

VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“JnanaSangama”, Belgaum -590014, Karnataka.



LAB REPORT On

DATA STRUCTURES (23CS3PCDST)

Submitted by

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in partial fulfillment for the award of the degree of
BACHELOR OF ENGINEERING
in
COMPUTER SCIENCE AND ENGINEERING



B.M.S. COLLEGE OF ENGINEERING
(Autonomous Institution under VTU)
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Computer Science and Engineering



This is to certify that the Lab work entitled “DATA STRUCTURES” carried out by DEV KANSAL(1BM19CS046), who is a bonafide student of B. M. S. College of Engineering. It is in partial fulfillment for the award of Bachelor of Engineering in Computer Science and Engineering of the Visvesvaraya Technological University, Belgaum during the year 2023-24. The Lab report has been approved as it satisfies the academic requirements in respect of Data structures Lab - (23CS3PCDST) work prescribed for the said degree.

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Course outcomes:

<u>CO1</u>	<u>Apply the concept of linear and nonlinear data structures.</u>
<u>CO2</u>	<u>Analyze data structure operations for a given problem</u>
<u>CO3</u>	<u>Design and develop solutions using the operations of linear and nonlinear data structure for a given specification.</u>

Lab program 1:

Write a program to simulate the working of stack using an array with the following: a)

Push

b) Pop

c) Display

The program should print appropriate messages for stack overflow, stack underflow.

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

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

```
#define SIZE 4 int
```

```
top = -1; int
```

```
inp_array[SIZE]
```

```
; void push();
```

```
void pop(); void
```

```
show();
```

```
void main()
```

```
{ int ch; while
```

```
(1)
```

```
{
```

```
    printf("Operations on the stack:\n");    printf("1.Push the
element\n2.Pop the element\n3.Show\n4.End\n");    printf("Enter the
choice:\n ");    scanf("%d",&ch);
```

```
    switch (ch)
```

```
{
```

```
case 1:
```

```
push();
```

```
break;
```

```

case 2:
pop();
break;
case 3:
show();
break;
case 4:
exit(0);

default:      printf("Invalid
choice\n");
    }
    }
}

void push()
{   int x;
    if (top == SIZE - 1)
    {
        printf("Overflow\n");
    }   else
    {       printf("Enter the element to be added in the
stack:\n ");       scanf("%d", &x);       top = top + 1;
inp_array[top] = x;
    }
} void pop() {
if (top == -1)
{
    printf("Underflow\n");
}   else
{
    printf("Popped element: %d\n", inp_array[top]);
top = top - 1;
}
} void show()
{   if (top ==
-1)
{
    printf("Underflow\n");
}   else
{       printf("Elements in the stack are:
\n");       for (int i = top; i >= 0; --i)
printf("%d\n", inp_array[i]);
    }
}

```

}

Output:

```
C:\Users\Admin\Desktop\1BM22CS227\DS\stackimplementation.exe
Operations on the stack:
1.Push the element
2.Pop the element
3.Show
4.End
Enter the choice:
1
Enter the element to be added in the stack:
4
Operations on the stack:
1.Push the element
2.Pop the element
3.Show
4.End
Enter the choice:
1
Enter the element to be added in the stack:
5
Operations on the stack:
1.Push the element
2.Pop the element
3.Show
4.End
Enter the choice:
2
Popped element: 5
Operations on the stack:
1.Push the element
2.Pop the element
3.Show
4.End
Enter the choice:
3
Elements in the stack are:
4
Operations on the stack:
1.Push the element
2.Pop the element
3.Show
4.End
Enter the choice:
4

Process returned 0 (0x0)   execution time : 12.759 s
Press any key to continue.
```

Lab program 2:

WAP to convert a given valid parenthesized infix arithmetic expression to postfix expression. The expression consists of single character operands and the binary operators + (plus), - (minus), * (multiply) and / (divide)

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

#define SIZE 100

char stack[MAX];
int top = -1;

void push(char); char pop();
int
precedence(char);
void infixToPos ix(char infix[], char pos
ix[]);

void push(char item) {    if
(top == MAX - 1) {
    prin ("Overflow!\n");
    } else {        top++;
    stack[top] = item;
    }
}

char pop() {    if (top == -
1) {        prin
("Underflow!\n");
    } else {
    char popped =
stack[top];    top--;
return popped;
    }
}

int precedence(char symbol) {
if (symbol == '^') {    return
3;
    } else if (symbol == '*' || symbol == '/') {
    return 2;
```



```

    } else if (symbol == '+' || symbol == '-')
    {
        return 1;
    } else {
        return -1;
    }
}

```

```

void infixToPos ix(char infix[], char pos ix[]) {
int i = 0, j = 0;
    char symbol, temp;

```

```

    push('#');

```

```

    while ((symbol = infix[i++]) != '\0') {
if (symbol == '(') {
push(symbol);
    } else if
(isalnum(symbol)) {
        pos
ix[j++] = symbol;
    } else if
(symbol == ')') {
        while
(stack[top] != '(') {
            pos ix[j++] = pop();
        }
        temp = pop(); // Remove '(' from the stack
    } else {
        while (precedence(stack[top]) >= precedence(symbol)) {
pos ix[j++] = pop();
        }
        push(symbol);
    }
}
}

```

```

    while (stack[top] != '#') {
pos ix[j++] = pop();
    }

```

```

    pos ix[j] = '\0';
}

```

```

int main() {
    char infix[MAX],
pos ix[MAX];

```

```

    prin ("Enter a valid parenthesized infix expression: ");
    scanf("%s", infix);
    infixToPos
ix(infix, pos ix);

```

```

    prin ("The pos ix exp is: %s\n", pos ix);
return 0;

```

```
}
```

Output:

```
Enter a valid parenthesized infix expression:
a*b+c*d-e
The postfix exp is: ab*cd*+e-

Process returned 0 (0x0)   execution time : 20.804 s
Press any key to continue.
```

Lab program 3:

3a) WAP to simulate the working of a queue of integers using an array.

Provide the following operations: Insert, Delete, Display

The program should print appropriate messages for queue empty and queue overflow conditions

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

```
#define size 30
```

```
int queue[size];
```

```
int front=-1; int
```

```
rear=-1;
```

```
void insert(int a)
```

```
{
```

```
if(rear==size-1)
```

```
{
```

```
    printf("Queue overflow\n");
```

```
return;
```

```
    } else {        if(front==-
```

```
1)
```

```

        front=0;
queue[++rear]=a;
    }
}

void delete() {    if(front==
1||front>rear)
    {
        printf("Queue Empty\n");
    }    else
    {
front++;
    }
}

void display()
{
if(front==1)
{
    printf("Queue Empty\n");
return;
}    printf("Queue:");
for(int i=front;i<=rear;i++)
    {        printf("%d
",queue[i]);
    }
}

void main()
{    int
choice;    int
a;
while(1)
    {
        printf("\n1.Insert\n2.Delete\n3.Display\nChoice:");
scanf("%d",&choice);

        switch (choice)
        {
            case 1:printf("Enter an element:");
scanf("%d",&a);        insert(a);
display();        break;

```

