DOUBLE LINKED LIST

Teaching Team of Algorithm and Data Structure

Learning Outcome

- Students must be able to understand basic concept of double linked list
- Students must be able to have a good knowledge of steps for implementing double linked list to solve a problem

Topics

- Double linked list basic concept
- Declaring double linked list
- Adding node
- Deleting node
- Inserting node

Double Linked List

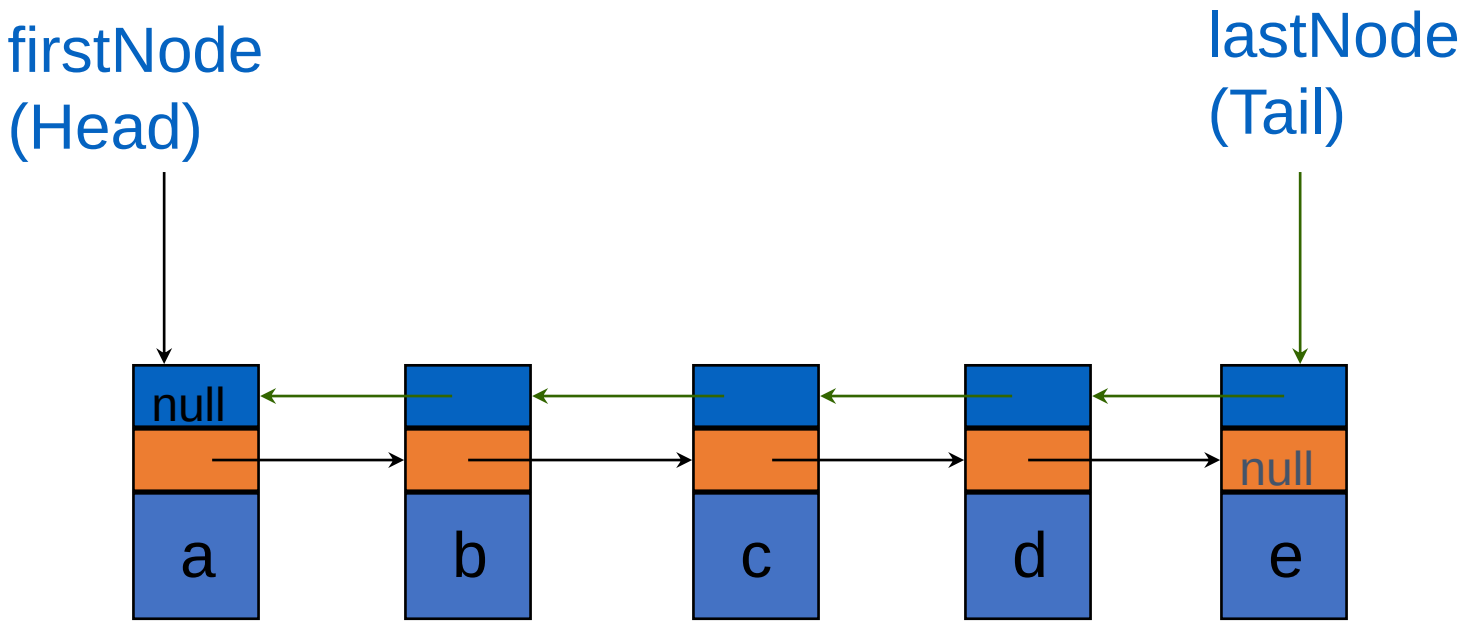
- Double : means there are 2 fields of pointer(link). One points to the next node while another points to the previous node.
- Traversal can run in 2 ways (start form head to tail, or start form tail to head)
- Pointer **next** : links current node to the next node.
- Pointer **prev** : links current node to the previous node.

Node "Double"

- If there is only one node, then next and prev will point to NULL
- Feasible to perform 2 ways traversal:
  1. head to tail
  2. tail to head

Double Linked List

- First node (head) has the pointer prev that points to NULL.
- Last node (tail) has the pointer next that points to NULL.

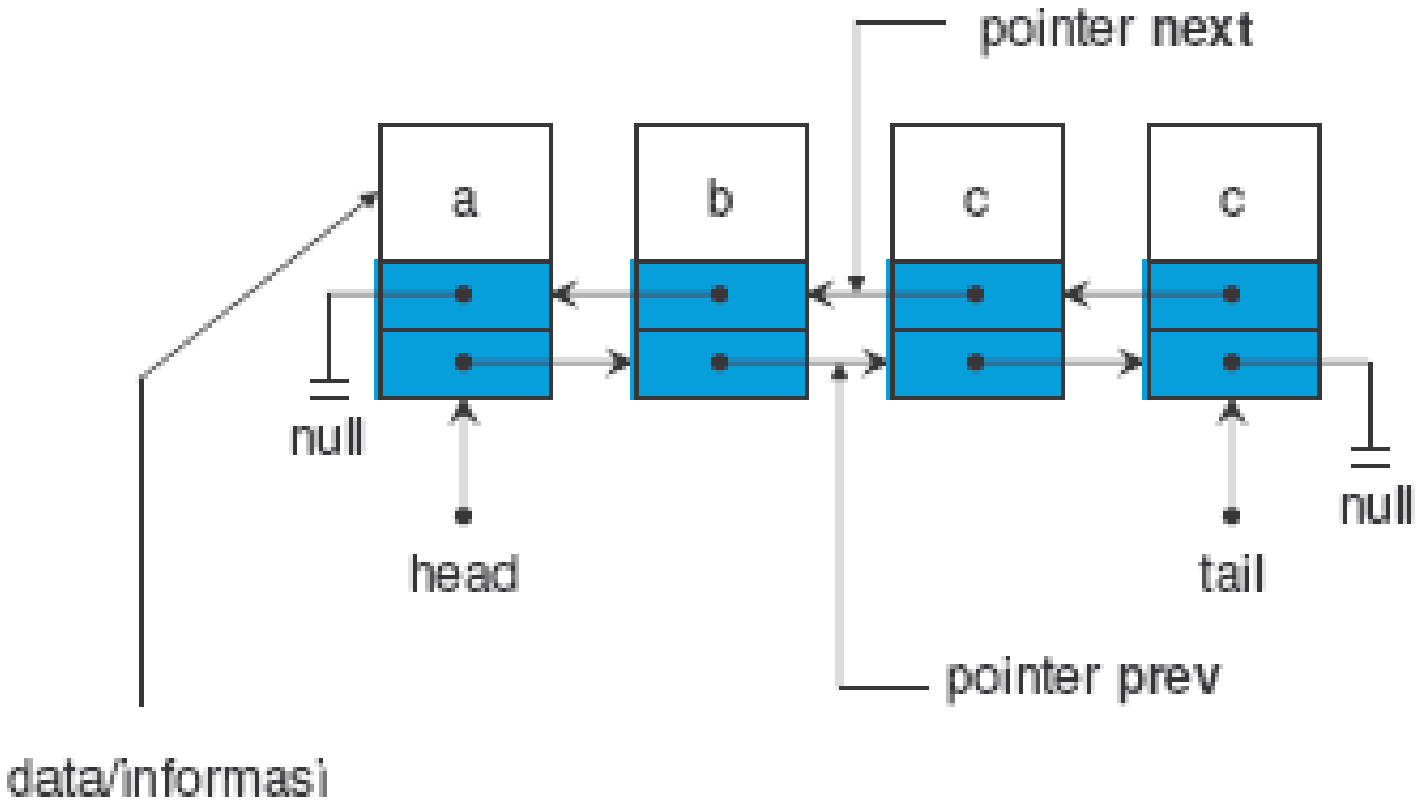


Head and Tail

- Head : a reference to the first node
- Tail : a reference to the last node

Double Linked List

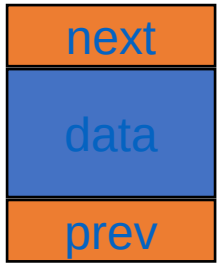
- Example: There are 4 nodes in a double linked list:



“Double” Representation

```
class Node2P
{
        int data; // data
        Node2P next;       // pointer next
        Node2P prev;       // pointer prev
}
```

Illustration :

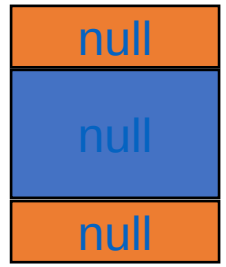


- **data** : save a data.
- **next**: refers/links to the next node
- **prev**: refers/links to the previous node

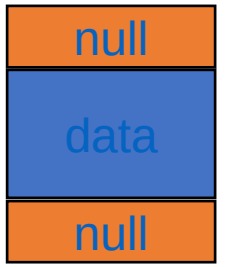
Class Node

```
public class Node2P {
  int data;
  Node2P next;
  Node2P previous;

  Node2P() {}

  Node2P(int theData)
    { data = theData;}

  Node2P(int theData, Node2P thePrevious, Node2P theNext)
  {
     data= theData;
     prev = thePrevious;
     next = theNext;
  }
}
```

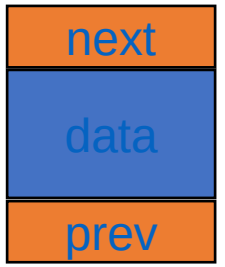
Constructor 1



Constructor 2

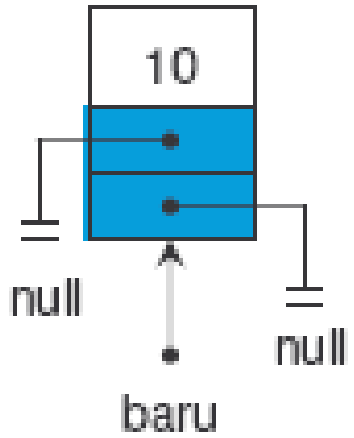


Constructor 3



Node Instantiation

```
Node2P baru = new Node2P(10);
```



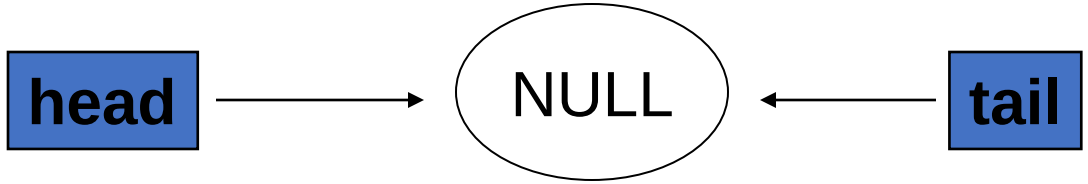
Linked List Operation

1. initialization
2. isEmpty
3. size
4. addition
5. deletion
6. insertion
7. sarching
8. accessing

(1) Initialization

```
Node2P head = null;
Node2P tail= null;
```

There is still no node in a double linked list



(2)isEmpty

Is a double linked list currently empty?

```
boolean isEmpty()
{
    return size==0;
}
```

(3) size

This method will return the size of double linked list. Or how many node is in a linked list?

