

Class specifications

CSE 331 – Section 3
10/11/12

Slides by Kellen Donohue
with material from Krystal Yousoufian, Mike Ernst

Agenda

- hw3 due tonight
- hw4 out tomorrow
 - Due next Thurs
 - Rational numbers, polynomial, graphing calculator
- Javadoc
- JUnit
- Representation Invariants & Abstraction Functions

hw4

- Polynomial Addition

$$(5x^4 + 4x^3 - x^2 + 5) + (3x^5 - 2x^3 + x - 5)$$

hw4

- Polynomial Addition

$$(5x^4 + 4x^3 - x^2 + 5) + (3x^5 - 2x^3 + x - 5)$$

$$\begin{array}{r} 5x^4 + 4x^3 - x^2 + 5 \\ + 3x^5 - 2x^3 + x - 5 \end{array}$$

hw4

- Polynomial Addition

$$(5x^4 + 4x^3 - x^2 + 5) + (3x^5 - 2x^3 + x - 5)$$

$$\begin{array}{r} 5x^4 + 4x^3 - x^2 + 5 \\ + 3x^5 + 0x^4 - 2x^3 + 0x^2 + x - 5 \end{array}$$

hw4

- Polynomial Addition

$$(5x^4 + 4x^3 - x^2 + 5) + (3x^5 - 2x^3 + x - 5)$$

$$\begin{array}{r} 5x^4 + 4x^3 - x^2 + 0x + 5 \\ + 3x^5 + 0x^4 - 2x^3 + 0x^2 + x - 5 \\ \hline \end{array}$$

$$3x^5 + 5x^4 - 2x^3 - x^2 + x + 0$$

hw4

- Polynomial Subtraction

$$(5x^4 + 4x^3 - x^2 + 5) - (3x^5 - 2x^3 + x - 5)$$

$$5x^4 + 4x^3 - x^2 + 5$$

$$- 3x^5 - 2x^3 + x - 5$$

hw4

- Polynomial Subtraction

$$(5x^4 + 4x^3 - x^2 + 5) - (3x^5 - 2x^3 + x - 5)$$

$$\begin{array}{r} 5x^4 + 4x^3 - x^2 + 0x + 5 \\ - 3x^5 + 0x^4 - 2x^3 + 0x^2 + x - 5 \end{array}$$

hw4

- Polynomial Subtraction

$$(5x^4 + 4x^3 - x^2 + 5) - (3x^5 - 2x^3 + x - 5)$$

$$\begin{array}{r} 5x^4 + 4x^3 - x^2 + 0x + 5 \\ - 3x^5 + 0x^4 - 2x^3 + 0x^2 + x - 5 \\ \hline \end{array}$$

$$-3x^5 + 5x^4 + 6x^3 - x^2 - x + 10$$

hw4

- Polynomial Multiplication

$$(4x^3 - x^2 + 5) * (x - 5)$$

hw4

- Polynomial Multiplication

$$(4x^3 - x^2 + 5) * (x - 5)$$

$$4x^3 - x^2 + 5$$

$$x - 5$$

*

hw4

- Polynomial Multiplication

$$(4x^3 - x^2 + 5) * (x - 5)$$

$$4x^3 - x^2 + 5$$

$$x - 5$$

*

$$-20x^3 + 5x^2 - 25$$

hw4

- Polynomial Multiplication

$$(4x^3 - x^2 + 5) * (x - 5)$$

$$4x^3 - x^2 + 5$$

*

$$x - 5$$

$$\begin{array}{r} 4x^4 - 20x^3 + 5x^2 - 25 \\ -x^3 + 5x \end{array}$$

hw4

- Polynomial Multiplication

$$(4x^3 - x^2 + 5) * (x - 5)$$

$$4x^3 - x^2 + 5$$

*

$$x - 5$$

$$-20x^3 + 5x^2 - 25$$

+

$$4x^4 - x^3 + 5x$$

$$4x^4 - 21x^3 + 5x^2 + 5x - 25$$

Polynomial Division

$$(5x^6 + 4x^4 - x^3 + 5) / (x^3 - 2x - 5)$$

Polynomial Division

$$(5x^6 + 4x^4 - x^3 + 5) / (x^3 - 2x - 5)$$

$$\begin{array}{r|l} x^3 - 2x - 5 & 5x^6 + 4x^4 - x^3 + 5 \end{array}$$

Polynomial Division

$$\begin{array}{r|rrrrrrrr} 1 & 0 & -2 & -5 & 5 & 0 & 4 & -1 & 0 & 0 & 5 \end{array}$$

