Assignment 7

Dated Jan 27th, 2025

Problem Statement

A program in C to convert an infix expression into a postfix, where the input is given by the user.

Algorithm

Input

createStack(), push(), infixToPostfix() takes necessary input.

Output

peek() and infixToPostfix() displays the necessary output.

Algorithm for createStack(cap)

Step 1: Start.
Step 2: Input an integer cap (capacity of the stack).
Step 3: Allocate memory for a Stack structure and assign it to stack.
Step 4: Set stack->cap = cap.
Step 5: Set stack->top = -1 (indicating an empty stack).
Step 6: Allocate memory for stack->array of size cap.
Step 7: Return the pointer to the newly created stack.
Step 8: Stop.
Step 9: [End of function createStack defined at Step 1.]

Algorithm for isFull(stack)

Step 10: Start.
Step 11: Input a pointer to stack.
Step 12: If stack->top == stack->cap - 1, return 1 (stack is full).
Step 13: Otherwise, return 0 (stack is not full).
Step 14: Stop.
Step 15: [End of function isFull defined at Step 10.]

Algorithm for isEmpty(stack)

Step 16: Start.
Step 17: Input a pointer to stack.
Step 18: If stack->top == -1, return 1 (stack is empty).
Step 19: Otherwise, return 0 (stack is not empty).
Step 20: Stop.
Step 21: [End of function isEmpty defined at Step 16.]

Algorithm for push(stack, item)

Step 22: Start.
Step 23: Input a pointer to stack and a character item.
Step 24: If isFull(stack) == 1, return (stack is full, no push operation).
Step 25: Increment stack->top by 1.
Step 26: Assign item to stack->array[stack->top].
Step 27: Stop.
Step 28: [End of function push defined at Step 22.]

Algorithm for pop(stack)

Step 29: Start.
Step 30: Input a pointer to stack.
Step 31: If isEmpty(stack) == 1, return '$', indicating an underflow.
Step 32: Retrieve stack->array[stack->top] and store it in popped.
Step 33: Decrement stack->top by 1.
Step 34: Return popped.
Step 35: Stop.
Step 36: [End of function pop defined at Step 29.]

Algorithm for peek(stack)

Step 37: Start.
Step 38: Input a pointer to stack.
Step 39: If isEmpty(stack) == 1, return '$', indicating an empty stack.
Step 40: Return stack->array[stack->top] without modifying top.
Step 41: Stop.
Step 42: [End of function peek defined at Step 37.]

Algorithm for isOperand(ch)

Step 43: Start.
Step 44: Input a character ch.
Step 45: If ch is an alphanumeric character, return 1.
Step 46: Otherwise, return 0.
Step 47: Stop.
Step 48: [End of function isOperand defined at Step 43.]

Algorithm for precedence(ch)

Step 49: Start.
Step 50: Input a character ch.
Step 51: If ch is '+' or '-', return 1.
Step 52: If ch is '*' or '/', return 2.
Step 53: If ch is '^', return 3.
Step 54: Otherwise, return -1.
Step 55: Stop.
Step 56: [End of function precedence defined at Step 49.]

Algorithm for infixToPostfix(exp)

Step 57: Start.
Step 58: Input a character array exp.
Step 59: Declare integers i and k.
Step 60: Create a stack of capacity equal to strlen(exp) and store it in stack.
Step 61: If memory allocation for stack fails, return -1.
Step 62: Initialize k = -1 (to track output position).
Step 63: Iterate over each character of exp using a loop:

- **Step 63.1:** If exp[i] is an operand, append it to exp[++k].
- **Step 63.2:** If exp[i] is '(', push it onto stack.
- **Step 63.3:** If exp[i] is ')':
    - While stack is not empty and peek(stack) != '(', append pop(stack) to exp[++k].
    - If peek(stack) == '(', pop it.

- **Step 63.4:** If exp[i] is an operator:
    - While stack is not empty and precedence(exp[i]) <= precedence(peek(stack)), append pop(stack) to exp[++k].
    - Push exp[i] onto stack.
      Step 64: After the loop, pop all remaining elements from stack and append to exp[++k].
      Step 65: Append '\0' at the end of exp to terminate the string.
      Step 66: Print the postfix expression.
      Step 67: Return 0.
      Step 68: Stop.
      Step 69: [End of function infixToPostfix defined at Step 57.]

Algorithm for main()

Step 70: Start.
Step 71: Declare a character array exp[100].
Step 72: Display a prompt: "Enter an infix expression:".
Step 73: Input a string into exp.
Step 74: Call infixToPostfix(exp).
Step 75: Return 0 to indicate successful execution.
Step 76: Stop.
Step 77: [End of function main defined at Step 70.]

