Lecture 16:
Rational Numbers

Last time:
1. Aliasing and Mutability
2. Floating Point calculations

Today:
1. Example class development: Rational Numbers

Definition of a Rational Number

- What is a rational number?
- As a decimal it either terminates or repeats a pattern:
  - 1.75
  - 0.242935353535
- As a fraction, it can be represented as a fraction of two integers.

Today we will start an extended example

- We will implement a class, Rational, for (immutable) rational numbers
- The class will include
  - Constructors
  - Arithmetic operations (+, -, *, /)
  - toString
  - Comparisons (equals, compareTo)
“Lowest Terms”?

- How do we represent the fraction 20/60?
  - Reduce to lowest terms.
- Given a fraction p/q, how do you put it into lowest terms?
- Method
  - Find greatest common divisor (gcd) of p, q
    - gcd of p, q: largest number that divides both p, q
  - Euclid’s algorithm (beyond scope of this lecture) performs this if p, q are both positive
  - Replace p/q by (p/gcd) / (q/gcd)
- Example
  - Consider 18/24
  - gcd of 18 and 24 is 6
  - So 18/24 = (18/6) / (24/6) = 3/4

Hints

- Come up with representative test cases
- Intertwine implementation and testing
  - Do constructors and getters first, then test
  - Implement “related operations”, then test
- Rerun each test (even ones for previously tested methods) when you test
  - This is called regression testing
  - Useful for detecting changes that may invalidate previous test results!
  - Easy to set up in Eclipse
- Use debugger to track down sources of errors in tests

Rational Numbers (continued):
Arithmetic Operations

- What you remember from middle / high school
  - p/q + s/t = (p*t + q*s) / (q*t)
  - p*q - s/t = p/q + (-s/t)
  - 1/(p/q) = q/p
  - (p/q) / (s/t) = p/q * t/s = p/q * (1/(s/t))
Comparisons

- \( \frac{p}{q} = \frac{s}{t} \) if
  - \( \frac{p}{q}, \frac{s}{t} \) are in lowest terms, and
  - \( p = q \) and \( s = t \)
- \( \frac{p}{q} < \frac{s}{t} \) if \( pt < qs \)

We will focus on this case.