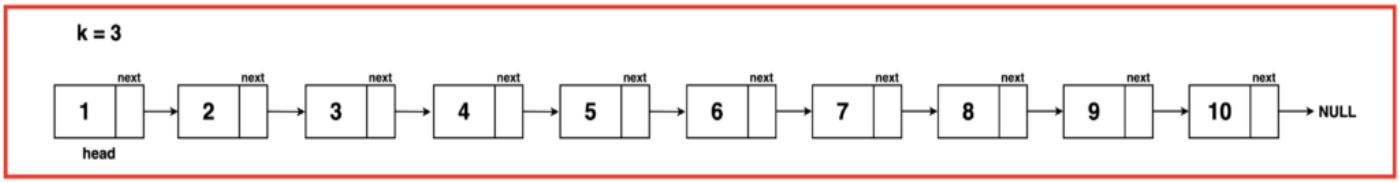
Reverse Linked List in groups of Size K

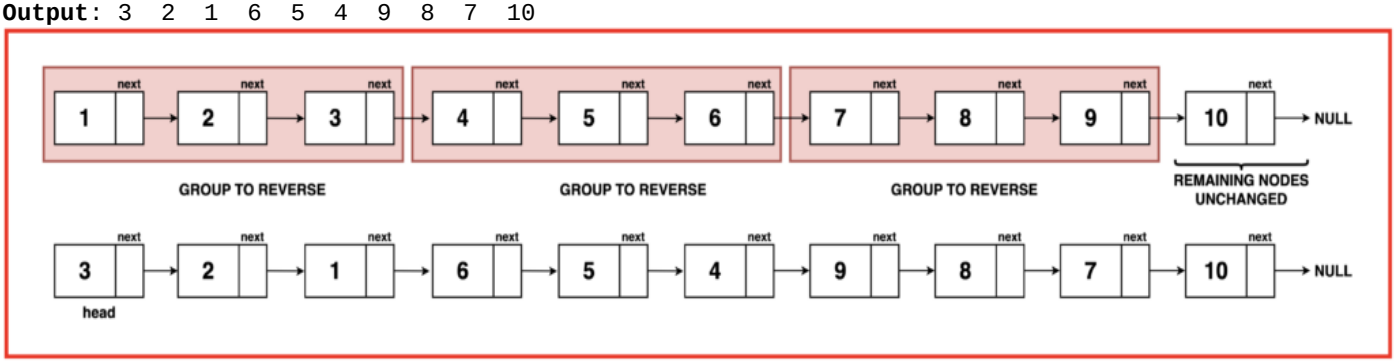
Problem Statement: Given the **head** of a singly linked list of **`n` nodes** and an integer **`k`**, where **k** is less than or equal to **`n`**. Your task is to **reverse** the order of **each group** of **`k` consecutive nodes**, if **`n`** is not divisible by **`k`**, then the **last group** of **remaining nodes** should remain **unchanged**.

Examples

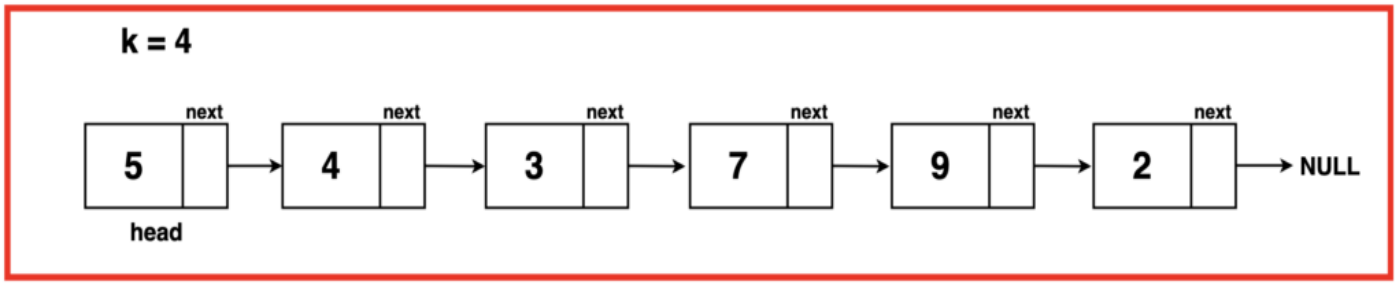
Example 1:
Input Format:
LL: 1 2 3 4 5 6 7 8 9 10
K = 3



