Reverse a Linked List

Problem Statement: Given the *head* of a singly linked list, write a program to reverse the linked list, and return *the head pointer to the reversed list*.

Examples:

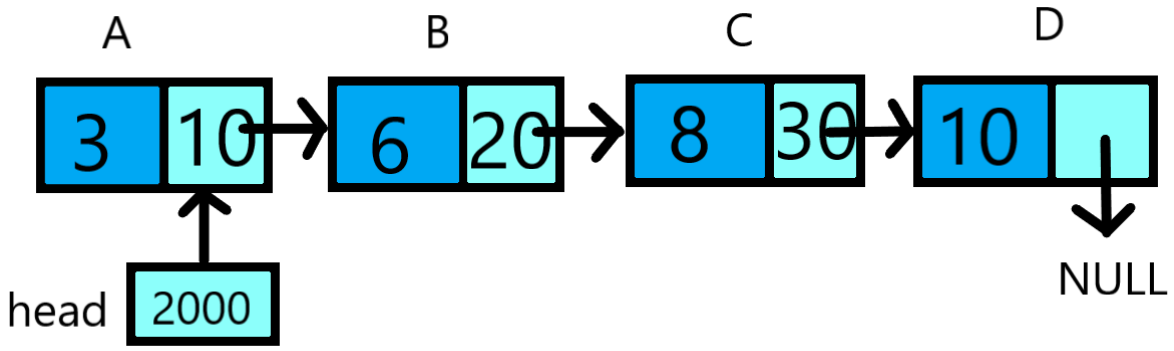
Input Format:

```
head = [3,6,8,10]

This means the given linked list is 3->6->8->10 with head pointer at node 3.
```

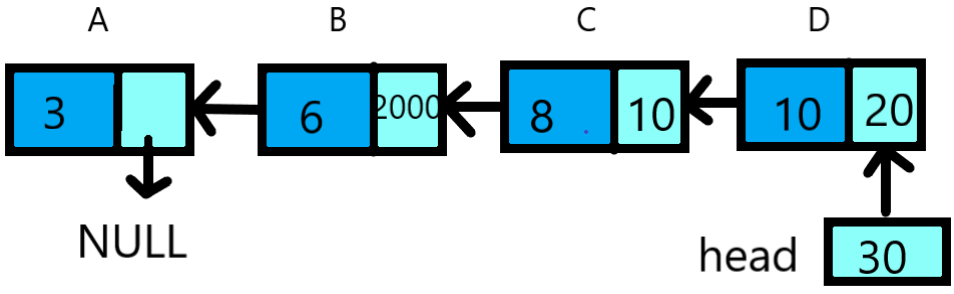
Result:

```
Output = [10,6,8,3]

This means, after reversal, the list should be 10->6->8->3 with the head pointer at node 10.
```

Explanation:



This is how a linked list looks for a given input. th*e head* is a reference that points to the initial or starting node of the list. To reverse it, we need to invert linking between nodes. That is, node D should point to node C, node C to node B and node B to node A. Then *head* points to node D and node A has *NULL*.



Input Format:

```
head = []
```

```
This means the given linked list is empty.
```

Result:

```
Output = []
```

Explanation:

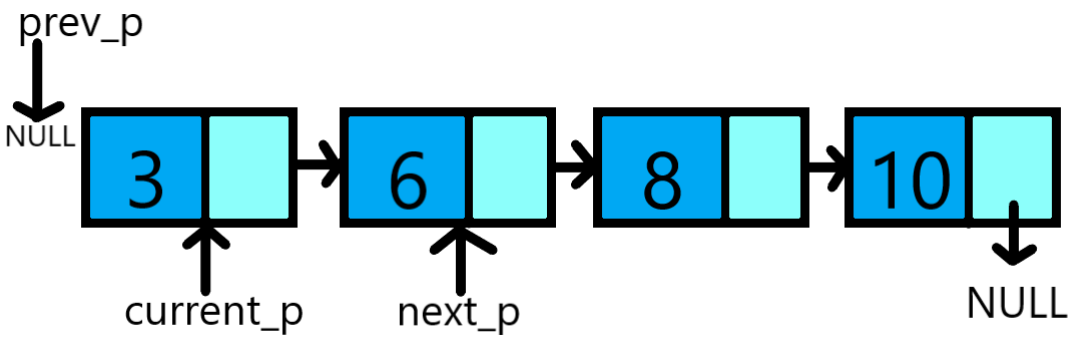
```
The linked list is empty. That is, no nodes are present in the list. Thus, even reversing
will give the list as empty.
```

Solution

Disclaimer: *Don't jump directly to the solution, try it out yourself first.*

Reverse Linked List : Iterative

We will use three-pointers to traverse through the entire list and interchange links between nodes. One pointer to keep track of the current node in the list. The second one is to keep track of the previous node to the current node and change links. Lastly, a pointer to keep track of nodes in front of current nodes.



