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

Faculty Incharge

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B.M.S. COLLEGE OF ENGINEERING
(Autonomous Institution under VTU)
BENGALURU-560019
Dec 2023- March 2024

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This is to certify that the Lab work entitled **“DATA STRUCTURES”** carried out by **VARSHA P(1BM22CS320)**, 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:

CO1	Apply the concept of linear and nonlinear data structures.
CO2	Analyze data structure operations for a given problem
CO3	Design and develop solutions using the operations of linear and nonlinear data structure for a given specification.
CO4	Conduct practical experiments for demonstrating the operations of different data structures.

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 max 10
int stack[max];
int top = -1;
int val;
void push(int);
void pop();
void display();
int main()
{
int choice = 0;
do
{
printf("Enter your choice\n");
printf("1.Push\n2.Pop\n3.Display\n4.Exit\n");
scanf("%d", &choice);
switch (choice)
{
case 1:
if (top == max - 1)
{
printf("Overflow\n");
}
else
{
printf("Enter value to be pushed\n");
scanf("%d", &val);
push(val);
printf("-----------------Push operation completed\n");
}
break;
case 2:
if (top == -1)
{
printf("Underflow\n");
}
```

```
else
{
pop();
printf("-------------------Pop operation completed\n");
}
break;
case 3:
if (top == -1)
{
printf("Stack is empty\n");
}
else
{
display();
}
break;
case 4:
printf("Exit\n");
exit(0);
default:
printf("Incorrect input\n");
}
} while (choice != 4);
return 0;
}
void push(int val)
{
if (top != max - 1)
{
top++;
stack[top] = val;
}
else
{
printf("Overflow\n");
}
}
void pop()
{
if (top != -1)
{
val = stack[top];
top--;
```

```
}
else
{
printf("Underflow\n");
}
}
void display()
{
    printf("---------------");
if (top != -1)
{
for (int i = 0; i <= top; i++)
printf("%d\t", stack[i]);
}
printf("\n");
}
```

OUTPUT:

```
Enter your choice
1.Push
2.Pop
3.Display
4.Exit
1
Enter value to be pushed
3
-----------------Push operation completed
Enter your choice
1.Push
2.Pop
3.Display
4.Exit
1
Enter value to be pushed
4
-----------------Push operation completed
Enter your choice
1.Push
2.Pop
3.Display
4.Exit
1
Enter value to be pushed
5
-----------------Push operation completed
Enter your choice
1.Push
2.Pop
3.Display
4.Exit
2
------------------Pop operation completed
Enter your choice
1.Push
2.Pop
3.Display
4.Exit
3
--------------- 34
```

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

```
#include<stdio.h>
#include<conio.h>
#include<string.h>
#include<ctype.h>
#include<stdlib.h>
#define max 100
char st[max];
int top=-1;
void push(char st[], char);
char pop(char st[]);
void infixToPostfix(char source[], char target[]);
int getPriority(char);
int main()
{
char infix[100], postfix[100];
printf("Enter infix expression\n");
gets(infix);
strcpy(postfix," ");
infixToPostfix(infix, postfix);
printf("Postfix expression is-\n");
puts(postfix);
return 0;
}
void infixToPostfix(char source[], char target[])
{
int i=0, j=0;
char temp;
strcpy(target," ");
while (source[i]!='\0')
{
if(source[i]=='(')
{
push(st,source[i]);
i++;
}
else if(source[i]==')')
{
while((top!=-1)&&(st[top]!='('))
{
```

```
target[j]=pop(st);
j++;
}
if(top==-1)
{
printf("Incorrect expression\n");
exit(1);
}
temp=pop(st);
i++;
}
else if(isdigit(source[i])||isalpha(source[i]))
{
target[j]=source[i];
j++;
i++;
}
else
if(source[i]=='+'||source[i]=='-'||source[i]=='*'||source[i]=='/'||source[i]=='%')
{
while( (top!=-1) && (st[top]!='(') &&
(getPriority(st[top])>getPriority(source[i])) )
{
target[j]=pop(st);
j++;
}
push(st,source[i]);
i++;
}
else
{
printf("Incorrect element in expression\n");
exit(1);
}
}
while((top!=-1)&&(st[top]!='('))
{
target[j]=pop(st);
j++;
}
target[j]='\0';
}
int getPriority(char op)
```

```
{
if(op=='/'|| op=='*'||op=='%')
return 1;
else if(op=='+'||op=='-')
return 0;
}
void push(char st[],char val)
{
if(top==max-1)
{
printf("Stack overflow\n");
}
else
{
top++;
st[top]=val;
}
}
char pop(char st[])
{
char val = ' ';
if(top == -1)
{
printf("Stack underflow\n");
}
else
{
val = st[top];
top--;
}
return val;
}
```

OUTPUT:

```
Enter infix expression
A+B+C*D
Postfix expression is-
ABCD*++
```

3.Write a program to simulate the working of the queue of integers using an array. Provide the following operations: Insert, delete, display. The program should print appropriate messages for overflow and underflow conditions.

