**Final Assignment**

**Single circular:**

**1: Forward & Reverse**

#include <iostream>

using namespace std;

// Node structure

struct Node {

int data;

Node\* next;

};

// Function to delete a node at a specific position in a circular linked list

void deleteNodeAtPosition(Node\*& head, int position) {

if (head == nullptr) { // List is empty

cout << "List is empty. Nothing to delete." << endl;

return;

}

// If the position is 0, delete the head node

if (position == 0) {

if (head->next == head) { // Only one node in the list

delete head;

head = nullptr;

} else {

Node\* last = head;

while (last->next != head) { // Find the last node

last = last->next;

}

Node\* temp = head;

head = head->next; // Move the head pointer

last->next = head; // Update the last node's next pointer

delete temp; // Delete the old head

}

return;

}

Node\* current = head;

Node\* previous = nullptr;

int count = 0;

// Traverse to the desired position

while (current->next != head && count < position) {

previous = current;

current = current->next;

count++;

}

// If position is out of bounds

if (current->next == head && count < position) {

cout << "Position out of bounds." << endl;

return;

}

// Delete the node

previous->next = current->next;

delete current;

}

// Function to insert a node at the end of the circular linked list

void insert(Node\*& head, int data) {

Node\* newNode = new Node{data, nullptr};

if (head == nullptr) {

head = newNode;

newNode->next = head;

return;

}

Node\* temp = head;

while (temp->next != head) {

temp = temp->next;

}

temp->next = newNode;

newNode->next = head;

}

// Function to display the circular linked list in forward traversal

void display(Node\* head) {

if (head == nullptr) {

cout << "List is empty." << endl;

return;

}

Node\* temp = head;

do {

cout << temp->data << " ";

temp = temp->next;

} while (temp != head);

cout << endl;

}

// Main function

int main() {

Node\* head = nullptr;

// Insert some nodes

insert(head, 10);

insert(head, 20);

insert(head, 30);

insert(head, 40);

cout << "Original list: ";

display(head);

// Delete node at position 2

deleteNodeAtPosition(head, 2);

cout << "After deleting node at position 2: ";

display(head);

// Delete node at position 0 (head node)

deleteNodeAtPosition(head, 0);

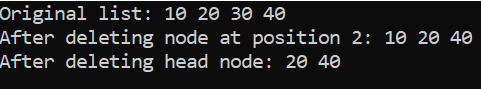
cout << "After deleting head node: ";

display(head);

return 0;

}

**Output:**

****

**Deletion at Start**

#include <iostream>

using namespace std;

// Node structure

struct Node {

int data;

Node\* next;

};

// Function to delete the first node of a circular linked list

void deleteFirstNode(Node\*& head) {

if (head == nullptr) { // List is empty

cout << "List is empty. Nothing to delete." << endl;

return;

}

if (head->next == head) { // Only one node in the list

delete head;

head = nullptr;

return;

}

// Find the last node in the list

Node\* last = head;

while (last->next != head) {

last = last->next;

}

// Point the last node to the second node

Node\* temp = head;

head = head->next;

last->next = head;

// Delete the first node

delete temp;

}

// Function to insert a node at the end of the circular linked list

void insert(Node\*& head, int data) {

Node\* newNode = new Node{data, nullptr}; // Using initializer list for node creation

if (head == nullptr) {

head = newNode;

newNode->next = head;

return;

}

Node\* temp = head;

while (temp->next != head) {

temp = temp->next;

}

temp->next = newNode;

newNode->next = head;

}

// Function to display the circular linked list

void display(Node\* head) {

if (head == nullptr) {

cout << "List is empty." << endl;

return;

}

Node\* temp = head;

do {

cout << temp->data << " ";

temp = temp->next;

} while (temp != head);

cout << endl;

}

// Main function

int main() {

Node\* head = nullptr;

// Insert some nodes

insert(head, 10);

insert(head, 20);

insert(head, 30);

insert(head, 40);

cout << "Original list: ";

display(head);