STEP 1:

- currrent_p is a pointer to keep track of current nodes. Set it to head.
- prev_p is a pointer to keep track of previous nodes. Set it to NULL.
- next_p is a pointer to keep track of next nodes.

STEP 2:

- Set next_p to point next node to node pointed by current_p.
- Change link between nodes pointed by current_p and prev_p.
- Update prev_p to current_p and current_p pointer to next_p.

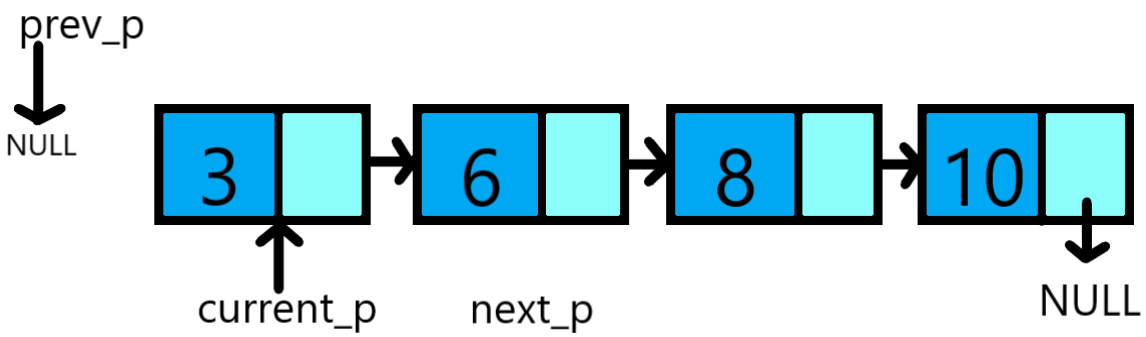
Perform STEP 2 until current_p reaches the end of the list.

STEP 3:

Set head as prev_p. This makes the head point at the last node.

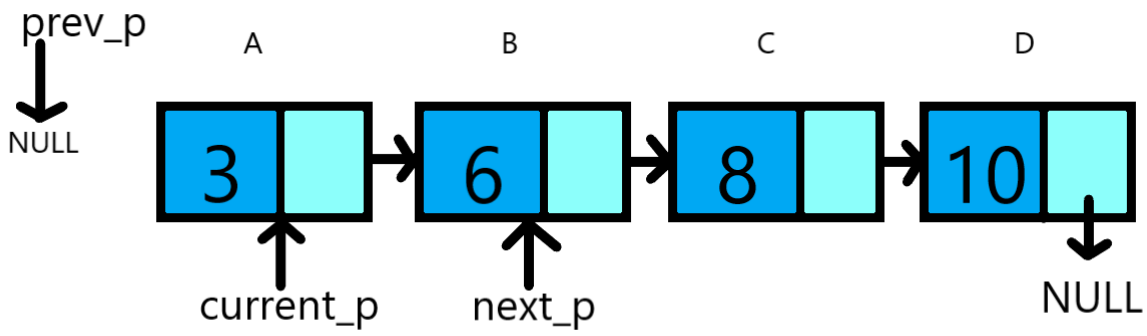
Dry Run:

At beginning,



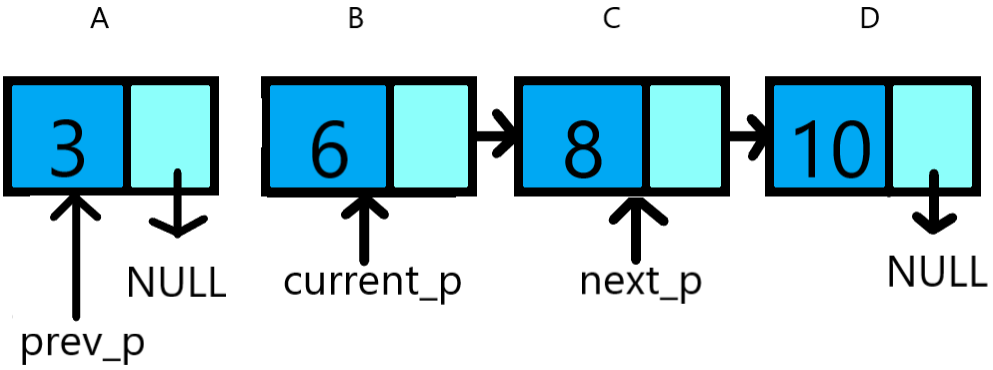
As per this example, current_p points node with 3 and prev_p points to NULL

Now, we start iterating throughout the list until current_p has a value equal to NULL. Set next_p to the next node of the current_p pointed node present in the list.



