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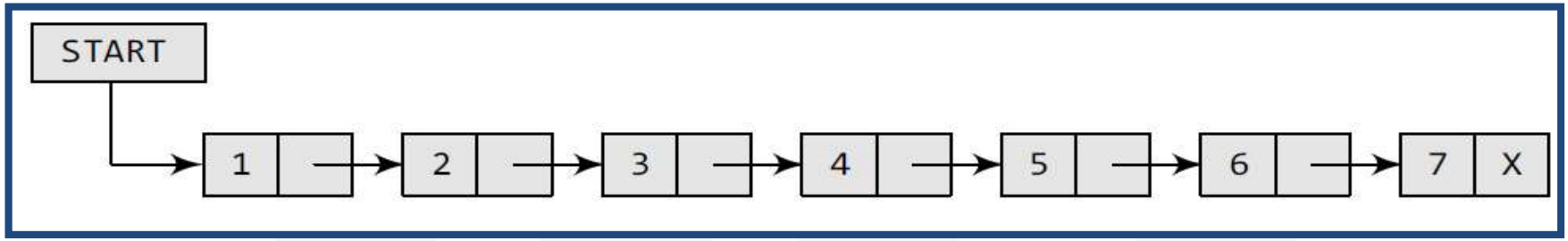
Operations in Link List

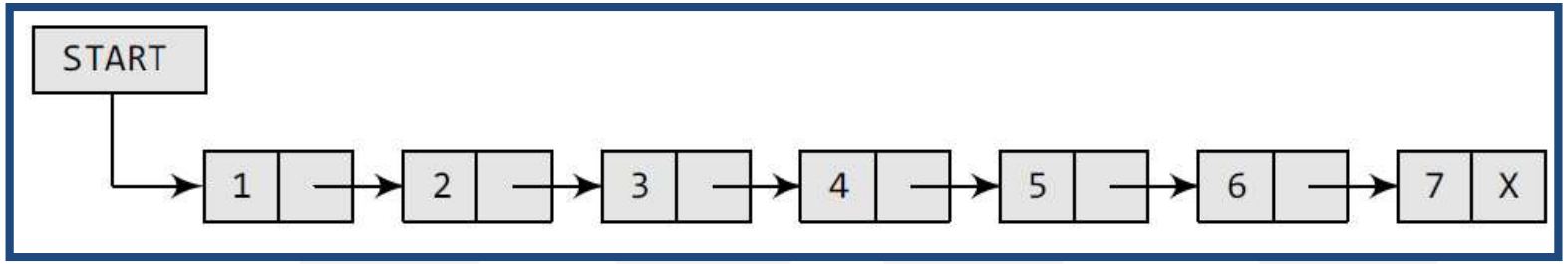
- Traversing list : accessing the nodes of the list in order to perform some processing on them.
- Insert element in link list
- Delete element from link list
- Search for element in link list

Traversing Single Link List



- Traversing a linked list means accessing the nodes of the list in order to perform some processing on them.
- A linked list always contains a pointer variable START which stores the address of the first node of the list.
- We also make use of another pointer variable PTR which points to the node that is currently being accessed.

Traversing Single Link List




```
Step 1: [INITIALIZE] SET PTR = START
Step 2: Repeat Steps 3 and 4 while PTR != NULL
Step 3:             Apply Process to PTR->DATA
Step 4:             SET PTR = PTR->NEXT
        [END OF LOOP]
Step 5: EXIT
```

