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
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Bull Temple Road, Bangalore 560019

(Affiliated To Visvesvaraya Technological University, Belgaum)
Department of Computer Science and Engineering

This is to certify that the Lab work entitled **"DATA STRUCTURES"** carried out by DARSHAN P N **(1BM25CS090)**, who is 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 20252026. 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.

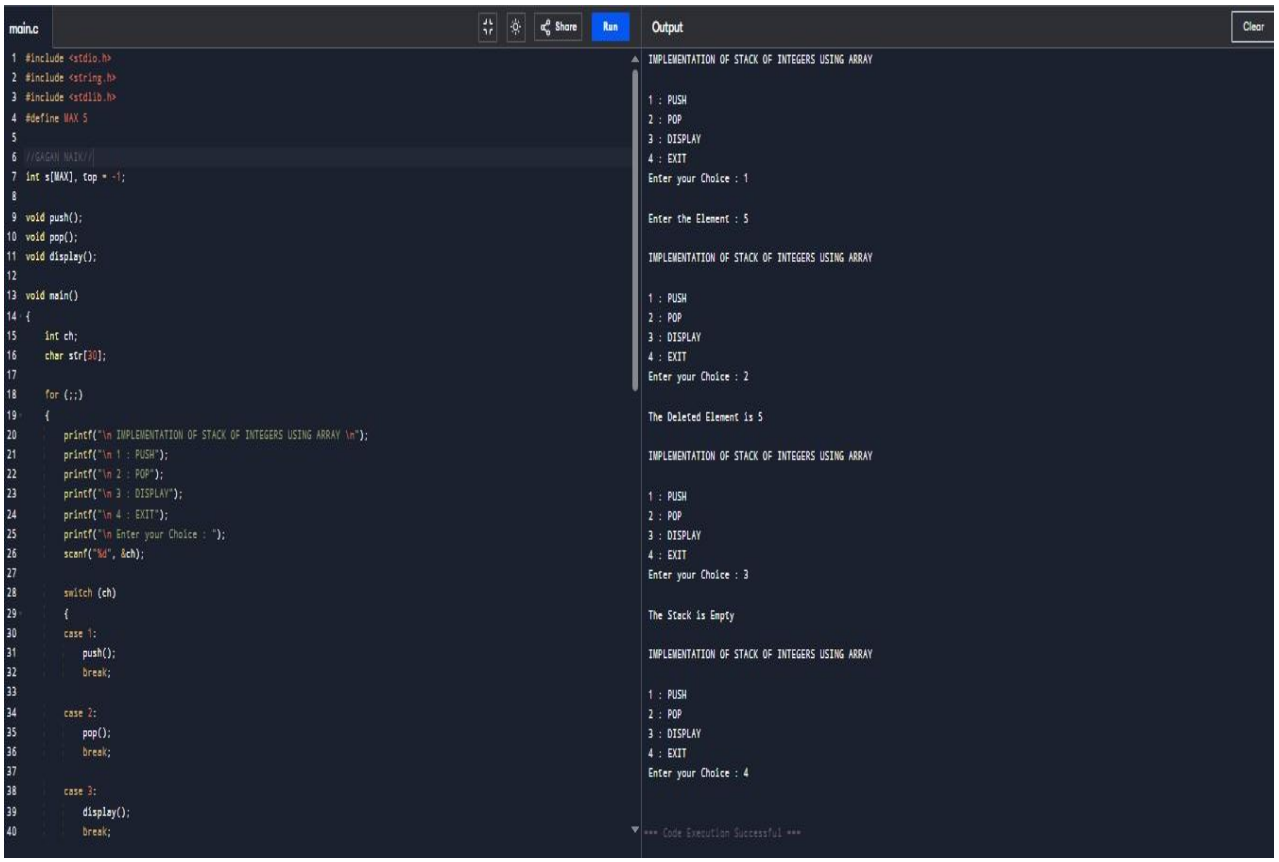
Lab program 1:

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 STACK_SIZE 5
void push(int st[],int *top)
{
        int item;
        if(*top==STACK_SIZE-1)
                printf("Stack overflow\n");
        else
        {
                printf("\nEnter an item :");
                scanf("%d",&item); (*top)+
                +;
                st[*top]=item;
        }
}
void pop(int st[],int *top)
{ if(*top==-1) printf("Stack underflow\n");
        else
        {
                printf("\n%d item was
        deleted",st[(*top)--]); }
}
void display(int st[],int *top)
{
        int i;
        if(*top==-1) printf("Stack is
                empty\n");
        for(i=0;i<=*top;i++)
                printf("%d\t",st[i]);
} void
main()
{
        int st[10],top=-1, c,val_del;
        while(1)
        { printf("\n1. Push\n2. Pop\n3. Display\n");
                printf("\nEnter your choice :");
                scanf("%d",&c);
```

```
                switch(c)
                { case 1: push(st,&top);
                        break;
                        case 2: pop(st,&top);
                                break;
                        case 3: display(st,&top);
                                break;
                        default: printf("\nInvalid choice!!!");
                                exit(0);
                }
        }
}
```

Output:



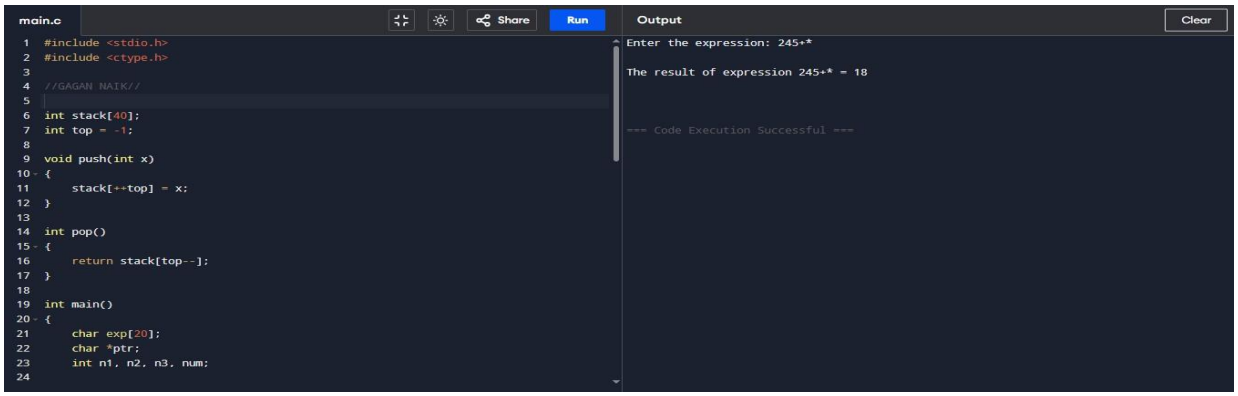
Lab Program 2

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 <ctype.h>
#define MAX 100
char stack[MAX];
int top = -1;

void push(char x) {
   stack[++top] = x;
}

char pop() {
   if (top == -1)
      return -1;
   else
      return stack[top--];
}

int priority(char x) {
   if (x == '+' || x == '-')
      return 1;
   if (x == '*' || x == '/')
      return 2;
   return 0;
}

int main() {
   char infix[MAX], postfix[MAX];
   int i = 0, k = 0;
   char ch;

   printf("Enter a valid parenthesized infix expression: ");
   scanf("%s", infix);

   while ((ch = infix[i++]) != '\0') {
```

```
            if (isalnum(ch)) {
            postfix[k++] = ch;
        }

            else if (ch == '(') {
            push(ch);
        }

            else if (ch == ')') {
            while (stack[top] != '(') {
                postfix[k++] = pop();
            }
            pop();
        }

            else {
            while (top != -1 && priority(stack[top]) >= priority(ch)) {
                postfix[k++] = pop();
            }
            push(ch);
        }
    }

    while (top != -1) {
    postfix[k++] = pop();
    }

    postfix[k] = '\0';

    printf("Postfix expression: %s\n", postfix);

    return 0;
}
```

Output:

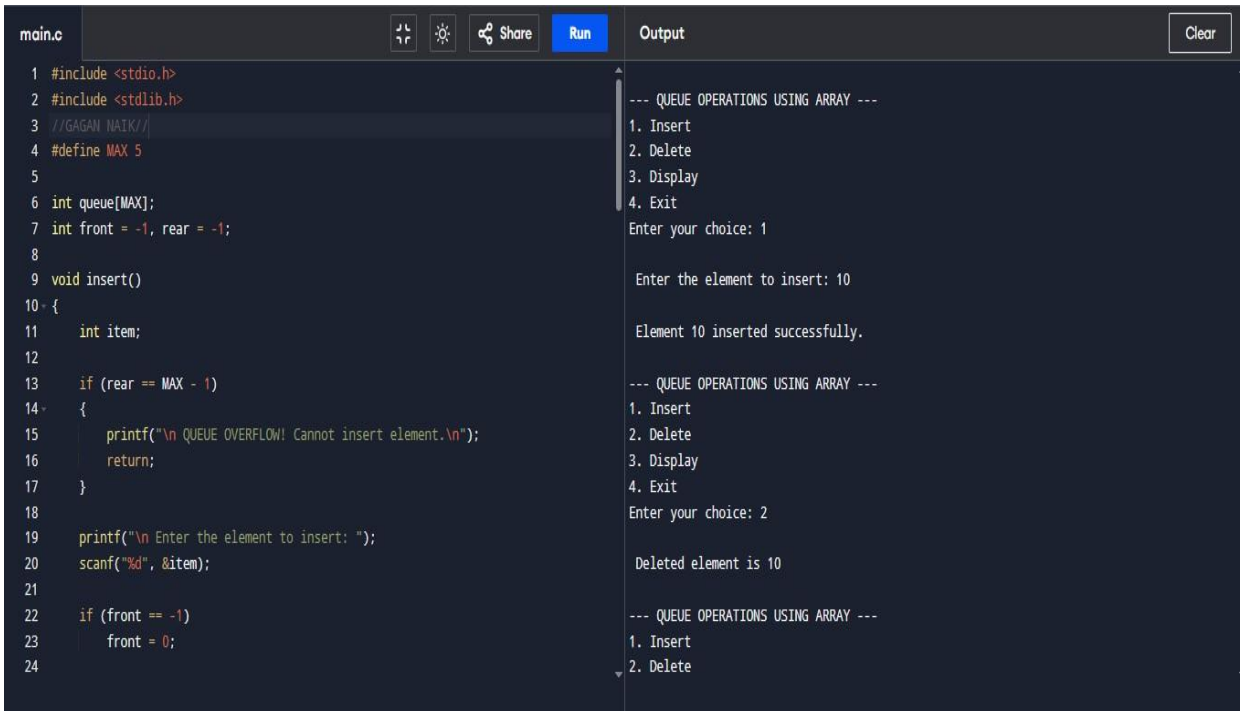


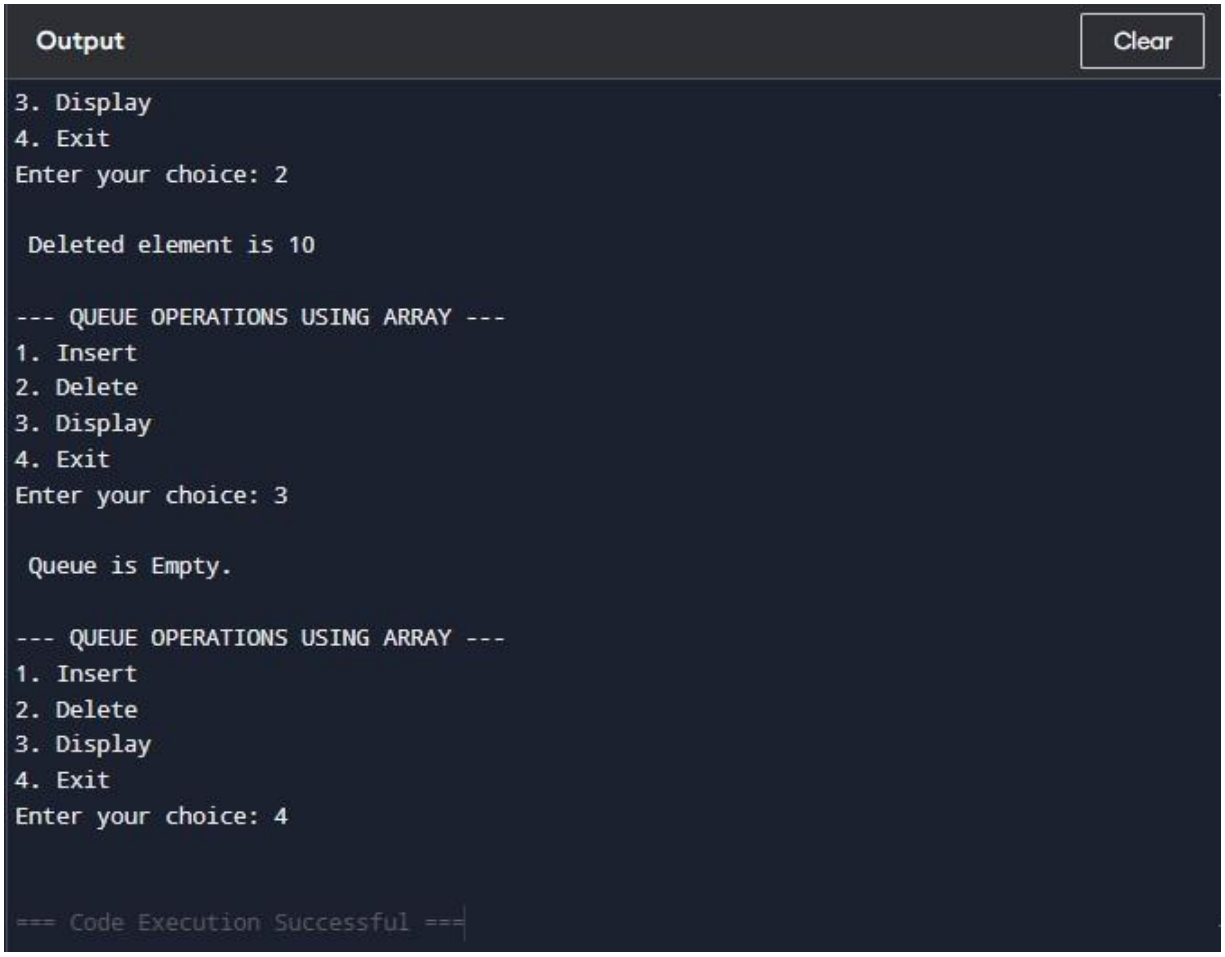
Lab Program 2

a) WAP to simulate the working of a queue of integers using an array. Provide the following operations: Insert, Delete, Display The programshould print appropriate messagesfor queue empty and queue overflow conditions

```
#include <stdio.h>

#define MAX 5

int queue[MAX];
int front = -1, rear = -1;

void insert() {
   int x;
   if (rear == MAX - 1) {
      printf("Queue Overflow\n");
      return;
   }
   if (front == -1)
      front = 0;
   printf("Enter element: ");
   scanf("%d", &x);
   queue[++rear] = x;
}

void delete() {
   if (front == -1 || front > rear) {
      printf("Queue Empty\n");
      return;
   }
   printf("Deleted element: %d\n", queue[front++]);
}

void display() {
   int i;
   if (front == -1 || front > rear) {
      printf("Queue Empty\n");
      return;
```

```
    }
    for (i = front; i <= rear; i++)
        printf("%d ", queue[i]);
    printf("\n");
}

int main() {
    int choice;
    while (1) {
        printf("1.Insert 2.Delete 3.Display 4.Exit\n");
        scanf("%d", &choice);
        switch (choice) {
            case 1: insert(); break;
            case 2: delete(); break;
            case 3: display(); break;
            case 4: return 0;
            default: printf("Invalid choice\n");
        }
    }
}
```




