Experiment No.6
Implement Singly Linked List ADT
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Experiment No. 6: Singly Linked List Operations

Aim: Implementation of Singly Linked List

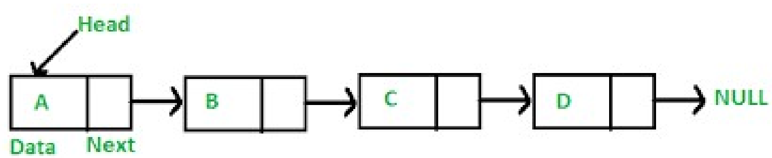
Objective:

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_before(struct node *);
struct node *insert_after(struct node *);
struct node *delete_beg(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 ** IMPLEMENRTATION OF SINGLY LINDED LIST **");

 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 4: start = insert_end(start);

break;

case 5: start = insert_before(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);
 break;
 }
}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)
 {
 new_node -> next = 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;
```

```
int num, val;

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));

new_node -> data = num;

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;

int num, val;
```

```
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;

ptr = start;

preptr = ptr;

while(preptr -> data != val)

{

 preptr = ptr;

 ptr = ptr -> next;

}

preptr -> next=new_node;

new_node -> next = ptr;

return start;

}

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)

{

 preptr = ptr;

 ptr = ptr -> next;

}

preptr -> next = NULL;

free(ptr);

return start;

}

struct node *delete_node(struct node *start)

{

struct node *ptr, *preptr;

int val;
```

```
printf("\n Enter the value of the node which has to be deleted : ");
scanf("%d", &val);
ptr = start;
if(ptr -> data == val)
{
 start = delete_beg(start);
 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;
int val;
printf("\n Enter the value after which the node has to deleted : ");
scanf("%d", &val);
ptr = start;
preptr = ptr;
while(preptr -> data != val)
{
 preptr = ptr;
 ptr = ptr -> next;
}
preptr -> next=ptr -> next;
free(ptr);
return start;
}
struct node *delete_list(struct node *start)
{
	struct node *ptr; // Lines 252-254 were modified from original code to fix unresposiveness in output window
if(start!=NULL){
 ptr=start;
```

```
 while(ptr != NULL)
 {
 printf("\n %d is to be deleted next", ptr -> data);
 start = delete_beg(ptr);
ptr = start;
 }
}
return start;
}
struct node *sort_list(struct node *start)
{
struct node *ptr1, *ptr2;
int temp;
ptr1 = start;
while(ptr1 -> next != NULL)
{
 ptr2 = ptr1 -> next;
 while(ptr2 != NULL)
 {
 if(ptr1 -> data > ptr2 -> data)
 {
```

```
 temp = ptr1 -> data;

 ptr1 -> data = ptr2 -> data;

 ptr2 -> data = temp;

 }

 ptr2 = ptr2 -> next;

 }

 ptr1 = ptr1 -> next;

}

return start;

 }
```

Output:

**** IMPLEMENRTATION OF SINGLY LINDED LIST ****

1: Create a list

2: Display the list

3: Add a node at the beginning

4: Add a node at the end

5: Add a node before a given node

6: Add a node after a given node

7: Delete a node from the beginning

8: Delete a node from the end

9: Delete a given node

10: Delete a node after a given node

11: Delete the entire list

12: Sort the list

13: EXIT

Enter your option : 1

Enter -1 to end

Enter the data : 23

Enter the data : 14

Enter the data : -1

LINKED LIST CREATED

**** IMPLEMENRTATION OF SINGLY LINDED LIST ****

1: Create a list

2: Display the list

3: Add a node at the beginning

4: Add a node at the end

5: Add a node before a given node

6: Add a node after a given node

7: Delete a node from the beginning

8: Delete a node from the end

9: Delete a given node

10: Delete a node after a given node

11: Delete the entire list

12: Sort the list

13: EXIT

Enter your option : 2

23 14

**** IMPLEMENRTATION OF SINGLY LINDED LIST ****

1: Create a list

2: Display the list

3: Add a node at the beginning

4: Add a node at the end

5: Add a node before a given node

6: Add a node after a given node

7: Delete a node from the beginning

8: Delete a node from the end

9: Delete a given node

10: Delete a node after a given node

11: Delete the entire list

12: Sort the list

13: EXIT

Enter your option : 13

Conclusion:

Q1 Write an example of stack and queue implementation using singly linked list?

The provided code is for implementing a singly linked list and various operations on it, such as creating a list, displaying it, adding nodes at the beginning or end, inserting nodes before or after a given node, deleting nodes, sorting the list, and deleting the entire list. The code appears to be written in C and includes a menu-driven approach for interacting with the linked list.

However, the code includes header files like `<conio.h>` and `<malloc.h>`, which are not part of the standard C library and are platform-dependent. It also uses the `getch()` function, which is typically found in older DOS-based compilers. These dependencies might limit the portability of the code to modern systems.

Regarding your question about stack and queue implementations using a singly linked list, here's a brief explanation:\

Stack Implementation using Singly Linked List:

A stack can be implemented using a singly linked list by restricting operations to one end of the list, typically the head. The most recent element pushed onto the stack becomes the new head. Stack operations are as follows:

- Push: Add an element to the head of the list.
- Pop: Remove and return the element at the head of the list.
- Peek: Return the element at the head without removing it.
- IsEmpty: Check if the list is empty.

Q2 Queue Implementation using Singly Linked List:

A queue can also be implemented using a singly linked list. In a queue, elements are added at one end (rear) and removed from the other end (front) of the list. Queue operations are as follows:

- Enqueue: Add an element to the rear of the list.
- Dequeue: Remove and return the element at the front of the list.
- Front: Return the element at the front without removing it.
- IsEmpty: Check if the list is empty.

To implement these data structures using a singly linked list, you can adapt the provided code by defining appropriate functions for stack and queue operations. The fundamental idea is to manipulate the linked list in a way that preserves the desired behavior of stacks and queues.