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Traversing Single Link List

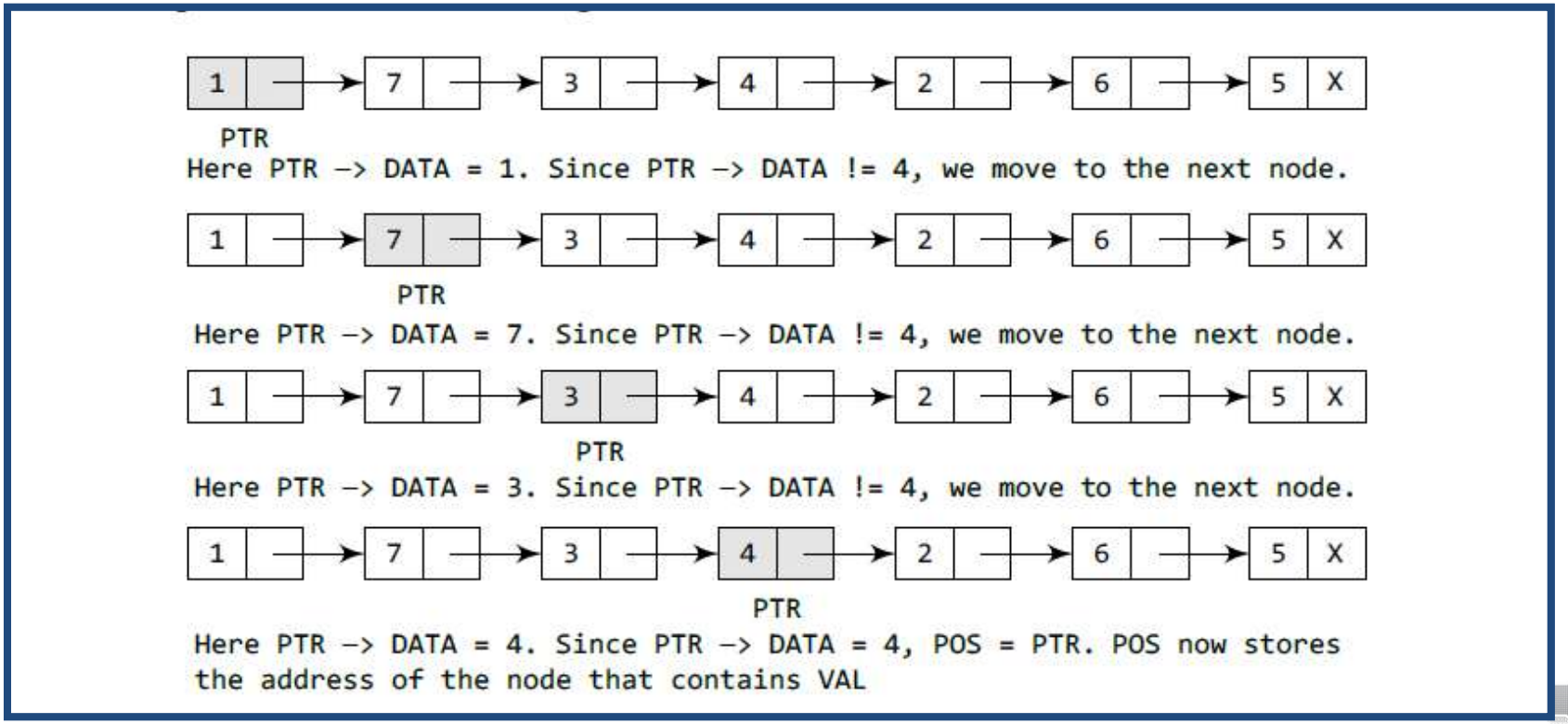
- In this algorithm, we first initialize PTR with the address of START. So now, PTR points to the first node of the linked list.
- Then in Step 2, a while loop is executed which is repeated till PTR processes the last node, that is until it encounters NULL.
- In Step 3, we apply the process (e.g., print) to the current node, that is, the node pointed by PTR.
- In Step 4, we move to the next node by making the PTR variable point to the node whose address is stored in the NEXT field.

Searching : Single Link List

```
Step 1: [INITIALIZE] SET PTR = START
Step 2: Repeat Step 3 while PTR != NULL
Step 3:     IF VAL = PTR -> DATA
                SET POS = PTR
                Go To Step 5
            ELSE
                SET PTR = PTR -> NEXT
            [END OF IF]
        [END OF LOOP]
Step 4: SET POS = NULL
Step 5: EXIT
```

- In Step 1, we initialize the pointer variable PTR with START that contains the address of the first node.
- In Step 2, a while loop is executed which will compare every node's DATA with VAL for which the search is being made. If the search is successful, that is, VAL has been found, then the address of that node is stored in POS and the control jumps to the last statement of the algorithm.
- However, if the search is unsuccessful, POS is set to NULL which indicates that VAL is not present in the linked list.

Searching : Single Link List



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Insertion : Single Link List

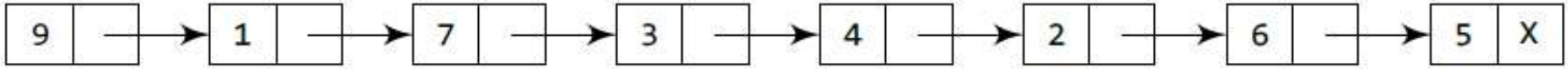
- Case 1: The new node is inserted at the beginning.
- Case 2: The new node is inserted at the end.
- Case 3: The new node is inserted after a given node.