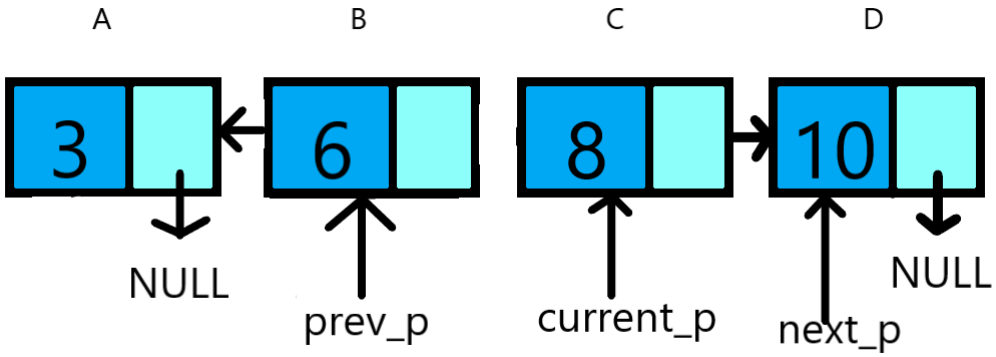
Since the next node to current_p pointed node is B. Therefore next_p points to node B.

Now, interchange linking between nodes pointed by prev_p and next_p,i.e, node A and NULL. Then, prev_p moves to node A, current_p moves to B, and next_p to C.

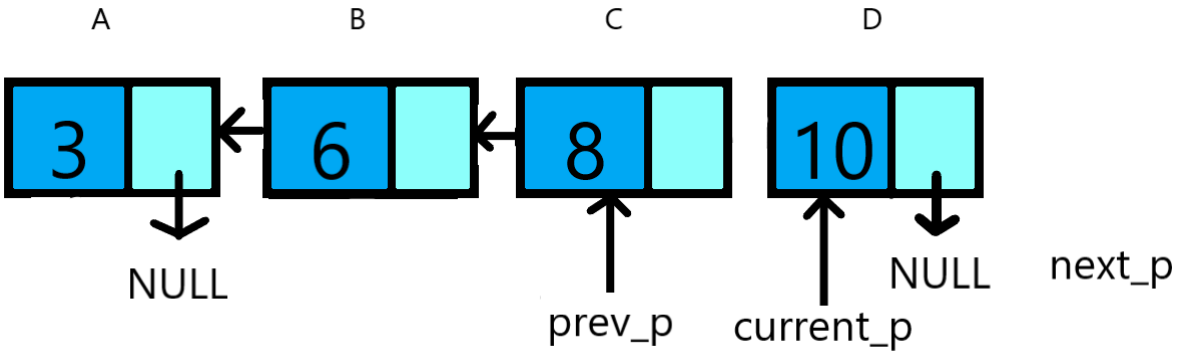


Thus, at the first iteration, we pointed node A from node B to NULL.

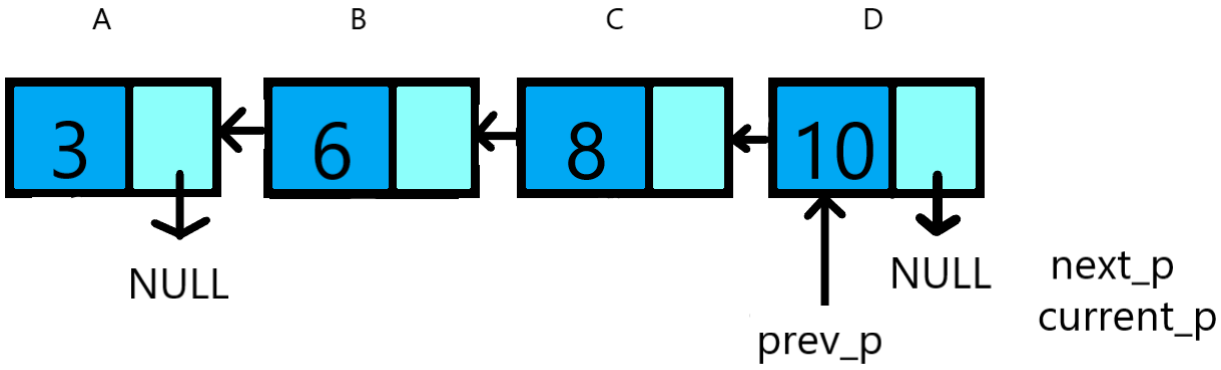
In the second iteration, we point node B from node C to node A. Move next_p to node D, current_p to node C and prev_p to node A. This is performed by the same steps.