Output
Clear
3. Display
4. Exit
Enter your choice: 2
Deleted element is 10
--- QUEUE OPERATIONS USING ARRAY ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 3
Queue is Empty.
--- QUEUE OPERATIONS USING ARRAY ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 4
=== Code Execution Successful ===

Lab Program 3

b) WAP to simulate the working of a circular queue of integers using an array. Provide the following operations: Insert, Delete & Display The programshould print appropriate messagesfor queue empty and queue overflow conditions

```
#include <stdio.h>

#define MAX 5

int queue[MAX];
int front = -1, rear = -1;

void insert() {
   int x;
   if ((front == 0 && rear == MAX - 1) || (front == rear + 1)) {
      printf("Queue Overflow\n");
      return;
   }
   printf("Enter element: ");
   scanf("%d", &x);
   if (front == -1) {
      front = 0;
      rear = 0;
   } else if (rear == MAX - 1) {
      rear = 0;
   } else {
      rear++;
   }
   queue[rear] = x;
}

void delete() {
   if (front == -1) {
      printf("Queue Empty\n");
      return;
   }
   printf("Deleted element: %d\n", queue[front]);
   if (front == rear) {
      front = -1;
      rear = -1;
   } else if (front == MAX - 1) {
```

```
        front = 0;
    } else {
        front++;
    }
}

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

int main() {
    int choice;
    while (1) {
        printf("1.Insert 2.Delete 3.Display 4.Exit\n");
        scanf("%d", &choice);
        switch (choice) {
            case 1: insert(); break;
            case 2: delete(); break;
            case 3: display(); break;
            case 4: return 0;
            default: printf("Invalid choice\n");
        }
    }
}
```

Output

main.c

```c
#include <stdio.h>
#include <stdlib.h>
//GAGAN NAIK//

#define MAX 5

int cq[MAX];
int front = -1, rear = -1;


void insert()
{
    int item;


    if ((front == 0 && rear == MAX - 1) || (front == rear + 1))
    {
        printf("\n CIRCULAR QUEUE OVERFLOW! Cannot insert element.\n");
        return;
    }

    printf("\n Enter the element to insert: ");
    scanf("%d", &item);

```

Output

```
--- CIRCULAR QUEUE OPERATIONS ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 1

 Enter the element to insert: 10

 Element 10 inserted successfully.

--- CIRCULAR QUEUE OPERATIONS ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 2

 Deleted element is 10

--- CIRCULAR QUEUE OPERATIONS ---
1. Insert
2. Delete
```

Output

```
3. Display
4. Exit
Enter your choice: 2

 Deleted element is 10

--- CIRCULAR QUEUE OPERATIONS ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 3

 Circular Queue is Empty.

--- CIRCULAR QUEUE OPERATIONS ---
1. Insert
2. Delete
3. Display
4. Exit
Enter your choice: 4


=== Code Execution Successful ===
```

Lab Program 4

WAP to Implement Singly Linked List with following operations
a) Createalinkedlist.
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 *head = NULL;

void createList(int n) {
   struct node *newNode, *temp;
   int data;

   for (int i = 0; i < n; i++) {
      newNode = (struct node *)malloc(sizeof(struct node));
      scanf("%d", &data);
      newNode->data = data;
      newNode->next = NULL;

      if (head == NULL) {
         head = newNode;
         temp = head;
      } else {
         temp->next = newNode;
         temp = newNode;
      }
   }
}

void insertAtFirst(int data) {
   struct node *newNode = (struct node *)malloc(sizeof(struct node));
   newNode->data = data;
   newNode->next = head;
   head = newNode;
}

void insertAtEnd(int data) {
```

```
    struct node *newNode = (struct node *)malloc(sizeof(struct node));
    struct node *temp = head;

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

    if (head == NULL) {
        head = newNode;
        return;
    }

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

    temp->next = newNode;
}

void insertAtPosition(int data, int pos) {
    struct node *newNode = (struct node *)malloc(sizeof(struct node));
    struct node *temp = head;

    newNode->data = data;

    if (pos == 1) {
        newNode->next = head;
        head = newNode;
        return;
    }

    for (int i = 1; i < pos - 1; i++) {
        if (temp == NULL)
            return;
        temp = temp->next;
    }

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

void displayList() {
    struct node *temp = head;

    if (head == NULL) {
        printf("List is empty\n");
        return;
    }

    while (temp != NULL) {
        printf("%d -> ", temp->data);
```

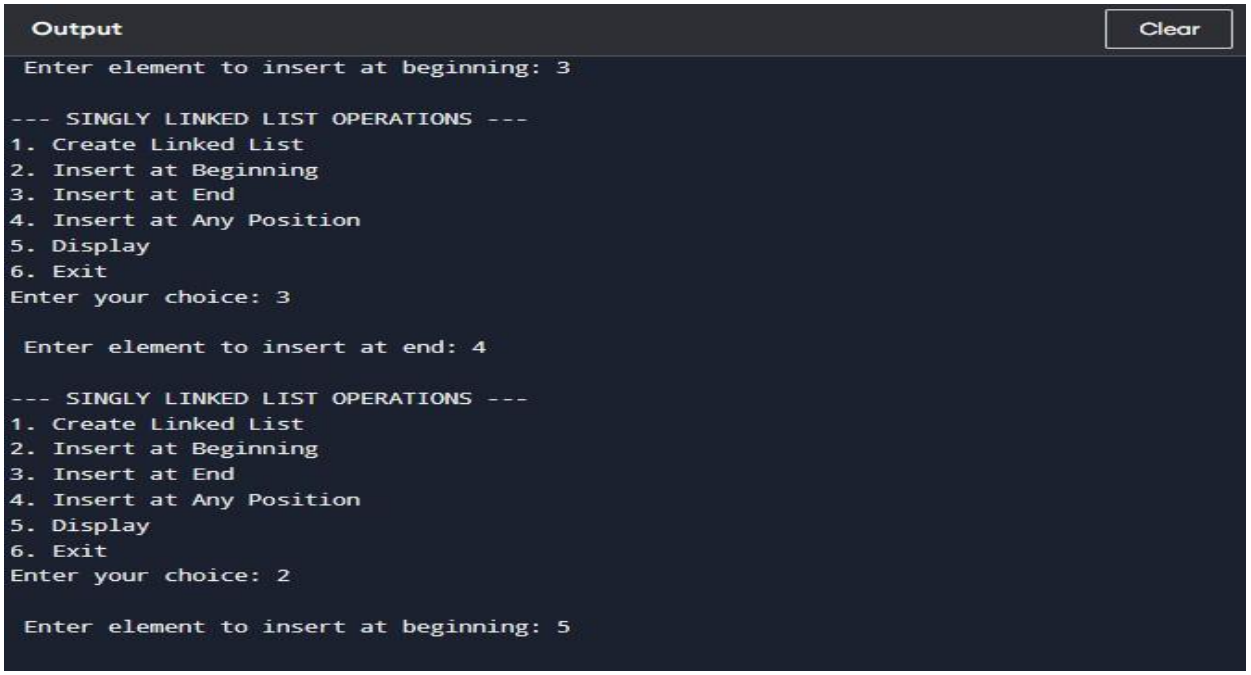
```
        temp = temp->next;
    }
    printf("NULL\n");
}

int main() {
    int n, data, pos;

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

    printf("Enter node values:\n");
    createList(n);

    printf("Linked List:\n");
    displayList();

    printf("Enter value to insert at first: ");
    scanf("%d", &data);
    insertAtFirst(data);
    displayList();

    printf("Enter value to insert at end: ");
    scanf("%d", &data);
    insertAtEnd(data);
    displayList();

    printf("Enter value and position to insert: ");
    scanf("%d %d", &data, &pos);
    insertAtPosition(data, pos);
    displayList();

    return 0;
}
```

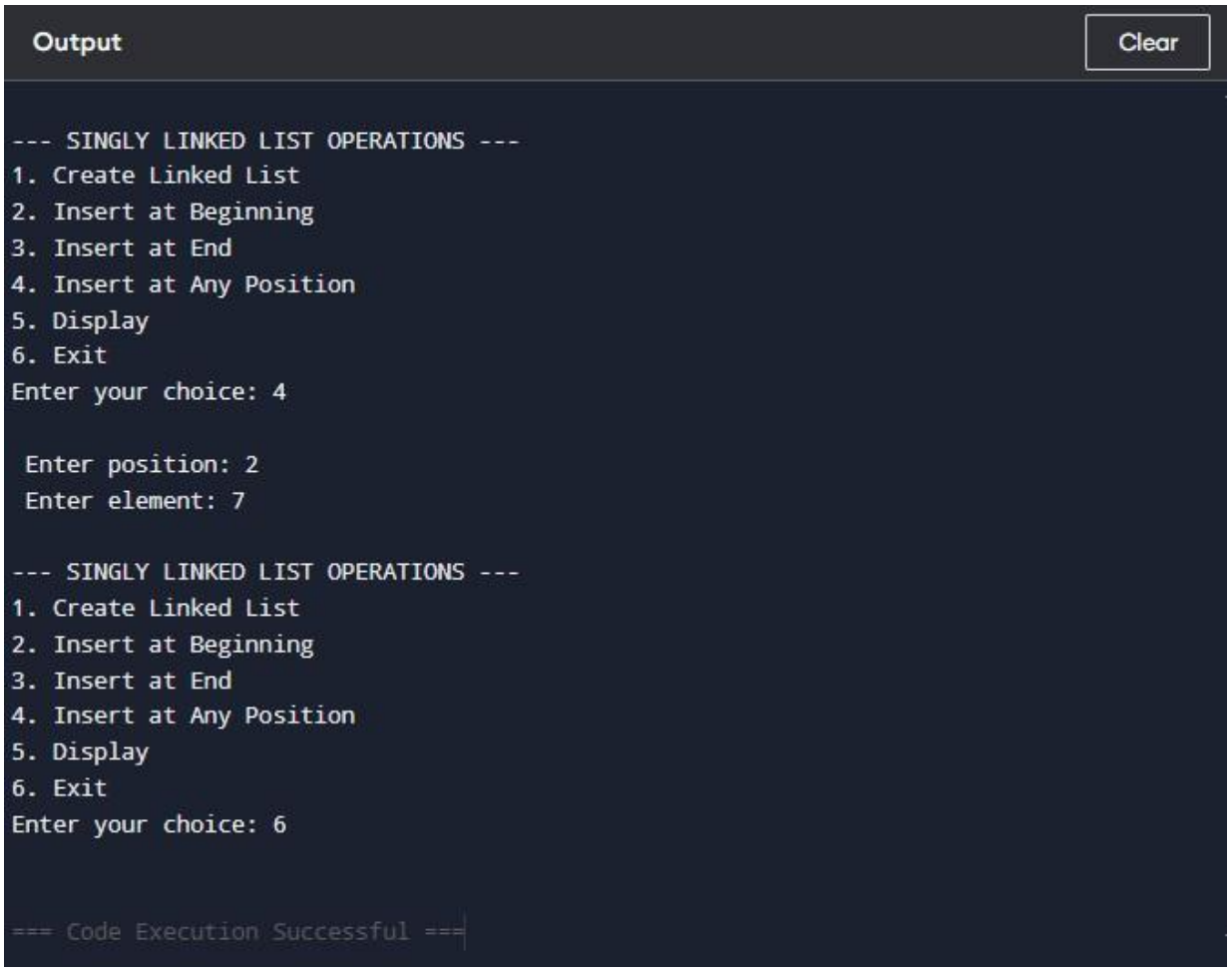
main.c | Share | Run

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

// GAGAN NAIK
struct node
{
    int data;
    struct node *next;
};
struct node *head = NULL;

void create()
{
    int n, i, item;
    struct node *temp, *newNode;

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

    for (i = 0; i < n; i++)
    {
        newNode = (struct node *)malloc(sizeof(struct node));
        printf(" Enter data for node %d: ", i + 1);
        scanf("%d", &item);
```

Output | Clear

```
--- SINGLY LINKED LIST OPERATIONS ---
1. Create Linked List
2. Insert at Beginning
3. Insert at End
4. Insert at Any Position
5. Display
6. Exit
Enter your choice: 1

 Enter number of nodes: 2
 Enter data for node 1: 1
 Enter data for node 2: 2

--- SINGLY LINKED LIST OPERATIONS ---
1. Create Linked List
2. Insert at Beginning
3. Insert at End
4. Insert at Any Position
5. Display
6. Exit
Enter your choice: 2

 Enter element to insert at beginning: 3
```


Output
Clear
Enter element to insert at beginning: 3
--- SINGLY LINKED LIST OPERATIONS ---
1. Create Linked List
2. Insert at Beginning
3. Insert at End
4. Insert at Any Position
5. Display
6. Exit
Enter your choice: 3
Enter element to insert at end: 4
--- SINGLY LINKED LIST OPERATIONS ---
1. Create Linked List
2. Insert at Beginning
3. Insert at End
4. Insert at Any Position
5. Display
6. Exit
Enter your choice: 2
Enter element to insert at beginning: 5


Output
Clear
--- SINGLY LINKED LIST OPERATIONS ---
1. Create Linked List
2. Insert at Beginning
3. Insert at End
4. Insert at Any Position
5. Display
6. Exit
Enter your choice: 4
Enter position: 2
Enter element: 7
--- SINGLY LINKED LIST OPERATIONS ---
1. Create Linked List
2. Insert at Beginning
3. Insert at End
4. Insert at Any Position
5. Display
6. Exit
Enter your choice: 6
=== Code Execution Successful ===