```

        case 2:delete();
display();          break;
        case
3:display();
break;
    }
}
}

```

Output:

```

1.Insert
2.Delete
3.Display
Choice:1
Enter an element:7
Queue:7
1.Insert
2.Delete
3.Display
Choice:1
Enter an element:8
Queue:7 8
1.Insert
2.Delete
3.Display
Choice:2
Queue:8
1.Insert
2.Delete
3.Display
Choice:3
Queue:8

```

3b) WAP to simulate the working of a circular queue of integers using an array. Provide the following operations: Insert, Delete & Display The

program should print appropriate messages for queue empty and queue overflow conditions

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

```
#define size 5
```

```
int queue[size];
```

```
int front=-1;
```

```
int rear =-1;
```

```
void enqueue(int a)
```

```
{
    if((front==rear+1) || (front==0 &&
rear==size-1)) { printf("Queue overflow\n");
return; } else { if(front==-1)
front=0; rear=(rear+1)%size;
queue[rear]=a;
}
}
```

```
void dequeue()
```

```
{
if(front==-1)
{
printf("Queue Empty\n");
}
else
{
int a=queue[front];
if(front==rear)
{
front=-1; rear=-1;
}
else
{
front=(front+1)%size;
}
printf("Deleted element=%d\n",a);
return(a);
}
}
```

```

void display() {    if(front==1)
{                    printf("Queue
Empty\n");          return;    }
else {    int i;
        printf("\nFront=%d", front);
printf("\nItems=");
for(i=front;i!=rear;i=(i+1)%size)
    {
        printf("%d",queue[i]);
    }
printf("%d",queue[i]);
printf("\nRear=%d",rear);
    }
}

```

```

void main()
{    int
choice;
int a;
while(1)
    {
        printf("\n1.Insert\n2.Delete\n3.Display\nChoice:");
scanf("%d",&choice);

        switch (choice)
        {
            case 1:printf("Enter an
element:");          scanf("%d",&a);
enqueue(a);          display();
break;

            case 2:dequeue();
display();
break;

            case 3:display();
break;
        }
    }
}

```

Output:

```

1.Insert
2.Delete
3.Display
Choice:1
Enter an element:2

Front=0
Items=2
Rear=0
1.Insert
2.Delete
3.Display
Choice:1
Enter an element:3

Front=0
Items=23
Rear=1
1.Insert
2.Delete
3.Display
Choice:1
Enter an element:4

Front=0
Items=234
Rear=2
1.Insert
2.Delete
3.Display
Choice:2
Deleted element=2

Front=1
Items=34
Rear=2

```

Lab program 4:

WAP to Implement Singly Linked List with following operations

- a) Create a linked list.
 - b) Insertion of a node at first position, at any position and at end of list.
- Display the contents of the linked list.

```

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

```

```

struct Node {    int
data;    struct Node
*next;
};

```

```

struct Node *createNode(int value)
{    struct Node *newNode = (struct Node*)malloc(sizeof(struct Node));
if (newNode == NULL)
    {        printf("Memory allocation
failed.\n");        exit(1);
    }
    newNode->data = value;
newNode->next = NULL;
return newNode;
}

```

```

void displayList(struct Node *head)
{
    if (head == NULL)
    {        printf("List is empty.\n");
return;
    }

```

```

    struct Node *temp = head;
printf("Linked List:\n ");    while
(temp != NULL)
    {
        printf("%d -> ", temp->data);
temp = temp->next;
    }
    printf("NULL\n");
}

```

```

struct Node *insertatbeginning(struct Node *head, int value)
{    struct Node *newNode =
createNode(value);    newNode->next = head;
return newNode;
}

```

```

void insertatend(struct Node *head, int value)

```



```

{   struct Node *newNode =
createNode(value);   struct Node *temp =
head;

    while (temp->next != NULL)
    {
        temp = temp->next;
    }

    temp->next = newNode;
}

void insertatposition(struct Node *head, int position, int value)
{   struct Node *newNode =
createNode(value);   struct Node *temp =
head;   int count = 1;

    while (temp != NULL && count < position - 1)
    {
        temp = temp-
>next;        count++;
    }

    if (temp == NULL)
    {
        printf("Position out of
range.\n");        free(newNode);
return;
    }

    newNode->next = temp->next;    temp-
>next = newNode;
}

int main()
{   struct Node *head =
NULL;

    head = createNode(1);   head->next
= createNode(2);   head->next->next
= createNode(3);

    printf("Initial:\n ");
displayList(head);

```

```

    head = insertatbeginning(head, 0);
    printf("After insertion at the beginning:\n ");
    displayList(head);

```

```

    insertatposition(head, 3, 10);
    printf("After insertion at position 3:\n ");
    displayList(head);

```

```

    insertatend(head, 20);
    printf("After insertion at the end:\n ");
    displayList(head);

```

```

    return 0;
}

```

Output:

```

Initial Linked List: 1 -> 2 -> 3 -> NULL
After insertion at the beginning: Linked List: 0 -> 1 -> 2 -> 3 -> NULL
After insertion at position 3: Linked List: 0 -> 1 -> 10 -> 2 -> 3 -> NULL
After insertion at the end: Linked List: 0 -> 1 -> 10 -> 2 -> 3 -> 20 -> NULL

Process returned 0 (0x0)   execution time : 0.023 s
Press any key to continue.

```

Leetcode Problem-1:

Min Stack Problem

```

#include<stdio.h>
#include<stdlib.h> typedef
struct {    int value;
int min;

} StackNode;

typedef struct
{
    StackNode
*array;    int
capacity;    int top;

```

```
}MinStack;
```

```
MinStack* minStackCreate()
```

```
{  
    MinStack* stack=(MinStack*)malloc(sizeof(MinStack));  stack->capacity  
= 10;    stack->array = (StackNode*)malloc(stack->capacity *  
sizeof(StackNode));  stack->top = -1;  return stack;  
  
}
```

```
void minStackPush(MinStack* obj, int val)
```

```
{  
    if (obj->top == obj->capacity - 1)  
    {  
        obj->capacity  
*= 2;    obj->array = (StackNode*)realloc(obj->array, obj->capacity *  
sizeof(StackNode));  
    }  
    StackNode newNode;  newNode.value = val;  newNode.min = (obj->top == -1)  
? val : (val < obj->array[obj->top].min) ? val : obj-  
>array[obj->top].min;  obj->array[++(obj->top)]  
= newNode;  
}
```

```
void minStackPop(MinStack* obj)
```

```
{  
    if (obj->top != 1)  
    {  
        obj->top--;  
    }  
  
}
```

```
int minStackTop(MinStack* obj)
```

```
{  
    if (obj->top != 1)  
    {  
        return obj->array[obj->top].value;  
    }  
    return -1;  
  