```
#include<stdio.h>
#include<conio.h>
#include<stdlib.h>
#define max 100
int q[max], front=1, rear=-1;
void insert();
void delete();
void display();
void main()
{
while(1)
{
printf("Enter your choice\n");
printf("1.Enqueue\n 2.Dequeue\n 3.Display\n 4.Exit\n");
int choice=0;
scanf("%d", & choice);
switch(choice)
{
case 1:
insert();
break;
case 2:
delete();
break;
case 3:
display();
break;
case 4:
exit(0);
break;
default:
printf("Incorrect Input\n");
}
}
}
void insert()
{
int val=0;
printf("Enter value to be inserted\n");
scanf("%d", & val);
```

```
if(rear==max-1)
printf("Queue Overflow\n");
if (front==-1||rear==-1)
{
front=0;
rear=0;
}
else{
rear=rear+1;
}
q[rear]=val;
}
void delete()
{
if (front>rear||front==-1)
{
printf("Queue Underflow\n");
}
else{
printf("------------------%d has been deleted\n",q[front]);
front=front+1;
}
}
void display()
{
printf("The queue is-\n");
printf("--------------------");
for(int i=front; i<=rear; i++)
printf("%d\t",q[i]);
printf("\n");
}
```

OUTPUT:

```
1.Enqueue
 2.Dequeue
 3.Display
 4.Exit
1
Enter value to be inserted
2
Enter your choice
1.Enqueue
 2.Dequeue
 3.Display
 4.Exit
1
Enter value to be inserted
4
Enter your choice
1.Enqueue
 2.Dequeue
 3.Display
 4.Exit
1
Enter value to be inserted
6
Enter your choice
1.Enqueue
 2.Dequeue
 3.Display
 4.Exit
2
------------------2 has been deleted
Enter your choice
1.Enqueue
 2.Dequeue
 3.Display
 4.Exit
3
The queue is-
--------------------46
Enter your choice
1.Enqueue
 2.Dequeue
 3.Display
 4.Exit
```

4.Write a program to simulate the working of a circular queue 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>
#include<conio.h>
#include<stdlib.h>
#define max 20
int q[max], rear=-1, front=-1;
int isFull();
int isEmpty();
void insert (int element);
int delete();
void display();
void main()
{
int choice, element;
while(1)
{
printf("Enter choice\n");
printf("1.Insert\n2.Delete\n3.Display\n4.Exit\n\n");
scanf("%d", &choice);
switch(choice)
{
case 1:
printf("Enter element to be inserted\n");
scanf("%d", & element);
insert(element);
break;
case 2:
element=delete();
break;
case 3:
display();
break;
case 4:
exit(0); break;
default:
printf("Incorrect Input\n");
break;
}
}
}
```

```
int isFull()
{
if((front==rear+1)||(front==0 && rear==max-1))
return 1;
return 0;
}
int isEmpty()
{
if(front==-1)
return 1;
return 0;
}
void insert(int element)
{
if (isFull())
{ printf("Overflow\n");
}
else
{
if(front==-1)
front=0;
rear=(rear+1)%max;
q[rear]=element;
}
}
int delete()
{
int value;
if (isEmpty())
{
printf("Underflow\n");
return -1;
}
else{
value=q[front];
if(front==rear)
{
front==-1;
rear==-1;
}
else
{
front=(front+1)%max;
```

```
}
return(value);
}}

void display()
{
int i;
if(isEmpty())
printf("Underflow\n");
else{
for(i=front;i!=rear;i=(i+1)%max)
printf("%d\t",q[i]);
printf("%d\t",q[i]);
printf("\n");
}
}
```

OUTPUT:

```
1.Insert
2.Delete
3.Display
4.Exit

2
Enter choice
1.Insert
2.Delete
3.Display
4.Exit

3
4
Enter choice
1.Insert
2.Delete
3.Display
4.Exit

1
Enter element to be inserted
6
Enter choice
1.Insert
2.Delete
3.Display
4.Exit

2
Enter choice
1.Insert
2.Delete
3.Display
4.Exit

3
6
Enter choice
1.Insert
2.Delete
3.Display
4.Exit
```

5.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 newData) {
struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
newNode->data = newData;
newNode->next = NULL;
return newNode;
}
struct Node* insertAtFirst(struct Node* head, int newData) {
struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
newNode->data=newData;
newNode->next = head;
return newNode;
}
struct Node* insertAtPosition(struct Node* head, int newData, int
position)
{
struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
newNode->data=newData;
if (position == 1) {
newNode->next = head;
return newNode;
}
struct Node* temp = head;
for (int i = 1; i < position - 1 && temp != NULL; i++) {
temp = temp->next;
}
if (temp == NULL) {
printf("Invalid position\n");
return head;
}
newNode->next = temp->next;
temp->next = newNode;
return head;
```

