EXPERIMENT - 6

Data Structures

Aim

Create a Doubly linked list and perform following operations: Insertion at front and Deletion at end.

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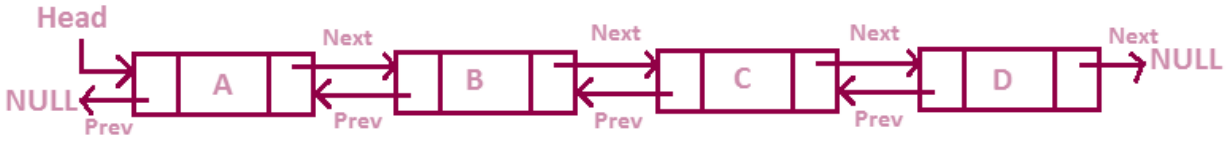
THEORY

A Doubly Linked List (DLL) contains an extra pointer, typically called previous pointer, together with next pointer and data which are there in singly linked list.



Advantages over singly linked list

1. A DLL can be traversed in both forward and backward direction.
2. The delete operation in DLL is more efficient if pointer to the node to be deleted is given.
3. We can quickly insert a new node before a given node.
4. In singly linked list, to delete a node, pointer to the previous node is needed. To get this previous node, sometimes the list is traversed.
5. In DLL, we can get the previous node using previous pointer.

Disadvantages over singly linked list

1. Every node of DLL Require extra space for an previous pointer. It is possible to implement DLL with single pointer though (See this and this).
2. All operations require an extra pointer previous to be maintained. For example, in insertion, we need to modify previous pointers together with next pointers. For example in following functions for insertions at different positions, we need 1 or 2 extra steps to set previous pointer.