}
```

```
int minStackGetMin(MinStack* obj)
```

```
{  
    if (obj->top != 1)  
    {  
        return obj->array[obj->top].min;  
    }  
}
```

```

return -1;

}

void minStackFree(MinStack* obj)
{
    free(obj->array);
    free(obj);
}

```

Result:

Min Stack

Submission Detail

31 / 31 test cases passed.

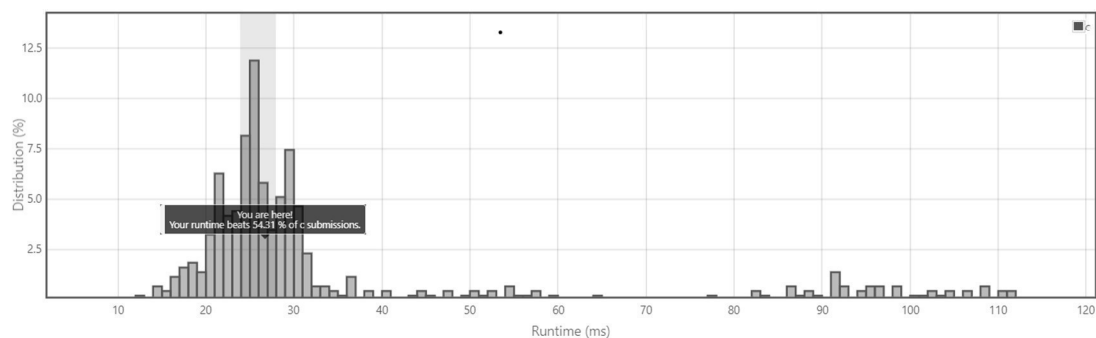
Runtime: 26 ms

Memory Usage: 13.8 MB

Status: **Accepted**

Submitted: 1 month, 2 weeks ago

Accepted Solutions Runtime Distribution



Lab program 5:

WAP to Implement Singly Linked List with following operations

- Create a linked list.
- Deletion of first element, specified element and last element in the list.
- Display the contents of the linked list.

```

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

```

```

struct Node {
    int data;
    struct Node* next;
}

```

```
};
```

```
struct Node* createNode(int value) {    struct Node* newNode = (struct  
Node*)malloc(sizeof(struct Node));    newNode->data = value;  
newNode->next = NULL;    return newNode;  
}
```

```
void insertAtEnd(struct Node** head, int value) {  
    struct Node* newNode = createNode(value);    if  
    (*head == NULL) {  
        *head = newNode;  
    } else {        struct Node* temp =  
    *head;        while (temp->next !=  
    NULL) {            temp = temp-  
    >next;  
        }  
        temp->next = newNode;  
    }  
}
```

```
void deleteFirst(struct Node** head)  
{    if (*head != NULL) {        struct  
Node* temp = *head;        *head =  
(*head)->next;        free(temp);  
    }  
}
```

```
void deleteElement(struct Node** head, int value) {  
    struct Node* current = *head;    struct Node* prev  
    = NULL;  
  
    while (current != NULL && current->data != value)  
{        prev = current;        current = current->next;  
    }  
  
    if (current == NULL) {  
        return;  
    }  
  
    if (prev == NULL) {  
        *head = current->next;    }  
}
```

```
else {      prev->next =
current->next;
}
```

```
    free(current);
} void deleteLast(struct Node**
head) {    if (*head == NULL) {
return;
}
```

```
    struct Node* temp = *head;
    struct Node* prev = NULL;
```

```
    while (temp->next != NULL)
    {        prev = temp;        temp =
temp->next;
    }
```

```
    if (prev == NULL) {
*head = NULL;    } else {
prev->next =
NULL;
    }
```

```
    free(temp);
}
```

```
void displayList(struct Node* head)
{    struct Node* temp = head;
while (temp != NULL) {
printf("%d -> ", temp->data);
temp = temp->next;
}
printf("NULL\n");
}
```

```
int main() {    struct Node* head
= NULL;
insertAtEnd(&head, 1);
insertAtEnd(&head, 2);    insertAtEnd(&head,
3);
```

```

    printf("Initial Linked List: ");
    displayList(head);

    deleteFirst(&head);    printf("\nAfter
deleting the first element: ");
    displayList(head);

    deleteElement(&head, 2);    printf("\nAfter deleting
the specified element (2): ");    displayList(head);

    deleteLast(&head);    printf("\nAfter deleting
the last element: ");    displayList(head);

    return 0;
}

```

Output:

```

Initial Linked List: 1 -> 2 -> 3 -> NULL

After deleting the first element: 2 -> 3 -> NULL

After deleting the specified element (2): 3 -> NULL

After deleting the last element: NULL

Process returned 0 (0x0)    execution time : 0.052 s
Press any key to continue.

```

Leetcode Problem -2:

Reversal Linked List-II

```

/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */

```

```

struct ListNode* reverseBetween(struct ListNode* head, int left, int right) {

    if (head == NULL) return NULL;

    if (left == right) return head;

    struct ListNode* prev = NULL;
    struct ListNode* curr = head;

    int index = 1; while
    (index < left)
    {
        prev = curr; curr
        = curr->next;
        index++;
    }

    struct ListNode* leftMinusOneNode = prev;

    struct ListNode* leftNode = curr;
    struct ListNode* next = NULL;

    while (left <= right)
    {   next = curr-
        >next;

        curr->next = prev;

        prev = curr;
        curr = next;
        left++;
    }

    if (leftMinusOneNode == NULL) // means head
    changes head = prev; else leftMinusOneNode-
    >next = prev;

    leftNode->next = curr;

    return head;
}

```


Result:

Reverse Linked List II

Submission Detail

44 / 44 test cases passed.

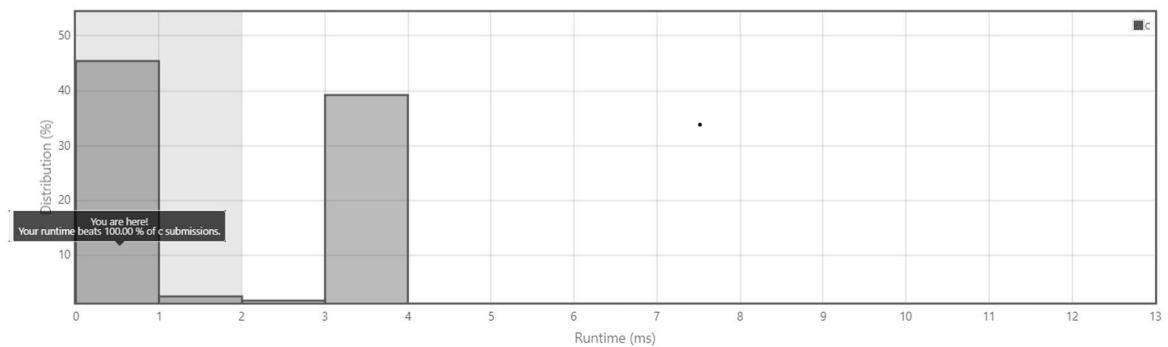
Runtime: 0 ms

Memory Usage: 5.9 MB

Status: **Accepted**

Submitted: 1 month, 1 week ago

Accepted Solutions Runtime Distribution



Lab program 6:

6a) WAP to Implement Single Link List with following operations: Sort the linked list, Reverse the linked list, Concatenation of two linked lists.

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