// Delete the first node

deleteFirstNode(head);

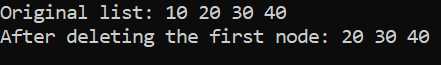
cout << "After deleting the first node: ";

display(head);

return 0;

}

**Output :**

****

**Delete at end :**

#include <iostream>

using namespace std;

// Node structure

struct Node {

int data;

Node\* next;

};

// Function to delete the last node of a circular linked list

void deleteLastNode(Node\*& head) {

if (head == nullptr) { // List is empty

cout << "List is empty. Nothing to delete." << endl;

return;

}

if (head->next == head) { // Only one node in the list

delete head;

head = nullptr;

return;

}

// Traverse the list to find the second last node

Node\* current = head;

while (current->next->next != head) {

current = current->next;

}

// Adjust pointers and delete the last node

Node\* last = current->next;

current->next = head;

delete last;

}

// Function to insert a node at the end of the circular linked list

void insert(Node\*& head, int data) {

Node\* newNode = new Node{data, nullptr}; // Using initializer list for cleaner code

if (head == nullptr) {

head = newNode;

newNode->next = head;

return;

}

Node\* temp = head;

while (temp->next != head) {

temp = temp->next;

}

temp->next = newNode;

newNode->next = head;

}

// Function to display the circular linked list

void display(Node\* head) {

if (head == nullptr) {

cout << "List is empty." << endl;

return;

}

Node\* temp = head;

do {

cout << temp->data << " ";

temp = temp->next;

} while (temp != head);

cout << endl;

}

// Main function

int main() {

Node\* head = nullptr;

// Insert some nodes

insert(head, 10);

insert(head, 20);

insert(head, 30);

insert(head, 40);

cout << "Original list: ";

display(head);

// Delete the last node

deleteLastNode(head);

cout << "After deleting the last node: ";

display(head);

return 0;

}

**Output :**

****

**Delete by value :**

#include <iostream>

using namespace std;

// Node structure

struct Node {

int data;

Node\* next;

};

// Function to delete a node by its value in a circular linked list

void deleteNodeByValue(Node\*& head, int value) {

if (head == nullptr) { // List is empty

cout << "List is empty. Nothing to delete." << endl;

return;

}

Node\* current = head;

Node\* previous = nullptr;

// Case 1: The node to be deleted is the only node in the list

if (head->data == value && head->next == head) {

delete head;

head = nullptr;

return;

}

// Case 2: The node to be deleted is the head node

if (head->data == value) {

// Find the last node

while (current->next != head) {

current = current->next;

}

Node\* temp = head;

head = head->next;

current->next = head;

delete temp;

return;

}

// Case 3: The node to be deleted is in the middle or end of the list

do {

previous = current;

current = current->next;

if (current->data == value) {

previous->next = current->next;

delete current;

return;

}

} while (current != head);

// If the value was not found

cout << "Value " << value << " not found in the list." << endl;

}

// Function to insert a node at the end of the circular linked list

void insert(Node\*& head, int data) {

Node\* newNode = new Node{data, nullptr}; // Using initializer list for cleaner code

if (head == nullptr) {

head = newNode;

newNode->next = head;

return;

}

Node\* temp = head;

while (temp->next != head) {

temp = temp->next;

}

temp->next = newNode;

newNode->next = head;

}

// Function to display the circular linked list

void display(Node\* head) {

if (head == nullptr) {

cout << "List is empty." << endl;

return;

}

Node\* temp = head;

do {

cout << temp->data << " ";

temp = temp->next;

} while (temp != head);

cout << endl;

}

// Main function

int main() {

Node\* head = nullptr;

// Insert some nodes

insert(head, 10);

insert(head, 20);

insert(head, 30);

insert(head, 40);

cout << "Original list: ";

display(head);

// Delete a node by value

deleteNodeByValue(head, 20);

cout << "After deleting node with value 20: ";

display(head);