Source Code

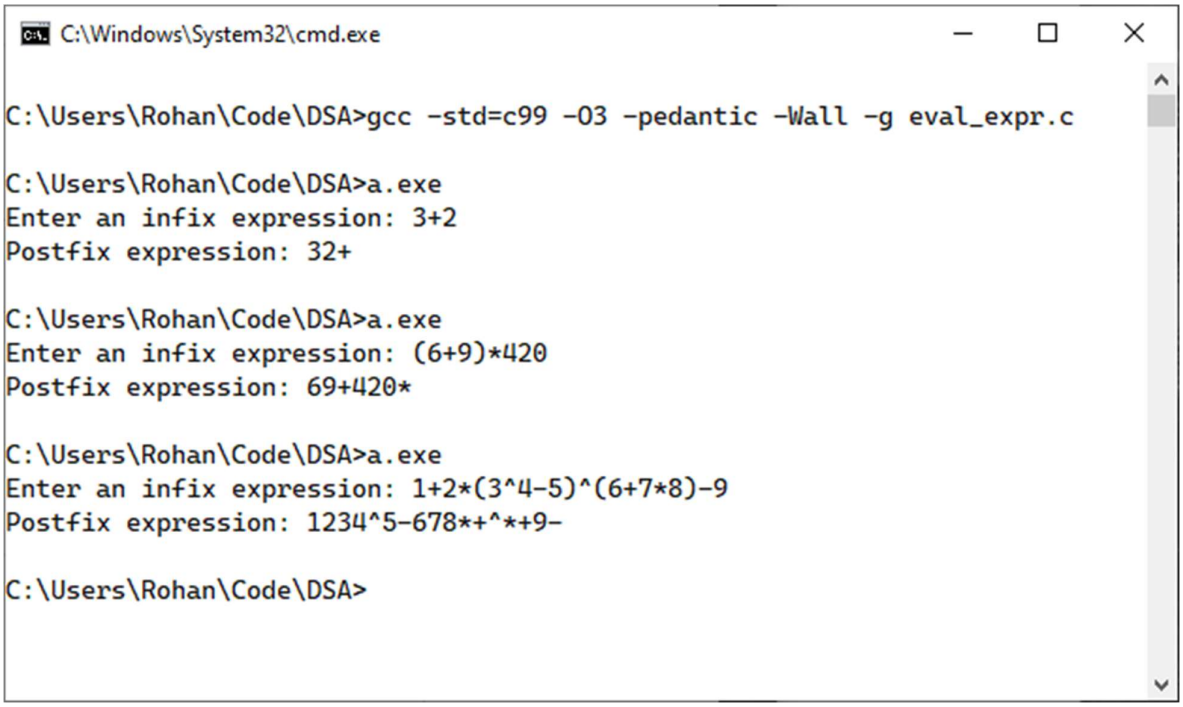
```
#include <ctype.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

// Stack structure
typedef struct {
    int top;
    size_t cap;
    int* array;
} Stack;

// Function to create a stack of given cap
Stack* createStack(unsigned cap)
{
```

```
    Stack* stack = (Stack*)malloc(sizeof(Stack));
    stack->cap = cap;
    stack->top = -1;
    stack->array = (int*)malloc(stack->cap * sizeof(int));
    return stack;
}

// Stack is full when top is equal to the last index
int isFull(Stack* stack)
{
    return stack->top == stack->cap - 1;
}

// Stack is empty when top is -1
int isEmpty(Stack* stack)
{
    return stack->top == -1;
}

// Function to add an item to stack, increases top by 1
void push(Stack* stack, char item)
{
    if (isFull(stack))
        return;
    stack->array[++stack->top] = item;
}

// Function to remove an item from stack, decreases top by 1
char pop(Stack* stack)
{
    if (isEmpty(stack))
        return '$';
    return stack->array[stack->top--];
}

// Function to get the top item without removing it
char peek(Stack* stack)
{
    if (isEmpty(stack))
        return '$';
    return stack->array[stack->top];
}

// A utility function to check if the given character is operand
int isOperand(char ch)
{
    return isalnum(ch);
}

// A utility function to return precedence of a given operator
```

```
int precedence(char ch)
{
    switch (ch) {
    case '+':
    case '-':
        return 1;
    case '*':
    case '/':
        return 2;
    case '^':
        return 3;
    }
    return -1;
}

// The function to convert infix expression to postfix expression
int infixToPostfix(char* exp)
{
    int i, k;

    // Create a stack of cap equal to expression length
    Stack* stack = createStack(strlen(exp));

    if (!stack)
        return -1;

    for (i = 0, k = -1; exp[i]; ++i) {
        // If the character is an operand, add it to output
        if (isOperand(exp[i]))
            exp[++k] = exp[i];
        // If the character is '(', push it to stack
        else if (exp[i] == '(')
            push(stack, exp[i]);
        // If the character is ')', pop and output from the stack until '(' is
encountered
        else if (exp[i] == ')') {
            while (!isEmpty(stack) && peek(stack) != '(')
                exp[++k] = pop(stack);
            if (!isEmpty(stack) && peek(stack) != '(')
                return -1; // Invalid expression
            else
                pop(stack);
        } else { // an operator is encountered
            while (!isEmpty(stack) && precedence(exp[i]) <=
precedence(peek(stack)))
                exp[++k] = pop(stack);
            push(stack, exp[i]);
        }
    }
```

```
    // pop all the operators from the stack
    while (!isEmpty(stack))
        exp[++k] = pop(stack);

    exp[++k] = '\0';
    printf("Postfix expression: %s\n", exp);

    return 0;
}

// Driver program to test above functions
int main()
{
    char exp[100];

    printf("Enter an infix expression: ");
    scanf("%s", exp);

    infixToPostfix(exp);

    return 0;
}
```

Output



Discussion

Stack should be properly initialized before use. The precedence order must be considered carefully.

Teacher's signature