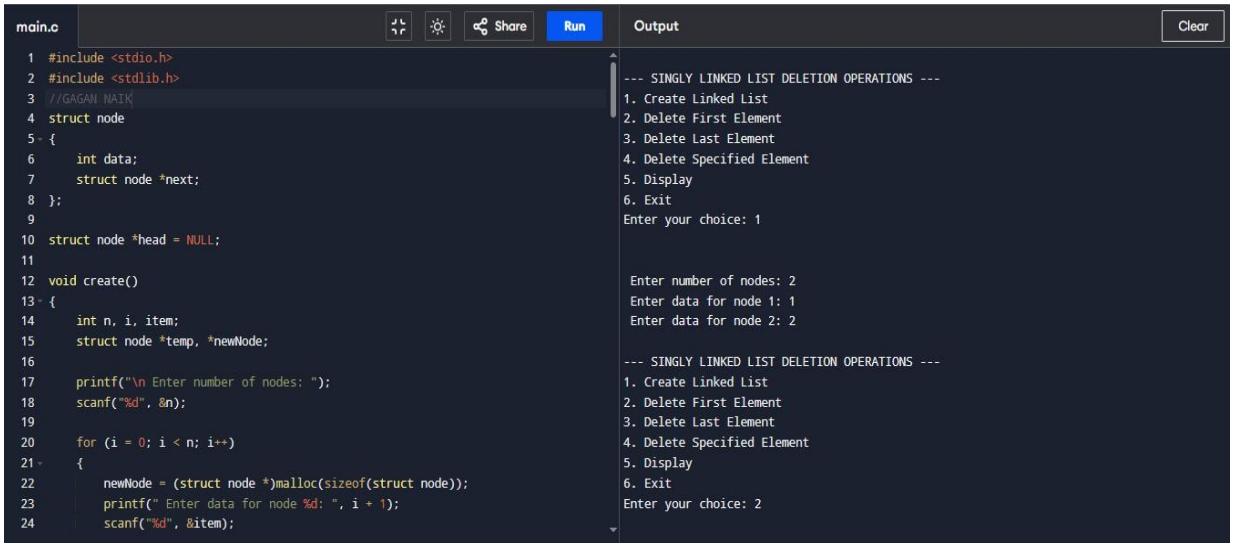
Lab Program 5

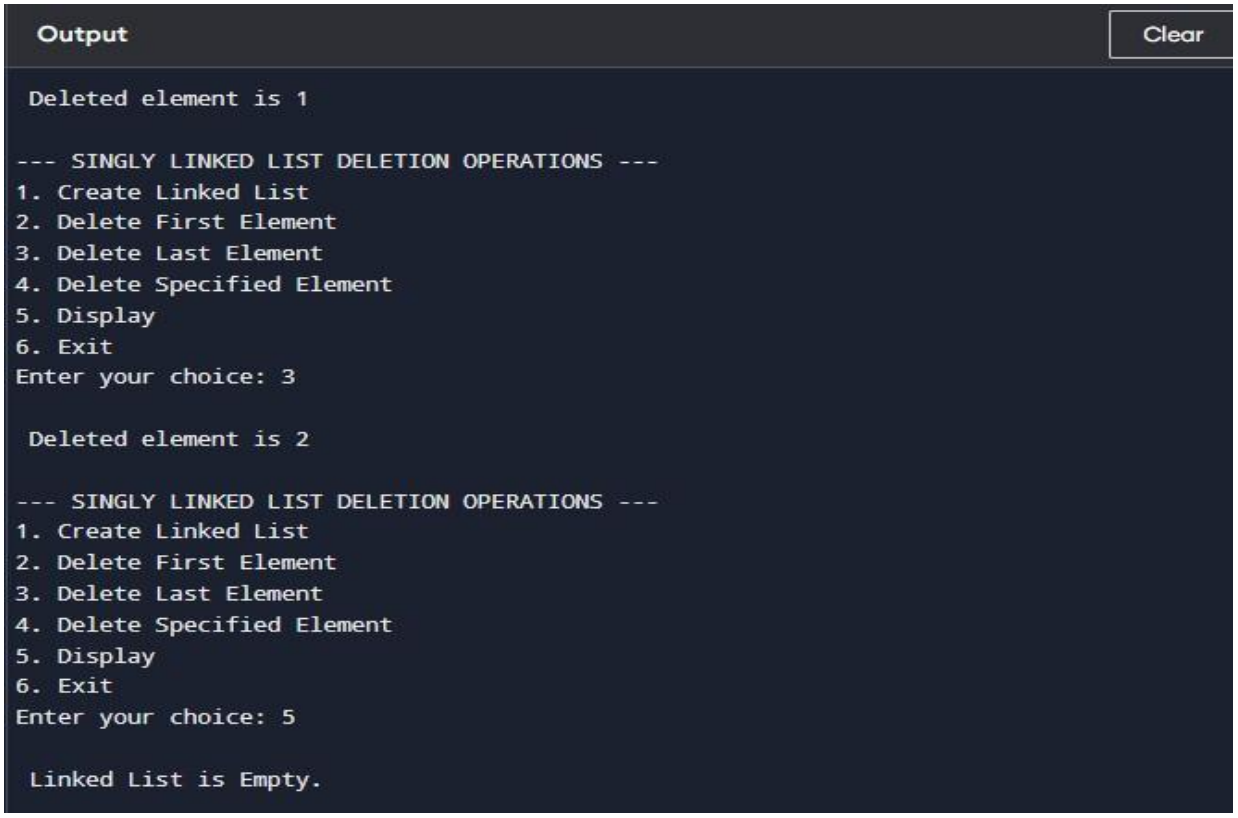
WAP to Implement Singly Linked List with following operations
a) Create a linked list.
b) Deletion of first element, specified element and last element in the list.
c) Display the contents of the linked list.

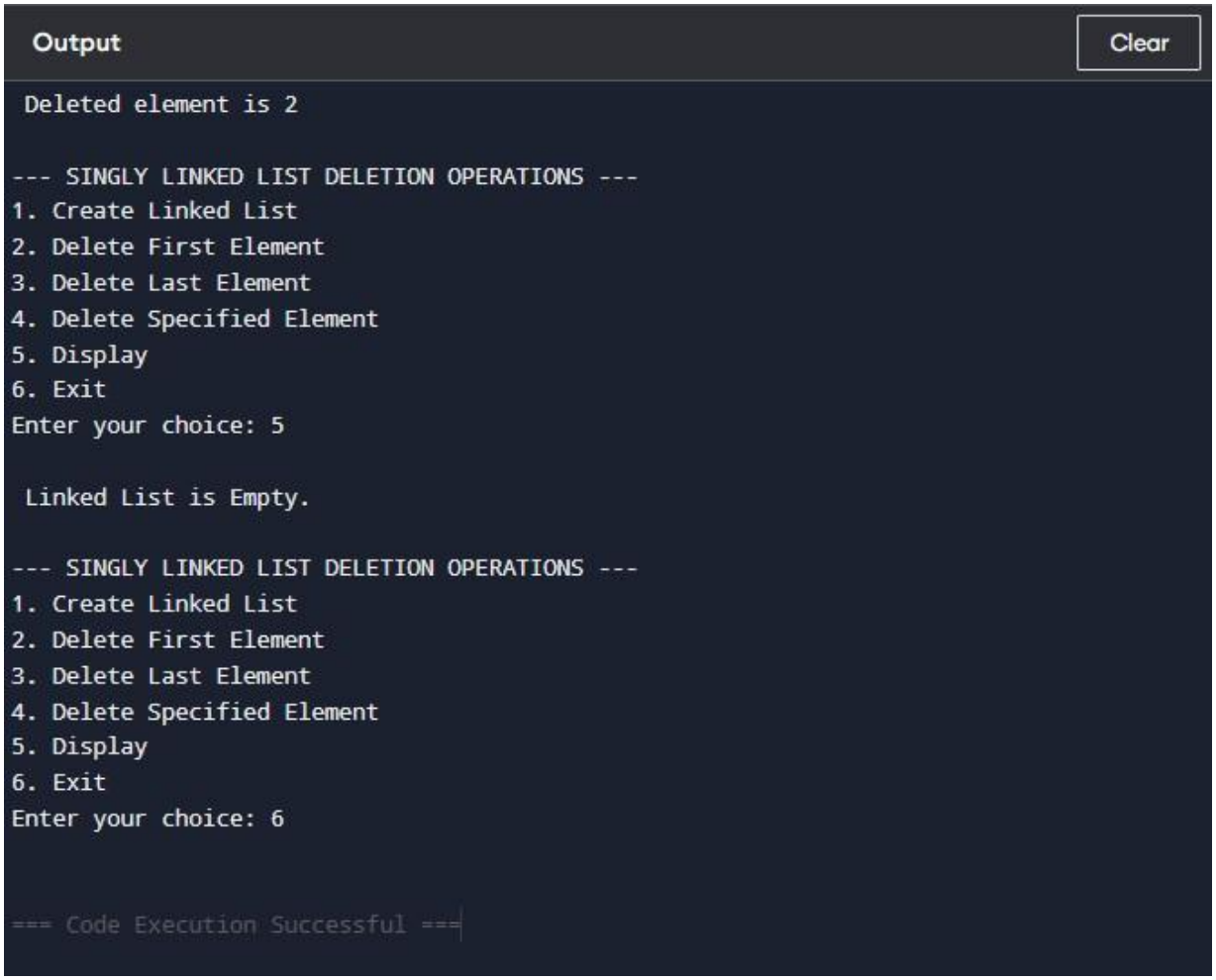
```
#include <stdio.h>
#include <stdlib.h>

struct node {
    int data;
    struct node *next;
};
struct node *head = NULL;

void delete_first() {
    struct node *temp;
    if (head == NULL) {
        printf("List is empty\n");
        return;
    }
    temp = head;
    head = head->next;
    free(temp);
}

void delete_end() {
    struct node *temp, *prev;
    if (head == NULL) {
        printf("List is empty\n");
        return;
    }
    if (head->next == NULL) {
        free(head);
        head = NULL;
        return;
    }
    temp = head;
    while (temp->next != NULL) {
        prev = temp;
        temp = temp->next;
```

```
    }
    prev->next = NULL;
    free(temp);
}

void delete_element() {
    int x;
struct node *temp, *previf (head
== NULL) { printf("List is
empty\n"); return;
    }
    scanf("%d", &x);
    if (head->data == x) {
        delete_first();
        return;
    }
    temp = head;
    while (temp != NULL && temp->data != x) {
        prev = temp;
        temp = temp->next;
    }
    if (temp == NULL) {
        printf("Element not found\n");
        return;
    }
    prev->next = temp->next;
    free(temp);
}

void display() {
    struct node *temp = head;
    if (temp == NULL) {
        printf("List is empty\n");
        return;
    }
    while (temp != NULL) {
        printf("%d ", temp->data);
        temp = temp->next;
    }
    printf("\n");
}

int main() {
    int choice;
    while (1) {
        printf("1.Create 2.DeleteFirst 3.DeleteElement 4.DeleteEnd 5.Display 6.Exit\n");
```

```
        scanf("%d", &choice);
        switch (choice) {
case 1: create(); break;
case 2: delete_first(); break;
case 3: delete_element(); break;
case 4: delete_end(); break;
case 5: display(); break;
case 6: return 0;
            default: printf("Invalid choice\n");
        }
    }
```




Output
Clear
Deleted element is 1
--- SINGLY LINKED LIST DELETION OPERATIONS ---
1. Create Linked List
2. Delete First Element
3. Delete Last Element
4. Delete Specified Element
5. Display
6. Exit
Enter your choice: 3
Deleted element is 2
--- SINGLY LINKED LIST DELETION OPERATIONS ---
1. Create Linked List
2. Delete First Element
3. Delete Last Element
4. Delete Specified Element
5. Display
6. Exit
Enter your choice: 5
Linked List is Empty.

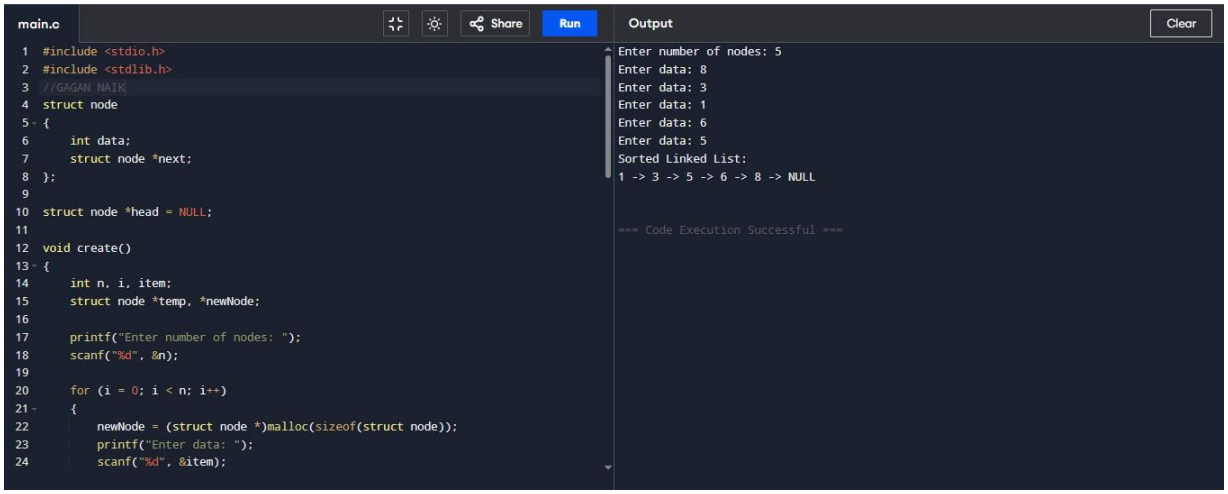

Output
Clear
Deleted element is 2
--- SINGLY LINKED LIST DELETION OPERATIONS ---
1. Create Linked List
2. Delete First Element
3. Delete Last Element
4. Delete Specified Element
5. Display
6. Exit
Enter your choice: 5
Linked List is Empty.
--- SINGLY LINKED LIST DELETION OPERATIONS ---
1. Create Linked List
2. Delete First Element
3. Delete Last Element
4. Delete Specified Element
5. Display
6. Exit
Enter your choice: 6
=== Code Execution Successful ===

Lab Program 6

a) 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;
};

struct node *head = NULL;

void create(int n) {
   struct node *newNode, *temp;
   int data;
   for (int i = 0; i < n; i++) {
      newNode = (struct node *)malloc(sizeof(struct node));
      scanf("%d", &data);
      newNode->data = data;
      newNode->next = NULL;
      if (head == NULL) {
         head = newNode;
         temp = head;
      } else {
         temp->next = newNode;
         temp = newNode;
      }
   }
}

void sortList() {
   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) {
            temp = i->data;
            i->data = j->data;
            j->data = temp;
         }
```

```
        }
    }
}

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

int main() {
    int n;
    printf("Enter number of nodes: ");
    scanf("%d", &n);
    printf("Enter values:\n");
    create(n);
    sortList();
    display();
    return 0;
}
```



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

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

struct node *head = NULL;

void create(int n) {
   struct node *newNode, *temp;
   int data;
   for (int i = 0; i < n; i++) {
      newNode = (struct node *)malloc(sizeof(struct node));
      scanf("%d", &data);
      newNode->data = data;
      newNode->next = NULL;
      if (head == NULL) {
         head = newNode;
         temp = head;
      } else {
         temp->next = newNode;
         temp = newNode;
      }
   }
}

void reverse() {
   struct node *prev = NULL, *curr = head, *next = NULL;
   while (curr != NULL) {
      next = curr->next;
      curr->next = prev;
      prev = curr;
      curr = next;
   }
   head = prev;
}

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

```
int main() {
    int n;
    printf("Enter number of nodes: ");
    scanf("%d", &n);
    printf("Enter values:\n");
    create(n);
    reverse();
    display();
    return 0;
}
```

main.c

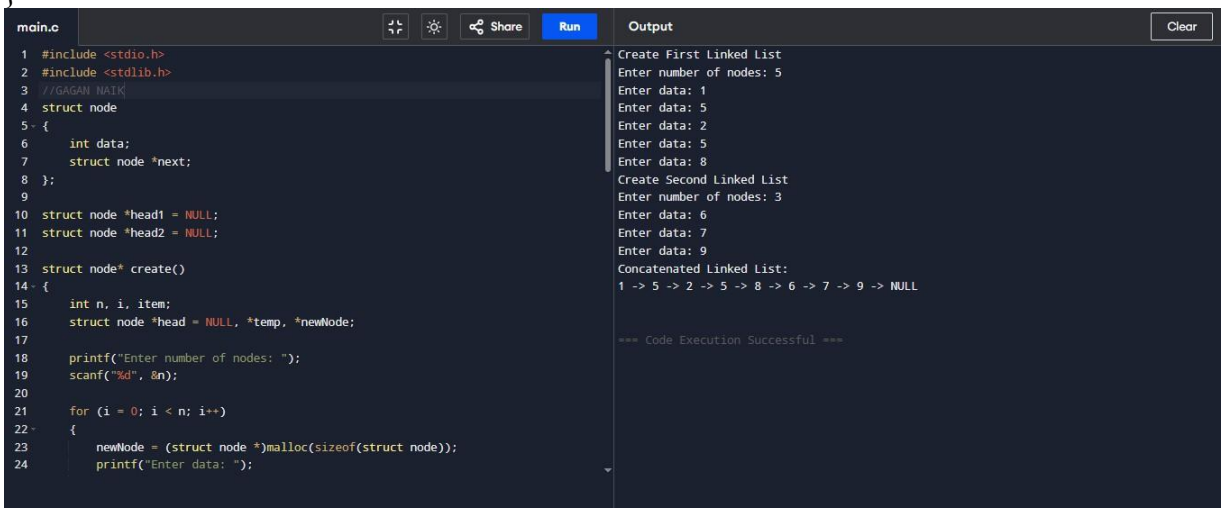
```
#include <stdio.h>
#include <stdlib.h>
//GAGAN NAIK
struct node
{
    int data;
    struct node *next;
};

struct node *head = NULL;

void create()
{
    int n, i, item;
    struct node *temp, *newNode;