// Try to delete a node not in the list

deleteNodeByValue(head, 50);

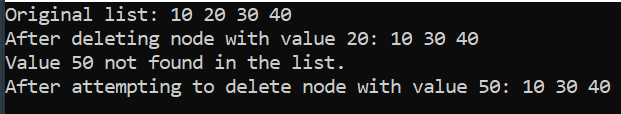
cout << "After attempting to delete node with value 50: ";

display(head);

return 0;

}

**Output :**

****

**Delete at Position :**

#include <iostream>

using namespace std;

// Node structure

struct Node {

int data;

Node\* next;

};

// Function to delete a node at a specific position in a circular linked list

void deleteNodeAtPosition(Node\*& head, int position) {

if (head == nullptr) { // List is empty

cout << "List is empty. Nothing to delete." << endl;

return;

}

// If the position is 0, delete the head node

if (position == 0) {

if (head->next == head) { // Only one node in the list

delete head;

head = nullptr;

} else {

Node\* last = head;

while (last->next != head) { // Find the last node

last = last->next;

}

Node\* temp = head;

head = head->next; // Move the head pointer

last->next = head; // Adjust the last node's next pointer

delete temp; // Delete the old head

}

return;

}

Node\* current = head;

Node\* previous = nullptr;

int count = 0;

// Traverse to the desired position

do {

if (count == position) break;

previous = current;

current = current->next;

count++;

} while (current != head);

// If position is out of bounds

if (count != position) {

cout << "Position out of bounds." << endl;

return;

}

// Delete the node

previous->next = current->next;

delete current;

}

// Function to insert a node at the end of the circular linked list

void insert(Node\*& head, int data) {

Node\* newNode = new Node{data, nullptr}; // Using initializer list

if (head == nullptr) {

head = newNode;

newNode->next = head;

return;

}

Node\* temp = head;

while (temp->next != head) {

temp = temp->next;

}

temp->next = newNode;

newNode->next = head;

}

// Function to display the circular linked list

void display(Node\* head) {

if (head == nullptr) {

cout << "List is empty." << endl;

return;

}

Node\* temp = head;

do {

cout << temp->data << " ";

temp = temp->next;

} while (temp != head);

cout << endl;

}

// Main function

int main() {

Node\* head = nullptr;

// Insert some nodes

insert(head, 10);

insert(head, 20);

insert(head, 30);

insert(head, 40);

cout << "Original list: ";

display(head);

// Delete node at position 2

deleteNodeAtPosition(head, 2);

cout << "After deleting node at position 2: ";

display(head);

// Try to delete node at an invalid position

deleteNodeAtPosition(head, 5);

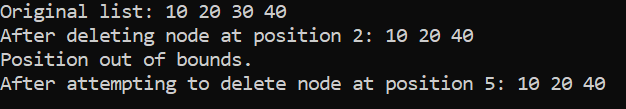
cout << "After attempting to delete node at position 5: ";

display(head);

return 0;

}

**Output :**



**Double :**

**Forward and Reverse :**

#include <iostream>

using namespace std;

// Define a Node of the doubly linked list

struct Node {

int data;

Node\* prev;

Node\* next;

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

};

// Function to perform forward traversal of the doubly linked list

void forwardTraversal(Node\* head) {

cout << "Forward Traversal: ";

for (Node\* temp = head; temp != nullptr; temp = temp->next) {

cout << temp->data << " ";

}

cout << endl;

}

// Function to perform reverse traversal of the doubly linked list

void reverseTraversal(Node\* head) {

if (!head) { // If the list is empty

cout << "Reverse Traversal: List is empty." << endl;

return;

}

// Move to the last node

Node\* temp = head;

while (temp->next) {

temp = temp->next;

}

// Traverse backward from the last node

cout << "Reverse Traversal: ";

for (; temp != nullptr; temp = temp->prev) {

cout << temp->data << " ";

}

cout << endl;

