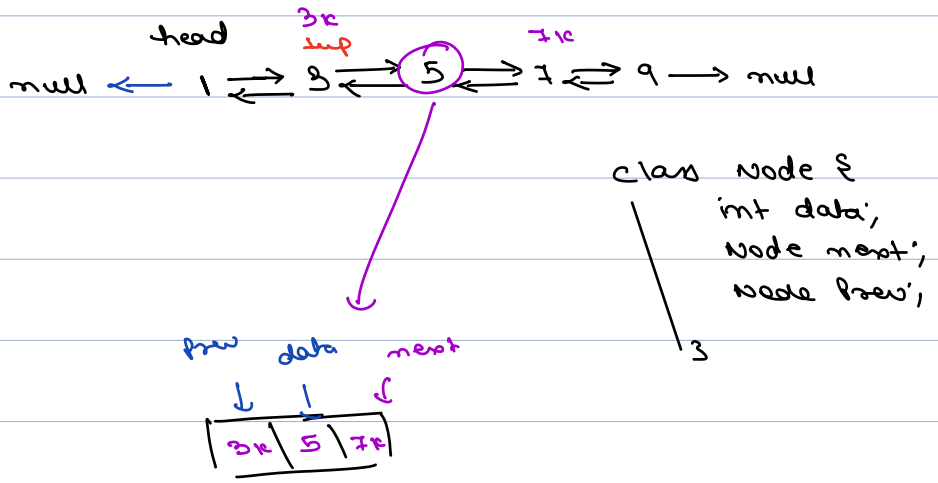
Today's content :-

- What is doubly linked list?
- How is doubly linked list different from singly linked list?
- 4 coding problems related to doubly linked list

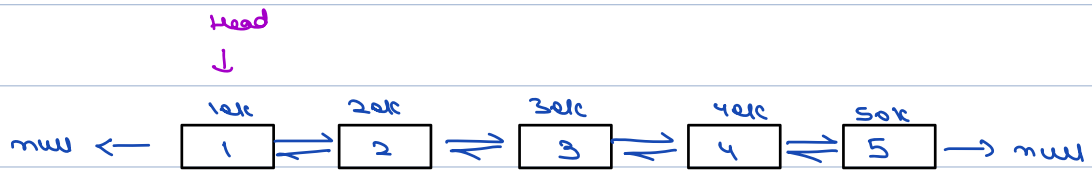
← Doubly LL →

A doubly linked list is a type of data structure used in computer science and programming to store and organize a collection of elements, such as nodes. It is similar to a singly linked list but with an additional feature: each node in a doubly linked list contains pointers or references to both the next and the previous nodes in the list.

