HW2: Polynomial Graphing Calculator

**Problem 0:** Write pseudocode algorithms for polynomial operations

**Problem 1:** Answer questions about RatNum

**Problem 2:** Implement RatTerm

**Problem 3:** Implement RatPoly

**Problem 4:** Implement RatPolyStack

**Problem 5:** Try out the calculator
RatThings

RatNum
- ADT for a Rational Number
- Has NaN

RatTerm
- Single polynomial term
- Coefficient (RatNum) & degree

RatPoly
- Sum of RatTerms

RatPolyStack
- Ordered collection of RatPolys
Polynomial Addition

\[(5x^4 + 4x^3 - x^2 + 5) + (3x^5 - 2x^3 + x - 5)\]
Polynomial Addition

\[(5x^4 + 4x^3 - x^2 + 5) + (3x^5 - 2x^3 + x - 5)\]

\[5x^4 + 4x^3 - x^2 + 5 + 3x^5 - 2x^3 + x - 5\]
Polynomial Addition

\[(5x^4 + 4x^3 - x^2 + 5) + (3x^5 - 2x^3 + x - 5)\]

\[
5x^4 + 4x^3 - x^2 \quad 0x \quad + 5 \\
+ \quad 3x^5 \quad 0x^4 \quad - 2x^3 \quad 0x^2 \quad + \quad x \quad - 5
\]
Polynomial Addition

\[(5x^4 + 4x^3 - x^2 + 5) + (3x^5 - 2x^3 + x - 5)\]

\[
\begin{array}{cccccc}
5x^4 & + & 4x^3 & - & x^2 & \text{ } 0x & + & 5 \\
3x^5 & + & 0x^4 & - & 2x^3 & \text{ } 0x^2 & + & x & - & 5 \\
\hline
3x^5 & + & 5x^4 & + & 2x^3 & - & x^2 & + & x & + & 0
\end{array}
\]
Polynomial Subtraction

\[(5x^4 + 4x^3 - x^2 + 5) - (3x^5 - 2x^3 + x - 5)\]

\[
5x^4 + 4x^3 - x^2 + 5
\]

\[
-3x^5 - 2x^3 + x - 5
\]
Polynomial Subtraction

\[(5x^4 + 4x^3 - x^2 + 5) - (3x^5 - 2x^3 + x - 5)\]

\[5x^4 + 4x^3 - x^2 \quad 0x \quad + 5\]

\[-3x^5 \quad 0x^4 - 2x^3 \quad 0x^2 + x \quad - 5\]
Polynomial Subtraction

\[(5x^4 + 4x^3 - x^2 + 5) - (3x^5 - 2x^3 + x - 5)\]

\[
\begin{align*}
5x^4 &+ 4x^3 - x^2 & &\quad 0x &+ 5 \\
-3x^5 & & &- 2x^3 & & &0x^2 &+ x &- 5 \\
\hline
-3x^5 & + 5x^4 &+ 6x^3 &- x^2 &- x &+ 10
\end{align*}
\]
Polynomial Multiplication

\[(4x^3 - x^2 + 5) \times (x - 5)\]
Polynomial Multiplication

\[(4x^3 - x^2 + 5) \times (x - 5)\]

\[4x^3 - x^2 + 5\]

\[\times\]

\[x - 5\]
Polynomial Multiplication

\[(4x^3 - x^2 + 5) \times (x - 5)\]

\[= 4x^3 - x^2 + 5\]
\[\times\]
\[= x - 5\]

\[= -20x^3 + 5x^2 - 25\]
Polynomial Multiplication

\[(4x^3 - x^2 + 5) \ast (x - 5)\]

\[
\begin{array}{c}
4x^3 - x^2 + 5 \\
\ast \\
\hline
\end{array}
\]

\[
\begin{array}{c}
x - 5 \\
\hline
\end{array}
\]

\[
\begin{array}{c}
-20x^3 + 5x^2 \\
\hline
\end{array}
\]

\[
\begin{array}{c}
4x^4 - x^3 + 5x \\
\hline
\end{array}
\]

\[ - 25 \]
Polynomial Multiplication

\[(4x^3 - x^2 + 5) \times (x - 5)\]

\[4x^3 - x^2 + 5\]

