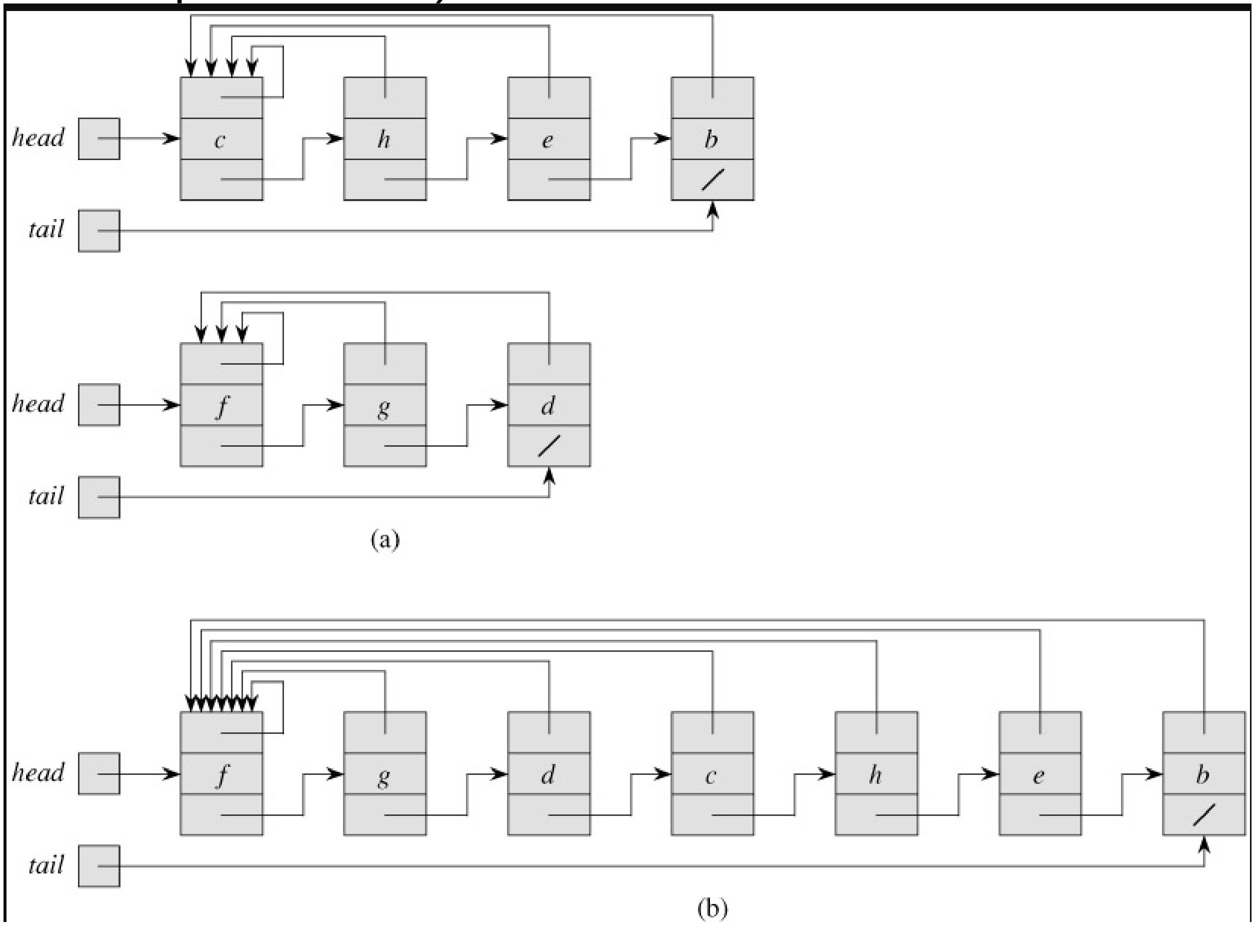
1)How do we represent disjoint set using Linked List?

A simple way to implement a disjoint-set data structure is to represent each set by a linked list. The first object in each linked list serves as its set's representative. Each object in the linked list contains a set member, a pointer to the object containing the next set member, and a pointer back to the representative. Each list maintains pointers *head*, to the representative, and *tail*, to the last object in the list. Figure 21.2(a) shows two sets. Within each linked list, the objects may appear in any order (subject to our assumption that the first object in each list is the representative).



(a)

(b)

Figure 21.2: *(a)* Linked-list representations of two sets. One contains objects *b*, *c*, *e*, and *h*, with *c* as the representative, and the other contains objects *d*, *f*, and *g*, with *f* as the representative. Each object on the list contains a set member, a pointer to the next object on the list, and a pointer back to the first object on the list, which is the representative. Each list has pointers *head* and *tail* to the first and last objects, respectively. *(b)* The result of UNION(*e*, *g*). The representative of the resulting set is *f*.

With this linked-list representation, both MAKE-SET and FIND-SET are easy, requiring *O*(1) time. To carry out MAKE-SET(*x*), we create a new linked list whose only object is *x*. For FIND-SET(*x*), we just return the pointer from *x* back to the representative

2)How can we union two disjoint sets according to their rank?

The *union()* and *find()* in naïve way , the worst case time complexity is linear. The operations can be optimized to *O(Log n)* in worst case. The idea is to always attach smaller depth tree under the root of the deeper tree. This technique is called ***union by rank***.

```
Let us see the above example with union by rank

Initially, all elements are single element subsets.

0 1 2 3


Do Union(0, 1)

   1   2   3

  /

 0


Do Union(1, 2)

   1    3

 /  \

0    2


Do Union(2, 3)

    1

 /  |  \

0   2   3
```

And here is the implementation of union by rank based on the depth of the trees:

```
void make_set(int v) {
    parent[v] = v;
    rank[v] = 0;
}

void union_sets(int a, int b) {
    a = find_set(a);
    b = find_set(b);
    if (a != b) {
        if (rank[a] < rank[b])
            swap(a, b);
        parent[b] = a;
        if (rank[a] == rank[b])
            rank[a]++;
    }
}
```