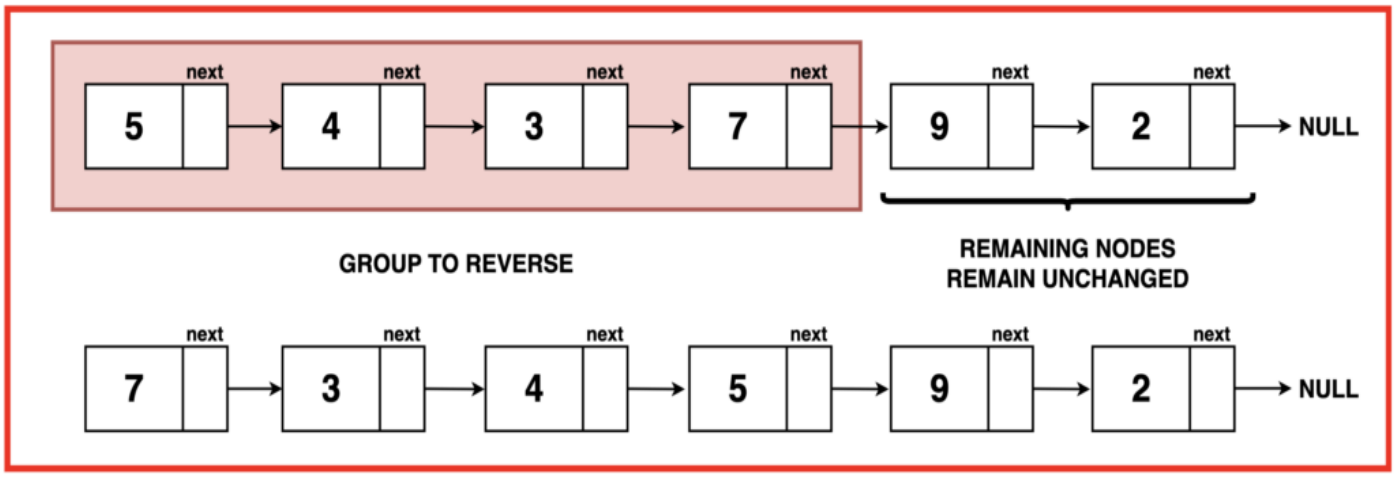
Output: 3 2 1 6 5 4 9 8 7 10



Explanation:
Group 1: Reverse nodes 1 -> 2 -> 3 to become 3 -> 2 -> 1.Group 2: Reverse nodes 4 -> 5 -> 6 to become 6 -> 5 -> 4.Group 3: Reverse nodes 7 -> 8 -> 9 to become 9 -> 8 -> 7.Node 10 remains as is since there are no more groups of size K remaining.
Example 2:
Input Format:
LL: 5 4 3 7 9 2
K = 4



Output: 7 3 4 5 9 2



Explanation:

```
Group 1: Reversed nodes 5 -> 4 -> 3 -> 7 to become 7 -> 3 -> 4 -> 5.Group 2: Nodes 9 -> 2 remain unchanged as they are not a complete group of size K.
```

Solution:

Reverse Linked List is a prerequisite to this question. Make sure you are thorough with the fundamentals and procedures that go into reversing a linked list.

Approach:

The approach simplifies reversing linked list nodes by **breaking** the list into **segments** of **K nodes** and **reversing each segment individually**. Starting from the head, the algorithm traverses the list to **identify segments of K nodes**. Upon finding a segment, it **reverses it**, returning the modified list. If a segment has less than K nodes left (ie. **remaining nodes** at the end), they are left **unaltered**.

To implement this (**complex**) **algorithm** we can break down the process into **three parts**:

`reverseLinkedList`: This function takes the **head** of a segment as **input** and reverses the linked list formed by that segment. It operates by utilizing the **classic iterative 3-pointer method** to reverse the direction of pointers within the segment.

