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Experiment No. : 2

Grade: AA / AB / BB / BC / CC / CD /DD

Title: Implementation of different operations on Linked List – creation, insertion, deletion, traversal, searching an element

Objective: To understand the advantage of linked list over other structures like arrays in implementing the general linear list

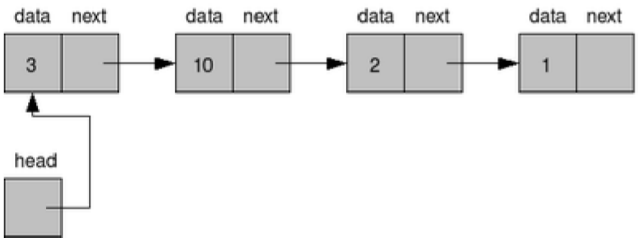
Expected Outcome of Experiment:

CO	Outcome
CO 1	To understand the advantage of linked list over other structures like arrays in implementing the general linear list

Books/ Journals/ Websites referred:

Introduction:

A linear list is a list where each element has a unique successor. There are four common operations associated with linear list: insertion, deletion, retrieval, and traversal. Linear list can be divided into two categories: general list and restricted list. In general list the data can be inserted or deleted without any restriction whereas in restricted list there is restrictions for these operations. Linked list and arrays are commonly used to implement general linear list. A linked list is simply a chain of structures which contain a pointer to the next element. It is dynamic in nature. Items may be added to it or deleted from it at will.



A list item has a pointer to the next element, or to NULL if the current element is the tail (end of the list). This pointer points to a structure of the same type as itself. This Structure that contains elements and pointers to the next structure is called a Node.

Related Theory: -

In computer science, a linked list is a linear collection of data elements, whose order is not given by their physical placement in memory. Instead, each element points to the next. It is a data structure consisting of a collection of nodes which together represent a sequence. In its most basic form, each node contains: data, and a reference to the next node in the sequence. This structure allows for efficient insertion or removal of elements from any position in the sequence during iteration.

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

Linked List ADT:

Linked List is an *Abstract Data Type (ADT)* that holds a collection of **Nodes,** the nodes can be accessed in a sequential way. Linked List doesn't provide a random access to a Node.

Usually, those Nodes are connected to the next node and/or with the previous one, this gives the linked effect. When the Nodes are connected with only the next pointer the list is called Singly Linked List and when it's connected by the next and previous the list is called Doubly Linked List.

Value definition:

Abstract Typedef linked_list/node<<int number, struct linked_list *next>>

Condition: None

Operator Definition

1. Abstract void beginsert<< >>
   Pre-condition: none
   Post-condition: New node of linked list are linked with it's next node; and tail as ptr thus, successively creating circular linked lists. Takes head node as the argument

2. Abstract void lastinsert<< >>

   Pre-condition: none

   Post-condition: Node of linked list are linked with it's tail as ptr thus and tail to its head

3. Abstract linked_list/node begin_delete<< >>

   Pre-condition: None

Post-condition: The function then deletes the node aptly at the beginning.

4. Abstract linked_list/node last_delete<< >>

   Pre-condition: None

Post-condition: The function then deletes the node aptly at the ending.

5. Abstract void display<< >>

   Pre-condition: The next node for tail node must point to head

   Post-condition: All nodes of the linked list is printed from head to tail; demonstrating that the linked list previously created is indeed, circualr linked

6. Abstract linked_list/node searching<<node *head>>

   Pre-condition: None

   Post-condition: Requests the user to enter the value of the data stored at a particular node which is to be searched. The function then searches the linked list to find the data. Returns the index of the node where the data is stored.

Algorithm for creation, insertion, deletion, traversal and searching an element in assigned linked list type:

Insertion Operation

beginsert(): Begin
create a new node node
-> data := data if the
list is empty, then head
:= node next of node =
head else temp := head
while next of temp is not head, do
temp := next of temp done next of
node := head next of temp := node
head := node end if
End

Deletion Operation

deleteFirst(): Begin
if head is null, then it is
Underflow and return else if
next of head = head, then head
:= null deallocate head else ptr
:= head
while next of ptr is not head, do

ptr := next of ptr next of
ptr = next of head
deallocate head head :=
next of ptr end if
End

Display List Operation

display(): Begin
if head is null, then Nothing to
print and return else ptr := head
while next of ptr is not head, do
display data of ptr ptr := next
of ptr display data of ptr end if
End

Searching:

Step 1: SET PTR = HEAD
Step 2: Set I = 0
STEP 3: IF PTR = NULL WRITE
"EMPTY LIST"
GOTO STEP 8
END OF IF

STEP 4: REPEAT STEP 5 TO 7 UNTIL PTR != NULL STEP 5: if ptr → data = item
write i+1 End of IF