Polynomial Division

$$\begin{array}{r} 5 \\ 1 \ 0 \ -2 \ -5 \ \overline{) \ 5 \ 0 \ 4 \ -1 \ 0 \ 0 \ 5} \end{array}$$

Polynomial Division

$$\begin{array}{r|rrrrrrr} & & & & & & & 5 \\ 1 & 0 & -2 & -5 & 5 & 0 & 4 & -1 & 0 & 0 & 5 \\ & & & & 5 & 0 & -10 & -25 & & & \end{array}$$

Polynomial Division

$$\begin{array}{r} 5 \\ 1 \quad 0 \quad -2 \quad -5 \quad \overline{) \quad 5 \quad 0 \quad 4 \quad -1 \quad 0 \quad 0 \quad 5} \\ \underline{5 \quad 0 \quad -10 \quad -25} \\ 0 \quad 0 \quad 14 \quad 24 \end{array}$$

Polynomial Division

$$\begin{array}{r} 5 \\ 1 \quad 0 \quad -2 \quad -5 \quad \overline{) \quad 5 \quad 0 \quad 4 \quad -1 \quad 0 \quad 0 \quad 5} \\ \underline{5 \quad 0 \quad -10 \quad -25} \\ 0 \quad 0 \quad 14 \quad 24 \\ \underline{ \quad \quad 14 \quad 24 \quad 0} \\ 0 \end{array}$$

Polynomial Division

$$\begin{array}{r|rrrrrrr} & & & & 5 & 0 & & \\ & & & & 5 & 0 & 4 & -1 & 0 & 0 & 5 \\ & & & & 5 & 0 & -10 & -25 & & & \\ \hline & & & & 0 & 0 & 14 & 24 & & & \\ & & & & & & 14 & 24 & 0 & & \end{array}$$

Polynomial Division

$$\begin{array}{r|rrrrrrr} & & & & 5 & 0 & & \\ & & & & 5 & 0 & 4 & -1 & 0 & 0 & 5 \\ & & & 5 & 0 & -10 & -25 & & & & \\ \hline & & & 0 & 0 & 14 & 24 & & & & \\ & & & & & 14 & 24 & 0 & & & \\ & & & & & 14 & 24 & 0 & 0 & & \end{array}$$

Polynomial Division

					5	0	14			
1	0	-2	-5	5	0	4	-1	0	0	5
				5	0	-10	-25			
				0	0	14	24			
						14	24	0		
						14	24	0	0	

Polynomial Division

					5	0	14				
1	0	-2	-5		5	0	4	-1	0	0	5
					5	0	-10	-25			
					0	0	14	24			
							14	24	0		
							14	24	0	0	
					14	0	-28	-70			

Polynomial Division

					5	0	14				
1	0	-2	-5	5	0	4	-1	0	0	5	
				5	0	-10	-25				
				0	0	14	24				
						14	24	0			
						14	24	0	0		
						14	0	-28	-70		
						0	24	28	70		

Polynomial Division

				5	0	14	
1	0	-2	-5	5	0	4	-1
				5	0	-10	-25
				0	0	14	24
						14	24
						14	24
						14	0
						-28	-70
						0	24
						24	28
						24	28
						70	70
						70	70
							5

Polynomial Division

					5	0	14	24				
1	0	-2	-5		5	0	4	-1	0	0	5	
					5	0	-10	-25				
					<hr/>							
				0	0	14	24					
						14	24	0				
						14	24	0	0			
						14	0	-28	-70			
					<hr/>							
					0	24	28	70				
						24	28	70	5			
						24	0	-48	120			
					<hr/>							
					0	28	118	125				

Polynomial Division

$$(5x^6 + 4x^4 - x^3 + 5) / (x^3 - 2x - 5)$$

$$5x^3 + 14x + 24$$

Polynomial Division

$$(5x^6 + 4x^4 - x^3 + 5) / (x^3 - 2x - 5)$$

$$5x^3 + 14x + 24 + \frac{28x^2 + 118x + 125}{x^3 - 2x - 5}$$

RatNum & RatTerm

- RatNum
 - ADT for a Rational Number
 - Immutable
 - Has NaN
 - Implement add/sub/mul div
- RatTerm
 - Single polynomial term
 - Coefficient (RatNum) & degree
 - Basic math operations