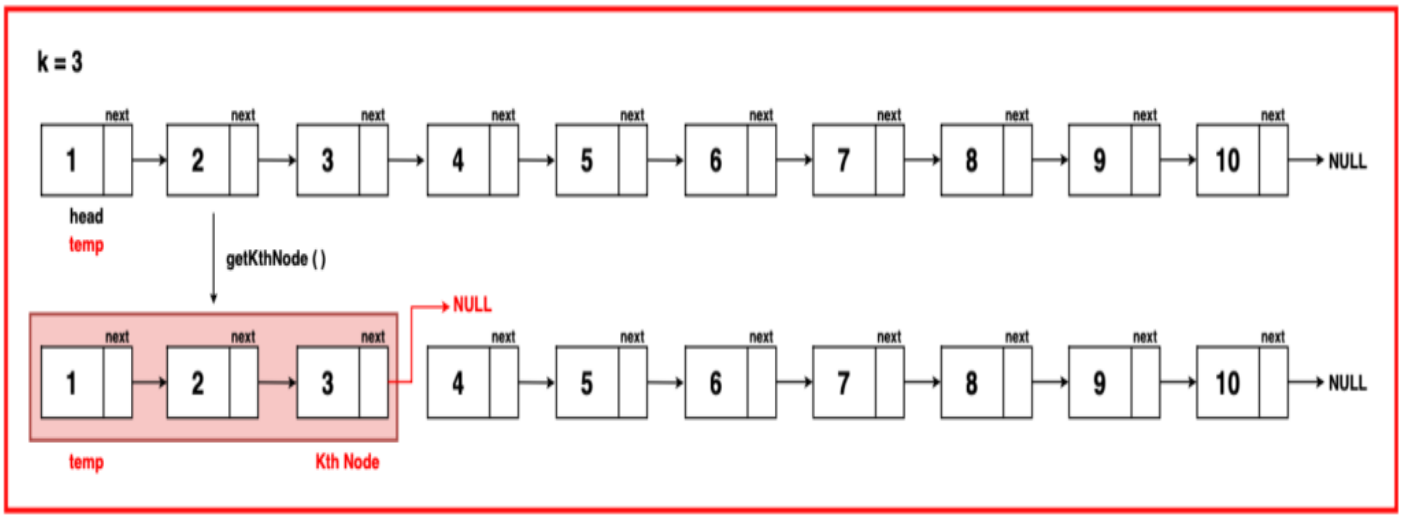
`getKthNode`: The purpose of this function is to **identify the end** of a segment of **K nodes** in the linked list. Given a starting node, it traverses K nodes in the list and **returns the Kth node**, allowing the segmentation of the list into **smaller parts** for reversal.

`kReverse`: The **main function** orchestrates the **reversal process**. It iterates through the linked list and identifies segments of K nodes using **getKthNode**. For each identified segment, it utilizes **reverseLinkedList** to reverse the nodes within that segment.
This **iterative approach** efficiently reverses the linked list nodes in **groups of K.**

Algorithm:

Step 1: Initialise a pointer **`temp`** to the head of the linked list. Using **`temp`**, traverse to the **Kth Node** iteratively.

