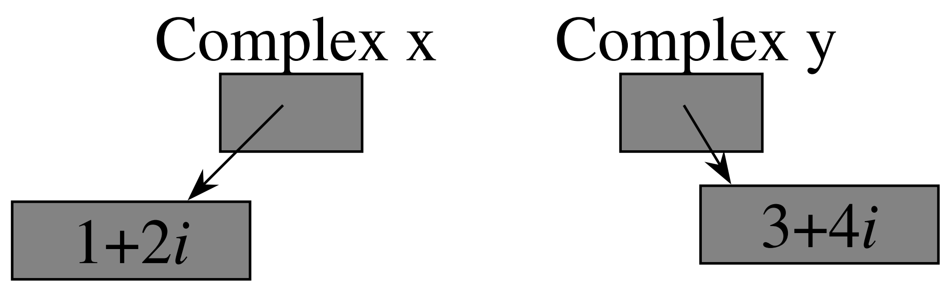
y = x;

x = 5.6;

double x 5.6

double y 1.2

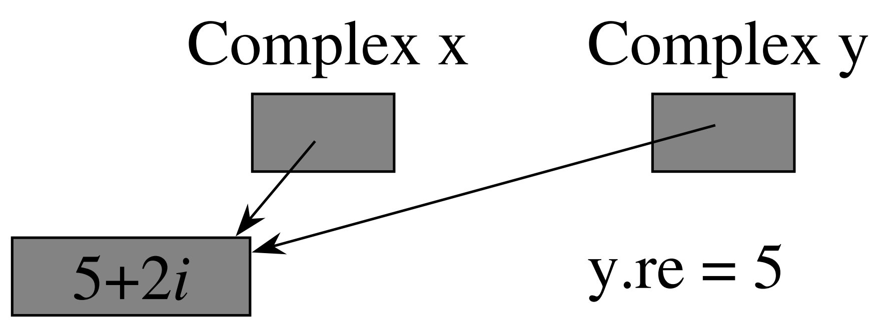
Initial



After

y = x;

x.re = 5;



y.re = 5

Complex Arithmetic

- x *op* y where *op* is plus, minus, times, over
  - » static Complex op(Complex x, Complex y)
  - » static Complex op(Complex x, double y)
  - » static Complex op(double x, Complex y)
- this *op* y
  - » Complex op(Complex y)
  - » Complex op(double y)
- x *op* this
  - » Complex opReverse(double x)

Complex Functions

- Implements
  - sqrt, exp, log, sin, cos, tan, asin, acos, atan, sinh, cosh, tanh, asinh, acosh, atanh, pow
- Numerical properties are as in the proposed C9X standard.
  - For example, sqrt has a branch cut along the negative real axis
  - sqrt($-\infty+iy$) = $+0+i\infty$, for all finite, positive y.
  - sqrt($-\infty-iy$) = $+0-i\infty$, for all finite, positive y.

Zeta Compiler

- A modified version of the IBM Jikes compiler
  - Open source Java compiler from IBM
  - Written in C++
  - Has been ported to a number of platforms

Zeta compiler enhancements

- Allows infix operations on Complex objects
  - supports + - * / += -= *= /=
- Infix expression x += y is compiled as if written x = Complex.plus(x,y).
- Equivalent to
  - x = new Complex(x.re+y.re, x.im+y.im)

Example

```
import com.imsl.math.Complex;

public class Quadratic
{
    static public void main(String argv[])
    {
            Complex a = new Complex(2,3);
            Complex b = new Complex(4,5);
            Complex c = new Complex(5,6);
            Complex x1 = solve1(a, b, c);
            System.out.println("Root" + x1);
            System.out.println("Check");
            System.out.println(a*x1*x1+b*x1+c);
    }

    static Complex solve1(Complex a, Complex b, Complex c)
    {
            Complex d = Complex.sqrt(b*b-4.0*a*c);
            return (-b+d)/(2.0*a);
    }
}
```

Obtaining Zeta

- Download from www.vni.com/corner/garage/grande/index.html
- Includes source to Java classes:
  - Complex class
  - Sfun (hyperbolic trig functions, error functions)
  - JMath (pure Java version of java.lang.Math)
- Binary for Windows 95/98/NT version of Zeta compiler.