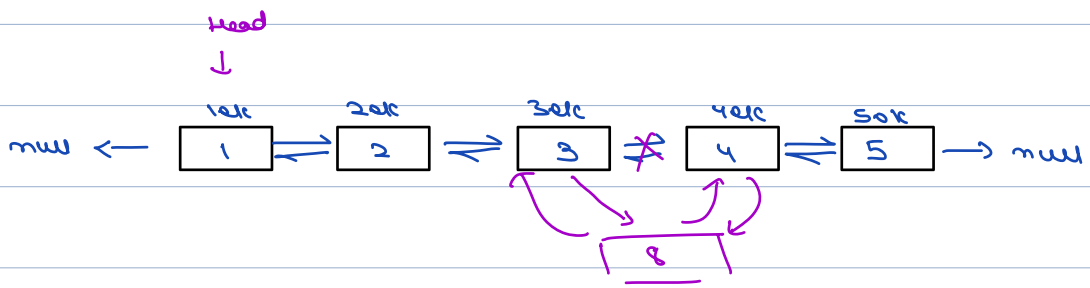


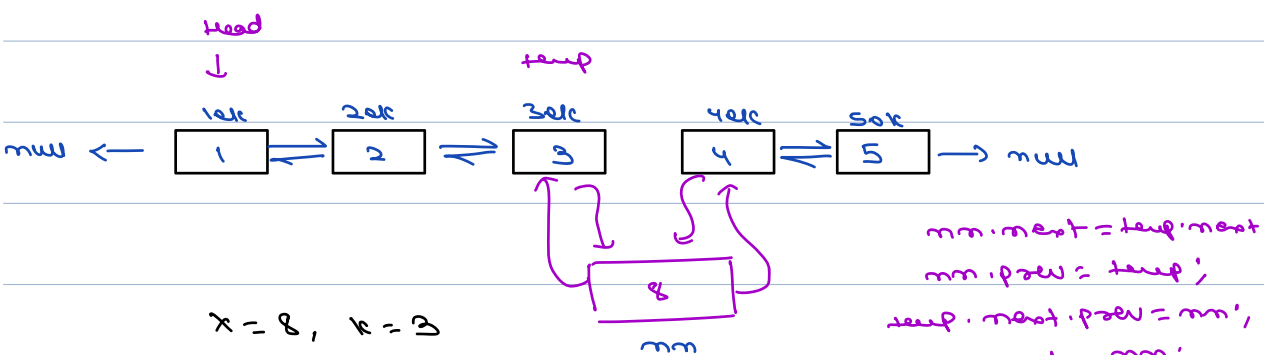
Ques

A doubly linked list is given. A node is to be inserted with data `X` at position `K`. The range of `K` is between 0 and `N` where `N` is the length of the doubly Linked list.



Ex → x = 8, k = 3





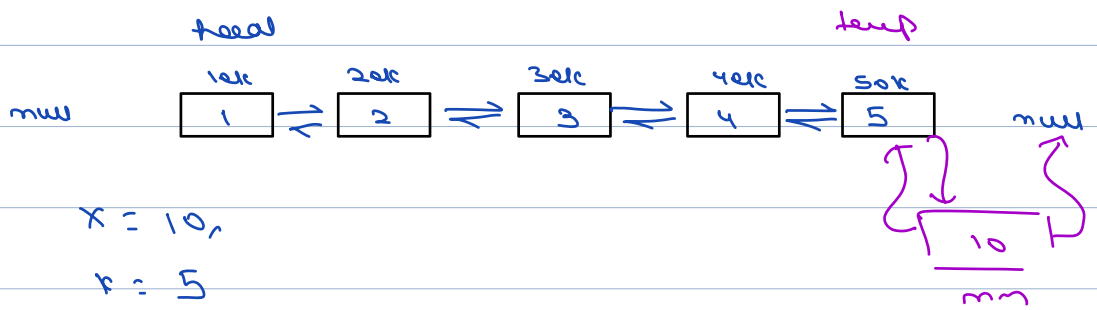
temp.next = nn
nn.prev = temp

```
nn = new Node(x);
if(head == null) { return nn }
if(x == 0) {
    nn.next = head
    head.prev = nn
    head = nn
    return head;
}
```

T.C → O(n)

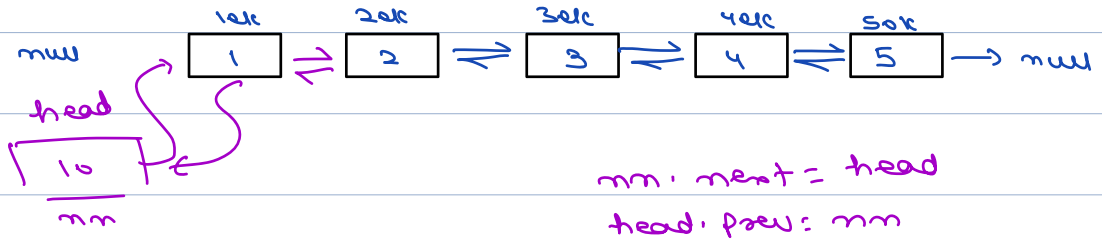
S.C → O(1)

```
temp = head;
for (i=1; i<x; i++) {
    temp = temp.next;
}
nn.next = temp.next
nn.prev = temp
if(temp.next != null) {
    temp.next.prev = nn;
}
temp.next = nn;
return head;
```