Case 1 :The new node is inserted at the beginning.

START

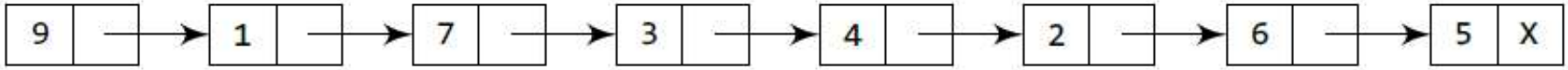
Allocate memory for the new node and initialize its DATA part to 9.

Add the new node as the first node of the list by making the NEXT part of the new node contain the address of START.



START

Now make START to point to the first node of the list.



START

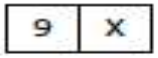
Case 1 :The new node is inserted at the beginning.

```
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 NEW_NODE -> DATA = VAL
Step 5: SET NEW_NODE -> NEXT = START
Step 6: SET START = NEW_NODE
Step 7: EXIT
```

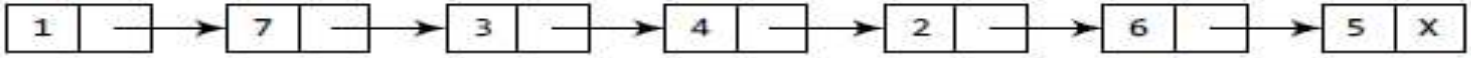
- In Step 1, we first check whether memory is available for the new node.
- If a free memory cell is available, then we allocate space for the new node. Set its DATA part with the given VAL and the NEXT part is initialized with the address of the first node of the list, which is stored in START
- Now, since the new node is added as the first node of the list, it will now be known as the START node, that is, the START pointer variable will now hold the address of the NEW_NODE.

Case 2 :The new node is inserted at the end.

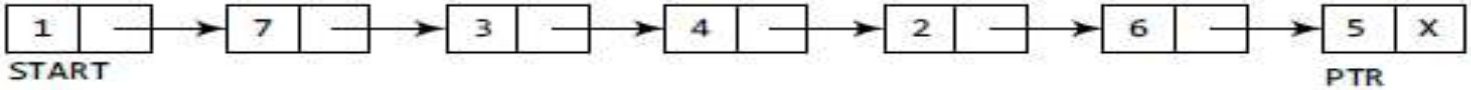
Allocate memory for the new node and initialize its DATA part to 9 and NEXT part to NULL.



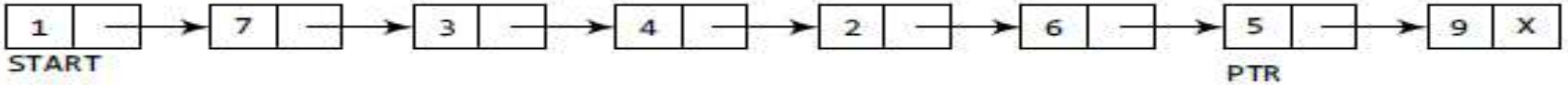
Take a pointer variable PTR which points to START.



Move PTR so that it points to the last node of the list.



Add the new node after the node pointed by PTR. This is done by storing the address of the new node in the NEXT part of PTR.