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

    for (i = 0; i < n; i++)
    {
        newNode = (struct node *)malloc(sizeof(struct node));
        printf("Enter data: ");
        scanf("%d", &item);
```

Output

```
Enter number of nodes: 5
Enter data: 1
Enter data: 5
Enter data: 2
Enter data: 8
Enter data: 6
Reversed Linked List:
6 -> 8 -> 2 -> 5 -> 1 -> NULL


=== Code Execution Successful ===
```

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

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

struct node *head1 = NULL, *head2 = NULL;

struct node* create(int n) {
   struct node *newNode, *temp = NULL, *head = NULL;
   int data;
   for (int i = 0; i < n; i++) {
      newNode = (struct node *)malloc(sizeof(struct node));
      scanf("%d", &data);
      newNode->data = data;
      newNode->next = NULL;
      if (head == NULL) {
         head = newNode;
         temp = head;
      } else {
         temp->next = newNode;
         temp = newNode;
      }
   }
   return head;
}

void concatenate() {
   struct node *temp = head1;
   while (temp->next != NULL)
      temp = temp->next;
   temp->next = head2;
}

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

```
int main() {
    int n1, n2;
    printf("Enter nodes for List 1: ");
    scanf("%d", &n1);
    head1 = create(n1);

    printf("Enter nodes for List 2: ");
    scanf("%d", &n2);
    head2 = create(n2);

    concatenate();
    display(head1);

    return 0;
}
```



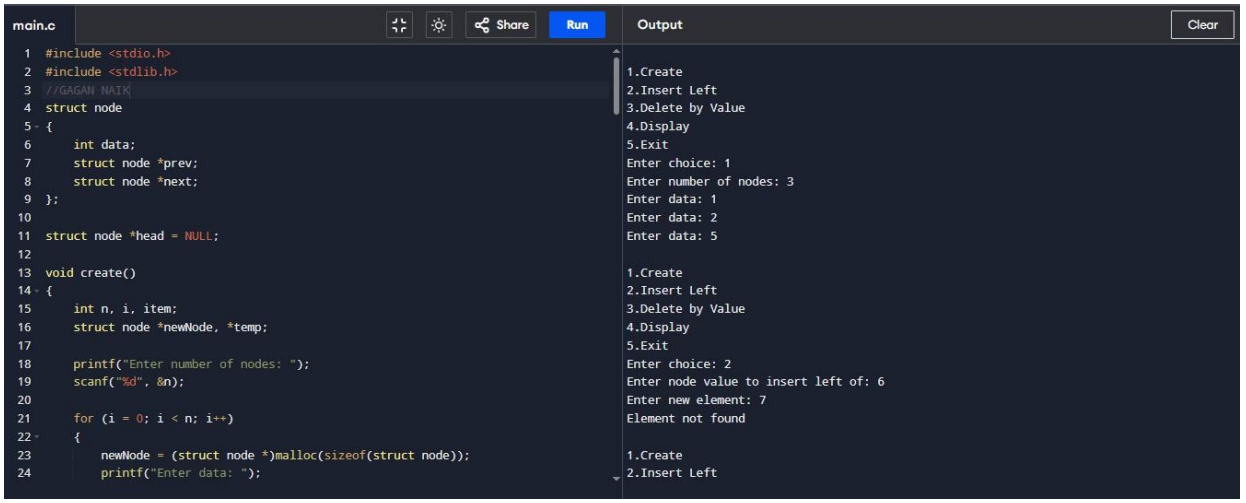
Lab Program 7

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 *head = NULL;

void create() {
   int n, x;
   struct node *temp, *newnode;
   scanf("%d", &n);
   while (n--) {
      newnode = malloc(sizeof(struct node));
      scanf("%d", &x);
      newnode->data = x;
      newnode->prev = newnode->next = NULL;
      if (head == NULL) {
         head = newnode;
      } else {
         temp = head;
         while (temp->next != NULL)
            temp = temp->next;
         temp->next = newnode;
         newnode->prev = temp;
      }
   }
}

void insert_left() {
   int key, x;
```

```
    struct node *temp, *newnode;
    scanf("%d", &key);
    scanf("%d", &x);
    temp = head;
    while (temp != NULL && temp->data != key)
        temp = temp->next;
    if (temp == NULL) {
        printf("Element not found\n");
        return;
    }
    newnode = malloc(sizeof(struct node));
    newnode->data = x;
    newnode->prev = temp->prev;
    newnode->next = temp;
    if (temp->prev != NULL)
        temp->prev->next = newnode;
    else
        head = newnode;
    temp->prev = newnode;
}

void delete_value() {
    int x;
    struct node *temp;
    scanf("%d", &x);
    temp = head;
    while (temp != NULL && temp->data != x)
        temp = temp->next;
    if (temp == NULL) {
        printf("Element not found\n");
        return;
    }
    if (temp->prev != NULL)
        temp->prev->next = temp->next;
    else
        head = temp->next;
    if (temp->next != NULL)
        temp->next->prev = temp->prev;
    free(temp);
}

void display() {
    struct node *temp = head;
```

```
    if (temp == NULL) {
        printf("List is empty\n");
        return;
    }
    while (temp != NULL) {
        printf("%d ", temp->data);
        temp = temp->next;
    }
    printf("\n");
}

int main() {
    int choice;
    while (1) {
        printf("1.Create 2.InsertLeft 3.DeleteValue 4.Display 5.Exit\n");
        scanf("%d", &choice);
        switch (choice) {
            case 1: create(); break;
            case 2: insert_left(); break;
            case 3: delete_value(); break;
            case 4: display(); break;
            case 5: return 0;
            default: printf("Invalid choice\n");
        }
    }
}
```



Output Clear

```
1.Create
2.Insert Left
3.Delete by Value
4.Display
5.Exit
Enter choice: 3
Enter value to delete: 5
Node deleted

1.Create
2.Insert Left
3.Delete by Value
4.Display
5.Exit
Enter choice: 4

1 <-> 2 <-> NULL

1.Create
2.Insert Left
3.Delete by Value
4.Display
5.Exit
Enter choice: 5
```

Lab Program 8

Write a program
a) ToconstructabinarySearchtree.
b) To traverse the tree using all the methods i.e., in-order, preorder and post order
c) 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 *root = NULL;

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

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

void preorder(struct node *root) {
```

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

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

int main() {
    int n, x, i, choice;
    while (1) {
        printf("1.Insert 2.Inorder 3.Preorder 4.Postorder 5.Exit\n");
        scanf("%d", &choice);
        switch (choice) {
            case 1:
                scanf("%d", &n);
                for (i = 0; i < n; i++) {
                    scanf("%d", &x);
                    root = insert(root, x);
                }
                break;
            case 2:
                inorder(root);
                printf("\n");
                break;
            case 3:
                preorder(root);
                printf("\n");
                break;
            case 4:
                postorder(root);
                printf("\n");
                break;
            case 5:
                return 0;
        }
```

```
    }
}
```

main.c

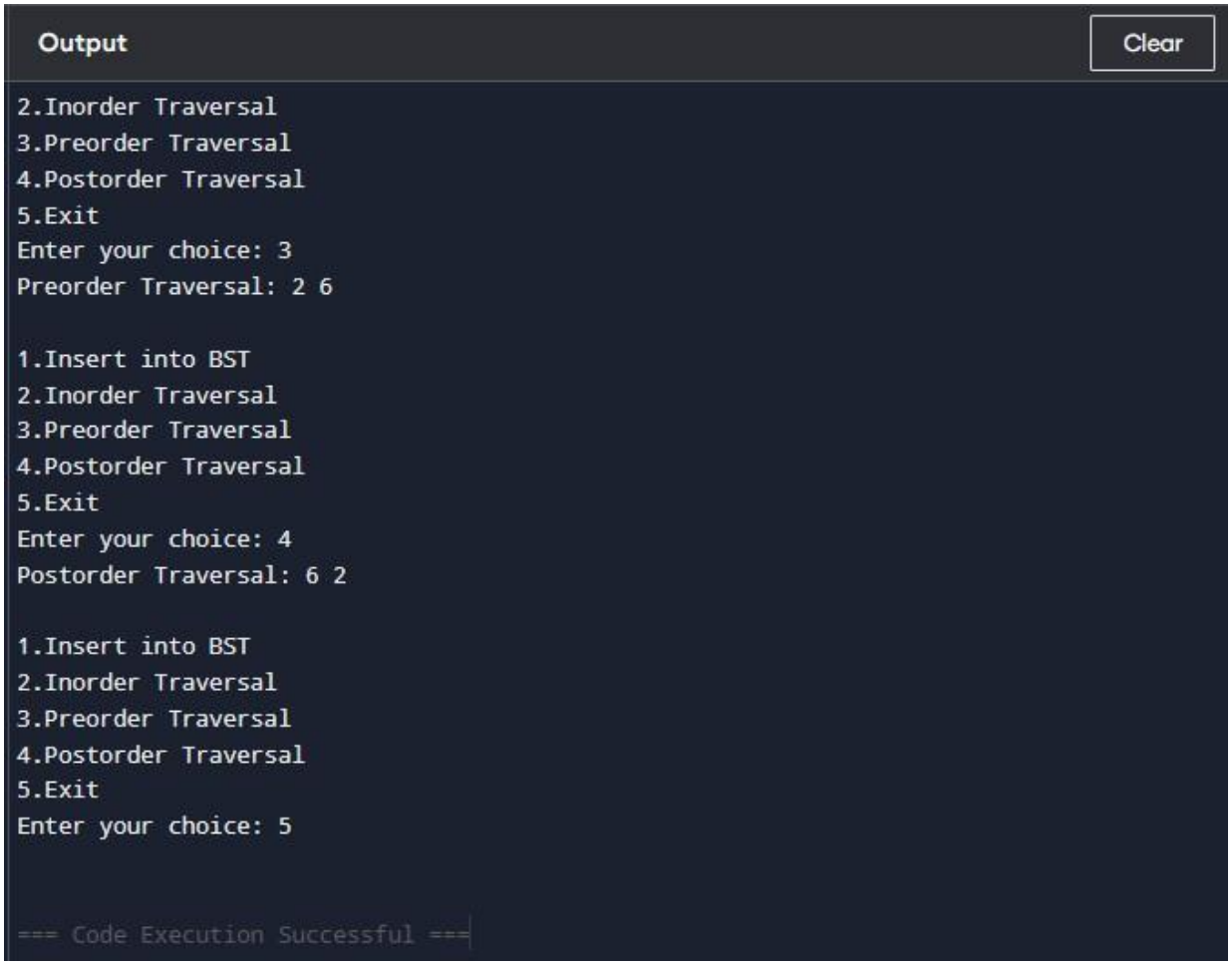
```c
#include <stdio.h>
#include <stdlib.h>
//GAGAN NAIK
struct node
{
    int data;
    struct node *left;
    struct node *right;
};

struct node *root = NULL;

struct node* insert(struct node *root, int item)
{
    if (root == NULL)
    {
        struct node *newNode = (struct node *)malloc(sizeof(struct node));
        newNode->data = item;
        newNode->left = NULL;
        newNode->right = NULL;
        return newNode;
    }

    if (item < root->data)
```

Output

```
1.Insert into BST
2.Inorder Traversal
3.Preorder Traversal
4.Postorder Traversal
5.Exit
Enter your choice: 1
Enter element: 2

1.Insert into BST
2.Inorder Traversal
3.Preorder Traversal
4.Postorder Traversal
5.Exit
Enter your choice: 1
Enter element: 6

1.Insert into BST
2.Inorder Traversal
3.Preorder Traversal
4.Postorder Traversal
5.Exit
Enter your choice: 1
Enter element: 2
```

Output

```
1.Insert into BST
2.Inorder Traversal
3.Preorder Traversal
4.Postorder Traversal
5.Exit
Enter your choice: 2
Inorder Traversal: 2 6

1.Insert into BST
2.Inorder Traversal
3.Preorder Traversal
4.Postorder Traversal
5.Exit
Enter your choice: 3
Preorder Traversal: 2 6

1.Insert into BST
2.Inorder Traversal
3.Preorder Traversal
4.Postorder Traversal
5.Exit
Enter your choice: 4
Postorder Traversal: 6 2
```


Output
Clear
2.Inorder Traversal
3.Preorder Traversal
4.Postorder Traversal
5.Exit
Enter your choice: 3
Preorder Traversal: 2 6
1.Insert into BST
2.Inorder Traversal
3.Preorder Traversal
4.Postorder Traversal
5.Exit
Enter your choice: 4
Postorder Traversal: 6 2
1.Insert into BST
2.Inorder Traversal
3.Preorder Traversal
4.Postorder Traversal
5.Exit
Enter your choice: 5
=== Code Execution Successful ===

Lab Program 9

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

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

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

#define MAX 20

int queue[MAX], front = -1, rear = -1;

void enqueue(int x) {
    if (rear == MAX - 1) return;
    if (front == -1) front = 0;
    queue[++rear] = x;
}

int dequeue() {
    if (front == -1) return -1;
    int x = queue[front];
    if (front == rear) front = rear = -1;
    else front++;
    return x;
}

void bfs(int n, int adj[n][n], int start) {
    int visited[n];
    for (int i = 0; i < n; i++) visited[i] = 0;
    enqueue(start);
    visited[start] = 1;
    printf("BFS: ");
    while (front != -1) {
        int u = dequeue();
        printf("%d ", u);
        for (int v = 0; v < n; v++) {
            if (adj[u][v] && !visited[v]) {
                enqueue(v);
                visited[v] = 1;
            }
```

```
        }
    }
    printf("\n");
}

void dfs_util(int n, int adj[n][n], int visited[n], int u) {
    visited[u] = 1;
    for (int v = 0; v < n; v++) {
        if (adj[u][v] && !visited[v])
            dfs_util(n, adj, visited, v);
    }
}

int is_connected(int n, int adj[n][n]) {
    int visited[n];
    for (int i = 0; i < n; i++) visited[i] = 0;
    dfs_util(n, adj, visited, 0);
    for (int i = 0; i < n; i++)
        if (!visited[i]) return 0;
    return 1;
}

int main() {
    int n, i, j;
    printf("Enter number of vertices: ");
    scanf("%d", &n);
    int adj[n][n];
    printf("Enter adjacency matrix:\n");
    for (i = 0; i < n; i++)
        for (j = 0; j < n; j++)
            scanf("%d", &adj[i][j]);
    bfs(n, adj, 0);
    if (is_connected(n, adj))
        printf("Graph is connected\n");
    else
        printf("Graph is not connected\n");
    return 0;
}
```

main.c

Share Run

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

//GAGAN NAIK

#define MAX 20
int queue[MAX], front = -1, rear = -1; void enqueue(int x) {
if (rear == MAX - 1) return; if (front == -1) front = 0; queue[++rear] = x;
}

int dequeue() {
if (front == -1) return -1; int x = queue[front];
if (front == rear) front = rear = -1; else front++;
return x;
}

void bfs(int n, int adj[n][n], int start) { int visited[n];
for (int i = 0; i < n; i++) visited[i] = 0; enqueue(start);
visited[start] = 1; printf("BFS: "); while (front != -1) {
int u = dequeue(); printf("%d ", u);
for (int v = 0; v < n; v++) {
if (adj[u][v] && !visited[v]) { enqueue(v);
visited[v] = 1;
}
```

