Experiment No. 6: Singly Linked List Operations

Aim: Implementation of Singly Linked List

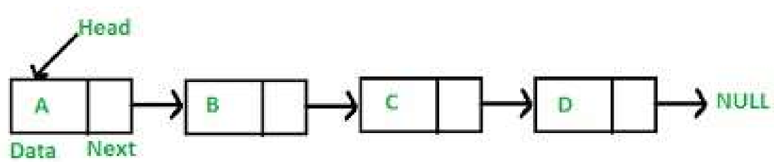
Objective:

It is used to implement stacks and queues which are like fundamental needs throughout computer science. To prevent the collision between the data in the hash map, we use a singly linked list.

Theory:

A linked list is an ordered collection of elements, known as nodes. Each node has two fields: one for data (information) and another to store the address of the next element in the list. The address field of the last node is null, indicating the end of the list. Unlike arrays, linked list elements are not stored in contiguous memory locations; instead, they are connected by explicit links, allowing for dynamic and non-contiguous memory allocation.

The structure of linked list is as shown below



Header is a node containing null in its information field and an next address field contains the address of the first data node in the list. Various operations can be performed on singly linked lists like insertion at front, end, after a given node, before a given node deletion at front, at end and after a given node.

Algorithm : Algorithm to insert a new node at the beginning

Step 1: IF AVAIL = NULL

Write OVERFLOW

Go to Step 7 [END OF IF]

Step 2: SET NEW_NODE = AVAIL

Step 3: SET AVAIL = AVAIL NEXT

Step 4: SET DATA = VAL

Step 5: SET NEW_NODE -->NEXT = START

Step 6: SET START = NEW_NODE

Step 7: EXIT

Algorithm to insert a new node at the end

Step 1: IF AVAIL = NULL

Write OVERFLOW

Go to Step 1 [END OF IF]

Step 2: SET = AVAIL

Step 3: SET AVAIL = AVAIL NEXT

Step 4: SET DATA = VAL

Step 5: SET NEW_NODE = NULL

Step 6: SET PTR = START

Step 7: Repeat Step 8 while PTR NEXT != NULL

Step 8: SET PTR = PTR NEXT [END OF LOOP]

Step 9: SET PTR--> NEXT = New_Node

Step 10: EXIT

Algorithm to insert a new node after a node that has value NUM

Step 1: IF AVAIL = NULL

Write OVERFLOW

Go to Step 12 [END OF IF]

Step 2: SET = AVAIL

Step 3: SET AVAIL = AVAIL-->NEXT

Step 4: SET DATA = VAL

Step 5: SET PTR = START

Step 6: SET PREPTR = PTR

Step 7: Repeat Steps 8 and 9 while != NUM

Step 8: SET PREPTR = PTR

Step 9: SET PTR = PTR -->NEXT [END OF LOOP]

Step 10 : PREPTR--> NEXT = NEW_NODE

Step 11: SET NEW_NODE NEXT = PTR

Step 12: EXIT

Algorithm to insert a new node before a node that has value NUM

Step 1: IF AVAIL = NULL

Write OVERFLOW

Go to Step 12 [END OF IF]

Step 2: SET = AVAIL

Step 3: SET AVAIL = AVAIL-->NEXT

Step 4: SET DATA = VAL

Step 5: SET PTR = START

Step 6: SET PREPTR = PTR

Step 7: Repeat Steps 8 and 9 while PTR DATA != NUM

Step 8: SET PREPTR = PTR

Step 9: SET PTR = PTR -->NEXT [END OF LOOP]

Step 10: PREPTR-->NEXT = NEW_NODE

Step 11: SET NEXT = PTR

Step 12: EXIT

Algorithm to delete the first node

Step 1: IF START = NULL

Write UNDERFLOW

Go to Step 5 [END OF IF]

Step 2: SET PTR = START

Step 3: SET START = START -->NEXT

Step 4: FREE PTR

Step 5: EXIT

Algorithm to delete the last node

Step 1: IF START = NULL

Write UNDERFLOW

Go to Step 8 [END OF IF]

Step 2: SET PTR = START

Step 3: Repeat Steps 4 and 5 while PTR NEXT != NULL

Step 4: SET PREPTR = PTR

Step 5: SET PTR = PTR -->NEXT [END OF LOOP]

Step 6: SET PREPTR-->NEXT = NULL

Step 7: FREE PTR

Step 8: EXIT

Algorithm to delete the node after a given node

Step 1: IF START = NULL

Write UNDERFLOW

Go to Step 1 [END OF IF]