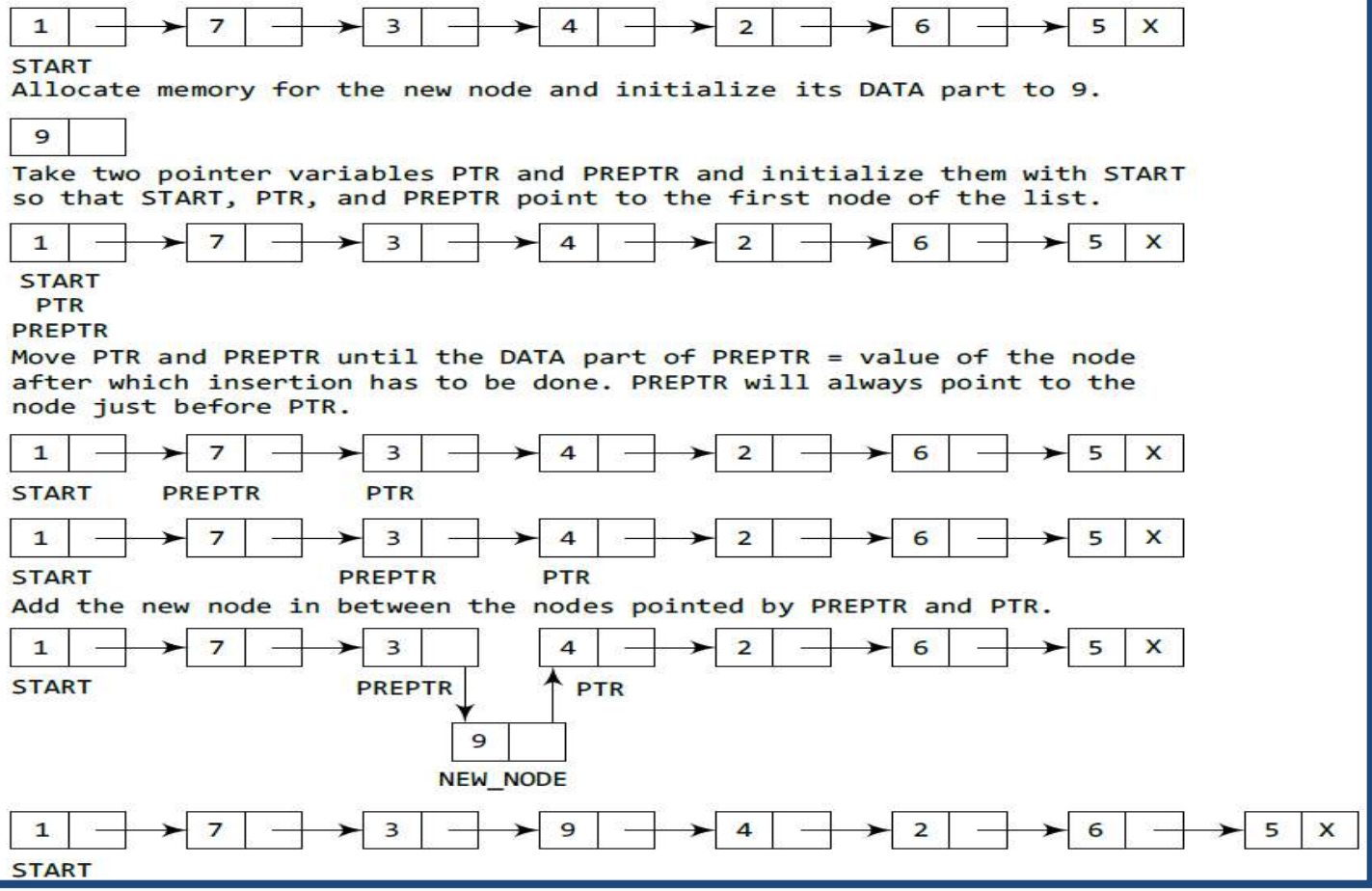


Case 2 :The new node is inserted at the end.

```
Step 1: IF AVAIL = NULL
            Write OVERFLOW
            Go to Step 10
        [END OF IF]
Step 2: SET NEW_NODE = AVAIL
Step 3: SET AVAIL = AVAIL->NEXT
Step 4: SET NEW_NODE->DATA = VAL
Step 5: SET NEW_NODE->NEXT = 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
```

- In Step 6, we take a pointer variable PTR and initialize it with START.
- That is, PTR now points to the first node of the linked list. In the while loop, we traverse through the linked list to reach the last node.
- Once we reach the last node, in Step 9, we change the NEXT pointer of the last node to store the address of the new node.
- Remember that the NEXT field of the new node contains NULL, which signifies the end of the linked list.

Case 3 :The new node is inserted in between.



Case 3 :The new node is inserted in between.

```
Step 1: IF AVAIL = NULL
            Write OVERFLOW
            Go to Step 12
        [END OF IF]
Step 2: SET NEW_NODE = AVAIL
Step 3: SET AVAIL = AVAIL->NEXT
Step 4: SET NEW_NODE->DATA = VAL
Step 5: SET PTR = START
Step 6: SET PREPTR = PTR
Step 7: Repeat Steps 8 and 9 while PREPTR->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 NEW_NODE->NEXT = PTR
Step 12: EXIT
```

- In Step 5, we take a pointer variable PTR and initialize it with START. That is, PTR now points to the first node of the linked list.
- Then we take another pointer variable PREPTR which will be used to store the address of the node preceding PTR.
- Initially, PREPTR is initialized to PTR.
- So now, PTR, PREPTR, and START are all pointing to the first node of the linked list.
- In the while loop, we traverse through the linked list to reach the node that has its value equal to NUM.
- We need to reach this node because the new node will be inserted after this node. Once we reach this node, in Steps 10 and 11, we change the NEXT pointers in such a way that new node is inserted after the desired node.