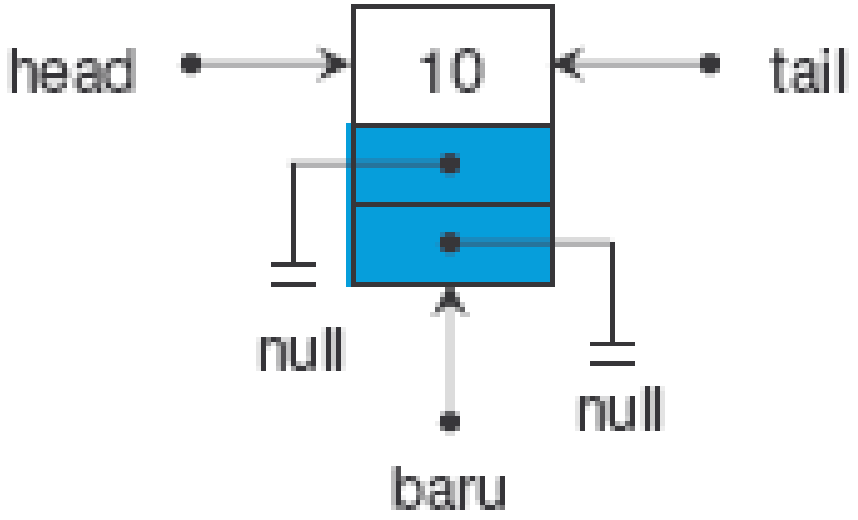
```
int size()
{
    return size;
}
```

(4) Addition

1. Add First
2. Add Last
3. Add After/Before a node

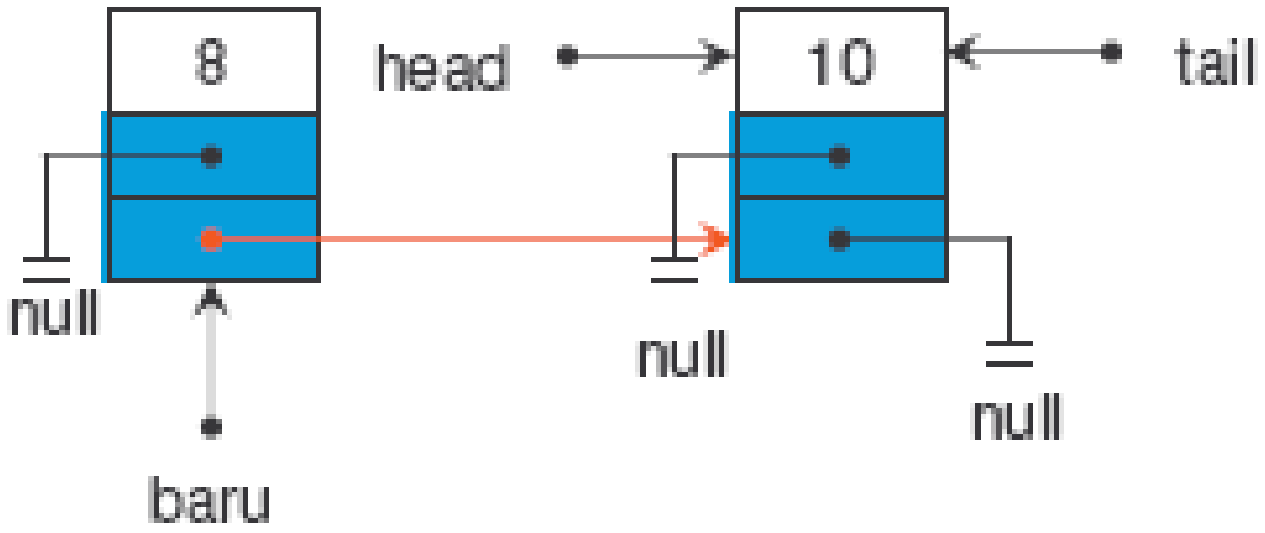
Add a node in an empty linked list

- head = tail= baru



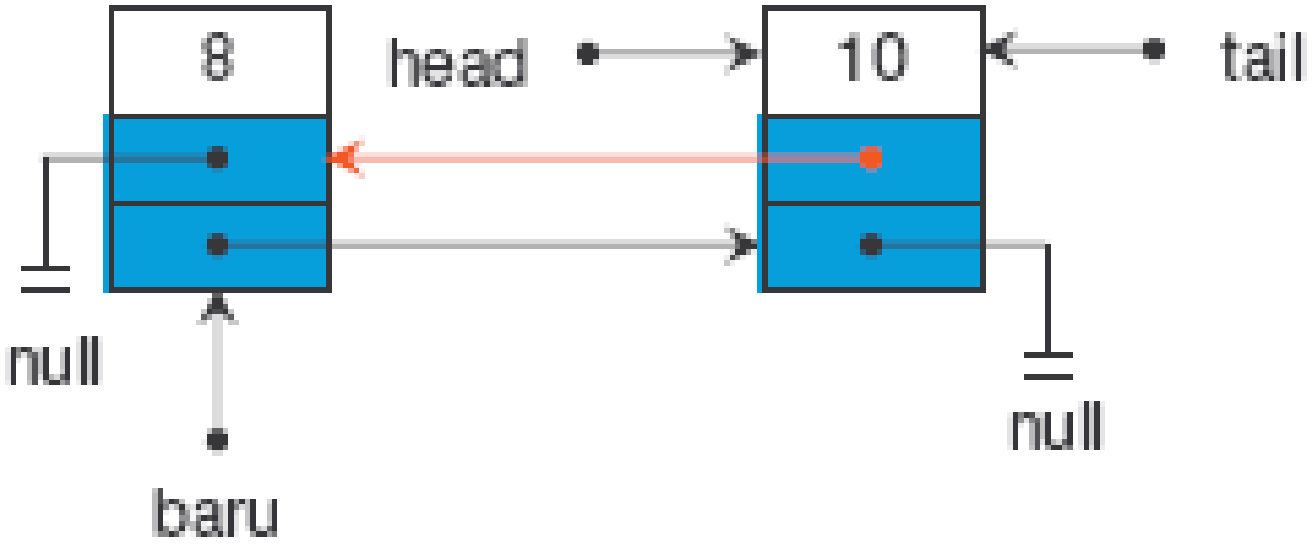
Add First

1. Baru.next = head



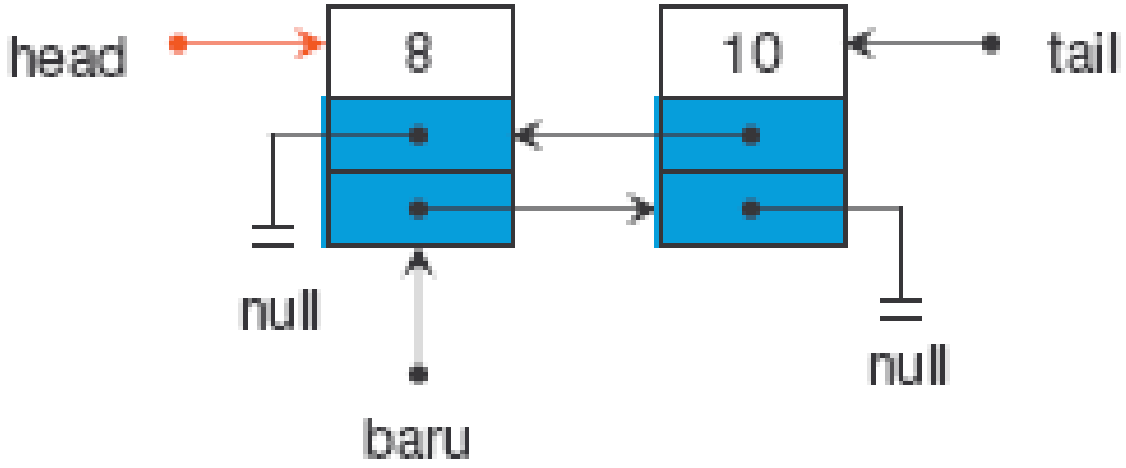
Add First

2. head.prev = Baru



Add First

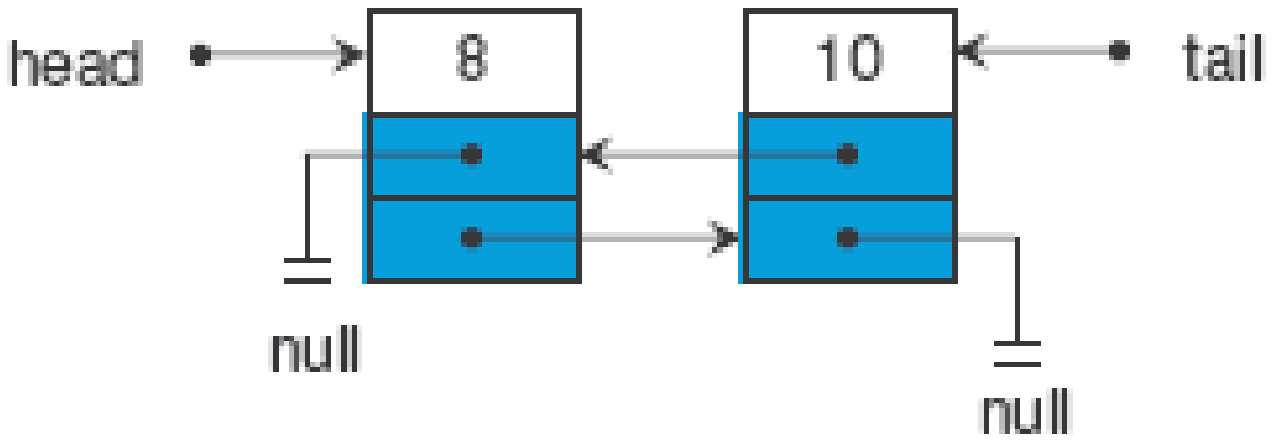
3. head = baru



Add First

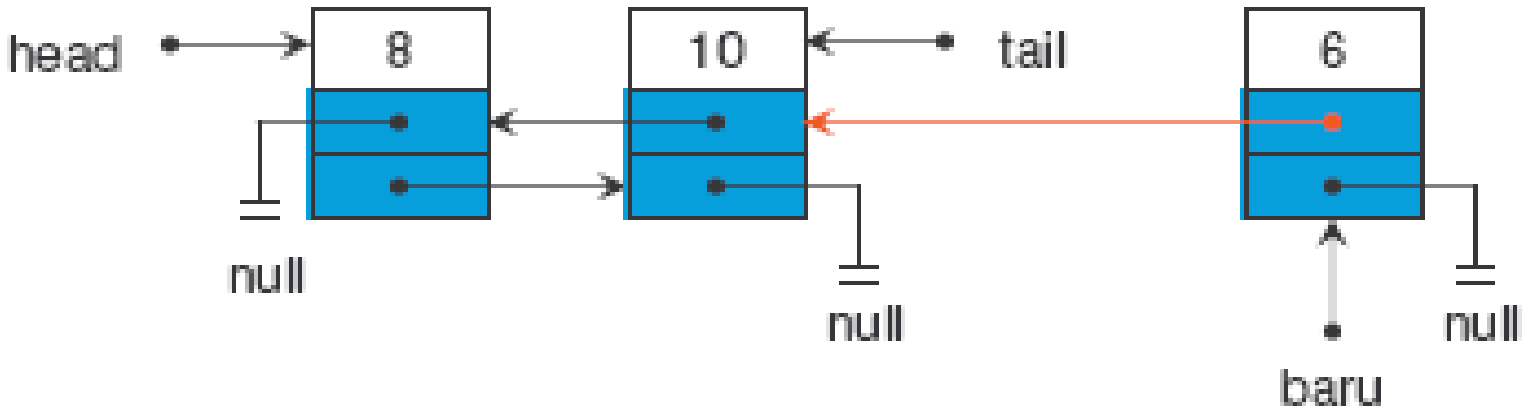
```
void addFirst(Node2P input){
        if (isEmpty()){
            head=input;
            tail=input;
        }
        else
        {
            input.next = head;
            head.previous = input;
            head = input;
        } size++;
    }
```

Add Last



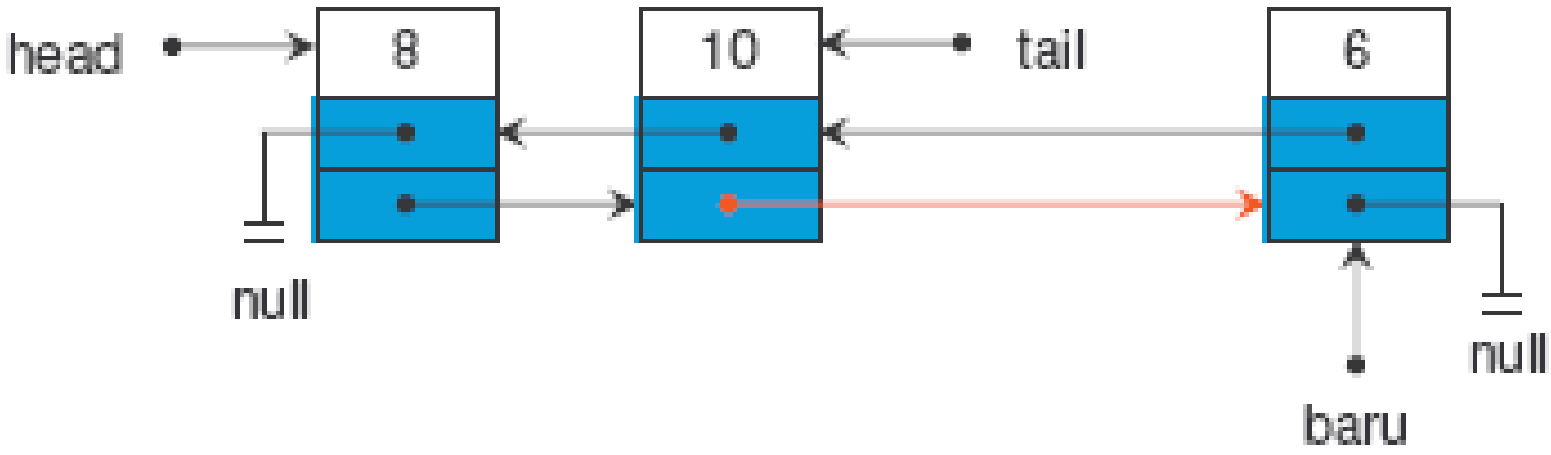
Add Last

1. Baru.prev = tail



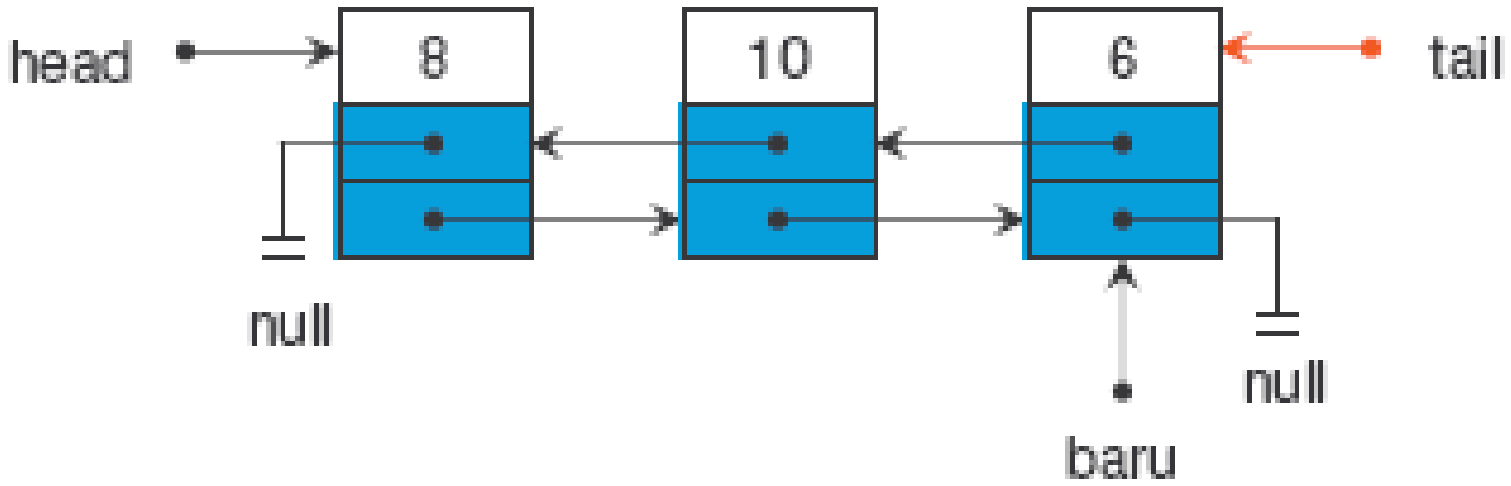
Add Last

2. tail.next = Baru



Add Last

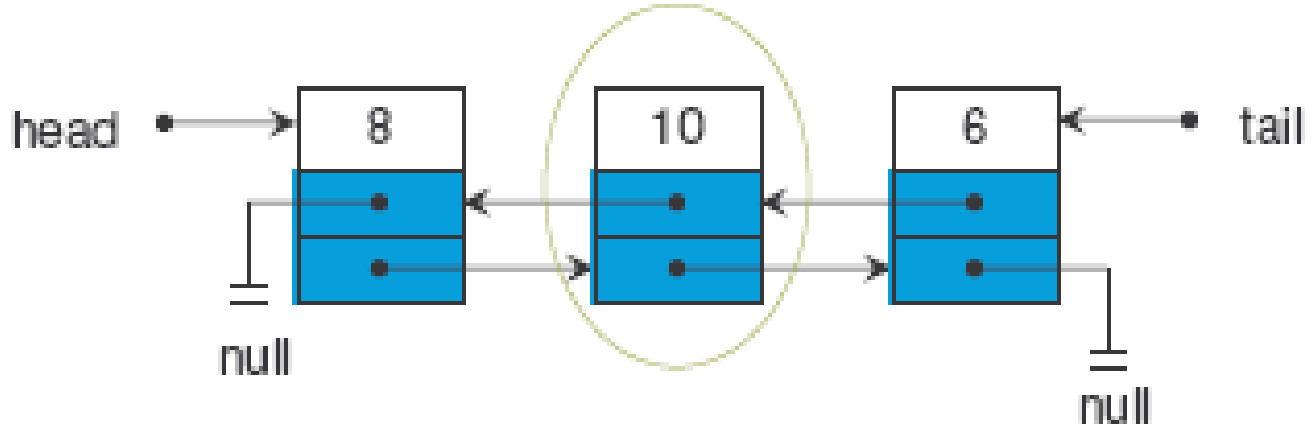
3. tail= Baru



Add Last

```
void addLast(Node2P input){
        if (isEmpty()){
            head = input;
            tail = input;
        }
        else
        {
        input.previous = tail;
        tail.next = input;
        tail = input;
        } size++;
    }
```