```
}
struct Node* insertAtEnd(struct Node* head, int newData)
{
struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
newNode->data=newData;
newNode->next=NULL;
if (head == NULL) {
return newNode;
}
struct Node* temp = head;
while (temp->next != NULL) {
temp = temp->next;
}
temp->next = newNode;
return head;
}
void displayList(struct Node* head) {
struct Node* temp = head;
while (temp != NULL) {
printf("%d -> ", temp->data);
temp = temp->next;
}
printf("NULL\n");
}
void main() {
struct Node* head = NULL;
head = insertAtEnd(head, 1);
head = insertAtEnd(head, 2);
head = insertAtEnd(head, 3);
printf("Linked List: ");
displayList(head);
head = insertAtFirst(head, 0);
printf("After insertion at first position: ");
displayList(head);
head = insertAtPosition(head, 4, 4);
printf("After insertion at position 4: ");
displayList(head);
head = insertAtEnd(head, 5);
printf("After insertion at end: ");
displayList(head);
}
```

OUTPUT:

```
Linked List: 1 -> 2 -> 3 -> NULL
After insertion at first position: 0 -> 1 -> 2 -> 3 -> NULL
After insertion at position 4: 0 -> 1 -> 2 -> 4 -> 3 -> NULL
After insertion at end: 0 -> 1 -> 2 -> 4 -> 3 -> 5 -> NULL

Process returned 0 (0x0)   execution time : 0.078 s
Press any key to continue.
```

6.WAP to Implement Singly Linked List with following operations.
a) Create a linked list.
b) Deletion of the 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* insertAtEnd(struct Node* head, int newData)
{
struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
newNode->data = newData;
newNode->next = NULL;
if (head == NULL)
{
return newNode;
}
struct Node* temp = head;
while (temp->next != NULL)
{
temp = temp->next;
}
temp->next = newNode;
return head;
}
struct Node* deleteFirst(struct Node* head)
{
if (head == NULL)
{
printf("List is Empty! Deletion not Possible");
return NULL;
}
struct Node* newHead = head->next;
free(head);
return newHead;
}
struct Node* deleteElement(struct Node* head, int target)
{
if (head == NULL)
```

```
{
printf("List is Empty, hence cannot Delete \n");
return NULL;
}
if (head->data == target)
{
struct Node* newHead = head->next;
free(head);
return newHead;
}
struct Node* temp = head;
while (temp->next != NULL && temp->next->data != target)
{
temp = temp->next;
}
if (temp->next == NULL)
{
printf("Element %d not found in the list \n", target);
return head;
}
struct Node* nodeToDelete = temp->next;
temp->next = temp->next->next;
free(nodeToDelete);
return head;
}
struct Node* deleteLast(struct Node* head)
{
if (head == NULL)
{
printf("List is Empty, hence cannot Delete \n");
return NULL;
}
if (head->next == NULL)
{
free(head);
return NULL;
}
struct Node* temp = head;
while (temp->next->next != NULL)
{
temp = temp->next;
}
free(temp->next);
```

```
temp->next = NULL;
return head;
}
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;
head = insertAtEnd(head, 1);
head = insertAtEnd(head, 2);
head = insertAtEnd(head, 3);
printf("Linked List:");
displayList(head);
head = deleteFirst(head);
printf("After deleting the first element:");
displayList(head);
head = deleteElement(head, 2);
printf("After deleting the second element:");
displayList(head);
head = deleteLast(head);
printf("After deleting the last Element:");
displayList(head);
return 0;
}
```

OUTPUT

```
Linked List: 1 -> 2 -> 3 ->NULL
After deleting the first element: 2 -> 3 ->NULL
After deleting the second element: 3 ->NULL
After deleting the last Element:NULL

Process returned 0 (0x0)   execution time : 0.062 s
Press any key to continue.
```

7.WAP using Single linked list
->Sorting
->Reversing
->Concatenation

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

// Node structure for the linked list
struct Node {
    int data;
    struct Node* next;
};

// Function to create a new node with the given data
struct Node* createNode(int data) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    if (newNode == NULL) {
        fprintf(stderr, "Memory allocation error\n");
        exit(EXIT_FAILURE);
    }
    newNode->data = data;
    newNode->next = NULL;
    return newNode;
}

// Function to insert a new node at the end of the linked list
void insertAtEnd(struct Node** head, int data) {
    struct Node* newNode = createNode(data);

    if (*head == NULL) {
        *head = newNode;
    } else {
        struct Node* current = *head;
        while (current->next != NULL) {
            current = current->next;
        }
        current->next = newNode;
    }
}

// Function to display the linked list
void displayList(struct Node* head) {
```

```c
    while (head != NULL) {
        printf("%d -> ", head->data);
        head = head->next;
    }
    printf("NULL\n");
}

// Function to sort the linked list using Bubble Sort
void sortList(struct Node* head) {
    struct Node *i, *j;
    int temp;

    for (i = head; i != NULL; i = i->next) {
        for (j = i->next; j != NULL; j = j->next) {
            if (i->data > j->data) {
                // Swap data of the two nodes
                temp = i->data;
                i->data = j->data;
                j->data = temp;
            }
        }
    }
}

// Function to reverse the linked list
void reverseList(struct Node** head) {
    struct Node* prev = NULL;
    struct Node* current = *head;
    struct Node* next = NULL;

