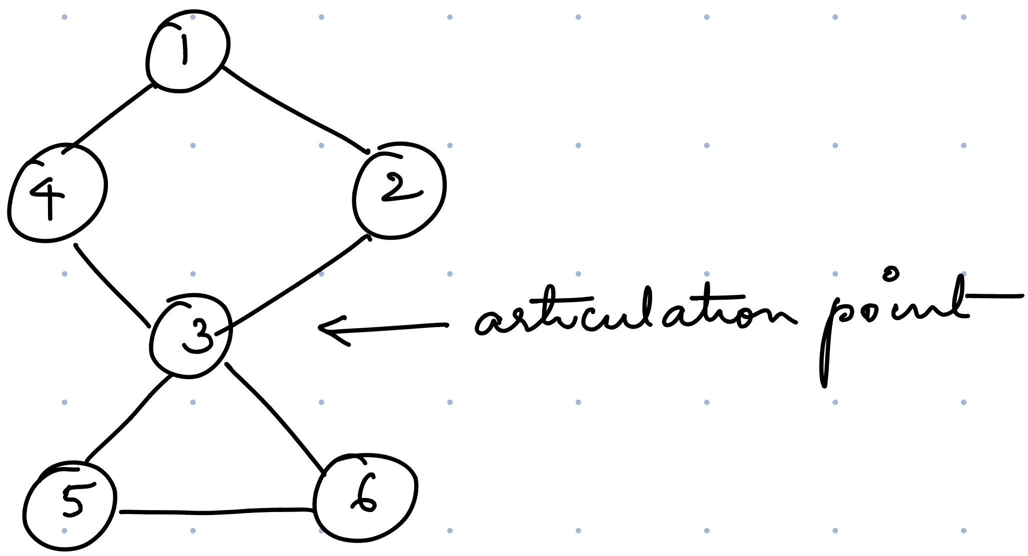
Articulation point

A node when removed makes the graph disconnected.



1. DFS
2. Find the discovery time of each node
3. Find the lowest node that can be reached from v.
4. If $L[v] \geq d[u]$ then u is an articulation point
   (u, v)
   parent child.
5. For the starting node to be an

articulation point, if it has 2 childs.

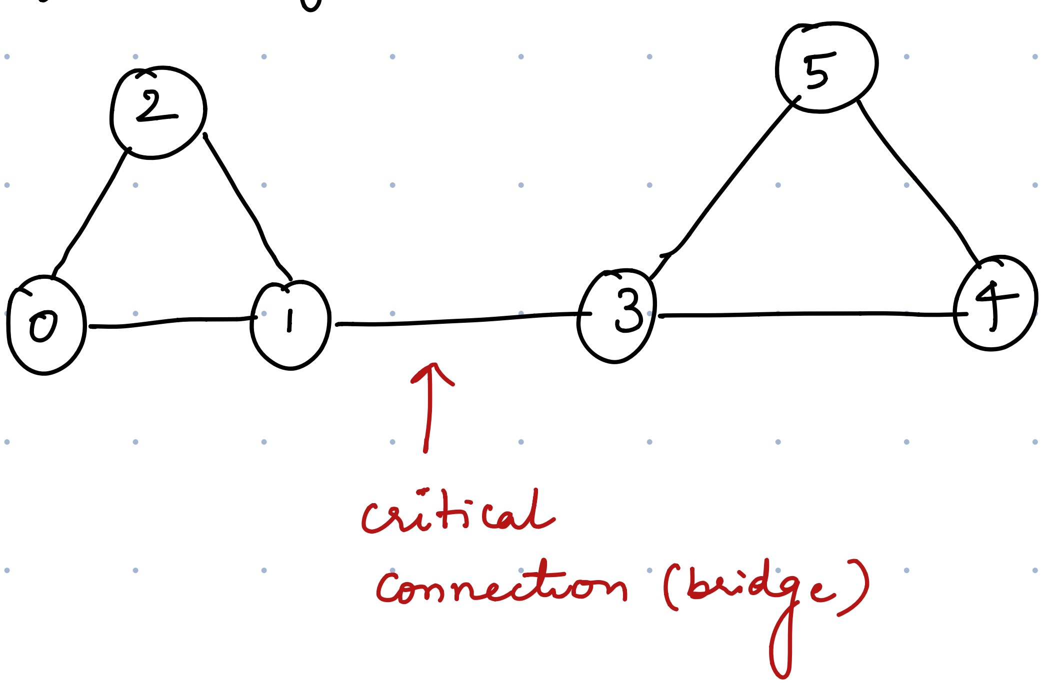
Bridge in a graph

(Critical Connection)

Brute force $O((|V|+|E|) * |E|)$

1. Remove one edge and do dfs
2. Nodes reached through dfs = Total nodes
3. That edge is not a bridge.

Tarjan's Algo $O(V+E)$

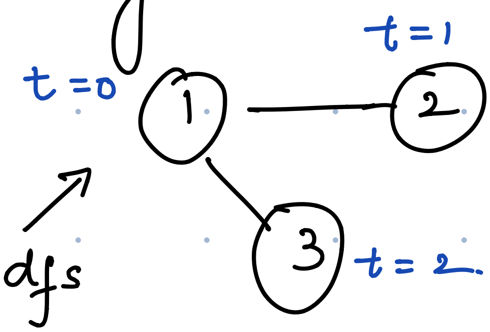


Algo

1. DFS with discovery time

→ As each node is visited assign a discovery time to it.