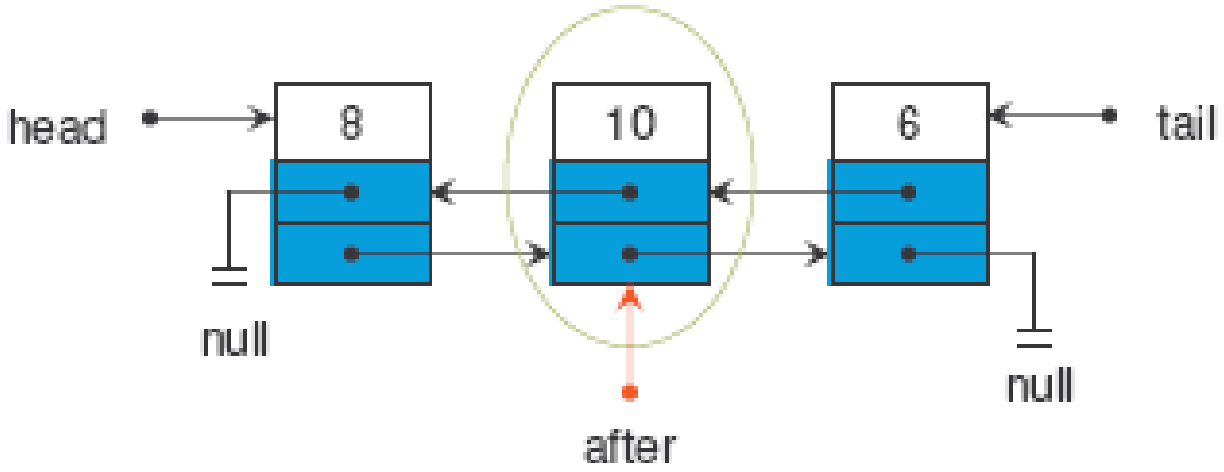
Add After Node x



Add After Node x

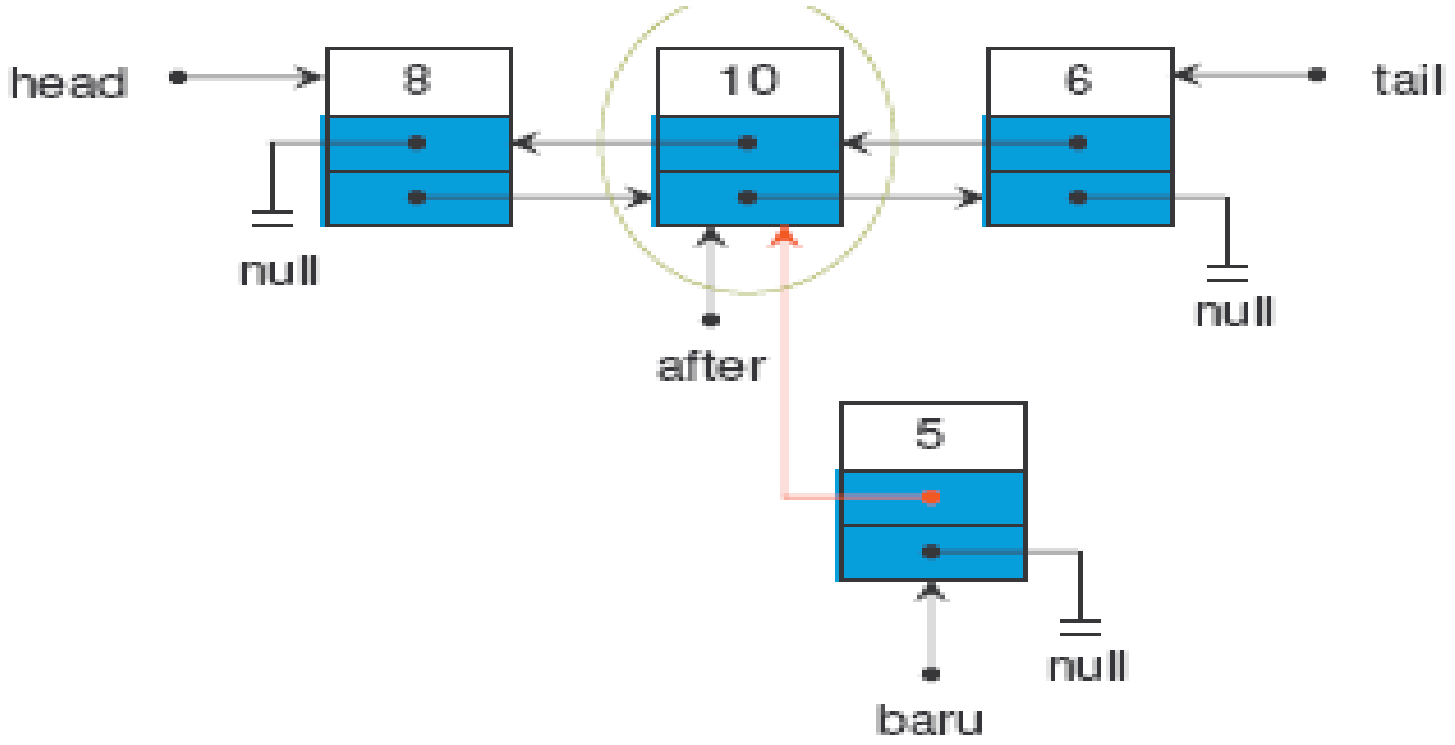
We need a new reference **after.** Initialize **after** to **head** and shift it until the node x.