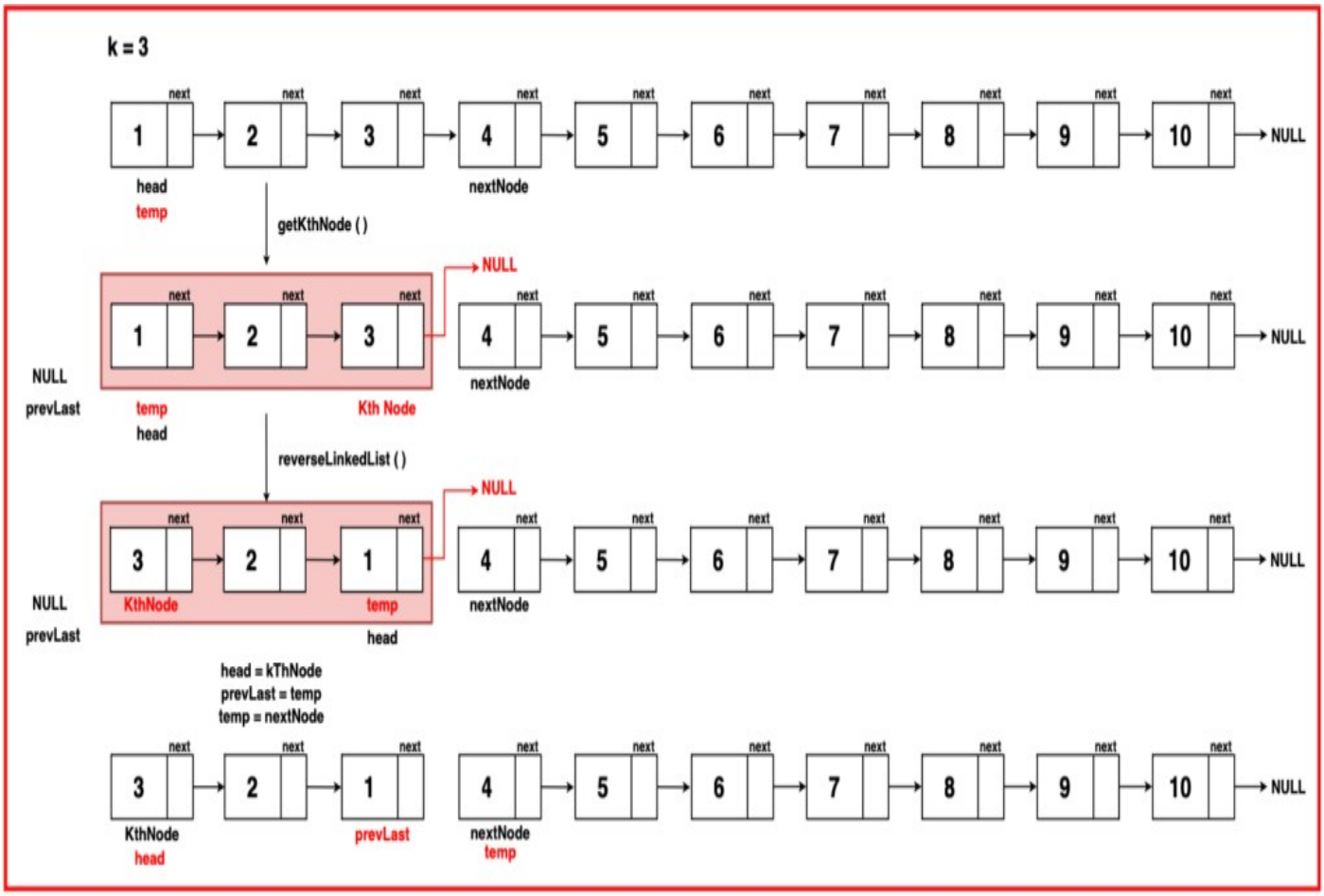
Step 2: On reaching the **Kth Node,** preserve the **Kth Node's next** node as **`nextNode`** and set the **Kth Node's next** pointer to **`null`**. This effectively **breaks** the linked list in a **smaller list** of size **K** that can be **reversed** and **attached back**.