INSERTION IN THE BEGINNING

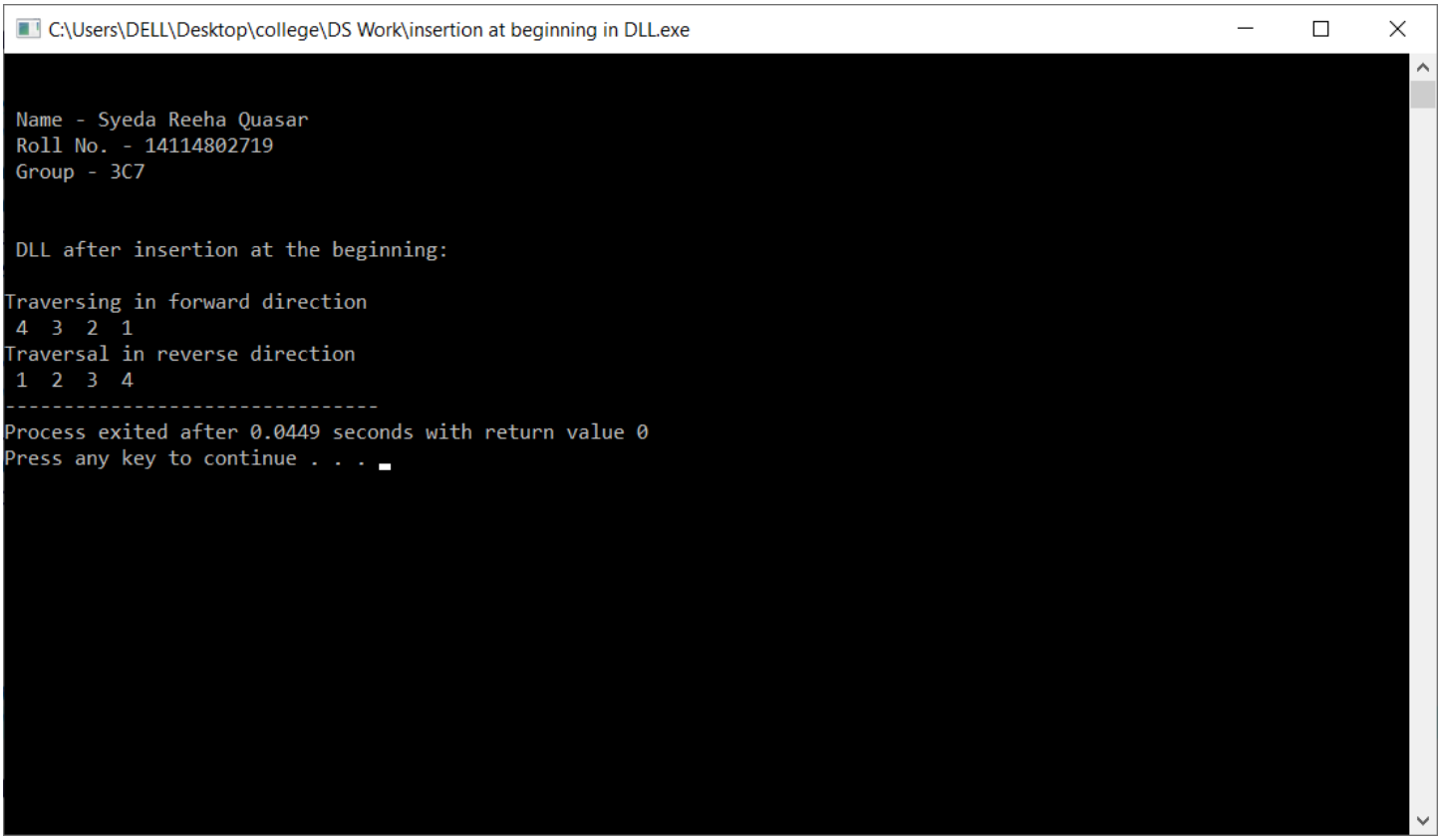
Source code:

```
// insertion in the beginning doubly linked list


//required libraries
#include <stdio.h>
#include <stdlib.h>


// doubly linked list declaration
struct Node {
   int data;
   struct Node* next; // Pointer to next node
   struct Node* prev; // Pointer to previous node
};


//function for insertion at the beginning
void insertAtBeginning(struct Node** head_ref, int newHeadData)
{
   struct Node* new_node = (struct Node*)malloc(sizeof(struct Node)); // new node

   // assigning value to the new node and assigning values to its pointers
   new_node->data = newHeadData; //storing given data into new node
   new_node->next = (*head_ref); //dll next of node to head
   new_node->prev = NULL;  // making new node head by pointing previous node to null

   if ((*head_ref) != NULL) // checking if head is present or not
      (*head_ref)->prev = new_node; // changing poiter of headnode from null to new node

   (*head_ref) = new_node; // changing head to new node
}
```

```
// printing the DLL
void printList(struct Node* node)
{
   struct Node* last;  // declaring a new node for reverse traversal

   // traversal in forward direction
   printf("\nTraversing in forward direction \n");
   while (node != NULL) {
      printf(" %d ", node->data);
      last = node;
      node = node->next;
   }

         //traversal in reverse direction
   printf("\nTraversal in reverse direction \n");
   while (last != NULL) {
      printf(" %d ", last->data);
      last = last->prev;
   }
}

int main()
{
         // my info
         printf("\n\n Name - Syeda Reeha Quasar \n Roll No. - 14114802719 \n Group - 3C7 \n\n");

         struct Node* head = NULL; // declaring head as null

         // all these elements are inserted in the beginning
```

```
    insertAtBeginning(&head, 1); //inserting 1
    insertAtBeginning(&head, 2); //inserting 2
    insertAtBeginning(&head, 3); //inserting 3
    insertAtBeginning(&head, 4); //inserting 4

    printf("\n DLL after insertion at the beginning: \n");
    printList(head); // printing DLL

    return 0;
}
```