1. Node after = head;



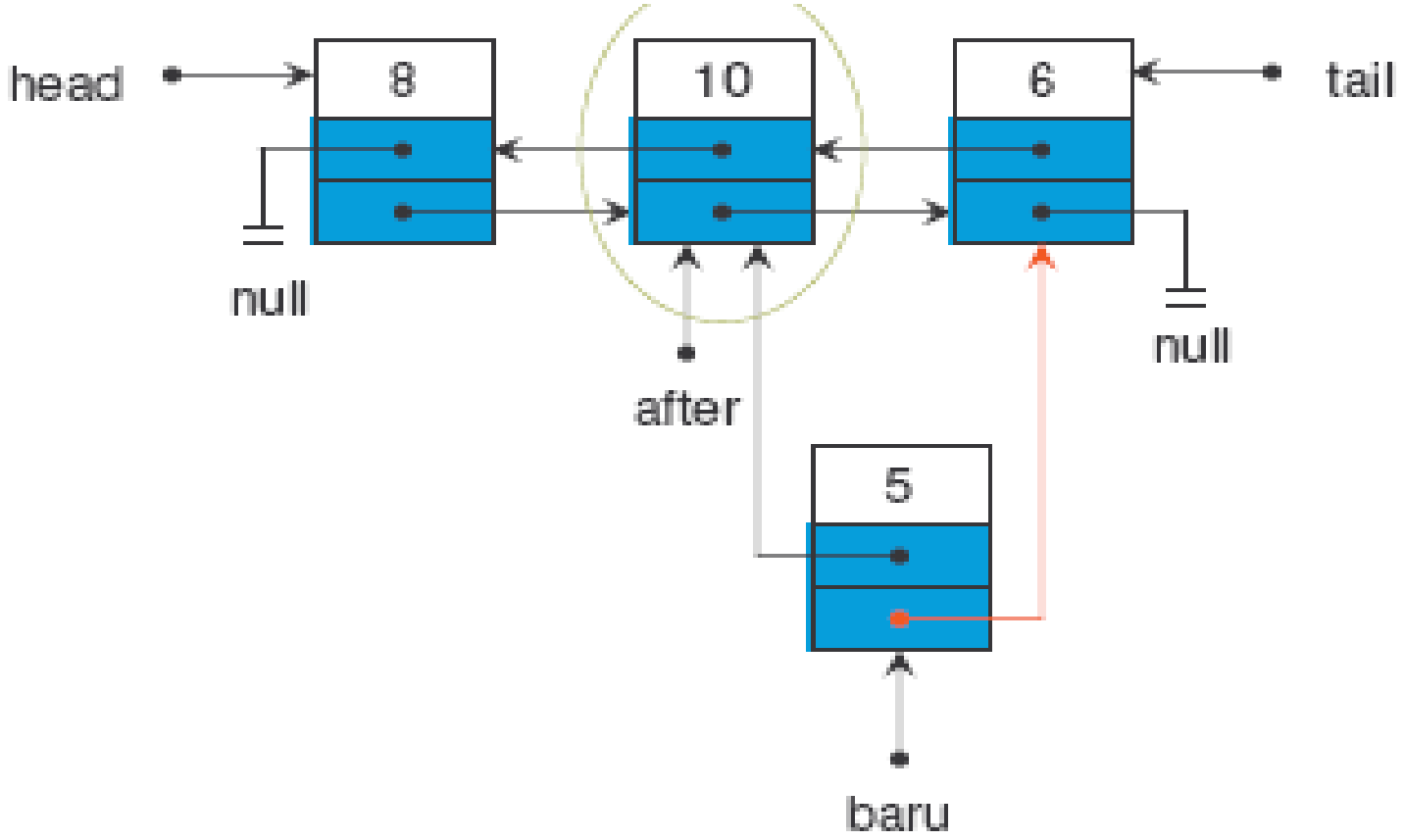
Add After Node x

2. Baru.prev = after



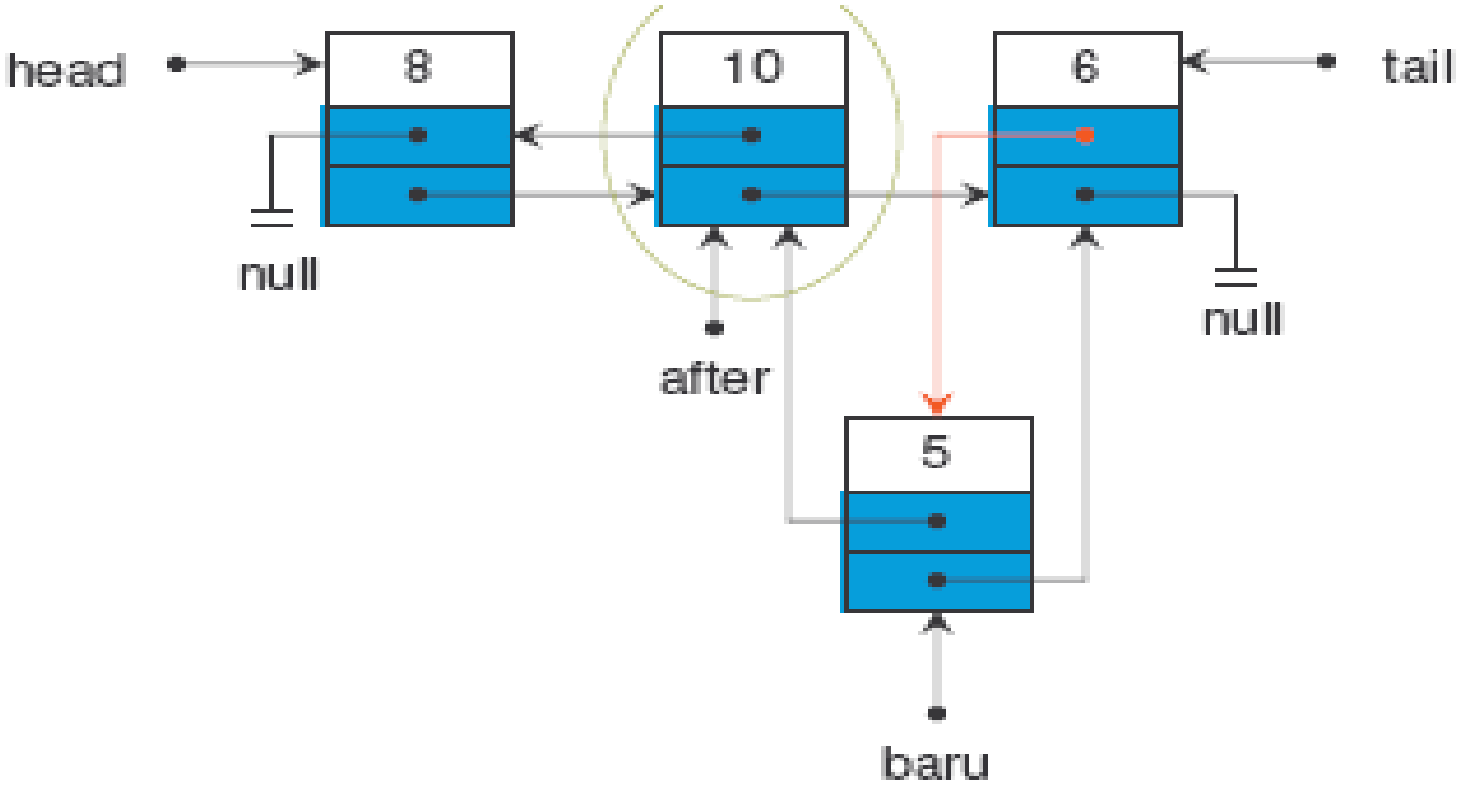
Add After Node x

3. Baru.next = after.next



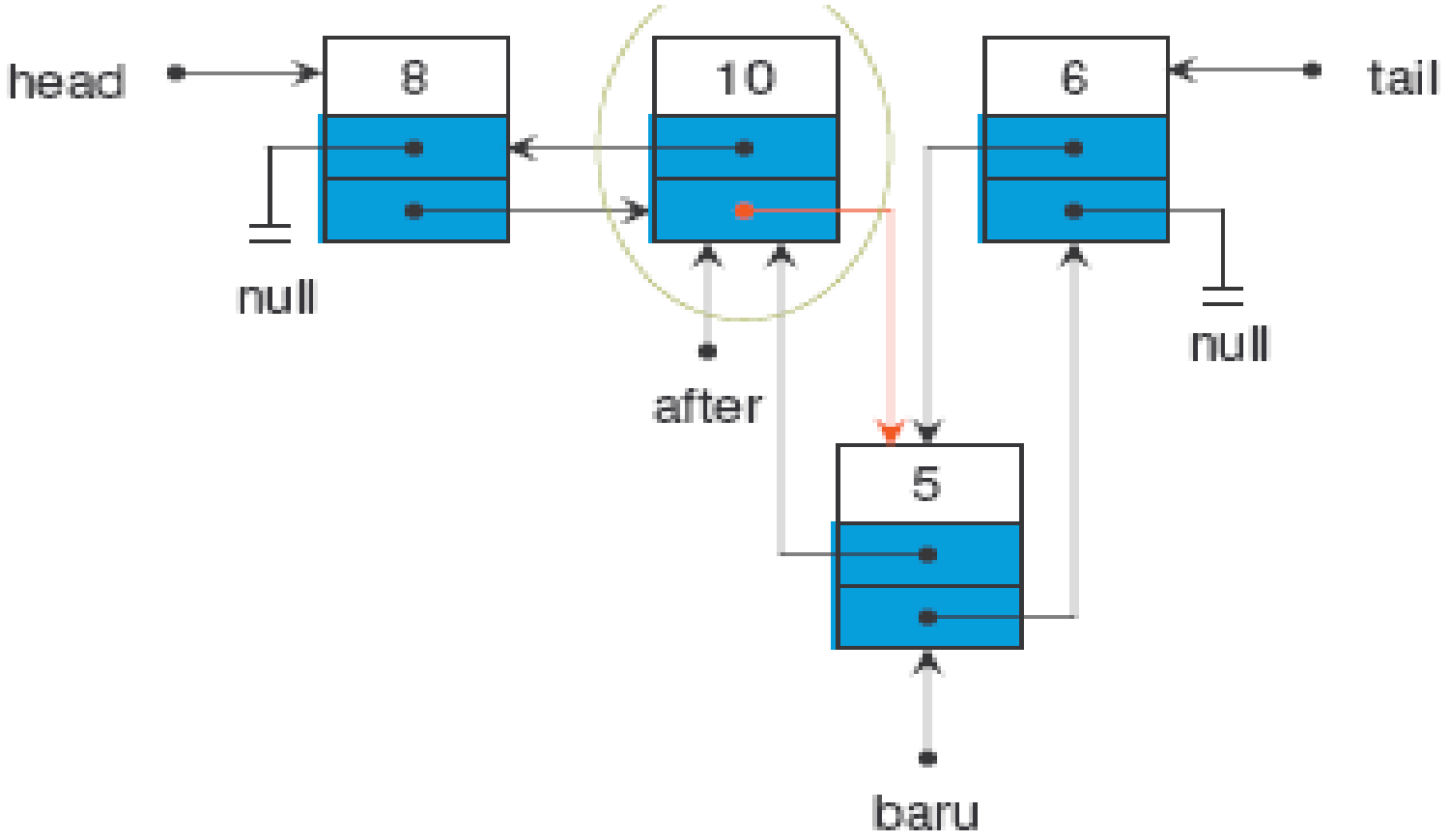
Add After Node x

4. after.next.prev = Baru



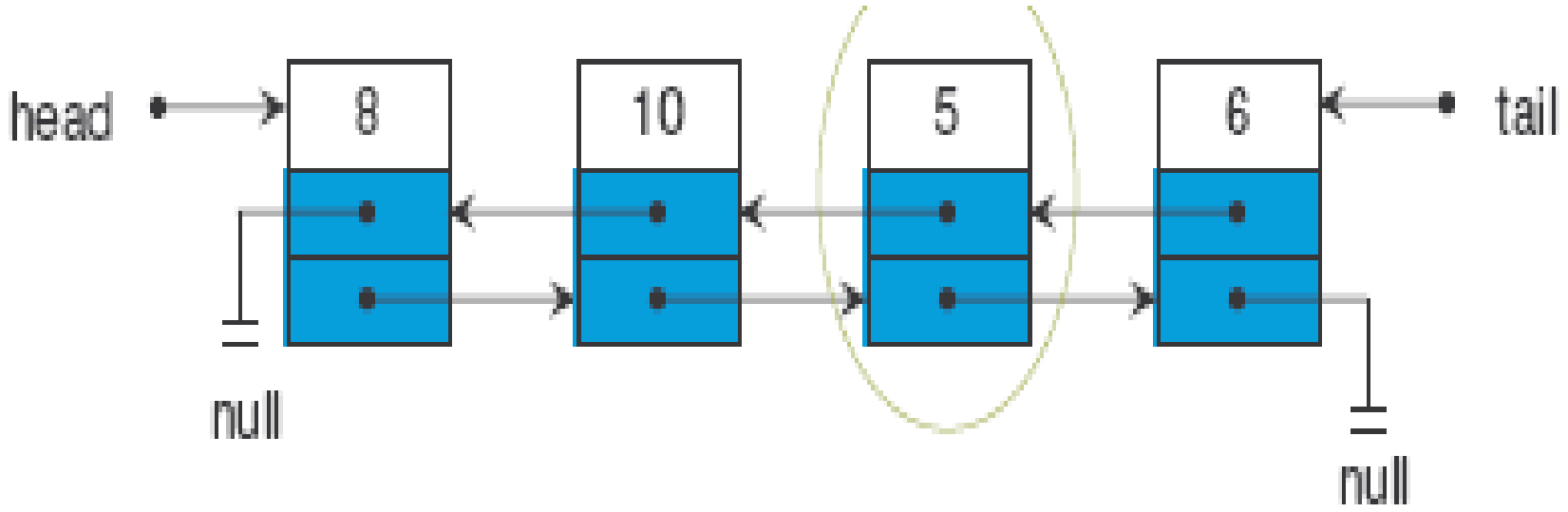
Add After Node x

5. after.next = Baru



Add After Node x

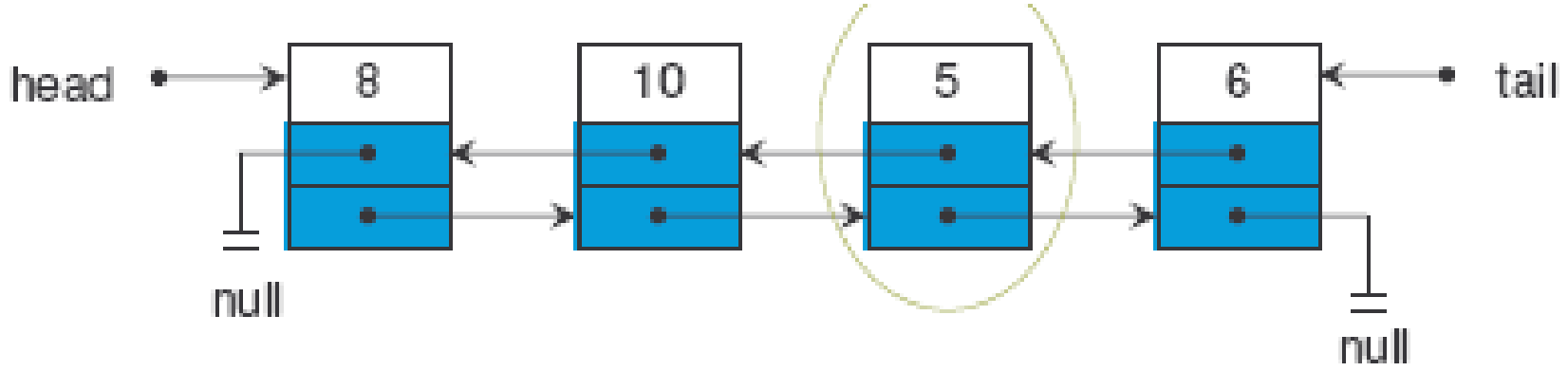
Final Result



Add After Node x

```
void insertAfter(Object key,Node2P input){
        Node2P temp = head;
        do{
            if(temp.data==key){
                input.previous = temp;
                input.next = temp.next;
                temp.next.previous = input;
                temp.next = input;
                size++;
                System.out.println("Insert data is succeed.");
                break;
            }
            temp = temp.next;
        }while (temp!=null);
    }
```

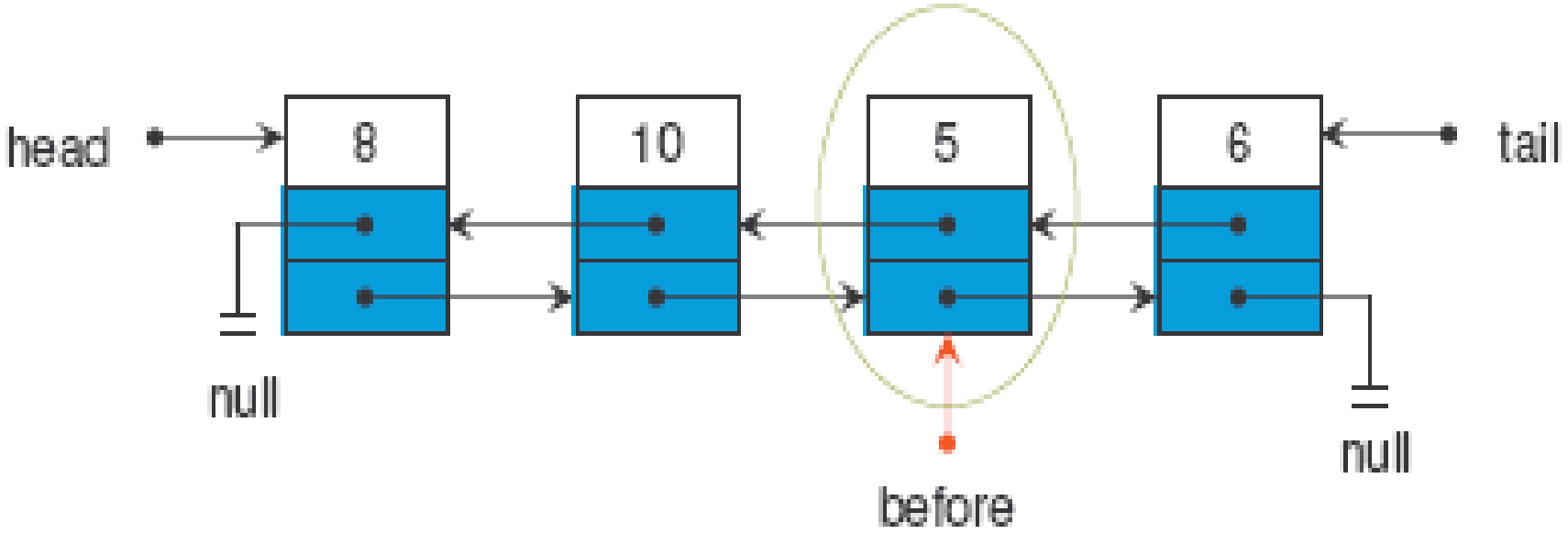
Add Before Node x



Add Before Node x

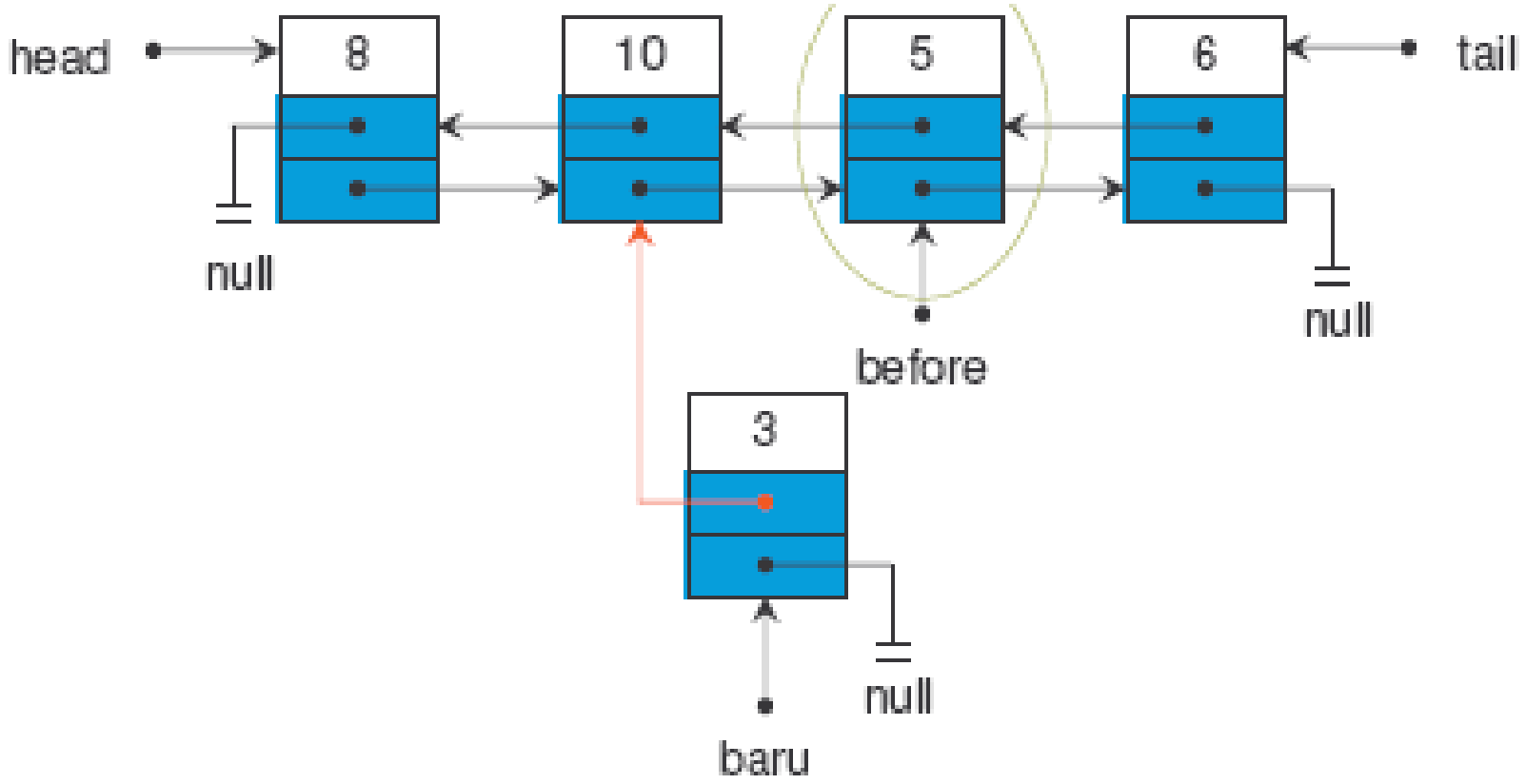
1. Node **before** = head;

   pointer **before** is firstly initialized to **head**, and it is then shifted to the correct location.