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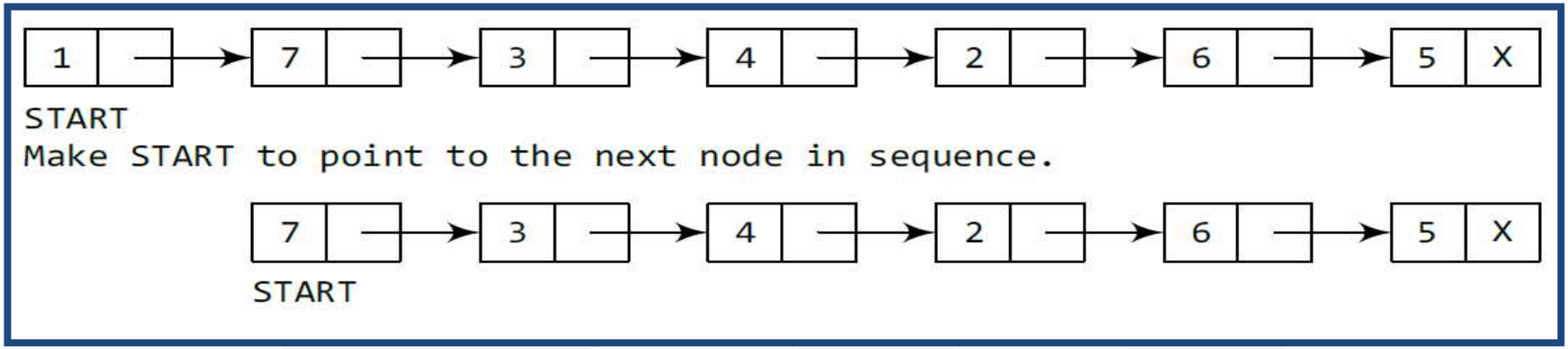
Single Link List : Deletion

Case 1: Delete first node

Case 2: Delete last node

Case 3: Delete from between

Case 1 : Delete first node



Case 1 : Delete 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
```

- In Step 1, we check if the linked list exists or not. If START = NULL, then it signifies that there are no nodes in the list and the control is transferred to the last statement of the algorithm.
- However, if there are nodes in the linked list, then we use a pointer variable PTR that is set to point to the first node of the list.
- For this, we initialize PTR with START that stores the address of the first node of the list.
- In Step 3, START is made to point to the next node in sequence and finally the memory occupied by the node pointed by PTR (initially the first node of the list) is freed and returned to the free pool.

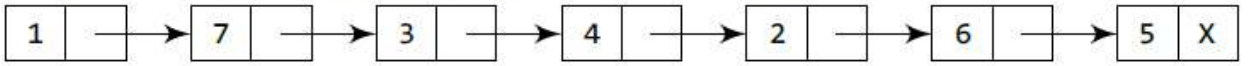
Case 2 : Deleting Last Node from Link List

START

Take pointer variables PTR and PREPTR which initially point to START.

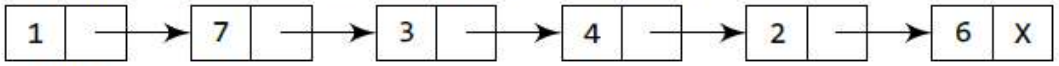
START
PREPTR
PTR

Move PTR and PREPTR such that NEXT part of PTR = NULL. PREPTR always points to the node just before the node pointed by PTR.



START PREPTR PTR

Set the NEXT part of PREPTR node to NULL.



START

Case 2 : Deleting Last Node from Link List