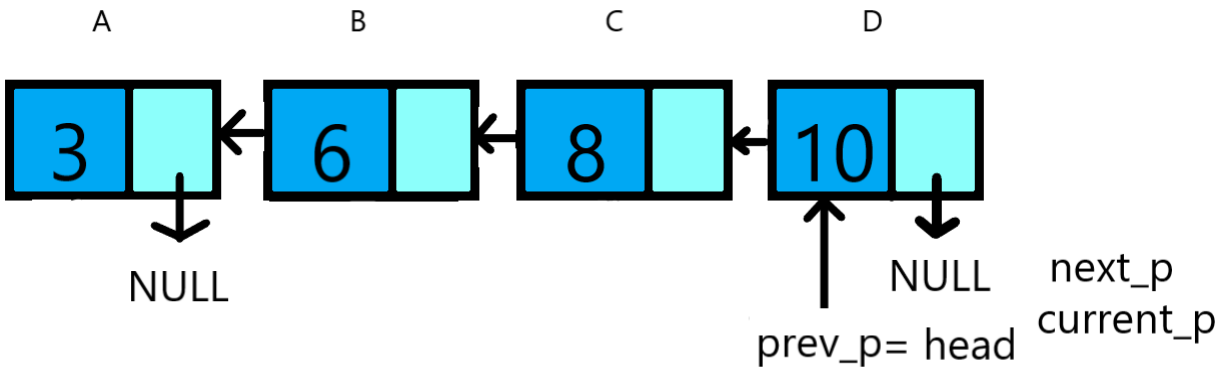
In the third iteration, we point node C from node D to node B. Move next_p to out of list, current_p to node D and prev_p to node C.



In the fourth iteration, we point node D from NULL to node C. Move current_p out of list and prev_p to node D.



Since current_p value is equal to NULL so iteration stops. We set head as prev_p.



Hence, we achieved our reversed list.

Source Code:

```
public ListNode reverseList(ListNode head) {
    ListNode curr=head,prev=null;
    while(curr!=null)
    {
       ListNode next=curr.next;
       curr.next=prev;
       prev=curr;
       curr=next;
```

```
        }
        return prev;
    }
```

Time Complexity:

Since we are iterating only once through the list and achieving reversed list. Thus, the time complexity is O(N) where N is the number of nodes present in the list.

Space Complexity:

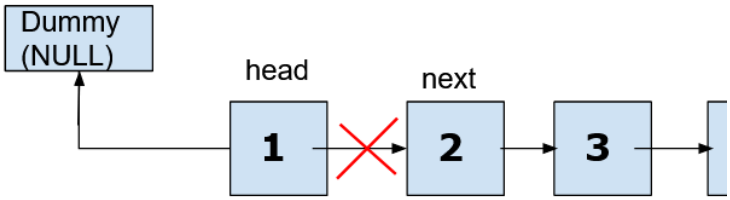
To perform given tasks, no external spaces are used except three-pointers. So, space complexity is O(1).

Reverse a Linked List : Recursive

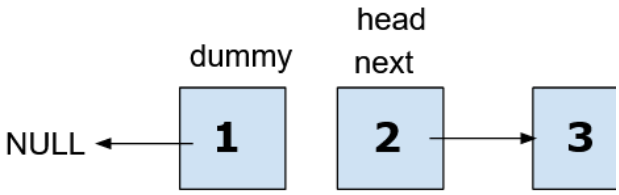
Intuition: This approach is very similar to the above 3 pointer approach. In the process of reversing, the base operation is manipulating the pointers of each node and at the end, the original head should be pointing towards NULL and the original last node should be 'head' of the reversed Linked List.

Approach:

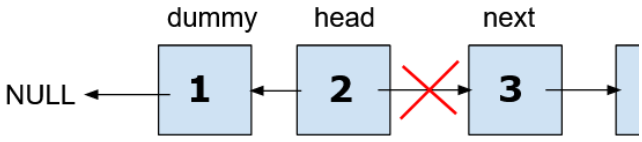
- In this type of scenario we first take a dummy node that will be assigned to NULL.
- Then we take a next pointer which will be initialized to head->next and in future iterations, next will again be set to head->next
- Now coming to changes on head node, as we have set dummy node as NULL and next to head->next, we can now update the next pointer of the head to dummy node.



-
- Before moving to next iteration dummy is set to head and then head is set to next node.



-
- Now coming to next iteration : We'll follow a similar process to set next as head->next and updating head->next = dummy, dummy set to head and head set to next



-
- These iterations will keep going while the head of original Linked List is not NULL, i.e. we'll reach end of the original Linked List and the Linked List has been reversed.

Source Code:

```
public ListNode reverseList(ListNode head) {
    if(head==null||head.next==null)
        return head;
    ListNode nextNode=reverseList(head.next);
    head.next.next=head;
    head.next=null;
    return nextNode;
```

```
}
```