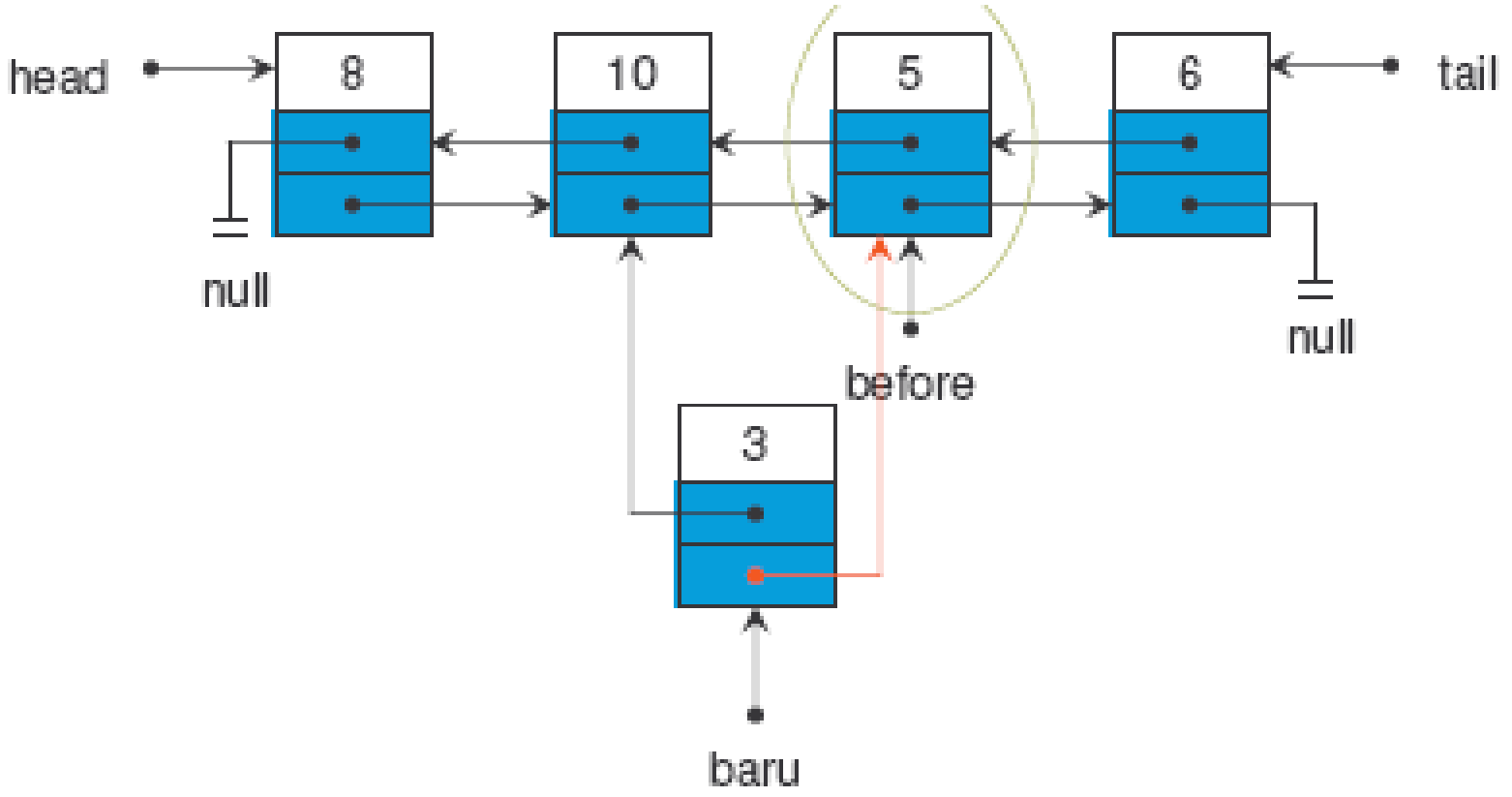
Add Before Node x

2. Baru.prev = before.prev



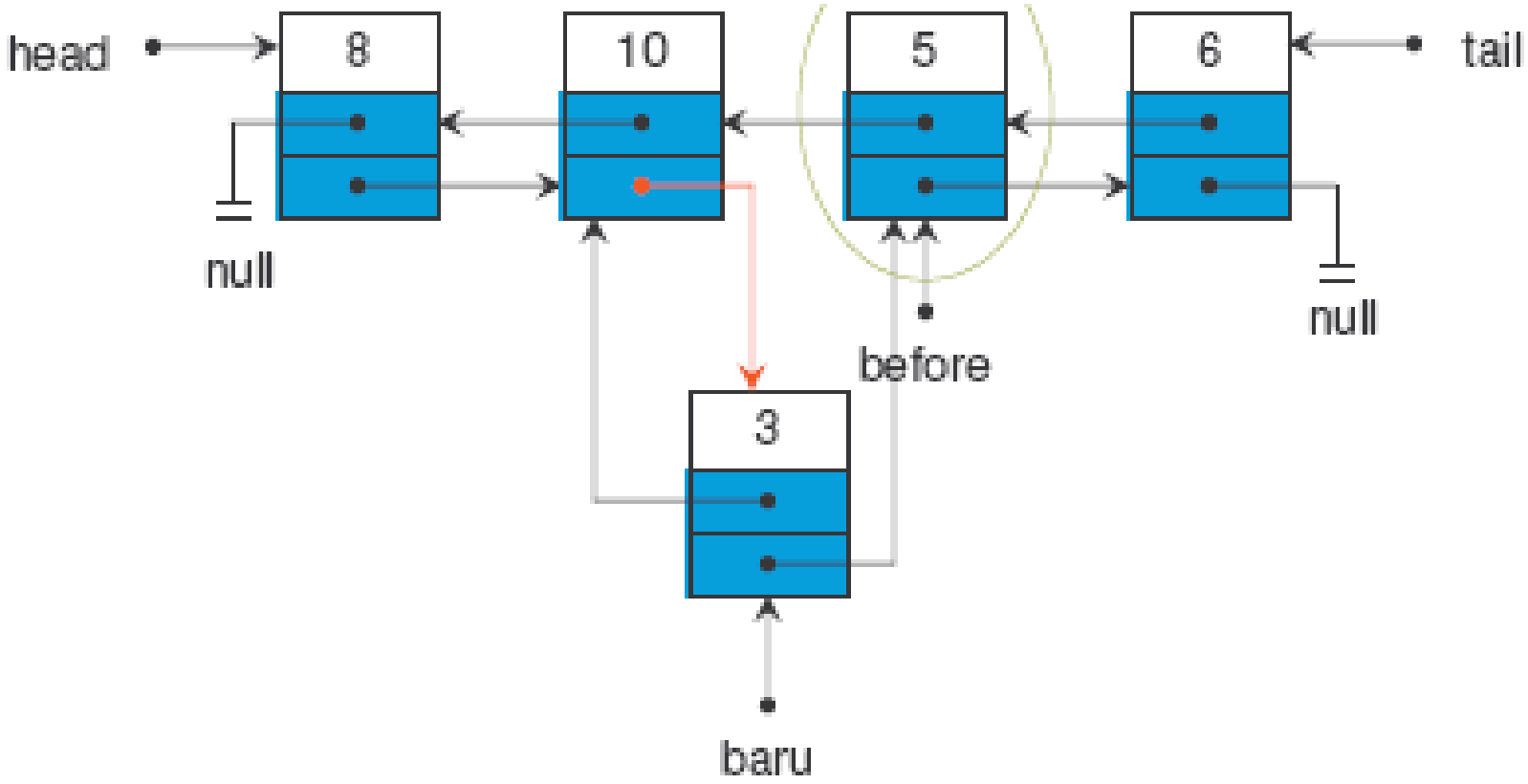
Add Before Node x

3. Baru.next = before



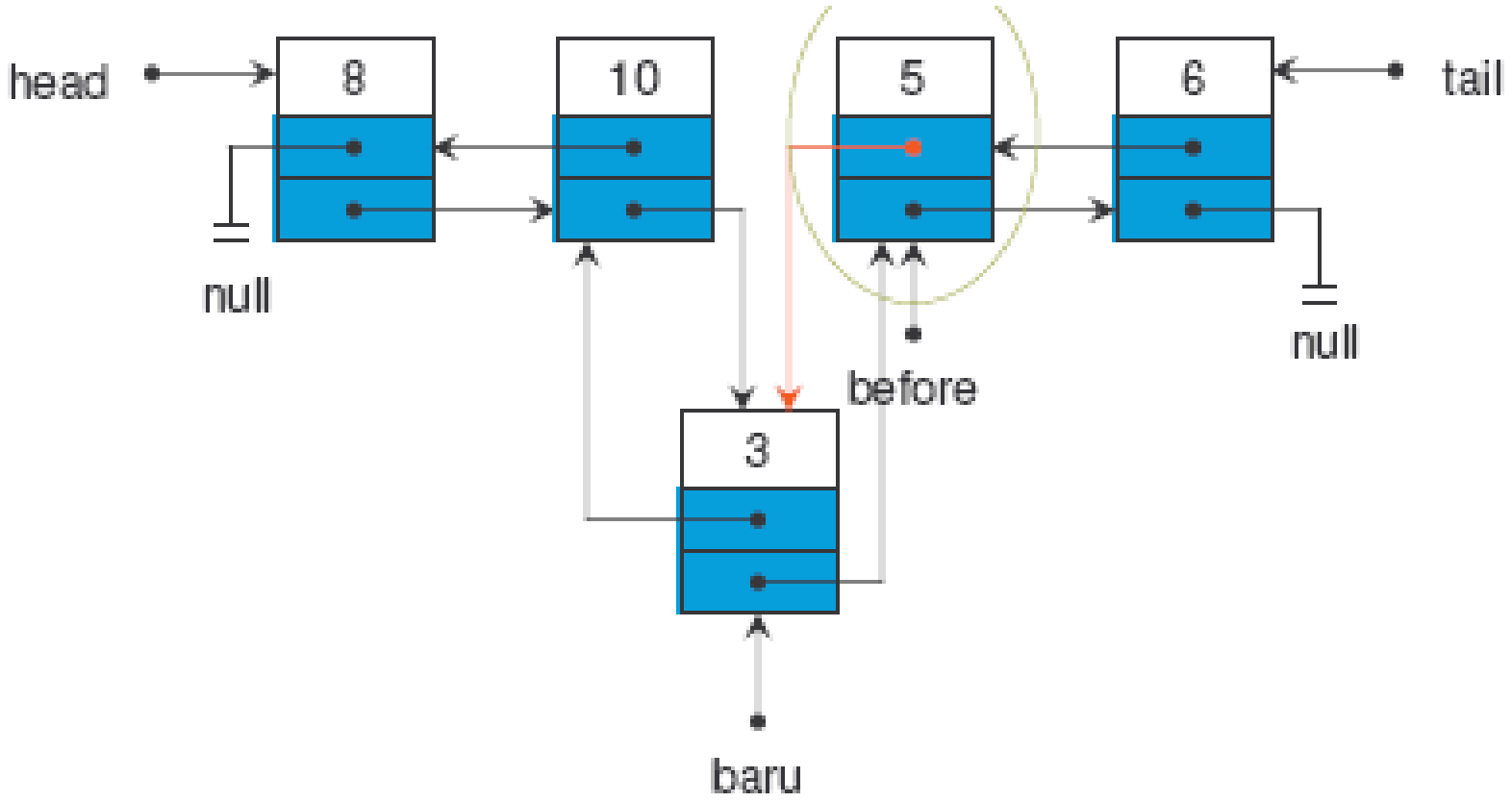
Add Before Node x

4. before.prev.next = Baru



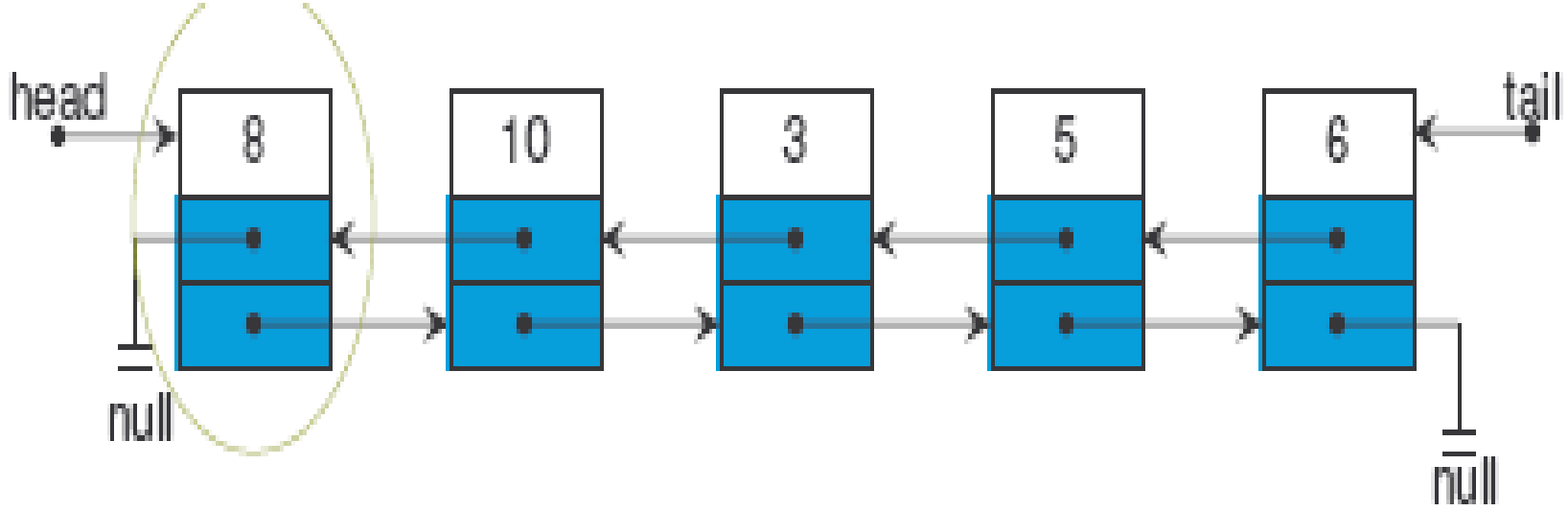
Add Before Node x

5. before.prev = Baru



Add Before Node x

Final Result:



Add Before Node x

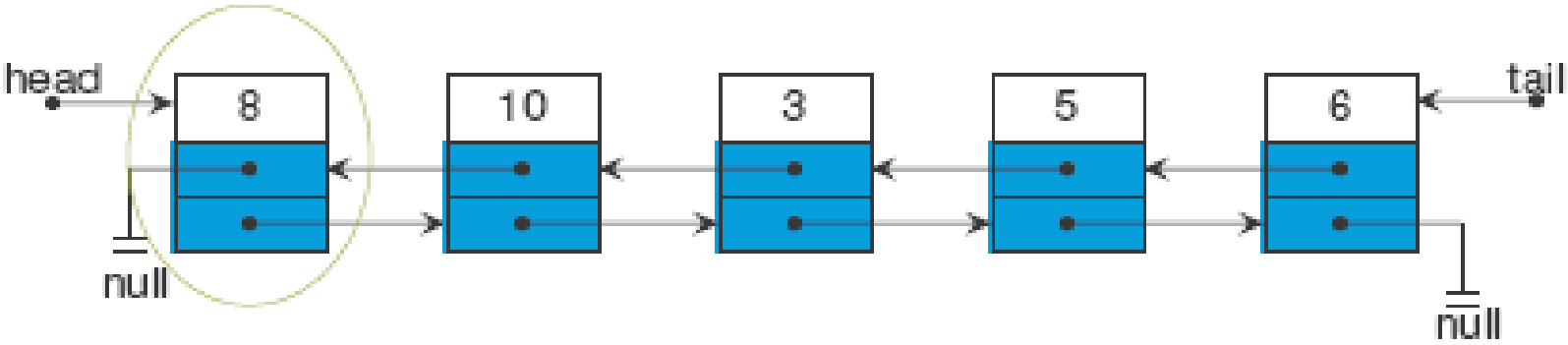
```
void insertBefore(Object key,Node2P input){
        Node2P temp = head;
        while (temp != null){
            if (temp.data == key)
            {
                if(temp == head)
                {
                    this.addFirst(input);
                    System.out.println("Insert data is succeed.");
                    size++;
                    break;
                }
                else
                {
                    input.previous = temp.previous;
                    input.next = temp;
                    temp.previous.next = input;
                    temp.previous = input;
                    System.out.println("Insert data is succeed.");
                    size++;
                    break;
                }
            }
            temp = temp.next;
        }
```

(5) Deletion

- Dibedakan menjadi :