Step 2: SET PTR = START

Step 3: SET PREPTR = PTR

Step 4: Repeat Steps 5 and 6 while PREPTR DATA != NUM

Step 5: SET PREPTR = PTR

Step 6: SET PTR = PTR--> NEXT [END OF LOOP]

Step 7: SET TEMP = PTR

Step 8: SET PREPTR -->NEXT = PTR--> NEXT

Step 9: FREE TEMP

Step 10: EXIT

Code:

```
#include <stdio.h>
#include <stdlib.h>
#include <conio.h>
#include <malloc.h>
struct node {
int data;
struct node *next;
};
```

```
struct node *start = NULL;
struct node *create_ll(struct node *);
struct node *display(struct node *);
struct node *insert_beg(struct node *);
struct node *insert_end(struct node *);
struct node *insert_after(struct node *);
struct node *delete_end(struct node *);
struct node *delete_node(struct node *);
struct node *delete_after(struct node *);
struct node *delete_list(struct node *);
struct node *sort_list(struct node *);
int main(int argc, char *argv[]) {
int option;
do {
printf("\n\n *****MAIN MENU *****");
printf("\n 1: Create a list");
printf("\n 2: Display the list");
printf("\n 3: Add a node at the beginning");
printf("\n 4: Add a node at the end");
printf("\n 5: Add a node before a given node");
printf("\n 6: Add a node after a given node");
printf("\n 7: Delete a node from the beginning");
printf("\n 8: Delete a node from the end");
printf("\n 9: Delete a given node");
printf("\n 10: Delete a node after a given node");
printf("\n 11: Delete the entire list");
```

```
printf("\n 12: Sort the list");
printf("\n 13: EXIT");
printf("\n\n Enter your option : ");
scanf("%d", &option);
switch(option) {
case 1: start = create_ll(start);
printf("\n LINKED LIST CREATED");
break;
case 2: start = display(start);
break;
case 3: start = insert_beg(start);
break;
case 6: start = insert_after(start);
break;
case 7: start = delete_beg(start);
break;
case 8: start = delete_end(start);
break;
case 9: start = delete_node(start);
break;
case 10: start = delete_after(start);
break;
case 11: start = delete_list(start);
printf("\n LINKED LIST DELETED");
break;
case 12: start = sort_list(start);
```

```
}
}while(option !=13);
getch();
return 0;
} struct node *create_ll(struct node *start) {
struct node *new_node, *ptr;
int num;
printf("\n Enter -1 to end");
printf("\n Enter the data : ");
scanf("%d", &num);
while(num!=-1) {
new_node = (struct node*)malloc(sizeof(struct node));
new_node -> data=num;
if(start==NULL) {
start = new_node;
} else {
ptr=start;
while(ptr->next!=NULL)
ptr=ptr->next;
ptr->next = new_node;
new_node->next=NULL;
}
printf("\n Enter the data : ");
scanf("%d", &num);
}
return start;
```

```
} struct node *display(struct node *start) {
struct node *ptr;
ptr = start;
while(ptr != NULL) {
printf("\t %d", ptr -> data);
ptr = ptr -> next;
}
return start;
} struct node *insert_beg(struct node *start) {
struct node *new_node;
int num;
printf("\n Enter the data : ");
scanf("%d", &num);
new_node = (struct node *)malloc(sizeof(struct node));
new_node -> data = num;
new_node -> next = start;
start = new_node;
return start;
} struct node *insert_end(struct node *start) {
struct node *ptr, *new_node;
int num;
printf("\n Enter the data : ");
scanf("%d", &num);
new_node = (struct node *)malloc(sizeof(struct node));
new_node -> data = num;
new_node -> next = NULL;
```