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

    *head = prev;
}

// Function to concatenate two linked lists
void concatenateLists(struct Node** list1, struct Node* list2) {
    if (*list1 == NULL) {
```

```
            *list1 = list2;
        } else {
            struct Node* current = *list1;
            while (current->next != NULL) {
                current = current->next;
            }
            current->next = list2;
        }
}

int main() {
    struct Node* list1 = NULL;
    struct Node* list2 = NULL;

    // Insert elements into the first linked list
    insertAtEnd(&list1, 5);
    insertAtEnd(&list1, 2);
    insertAtEnd(&list1, 8);

    // Display the original linked list
    printf("Original Linked List 1:\n");
    displayList(list1);

    // Sort the linked list 1
    sortList(list1);
    printf("Sorted Linked List 1:\n");
    displayList(list1);

    // Insert elements into the second linked list
    insertAtEnd(&list2, 3);
    insertAtEnd(&list2, 1);
    insertAtEnd(&list2, 7);

    // Display the original linked list 2
    printf("\nOriginal Linked List 2:\n");
    displayList(list2);

    // Concatenate the two linked lists
    concatenateLists(&list1, list2);

    // Display the concatenated linked list
    printf("\nConcatenated Linked List:\n");
    displayList(list1);
```

```c
    // Reverse the concatenated linked list
    reverseList(&list1);
    printf("\nReversed Linked List:\n");
    displayList(list1);

    // Free the memory used by the linked lists
    struct Node* temp;
    while (list1 != NULL) {
        temp = list1;
        list1 = list1->next;
        free(temp);
    }

    return 0;
}
```

OUTPUT:

```
Original Linked List 1:
5 -> 2 -> 8 -> NULL
Sorted Linked List 1:
2 -> 5 -> 8 -> NULL

Original Linked List 2:
3 -> 1 -> 7 -> NULL

Concatenated Linked List:
2 -> 5 -> 8 -> 3 -> 1 -> 7 -> NULL

Reversed Linked List:
7 -> 1 -> 3 -> 8 -> 5 -> 2 -> NULL

Process returned 0 (0x0)   execution time : 0.062 s
Press any key to continue.
```

8a.Stack implementation using single linked list

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

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

// Function to create a new node
struct Node* createNode(int data) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    if (newNode == NULL) {
        printf("Memory allocation failed.\n");
        exit(EXIT_FAILURE);
    }
    newNode->data = data;
    newNode->next = NULL;
    return newNode;
}

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

// Function to pop an element from the stack
struct Node* pop(struct Node* top) {
    if (top == NULL) {
        printf("Stack underflow. Cannot pop.\n");
        return NULL;
    }

    struct Node* temp = top;
    top = top->next;
    free(temp);
    return top;
}

// Function to display the elements of the stack
```

```c
void displayStack(struct Node* top) {
    printf("Stack: ");
    while (top != NULL) {
        printf("%d ", top->data);
        top = top->next;
    }
    printf("\n");
}

// Function to free the memory allocated for the stack
void freeStack(struct Node* top) {
    while (top != NULL) {
        struct Node* temp = top;
        top = top->next;
        free(temp);
    }
}

int main() {
    struct Node* top = NULL;
    int choice, data;

    do {
        printf("\nMenu:\n");
        printf("1. Push\n");
        printf("2. Pop\n");
        printf("3. Display\n");
        printf("4. Exit\n");

        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter data to push: ");
                scanf("%d", &data);
                top = push(top, data);
                break;

            case 2:
                top = pop(top);
                break;

```

```c
            case 3:
                displayStack(top);
                break;

            case 4:
                printf("Exiting the program.\n");
                break;

            default:
                printf("Invalid choice! Please enter a valid option.\n");
        }

    } while (choice != 4);

    // Free the memory allocated for the stack before exiting
    freeStack(top);

    return 0;
}
```

OUTPUT:

```
Menu:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 1
Enter data to push: 2

Menu:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 2

Menu:
1. Push
2. Pop
3. Display
4. Exit
Enter your choice: 3
Stack: 2

Menu:
1. Push
2. Pop
3. Display
4. Exit
```

9.Queue implementation using single linked list

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

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

// Queue structure
struct Queue {
    struct Node* front;
    struct Node* rear;
};

// Function to create a new node
struct Node* createNode(int data) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    if (newNode == NULL) {
        printf("Memory allocation failed.\n");
        exit(EXIT_FAILURE);
    }
    newNode->data = data;
    newNode->next = NULL;
    return newNode;
}

// Function to initialize an empty queue
struct Queue* initializeQueue() {
    struct Queue* queue = (struct Queue*)malloc(sizeof(struct Queue));
    if (queue == NULL) {
        printf("Memory allocation failed.\n");
        exit(EXIT_FAILURE);
    }
    queue->front = queue->rear = NULL;
    return queue;
}

// Function to enqueue an element into the queue
void enqueue(struct Queue* queue, int data) {
    struct Node* newNode = createNode(data);
```