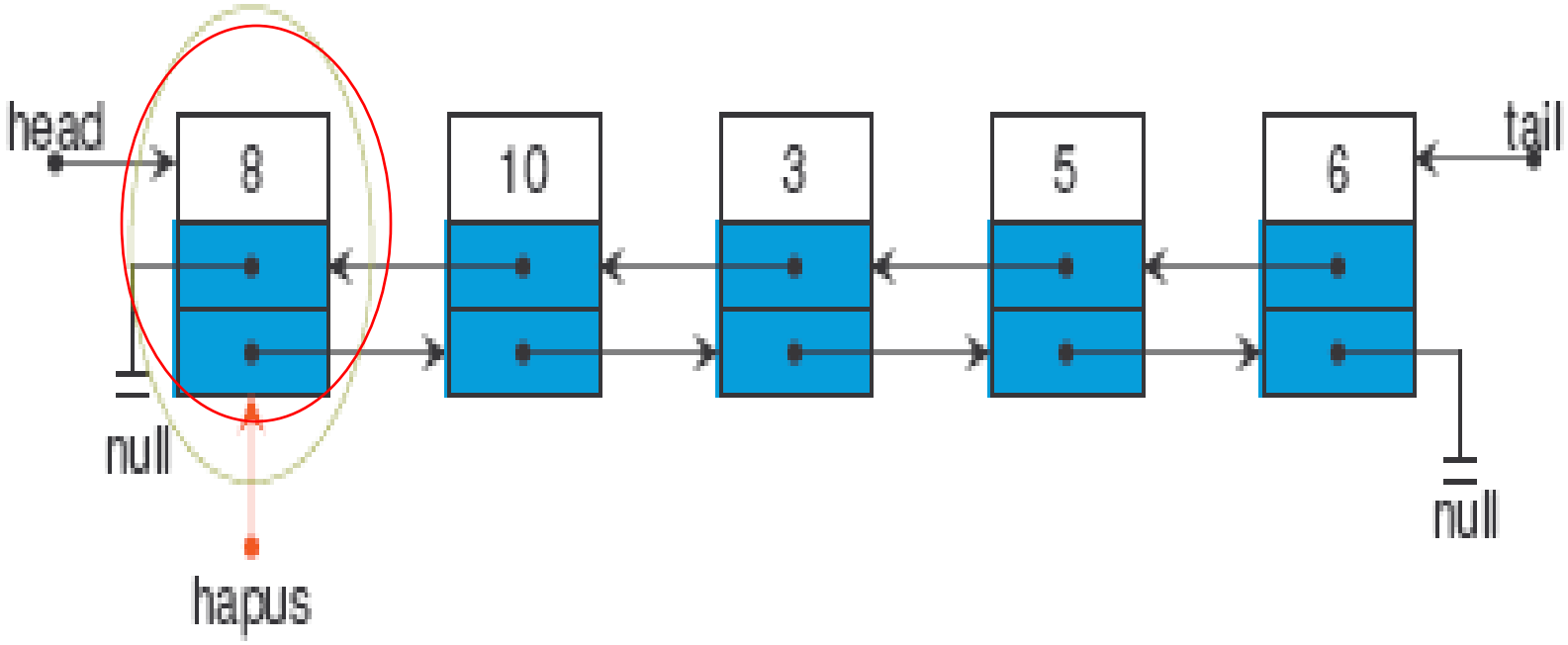
1. Delete First
2. Delete Last
3. Delete

Delete First



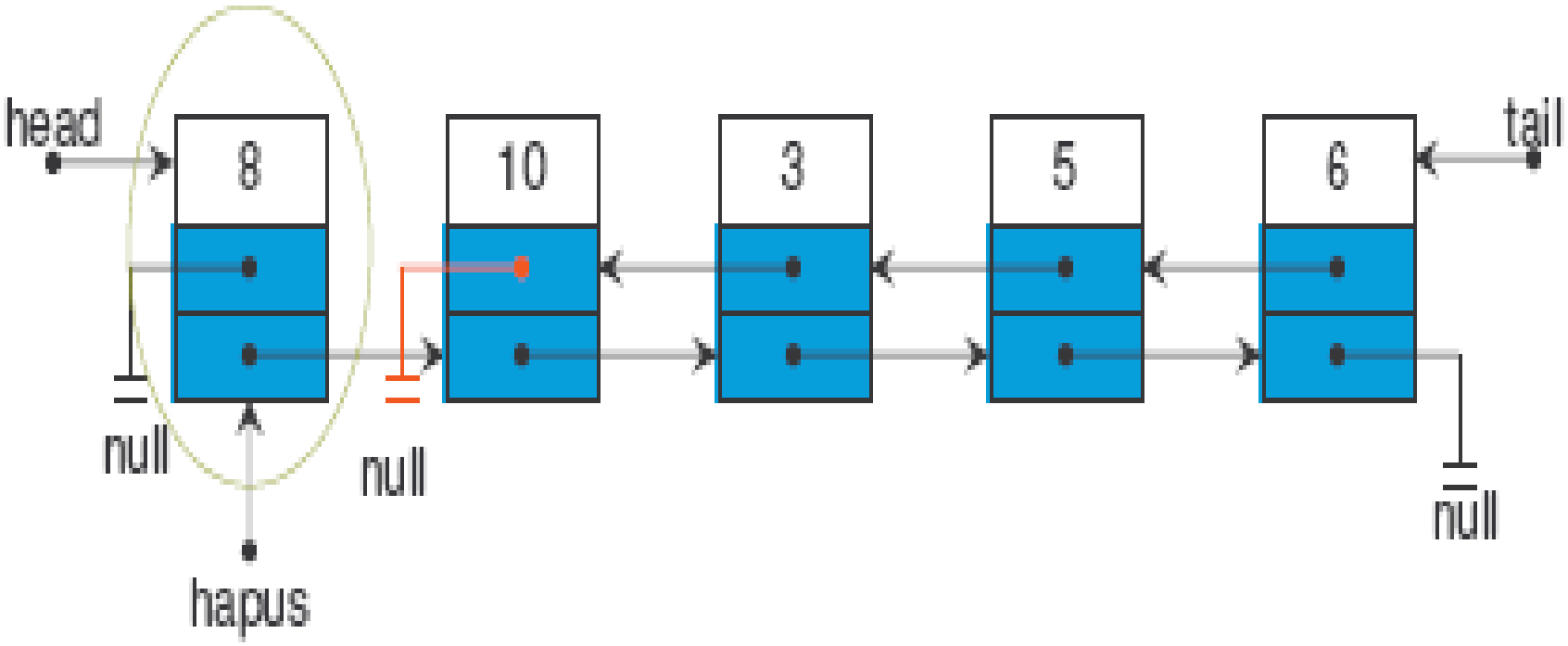
Delete First

1. Node hapus = head;



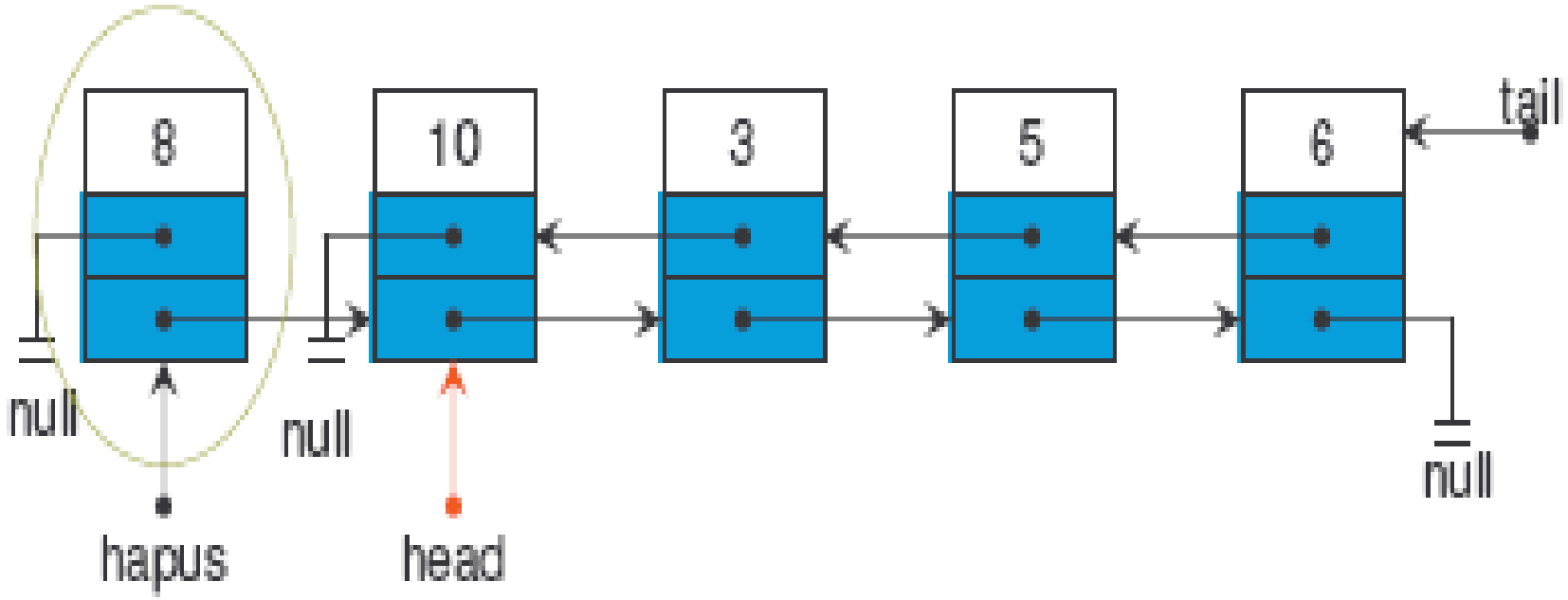
Delete First

2. head.next.prev = null



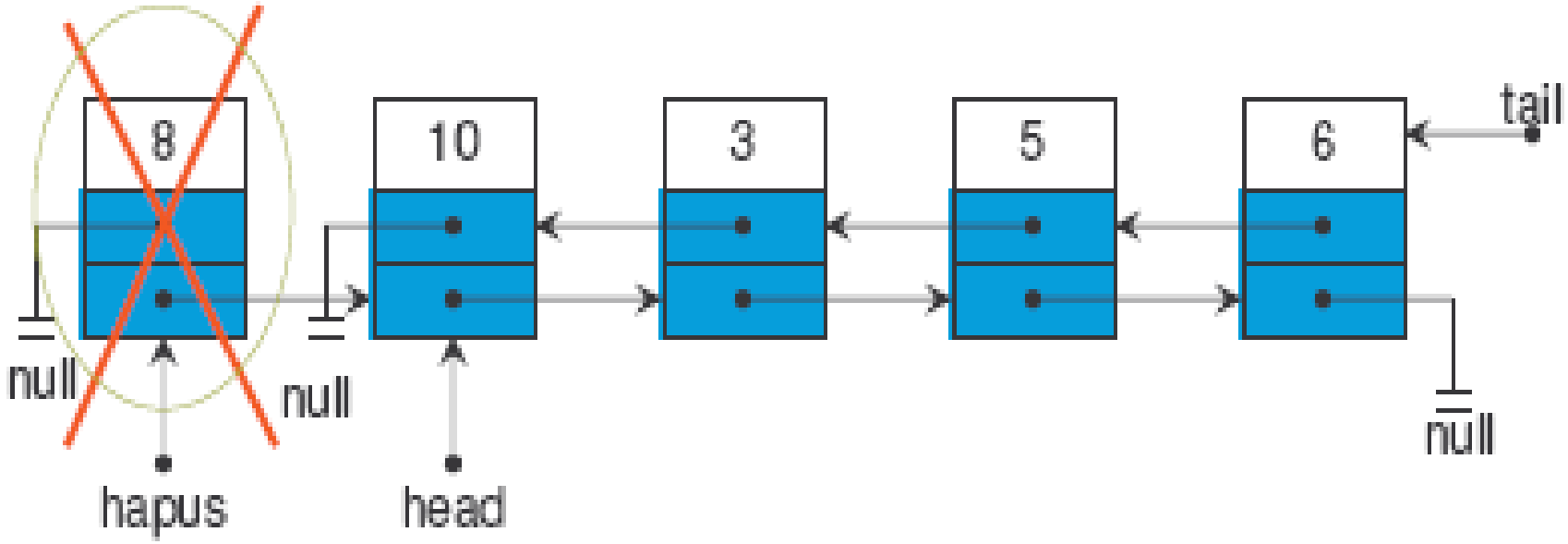
Delete First

3. head = hapus.next



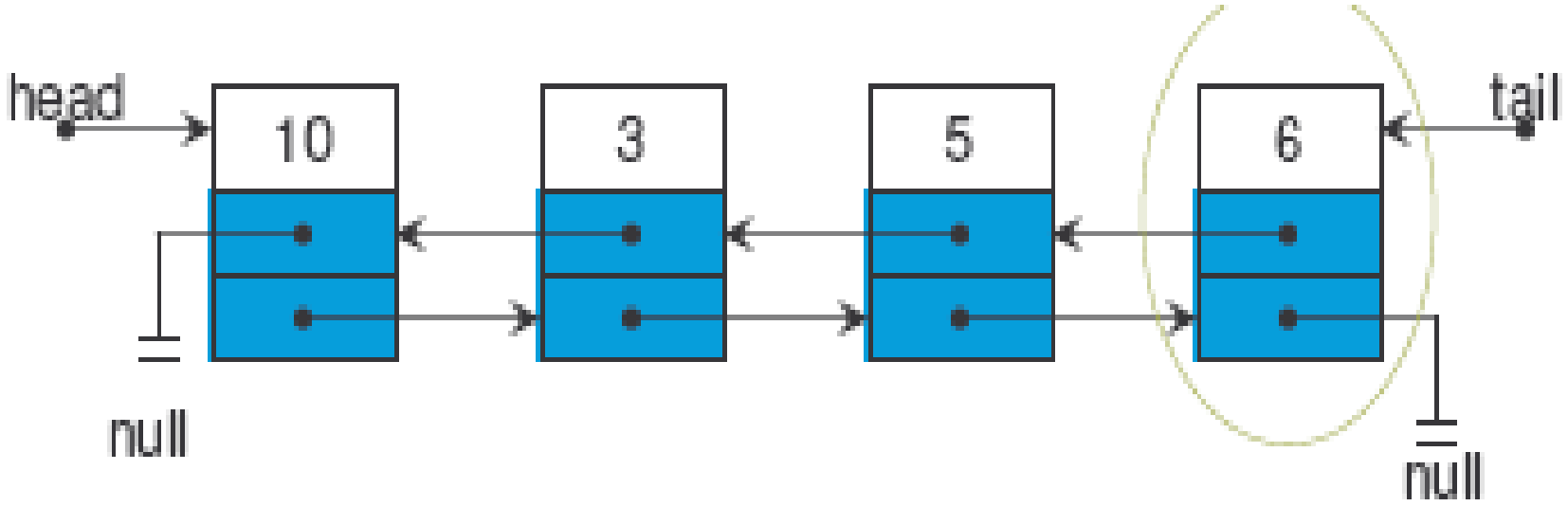
Delete First

Node 8 sudah terhapus



Delete First

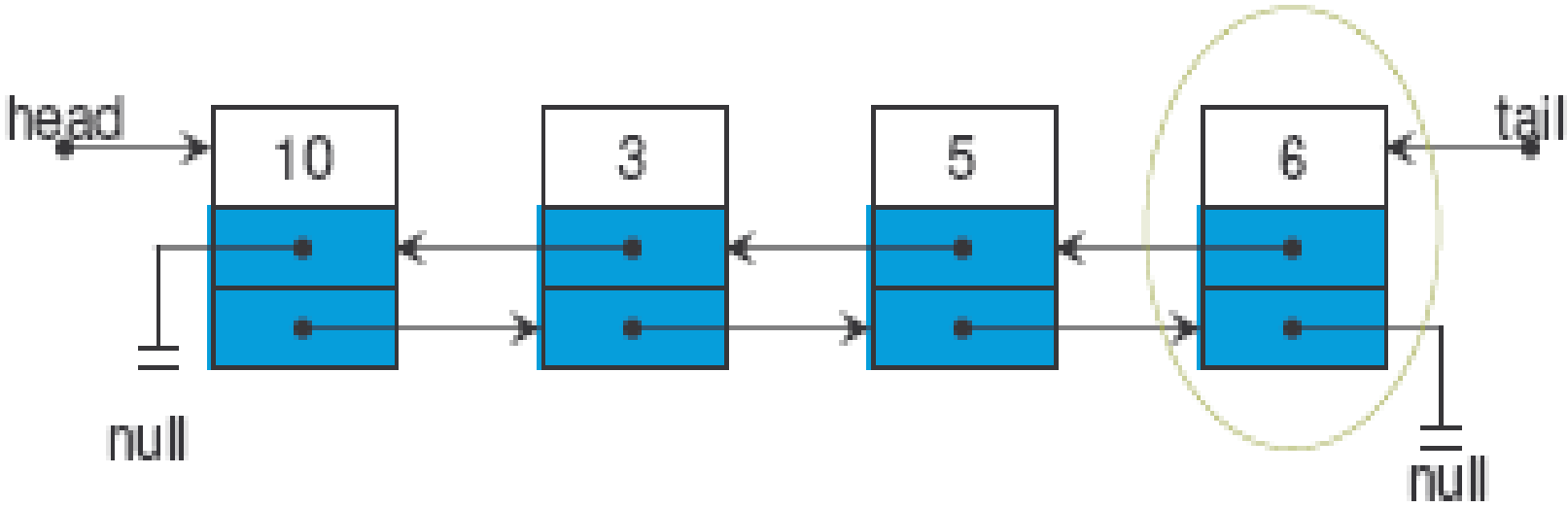
Hasil akhir :