}

// Function to append a node to the end of the doubly linked list

void appendNode(Node\*& head, int data) {

Node\* newNode = new Node(data);

if (!head) { // If the list is empty

head = newNode;

return;

}

Node\* temp = head;

while (temp->next) {

temp = temp->next;

}

temp->next = newNode;

newNode->prev = temp;

}

// Function to delete a node at a specific position in the doubly linked list

void deleteNodeAtPosition(Node\*& head, int position) {

if (!head) { // If the list is empty

cout << "The list is empty." << endl;

return;

}

if (position <= 0) { // Invalid position

cout << "Invalid position. Position should be greater than 0." << endl;

return;

}

Node\* temp = head;

int currentIndex = 1;

// Traverse to the node at the specified position

while (temp && currentIndex < position) {

temp = temp->next;

currentIndex++;

}

if (!temp) { // Position exceeds the list size

cout << "Position " << position << " exceeds the list size." << endl;

return;

}

if (temp == head) { // Deleting the head node

head = head->next;

if (head) {

head->prev = nullptr;

}

} else if (!temp->next) { // Deleting the last node

temp->prev->next = nullptr;

} else { // Deleting a middle node

temp->prev->next = temp->next;

temp->next->prev = temp->prev;

}

delete temp; // Free the memory of the node

cout << "Node at position " << position << " deleted successfully." << endl;

}

// Main function to demonstrate forward and reverse traversal

int main() {

Node\* head = nullptr;

// Add nodes to the doubly linked list

appendNode(head, 10);

appendNode(head, 20);

appendNode(head, 30);

appendNode(head, 40);

// Perform forward and reverse traversal before deletion

forwardTraversal(head);

reverseTraversal(head);

// Delete a node at position 2

deleteNodeAtPosition(head, 2);

// Perform forward and reverse traversal after deletion

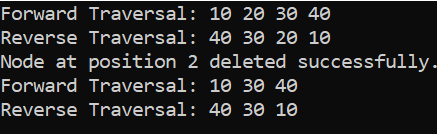
forwardTraversal(head);

reverseTraversal(head);

return 0;

}

**Output :**

****

**Delete at start :**

#include <iostream>

using namespace std;

// Define a Node of the doubly linked list

struct Node {

int data;

Node\* prev;

Node\* next;

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

};

// Function to delete the first node of a doubly linked list

void deleteFirstNode(Node\*& head) {

if (!head) { // If the list is empty

cout << "The list is already empty." << endl;

return;

}

Node\* temp = head; // Store the current head node

head = head->next; // Move the head pointer to the next node

if (head) { // If the list is not empty after deletion

head->prev = nullptr;

}

delete temp; // Free the memory of the old head node

cout << "First node deleted successfully." << endl;

}

// Function to display the doubly linked list

void displayList(Node\* head) {

if (!head) {

cout << "The list is empty." << endl;

return;

}

for (Node\* temp = head; temp != nullptr; temp = temp->next) {

cout << temp->data << " ";

}

cout << endl;

}

// Function to insert a node at the end of the doubly linked list

void appendNode(Node\*& head, int data) {

Node\* newNode = new Node(data);

if (!head) { // If the list is empty

head = newNode;

return;

}

Node\* temp = head;

while (temp->next) {

temp = temp->next;

}

temp->next = newNode;

newNode->prev = temp;

}

int main() {

Node\* head = nullptr;

// Add nodes to the doubly linked list

appendNode(head, 10);

appendNode(head, 20);

appendNode(head, 30);

cout << "Original list: ";

displayList(head);

// Delete the first node

deleteFirstNode(head);

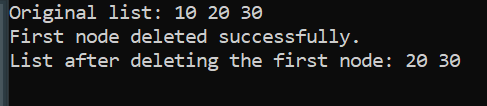
cout << "List after deleting the first node: ";

displayList(head);

return 0;

}

**Output :**

****

**Delete at start:**

#include <iostream>

using namespace std;

