Assignment 5

Dated Jan 6th, 2025

Problem Statement

A program in C to simulate the stack data structure with following operations like push, pop, peek (all elements), size, etc.

Algorithm

Input

createNode() is used here to take input values from the user. push() pushes the data onto the stack.

Output

peek() and display() is used to output the data.

Algorithm for createNode()

Step 1: Start.
Step 2: Input an integer data for the new node.
Step 3: Allocate memory for a new node of type Node.
Step 4: If memory allocation fails, display an error message and terminate the program.
Step 5: Assign data to the data field of the new node.
Step 6: Set the next pointer of the new node to NULL.
Step 7: Return the newly created node.
Step 8: Stop.
Step 9: [End of function createNode defined at Step 1.]

Algorithm for push()
Step 10: Start.
Step 11: Input a pointer to the top of the stack (top) and an integer data.
Step 12: Call createNode(data) to create a new node and store the result in newNode.
Step 13: Set newNode->next to the current *top.
Step 14: Update *top to point to newNode.
Step 15: Display a message indicating that data has been pushed onto the stack.
Step 16: Stop.
Step 17: [End of function push defined at Step 10.]

Algorithm for isEmpty()

```
Step 18: Start.
Step 19: Input a pointer to the top of the stack (top).
Step 20: If top == NULL, return 1 (stack is empty). Otherwise, return 0 (stack is not empty).
Step 21: Stop.
Step 22: [End of function isEmpty defined at Step 18.]
```

Algorithm for pop()

```
Step 23: Start.
Step 24: Input a pointer to the top of the stack (top).
Step 25: Call isEmpty(*top). If the result is 1, display an underflow message and return -1.
Step 26: Declare a temporary pointer temp and set it to *top.
Step 27: Update *top to point to (*top)->next.
Step 28: Store the data value of temp in a variable popped.
Step 29: Free the memory allocated for temp.
Step 30: Display a message indicating the popped value.
Step 31: Return popped.
Step 32: Stop.
Step 33: [End of function pop defined at Step 23.]
```

Algorithm for peek()

```
Step 34: Start.
Step 35: Input a pointer to the top of the stack (top).
Step 36: Call isEmpty(top). If the result is 1, display an empty stack message and return -1.
Step 37: Return top->data.
Step 38: Stop.
Step 39: [End of function peek defined at Step 34.]
```

Algorithm for display()

```
Step 40: Start.
Step 41: Input a pointer to the top of the stack (top).
Step 42: Call isEmpty(top). If the result is 1, display an empty stack message and stop.
Step 43: Declare a pointer temp and set it to top.
Step 44: Display a message "Stack elements:".
Step 45: While temp != NULL, perform the following:
    • Step 45.1: Print temp->data.
    • Step 45.2: Update temp to temp->next.
      Step 46: Print a newline.
      Step 47: Stop.
      Step 48: [End of function display defined at Step 40.]
```

Algorithm for displayMenu()

```
Step 49: Start.
Step 50: Display the available stack operations.
Step 51: Display a prompt for user choice.
Step 52: Stop.
Step 53: [End of function displayMenu defined at Step 49.]
```

Algorithm for main()

