

Disjoint set union

```
int find (int x) {
```

```
    if (par[x] == x) {
        return x;
    }
```

```
}
```

```
    int s1 = find (par[x]);
```

```
    return s1;
}
```

```
void union (int u, int v) {
```

```
    int s1u = find (u);
```

```
    int s1v = find (v);
```

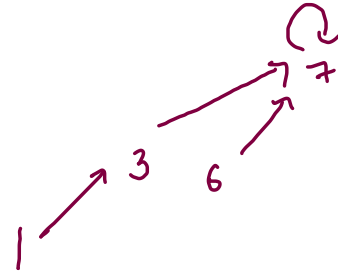
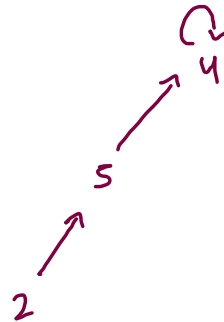
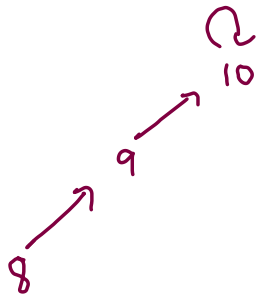
```
    if (s1u != s1v) {
```

```
        par[s1u] = s1v;
    }
```

```
}
```

parent

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|----|----|
| X | 3 | 5 | 7 | 4 | 4 | 7 | 7 | 9 | 10 | 10 |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |



1-3

2-5

6-7

2-4

1-6

8-9

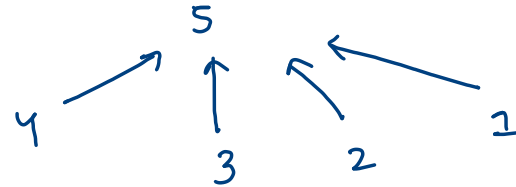
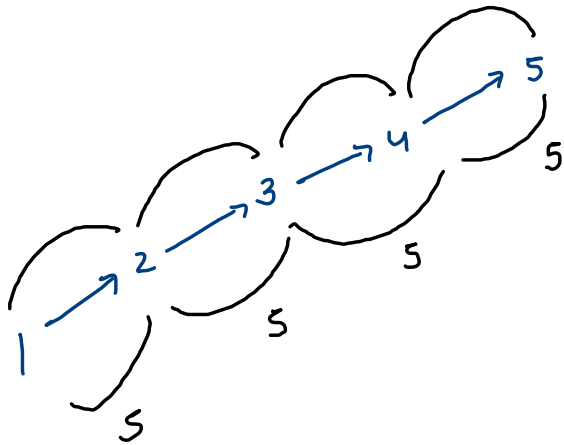
8-10

}

DSU optimisation:

| | | | | | |
|---|---|---|---|---|---|
| X | 5 | 5 | 5 | 5 | 5 |
| 0 | 1 | 2 | 3 | 4 | 5 |

(i) path compression:



1 - 2

2 - 3

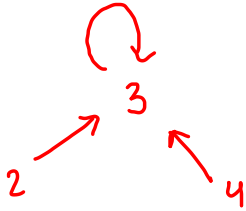
3 - 4

4 - 5

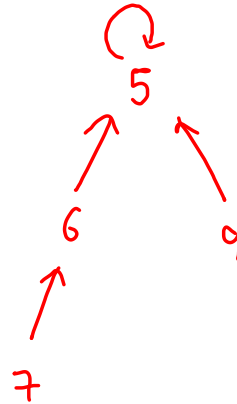
find(1)

(ii) union by rank:

$$\text{rank}(3) = 1$$



$$\text{rank}(5) = 2$$

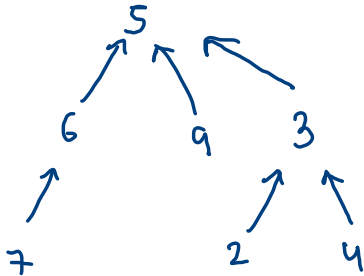


$$u = 2, v = 7$$

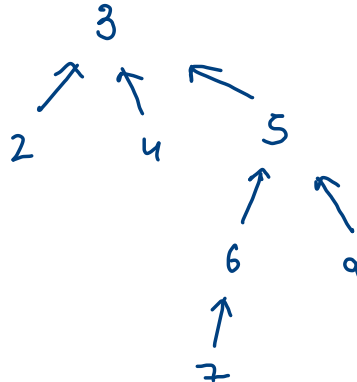
$$\text{sl}(2) = 3$$

$$\text{sl}(7) = 5$$

a)



b)