Delete First

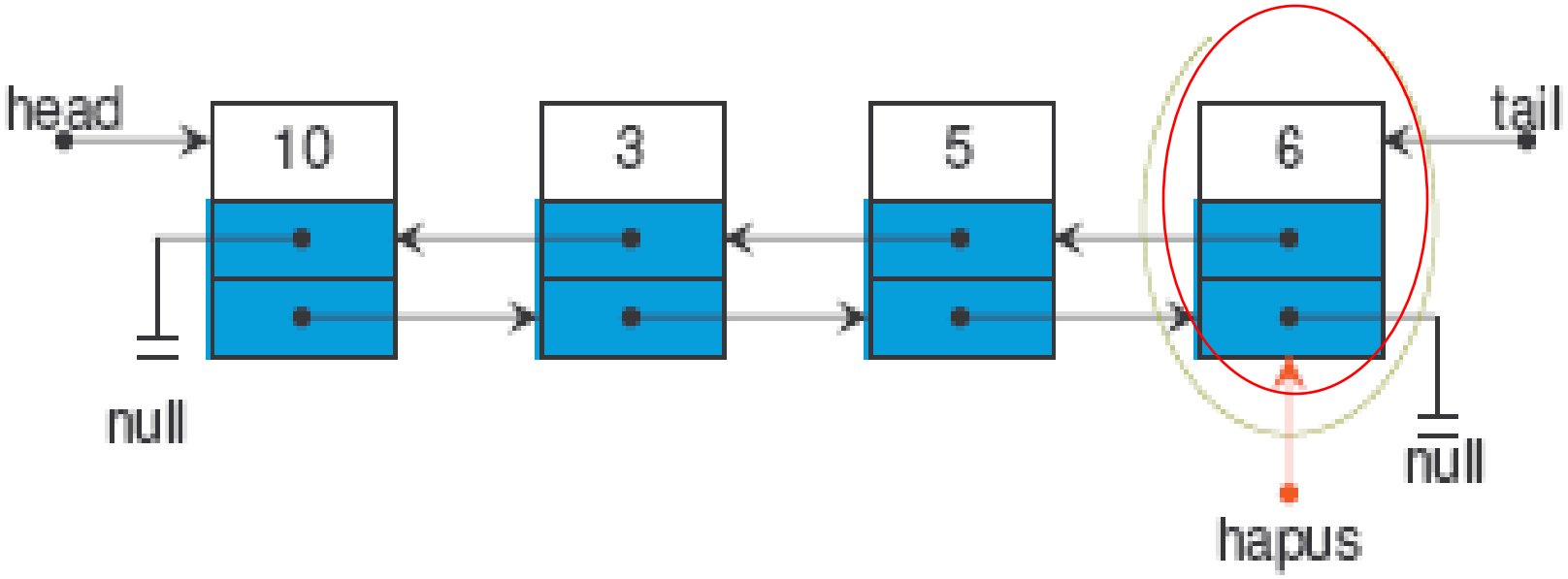
```
void removeFirst(){
        Node2P temp = head;
        if (!isEmpty()){
            if (head == tail)
                head = tail = null;
            else
            {
                head.next.previous = null;
                head = temp.next;
            } size--;
        }
        else
            System.out.println("Data is empty!");

    }
```

Delete Last



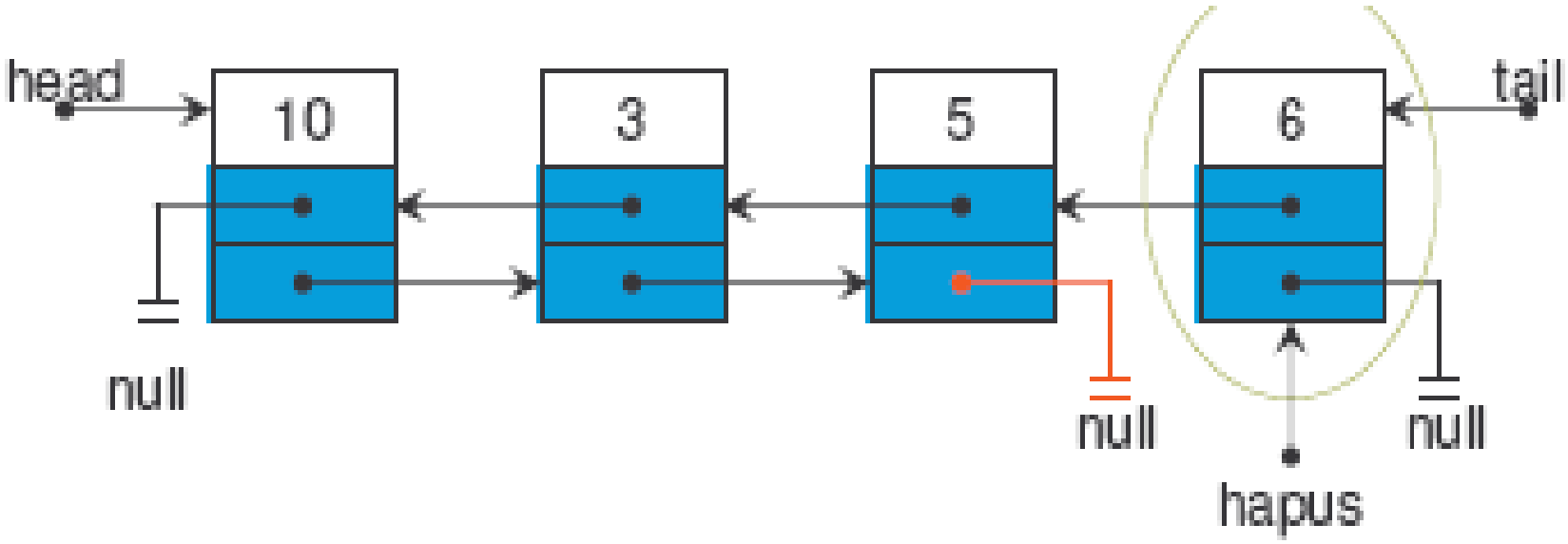
Delete Last

1. Node hapus=tail;



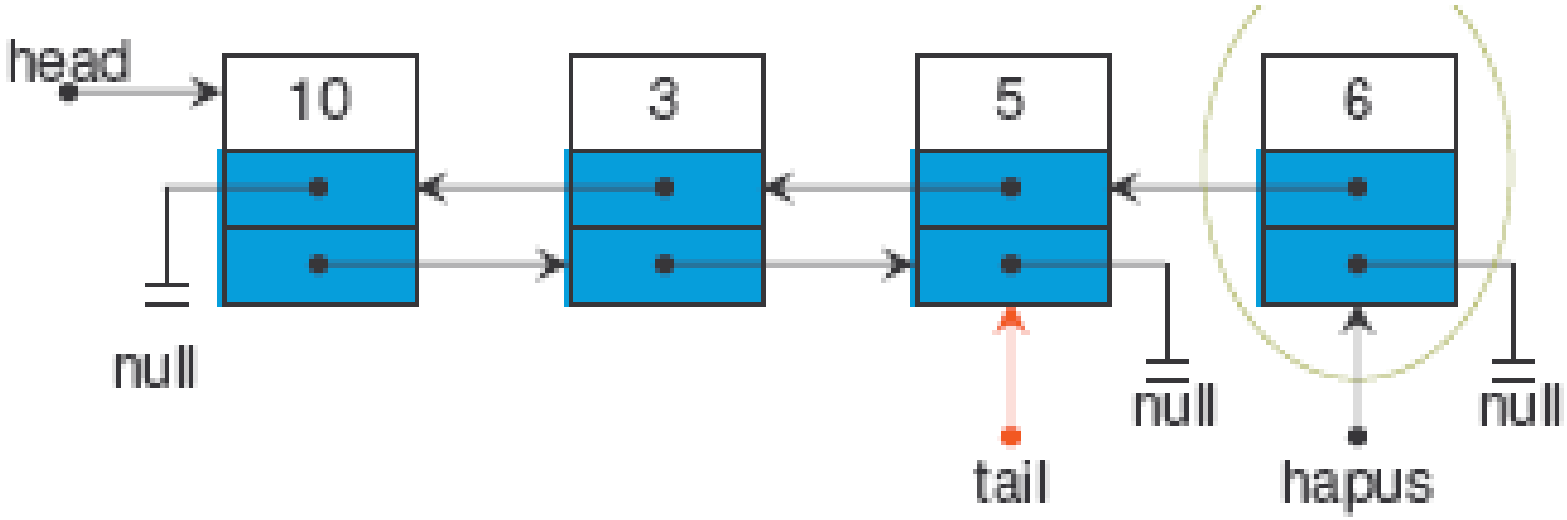
Delete Last

2. tail.prev.next = null



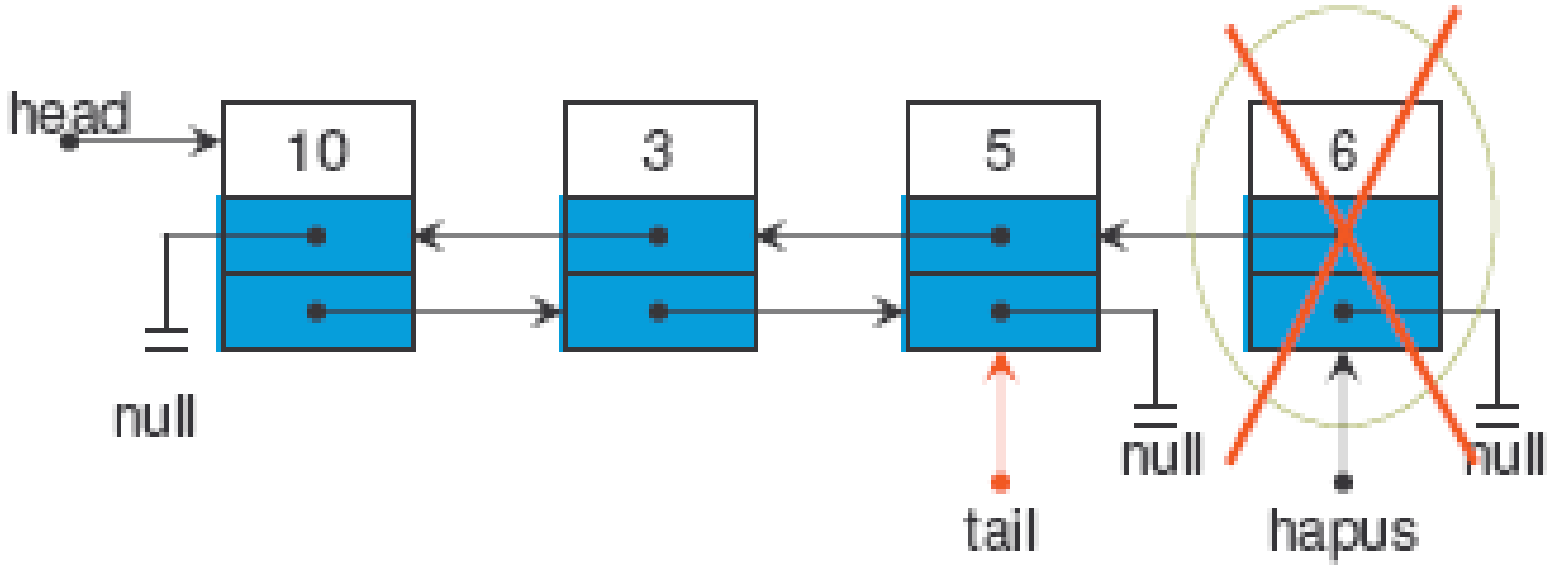
Delete Last

3. tail= hapus.prev

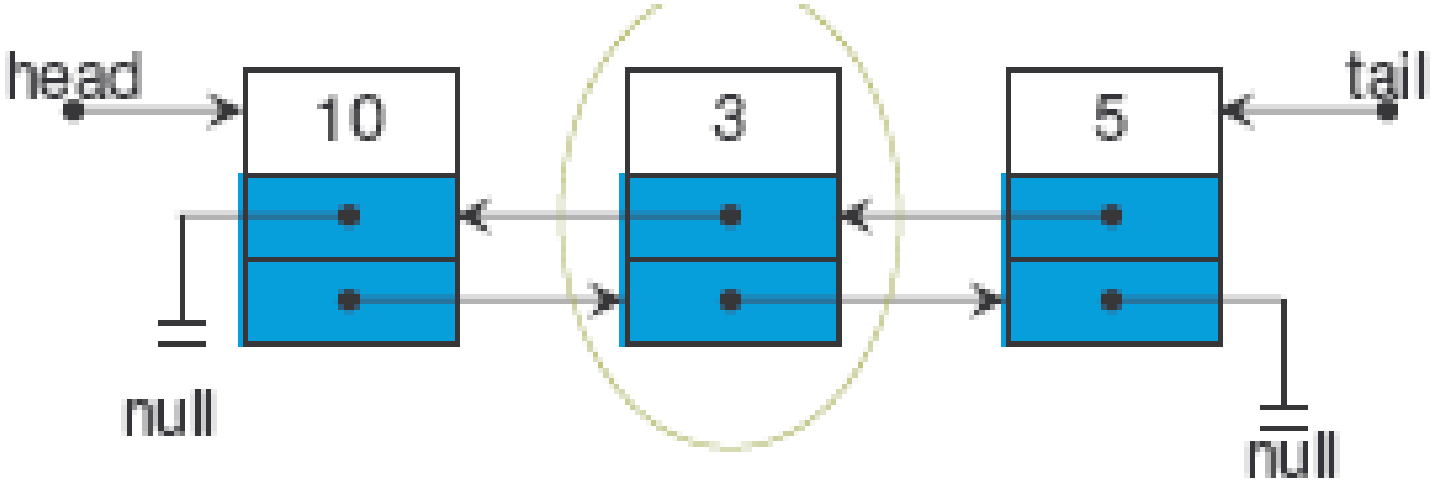


Delete Last

Node 6 sudah terhapus



Delete Last



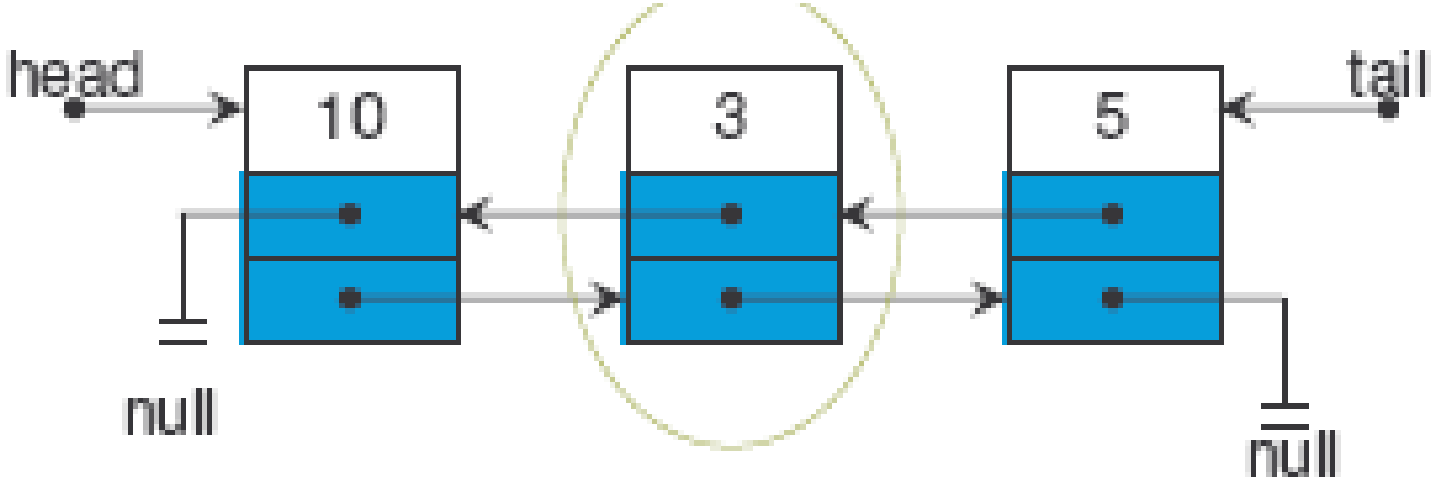
Delete Last

```
void removeLast(){
        Node2P temp = tail;
        if (!isEmpty()){
            if (tail == head){
                head = tail = null;
            }
            else {
                tail.previous.next = null;
                tail=temp.previous;
            } size--;
        }
        else System.out.println("Data is empty!");
    }
```

