DATA STRUCTURES AND ALGORITHMS

Assignment # 2

Expression Evaluation using Stack

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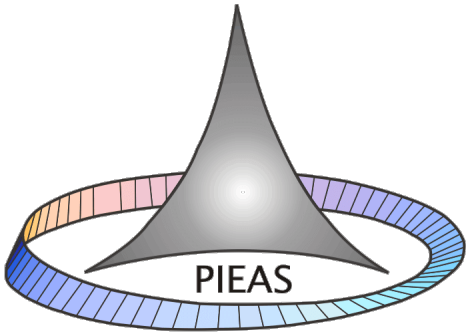

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Statement

You must implement Expression Evaluation System for space coordinate system <x,y,z> where x,y,z is of type real/float.

You must implement stack using STL. For driver/main function use expression, **"((A-(B+C)*(A+C/A))^A)+B''.** Lastly you must generate two tables as per **slides 53 and 69** against above said expression. Use A=<1,2,3>, B=<1.1,2.2,3.3> and C=<3.3,4.4,9.9>

Also

<a,b,c>+<x,y,z>=<a+x,b+y,c+z>,

<a,b,c>-<x,y,z>=<a-x,b-y,c-z>,

<a,b,c>/<x,y,z>=<a/x,b/y,c/z>,

<a,b,c>*<x,y,z>=<a*x,b*y,c*z>,

<a,b,c>^<x,y,z>=<a^x,b^y,c^z>.