Output

Clear

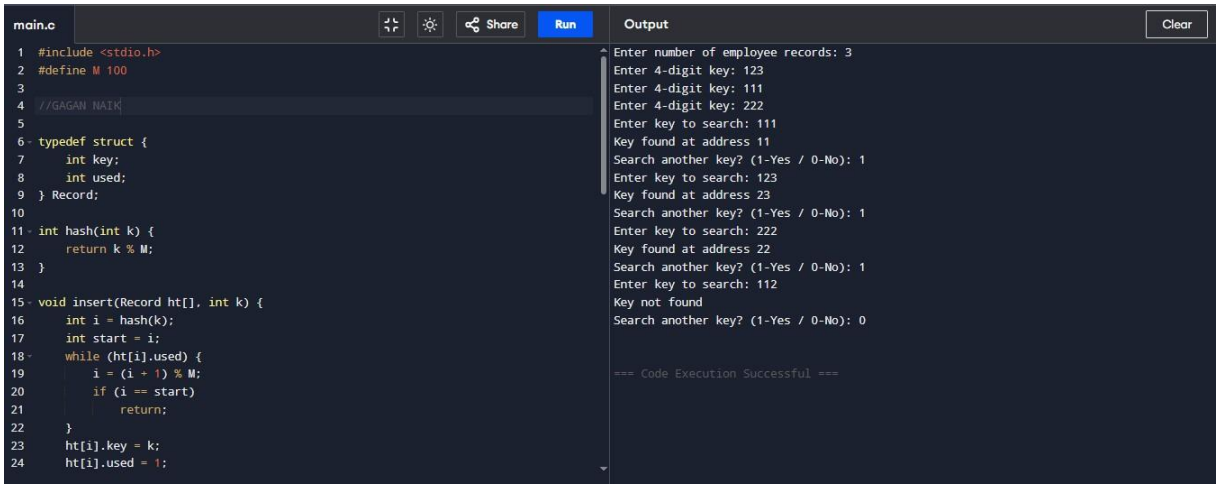
```
Enter number of vertices: 3
Enter adjacency matrix:
2
1
2
3
4
5
6
7
8
BFS: 0 1 2
Graph is connected


=== Code Execution Successful ===
```

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 -> L as H(K)=K mod 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 M 100

typedef struct {
    int key;
    int used;
} Record;

int hash(int k) {
    return k % M;
}

void insert(Record ht[], int k) {
    int i = hash(k);
    int start = i;
    while (ht[i].used) {
        i = (i + 1) % M;
        if (i == start)
            return;
    }
    ht[i].key = k;
    ht[i].used = 1;
}

int search(Record ht[], int k) {
    int i = hash(k);
    int start = i;
    while (ht[i].used) {
        if (ht[i].key == k)
            return i;
        i = (i + 1) % M;
        if (i == start)
            break;
    }
    return -1;
}
```

```
int main() {
    Record ht[M];
    int n, k, i, pos, choice;

    for (i = 0; i < M; i++)
        ht[i].used = 0;

    printf("Enter number of employee records: ");
    scanf("%d", &n);

    for (i = 0; i < n; i++) {
        printf("Enter 4-digit key: ");
        scanf("%d", &k);
        insert(ht, k);
    }

    do {
        printf("Enter key to search: ");
        scanf("%d", &k);
        pos = search(ht, k);
        if (pos == -1)
            printf("Key not found\n");
        else
            printf("Key found at address %02d\n", pos);

        printf("Search another key? (1-Yes / 0-No): ");
        scanf("%d", &choice);
    } while (choice == 1);

    return 0;
}
```

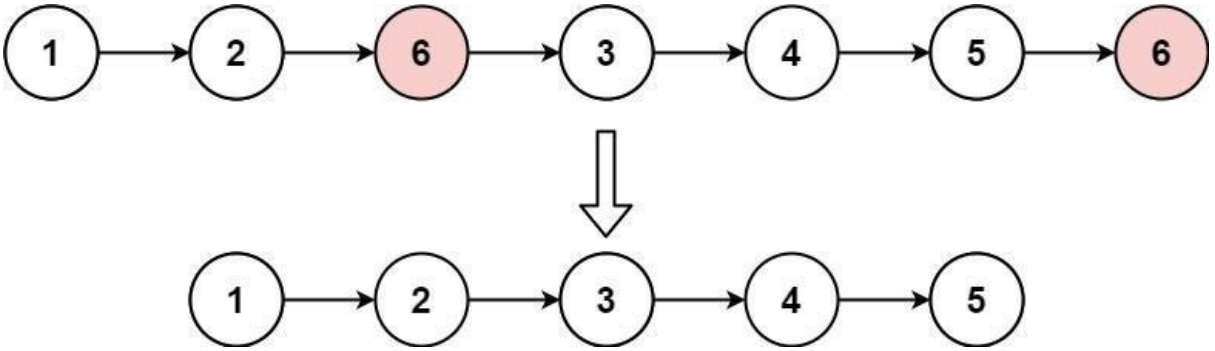


Leetcode Problem 1

Remove Linked List Elements

Given the `head` of a linked list and an integer `val`, remove all the nodes of the linked list that has `Node.val == val`, and return *the new head*.

Example 1:



Input: head = [1,2,6,3,4,5,6], val = 6
Output: [1,2,3,4,5]

Example 2:

Input: head = [], val = 1
Output: []

Example 3:

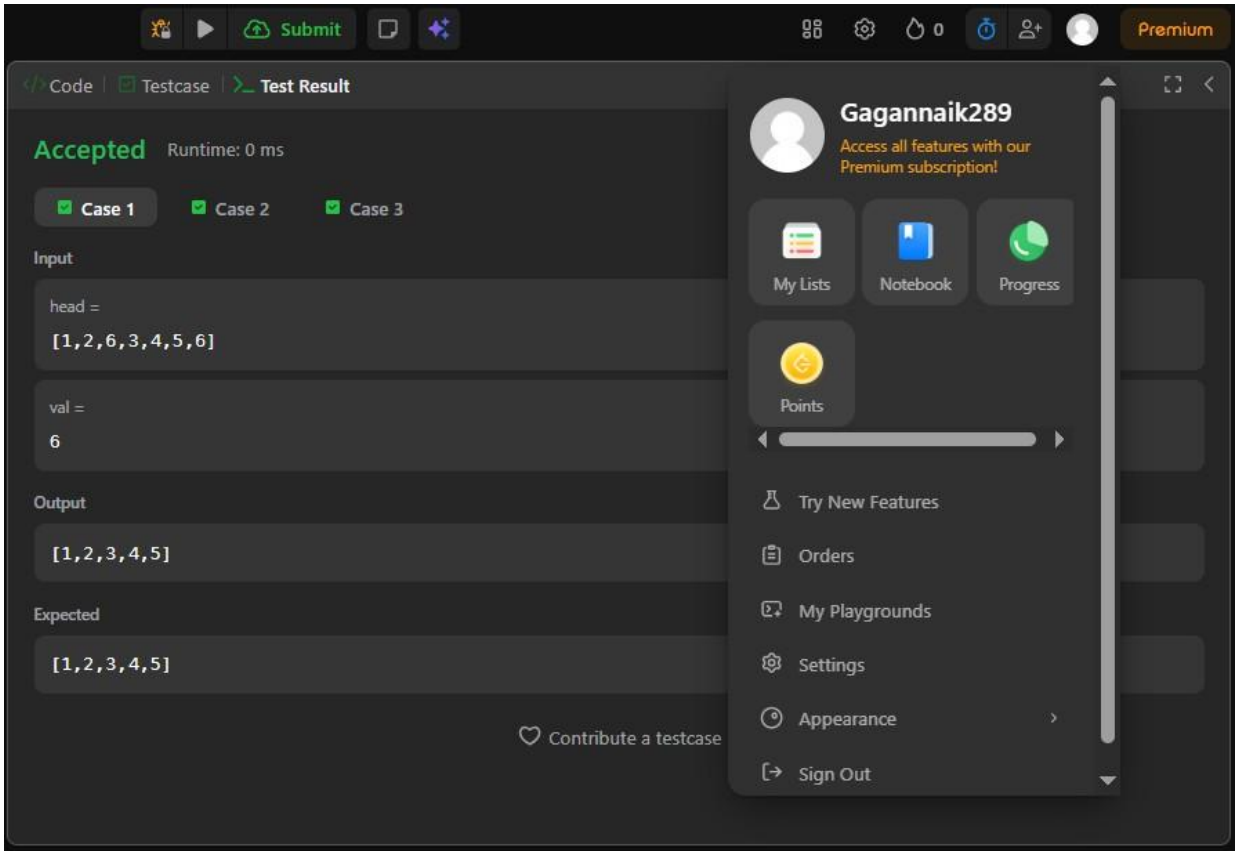
Input: head = [7,7,7,7], val = 7
Output: []

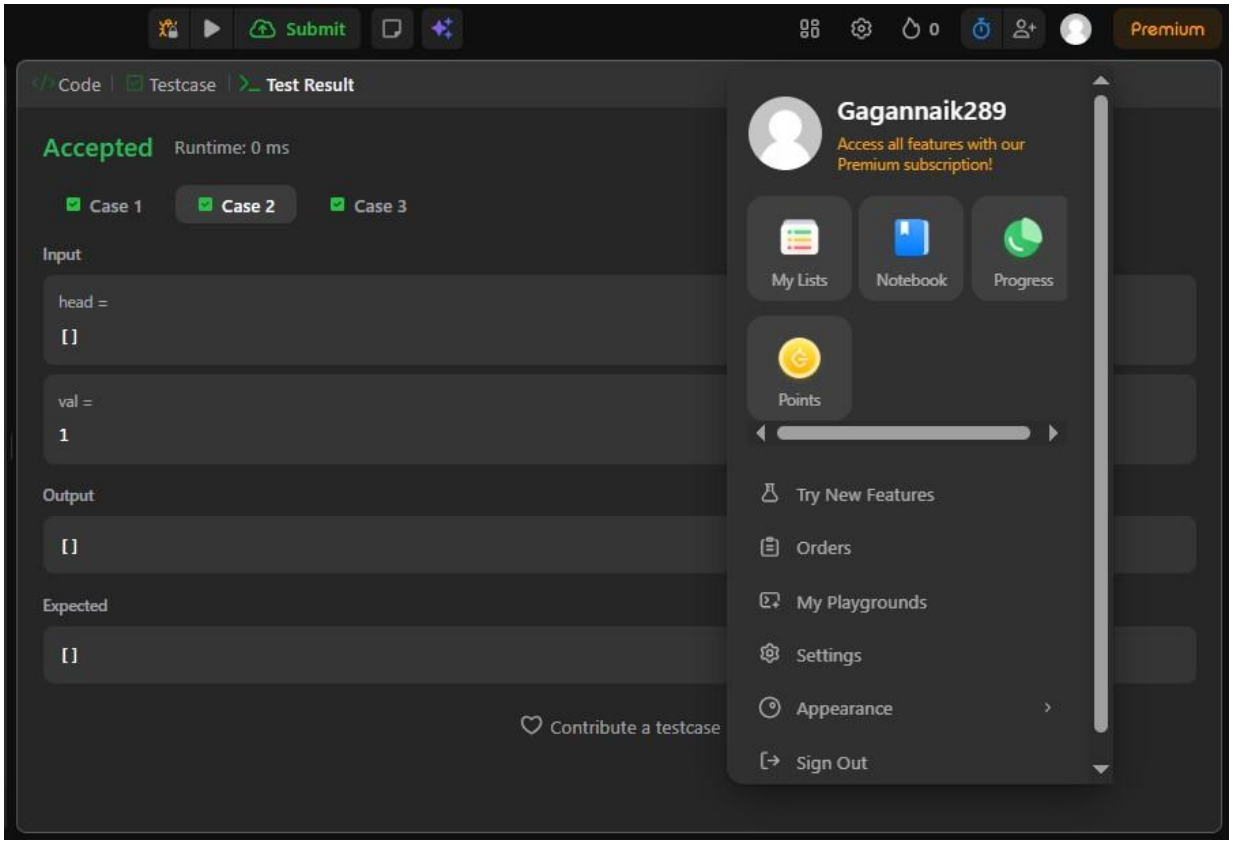
Constraints:

- The number of nodes in the list is in the range `[0, 10 4 ]`.
- `1 <= Node.val <= 50`
- `0 <= val <= 50`

```
struct ListNode* removeElements(struct ListNode* head, int val) {
    struct ListNode dummy;
    dummy.next = head;
    struct ListNode* current = &dummy;

    while (current->next != NULL) {
```

```
        if (current->next->val == val) {
            struct ListNode* temp = current->next;
            current->next = current->next->next;
            free(temp);
        } else {
            current = current->next;
        }
    }