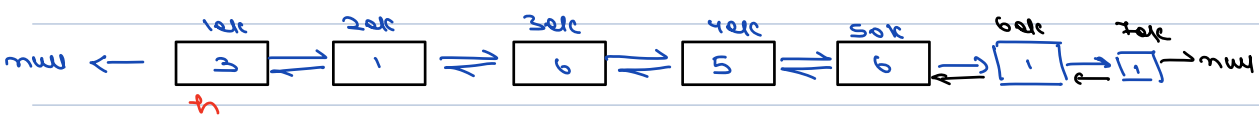
x = 10,

x = 5

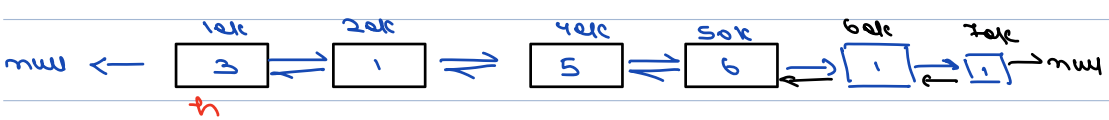


Ques

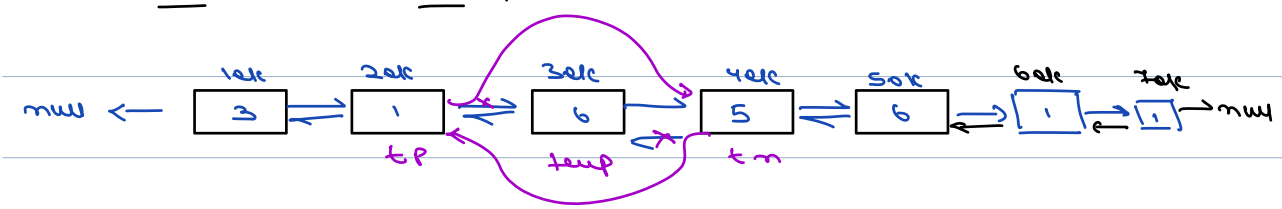
we have been given a doubly linked list of length N, we have to delete the first occurrence of data X from the given doubly linked list. If element X is not present, don't do anything.



Ans.



Soln :- x = 6 .



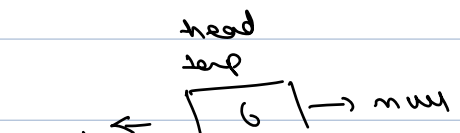
tp = temp.prev

tn = temp.next

tp.next = tn

tn.prev = tp

```
temp = head;
// Searching.
while (temp != null) {
    if (temp.data == x) {
        break;
    }
    temp = temp.next;
}
if (temp == null) {
    return head;
}
if (temp.prev == null && temp.next == null) {
    head = null;
    return null;
}
```



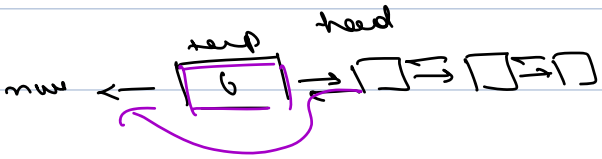
else if (temp.prev == null) {

temp.next.prev = null;

head = temp.next

return head;

}

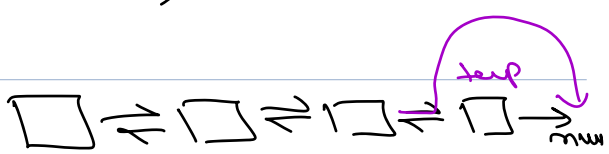


else if (temp.next == null) {

temp.prev.next = null;

return head;

}



else {

tp = temp.prev

tn = temp.next

tp.next = tn

tn.prev = tp

return head;

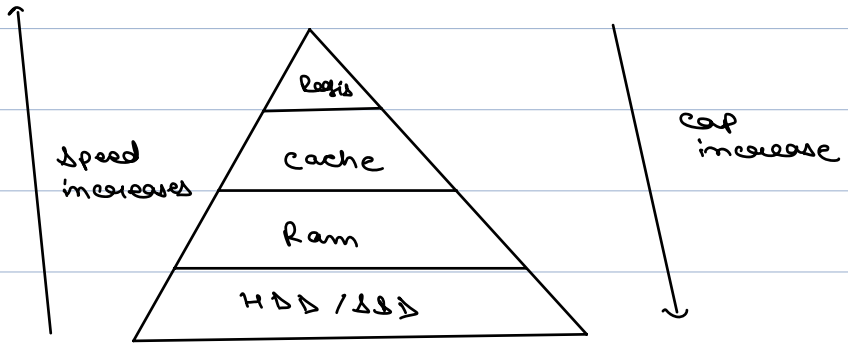
}

T.C → O(n) → searching

O(1) → deletion

S.C → O(1)

LRU Cache → least recently used.