```c
    if (queue->rear == NULL) {
        queue->front = queue->rear = newNode;
        return;
    }

    queue->rear->next = newNode;
    queue->rear = newNode;
}

// Function to dequeue an element from the queue
void dequeue(struct Queue* queue) {
    if (queue->front == NULL) {
        printf("Queue underflow. Cannot dequeue.\n");
        return;
    }

    struct Node* temp = queue->front;
    queue->front = queue->front->next;

    // If front becomes NULL, update rear to NULL as well
    if (queue->front == NULL) {
        queue->rear = NULL;
    }

    free(temp);
}

// Function to display the elements of the queue
void displayQueue(struct Queue* queue) {
    if (queue->front == NULL) {
        printf("Queue is empty.\n");
        return;
    }

    struct Node* current = queue->front;
    printf("Queue: ");
    while (current != NULL) {
        printf("%d ", current->data);
        current = current->next;
    }
    printf("\n");
}
```

```
// Function to free the memory allocated for the queue
void freeQueue(struct Queue* queue) {
    while (queue->front != NULL) {
        struct Node* temp = queue->front;
        queue->front = queue->front->next;
        free(temp);
    }
    free(queue);
}

int main() {
    struct Queue* queue = initializeQueue();
    int choice, data;

    do {
        printf("\nMenu:\n");
        printf("1. Enqueue\n");
        printf("2. Dequeue\n");
        printf("3. Display\n");
        printf("4. Exit\n");

        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter data to enqueue: ");
                scanf("%d", &data);
                enqueue(queue, data);
                break;

            case 2:
                dequeue(queue);
                break;

            case 3:
                displayQueue(queue);
                break;

            case 4:
                printf("Exiting the program.\n");
                break;
```

```c
            default:
                printf("Invalid choice! Please enter a valid option.\n");
        }

    } while (choice != 4);

    // Free the memory allocated for the queue before exiting
    freeQueue(queue);

    return 0;
}
```

OUTPUT:

```
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter data to enqueue: 4

Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 1
Enter data to enqueue: 5

Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 2

Menu:
1. Enqueue
2. Dequeue
3. Display
4. Exit
Enter your choice: 3
Queue: 3 4 5
```

9. 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

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

// Node structure for doubly linked list
struct Node {
    int data;
    struct Node* prev;
    struct Node* next;
};

// Function to create a new node
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->prev = NULL;
    newNode->next = NULL;
    return newNode;
}

// Function to insert a new node to the left of the given node
void insertLeft(struct Node** head, struct Node* target, int value) {
    struct Node* newNode = createNode(value);

    if (target->prev != NULL)
        target->prev->next = newNode;
    else
        *head = newNode;

    newNode->prev = target->prev;
    newNode->next = target;
    target->prev = newNode;
}
```

```c
// Function to delete the node based on a specific value
void deleteNode(struct Node** head, int value) {
    struct Node* current = *head;

    // Find the node with the given value
    while (current != NULL && current->data != value) {
        current = current->next;
    }

    if (current == NULL) {
        printf("Node with value %d not found\n", value);
        return;
    }

    // Adjust the links to skip the current node
    if (current->prev != NULL)
        current->prev->next = current->next;
    else
        *head = current->next;

    if (current->next != NULL)
        current->next->prev = current->prev;

    // Free the memory occupied by the deleted node
    free(current);
}

// Function to display the doubly linked list
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;

    // Creating a doubly linked list
    head = createNode(1);
    head->next = createNode(2);
```

```
    head->next->prev = head;
    head->next->next = createNode(3);
    head->next->next->prev = head->next;

    // Displaying the original list
    displayList(head);

    // Inserting a new node to the left of the second node
    insertLeft(&head, head->next, 4);
    displayList(head);

    // Deleting a node with a specific value (e.g., 2)
    deleteNode(&head, 2);
    displayList(head);

    return 0;
}
```

OUTPUT:

```
Doubly Linked List: 1 -> 2 -> 3 -> NULL
Doubly Linked List: 1 -> 4 -> 2 -> 3 -> NULL
Doubly Linked List: 1 -> 4 -> 3 -> NULL

Process returned 0 (0x0)   execution time : 0.062 s
Press any key to continue.
```

10.Write a program.

a. To construct Binary Search tree

b. Traverse the tree using inorder , postorder, preorder.

c. Display the elements in the tree.

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

// Node structure for Binary Search Tree
struct Node {
    int data;
    struct Node *left;
    struct Node *right;
};

// Function to create a new node
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->left = NULL;
    newNode->right = NULL;
    return newNode;
}

// Function to insert a new node into the Binary Search Tree
struct Node* insert(struct Node* root, int value) {
    if (root == NULL) {
        return createNode(value);
    }
    if (value < root->data) {
        root->left = insert(root->left, value);
    } else if (value > root->data) {
        root->right = insert(root->right, value);
    }
    return root;
}

// Function for inorder traversal of BST
void inorderTraversal(struct Node* root) {
```

```
    if (root != NULL) {
        inorderTraversal(root->left);
        printf("%d ", root->data);
        inorderTraversal(root->right);
    }
}

// Function for preorder traversal of BST
void preorderTraversal(struct Node* root) {
    if (root != NULL) {
        printf("%d ", root->data);
        preorderTraversal(root->left);
        preorderTraversal(root->right);
    }
}