Delete Node x

```
void remove(Object key){
        Node2P temp = head;
        if (!isEmpty()){
            while (temp != null){
                if (temp.data == key){
                    if (temp == head){
                        this.removeFirst();
                        size--;
                        break;
                    }
                    else
                    {
                        temp.previous.next = temp.next;
                        temp.next.previous = temp.previous;
                        if(temp.next == null)
                            tail=temp;
                        size--;
                        break;
                    }
                }
                temp = temp.next;
            }
        }
        else
            System.out.println("Data is empty!");
       size--;
    }
```

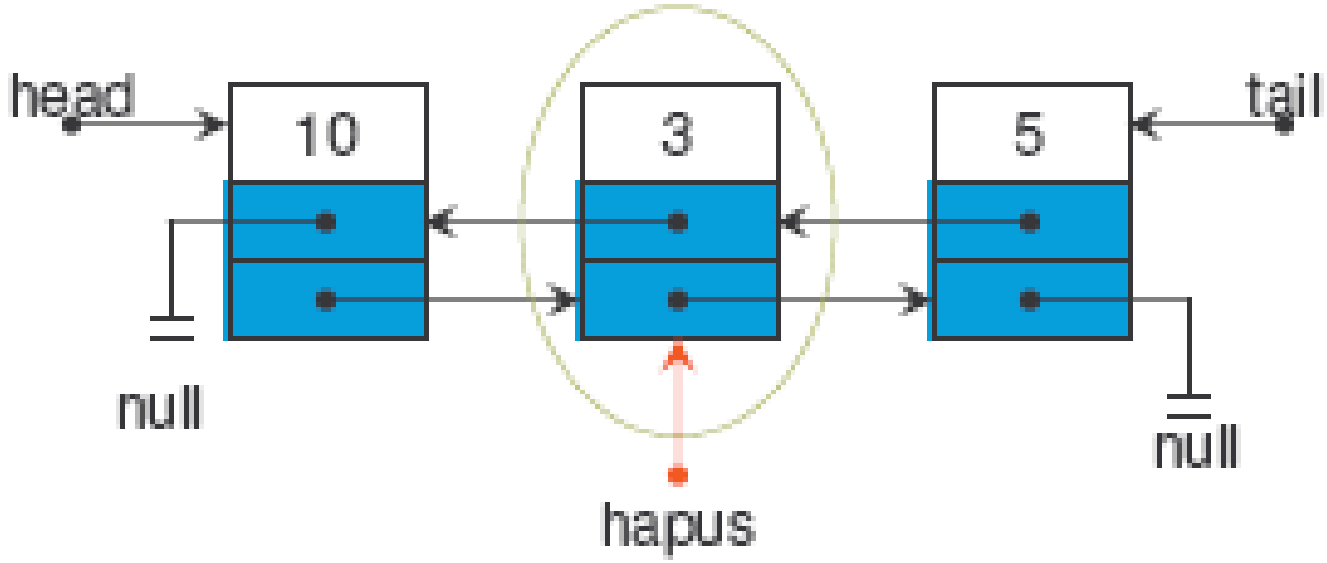
Delete Node x



Delete Node x

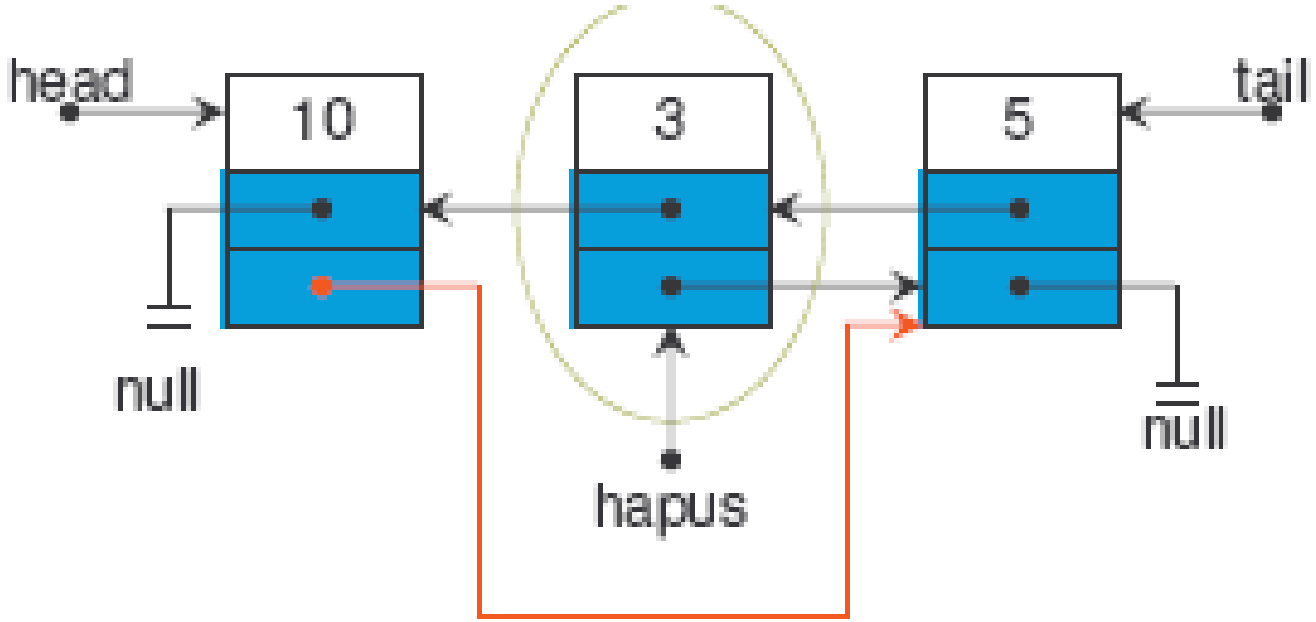
1. Node hapus=head;

   Initialize **hapus** as **head**. Through traversal process, move **hapus** to node x.



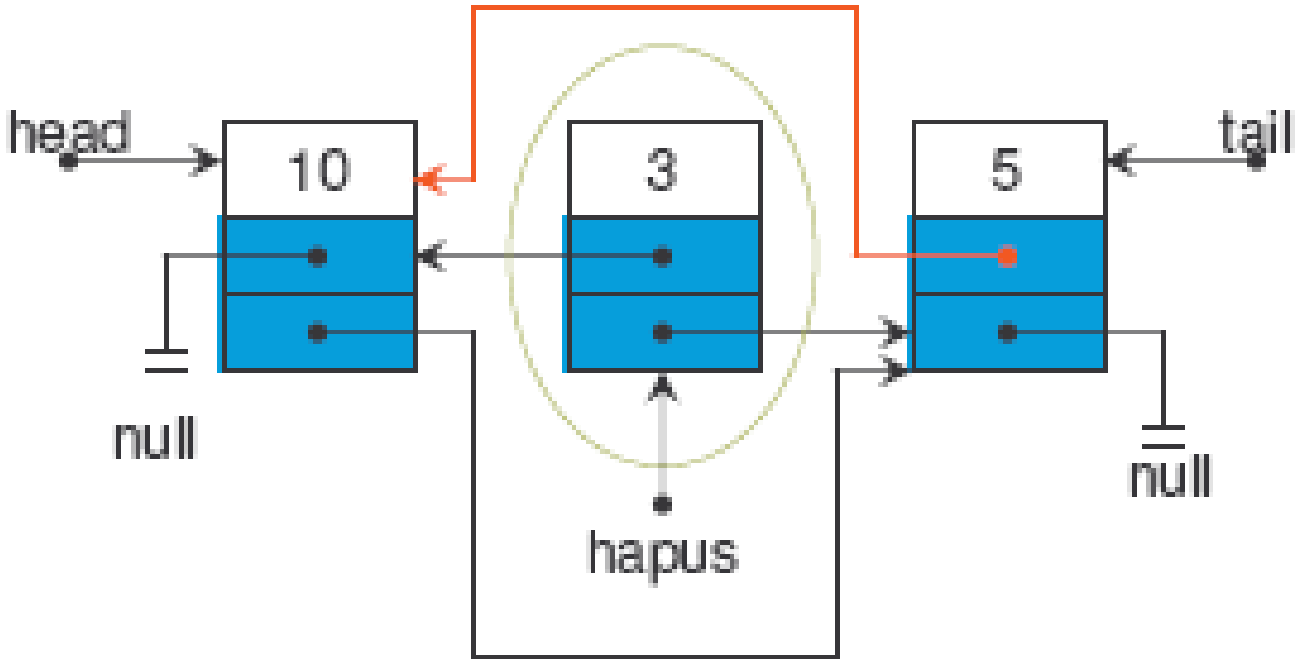
Delete Node x

2. hapus.prev.next = hapus.next;

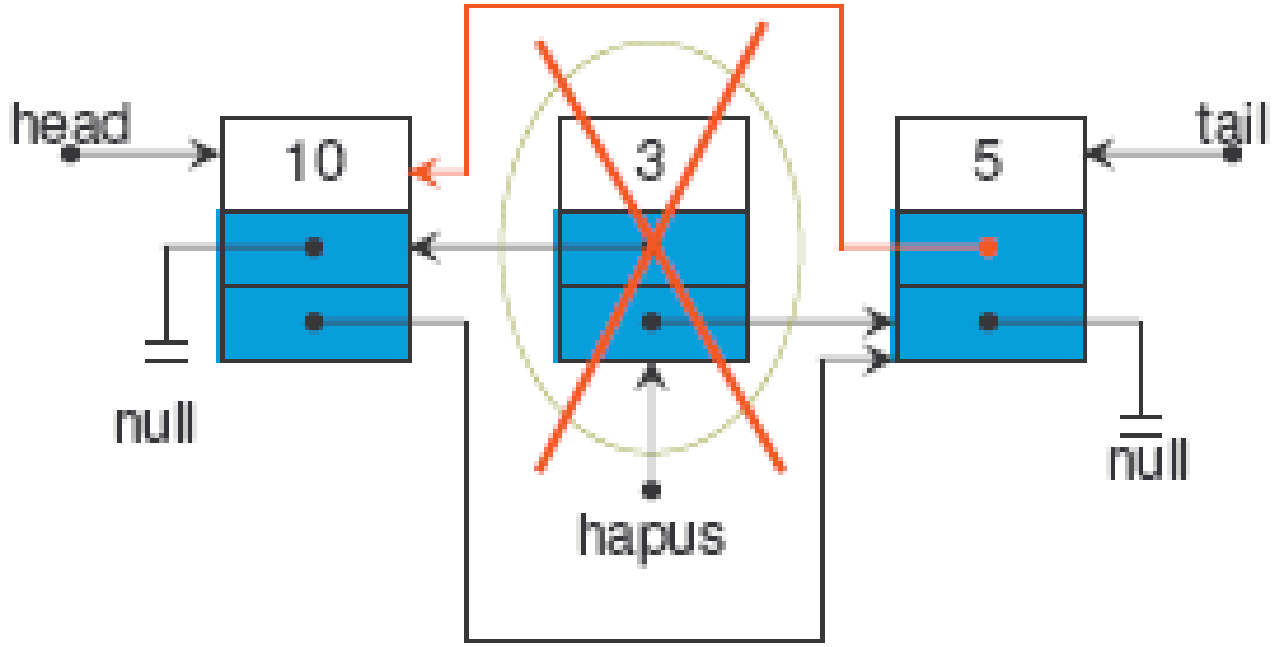


Delete Node x

3. hapus.next.prev = hapus.prev;

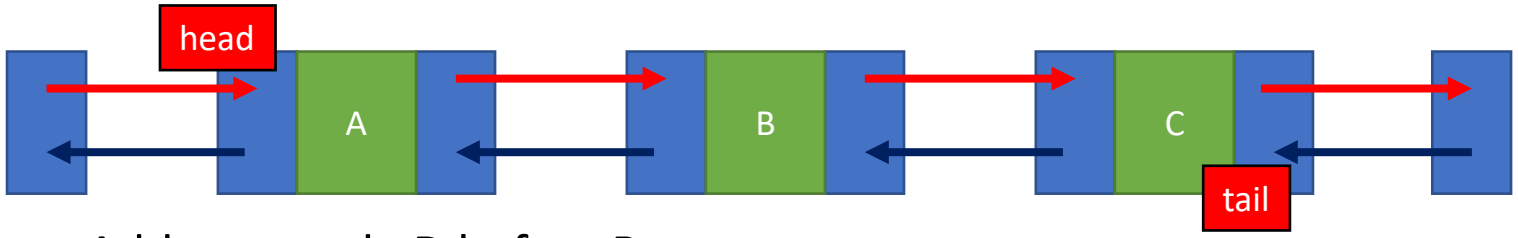


Delete Node x



Assignments

Explain the steps of the following cases, implemented to the given linked list!



1. Add new node D before B.
2. Add new node E after C.
3. Add new node F after D.
4. Add new node G at the 3rd position.
5. Add new node H at the first position.
6. Add new node I at the second position.
7. Delete the first node
8. Delete the last node
9. Delete A node
10. Delete node at 5th position
11. Display all nodes

Thank you ☺