OUTPUT



Deletion from the end

Source code:

```
// deletion from the end doubly linked list


//required libraries
#include <stdio.h>
#include <stdlib.h>


// doubly linked list declaration
struct Node {
    int data;
    struct Node* next; // Pointer to next node
    struct Node* prev; // Pointer to previous node
};


//function for insertion at the beginning
void insertAtBeginning(struct Node** head_ref, int newHeadData)
{
    struct Node* new_node = (struct Node*)malloc(sizeof(struct Node)); // new node

    // assigning value to the new node and assigning values to its pointers
    new_node->data = newHeadData; //storing given data into new node
    new_node->next = (*head_ref); //dll next of node to head
    new_node->prev = NULL;  // making new node head by pointing previous node to null

    if ((*head_ref) != NULL) // checking if head is present or not
        (*head_ref)->prev = new_node; // changing poiter of headnode from null to new node

    (*head_ref) = new_node; // changing head to new node
```

```
}

void deletionAtEnd(struct Node* node)
{
        //traversing the list to find second lastnode
   while (node -> next -> next != NULL) {
      node = node->next;
   }

   node -> next = NULL; // changing second last node pointer to null
}

// printing the DLL
void printList(struct Node* node)
{
   struct Node* last;  // declaring a new node for reverse traversal

   // traversal in forward direction
   printf("\nTraversing in forward direction \n");
   while (node != NULL) {
      printf(" %d ", node->data);
      last = node;
      node = node->next;
   }

        //traversal in reverse direction
   printf("\nTraversal in reverse direction \n");
   while (last != NULL) {
      printf(" %d ", last->data);
      last = last->prev;
```

```
    }
}

int main()
{
        // my info
        printf("\n\n Name - Syeda Reeha Quasar \n Roll No. - 14114802719 \n Group - 3C7 \n\n");

        struct Node* head = NULL; // declaring head as null

        // all these elements are inserted in the beginning
        insertAtBeginning(&head, 1); //inserting 1
        insertAtBeginning(&head, 2); //inserting 2
        insertAtBeginning(&head, 3); //inserting 3
        insertAtBeginning(&head, 4); //inserting 4

        printf("\n DLL before dletion: \n");
        printList(head); // printing DLL

        printf("\n\n\n\n DLL after deletion from the end: \n");
        deletionAtEnd(head);
        printList(head); // printing DLL

        return 0;
}
```

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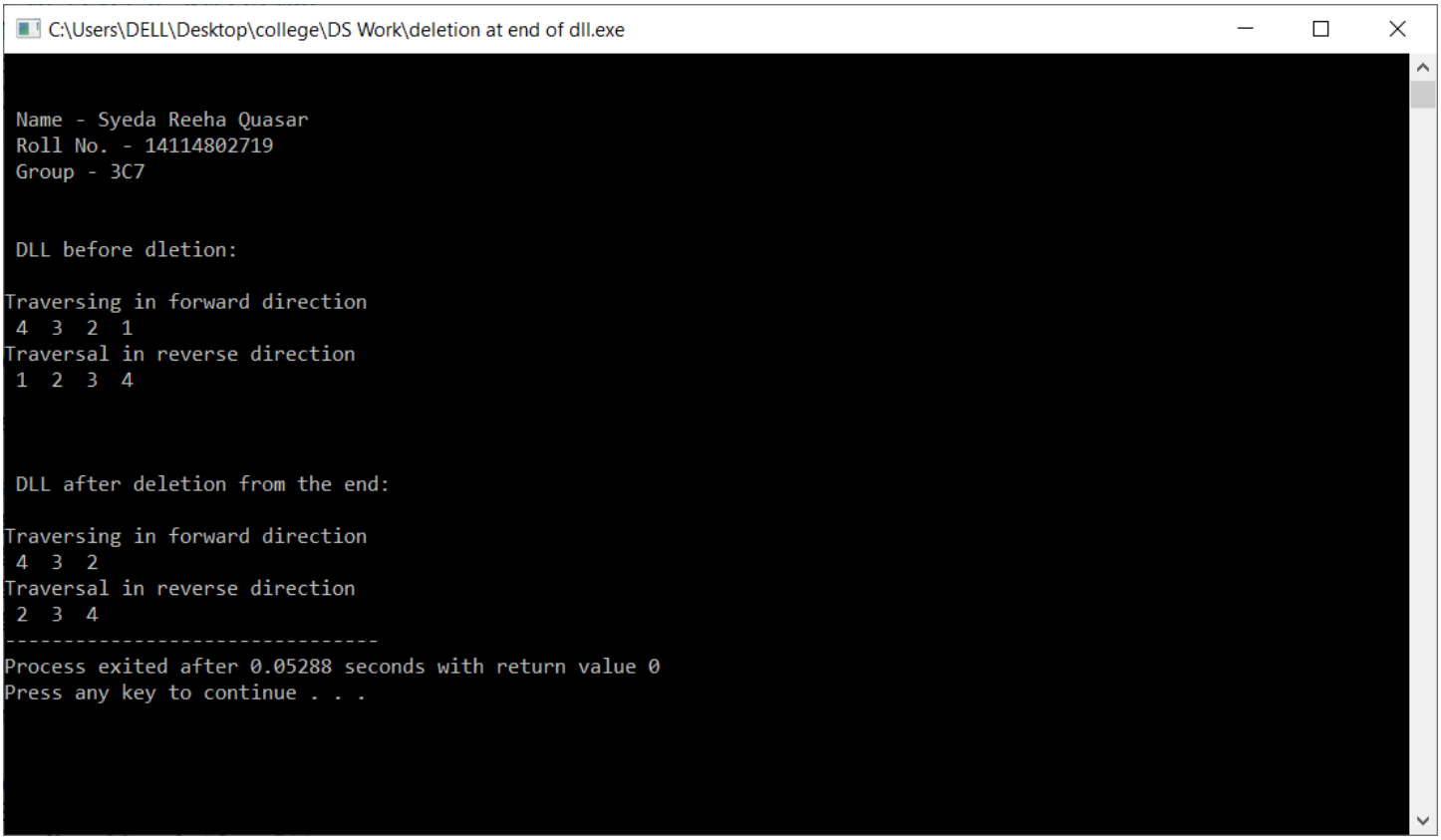
OUTPUT



