



CL2001
Data Structures Lab

Lab 03
Linked list and types
of linked list

NATIONAL UNIVERSITY OF COMPUTER AND EMERGING SCIENCES

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Lab Content

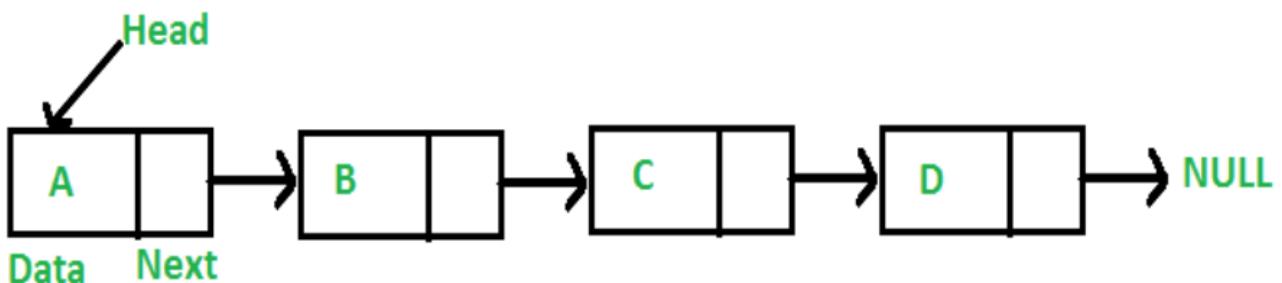
1. Linked List
2. Singly Linked List
3. Doubly Linked List
4. Circular Linked List

Linked List

Like arrays, Linked List is a linear data structure. Unlike arrays, linked list elements are not stored at a contiguous location; the elements are linked using pointers.

A singly linked list is a type of linked list where each element (node) consists of two parts:

- Data: This part of the node holds the actual value or data that you want to store in the list. It can be any data type, such as integers, characters, or custom data structures.
- Pointer to the Next Node: This part of the node contains a reference or pointer to the next node in the list. This pointer helps maintain the structure of the linked list and allows you to traverse the list in a unidirectional manner, usually from the head (the first node) to the last node. The last node typically points to NULL to indicate the end of the list.





Creating a Linked List: Node and Singly Class

```
class Node{
public:
int data;
Node * next;

Node(int val)
{
    data= val;
    next = NULL;
}

};

class Singly{
public:
Node * head; // the starting node of our List
Node * tail; //the Last node of our List
Singly()
{
    head = NULL;
    tail = NULL;
}
```

Adding Node to Linked List(Front,End and anywhere)

Adding a node to a linked list involves inserting an element, which consists of data and a reference to the next node, either at the front (beginning), the end (tail), or at any specified position within the list.



InsertionAtTail: Append

```
void insertAtTail(int val)
{
    Node * n= new Node(val);
    if(head == NULL)
    {
        head= n;
        return;
    }
    Node * temp = head;
    while( temp->next != tail)
    {
        temp = temp->next;
    }
    temp->next = n;
    n->next=tail;
    cout<<"Inserted"<<endl;

}
```



InsertAtStart: Append

```
void insertAtStart(int val)
{
    Node * n= new Node(val);
    n->next= head;
    head=n;
}
```

InsertAfter/Insert at any Position

```
void insertAfter(int pos, int val)
{
    Node * n= new Node(val);
    Node * curr;
    Node * pre;
    curr=head;
    for(int i=0;i<pos;i++)
    {
        pre=curr;
        curr=curr->next;
    }
    pre->next=n;
    n->next=curr;
}
```



Searching for a Key

```
bool Search(int key)

{
    Node * temp = head;
    while( temp!= NULL)
    {
        if( temp->data == key)
        {
            cout<<"\nFound"<<endl;
            return true;
        }
        temp = temp->next;

    }
    cout<<"\n Not Found"<<endl;
    return false;
}
```

Displaying the Linked List/Traversal

```
void Display()

{
    Node * temp = head;
    while( temp!= NULL)
    {
        cout<<temp->data<<" ";
        temp = temp->next;
    }
}
```



Removal of Nodes: Deletion

Performing a deletion operation on a linked list involves removing an element, either from the front (beginning), the end (tail), or from any specified position within the list, effectively altering the list's structure.

DeletionFromEnd

```
void deleteAtEnd()
{
    Node* temp = head;
    Node* pre;
//creating a previous pointer to reset temp
    while(temp->next!=NULL)
    {
        pre= temp;
// setting pre to hold temp
        temp=temp->next;
// moving the temp one position ahead
    }
    tail= pre;
//setting tail as the second last node
    tail->next= NULL;
// setting its next pointer to hold NULL
    delete temp;
// deleting the Last node.
}
```

DeletionFromStart

```
deleteAtFront()
{
    Node* temp = head;
    head=head->next;
    delete temp;
}
```



DeleteAfter/ Delete at any position

```
deleteAfter(int pos)
{
    Node* pre;
    Node* curr;
    curr = head;
    for(int i=1;i<pos;i++)
    {
        pre=curr;
        curr=curr->next;
    }
    pre->next=curr->next;
    delete curr;
}
```

Doubly Linked List:

A Doubly Linked List is a linear data structure similar to a singly linked list, but with an important difference: each node in a doubly linked list contains two pointers instead of one. It has a pointer to the next node as well as a pointer to the previous node. This bidirectional connectivity allows traversal in both forward and backward directions.