```
struct Node
{
    int data;
    struct Node *next;
};
```

```
typedef struct Node Node;
```

```
Node *createNode(int value)
{
    Node *newNode=(Node*)malloc(sizeof(Node));
    newNode->data=value;   newNode->next=NULL;
    return newNode;
}
```

```

void displayList(Node *head)
{
while(head!=NULL)
    {
        printf("%d->",head-
>data);    head=head->next;
    }
    printf("NULL\n");
}

Node *sortList(Node *head)
{
    if(head==NULL || head->next==NULL)
    {
        return
head;
    }

    int swapped;
    Node *temp;
    Node *end=NULL;

do
{

    swapped=0;
    temp=head;
    while(temp->next !=end)
    {
        if(temp->data > temp->next->data)
        {
            int
tempData=temp->data;
temp->data=temp->next->data;
temp->next->data=tempData;
swapped=1;

        }
        temp=temp->next;
    }
    end=temp;
}while(swapped);

    return head;
}

```

```

Node *reverseList(Node *head)
{
    Node *prev=NULL;
    Node *current=head;
    Node *nextNode=NULL;

    while(current!=NULL)
    {
        nextNode=current->next;
        current->next=prev;
        prev=current;
        current=nextNode;
    }    return
prev;

}

Node *concatenatedLists(Node *list1,Node *list2)
{

    if(list1==NULL)
    {
        return list2;
    }

    Node *temp=list1;    while(temp->next!=NULL)
    {
        temp=temp->next;
    }
    temp->next=list2;
    return list1;

}

int main()
{
    Node *list1=createNode(3);
    list1->next=createNode(1);    list1-
    >next->next=createNode(4);

    Node *list2=createNode(2);
    list2->next=createNode(5);

```

```

    printf("Original list 1:");
displayList(list1);    printf("Original list
2:");    displayList(list2);

    list1=sortList(list1);    printf("Sorted
list 1:");    displayList(list1);

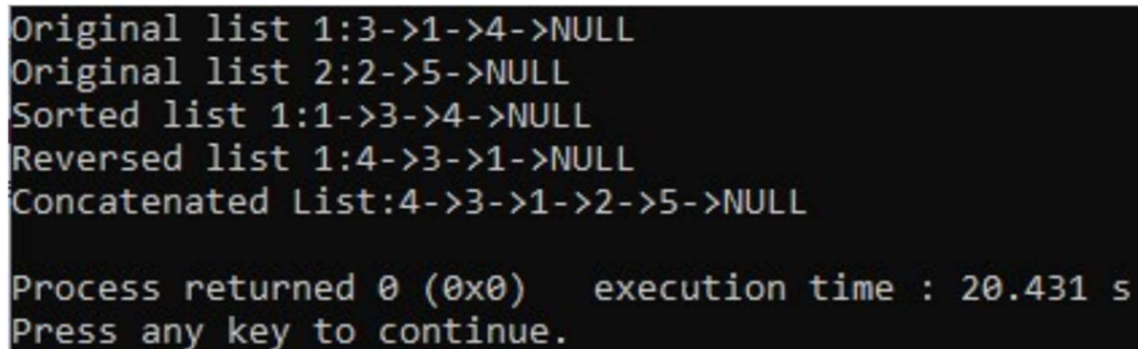
    list1=reverseList(list1);
printf("Reversed list 1:");
displayList(list1);

    Node *Concatenated= concatenatedLists(list1,list2);
printf("Concatenated List:");
displayList(Concatenated);    return 0;

}

```

Output:



```

Original list 1:3->1->4->NULL
Original list 2:2->5->NULL
Sorted list 1:1->3->4->NULL
Reversed list 1:4->3->1->NULL
Concatenated List:4->3->1->2->5->NULL

Process returned 0 (0x0)    execution time : 20.431 s
Press any key to continue.

```

6b) WAP to Implement Single Link List to simulate Stack & Queue Operations.

```
//Stack
```

```

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

```

```

struct Node
{
    int data;
    struct Node *next;
};

```

```

typedef struct Node Node;

Node *createNode(int value)
{
    Node *newNode=(Node*)malloc(sizeof(Node));
    newNode->data=value;    newNode->next=NULL;
    return newNode;

}

void displayList(Node *head)
{
    while(head!=NULL)
    {
        printf("%d->",head-
>data);    head=head->next;
    }
    printf("NULL\n");
}

typedef struct
{
    Node *top;

}LinkedList;

void push(LinkedList *stack,int value)
{
    Node *newNode=createNode(value);    newNode-
>next=stack->top;    stack->top=newNode;
}

int pop(LinkedList *stack)
{
    if(stack->top==NULL)
    {
        printf("stack is
empty\n");    return -1;
    }
    int poppedValue=stack->top->data;
    Node *temp=stack->top;    stack->top=stack-
>top->next;    free(temp);

    return poppedValue;
}

```

```

int main()
{

    LinkedList stack;
    stack.top=NULL;

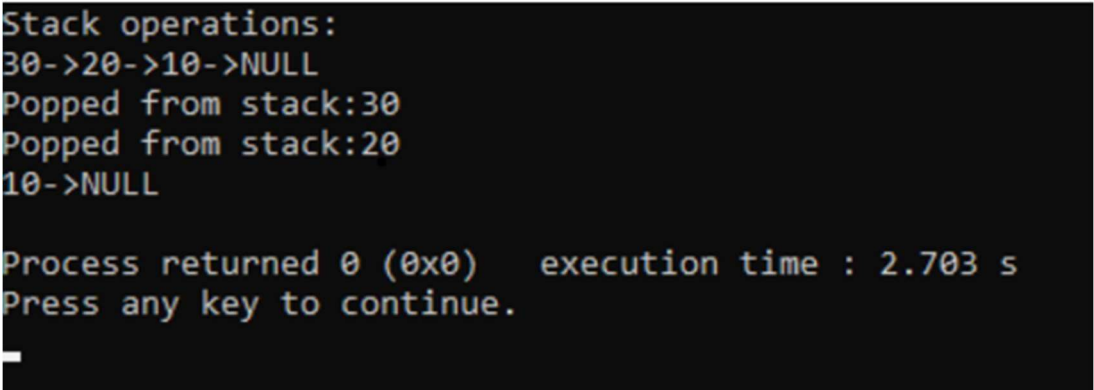
    printf("Stack operations:\n");
    push(&stack,10);   push(&stack,20);
    push(&stack,30);
    displayList(stack.top);

    printf("Popped from stack:%d\n",pop(&stack));
    printf("Popped from stack:%d\n",pop(&stack));

    displayList(stack.top);
    return 0;
}

```

Output:



```

Stack operations:
30->20->10->NULL
Popped from stack:30
Popped from stack:20
10->NULL

Process returned 0 (0x0)   execution time : 2.703 s
Press any key to continue.

```

//Queue

```

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

struct Node
{
    int data;
    struct Node *next;
};

typedef struct Node Node;

Node *createNode(int value)
{

```

```

    Node *newNode=(Node*)malloc(sizeof(Node));
newNode->data=value;   newNode->next=NULL;
return newNode;

}

void displayList(Node *head)
{
    while(head!=NULL)
    {
        printf("%d->",head-
>data);   head=head->next;
    }
    printf("NULL\n");
}

typedef struct
{
    Node *front;
    Node *rear;

}LinkedList;

void enqueue(LinkedList *queue,int value)
{
    Node *newNode=createNode(value);   if(queue-
>front==NULL)
    {
        queue->front=newNode;
queue->rear=newNode;
    }
else
    {
        queue->rear->next=newNode;
queue->rear=newNode;
    }

}

int dequeue(LinkedList *queue)
{
    if(queue-
>front==NULL)
    {
        printf("Queue is
empty\n");   return -1;
    }
}

```

```

    int dequeuedvalue=queue->front->data;
    Node *temp=queue->front;    queue-
    >front=queue->front->next;    free(temp);

    return dequeuedvalue;
}

int main()
{
    LinkedList queue;
    queue.front=NULL;
    queue.rear=NULL;

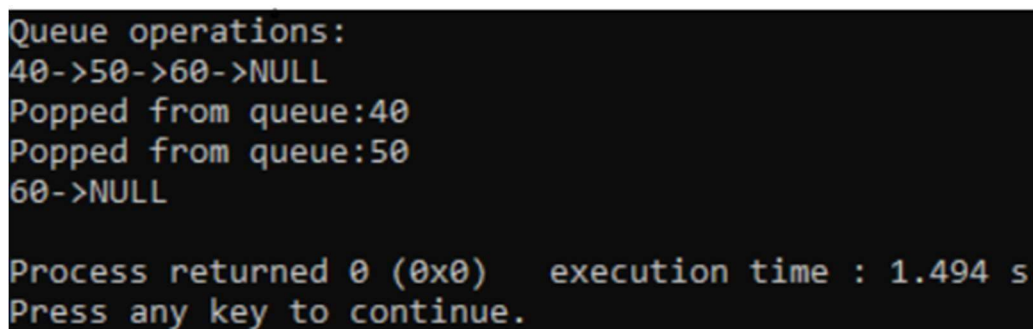
    printf("Queue operations:\n");
    enqueue(&queue,40);
    enqueue(&queue,50);
    enqueue(&queue,60);
    displayList(queue.front);

    printf("Popped from queue:%d\n",dequeue(&queue));
    printf("Popped from queue:%d\n",dequeue(&queue));

    displayList(queue.front);
    return 0;
}

```

Output:



```

Queue operations:
40->50->60->NULL
Popped from queue:40
Popped from queue:50
60->NULL

Process returned 0 (0x0)    execution time : 1.494 s
Press any key to continue.
_

```

Lab program 7:

WAP to Implement doubly link list with primitive operations

- a) Create a doubly linked list.
- b) Insert a new node to the left of the node.

- c) Delete the node based on a specific value
- d) Display the contents of the list

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

```
struct Node {    int
data;    struct Node*
prev;    struct
Node* next;
};
```

```
struct Node* createNode(int data)
{    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
if (newNode == NULL)
    {        printf("Memory allocation
failed\n");        exit(1);
    }
    newNode->data = data;
newNode->prev = NULL;
newNode->next = NULL;
return newNode;
}
```

```
void insertNodeToLeft(struct Node* head, struct Node* target, int data)
{
    struct Node* newNode = createNode(data);
if (target->prev != NULL)
    {
        target->prev->next = newNode;        newNode->
prev = target->prev;
    }
else
    {
        head = newNode;
    }
    newNode->next = target;    target->prev
= newNode;
}
```

```
void deleteNode(struct Node* head, int value)
{    struct Node* current =
head;    while (current !=
```

```

NULL)
{
    if (current->data ==
value)
    {
        if (current->prev != NULL)
        {
            current->prev->next = current->next;
        }
    }
else
    {
        head = current->next;
    }
    if (current->next != NULL)
    {
        current->next->prev = current->prev;
    }
}
free(current);
return;
}
current = current->next;
}
printf("Node with value %d not found\n", value);
}

```

```

void displayList(struct Node* head)
{
    printf("Doubly Linked List:
");
    while (head != NULL)
    {
        printf("%d <-> ", head-
>data);
        head = head->next;
    }
    printf("NULL\n");
}

```

```

int main()
{
    struct Node* head = NULL;

    head = createNode(1);
    head->next =
createNode(2);
    head->next->prev =
head;
    head->next->next =
createNode(3);
    head->next->next-
>prev = head->next;
}

```

```

displayList(head);

insertNodeToLeft(head, head->next, 10);
printf("After insertion:\n");
displayList(head);

deleteNode(head, 2);
printf("After deletion:\n");
displayList(head);

return 0;
}

```

Output:

```

Doubly Linked List: 1 <--> 2 <--> 3 <--> NULL
After insertion:
Doubly Linked List: 1 <--> 10 <--> 2 <--> 3 <--> NULL
After deletion:
Doubly Linked List: 1 <--> 10 <--> 3 <--> NULL

Process returned 0 (0x0)    execution time : 0.076 s
Press any key to continue.

```

Leetcode Problem -3:

Split Linked List in Parts

```

/**
 * Definition for singly-linked list.
 * struct ListNode {
 *     int val;
 *     struct ListNode *next;
 * };
 */
/**
 * Note: The returned array must be malloced,
 * assume caller calls free(). */ int getLength(struct
ListNode* head) {    int length = 0;    while (head
!= NULL) {        length++;        head
= head->next;

```

```

    }    return
length; }

```

```

struct ListNode** splitListToParts(struct ListNode* head, int k, int* returnSize)
{    int length = getLength(head);    int partSize = length / k;    int remainder =
length % k;

```

```

    struct ListNode** result = (struct ListNode**)malloc(k * sizeof(struct ListNode*));
    *returnSize = k;

```

```

    for (int i = 0; i < k; i++) {
        int currentPartSize = partSize + (i < remainder ? 1 : 0);

```