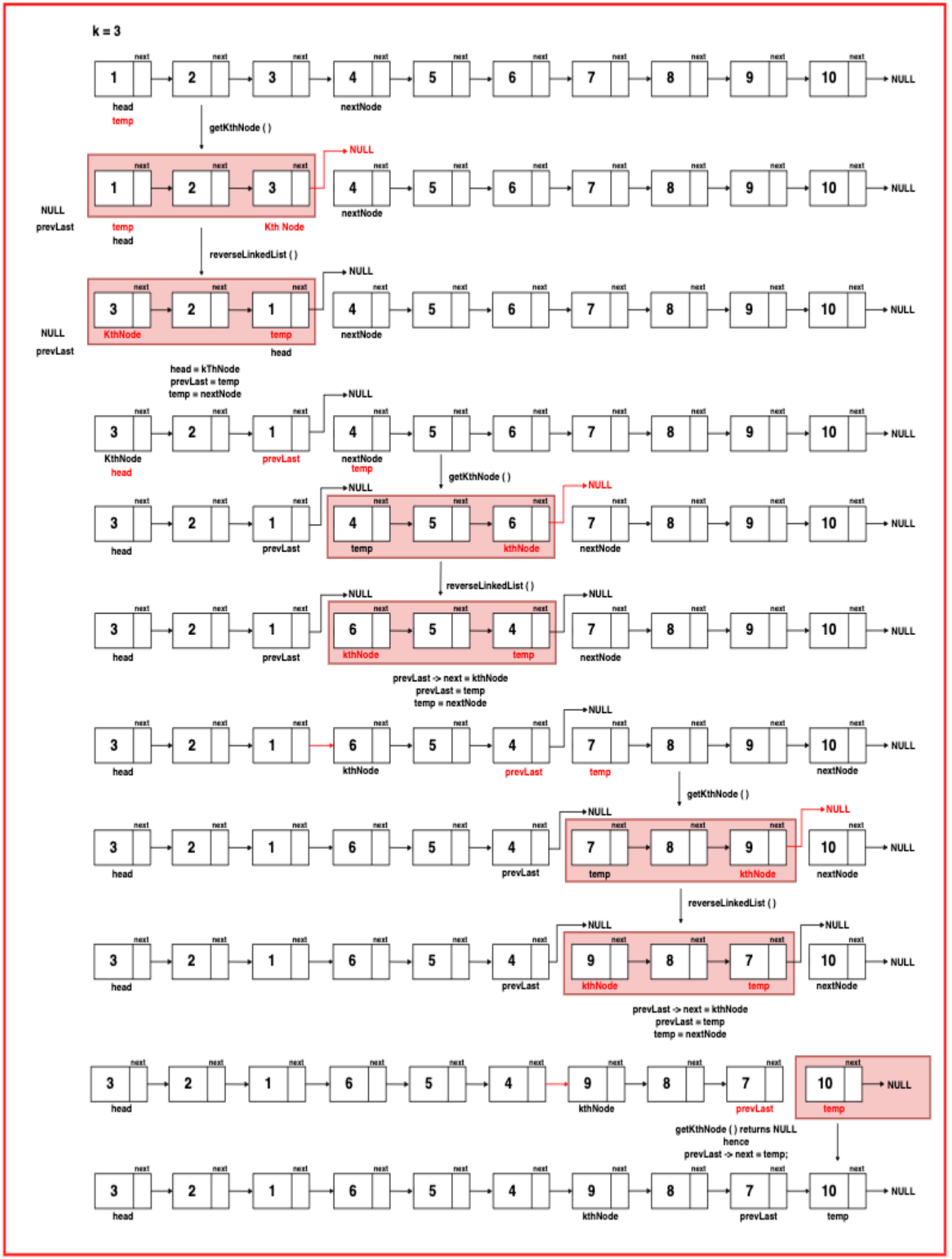
Step 3: Treat this **segment** from **`temp`** to **Kth Node** as an individual linked list and **reverse it.** This can be done via the **help** of a helper function **`reverseLinkedList`**

Step 4: The reversed linked list segment returns a modified list with **`temp`** now at its **tail** and the **`KthNode`** pointing to its head. Update the **`temp`s `next`** pointer to **`nextNode`**.

If we are at the **first segment** of K nodes, **update** the **head** to **`Kth Node`**.



Step 5: Continue this reversal for **further groups.** If a segment has fewer than **K Nodes**, leave them unmodified and return the **new head**. Use the **prevLast pointer** to maintain the **link** between the end of the **previous reversed segment** and the **current segment**.