✓ a) $\text{par}[3] = 5$

b) $\text{par}[5] = 3$

c) both are same
(complexity wise)

union by
rank
//

parent

| | | | | | |
|---|---|---|---|---|---|
| X | 3 | 4 | 4 | 4 | 4 |
| 0 | 1 | 2 | 3 | 4 | 5 |

rank

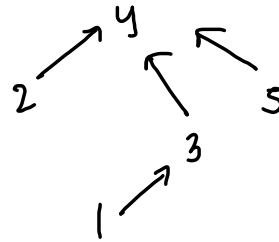
| | | | | | |
|---|---|---|---|---|---|
| X | 0 | 0 | 1 | 2 | 0 |
| 0 | 1 | 2 | 3 | 4 | 5 |

1-3 ✓

2-4 ✓

1-4 ✓

1-5 ✓



$u = 1$

$slu = 4$

$rank(u) = 2$

$v = 5$

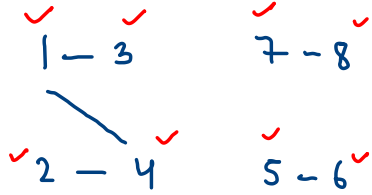
$slv = 5$

$rank(s) = 0$

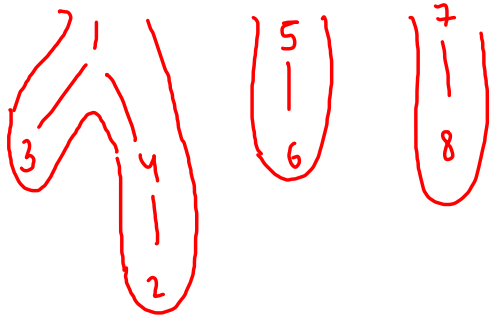
connected comps

DFS

edges
1-3
2-4
5-6
7-8
1-4



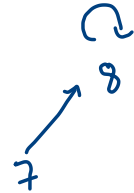
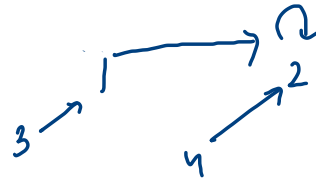
dfs call 1
dfs call 5
dfs call 7



DSU

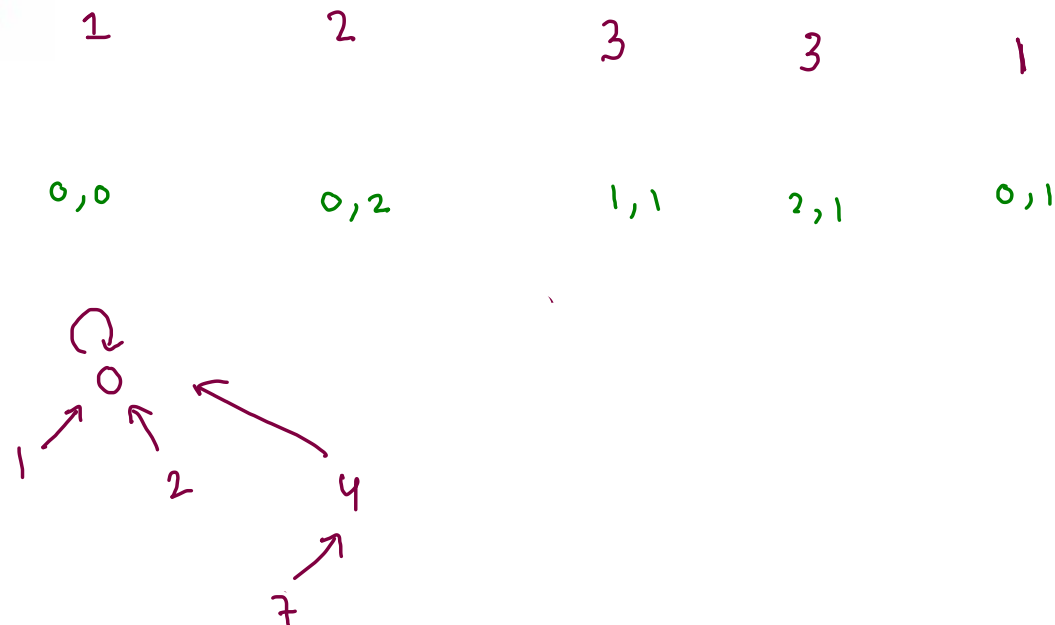
edges
1-3
2-4
5-6
7-8
1-4

in case of dynamic graph



434 · Number of Islands II ✓

| | 0 | 1 | 2 |
|---|---|---|---|
| 0 | 1 | 1 | 1 |
| 1 | 3 | 4 | 5 |
| 2 | 6 | 7 | 8 |



Count = 1

| | 0 | 1 | 2 | 3 |
|---|---|---|----|----|
| 0 | 0 | 1 | 2 | 3 |
| 1 | 4 | 5 | 6 | 7 |
| 2 | 8 | 9 | 10 | 11 |

① 2d to 1d
i, j to cell no.

r → rows
c → cols

$$\text{cell no.} = i * \text{cols} + j$$

② 1d to 2d
cell no. to i, j

$$i = \text{cell_no.} / \text{cols};$$

$$j = \text{cell_no.} \% \text{cols};$$