// Define a Node of the doubly linked list

struct Node {

int data;

Node\* prev;

Node\* next;

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

};

// Function to delete the last node of a doubly linked list

void deleteLastNode(Node\*& head) {

if (!head) { // If the list is empty

cout << "The list is already empty." << endl;

return;

}

if (!head->next) { // If the list has only one node

delete head;

head = nullptr;

cout << "Last node deleted successfully." << endl;

return;

}

Node\* temp = head;

// Traverse to the last node

while (temp->next) {

temp = temp->next;

}

// Update the previous node's next pointer

temp->prev->next = nullptr;

delete temp; // Free the memory of the last node

cout << "Last node deleted successfully." << endl;

}

// Function to display the doubly linked list

void displayList(Node\* head) {

if (!head) {

cout << "The list is empty." << endl;

return;

}

for (Node\* temp = head; temp != nullptr; temp = temp->next) {

cout << temp->data << " ";

}

cout << endl;

}

// Function to insert a node at the end of the doubly linked list

void appendNode(Node\*& head, int data) {

Node\* newNode = new Node(data);

if (!head) { // If the list is empty

head = newNode;

return;

}

Node\* temp = head;

while (temp->next) {

temp = temp->next;

}

temp->next = newNode;

newNode->prev = temp;

}

int main() {

Node\* head = nullptr;

// Add nodes to the doubly linked list

appendNode(head, 10);

appendNode(head, 20);

appendNode(head, 30);

cout << "Original list: ";

displayList(head);

// Delete the last node

deleteLastNode(head);

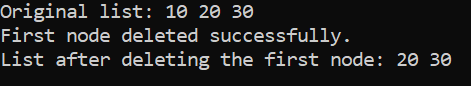
cout << "List after deleting the last node: ";

displayList(head);

return 0;

}

**Output :**

****

**Delete at last :**

#include <iostream>

using namespace std;

// Define a Node of the doubly linked list

struct Node {

int data;

Node\* prev;

Node\* next;

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

};

// Function to delete the last node of a doubly linked list

void deleteLastNode(Node\*& head) {

if (!head) { // If the list is empty

cout << "The list is already empty." << endl;

return;

}

if (!head->next) { // If the list has only one node

delete head;

head = nullptr;

cout << "Last node deleted successfully." << endl;

return;

}

Node\* temp = head;

// Traverse to the last node

while (temp->next) {

temp = temp->next;

}

// Update the previous node's next pointer

temp->prev->next = nullptr;

delete temp; // Free the memory of the last node

cout << "Last node deleted successfully." << endl;

}

// Function to display the doubly linked list

void displayList(Node\* head) {

if (!head) {

cout << "The list is empty." << endl;

return;

}

for (Node\* temp = head; temp != nullptr; temp = temp->next) {

cout << temp->data << " ";

}

cout << endl;

}

// Function to insert a node at the end of the doubly linked list

void appendNode(Node\*& head, int data) {

Node\* newNode = new Node(data);

if (!head) { // If the list is empty

head = newNode;

return;

}

Node\* temp = head;

while (temp->next) {

temp = temp->next;

}

temp->next = newNode;

newNode->prev = temp;

}

int main() {

Node\* head = nullptr;

// Add nodes to the doubly linked list

appendNode(head, 10);

appendNode(head, 20);

appendNode(head, 30);

cout << "Original list: ";

displayList(head);

// Delete the last node

deleteLastNode(head);

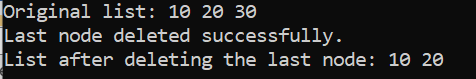
cout << "List after deleting the last node: ";

displayList(head);

return 0;

}

**Output**



**Delete at Position :**

#include <iostream>

using namespace std;

// Define a Node of the doubly linked list

struct Node {

int data;

Node\* prev;

Node\* next;

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

};

// Function to delete the last node of a doubly linked list

void deleteLastNode(Node\*& head) {

if (!head) { // If the list is empty

cout << "The list is already empty." << endl;

return;

