Reverse a linked list in groups of size k

Given a linked list, write a function to reverse every k nodes (where k is an input to the function).

Example:

> ***Input***: *1->2->3->4->5->6->7->8->NULL, K = 3*
> ***Output***: *3->2->1->6->5->4->8->7->NULL*
> ***Input***: *1->2->3->4->5->6->7->8->NULL, K = 5*
> ***Output***: *5->4->3->2->1->8->7->6->NULL*

- Reverse the first sub-list of size k. While reversing keep track of the next node and previous node. Let the pointer to the next node be *next* and pointer to the previous node be *prev*. See this post for reversing a linked list.
- *head->next = reverse(next, k)* (Recursively call for rest of the list and link the two sub-lists)
- Return *prev* (*prev* becomes the new head of the list (see the diagrams of an iterative method of this post)

Below is image shows how the reverse function works:

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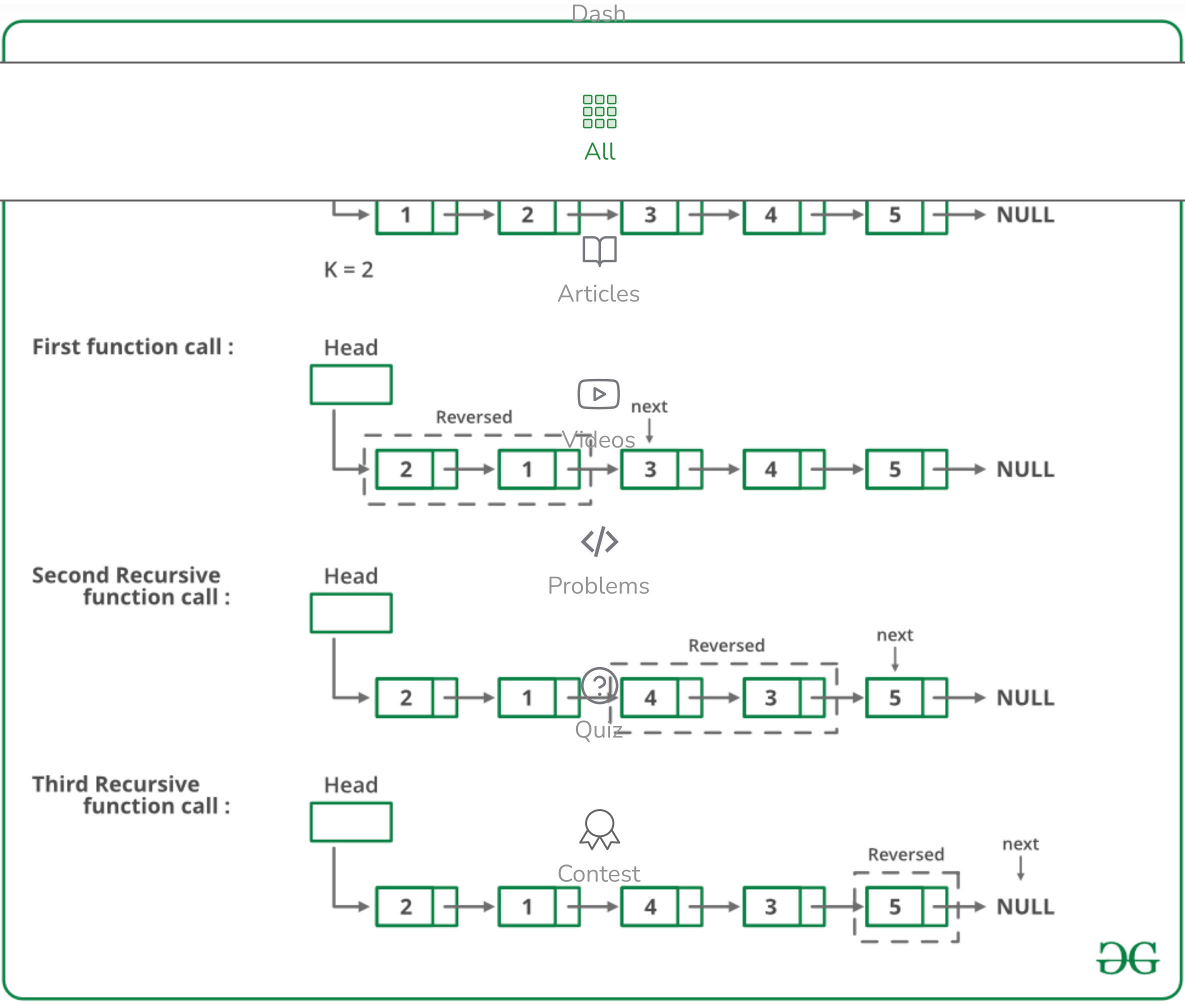

Below is the implementation of the above approach:

C++ Java

```
 // Java program to reverse a linked list in groups of
// given size
class LinkedList {
    Node head; // head of list

    /* Linked list Node*/
    class Node {
        int data;
        Node next;
        Node(int d)
        {
            data = d;
            next = null;
        }
```