k = 3
head
temp
nextNode
getKthNode ( )
NULL
prevLast
Kth Node
reverseLinkedList ( )
KthNode
head = kThNode
prevLast = temp
temp = nextNode
prevLast
kthNode
prevLast -> next = kthNode
prevLast = temp
temp = nextNode
getKthNode ( ) returns NULL
hence
prevLast -> next = temp;

```
import java.util.*;

// Node class represents a node in a linked list
class Node {
    // Data stored in the node
    int data;
    // Pointer to the next
    // node in the list
    Node next;

    // Constructor with both data
    // and next node as parameters
    Node(int data, Node next) {
        this.data = data;
        this.next = next;
    }

    // Constructor with only data as
    // a parameter, sets next to null
    Node(int data) {
        this.data = data;
        this.next = null;
    }
}
public class Main {

    // Function to reverse a linked list
    // using the 3-pointer approach
    static Node reverseLinkedList(Node head) {
        // Initialize'temp' at
        // head of linked list
        Node temp = head;

       // Initialize pointer 'prev' to NULL,
       // representing the previous node
       Node prev = null;

       // Traverse the list, continue till
       // 'temp' reaches the end (NULL)
       while(temp != null){
           // Store the next node in
           // 'front' to preserve the reference
           Node front = temp.next;

           // Reverse the direction of the
           // current node's 'next' pointer
           // to point to 'prev'
           temp.next = prev;

            // Move 'prev' to the current
            // node for the next iteration
           prev = temp;

            // Move 'temp' to the 'front' node
            // advancing the traversal
           temp = front;
       }

       // Return the new head of
       // the reversed linked list
       return prev;

    }

    // Function to get the Kth node from
    // a given position in the linked list
    static Node getKthNode(Node temp, int k) {
        // Decrement K as we already
        // start from the 1st node
        k -= 1;
```

```
    // Decrement K until it reaches
    // the desired position
    while (temp != null && k > 0) {
        // Decrement k as temp progresses
        k--;

        // Move to the next node
        temp = temp.next;
    }

    // Return the Kth node
    return temp;
}

// Function to reverse nodes in groups of K
static Node kReverse(Node head, int k) {
    // Initialize a temporary
    // node to traverse the list
    Node temp = head;

    // Initialize a pointer to track the
    // last node of the previous group
    Node prevLast = null;

    // Traverse through the linked list
    while (temp != null) {

        // Get the Kth node of the current group
        Node kThNode = getKthNode(temp, k);

        // If the Kth node is NULL
        // (not a complete group)
        if (kThNode == null) {

            // If there was a previous group,
            // link the last node to the current node
            if (prevLast != null) {
                prevLast.next = temp;
            }

            // Exit the loop
            break;
        }

        // Store the next node
        // after the Kth node
        Node nextNode = kThNode.next;

        // Disconnect the Kth node
        // to prepare for reversal
        kThNode.next = null;

        // Reverse the nodes from
        // temp to the Kth node
        reverseLinkedList(temp);

         // Adjust the head if the reversal
        // starts from the head
        if (temp == head) {
            head = kThNode;
        } else {
            // Link the last node of the previous
            // group to the reversed group
            prevLast.next = kThNode;
        }

        // Update the pointer to the
        // last node of the previous group
        prevLast = temp;

        // Move to the next group
```

```
            temp = nextNode;
        }

        // Return the head of the
        // modified linked list
        return head;
    }

    // Function to print the linked list
    static void printLinkedList(Node head) {
        Node temp = head;
        while (temp != null) {
            System.out.print(temp.data + " ");
            temp = temp.next;
        }
        System.out.println();
    }

    public static void main(String[] args) {
        // Create a linked list with
        // values 5, 4, 3, 7, 9 and 2
        Node head = new Node(5);
        head.next = new Node(4);
        head.next.next = new Node(3);
        head.next.next.next = new Node(7);
        head.next.next.next.next = new Node(9);
        head.next.next.next.next.next = new Node(2);

        // Print the original linked list
        System.out.print("Original Linked List: ");
        printLinkedList(head);

        // Reverse the linked list
        head = kReverse(head, 4);

        // Print the reversed linked list
        System.out.print("Reversed Linked List: ");
        printLinkedList(head);
    }
}
```

Output:
Original Linked List: 5 4 3 7 9 2 K = 4
Linked List Reversed in groups of 4: 7 3 4 5 9 2

Time Complexity: O(2N) The time complexity consists of actions of **reversing segments of K** and **finding the Kth node** which operates in linear time. Thus, **O(N) + O(N) = O(2N)**, which simplifies to O(N).

Space Complexity: O(1) The space complexity is O(1) as the algorithm **operates in place** without any additional space requirements.