}

if (!head->next) { // If the list has only one node

delete head;

head = nullptr;

cout << "Last node deleted successfully." << endl;

return;

}

Node\* temp = head;

// Traverse to the last node

while (temp->next) {

temp = temp->next;

}

// Update the previous node's next pointer

temp->prev->next = nullptr;

delete temp; // Free the memory of the last node

cout << "Last node deleted successfully." << endl;

}

// Function to display the doubly linked list

void displayList(Node\* head) {

if (!head) {

cout << "The list is empty." << endl;

return;

}

for (Node\* temp = head; temp != nullptr; temp = temp->next) {

cout << temp->data << " ";

}

cout << endl;

}

// Function to insert a node at the end of the doubly linked list

void appendNode(Node\*& head, int data) {

Node\* newNode = new Node(data);

if (!head) { // If the list is empty

head = newNode;

return;

}

Node\* temp = head;

while (temp->next) {

temp = temp->next;

}

temp->next = newNode;

newNode->prev = temp;

}

int main() {

Node\* head = nullptr;

// Add nodes to the doubly linked list

appendNode(head, 10);

appendNode(head, 20);

appendNode(head, 30);

cout << "Original list: ";

displayList(head);

// Delete the last node

deleteLastNode(head);

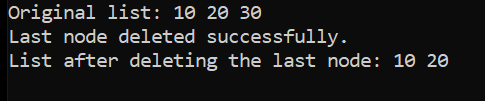
cout << "List after deleting the last node: ";

displayList(head);

return 0;

}

**Output :**

****

**Delete by Value :**

#include <iostream>

using namespace std;

// Define a Node of the doubly linked list

struct Node {

int data;

Node\* prev;

Node\* next;

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

};

// Function to delete a node by its value in a doubly linked list

void deleteNodeByValue(Node\*& head, int value) {

if (head == nullptr) { // If the list is empty

cout << "The list is empty." << endl;

return;

}

Node\* temp = head;

// Search for the node with the specified value

while (temp != nullptr && temp->data != value) {

temp = temp->next;

}

if (temp == nullptr) { // Value not found

cout << "Value " << value << " not found in the list." << endl;

return;

}

// Node with the value found

if (temp == head) { // If it's the head node

head = head->next;

if (head != nullptr) {

head->prev = nullptr;

}

} else if (temp->next == nullptr) { // If it's the last node

temp->prev->next = nullptr;

} else { // If it's a middle node

temp->prev->next = temp->next;

temp->next->prev = temp->prev;

}

delete temp; // Free the memory of the node

cout << "Node with value " << value << " deleted successfully." << endl;

}

// Function to display the doubly linked list

void displayList(Node\* head) {

Node\* temp = head;

while (temp != nullptr) {

cout << temp->data << " ";

temp = temp->next;

}

cout << endl;

}

// Function to insert a node at the end of the doubly linked list

void appendNode(Node\*& head, int data) {

Node\* newNode = new Node(data);

if (head == nullptr) { // If the list is empty

head = newNode;

return;

}

Node\* temp = head;

while (temp->next != nullptr) {

temp = temp->next;

}

temp->next = newNode;

newNode->prev = temp;

}

int main() {

Node\* head = nullptr;

// Add nodes to the doubly linked list

appendNode(head, 10);

appendNode(head, 20);

appendNode(head, 30);

appendNode(head, 40);

cout << "Original list: ";

displayList(head);

// Delete a node by value

deleteNodeByValue(head, 20);

cout << "List after deleting the node with value 20: ";

displayList(head);

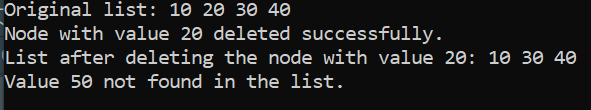
// Try deleting a non-existent value

deleteNodeByValue(head, 50);

return 0;