// Function for postorder traversal of BST
void postorderTraversal(struct Node* root) {
    if (root != NULL) {
        postorderTraversal(root->left);
        postorderTraversal(root->right);
        printf("%d ", root->data);
    }
}

// Function to display elements in the Binary Search Tree
void displayTree(struct Node* root) {
    printf("Elements in the Binary Search Tree: ");
    inorderTraversal(root);
    printf("\n");
}

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

    // Constructing the Binary Search Tree
    root = insert(root, 10);
    insert(root, 5);
    insert(root, 15);
    insert(root, 7);
    insert(root, 12);

    // Displaying elements in the tree
```

```c
    displayTree(root);

    // Traversing the tree using inorder, preorder, and postorder
    printf("Inorder traversal: ");
    inorderTraversal(root);
    printf("\n");

    printf("Preorder traversal: ");
    preorderTraversal(root);
    printf("\n");

    printf("Postorder traversal: ");
    postorderTraversal(root);
    printf("\n");

    return 0;
}
```

OUTPUT:

```
Doubly Linked List: 1 -> 2 -> 3 -> NULL
Doubly Linked List: 1 -> 4 -> 2 -> 3 -> NULL
Doubly Linked List: 1 -> 4 -> 3 -> NULL

Process returned 0 (0x0)   execution time : 0.062 s
Press any key to continue.
```

11. WAP Breadth First Search

```
#include<stdio.h>
#include<conio.h>
void bfs(int a[20][20], int n, int src, int t[20][2], int s[])
{
int f,r,q[20],u,v,k=0,i;
for(i=1;i<=n;i++)
s[i]=0;
f=r=k=0;
q[r]=src;
s[src]=1;
while(f<=r)
{
u=q[f++];
for(v=1;v<=n;v++)
{
if(a[u][v]==1 && s[v]==0)
{
s[v]=1;
q[++r]=v;
t[k][0]=u;
t[k][1]=v;
k++;
}
}
}
}
void main()
{
int n,a[20][20],src,t[20][2],flag,s[20],i,j;

printf("Enter the number of nodes\n");
scanf("%d", &n);
printf("Enter the adjacency matrix\n");
for(i=0;i<n;i++)
{
for(j=0;j<n;j++)
scanf("%d", &a[i][j]);

}
printf("Enter the source\n");
```

```
scanf("%d", &src);
bfs(a,n,src,t,s);
flag=0;
for(i=0;i<n;i++)
{
if(s[i]==0)
{

printf("Vertex %d is not reachable\n", i);
flag=1;
}
else
printf("Vertex %d is reachable\n", i);

}
if(flag==1)
printf("Some nodes are not visited\n");
else
{
printf("The BFS traversal is\n");
for(i=0;i<n;i++)
printf("%d%d\n", t[i][0], t[i][1]);

}
getch();
}
```

OUTPUT:

```
Enter the number of nodes
5
Enter the adjacency matrix
0 1 1 0 0
1 0 1 1 0
1 1 0 0 1
0 1 0 0 1
0 0 1 1 0
Enter the source
0
Vertex 0 is reachable
Vertex 1 is reachable
Vertex 2 is reachable
Vertex 3 is reachable
Vertex 4 is reachable
The BFS traversal is
01
02
13
24
```

12.WAP for Depth First Search:

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

int a[20][20], s[20], n;

void dfs(int v) {
    int i;
    s[v] = 1;

    for (i = 1; i <= n; i++) {
        if (a[v][i] && !s[i]) {
            printf("\n %d->%d", v, i);
            dfs(i);
        }
    }
}

int main() {
    int i, j, count = 0;

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

    for (i = 1; i <= n; i++) {
        s[i] = 0;

        for (j = 1; j <= n; j++) {
            a[i][j] = 0;
        }
    }

    printf("Enter the adjacency matrix:\n");

    for (i = 1; i <= n; i++) {
        for (j = 1; j <= n; j++) {
            scanf("%d", &a[i][j]);
        }
    }

    for (i = 1; i <= n; i++) {
        if (!s[i]) {
```

```
            dfs(i);
        }
    }

    printf("\n");

    for (i = 1; i <= n; i++) {
        if (s[i]) {
            count++;
        }
    }

    if (count == n) {
        printf("Graph is connected");
    } else {
        printf("Graph is not connected");
    }

    return 0;
}
```

OUTPUT:

```
 Enter number of vertices:4
Enter the adjacency matrix:
0 1 0 0
0 0 1 0
0 0 0 1
1 0 0 0

 1->2
 2->3
 3->4
Graph is connected
Process returned 0 (0x0)   execution time : 33.308 s
Press any key to continue.
```

13.

a.

856. Score of Parentheses

Medium | Topics | Companies

Given a balanced parentheses string `s`, return *the* ***score*** *of the string*.