* 

\[x - 5\]

\[\begin{array}{c}
4x^4 \\
-20x^3 + 5x^2 \\
+ \quad 4x^4 \\
\end{array} \quad \begin{array}{c}
-x^3 \\
- 21x^3 + 5x^2 + 5x \\
\end{array} \quad \begin{array}{c}
\phantom{-} - 25 \\
\phantom{+} - 25 \\
\end{array}\]

\[4x^4 - 21x^3 + 5x^2 + 5x - 25\]
Poly Division

\[
(5x^6 + 4x^4 - x^3 + 5) \div (x^3 - 2x - 5)
\]
Poly Division

\[
(5x^6 + 4x^4 - x^3 + 5) \div (x^3 - 2x - 5)
\]
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<tr>
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Poly Division

\[
\begin{array}{cccc|cccccc}
1 & 0 & -2 & -5 & 5 & 0 & 4 & -1 & 0 & 0 & 5 \\
\end{array}
\]
## Poly Division

\[
\begin{array}{cccc}
1 & 0 & -2 & -5 \\
\hline
5 & 0 & 4 & -1 \\
5 & 0 & -10 & -25 \\
\end{array}
\]
## Poly Division

| 1 | 0 | -2 | -5 |   | 5 | 0 | 4 | -1 | 0 | 0 | 5 |
|---|---|----|----|---|---|---|---|----|---|---|---|---|
|   |   |    |    |   | 5 | 0 | 4 | -1 | 0 | 0 | 5 |
|   |   | 5  | 0 | -10 | -25 |
|   | 0  | 0  | 14 | 24 |
## Poly Division

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## Poly Division

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\begin{array}{cccc}
1 & 0 & -2 & -5 \\
\hline
5 & 0 & 4 & -1 & 0 & 0 & 5 \\
5 & 0 & -10 & -25 \\
0 & 0 & 14 & 24 \\
14 & 24 & 0
\end{array}
\]
Poly Division

\[
\begin{array}{cccc}
1 & 0 & -2 & -5 \\
5 & 0 & 4 & -1 & 0 & 0 & 5 \\
5 & 0 & -10 & -25 \\
0 & 0 & 14 & 24 \\
14 & 24 & 0 \\
14 & 24 & 0 & 0 \\
\end{array}
\]
Poly Division

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0 & 0 & 14 & 24 \\
14 & 24 & 0 \\
14 & 24 & 0 & 0 \\
\end{array}
\]
### Poly Division

$$
\begin{array}{cccc}
1 & 0 & -2 & -5 \\
\end{array}
\begin{array}{cccccc}
5 & 0 & 4 & -1 & 0 & 0 & 5 \\
5 & 0 & -10 & -25 \\
5 & 0 & 14 & 24 \\
14 & 24 & 0 \\
14 & 24 & 0 & 0 \\
14 & 0 & -28 & -70 \\
\end{array}
$$
Poly Division

\[
\begin{array}{cccccc}
1 & 0 & -2 & -5 & 2 & 4 & -1 & 0 & 0 & 5 \\
\hline
& 5 & 0 & 4 & -1 & 0 & 0 & 5 & 5 & 0-10 & -25 \\
& 14 & 24 & 0 & & & & & & \\
\end{array}
\]
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Poly Division

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\begin{array}{cccc}
1 & 0 & -2 & -5 \\
\hline
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 \\
24 & 28 & 70 & 5 \\
24 & 0 & -48 & -120
\end{array}
\]
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Poly Division

\[(5x^6 + 4x^4 - x^3 + 5) \div (x^3 - 2x - 5)\]

\[5x^3 + 14x + 24\]
Poly Division

\[
(5x^6 + 4x^4 - x^3 + 5) \div (x^3 - 2x - 5)
\]

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