}

**Output :**

****

**Tree :**

**Count Nodes :**

#include <iostream>

using namespace std;

// Define a Node of the doubly linked list

struct Node {

int data;

Node\* prev;

Node\* next;

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

};

// Function to delete the last node of a doubly linked list

void deleteLastNode(Node\*& head) {

if (!head) { // If the list is empty

cout << "The list is already empty." << endl;

return;

}

if (!head->next) { // If the list has only one node

delete head;

head = nullptr;

cout << "Last node deleted successfully." << endl;

return;

}

Node\* temp = head;

// Traverse to the last node

while (temp->next) {

temp = temp->next;

}

// Update the previous node's next pointer

temp->prev->next = nullptr;

delete temp; // Free the memory of the last node

cout << "Last node deleted successfully." << endl;

}

// Function to display the doubly linked list

void displayList(Node\* head) {

if (!head) {

cout << "The list is empty." << endl;

return;

}

for (Node\* temp = head; temp != nullptr; temp = temp->next) {

cout << temp->data << " ";

}

cout << endl;

}

// Function to insert a node at the end of the doubly linked list

void appendNode(Node\*& head, int data) {

Node\* newNode = new Node(data);

if (!head) { // If the list is empty

head = newNode;

return;

}

Node\* temp = head;

while (temp->next) {

temp = temp->next;

}

temp->next = newNode;

newNode->prev = temp;

}

int main() {

Node\* head = nullptr;

// Add nodes to the doubly linked list

appendNode(head, 10);

appendNode(head, 20);

appendNode(head, 30);

cout << "Original list: ";

displayList(head);

// Delete the last node

deleteLastNode(head);

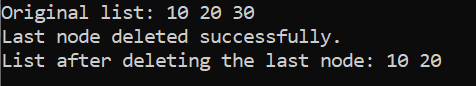
cout << "List after deleting the last node: ";

displayList(head);

return 0;

}

**Output :**

****

**Deletion**

#include <iostream>

using namespace std;

// Define a Node of the doubly linked list

struct Node {

int data;

Node\* prev;

Node\* next;

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

};

// Function to delete the last node of a doubly linked list

void deleteLastNode(Node\*& head) {

if (!head) { // If the list is empty

cout << "The list is already empty." << endl;

return;

}

if (!head->next) { // If the list has only one node

delete head;

head = nullptr;

cout << "Last node deleted successfully." << endl;

return;

}

Node\* temp = head;

// Traverse to the last node

while (temp->next) {

temp = temp->next;

}

// Update the previous node's next pointer

temp->prev->next = nullptr;

delete temp; // Free the memory of the last node

cout << "Last node deleted successfully." << endl;

}

// Function to display the doubly linked list

void displayList(Node\* head) {

if (!head) {

cout << "The list is empty." << endl;

return;

}

for (Node\* temp = head; temp != nullptr; temp = temp->next) {

cout << temp->data << " ";

}

cout << endl;

}

// Function to insert a node at the end of the doubly linked list

void appendNode(Node\*& head, int data) {

Node\* newNode = new Node(data);

if (!head) { // If the list is empty

head = newNode;

return;

}

Node\* temp = head;

while (temp->next) {

temp = temp->next;

}

temp->next = newNode;

newNode->prev = temp;

}

int main() {

Node\* head = nullptr;

// Add nodes to the doubly linked list

appendNode(head, 10);

appendNode(head, 20);

appendNode(head, 30);

cout << "Original list: ";

displayList(head);

// Delete the last node

deleteLastNode(head);

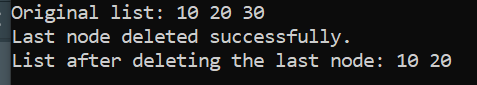
cout << "List after deleting the last node: ";

displayList(head);

return 0;

}

**Output :**

****

**Duplication :**

#include <iostream>

using namespace std;

// Node structure

struct Node {

int data;

Node\* left;

Node\* right;