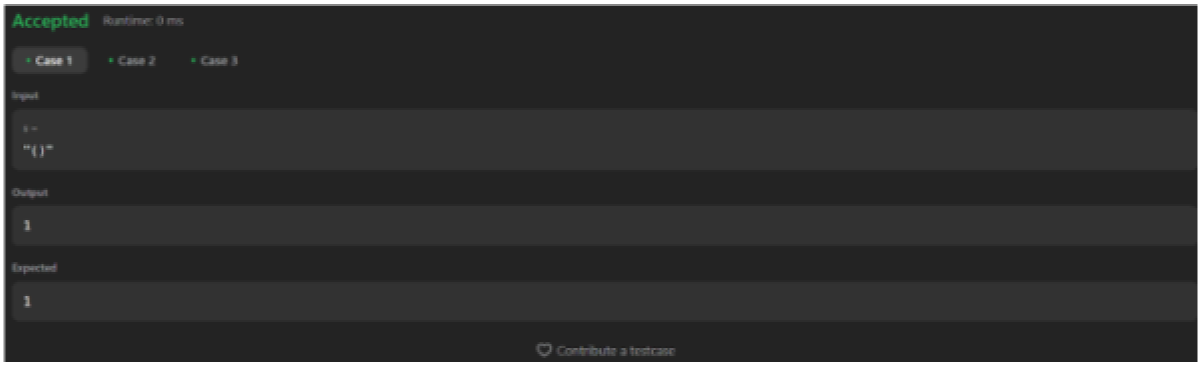
The **score** of a balanced parentheses string is based on the following rule:

- `"()"` has score `1`.
- `AB` has score `A + B`, where `A` and `B` are balanced parentheses strings.
- `(A)` has score `2 * A`, where `A` is a balanced parentheses string.

.

```
int scoreOfParentheses(char* s)
{
int len = strlen(s);
int score = 0;
int depth = 0;
for (int i = 0; i < len; i++)
{
if (s[i] == '(')
{
depth++;
}
else
{
depth--;
if (s[i - 1] == '(')
{
score += 1 << depth;
}
}
}
49| Page
return score;
}
```

OUTPUT:



Accepted
Runtime: 0 ms
Case 1
Case 2
Case 3
Input
"()"
Output
1
Expected
1
Contribute a testcase

b.

2095. Delete the Middle Node of a Linked List

Medium | Topics | Companies | Hint

You are given the `head` of a linked list. **Delete** the **middle node**, and return *the* `head` *of the modified linked list*.

The **middle node** of a linked list of size `n` is the `⌊n / 2⌋`th node from the **start** using **0-based indexing**, where `⌊x⌋` denotes the largest integer less than or equal to `x`.

- For `n` = `1`, `2`, `3`, `4`, and `5`, the middle nodes are `0`, `1`, `1`, `2`, and `2`, respectively.

```
struct ListNode* deleteMiddle(struct ListNode* head)
{
int count=0, middleNode, i=0;
struct ListNode* temp=head;
struct ListNode* node=head;
struct ListNode* prev;
struct ListNode* next=head;
while(temp!=NULL)
{
count++;
temp=temp->next;
}
middleNode=count/2;
if(middleNode==0)
{
struct ListNode* newHead=head->next;
free(head);
return newHead;
}
while(i<middleNode)
{
prev=node;
node=node->next;
next=node->next;
i++;
}
prev->next=next;
free(node);
return head;
```

```
}
```

OUTPUT:

Accepted
Runtime: 0 ms
Case 1
Case 2
Case 3
Input
head =
[2,1]
Output
[2]
Expected
[2]

c.

328. Odd Even Linked List

Medium · Topics · Companies

Given the `head` of a singly linked list, group all the nodes with odd indices together followed by the nodes with even indices, and return *the reordered list*.

The **first** node is considered **odd**, and the **second** node is **even**, and so on.

Note that the relative order inside both the even and odd groups should remain as it was in the input.

You must solve the problem in `O(1)` extra space complexity and `O(n)` time complexity.

```c
struct ListNode* oddEvenList(struct ListNode* head)
{
if(head==NULL||head->next==NULL)
{
return head;
}
struct ListNode* oddTemp=head;
struct ListNode* evenTemp=head->next;
struct ListNode* evenHead=evenTemp;
while(evenTemp!=NULL && evenTemp->next!=NULL)
{
oddTemp->next=evenTemp->next;
oddTemp=oddTemp->next;
evenTemp->next=oddTemp->next;
evenTemp=evenTemp->next;
}
oddTemp->next=evenHead;
return head;
}
```

OUTPUT:

Accepted
Runtime: 2 ms
Case 1
Case 2
Input
head =
[1,2,3,4,5]
Output
[1,3,5,2,4]
Expected
[1,3,5,2,4]

d.