STEP 6: I = I + 1
STEP 7: PTR = PTR → NEXT
[END OF LOOP]
STEP 8: EXIT

Implementation of an application using linked lists:

```
#include <stdio.h>
#include <stdlib.h>
struct node
{
   int value;
   struct node *hash;
};

struct node *list;

void insertBeg(int x)
{
   struct node *ptr = (struct node *)malloc(sizeof(struct node));
   ptr->value = x;
   ptr->hash = list;
   list = ptr;
}

void deleteBeg()
{
   if (list == NULL)
      printf("The list is empty!\n");
   else
   {
      struct node *ptr = list;
      list = ptr->hash;
      free(ptr);
   }
}

void insertEnd(int x)
{
   struct node *ptr = (struct node *)malloc(sizeof(struct node));
   ptr->value = x;
   ptr->hash = NULL;
   struct node *i = list;
   if (i == NULL)
      list = ptr;
   else
```

```
    {
        while (i->hash != NULL)
            i = i->hash;
        i->hash = ptr;
    }
}

void deleteEnd()
{
    if (list == NULL)
        printf("The list is empty!\n");
    else
    {
        struct node *i = list;
        struct node *j = i;
        while (i->hash != NULL)
        {
            j = i;
            i = i->hash;
        }
        j->hash = NULL;
        free(i);
    }
}

void insertAt(int x, int pos)
{
    if (list == NULL || pos == 0)
        insertBeg(x);
    else
    {
        struct node *ptr = (struct node *)malloc(sizeof(struct node));
        ptr->value = x;
        ptr->hash = NULL;
        struct node *i = list->hash;
        struct node *j = list;
        int counter = 0;
        while (i != NULL)
        {
            if (++counter == pos)
```

```
            {
                j->hash = ptr;
                ptr->hash = i;
                break;
            }
            j = i;
            i = i->hash;
        }
    }
}

void deleteAt(int pos)
{
    if (list == NULL)
        printf("The list is empty!\n");
    else if (pos == 0)
        deleteBeg();
    else
    {
        struct node *i = list->hash;
        struct node *j = list;
        int counter = 0;
        while (i != NULL)
        {
            if (++counter == pos)
            {
                j->hash = i->hash;
                free(i);
                break;
            }
            j = i;
            i = i->hash;
        }
    }
}

void printList()
{
    if (list == NULL)
        printf("The list is empty!\n");
```

```
    else
    {
        struct node *i = list;
        printf("\n\nThe list Elements are :\n");
        while (i != NULL)
        {
            printf("%d", i->value);
            i = i->hash;
            if (i != NULL)
                printf(" -> ");
        }
    }
}

void searchList(int x)
{
    if (list == NULL)
        printf("The list is empty!\n");
    else
    {
        struct node *i = list;
        int pos = 0;
        while (i != NULL)
        {
            if (i->value == x)
            {
                printf("Element found at pos: %d\n", pos);
                pos = -1;
                break;
            }
            i = i->hash;
            pos++;
        }
        if (pos != -1)
            printf("Element Not Found!\n");
    }
}

int main()
{
```

```
int t = 0;
while (t != 11)
{
    printf("\nSelect a function\n");
    printf("(1) Print List\n");
    printf("(2) Insert at Beginning\n");
    printf("(3) Delete Beginning\n");
    printf("(4) Insert at End\n");
    printf("(5) Delete End\n");
    printf("(6) Insert at position\n");
    printf("(7) Insert after position\n");
    printf("(8) Delete at position\n");
    printf("(9) Delete after position\n");
    printf("(10) Search Element\n");
    printf("(11) Exit\n");
    scanf("%d", &t);
    if (t == 1)
        printList();
    else if (t == 2)
    {
        int x;
        printf("Enter element to insert : ");
        scanf("%d", &x);
        insertBeg(x);
    }
    else if (t == 3)
        deleteBeg();
    else if (t == 4)
    {
        int x;
        printf("Enter element to insert : ");
        scanf("%d", &x);
        insertEnd(x);
    }
    else if (t == 5)
        deleteEnd();
    else if (t == 6)
    {
        int x, pos;
        printf("Enter element to insert : ");
```

```
        scanf("%d", &x);
        printf("Enter element position : ");
        scanf("%d", &pos);
        insertAt(x, pos);
    }
    else if (t == 7)
    {
        int x, pos;
        printf("Enter element to insert : ");
        scanf("%d", &x);
        printf("Enter position to insert after: ");
        scanf("%d", &pos);
        insertAt(x, pos + 1);
    }
    else if (t == 8)
    {
        int pos;
        printf("Enter position to delete: ");
        scanf("%d", &pos);
        deleteAt(pos);
    }
    else if (t == 9)
    {
        int pos;
        printf("Enter position to delete after: ");
        scanf("%d", &pos);
        deleteAt(pos + 1);
    }
    else if (t == 10)
    {
        int x;
        printf("Enter element to search: ");
        scanf("%d", &x);
        searchList(x);
    }
    else if (t == 11)
        break;
    else
        printf("Wrong entry!\n");
}
```

```
    return 0;
}
```

Conclusion:-

We have successfully understood algorithm for creation, traversal, insertion, deletion and searching an element in linked list. Written code for application of linked list.

Post lab questions:

1. **Write the differences between linked list and linear array**

Linear Array	Linked List
An array is a collection of elements of a similar data type.	A linked list is a collection of objects known as a node where node consists of two parts, i.e., data and address.
Array works with a static memory. Here static memory means that the memory size is fixed and cannot be changed at the run time.	The Linked list works with dynamic memory. Here, dynamic memory means that the memory size can be changed at the run time according to our requirements.
Array takes more time while performing any operation like insertion, deletion, etc.	Linked list takes less time while performing any operation like insertion, deletion, etc.
In the case of an array, memory is allocated at compile-time.	In the case of a linked list, memory is allocated at run time.
Memory utilization is inefficient in an array	Memory utilization is efficient when it comes to linked lists

2. **Name some applications which uses linked list.**

The Applications are as follows:

- Implementation of stacks and queues.
- Implementation of graphs: Adjacency list representation of graphs is most popular which is uses a linked list to store adjacent vertices.
- Dynamic memory allocation: We use a linked list of free blocks.
- Maintaining a directory of names.
- Image viewer – Previous and next images are linked, hence can be accessed by next and previous button.
- Useful for implementation of a queue. We can maintain a pointer to the last inserted node and the front can always be obtained as next of last