Node(int val) : data(val), left(nullptr), right(nullptr) {}

};

// Function to insert a value (with duplicate check)

Node\* insert(Node\* root, int val) {

if (!root) {

return new Node(val);

}

if (val < root->data) {

root->left = insert(root->left, val);

} else if (val > root->data) {

root->right = insert(root->right, val);

} else {

cout << "Duplicate value " << val << " is not allowed." << endl;

}

return root;

}

// Main function to test duplication handling

int main() {

Node\* root = nullptr;

root = insert(root, 10);

root = insert(root, 5);

root = insert(root, 15);

root = insert(root, 3);

root = insert(root, 7);

root = insert(root, 12);

root = insert(root, 10); // Attempting to insert a duplicate value

root = insert(root, 18);

cout << "Insertion complete." << endl;

return 0;

}

**Output :**

****

**Inorder :**

#include <iostream>

using namespace std;

// Node structure

struct Node {

int data;

Node\* left;

Node\* right;

Node(int val) {

data = val;

left = NULL;

right = NULL;

}

};

void inorder(Node\* root) {

if (root == NULL) return;

inorder(root->left);

cout << root->data << " ";

inorder(root->right);

}

// Function to insert a new value

Node\* insert(Node\* root, int val) {

if (root == NULL) {

return new Node(val);

}

if (val < root->data) {

root->left = insert(root->left, val);

} else if (val > root->data) {

root->right = insert(root->right, val);

}

return root;

}

// Main function to test insertion

int main() {

Node\* root = NULL;

root = insert(root, 10);

root = insert(root, 5);

root = insert(root, 15);

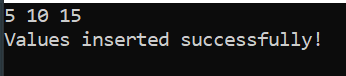
inorder(root);

cout << "\nValues inserted successfully!" << endl;

return 0;

}

**Output :**

****

**Searching :**

#include <iostream>

using namespace std;

// Node structure

struct Node {

int data;

Node\* left;

Node\* right;

Node(int val) : data(val), left(nullptr), right(nullptr) {}

};

// Function to search for a value

bool search(Node\* root, int key) {

if (!root) return false;

if (root->data == key) return true;

if (key < root->data) {

return search(root->left, key);

} else {

return search(root->right, key);

}

}

// Main function to test searching

int main() {

Node\* root = new Node(10);

root->left = new Node(5);

root->right = new Node(15);

int searchKey = 5;

if (search(root, searchKey)) {

cout << "Value " << searchKey << " is present in the tree." << endl;

} else {

cout << "Value " << searchKey << " is not present in the tree." << endl;

}

return 0;

}

**Output :**

****

**Traversing :**

#include <iostream>

using namespace std;

// Node structure

struct Node {

int data;

Node\* left;

Node\* right;

Node(int val) : data(val), left(nullptr), right(nullptr) {}

};

// Traversal functions

void inorder(Node\* root) {

if (!root) return;

inorder(root->left);

cout << root->data << " ";

inorder(root->right);

}

void preorder(Node\* root) {

if (!root) return;

cout << root->data << " ";

preorder(root->left);

preorder(root->right);

}

void postorder(Node\* root) {

if (!root) return;

postorder(root->left);

postorder(root->right);

cout << root->data << " ";

}

// Main function to test traversals

int main() {

Node\* root = new Node(10);

root->left = new Node(5);

root->right = new Node(15);

root->left->left = new Node(3);

root->left->right = new Node(7);

root->right->left = new Node(12);

root->right->right = new Node(18);

cout << "In-order Traversal: ";

inorder(root);

cout << endl;

cout << "Pre-order Traversal: ";

preorder(root);

cout << endl;

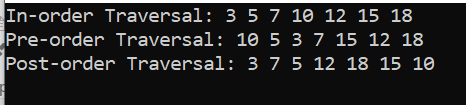
cout << "Post-order Traversal: ";

postorder(root);

cout << endl;

return 0;

}

**Output :  
**