Data 7 3 2 9 6 10 14 2 15 10 8 11 10 19

cap = 5

~~7~~ ~~3~~ ~~2~~ ~~9~~ ~~6~~ ~~10~~ ~~14~~ 15 ~~10~~ 8 11 10 19

flow chart (x)

Search (x)

x present

not present

remove (x)

insert_last (x);

if (cache.size() == limit) {

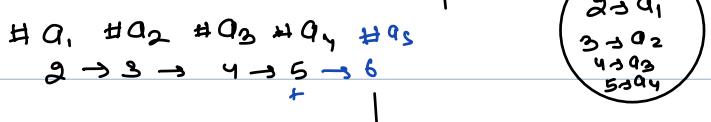
yes

delete_first()

insert_last (x)

insert_last (x)

Operations :-	Dynamic Array	LL
search (x)	O(n)	O(n)
remove (x)	O(n)	O(n)
insert_last (x)	O(1)	O(1) → tail
delete_first ( )	O(n)	O(1)



LL + HashMap

Operations :-	
search (x)	O(1)
remove (x)	O(n)
insert_last (x)	O(1) (tail)
delete_first ( )	O(1) Head

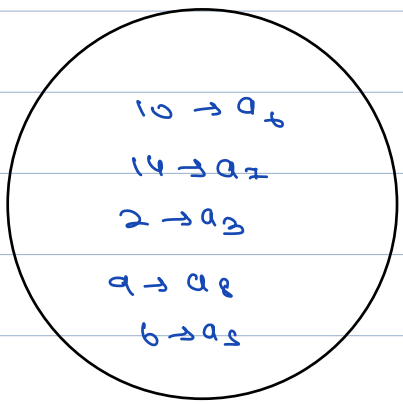
DLL + HashMap

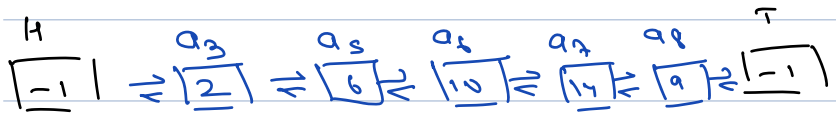
Data 7 3 2 9 6 10 14 9 15, 19,

Cap = 5

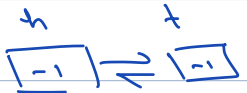
~~7~~ ~~3~~ 2 ~~9~~ 6 10 14 9

HashMap






```
Node h = new Node(-1);
Node t = new Node(-1);
h.next = t
t.prev = h
```




```
HashMap<int, Node> hm;
```

```
- LRU( int x, int limit) {
    if (hm.search(x)) {
        Node t = hm[x];
        DeleteNode(t);
        Node nn = new Node(x);
        insert_back(nn, tail);
        hm[x] = nn
    }
    else {
        if(hm.size() == limit) {
            Node t = h.next;
            hm.delete(t.data);
            DeleteNode(t);
        }
        Node nn = new Node(x);
        insert_back(nn, tail);
        hm.insert(x,nn);
    }
}
```

```
void Delete node (node temp) {
    tp = temp.prev
    tn = temp.next
    tp.next = tn
    tn.prev = tp
    return head;
}
```

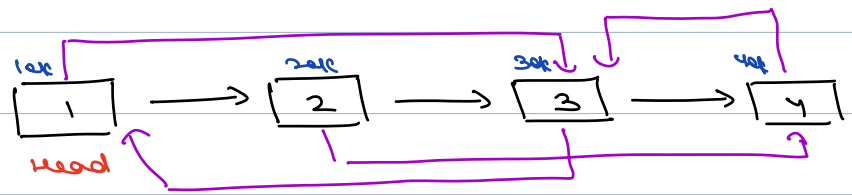
```
void insert_back (node nn, node tail) {
    node tp = tail.prev;
    tp.next = nn;
    nn.prev = tp;
    nn.next = tail;
    tail.prev = nn;
}
```

Ques Deep Copy of a LL.