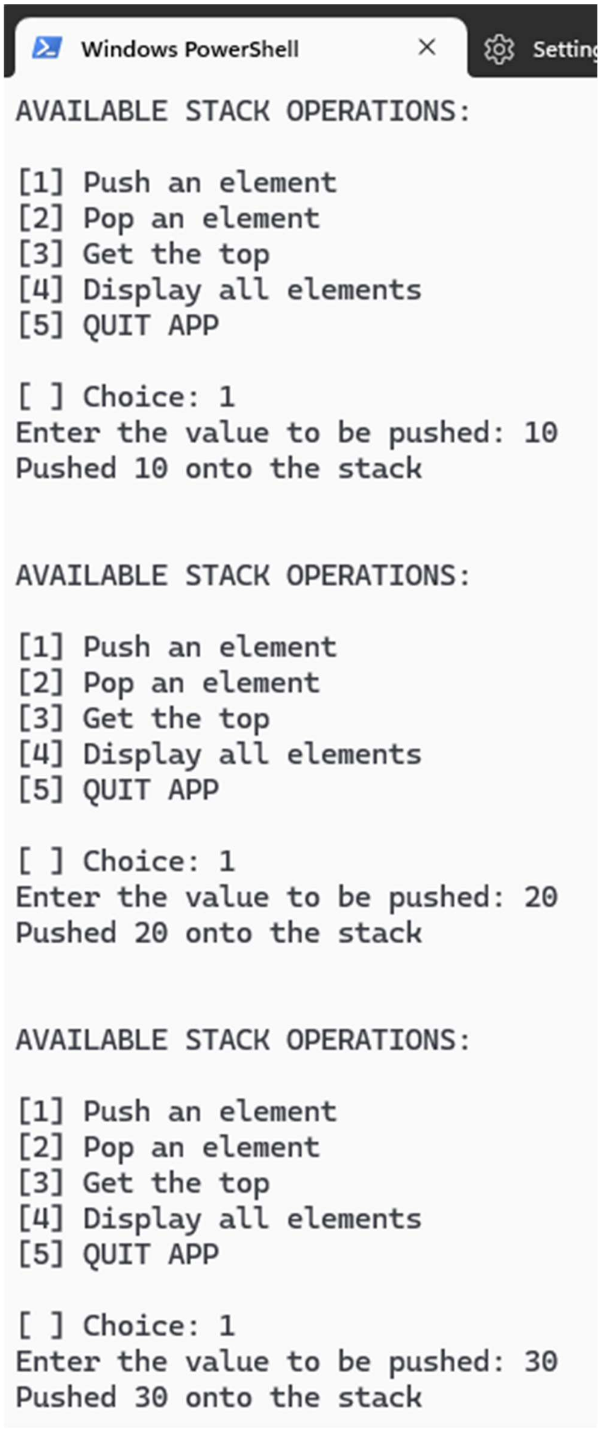
```
Step 54: Start.
Step 55: Declare a pointer stack and initialize it to NULL.
Step 56: Declare integers choice and value.
Step 57: Enter an infinite loop to handle user input:
    • Step 57.1: Call displayMenu().
    • Step 57.2: Input the user choice and store it in choice.
    • Step 57.3: Perform actions based on the value of choice:
            Case 1: Call push(&stack, value) after prompting the user for value.
            Case 2: Call pop(&stack).
            Case 3: Display the result of peek(stack).
            Case 4: Call display(stack).
            Case 5: Display an exit message and break the loop using goto end.
            Default Case: Display an invalid choice message.
Step 58: Label end to exit the loop and display a final thank-you message.
Step 59: Stop.
Step 60: [End of function main defined at Step 54.]
```

Source Code

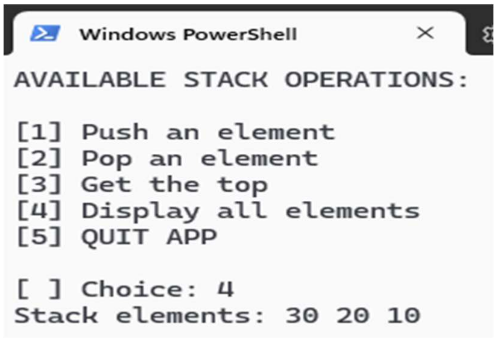
```
#include <stdio.h>
#include <stdlib.h>
```

```
// Define the node structure
typedef struct Node {
    int data;
    struct Node* next;
} Node;

// Function to create a new node
Node* createNode(int data)
{
    Node* newNode = (Node*)malloc(sizeof(Node));
    if (!newNode) {
        printf("Memory allocation error\n");
        exit(1);
    }

    newNode->data = data;
    newNode->next = NULL;

    return newNode;
}

// Function to push an element onto the stack
void push(Node** top, int data)
{
    Node* newNode = createNode(data);
    newNode->next = *top;
    *top = newNode;

    printf("Pushed %d onto the stack\n", data);
}

// Function to check if the stack is empty
int isEmpty(Node* top)
{
    return top == NULL;
}

// Function to pop an element from the stack
int pop(Node** top)
{
    if (isEmpty(*top)) {
        printf("Stack underflow\n");
        return -1;
    }

    Node* temp = *top;
    *top = (*top)->next;
    int popped = temp->data;
    free(temp);
    printf("Popped %d from the stack\n", popped);

    return popped;
}

// Function to peek the top element of the stack
int peek(Node* top)
{
    if (isEmpty(top)) {
        printf("Stack is empty\n");
        return -1;
    }

    return top->data;
}

// Function to display the stack
void display(Node* top)
{
    if (isEmpty(top)) {
        printf("Stack is empty\n");
        return;
    }

    Node* temp = top;
    printf("Stack elements: ");
    while (temp != NULL) {
        printf("%d ", temp->data);
        temp = temp->next;
    }
    printf("\n");
}

// Function to display the menu
void displayMenu()
{
    printf("\n\nAVAILABLE STACK OPERATIONS:\n\n");
    printf("[1] Push an element\n"
           "[2] Pop (delete the most recent element)\n"
           "[3] Get the last \n"
           "[4] Get stack's size\n\n");

    printf("[ ] Choice: ");
}

// Main function
int main()
{
    Node* stack = NULL;
    int choice, value;

    while (1) {
        displayMenu();
        scanf("%d", &choice);

        switch (choice) {
        case 1:
            printf("Enter the value to be pushed: ");
            scanf("%d", &value);

            push(&stack, value);
            break;
        case 2:
            pop(&stack);
            break;
        case 3:
            printf("Top element is %d\n", peek(stack));
            break;
        case 4:
            display(stack);
            break;
        case 5:
            printf("Exiting...\n");
            goto end;
            break;
        default:
            printf("Invalid choice! Please try again.\n");
            break;
        }
    }

end:
    printf("=== Thanks for using this app! ===\n");

    return 0;
}
```