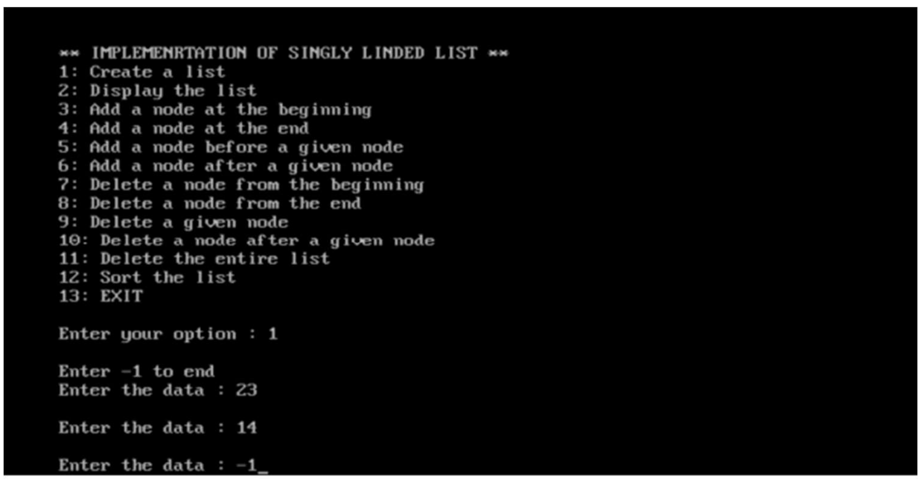
```
ptr = start;
while(ptr -> next != NULL)
ptr = ptr -> next;
ptr -> next = new_node;
return start;
} struct node *insert_before(struct node *start) {
struct node *new_node, *ptr, *preptr;
printf("\n Enter the data : ");
scanf("%d", &num);
printf("\n Enter the value before which the data has to be inserted : ");
scanf("%d", &val);
new_node = (struct node *)malloc(sizeof(struct node));
ptr = start;
while(ptr -> data != val) {
   preptr = ptr;
ptr = ptr -> next;
}preptr -> next = new_node;
new_node -> next = ptr;
return start;
} struct node *insert_after(struct node *start) {
struct node *new_node, *ptr, *preptr;
printf("\n Enter the data : ");
scanf("%d", &num);
printf("\n Enter the value after which the data has to be inserted : ");
scanf("%d", &val);
new_node = (struct node *)malloc(sizeof(struct node));
```

```
new_node -> data = num;
preptr = ptr;
while(preptr -> data != val) {
preptr = ptr;
ptr = ptr -> next;
}preptr -> next=new_node;
} struct node *delete_beg(struct node *start) {
struct node *ptr;
ptr = start;
start = start -> next;
free(ptr);
return start;
} struct node *delete_end(struct node *start) {
struct node *ptr, *preptr;
ptr = start;
while(ptr -> next != NULL) {
ptr = ptr -> next;
} preptr -> next = NULL;
free(ptr);
return start;
} struct node *delete_node(struct node *start) {
struct node *ptr, *preptr;
printf("\n Enter the value of the node which has to be deleted : ");
scanf("%d", &val);
ptr = start;
if(ptr -> data == val) {
```

```
return start;
} else {
   while(ptr -> data != val) {
preptr = ptr;
ptr = ptr -> next;
} preptr -> next = ptr -> next;
free(ptr);
return start;
}} struct node *delete_after(struct node *start) {
struct node *ptr, *preptr;
printf("\n Enter the value after which the node has to deleted : ");
scanf("%d", &val);
while(preptr -> data != val) {
preptr = ptr;
} preptr -> next=ptr -> next;
return start;
} struct node *delete_list(struct node *start) {
if(start!=NULL){
while(ptr != NULL) {
printf("\n %d is to be deleted next", ptr -> data);
start = delete_beg(ptr);
ptr = start;  }}}
 struct node *sort_list(struct node *start) {
int temp;
ptr1 = start;
while(ptr1 -> next != NULL) {
```

```
ptr2 = ptr1 -> next;

while(ptr2 != NULL) {

if(ptr1 -> data > ptr2 -> data) {

ptr1 -> data = ptr2 -> data;

ptr2 -> data = temp;}

ptr2 = ptr2 -> next;}

ptr1 = ptr1 -> next;

}} }
```

Output:



Conclusion:

Write an example of stack and queue implementation using singly linked list?

- A stack and a queue are two common data structures that can be implemented using a linked list. To implement a stack using a linked list, we to maintain a pointer to the top node of the list, and perform all the operations at the top node. For example, to push an element, we create a new node, assign it the data, link it to the top node, and update the top pointer. To pop an element, we check if the stack is empty, then delete the top node, and update the top pointerA queue is a data structure that follows the FIFO (first in, first out) principle. It means that the element that is inserted first in the queue is the one that is removed first To implement a queue using a linked list, we need to maintain two pointers: one to the front node and one to the rear node of the list. For example, to enqueue an element, we create a new node, assign it the data, link it to the rear node, and update the rear pointer. To dequeue an element, we check if the queue is empty, then delete the front node, and update the front pointer.