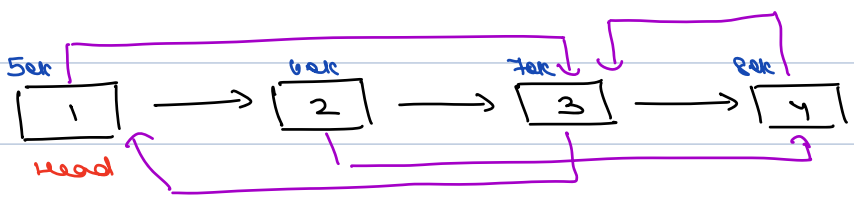
```
class node {
    int data;
    node next;
    node rand;
}
```

3

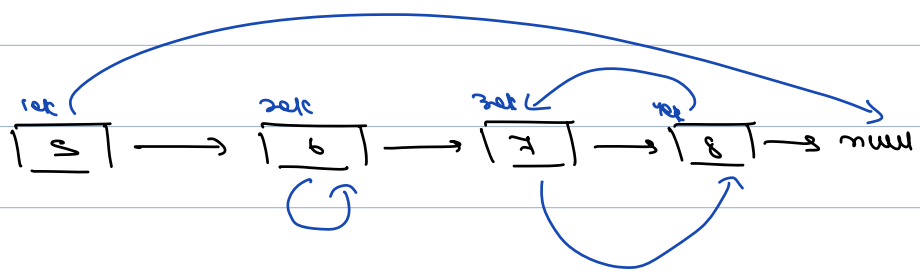
I/p

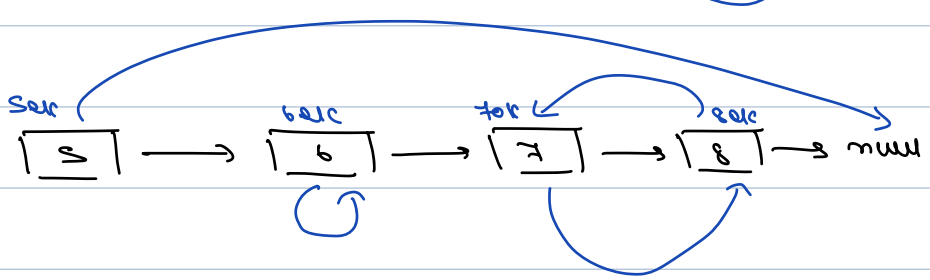


O/p

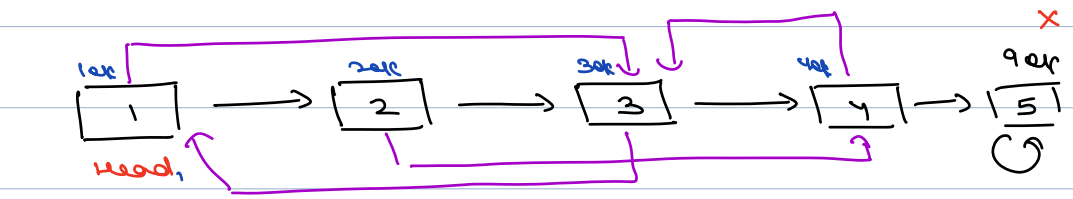


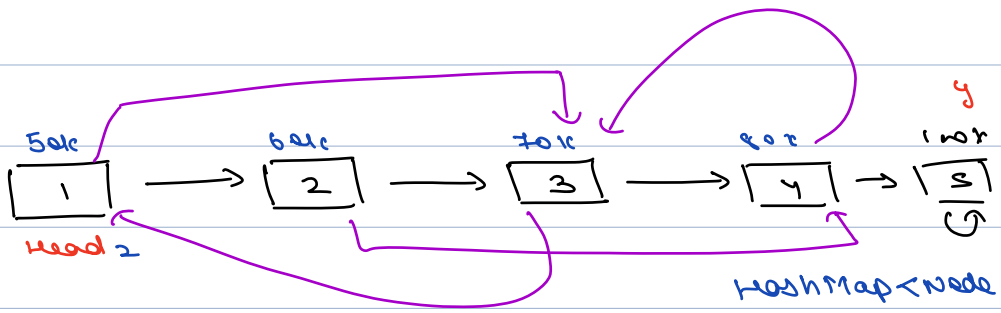
I/p





idea





HashMap<Node, Node>

1 → 5

2 → 6

3 → 7

4 → 8

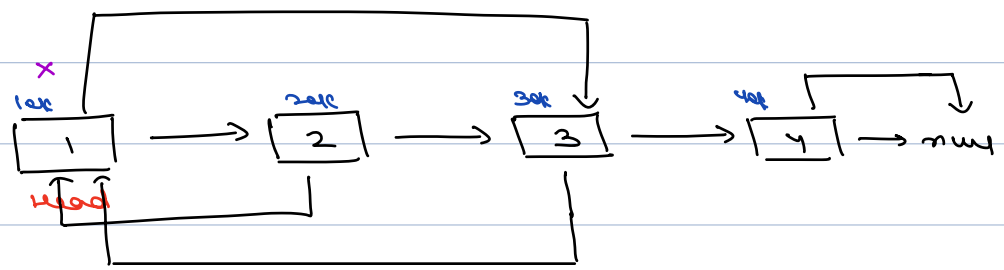
9 → 10

```
while (x != null) {
    temp = x.rand;
    y.rand = hmap.get(temp);
    x = x.next;
    y = y.next;
}
```