Solution

Source Code

```
#include <iostream>
#include <conio.h>
#include <vector>
#include <math.h>
#include <string>
using namespace std;

template <class TV> class Node
{
public:
	TV data;
	Node <TV>*link;
	Node <TV>()
	{
	};
};
//We are using template so that character stack and vector stack can be
implemented simultaneously
template <class T> class Stack {
private:
	Node<T> *top = NULL;

public:
	Stack()
	{
```

```
	top = NULL;
}
~Stack()
{
	delete top;
}
bool isempty()
{
	if (top == NULL)
		return true; else
		return false;
}
void push(T value)
{
	Node<T> *ptr = new Node<T>();
	ptr->data = value;
	ptr->link = top;
	top = ptr;
}
T pop()
{
	if (isempty())
		cout << "Stack is Empty";
	else
	{
		Node<T> *ptr = top;
		top = top->link;
		return ptr->data;
		delete(ptr);
	}
}
void showTop()
{
	if (isempty())
		cout << "Stack is Empty";
	else {
		for (int i = 0; i < 3; i++)
			std::cout << top->data.at(i) << ' ';
	}
}
T sTop()
{
	if (isempty())
		cout << "Stack is Empty";
	else
	{
		return top->data;
	}
}
void displayStack()
{
	if (isempty())
		cout << "Stack is Empty\n";
	else
	{
		Node<T> *temp = top;
		while (temp != NULL)
		{
			cout << "";
```

```
                        for (int i = 0; i < 3; i++)
                                cout << "\t" << temp->data.at(i);
                        cout << "\t|";
                        temp = temp->link;
                }
                cout << "\n";
        }
    }
};
//operator precedence
int prec(char c)
{
    if (c == '^')
        return 3;
    else if (c == '*' || c == '/')
        return 2;
    else if (c == '+' || c == '-')
        return 1;
    else
        return -1;
}
//Function to convert Infix string to Postfix string
string infixToPostfix(string s)
{
    Stack <char> stackOfChar;
    stackOfChar.push('n');
    int l = s.length();
    string arrangedStack;
    for (int i = 0; i < l; i++)
    {
        if ((s[i] >= 'A' && s[i] <= 'Z') || (s[i] >= 'A' && s[i] <= 'Z'))
            arrangedStack += s[i];
        else if (s[i] == '(')

            stackOfChar.push('(');
        else if (s[i] == ')')
        {
            while (stackOfChar.sTop() != 'n' && stackOfChar.sTop() != '(')
            {
                char c = stackOfChar.sTop();
                stackOfChar.pop();
                arrangedStack += c;
            }
            if (stackOfChar.sTop() == '(')
            {
                char c = stackOfChar.sTop();
                stackOfChar.pop();
            }
        }
        else {
            while (stackOfChar.sTop() != 'n' && prec(s[i]) <=
prec(stackOfChar.sTop()))
            {
                char c = stackOfChar.sTop();
                stackOfChar.pop();
                arrangedStack += c;
            }
            stackOfChar.push(s[i]);
        }
```

```
	}
	while (stackOfChar.sTop() != 'n')
	{
		char c = stackOfChar.sTop();
		stackOfChar.pop();
		arrangedStack += c;
	}
	cout << "infinix expression is: "<< arrangedStack << "\n\n";
	return arrangedStack;
}

int main()
{
	int choice, flag = 1;
	vector<double> A = { 1,2,3 }, B = { 1.1,2.2,3.3 }, C = { 3.3,4.4,9.9 },
ans{ 0,0,0 };
	Stack <char> ch;
	Stack <vector<double>>  s;

	string expression = "((A-(B+C)*(A+C/A))^A)+B";
	string postfixExpression;
	postfixExpression = infixToPostfix(expression); //Conversion of Expression
from Infix to Postfix

	//Postfix String to char array conversion
	char e[16];
	for (int i = 0; i < sizeof(e); i++)
		e[i] = postfixExpression[i];

	//Postfix Array Evaluation
	cout << "Stack Flow:\n";
	for (int i = 0; i < 15; ++i)
	{
		s.displayStack();
		if (e[i] == 'A')
			s.push(A);
		else if (e[i] == 'B')
			s.push(B);
		else if (e[i] == 'C')
			s.push(C);
		else
		{
			vector<double> op1 = s.pop();
			vector<double> op2 = s.pop();
			switch (e[i])
			{
			case '+':
				for (int i = 0; i<3; i++) {
					op2[i] = op2[i] + op1[i];
				}
				s.push(op2);
				break;
			case '-':
				for (int i = 0; i < 3; i++) {
					op2[i] = op2[i] - op1[i];
				}
				s.push(op2);
				break;
			case '*':
```

```
                        for (int i = 0; i < 3; i++) {
                                op2[i] = op2[i] * op1[i];
                        }
                        s.push(op2);
                        break;
                case '/':
                        for (int i = 0; i < 3; i++) {
                                op2[i] = op2[i] / op1[i];
                        }
                        s.push(op2);
                        break;
                case '^':
                        for (int i = 0; i < 3; i++) {
                                op2[i] = pow(op2[i], op1[i]);
                        }
                        s.push(op2);
                        break;
                }
        }
    }
    s.displayStack();
    ans = s.sTop();
    cout << "\n\nInfix expression " << expression << " is: " << endl;
    cout << "\nIt becomes postfix expression as " << e << " is: " << endl;
    cout << "\nSolution is: " << e << " is: ";
    for(int i=0;i<3;i++)
        cout << ans[i] << "\t";

    _getch();
    return 0;
}
```

Output

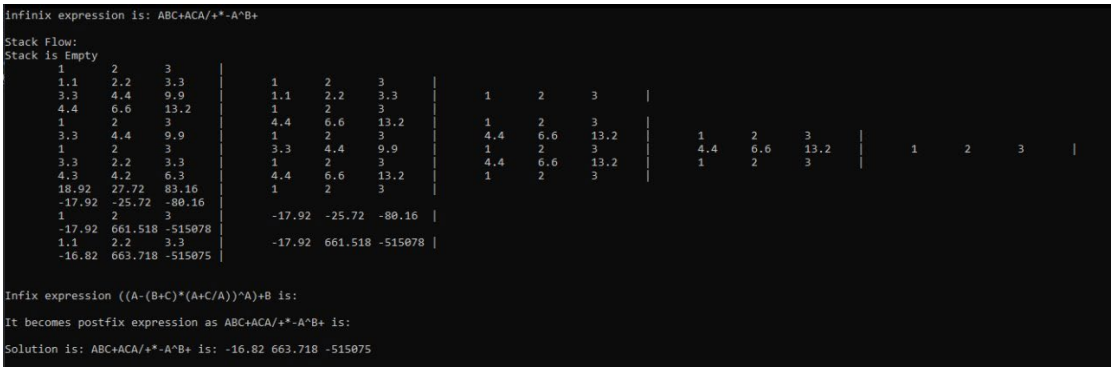

Figure 1: Output of the program

Infix to Postfix:

((A-(B+C)*(A+C/A))^A)+B

Steps	Input	stack	Postfix
1	(	(	
2	(	((	
3	A	((	A
4	-	((-	A
5	(	((-(	A

6	B	((-(	AB
7	+	((-(+	AB
8	C	((-(+	ABC
9	)		ABC+
10	*	((-*	ABC+
11	(	((-*(	ABC+
12	A	((-*(	ABC+A
13	+	((-*(+	ABC+A
14	C	((-*(+	ABC+AC
15	/	((-*(+/	ABC+AC
16	A	((-*(+/	ABC+ACA
17	)		ABC+ACA/+
18	)		ABC+ACA/+*-
19	^	(^	ABC+ACA/+*-
20	A	(^	ABC+ACA/+*-A
21	)		ABC+ACA/+*-A^
22	+	+	ABC+ACA/+*-A^
23	B	+	ABC+ACA/+*-A^B
24	final		ABC+ACA/+*-A^B+

Postfix expression: ABC+ACA/+*-A^B+

Evaluation of Postfix Expression:

Input	Op1	Op2	value	stack
A	--	--	--	A
B	--	--	--	A | B
C	--	--	--	A|B|C
+	B	C	B+C	A | (B+C)
A	--	--	----	A|(B+C)|A
C	--	--	--	A|(B+C)|A|C
A	--	--	--	A|(B+C)|A|C|A
/	C	A	C/A	A|(B+C)|A|C/A
+	A	C/A	A+C/A	A|(B+C)|(A+C/A)
*	B+C	A+C/A	(B+C)*(A+C/A)	A|((B+C)*(A+C/A))
-	A	(B+C)*(A+C/A)	A-(B+C)*(A+C/A)	A-(B+C)*(A+C/A)
A	--	--	--	A-(B+C)*(A+C/A)|A
^	A	A-(B+C)*(A+C/A)	A^(A-(B+C)*(A+C/A))	(A-(B+C)*(A+C/A))^A
B	--	--	--	((A-(B+C)*(A+C/A))^A)|B
+	B	A^ A-(B+C)*(A+C/A)	B+(A^(A-(B+C)*(A+C/A)))	((A-(B+C)*(A+C/A))^A)+B

Input	Op1	Op2	value	stack
1,2,3	--	--	--	1,2,3
1.1,2.2,3.3	--	--	--	1,2,3 |1.1,2.2,3.3
3.3,4.4,9.9	--	--	--	1,2,3 |1.1,2.2,3.3|3.3,4.4,9.9
+	1.1,2.2,3.3	3.3,4.4,9.9	4.4,6.6,13.2	1,2,3 | 4.4,6.6,13.2
1,2,3	--	--	----	1,2,3 | 4.4,6.6,13.2|1,2,3
3.3,4.4,9.9	--	--	--	1,2,3 | 4.4,6.6,13.2|1,2,3|3.3,4.4,9.9
1,2,3	--	--	--	1,2,3 | 4.4,6.6,13.2|1,2,3|3.3,4.4,9.9|1,2,3
/	3.3,4.4,9.9	1,2,3	3.3,2.2,3.3	1,2,3 | 4.4,6.6,13.2|1,2,3|3.3,2.2,3.3
+	1,2,3	3.3,2.2,3.3	4.3,4.2,6.3	1,2,3 | 4.4,6.6,13.2|4.3,4.2,6.3
*	4.4,6.6,13.2	4.3,4.2,6.3	18.92,27.72,83.16	1,2,3 |18.92,27.72,83.16
-	1,2,3	18.92,27.72,83.16	-17.92,-25.72,-80.16	-17.92,-25.72,-80.16
1,2,3	--	--	--	-17.92,-25.72,-80.16|1,2,3
^	-17.92,-25.72,-80.16	1,2,3	-17.92,661.518,-515078	-17.92,661.518,-515078
1.1,2.2,3.3	--	--	--	-17.92,661.518,-515078|1.1,2.2,3.3
+	1.1,2.2,3.3	17.92,661.518,-515078	-16.82,663.718,-515075	-16.82,663.718,-515075