Creation of Doubly Linked List

```
class Node {
public:
    int data;
    Node* next;
    Node* prev;

    Node() : data(0), next(NULL), prev(NULL) {}

    Node(int val) : data(val), next(NULL), prev(NULL) {}
};

class DoublyLinkedList {
public:
    Node* head;
    Node* tail;
```



```
DoublyLinkedList() : head(NULL), tail(NULL) {}

void insertAtEnd(int val) {
    Node* newNode = new Node(val);

    if (tail == nullptr) {
        head = newNode;
        tail = newNode;
    } else {
        tail->next = newNode;
        newNode->prev = tail;
        tail = newNode;
    }
};
```

Circular Linked List and Helper Functions:

A Circular Linked List is a data structure in which elements, known as nodes, are connected in a circular fashion. Unlike a regular singly linked list, where the last node points to null, in a circular linked list, the last node points back to the first node, creating a loop.

Here's a list of common helper functions that are often implemented in a Circular Linked List:

Append: Add a new node to the end of the circular linked list.

Insert: Add a new node at a specific position in the circular linked list.

Delete: Remove a node with a given value from the circular linked list.

Search: Find a node with a specific value in the circular linked list.

Display: Print the elements of the circular linked list.

Reverse: Reverse the order of nodes in the circular linked list.



Creation of Circular Linked List

```
class Node{
public:
int data;
Node * next;
Node()
{
    data =0;
    next=NULL;
}
Node(int val)
{
    data=val;
    next = NULL;
}
};

class Circular{
public:
Node * head;
Node * tail;
void insertatend( int val)
{
    Node* n= new Node(val);
    if(head == NULL)
    {
        head=n;
        tail=n;
        tail->next=head;
    }
    tail->next=n;
    tail=tail->next;
    tail->next=head;
}
void insertATFront( int val)
{
    Node * n = new Node(val);
    tail->next= n;
    n->next=head;
    head=n;
}
```



LAB TASKS

Task # 01:

A university wants to maintain a dynamic list of students registering for a course. Each student has a roll number, name, and department.

Implement a singly linked list to store student data.

Write functions to:

1. Add a new student at the end of the list.
2. Delete a student by roll number.
3. Display all registered students.

Question: Implement the above scenario in C++.

Task # 02:

A **Bookstore** wants to maintain a list of books available in its store using a **singly linked list**. Each book record contains:

- **Book ID**
- **Book Title**
- **Author Name**

The system should support the following operations:

- Insert a new book at the beginning of the list.
- Insert a new book at the end of the list.
- Insert a new book at a specific position in the list (any point).
- Delete a book from the beginning of the list.
- Delete a book from the end of the list.
- Delete a book from a specific position in the list (any point).
- Search for a book by its ID and display its details.



Task # 03:

Solve the following problem using a Singly Linked List:

Given a Linked list of integers (input by user), write a function to modify the linked list such that all even numbers appear before all the odd numbers in the modified linked list. Also, keep the order of even and odd numbers same.

Examples:

Input: 17 -> 15 -> 8 -> 12 -> 10 -> 5 -> 4 -> 1 -> 7 -> 6 -> NULL

Output: 8 -> 12 -> 10 -> 4 -> 6 -> 17 -> 15 -> 5 -> 1 -> 7 -> NULL

Input: 8 -> 12 -> 10 -> 5 -> 4 -> 1 -> 6 -> NULL

Output: 8 -> 12 -> 10 -> 4 -> 6 -> 5 -> 1 -> NULL

- If all numbers are EVEN then do not change the list

Input: 8 -> 12 -> 10 -> NULL

Output: 8 -> 12 -> 10 -> NULL

- If all numbers are ODD then do not change the list

Input: 1 -> 3 -> 5 -> 7 -> NULL

Output: 1 -> 3 -> 5 -> 7 -> NULL



Task # 04:

A **text editor** stores each character of a word in a singly linked list, where each node contains a single character.

The editor needs to check whether the word entered by the user is a **Palindrome** (a string that reads the same forwards and backwards, e.g. madam, level).

Tasks:

1. Implement a singly linked list to store the characters of the word.
2. Write a function to check whether the linked list forms a palindrome.
3. Display an appropriate message:
 - If the word is a palindrome → display `true`
 - Otherwise → display `false`

Task # 05:

Create a **deque (double-ended queue)** using a doubly linked list.

Support the following operations:

- `insertFront(int x)`
- `insertRear(int x)`
- `deleteFront()`
- `deleteRear()`
- `getFront()` and `getRear()`

Demonstrate usage with test cases.



Task # 06:

Implement a function to merge two sorted singly linked lists into one sorted list.

Example:

- List A: 1 → 3 → 5
- List B: 2 → 4 → 6
- Output: 1 → 2 → 3 → 4 → 5 → 6

Bonus: Solve without creating new nodes (rearrange pointers).

Task # 07:

Implement functions for conversion:

- Convert a singly linked list into a doubly linked list.
- Convert a singly linked list into a circular linked list.
- Demonstrate both conversions with sample input lists.

Deliverables:

Submit the code file along with a Word file containing screenshots of the output for each task and a short explanation.