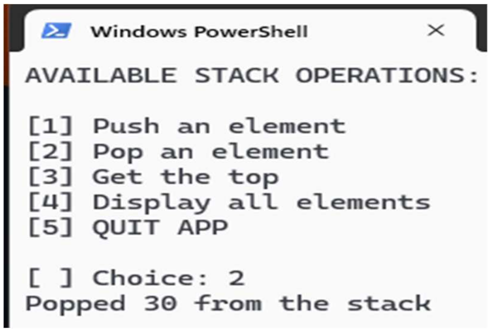
Output



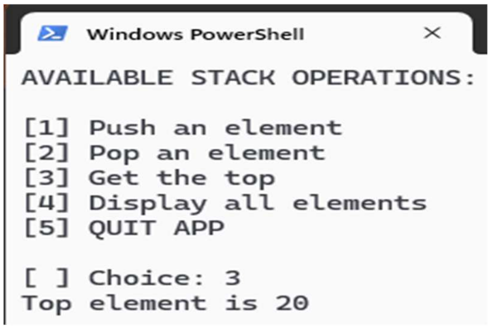
```
AVAILABLE STACK OPERATIONS:

[1] Push an element
[2] Pop an element
[3] Get the top
[4] Display all elements
[5] QUIT APP

[ ] Choice: 1
Enter the value to be pushed: 10
Pushed 10 onto the stack


AVAILABLE STACK OPERATIONS:

[1] Push an element
[2] Pop an element
[3] Get the top
[4] Display all elements
[5] QUIT APP

[ ] Choice: 1
Enter the value to be pushed: 20
Pushed 20 onto the stack


AVAILABLE STACK OPERATIONS:

[1] Push an element
[2] Pop an element
[3] Get the top
[4] Display all elements
[5] QUIT APP

[ ] Choice: 1
Enter the value to be pushed: 30
Pushed 30 onto the stack
```



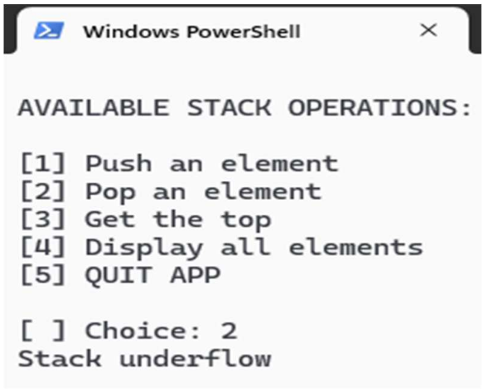
```
AVAILABLE STACK OPERATIONS:

[1] Push an element
[2] Pop an element
[3] Get the top
[4] Display all elements
[5] QUIT APP

[ ] Choice: 4
Stack elements: 30 20 10
```



```
AVAILABLE STACK OPERATIONS:

[1] Push an element
[2] Pop an element
[3] Get the top
[4] Display all elements
[5] QUIT APP

[ ] Choice: 2
Popped 30 from the stack
```



```
AVAILABLE STACK OPERATIONS:

[1] Push an element
[2] Pop an element
[3] Get the top
[4] Display all elements
[5] QUIT APP

[ ] Choice: 3
Top element is 20
```



```
AVAILABLE STACK OPERATIONS:

[1] Push an element
[2] Pop an element
[3] Get the top
[4] Display all elements
[5] QUIT APP

[ ] Choice: 2
Stack underflow
```

Discussion

Global variables should be used to the least. However, it has been applied here to reduce the complexity of using pointers and tricky lines.

Teacher's signature