Viva Questions

Q1. What is a memory efficient doubly linked list?

Ans.

A memory efficient version of Doubly Linked List can be created using only one space for address field with every node. This memory efficient Doubly Linked List is called XOR Linked List or Memory Efficient as the list uses bitwise XOR operation to save space for one address.

Q2. What is the advantage of doubly linked list?

Ans.

Advantages of Doubly Linked List. A DLL can be traversed in both forward and backward direction. The delete operation in DLL is more efficient if pointer to the node to be deleted is given. We can quickly insert a new node before a given node.

Q3. Why is a doubly linked list more useful than a singly linked list?

Ans.

1. A DLL can be traversed in both forward and backward direction.
2. The delete operation in DLL is more efficient if pointer to the node to be deleted is given.
3. We can quickly insert a new node before a given node

Q4. What is the difference between LinkedList and doubly linked list?

Ans.

The main difference between singly linked list and doubly linked list is the ability to traverse. On the other hand doubly linked list maintains two pointers, towards next and previous node, which allows you to navigate in both direction in any linked list.

Sr. No.	Key	Singly linked list	Doubly linked list
1	Complexity	In singly linked list the complexity of insertion and deletion at a known position is O(n)	In case od doubly linked list the complexity of insertion and deletion at a known position is O(1)
2	Internal implementation	In singly linked list implementation is such as where the node contains some data and a pointer to the next node in the list	While doubly linked list has some more complex implementation where the node contains some data and a pointer to the next as well as the previous node in the list
3	Order of elements	Singly linked list allows traversal elements only in one way.	Doubly linked list allows element two way traversal.
4	Usage	Singly linked list are generally used for implementation of stacks	On other hand doubly linked list can be used to implement stacks as well as heaps and binary trees.
5	Index performance	Singly linked list is preferred when we need to save memory and searching is not required as pointer of single index is stored.	If we need better performance while searching and memory is not a limitation in this case doubly linked list is more preferred.
6	Memory consumption	As singly linked list store pointer of only one node so consumes lesser memory.	On other hand Doubly linked list uses more memory per node(two pointers).