    return dummy.next;
}
```




Submit
Premium
Code
Testcase
Test Result
Accepted
Runtime: 0 ms
Case 1
Case 2
Case 3
Input
head =
[]
val =
1
Output
[]
Expected
[]
Contribute a testcase
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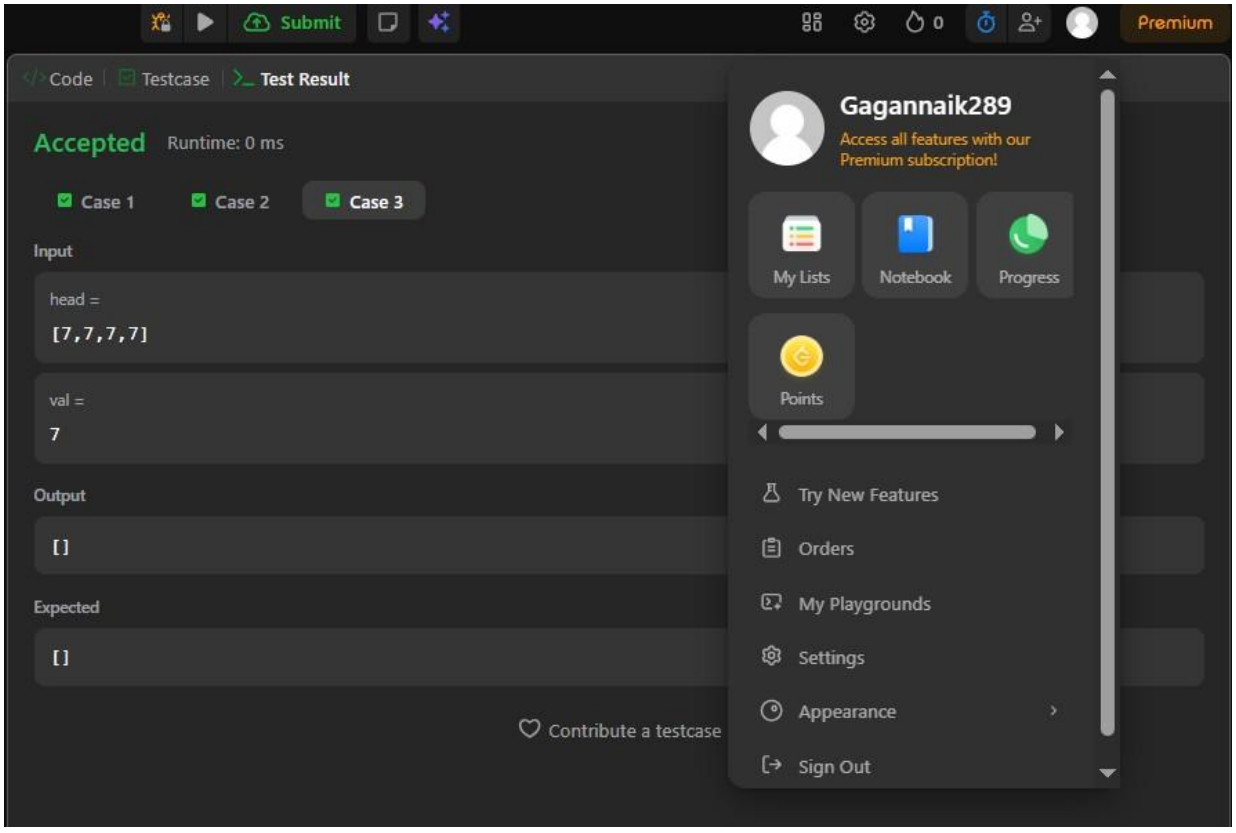
Submit
Premium
Code
Testcase
Test Result
Accepted
Runtime: 0 ms
Case 1
Case 2
Case 3
Input
head =
[7,7,7,7]
val =
7
Output
[]
Expected
[]
Contribute a testcase
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Leetcode Problem 2

Sort List

Given the `head` of a linked list, return *the list after sorting it in* ***ascending order***.

Example 1:

Input: head = [4,2,1,3]
Output: [1,2,3,4]
Example 2:

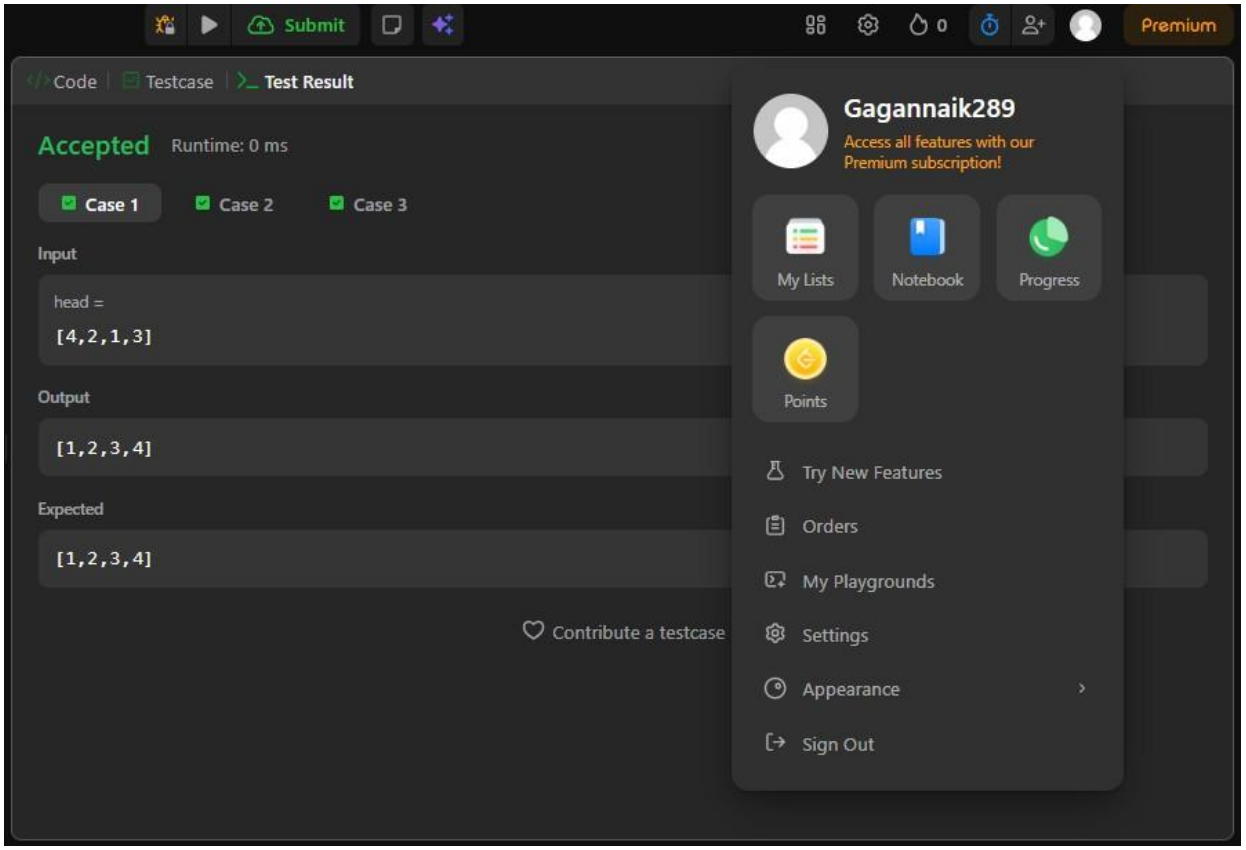
Input: head = [-1,5,3,4,0]
Output: [-1,0,3,4,5]
Example 3:
Input: head = []
Output: []

Constraints:

- The number of nodes in the list is in the range `[0, 5 * 10 4 ]`.
- `-10 5 <= Node.val <= 10 5`

```
struct ListNode* merge(struct ListNode* l1, struct ListNode* l2) {
    struct ListNode dummy;
    struct ListNode* tail = &dummy;
    dummy.next = NULL;

    while (l1 && l2) {
        if (l1->val < l2->val) {
            tail->next = l1;
            l1 = l1->next;
        } else {
            tail->next = l2;
            l2 = l2->next;
        }
        tail = tail->next;
    }

    tail->next = l1 ? l1 : l2;
```

```
    return dummy.next;
}

struct ListNode* getMid(struct ListNode* head) {
    struct ListNode* slow = head;
    struct ListNode* fast = head->next;

    while (fast && fast->next) {
        slow = slow->next;
        fast = fast->next->next;
    }

    return slow;
}

struct ListNode* sortList(struct ListNode* head) {
    if (!head || !head->next)
        return head;

   struct ListNode* mid = getMid(head);
    struct ListNode* right = mid->next;
    mid->next = NULL;

    struct ListNode* leftSorted = sortList(head);
    struct ListNode* rightSorted = sortList(right);

    return merge(leftSorted, rightSorted);
}
```


Submit
Premium
Code
Testcase
Test Result
Accepted
Runtime: 0 ms
Case 1
Case 2
Case 3
Input
head =
[4,2,1,3]
Output
[1,2,3,4]
Expected
[1,2,3,4]
Contribute a testcase
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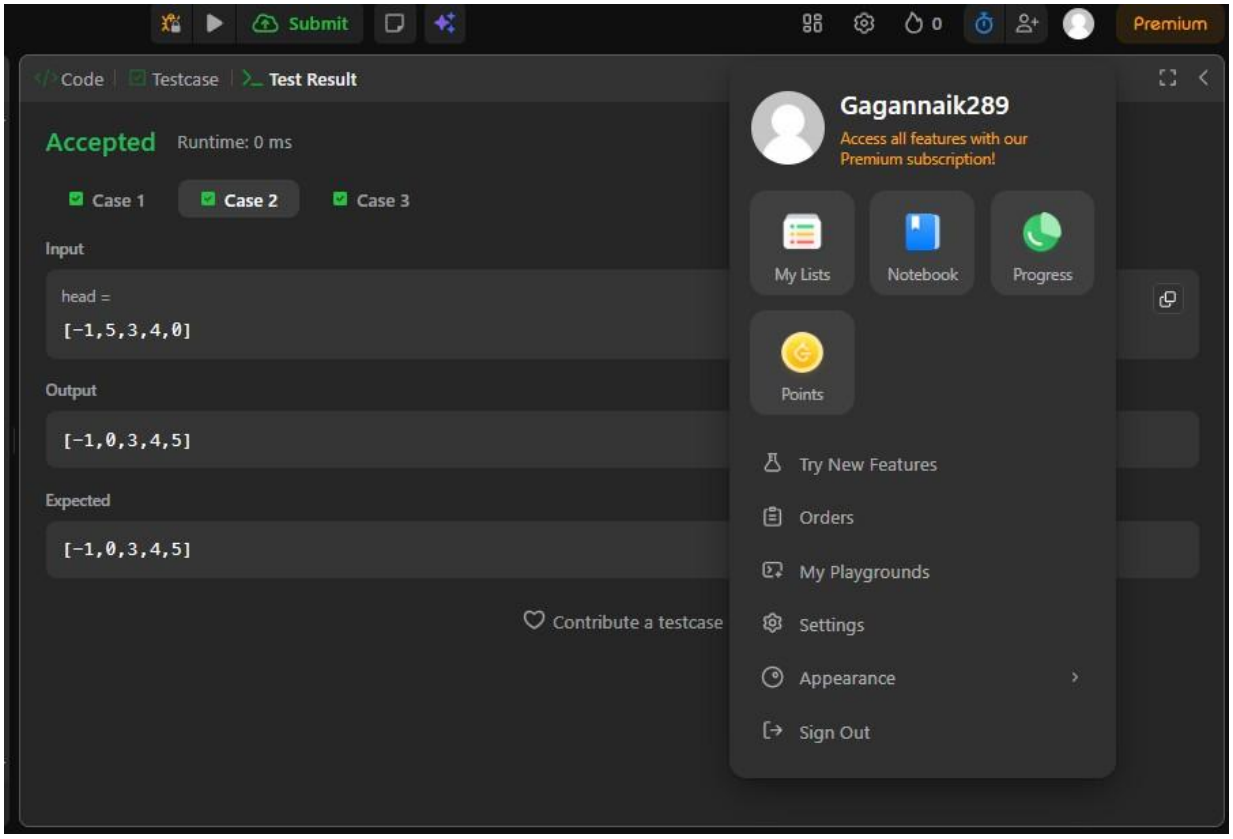
Submit
Premium
Code
Testcase
Test Result
Accepted
Runtime: 0 ms
Case 1
Case 2
Case 3
Input
head =
[-1,5,3,4,0]
Output
[-1,0,3,4,5]
Expected
[-1,0,3,4,5]
Contribute a testcase
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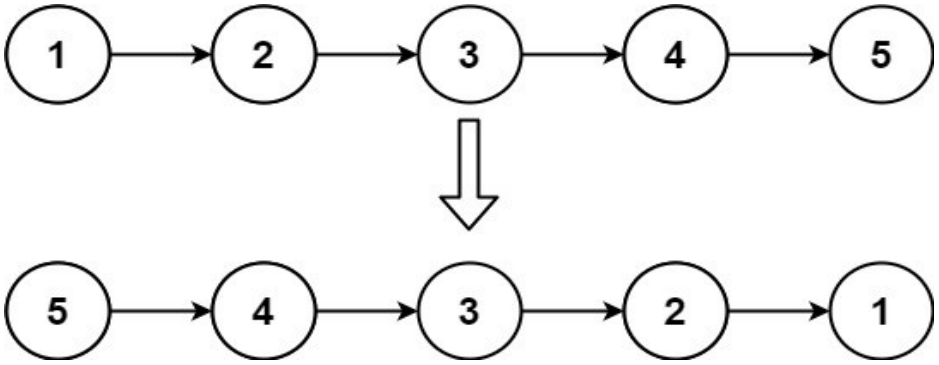
Leetcode Problem 3

Given the `head` of a singly linked list, reverse the list, and return *the reversed list*.

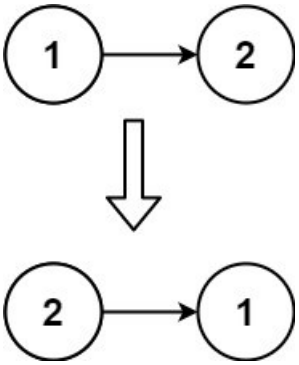
Example 1:



Input: head = [1,2,3,4,5]

Output: [5,4,3,2,1]

Example 2:



Input: head = [1,2]

Output: [2,1]

Example 3:

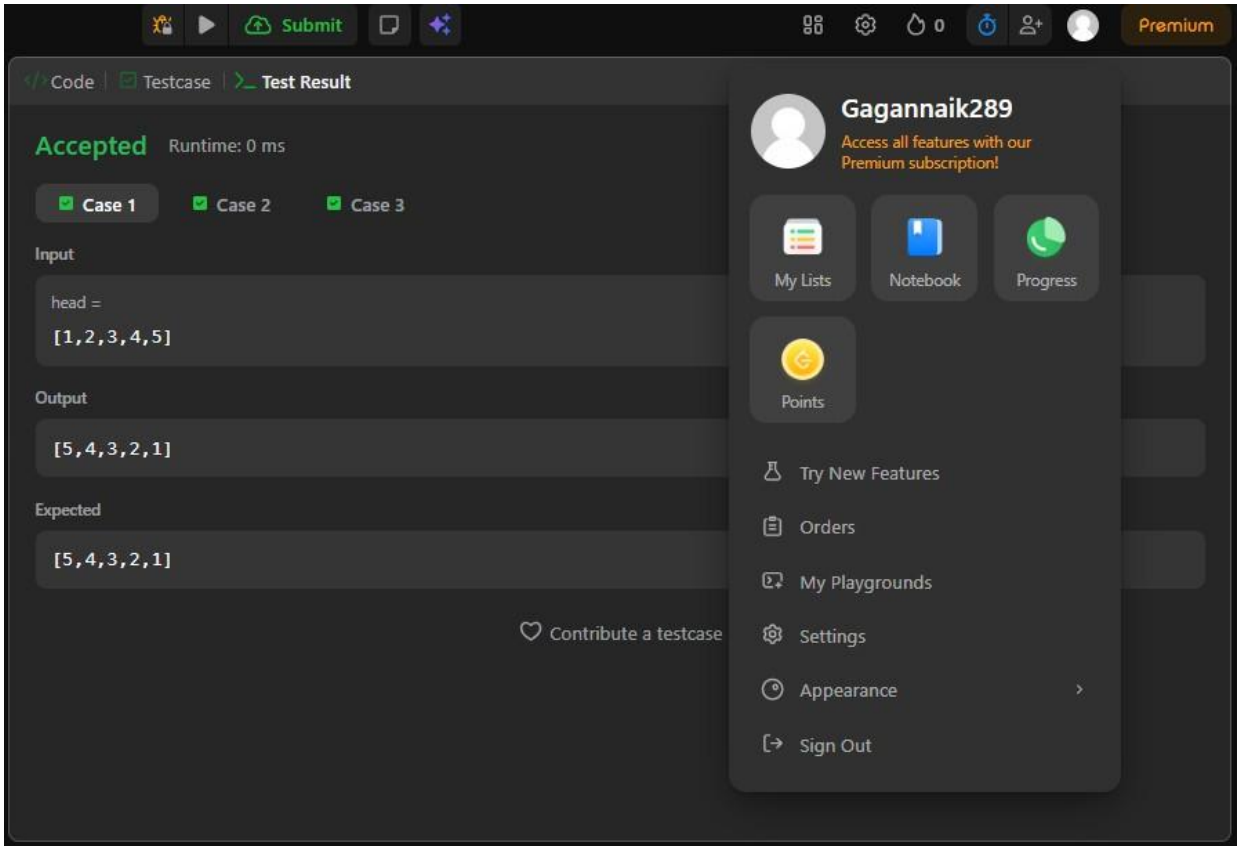
Input: head = []

Output: []

Constraints:

- The number of nodes in the list is the range `[0, 5000]`.
- `-5000 <= Node.val <= 5000`