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```
    {
        Node next = null;
        Node prev = null;

        int count = 0;

        /* Reverse first k nodes of linked list */
        while (count < k && current != null) {
            next = current.next;
            current.next = prev;
            prev = current;
            current = next;
            count++;
        }

        /* next is now a pointer to (k+1)th node
        Recursively call for the list starting from
        current. And make rest of the list as next of
        first node */
        if (next != null)
            head.next = reverse(next, k);

        // prev is now head of input list
        return prev;
    }

    /* Utility functions */

    /* Inserts a new Node at front of the list. */
    public void push(int new_data)
    {
        /* 1 & 2: Allocate the Node &
                  Put in the data*/
        Node new_node = new Node(new_data);

        /* 3. Make next of new Node as head */
        new_node.next = head;
```

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```
    }

    {
        Node temp = head;
        while (temp != null) {
            System.out.print(temp.data + " ");
            temp = temp.next;
        }
        System.out.println();
    }

    /* Driver program to test above functions */
    public static void main(String args[])
    {
        LinkedList llist = new LinkedList();

        /* Constructed Linked List is 1->2->3->4->5->6->
        7->8->8->9->null */
        llist.push(9);
        llist.push(8);
        llist.push(7);
        llist.push(6);
        llist.push(5);
        llist.push(4);
        llist.push(3);
        llist.push(2);
        llist.push(1);

        System.out.println("Given Linked List");
        llist.printList();

        llist.head = llist.reverse(llist.head, 3);

        System.out.println("Reversed list");
        llist.printList();
    }
}
```

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```
Given linked list
```

Complexity Analysis:

- **Time Complexity:** O(n).
  Traversal of list is done only once and it has 'n' elements.
- **Auxiliary Space:** O(n/k).
  For each Linked List of size n, n/k or (n/k)+1 calls will be made during the recursion.

We can solve this question in O(1) Space Complexity.

Approach – 2 Space Optimized – Iterative

The following steps are required for this Algorithm:

1. Create a dummy node and point it to the head of input i.e dummy->next = head.
2. Calculate the length of the linked list which takes O(N) time, where N is the length of the linked list.
3. Initialize three-pointers prev, curr, next to reverse k elements for every group.
4. Iterate over the linked lists till next!=NULL.
5. Points curr to the prev->next and next to the curr next.
6. Then, Using the inner for loop reverse the particular group using these four steps:

> - *curr->next = next->next*
> - *next->next = prev->next*
> - *prev->next = next*
> - *next = curr->next*

7. This for loop runs for k-1 times for all groups except the last remaining element, for the last remaining element it runs for the remaining length of the linked list – 1.

8. Decrement count after for loop by k count -= k, to determine the length of the remaining linked list.

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9. Change prev position to curr, prev = curr.

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```
// Linked List Node
class Node {
    int data;
    Node next;
    Node(int a)
    {
        data = a;
        next = null;
    }
}

class GFG {
    // utility function to insert node in the list
    static Node push(Node head, int val)
    {
        Node newNode = new Node(val);
        if (head == null) {
            head = newNode;
            return head;
        }

        Node temp = head;
        while (temp.next != null)
            temp = temp.next;

        temp.next = newNode;
        return head;
    }

    // utility function to reverse k nodes in the list
    static Node reverse(Node head, int k)
    {
        // If head is NULL or K is 1 then return head
        if (head == null || head.next == null)
            return head;
        dummy.next = head;
        Node curr = dummy;
        Node next = dummy;

        // Calculating the length of linked list
        int count = 0;
        while (curr != null) {
            count++;
            curr = curr.next;
        }

        // Iterating till next is not NULL
        while (next != null) {
            curr = prev.next; // Curr position after every
                            // reverse group
            next = curr.next; // Next will always next to
                            // curr
            int toLoop
                = count > k
                    ? k
                    : count - 1; // toLoop will set to
                                // count - 1 in case of
                                // remaining element

            for (int i = 1; i < toLoop; i++) {
                // 4 steps as discussed above
                curr.next = next.next;
                next.next = prev.next;
                prev.next = next;
                next = curr.next;
            }
            prev = curr; // Setting prev to curr
            count -= k; // Update count
        }
        return dummy.next; // dummy -> next will be our new
                        // head for output linked
        // list
    }
```

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```
    {
        }
        System.out.println(head.data);

    public static void main(String args[])
    {
        Node head = null;
        int k = 3;
        head = push(head, 1);
        head = push(head, 2);
        head = push(head, 3);
        head = push(head, 4);
        head = push(head, 5);
        head = push(head, 6);
        head = push(head, 7);
        head = push(head, 8);
        head = push(head, 9);

        System.out.println("Given Linked List");
        print(head);
        System.out.println("Reversed list");
        Node newHead = reverse(head, k);
        print(newHead);
    }
}
```

Output

```
Given linked list
1 2 3 4 5 6 7 8 9
Reversed Linked list
3 2 1 6 5 4 9 8 7
```

Complexity Analysis

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Space Complexity: O(1) : No extra space is used.

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