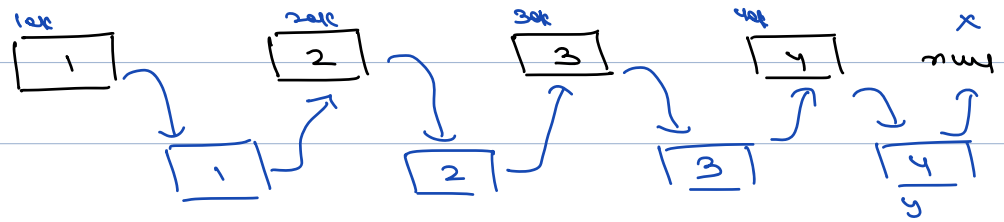
T.C → O(n)

S.C → O(n)

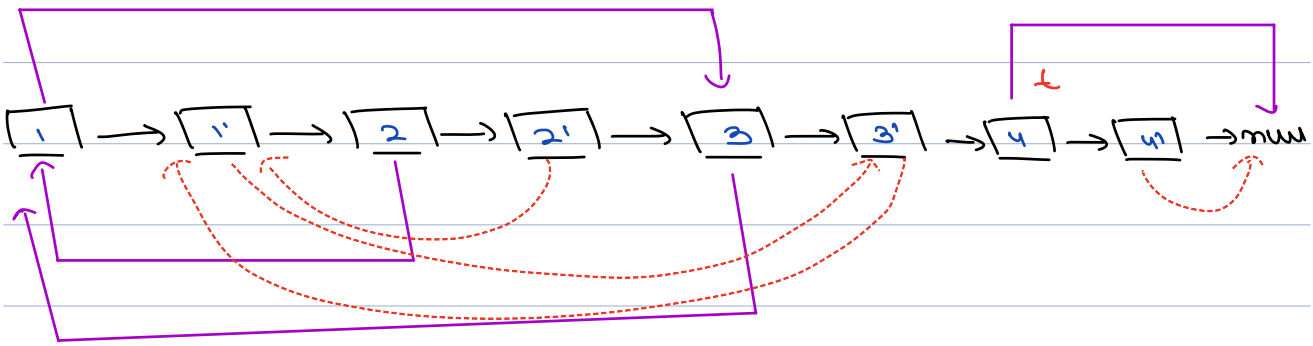
Constraint :- Do it in Constant Space :-



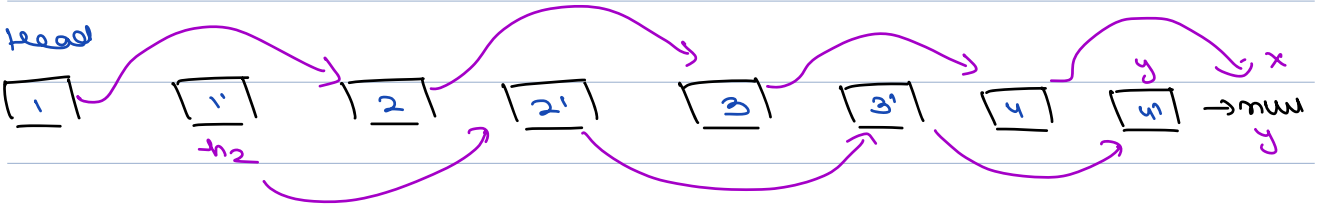
1)




```
while (x != null) {
    y = new Node(x.data);
    y.next = x.next;
    x.next = y;
    x = x.next.next;
}
```




```
while (temp != null) {
    if (temp.random == null) { temp.next.random = null }
    else { temp.next.random = temp.random.next }
    temp = temp.next.next
}
```




```
h2 = head.next
x = head;
y = head.next
while (x != null) {
    x.next = x.next.next
    if (y.next != null) {
        y.next = y.next.next
    }
    x = x.next;
    y = y.next;
```

where h_2:

$T.C \rightarrow O(n)$

$S.C \rightarrow O(1)$