450. Delete Node in a BST

Medium | Topics | Companies

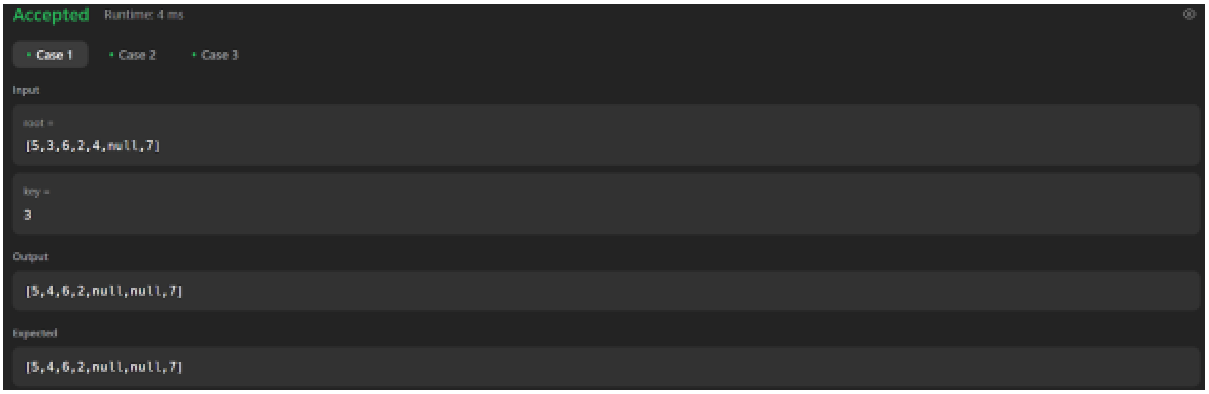
Given a root node reference of a BST and a key, delete the node with the given key in the BST. Return *the* ***root node reference*** *(possibly updated) of the BST*.

Basically, the deletion can be divided into two stages:

1. Search for a node to remove.
2. If the node is found, delete the node.

```
struct TreeNode* deleteNode(struct TreeNode* root, int key)
{
if (root == NULL) return root;
if (key < root->val)
{
root->left = deleteNode(root->left, key);
}
else if (key > root->val)
{
root->right = deleteNode(root->right, key);
}
else
{
if (root->left == NULL) {
struct TreeNode* temp = root->right;
free(root);
return temp;
} else if (root->right == NULL) {
struct TreeNode* temp = root->left;
free(root);
return temp;
}
struct TreeNode* temp = root->right;
while (temp && temp->left != NULL)
temp = temp->left;
root->val = temp->val;
root->right = deleteNode(root->right, temp->val);
}
return root;
}
```

OUTPUT:


Accepted
Runtime: 4 ms
Case 1
Case 2
Case 3
Input
root =
[5,3,6,2,4,null,7]
key =
3
Output
[5,4,6,2,null,null,7]
Expected
[5,4,6,2,null,null,7]

e.

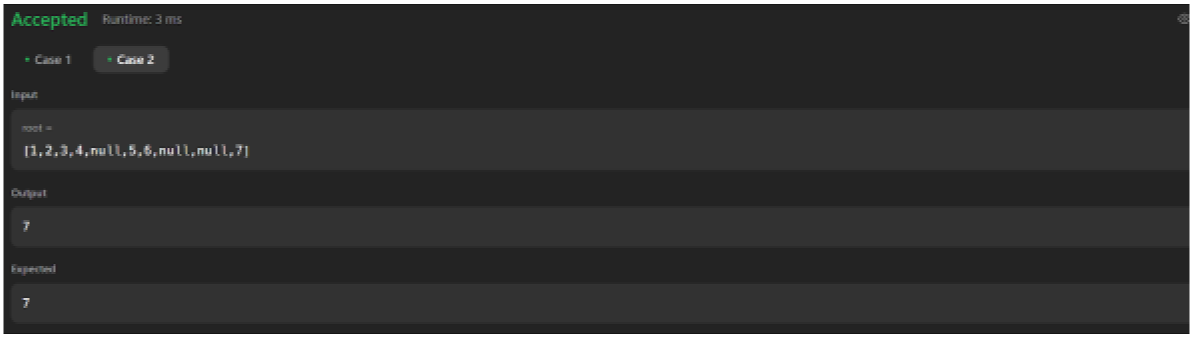
513. Find Bottom Left Tree Value

Medium Topics Companies

Given the `root` of a binary tree, return the leftmost value in the last row of the tree.

```
int findBottomLeftValue(struct TreeNode* root)
{
if (root == NULL)
return -1; // No nodes in the tree
struct TreeNode** queue = (struct TreeNode**)malloc(sizeof(struct TreeNode*)
* 10000);
int front = 0, rear = 0, nextLevelCount = 0, currentLevelCount = 1;
int leftmostValue = root->val;
queue[rear++] = root;
while (front < rear) {
struct TreeNode* current = queue[front++];
currentLevelCount--;
if (current->left != NULL) {
queue[rear++] = current->left;
nextLevelCount++;
}
if (current->right != NULL) {
queue[rear++] = current->right;
nextLevelCount++;
}
if (currentLevelCount == 0) {
if (nextLevelCount > 0)
leftmostValue = queue[front]->val;
currentLevelCount = nextLevelCount;
nextLevelCount = 0;
}
}
free(queue);
return leftmostValue;
}
```

OUTPUT:


Accepted
Runtime: 3 ms
Case 1
Case 2
Input
root =
[1,2,3,4,null,5,6,null,null,7]
Output
7
Expected
7