Copy List with Random Pointer

A linked list of length `n` is given such that each node contains an additional random pointer, which could point to any node in the list, or `null`.

Construct a **deep copy** of the list. The deep copy should consist of exactly `n` **brand new** nodes, where each new node has its value set to the value of its corresponding original node. Both the `next` and `random` pointer of the new nodes should point to new nodes in the copied list such that the pointers in the original list and copied list represent the same list state. **None of the pointers in the new list should point to nodes in the original list**.

For example, if there are two nodes `X` and `Y` in the original list, where `X.random --> Y`, then for the corresponding two nodes `x` and `y` in the copied list, `x.random --> y`.

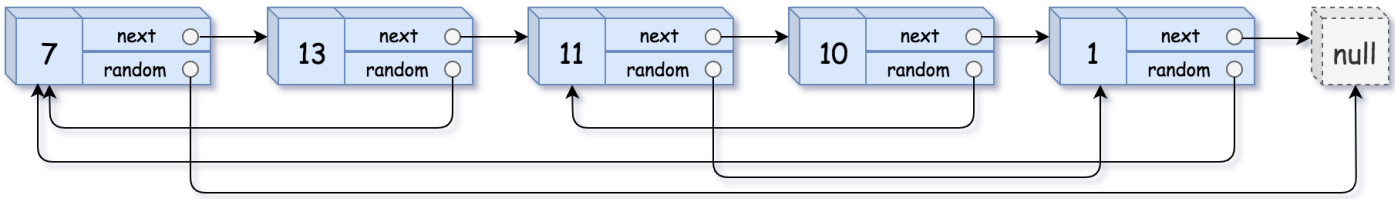
Return *the head of the copied linked list*.

The linked list is represented in the input/output as a list of `n` nodes. Each node is represented as a pair of `[val, random_index]` where:

- `val`: an integer representing `Node.val`
- `random_index`: the index of the node (range from `0` to `n-1`) that the `random` pointer points to, or `null` if it does not point to any node.

Your code will **only** be given the `head` of the original linked list.

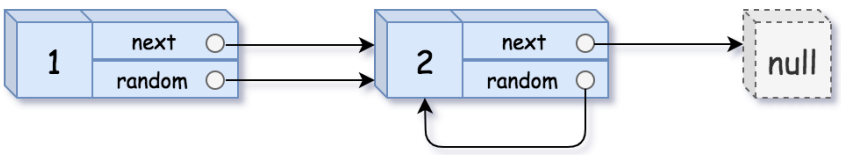
Example 1:




```
Input: head = [[7,null],[13,0],[11,4],[10,2],[1,0]]

Output: [[7,null],[13,0],[11,4],[10,2],[1,0]]
```

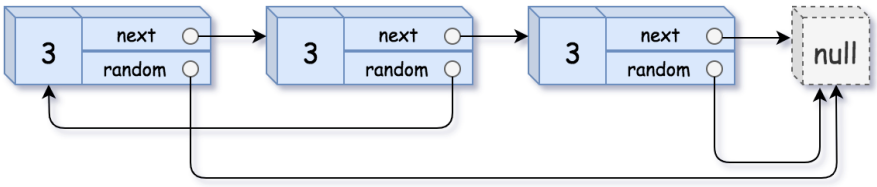
Example 2:




```
Input: head = [[1,1],[2,1]]
```

Output: [[1,1],[2,1]]

Example 3:



Input: head = [[3,null],[3,0],[3,null]]

Output: [[3,null],[3,0],[3,null]]

Approach 1: Brute Force

```
public Node copyRandomList(Node head) {
        Node curr=head;
        Node root=new Node(0);
        Node tail=root;
        while(curr!=null)
        {
            Node temp=new Node(curr.val);
            tail.next=temp;
            tail=tail.next;
            curr=curr.next;
        }
        curr=head;
        tail=root.next;
        while(curr!=null)
        {
            if(curr.random!=null)
            {
                Node i=curr.random;
```

```
                Node temp1=root.next;
                Node temp2=head;
                while(temp2!=null&&temp1!=null)
                {
                    if(temp2==i)
                        break;
                    temp1=temp1.next;
                    temp2=temp2.next;
                }
                tail.random=temp1;
            }
            curr=curr.next;
            tail=tail.next;
        }
        return root.next;
    }
```

Time:O(n^2)

Space: O(1)

Approach 2:HashMap

```
public Node copyRandomList(Node head) {
        Node curr=head;
        Node root=new Node(0);
        Node tail=root;
        HashMap<Node,Node> map=new HashMap();
        while(curr!=null)
        {
            Node temp=new Node(curr.val);
```

```
            map.put(curr,temp);
            tail.next=temp;
            tail=tail.next;
            curr=curr.next;
        }
        curr=head;
        root=root.next;
        tail=root;
        while(curr!=null)
        {
            if(curr.random!=null)
            {
                Node temp=map.get(curr.random);
                tail.random=temp;
            }
            curr=curr.next;
            tail=tail.next;
        }
        return root;
    }
```

Time: O(n);

Space: O(n) → hashMap

Approach 3: 3 rounds

```
public Node copyRandomList(Node head) {
          Node iter = head;
          Node front = head;
```

```
        // First round: make copy of each node,
        // and link them together side-by-side in a single list.
        while (iter != null) {
          front = iter.next;

          Node copy = new Node(iter.val);
          iter.next = copy;
          copy.next = front;

          iter = front;
        }

        // Second round: assign random pointers for the copy nodes.
        iter = head;
        while (iter != null) {
          if (iter.random != null) {
            iter.next.random = iter.random.next;
          }
          iter = iter.next.next;
        }

        // Third round: restore the original list, and extract the copy
list.
        iter = head;
        Node pseudoHead = new Node(0);
        Node copy = pseudoHead;
```

```
        while (iter != null) {
          front = iter.next.next;

          // extract the copy
          copy.next = iter.next;
          copy = copy.next;

          // restore the original list
          iter.next = front;

          iter = front;
        }

        return pseudoHead.next;
    }
```

Time: O(n)

Space: O(1)