```

        if (currentPartSize == 0) {
result[i] = NULL;
        } else {            result[i] = head;            for
(int j = 0; j < currentPartSize - 1; j++) {
head = head->next;
        }

```

```

        struct ListNode* temp = head->next;
head->next = NULL;        head = temp;
    }
}

```

```

    return result;
}

```

Result:

Split Linked List in Parts

Submission Detail

43 / 43 test cases passed.

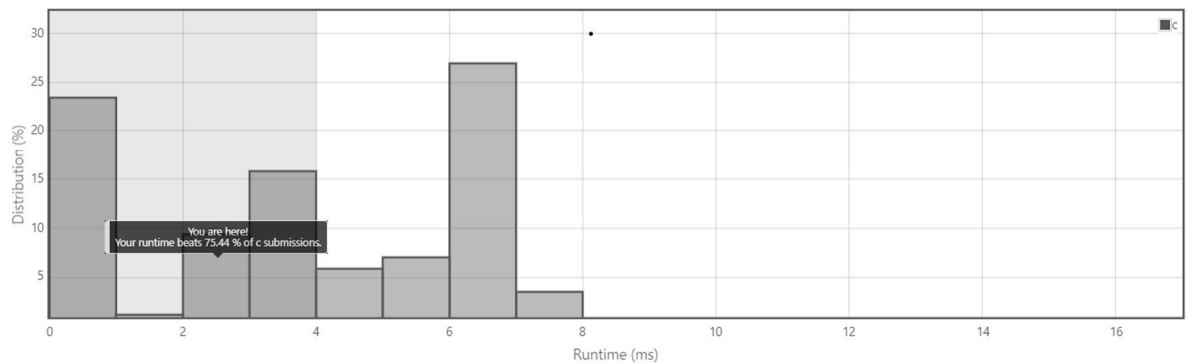
Runtime: 2 ms

Memory Usage: 6.2 MB

Status: **Accepted**

Submitted: 1 month ago

Accepted Solutions Runtime Distribution



Lab program 8:

Write a program

- To construct a binary Search tree.
- To traverse the tree using all the methods i.e., in-order, preorder and post order
- To display the elements in the tree.

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

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

```
struct node {    int  
data; struct node*  
left;  struct node*  
right;  
};
```

```
struct node* newNode(int data) { struct node* node = (struct  
node*)malloc(sizeof(struct node)); node->data = data;  
node->left = node->right = NULL; return node;  
}
```

```
struct node* insert(struct node* root, int data) { if (root  
== NULL) return newNode(data); if (data <= root-  
>data) root->left = insert(root->left, data); else root-  
>right = insert(root->right, data); return root; }
```

```

void inorder(struct node* temp)
{ if (temp == NULL) return;
inorder(temp->left); printf("%d
", temp->data); inorder(temp->right);
}

```

```

void preorder(struct node* temp) {
if (temp == NULL) return;
printf("%d ", temp->data);
preorder(temp->left);
preorder(temp->right);
}

```

```

void postorder(struct node* temp) {
if (temp == NULL) return;
postorder(temp->left);
postorder(temp->right); printf("%d
", temp->data);
}

```

```

int main() { struct node* root
= NULL; int data, choice;

```

```

do {
printf("Enter your choice:\n1. Insert\n2. Print Inorder\n3. Print Preorder\n4. Print
Postorder\n5. Exit\n"); scanf("%d", &choice);

```

```

switch (choice) {
case 1:
printf("Enter the value to be inserted:
"); scanf("%d", &data); root =
insert(root, data); break; case 2:
printf("Inorder traversal of binary tree is \n");

```

```

inorder(root);
printf("\n");
break; case 3:
printf("Preorder traversal of binary tree is
\n"); preorder(root); printf("\n");
break; case 4:
printf("Postorder traversal of binary tree is
\n"); postorder(root); printf("\n");
break; case 5: printf("Exiting...\n");
break; default:

```

```
        printf("Invalid choice. Please try again.\n");
    }
} while (choice != 5);

return 0;
}
```

Output:

```

Enter your choice:
1. Insert
2. Print Inorder
3. Print Preorder
4. Print Postorder
5. Exit
1
Enter the value to be inserted: 20
Enter your choice:
1. Insert
2. Print Inorder
3. Print Preorder
4. Print Postorder
5. Exit
1
Enter the value to be inserted: 10
Enter your choice:
1. Insert
2. Print Inorder
3. Print Preorder
4. Print Postorder
5. Exit
1
Enter the value to be inserted: 30
Enter your choice:
1. Insert
2. Print Inorder
3. Print Preorder
4. Print Postorder
5. Exit
1
Enter the value to be inserted: 5
Enter your choice:
1. Insert
2. Print Inorder
3. Print Preorder
4. Print Postorder
5. Exit
1
Enter the value to be inserted: 15
Enter your choice:
1. Insert
2. Print Inorder
3. Print Preorder
4. Print Postorder
5. Exit
1
Enter the value to be inserted: 45
Enter your choice:
1. Insert
2. Print Inorder
3. Print Preorder
4. Print Postorder
5. Exit
2
Inorder traversal of binary tree is
5 10 15 20 30 45
Enter your choice:
1. Insert
2. Print Inorder
3. Print Preorder
4. Print Postorder
5. Exit
3
Preorder traversal of binary tree is
20 10 5 15 30 45
Enter your choice:
1. Insert
2. Print Inorder
3. Print Preorder
4. Print Postorder
5. Exit
4
Postorder traversal of binary tree is
5 15 10 45 30 20
Enter your choice:
1. Insert
2. Print Inorder
3. Print Preorder
4. Print Postorder
5. Exit
5
Exiting...

Process returned 0 (0x0)   execution time : 42.620 s
Press any key to continue.

```

Leetcode Problem -4:

Rotate List

```
/**
 * Definition for singly-linked list.
 * struct ListNode {
 *   int val;
 *   struct ListNode *next;
 * };
 */
struct ListNode* rotateRight(struct ListNode* head, int k) {

    if (head == NULL || head->next == NULL || k == 0)

        return head;

    int len = 1;

    struct ListNode *tail = head;

    while (tail->next != NULL) {

        tail = tail->next;

        len++;

    }

    k = k % len;

    if (k == 0)

        return head;

    struct ListNode *p = head;

    for (int i = 0; i < len - k - 1; i++) {

        p = p->next;

    }

    tail->next = head;
```

```

head = p->next;

p->next = NULL;

return head;

