DATA STRUCTURES AND ALGORITHMS

Assignment # 2

Stack Using STL

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April 28, 2020

Statement

You have to 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

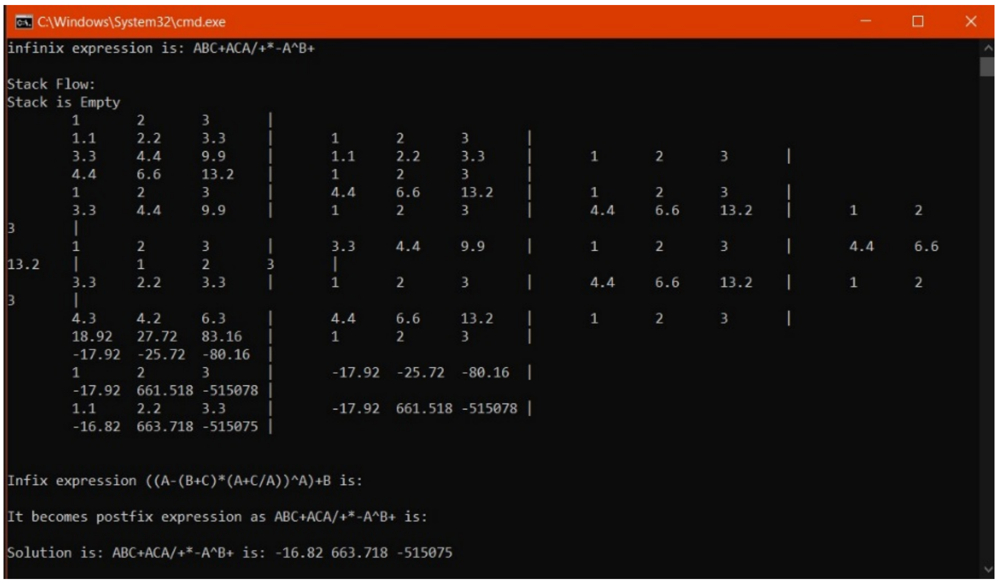
```
#include <iostream>
#include <conio.h>
#include <vector>
#include <math.h>
#include <string>
using namespace std;

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
		{
```

```cpp
				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



```
infinix expression is: ABC+ACA/+*-A^B+

Stack Flow:
Stack is Empty
        1       2       3       |
        1.1     2.2     3.3     |       1       2       3       |
        3.3     4.4     9.9     |       1.1     2.2     3.3     |       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       |
        1       2       3       |       3.3     4.4     9.9     |       1       2       3       |       4.4     6.6
13.2    |       1       2       3       |
        3.3     2.2     3.3     |       1       2       3       |       4.4     6.6     13.2    |       1       2
3       |
        4.3     4.2     6.3     |       4.4     6.6     13.2    |       1       2       3       |
        18.92   27.72   83.16   |       1       2       3       |
        -17.92  -25.72  -80.16  |
        1       2       3       |       -17.92  -25.72  -80.16  |
        -17.92  661.518 -515078 |
        1.1     2.2     3.3     |       -17.92  661.518 -515078 |
        -16.82  663.718 -515075 |


Infix expression ((A-(B+C)*(A+C/A))^A)+B is:

It becomes postfix expression as ABC+ACA/+*-A^B+ is:

Solution is: ABC+ACA/+*-A^B+ is: -16.82 663.718 -515075
```

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+

ABC+ACA/+*-A^B+

Solution:

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