```
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
```

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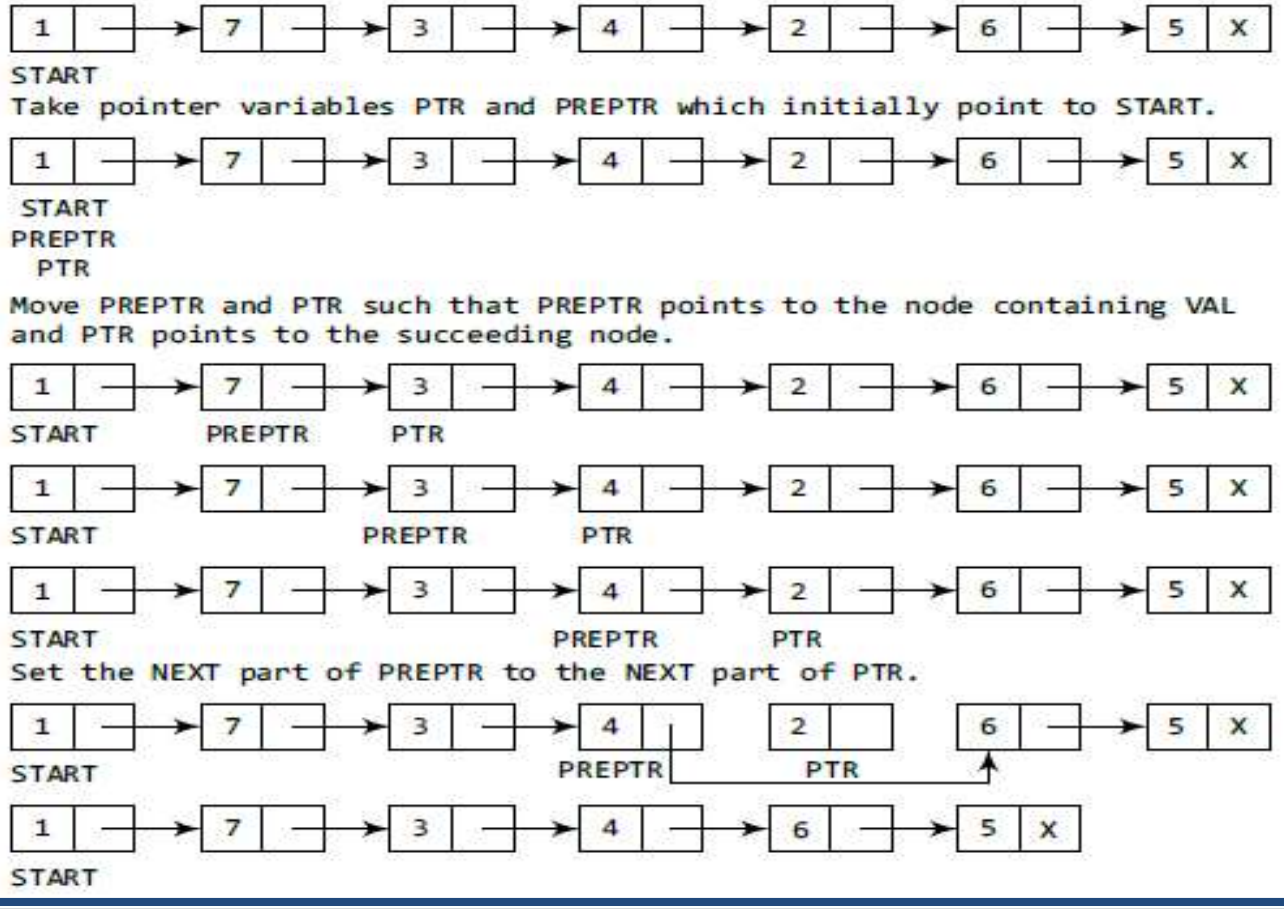
Case 2 : Deleting Last Node from Link List

- Figure shows the algorithm to delete the last node from a linked list.
- In Step 2, we take a pointer variable PTR and initialize it with START. That is, PTR now points to the first node of the linked list.
- In the while loop, we take another pointer variable PREPTR such that it always points to one node before the PTR.
- Once we reach the last node and the second last node, we set the NEXT pointer of the second last node to NULL, so that it now becomes the (new) last node of the linked list.
- The memory of the previous last node is freed and returned back to the free pool.

Case 3 :Deleting Node after a given position in Linked



Case 3 :Deleting Node after a given position in Linked

```
Step 1: IF START = NULL
            Write UNDERFLOW
            Go to Step 10
        [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
```

Case 3 :Deleting Node after a given position in Linked

- Figure shows the algorithm to delete the node after a given node from a linked list.
- In Step 2, we take a pointer variable PTR and initialize it with START. That is, PTR now points to the first node of the linked list. In the while loop, we take another pointer variable PREPTR such that it always points to one node before the PTR.
- Once we reach the node containing VAL and the node succeeding it, we set the next pointer of the node containing VAL to the address contained in next field of the node succeeding it. The memory of the node succeeding the given node is freed and returned back to the free pool.