}

```

Result:

[Rotate List](#)

Submission Detail

232 / 232 test cases passed.

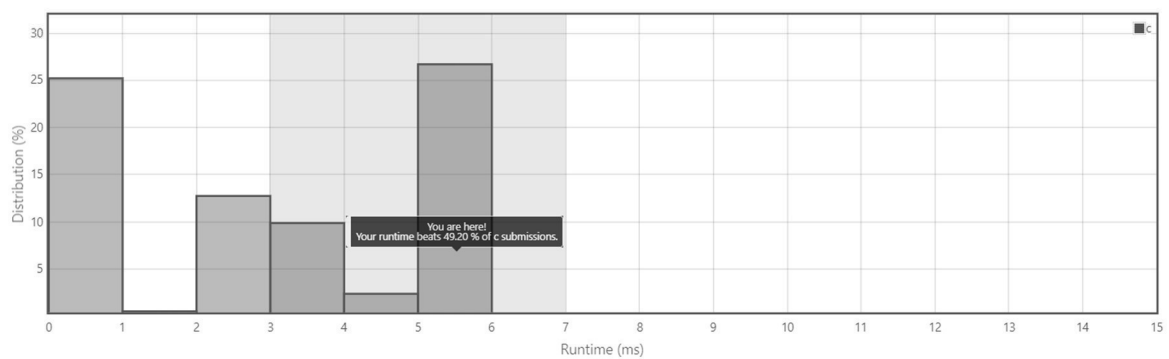
Runtime: 5 ms

Memory Usage: 6.1 MB

Status: **Accepted**

Submitted: 2 weeks, 3 days ago

Accepted Solutions Runtime Distribution



Lab program 9:

9a) Write a program to traverse a graph using BFS method.

```

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

```

```

#define MAX_SIZE 100

```

```

// Queue implementation
struct Queue
{
    int
    items[MAX_SIZE];
    int front;    int rear;
};

```

```

// Initialize queue struct
Queue* createQueue() {
    struct Queue* queue =
    (struct
    Queue*)malloc(sizeof(struc
    t Queue));    queue->front =
    -1;    queue->rear = -1;
    return queue;
}

// Check if the queue is empty int
isEmpty(struct Queue* queue) {
    if (queue->rear == -
    1)    return 1;    else
    return 0;
}

// Add an item to the queue void
enqueue(struct Queue* queue, int value) {
    if (queue->rear == MAX_SIZE - 1)
    printf("\nQueue is Full!!");    else
    {    if (queue->front
    == -1)    queue->front = 0;    queue-
    >rear++;    queue->items[queue->rear]
    = value;
    }
}

// Remove an item from the queue
int dequeue(struct Queue* queue)
{    int item;    if
(isEmpty(queue))
    {
        printf("Queue is empty");    item
    = -1;
    }
    else
    {
        item = queue->items[queue->front];    queue-
    >front++;
        if (queue->front > queue->rear)
        {
            queue->front = queue->rear = -1;
        }    }
    return item;
}

```

```

}

// Graph implementation
struct Graph {    int
vertices;    int**
adjMatrix;
};

// Create a graph with 'vertices' number of vertices struct
Graph* createGraph(int vertices)
{    struct Graph* graph = (struct Graph*)malloc(sizeof(struct
Graph));    graph->vertices = vertices;

    graph->adjMatrix = (int**)malloc(vertices * sizeof(int*));
    for (int i = 0; i < vertices; i++)
    {
        graph->adjMatrix[i] = (int*)malloc(vertices *
sizeof(int));        for (int j = 0; j < vertices; j++)            graph->adjMatrix[i][j]
= 0;
    }
    return graph;
}

// Add an edge to the graph void addEdge(struct
Graph* graph, int src, int dest)
{    graph->adjMatrix[src][dest] =
1;        graph->adjMatrix[dest][src] = 1; // Uncomment if the graph is
undirected }

// Breadth First Search traversal
void BFS(struct Graph* graph, int startVertex)
{    int visited[MAX_SIZE] = {0}; // Initialize all vertices as not visited
    struct Queue* queue = createQueue();

    visited[startVertex] = 1;
    enqueue(queue, startVertex);

    printf("Breadth First Search Traversal: ");

    while (!isEmpty(queue))
    {
        int currentVertex = dequeue(queue);
        printf("%d ", currentVertex);

```

```

        for (int i = 0; i < graph->vertices; i++)
        {
            if (graph->adjMatrix[currentVertex][i] == 1 && visited[i] == 0)
            {
                visited[i]
= 1;
enqueue(queue, i);
            }
        }
    }
    printf("\n");
}

```

```

int main() {    int vertices,
edges, src, dest;

```

```

    printf("Enter the number of vertices: ");
    scanf("%d", &vertices);

```

```

    struct Graph* graph = createGraph(vertices);

```

```

    printf("Enter the number of edges: ");
    scanf("%d", &edges);

```

```

    for (int i = 0; i < edges; i++)
    {
        printf("Enter edge %d (source destination): ", i + 1);
        scanf("%d%d", &src, &dest);    addEdge(graph, src,
dest);
    }

```

```

    int startVertex;
    printf("Enter the starting vertex for BFS: ");
    scanf("%d", &startVertex);

```

```

    BFS(graph, startVertex);

```

```

    return 0;
}

```

Output:

```

Enter the number of vertices: 6
Enter the number of edges: 5
Enter edge 1 (source destination): 0 1
Enter edge 2 (source destination): 0 2
Enter edge 3 (source destination): 1 3
Enter edge 4 (source destination): 1 4
Enter edge 5 (source destination): 2 5
Enter the starting vertex for BFS: 0
Breadth First Search Traversal: 0 1 2 3 4 5

Process returned 0 (0x0)    execution time : 57.435 s
Press any key to continue.
|

```

9b) Write a program to check whether given graph is connected or not using DFS method.

```

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

#define MAX_SIZE 100

// Graph implementation struct
struct Graph
{
    int vertices;
    int** adjMatrix;
};

// Create a graph with 'vertices' number of vertices
struct Graph* createGraph(int vertices)
{
    struct Graph* graph = (struct Graph*)malloc(sizeof(struct Graph));
    graph->vertices = vertices;

    graph->adjMatrix = (int**)malloc(vertices * sizeof(int*));
    for (int i = 0; i < vertices; i++)
    {
        graph->adjMatrix[i] = (int*)malloc(vertices *
sizeof(int));
        for (int j = 0; j < vertices; j++)
            graph->adjMatrix[i][j] = 0;
    }
    return graph;
}

// Add an edge to the graph void addEdge(struct

```

```

Graph* graph, int src, int dest)
{   graph->adjMatrix[src][dest] = 1;   graph->adjMatrix[dest][src] = 1; //
Uncomment if the graph is undirected
}

// Depth First Search traversal void DFS(struct Graph*
graph, int startVertex, int visited[])
{   visited[startVertex] =
1;

    for (int i = 0; i < graph->vertices; i++)
    {
        if (graph->adjMatrix[startVertex][i] == 1 && visited[i] == 0)
            DFS(graph, i, visited);
    }
}

// Check if the graph is connected int
isConnected(struct Graph* graph)
{   int* visited = (int*)malloc(graph->vertices *
sizeof(int));

    for (int i = 0; i < graph->vertices; i++)
        visited[i] = 0;

