

Report Lab 1: Large Integer Arithmetic Expression

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No.	Percentage understood	Content understood	Percentage Referenced	Reference Source
1	100%	Add two big integers	0%	
2	100%	Subtract two big integers	0%	
3	100%	Multiply two big integers (Karatsuba algorithm)	0%	
4	100%	Divide two big integers	0%	
5	100%	Operator precedence and parentheses	0%	
6	100%	Read input and save result to file	0%	
7	100%	Command line arguments	0%	

Multiply using Karatsuba Algorithm

Input: Two big integers a and b

Output: The product of a and b.

Step 1. determine the sign of two integers

+ if both a and b are positive, return the product with a sign positive.

+ if one of them is negative, convert the negative number to positive, compute the product and add a negative sign to result.

+ if both a and b are negative, convert both to positive and return the product with a positive sign

Step 2: Recursively compute the product using Karatsuba's method.

+ let $X = a$ and $Y = b$.

We split each number into two halves:

- $X = X_1 \cdot 10^m + X_0$

- $Y = Y_1 \cdot 10^m + Y_0$

Then, the product XY can be computed as:

$$XY = (X_1Y_1) \cdot 10^{2m} + ((X_1 + X_0)(Y_1 + Y_0) - X_1Y_1 - X_0Y_0) \cdot 10^m + X_0Y_0$$

Where: m is $n / 2$, and n is the maximum length of the two numbers.

Then compute:

$$Z1 = X1 \times Y1$$

$$Z2 = X0 \times Y0$$

$$Z3 = (X1 + X0) \times (Y1 + Y0)$$

We compute it to get the product faster because:

$$X1 \times Y1 = Z1$$

$$X0 \times Y0 = Z2$$

$$(X1 + X0) \times (Y1 + Y0) - X1 \times Y1 - X0 \times Y0 = Z3 - Z1 - Z2$$

Then we will have the product like this:

$$Z1 \times 10^{(2 \times m)} + (Z3 - Z1 - Z2) \times 10^m + z2;$$

Operator Precedence and Parentheses

Input: An arithmetic expression string with large integers, operators (+, -, *, /), and parentheses.

Output: The calculated result of the expression.

1. Traverse the expression from left to right.
2. If a number is found, convert it into a vector and push to the value stack.
3. If '(' is found, push it to the operator stack.
4. If ')' is found, apply all operators inside the parentheses.
5. If an operator is found, apply all operators with higher or equal precedence from the stack before pushing the new one.
6. After traversal, apply all remaining operators.
7. Return the final result from the value stack.