RatPoly & RatPolyStack

- RatPoly
 - Sum of RatTerms
 - Implement add/sub/div/mul (as demonstrated)
- RatPolyStack
 - Push/pop terms
 - add/sub/div/mul top two

CalculatorFrame

- Quick demo

Javadoc

- Javadoc comments are a special kind of Java comment

```
/**  
 * This is a javadoc comment.    // This is just a regular comment.  
 */
```

- Javadoc comments are used to communicate your API to the outside world.
- Automatic documentation generation, Eclipse hovercards

Recall: Class Specifications

- Describe **abstract value**: what the class represents at an abstract level
 - What the client sees
 - What data the ADT holds
- Brief summary of the ADT
- Doesn't describe implementation details

Recall: Representation Invariant

- Constrains an object's internal state
- Defines what must be true for abstraction function to hold
- If representation invariant is violated:
 - Object is “broken” – doesn't map to any abstract value

Verifying RI

- Representation invariant should hold before and after every public method
- Write & Use `checkRep()`
 - Call before and after public methods
 - OK that it adds extra code
 - Asserts won't be included on release builds
 - Important for finding bugs

Aside on optimization

- "More computing sins are committed in the name of efficiency (without necessarily achieving it) than for any other single reason — including blind stupidity." — [W.A. Wulf](#)
- "...[A]bout 97% of the time: premature optimization is the root of all evil. A good programmer ... will be wise to look carefully at the critical code; but only after that code has been identified" — [Donald Knuth](#)
- "The First Rule of Program Optimization: Don't do it. The Second Rule of Program Optimization (for experts only!): Don't do it yet." — [Michael A. Jackson](#)

Recall: Abstraction Function

- Abstraction function: a **mapping** from **internal state** to **abstract value**
- Abstract fields may not map directly to representation fields
 - Circle has **radius** but not necessarily
`private int radius;`
- Internal representation can be anything as long as it somehow encodes the abstract value

ADT Example: NonNullStringList

```
public class NonNullStringList {  
    // AF = ???  
    // RI = ???  
  
    public void add(String s) { ... }  
    public boolean remove(String s) { ... }  
    public String get(int i) { ... }  
}
```

ADT Example: NonNullStringList

```
public class NonNullStringList {  
    // AF = ???  
    // RI = ???  
  
    public void add(String s) { ... }  
    public boolean remove(String s) { ... }  
    public String get(int i) { ... }  
}
```

Internal representation with an array

ADT Example: NonNullStringList

```
public class NonNullStringList {
    // AF = Index i in arr contains the ith element in the list
    // RI = [0,count-1] != null

    private String[] arr;
    private int count;

    public void add(String s) { ... }
    public boolean remove(String s) { ... }
    public String get(int i) { ... }
}
```

ADT Example: NonNullStringList

```
public class NonNullStringList {  
    // AF = Index i in arr contains the ith element in the list  
    // RI = [0,count-1] != null  
  
    private String[] arr;  
    private int count;  
  
    public void add(String s) { ... }  
    public boolean remove(String s) { ... }  
    public String get(int i) { ... }  
}
```

How to implement remove?

ADT Example: NonNullStringList

```
public class NonNullStringList {  
    // AF = ???  
    // RI = ???  
  
    public void add(String s) { ... }  
    public boolean remove(String s) { ... }  
    public String get(int i) { ... }  
}
```

Internal representation with a LinkedList

ADT Example: NonNullStringList

```
public class NonNullStringList {
    // AF = Value in the nth node after head contains the nth item
    //      in the list
    // RI = Head has size nodes after it, each whose value is non-
    //      null, no cycle in ListNodes

    public int size;
    public ListNode head;

    public void add(String s) { ... }
    public boolean remove(String s) { ... }
    public String get(int i) { ... }
}
```

ADT Example: ComplexNumber

```
public class ComplexNumber {  
  
    // AF = ???  
    // RI = ???  
  
    public double getReal() { }  
    public double getImag() { }  
    public double getAbs() { }  
}
```

- Two possible implementations
 - x, y
 - r, θ

ADT Example: Circle

```
public class Circle {  
  
    // AF = ???  
    // RI = ???  
  
    public boolean isPointOnBorder(Point p) { }  
    public boolean containPoint(Point p) { }  
}
```

- Two possible implementations
 - Center, radius
 - Center, edge point