**Disjoint Set**

**PreLab:**

1. What is the worst-case running time of union in Fast Union Slow Find technique?

a) O(N)

b) O(logN)

c) O(1)

d) O(M logN)

1. What is the condition for an equivalence relation if two cities are related within a country?

a) the two cities should have a one-way connection

b) the two cities should have a two-way connection

c) the two cities should be in different countries

d) no equivalence relation will exist between two cities

1. Electrical connectivity is an example of equivalence relation. Put forth your justification for the answer.

a) true

b) false

1. If |V| is the total number of elements, in the worst case, how many updates are needed for fusing two groups in the union method of Fast Find technique?

**a) O(1)**

**b) O(log|V|)**

**c) O(|V|)**

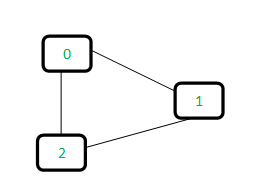
**d) O(|V|2)**

1. Path compression is used to improve the efficiency of

**(A)** Find  
**(B)** Union  
**(C)** Both Find and Union  
**(D)** None

**Program:**

1. Implement Disjoint Set Union on Arrays
2. Implement Disjoint Set Union on Trees
3. Implement Disjoint Set Union on Trees efficiently with quick find to detect cycle in an undirected graph

Let us consider the following graph:  
  
For each edge, make subsets using both the vertices of the edge. If both the vertices are in the same subset, a cycle is found.

Initially, all slots of parent array are initialized to -1 (means there is only one item in every subset).

0 1 2

-1 -1 -1

Now process all edges one by one.

Edge 0-1: Find the subsets in which vertices 0 and 1 are. Since they are in different subsets, we take the union of them. For taking the union, either make node 0 as parent of node 1 or vice-versa.

0 1 2 <----- 1 is made parent of 0 (1 is now representative of subset {0, 1})

1 -1 -1

Edge 1-2: 1 is in subset 1 and 2 is in subset 2. So, take union.

0 1 2 <----- 2 is made parent of 1 (2 is now representative of subset {0, 1, 2})

1 2 -1

Edge 0-2: 0 is in subset 2 and 2 is also in subset 2. Hence, including this edge forms a cycle.

How subset of 0 is same as 2?  
0->1->2 // 1 is parent of 0 and 2 is parent of 1

# Find the number of Islands | Set 2 (Using Disjoint Set)

Given a boolean 2D matrix, find the number of islands.

A group of connected 1s forms an island. For example, the below matrix contains 5 islands

{1, 1, 0, 0, 0},

{0, 1, 0, 0, 1},

{1, 0, 0, 1, 1},

{0, 0, 0, 0, 0},

{1, 0, 1, 0, 1}

A cell in the 2D matrix can be connected to 8 neighbours.

The idea is to consider all 1 values as individual sets. Traverse the matrix and do a union of all adjacent 1 vertices. Below are detailed steps.

**Approach:**  
1) Initialize result (count of islands) as 0  
2) Traverse each index of the 2D matrix.  
3) If the value at that index is 1, check all its 8 neighbours. If a neighbour is also equal to 1, take the union of the index and its neighbour.  
4) Now define an array of size row\*column to store frequencies of all sets.  
5) Now traverse the matrix again.  
6) If the value at index is 1, find its set.  
7) If the frequency of the set in the above array is 0, increment the result be 1.