```
struct ListNode* reverseList(struct ListNode* head) {
    struct ListNode* prev = NULL;
    struct ListNode* curr = head;
    struct ListNode* next = NULL;

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

    return prev;
}
```



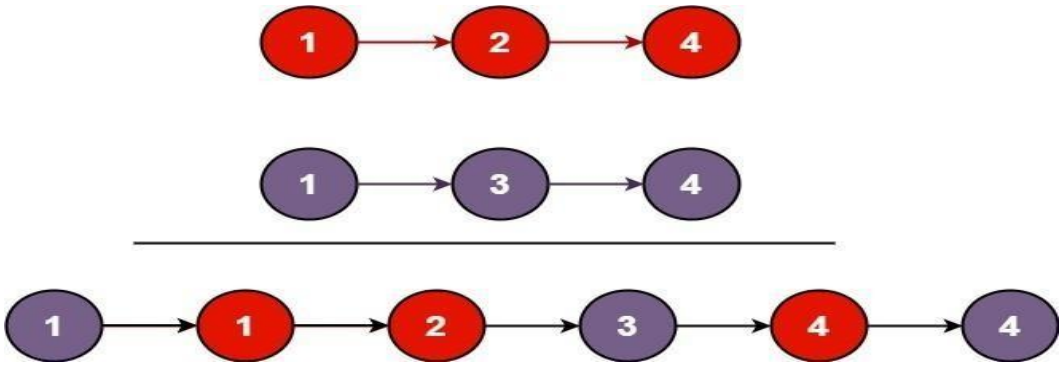
Leetcode Program 4

You are given the heads of two sorted linked lists `list1` and `list2`.

Merge the two lists into one **sorted** list. The list should be made by splicing together the nodes of the first two lists.

Return *the head of the merged linked list*.

Example 1:



Input: list1 = [1,2,4], list2 = [1,3,4]

Output: [1,1,2,3,4,4]

Example 2:

Input: list1 = [], list2 = []

Output: []

Example 3:

Input: list1 = [], list2 = [0]

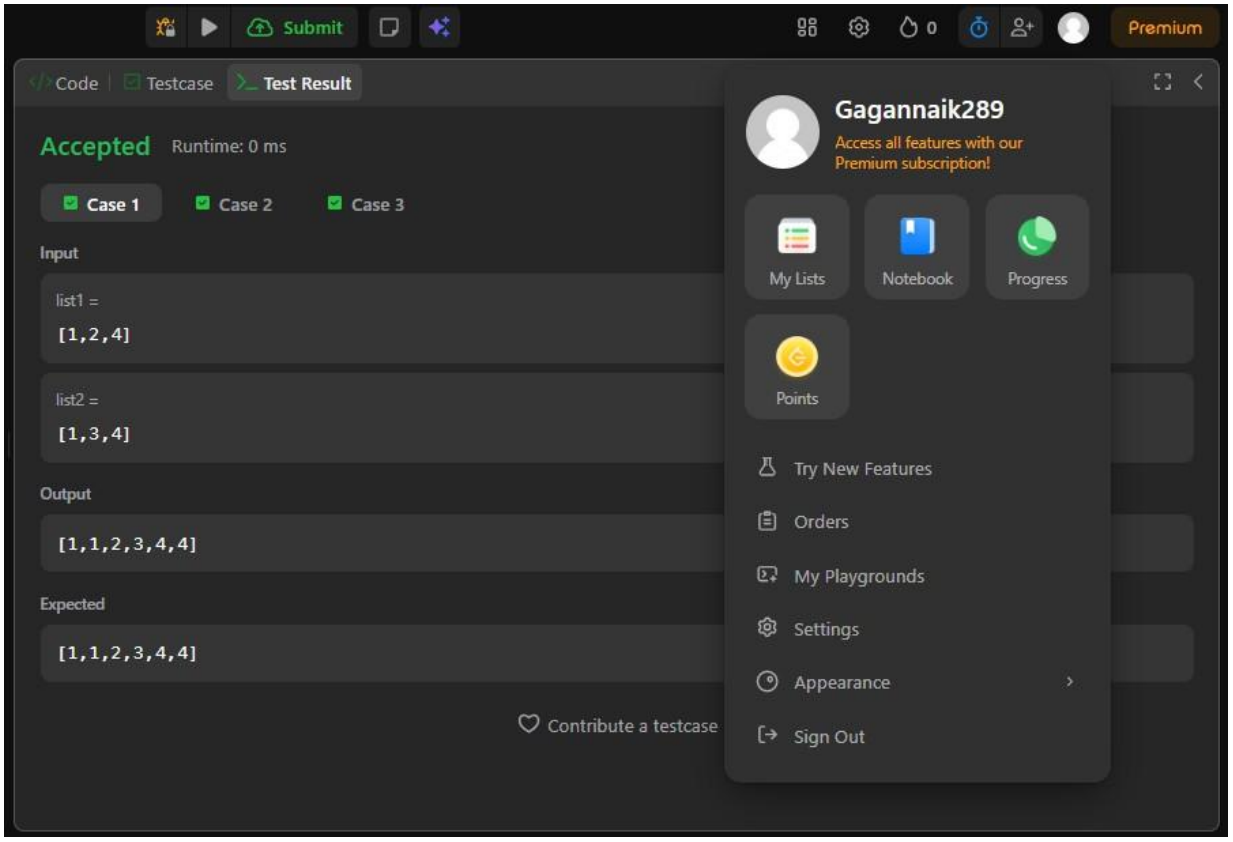
Output: [0]

Constraints:

- The number of nodes in both lists is in the range `[0, 50]`.
- `-100 <= Node.val <= 100`
- Both `list1` and `list2` are sorted in **non-decreasing** order.

```
struct ListNode* mergeTwoLists(struct ListNode* list1, struct ListNode* list2) {
    struct ListNode dummy;
```

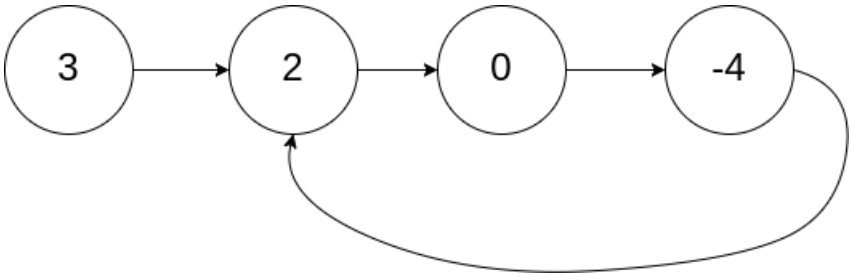
```
    struct ListNode* tail = &dummy;
    dummy.next = NULL;

    while (list1 && list2) {
        if (list1->val <= list2->val) {
            tail->next = list1;
            list1 = list1->next;
        } else {
            tail->next = list2;
            list2 = list2->next;
        }
        tail = tail->next;
    }

    tail->next = list1 ? list1 : list2;
    return dummy.next;
}
```



Leetcode Program 5

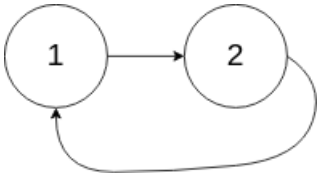
Given `head`, the head of a linked list, determine if the linked list has a cycle in it.
There is a cycle in a linked list if there is some node in the list that can be reached again by continuously following the `next` pointer. Internally, `pos` is used to denote the index of the node that tail's `next` pointer is connected to. **Note that `pos` is not passed as a parameter**.
Return `true` *if there is a cycle in the linked list*. Otherwise, return `false`.

Example 1:



Input: head = [3,2,0,-4], pos = 1
Output: true
Explanation: There is a cycle in the linked list, where the tail connects to the 1st node (0-indexed).

Example 2:



Input: head = [1,2], pos = 0
Output: true
Explanation: There is a cycle in the linked list, where the tail connects to the 0th node.

Example 3:

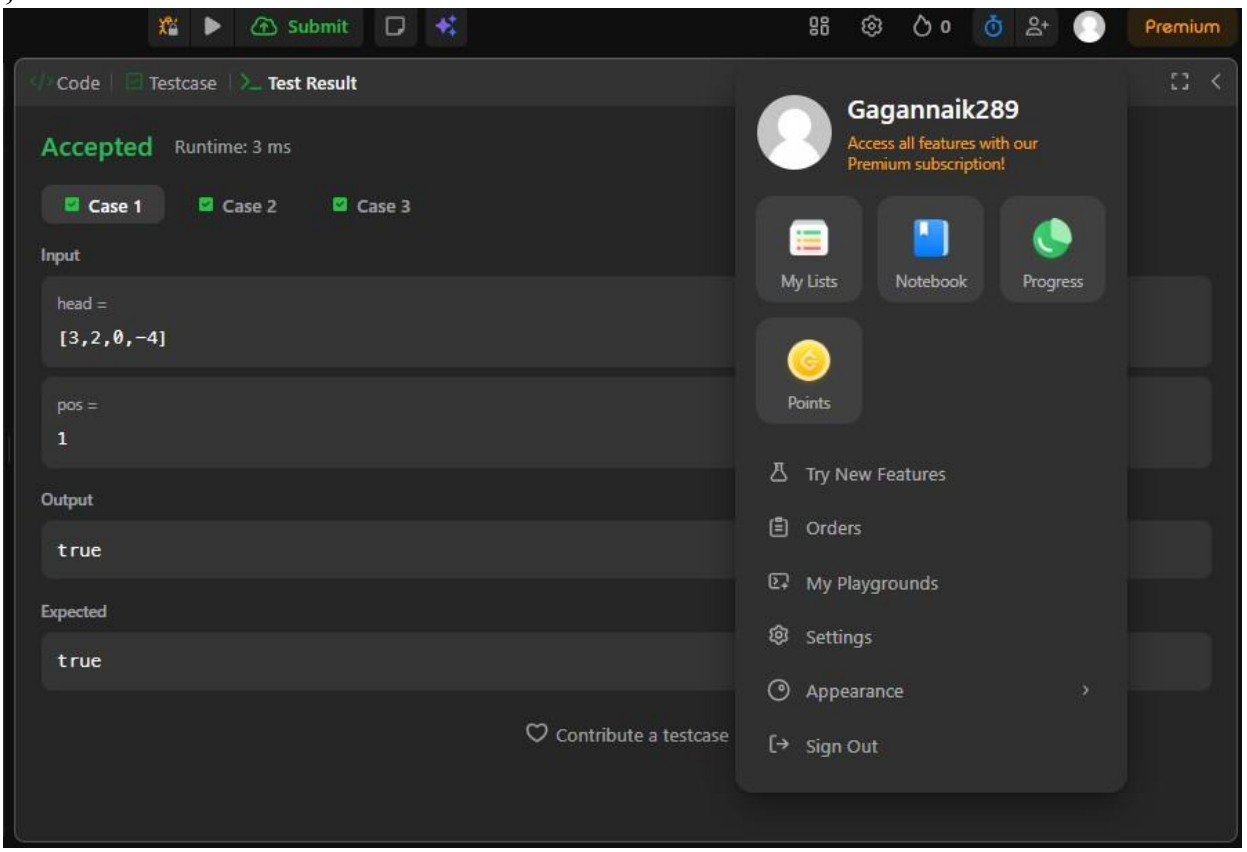
Input: head = [1], pos = -1
Output: false
Explanation: There is no cycle in the linked list.

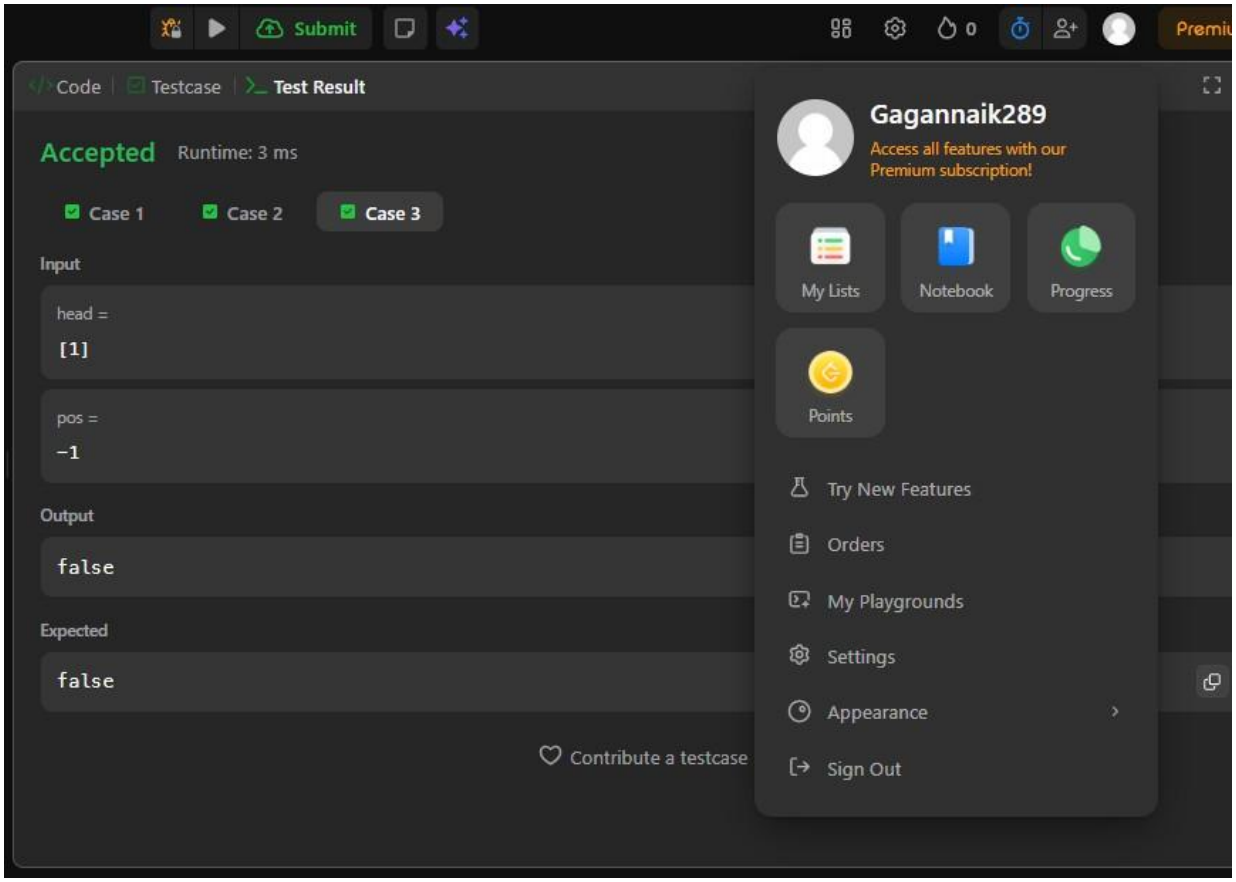
Constraints:

- The number of the nodes in the list is in the range `[0, 10 4 ].`
- `-10 5 <= Node.val <= 10 5`
- `pos` is `-1` or a **valid index** in the linked-list.

Follow up: Can you solve it using `O(1)` (i.e. constant) memory?