    DFS(graph, 0, visited);

    for (int i = 0; i < graph->vertices; i++)
    {
        if (visited[i] == 0)
            return 0; // Graph is not connected
    }
    return 1; // Graph is connected
}

int main() {
    int vertices, edges, src, dest;

    printf("Enter the number of vertices: ");
    scanf("%d", &vertices);
    struct Graph* graph = createGraph(vertices);

    printf("Enter the number of edges: ");
    scanf("%d", &edges);

```

```

    for (int i = 0; i < edges; i++)
    {
        printf("Enter edge %d (source destination): ", i
+ 1);
        scanf("%d%d", &src, &dest);
        addEdge(graph, src, dest);
    }

    if (isConnected(graph))    printf("The
graph is connected.\n");    else
printf("The graph is not connected.\n");

    return 0;
}

```

Output:

```

Enter the number of vertices: 6
Enter the number of edges: 5
Enter edge 1 (source destination): 0 1
Enter edge 2 (source destination): 0 2
Enter edge 3 (source destination): 1 3
Enter edge 4 (source destination): 1 4
Enter edge 5 (source destination): 2 5
The graph is connected.

Process returned 0 (0x0)    execution time : 13.878 s
Press any key to continue.

```

HackerRank Problem

Swap Nodes

```

#include <assert.h>
#include <stdbool.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

typedef struct Node {
    int data;    struct Node*
left;    struct
Node* right;
} Node;

```



```

Node* createNode(int data) {
    Node* newNode = (Node*)malloc(sizeof(Node));
    newNode->data = data;    newNode->left = NULL;
    newNode->right = NULL;    return newNode;
}

void inOrderTraversal(Node* root, int* result, int* index)
{    if (root == NULL) return;
  inOrderTraversal(root->left, result, index);
  result[(*index)++] = root->data;    inOrderTraversal(root-
->right, result, index);
}

void swapAtLevel(Node* root, int k, int level) {    if
(root == NULL) return;    if (level % k == 0)
{        Node* temp = root->left;        root->left
= root->right;        root->right = temp;
    }
    swapAtLevel(root->left, k, level + 1);
    swapAtLevel(root->right, k, level + 1);
}

int** swapNodes(int indexes_rows, int indexes_columns, int** indexes, int queries_count,
int* queries, int* result_rows, int* result_columns) {
    // Build the tree
    Node** nodes = (Node**)malloc((indexes_rows + 1) * sizeof(Node*));    for
(int i = 1; i <= indexes_rows; i++) {        nodes[i] = createNode(i);
    }

    for (int i = 0; i < indexes_rows; i++) {        int leftIndex =
indexes[i][0];        int rightIndex = indexes[i][1];        if
(leftIndex != -1) nodes[i + 1]->left = nodes[leftIndex];        if
(rightIndex != -1) nodes[i + 1]->right = nodes[rightIndex];
    }

    // Perform swaps and store results    int** result =
(int**)malloc(queries_count * sizeof(int*));
    *result_rows = queries_count;
    *result_columns = indexes_rows;    for (int i = 0; i
<
queries_count; i++) {        swapAtLevel(nodes[1], queries[i], 1);
    int* traversalResult = (int*)malloc(indexes_rows * sizeof(int));
    int index = 0;        inOrderTraversal(nodes[1], traversalResult,
&index);        result[i] = traversalResult;
    }
}

```

```

    free(nodes);
return result;
}

int main() {
int n;
    scanf("%d", &n);

    int** indexes = malloc(n * sizeof(int*));    for
(int i = 0; i < n; i++) {        indexes[i]
= malloc(2 * sizeof(int));
        scanf("%d %d", &indexes[i][0], &indexes[i][1]);
    }

    int queries_count;
    scanf("%d", &queries_count);

    int* queries = malloc(queries_count * sizeof(int));
for (int i = 0; i < queries_count; i++) {
scanf("%d", &queries[i]);
    }

    int result_rows;    int result_columns;    int** result = swapNodes(n, 2,
indexes, queries_count, queries, &result_rows, &result_columns);

    for (int i = 0; i < result_rows; i++) {
for (int j = 0; j < result_columns; j++) {
printf("%d ", result[i][j]);
        }
printf("\n");        free(result[i]); // Free memory allocated
for each row
    }
    free(result); // Free memory allocated for the result array

    // Free memory allocated for indexes and queries
arrays    for (int i = 0; i < n; i++) {        free(indexes[i]);
    }
free(indexes);
free(queries);

    return 0;
}

```

Result:

Swap Nodes [Algo] ★

Problem

Submissions

Leaderboard

Discussions

Editorial

You made this submission 3 days ago.

Score: 40.00 Status: **Accepted**

Lab program 10:

Given a File of N employee records with a set K of Keys(4-digit) which uniquely determine the records in file F.

Assume that file F is maintained in memory by a Hash Table (HT) of m memory locations with L as the set of memory addresses (2-digit) of locations in HT.

Let the keys in K and addresses in L are integers.

Design and develop a Program in C that uses Hash function H: $K \rightarrow L$ as $H(K) = K \bmod m$ (remainder method), and implement hashing technique to map a given key K to the address space L. Resolve the collision (if any) using linear probing.

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

```
#define TABLE_SIZE 10
```

```
int hashFunction(int key) {  
    return key % TABLE_SIZE;  
}
```

```
void insertValue(int hashTable[], int key)  
{  
    int i = 0;    int hkey = hashFunction(key);  
    int index;
```

```

    do {          index = (hkey + i) % TABLE_SIZE;
if(hashTable[index] == -1) {      hashCode[index]
= key;          printf("Inserted key %d at index
%d\n", key, index);      return;    }      i++;
    } while (i < TABLE_SIZE);

    printf("Unable to insert key %d. Hash table is full.\n", key);
}

int searchValue(int hashCode[], int key)
{   int i = 0;   int hkey = hashCode(key);
int index;

    do {          index = (hkey + i) %
TABLE_SIZE;      if (hashCode[index]
== key) {
        printf("Key %d found at index %d\n", key, index);
return index;
    }
    i++;
    } while (i < TABLE_SIZE);

    printf("Key %d not found in hash table.\n", key);
return -1;
}

int main() {   int
hashCode[TABLE_SIZE];   for
(int i = 0; i < TABLE_SIZE;
i++) {          hashCode[i] = -1;
    }

    insertValue(hashCode, 1234);
insertValue(hashCode, 5678);
insertValue(hashCode, 9876);

    searchValue(hashCode, 5678);
searchValue(hashCode, 1111);

    return 0;
}

```

Output:

```
Inserted key 1234 at index 4
Inserted key 5678 at index 8
Inserted key 9876 at index 6
Key 5678 found at index 8
Key 1111 not found in hash table.

Process returned 0 (0x0)   execution time : 0.074 s
Press any key to continue.
|
```