```
bool hasCycle(struct ListNode *head) {
    struct ListNode* slow = head;
    struct ListNode* fast = head;

    while (fast && fast->next) {
        slow = slow->next;
        fast = fast->next->next;
        if (slow == fast)
            return true;
    }

    return false;
}
```




Submit
0
Premiu
Code
Testcase
Test Result
Accepted
Runtime: 3 ms
Case 1
Case 2
Case 3
Input
head =
[1]
pos =
-1
Output
false
Expected
false
Contribute a testcase
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Points
Try New Features
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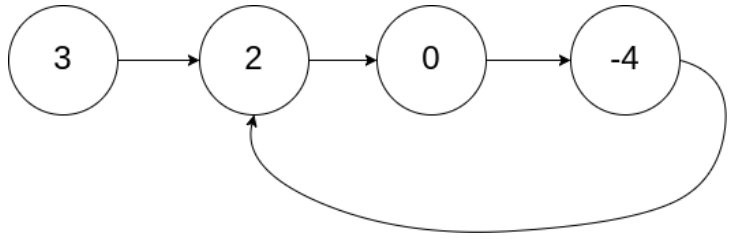
Leetcode Problem 6

Given the `head` of a linked list, return *the node where the cycle begins. If there is no cycle, return* `null`.

There is a cycle in a linked list if there is some node in the list that can be reached again by continuously following the `next` pointer. Internally, `pos` is used to denote the index of the node that tail's `next` pointer is connected to (**0-indexed**). It is `-1` if there is no cycle. **Note that** `pos` **is not passed as a parameter**.

Do not modify the linked list.

Example 1:

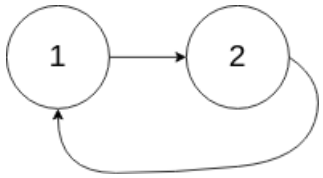


Input: head = [3,2,0,-4], pos = 1

Output: tail connects to node index 1

Explanation: There is a cycle in the linked list, where tail connects to the second node.

Example 2:



Input: head = [1,2], pos = 0

Output: tail connects to node index 0

Explanation: There is a cycle in the linked list, where tail connects to the first node.

Example 3:

Input: head = [1], pos = -1

Output: no cycle

Explanation: There is no cycle in the linked list.

Constraints:

- The number of the nodes in the list is in the range `[0, 10 4 ].`
- `-10 5 <= Node.val <= 10 5`
- `pos` is `-1` or a **valid index** in the linked-list.

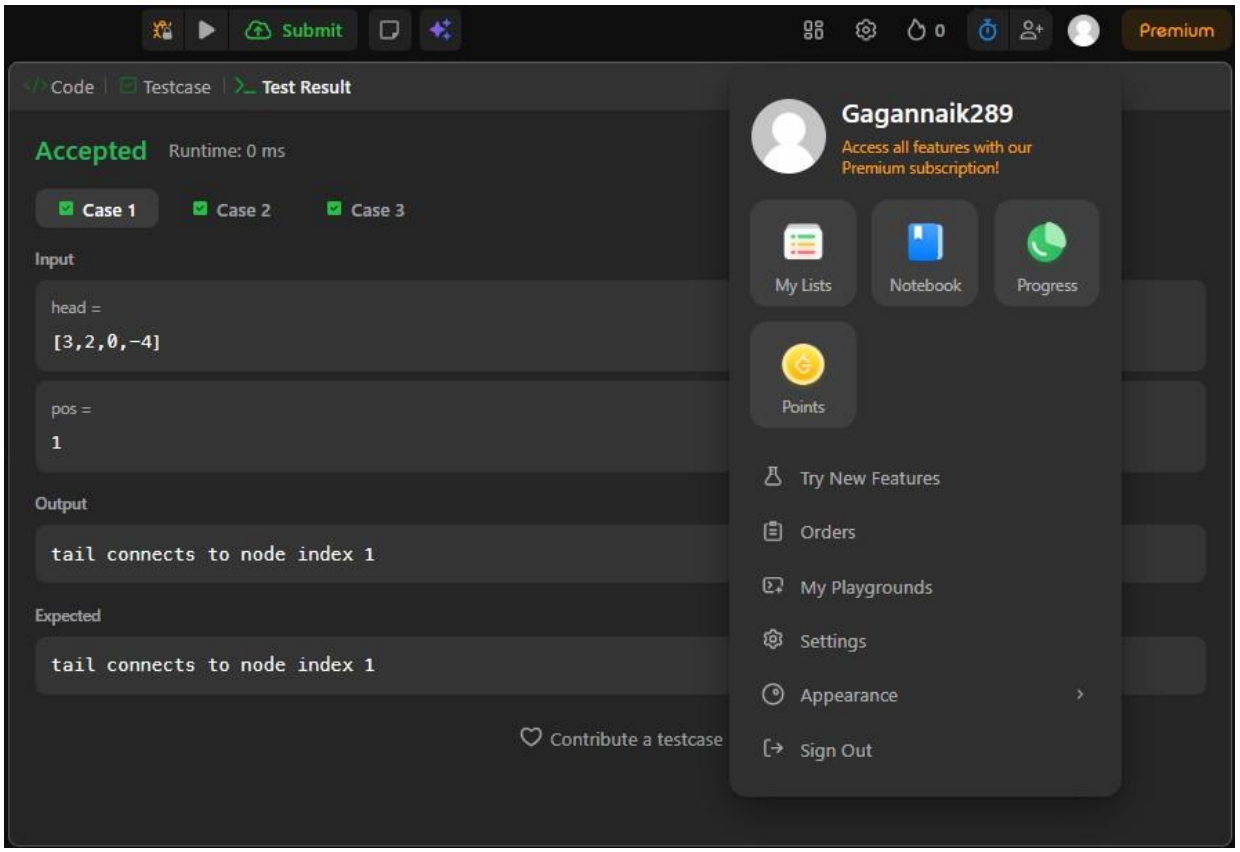
```
struct ListNode *detectCycle(struct ListNode *head) {
    struct ListNode* slow = head;
    struct ListNode* fast = head;

    while (fast && fast->next) {
        slow = slow->next;
        fast = fast->next->next;
        if (slow == fast)
            break;
    }

    if (!fast || !fast->next)
        return NULL;

    slow = head;
    while (slow != fast) {
        slow = slow->next;
        fast = fast->next;
    }

    return slow;
}
```


Submit
0
Premium
Code
Testcase
Test Result
Accepted
Runtime: 0 ms
Case 1
Case 2
Case 3
Input
head =
[3,2,0,-4]
pos =
1
Output
tail connects to node index 1
Expected
tail connects to node index 1
Contribute a testcase
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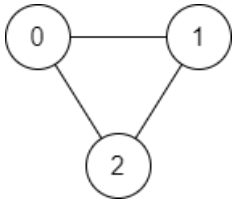
Leetcode Problem 7

There is a **bi-directional** graph with `n` vertices, where each vertex is labeled from `0` to `n - 1` (**inclusive**). The edges in the graph are represented as a 2D integer array `edges`, where each `edges[i] = [u i, v i]` denotes a bi-directional edge between vertex `u i` and vertex `v i`. Every vertex pair is connected by **at most one** edge, and no vertex has an edge to itself.

You want to determine if there is a **valid path** that exists from vertex `source` to vertex `destination`.

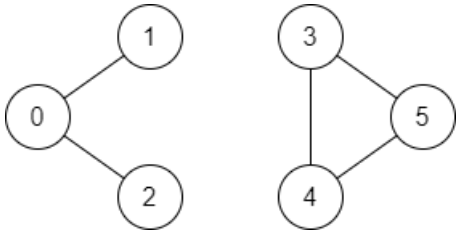
Given `edges` and the integers `n`, `source`, and `destination`, return `true` *if there is a* ***valid path*** *from* `source` *to* `destination`*, or* `false` *otherwise.*

Example 1:



Input: n = 3, edges = [[0,1],[1,2],[2,0]], source = 0, destination = 2
Output: true
Explanation: There are two paths from vertex 0 to vertex 2:
- 0 → 1 → 2
- 0 → 2

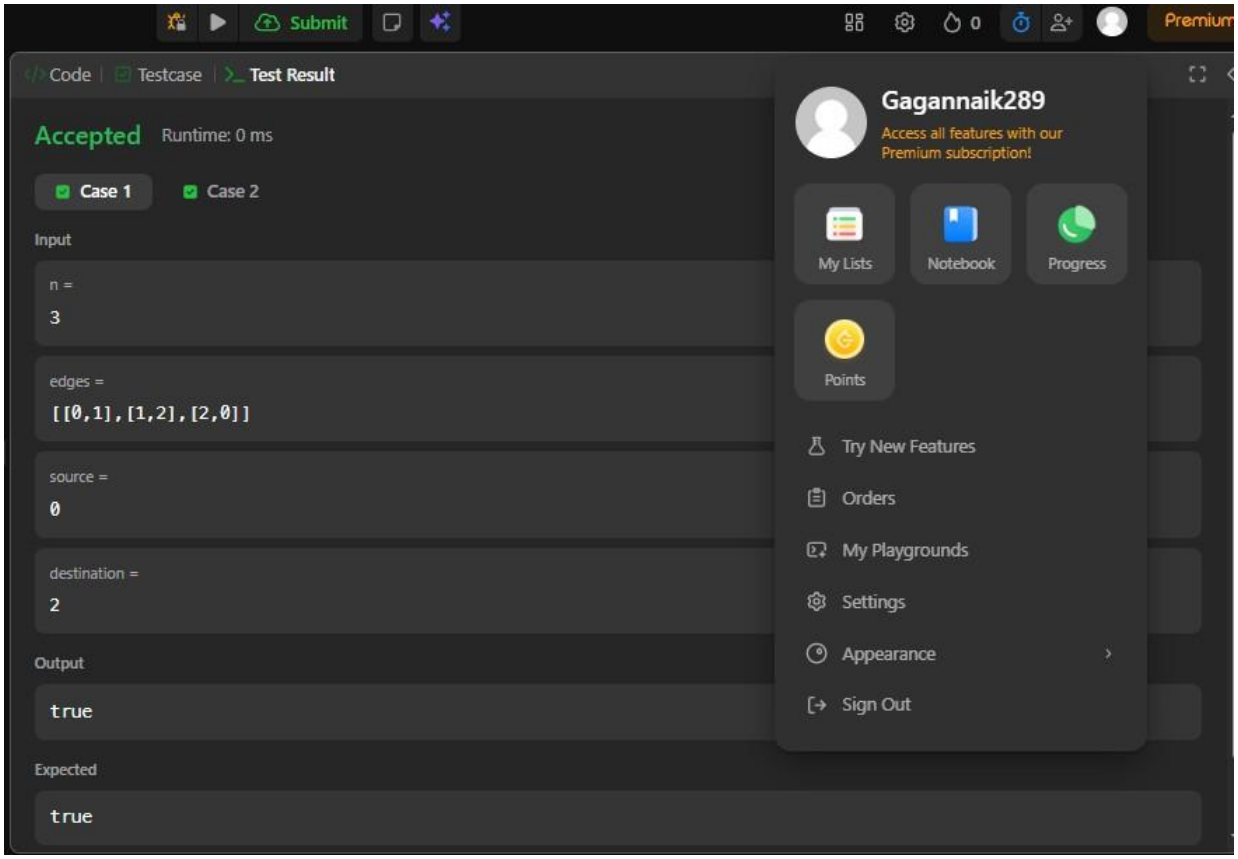
Example 2:

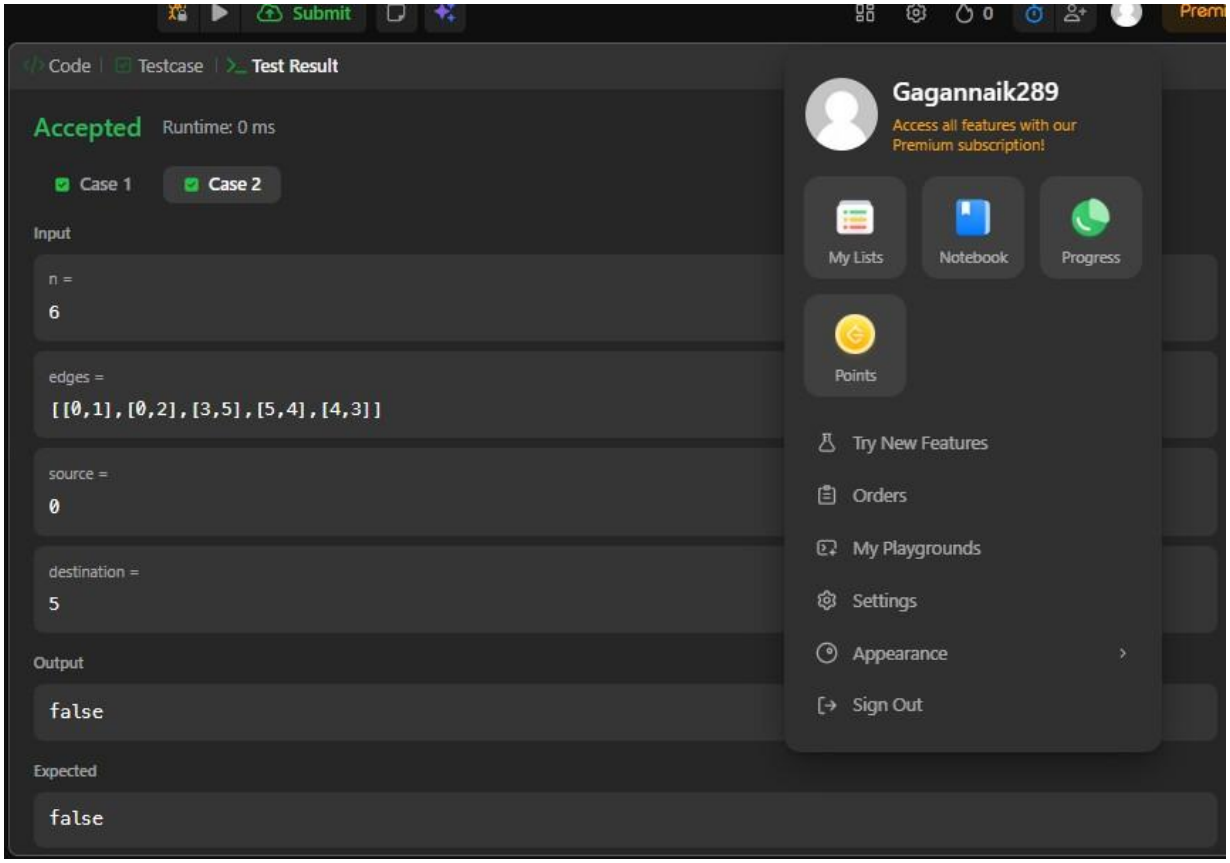


Input: n = 6, edges = [[0,1],[0,2],[3,5],[5,4],[4,3]], source = 0, destination = 5
Output: false
Explanation: There is no path from vertex 0 to vertex 5.

Constraints:

- `1 <= n <= 2 * 10 5`
- `0 <= edges.length <= 2 * 10 5`
- `edges[i].length == 2`
- `0 <= u i , v i <= n - 1`
- `u i != v i`
- `0 <= source, destination <= n - 1`
- There are no duplicate edges.
- There are no self edges.




Submit
Code
Testcase
Test Result
Accepted
Runtime: 0 ms
Case 1
Case 2
Input
n =
6
edges =
[[0,1],[0,2],[3,5],[5,4],[4,3]]
source =
0
destination =
5
Output
false
Expected
false
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My Lists
Notebook
Progress
Points
Try New Features
Orders
My Playgrounds
Settings
Appearance
Sign Out