ex. :



dfs

order

dfs(1) → dfs(2) → dfs(3)

(or)

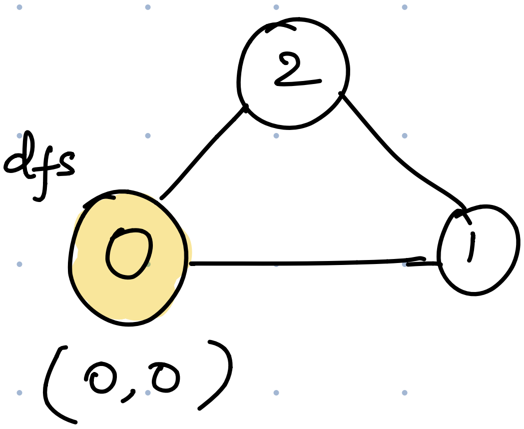
dfs(1) → dfs(3) → dfs(2)

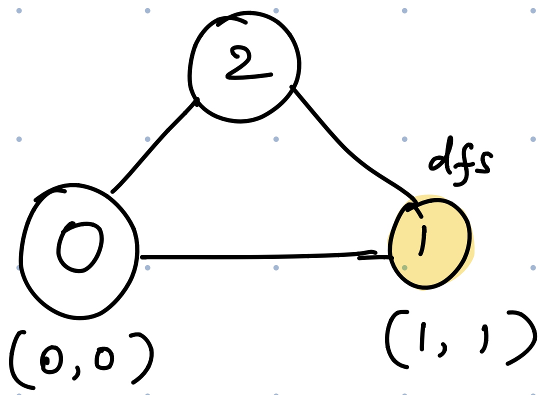
2. Lowest node reachable from a node is also stored.

For every node (discovery time, lowest node it can reach)

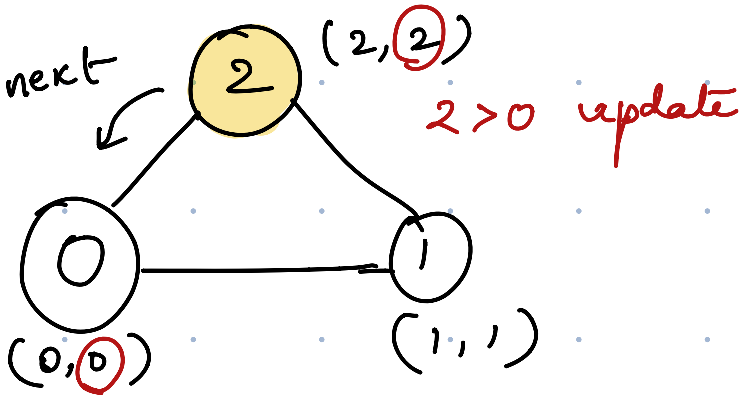
3. In DFS, once the node is visited we store initial values (discovery time, node itself)

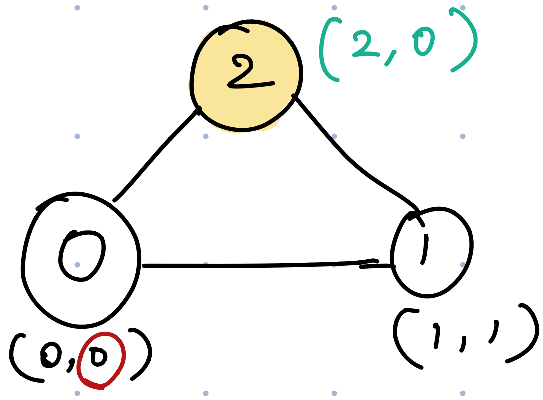
4. When there is func return from its neighboring nodes, lowest node (LN) discovered values are compared. and if the parent's LN is greater than the child's LN, parent's LN is updated.

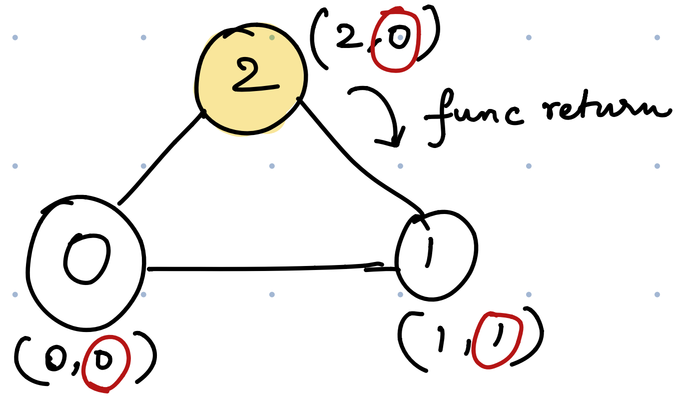


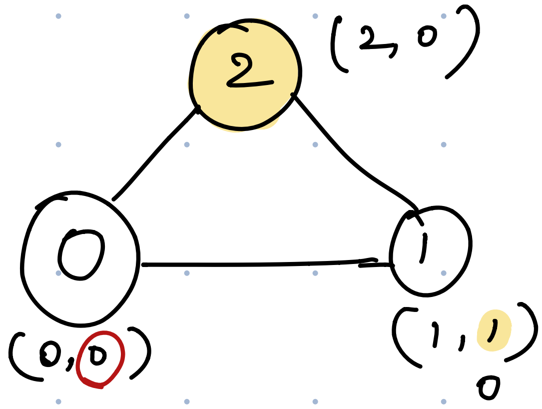


(No child explored to compare LN)



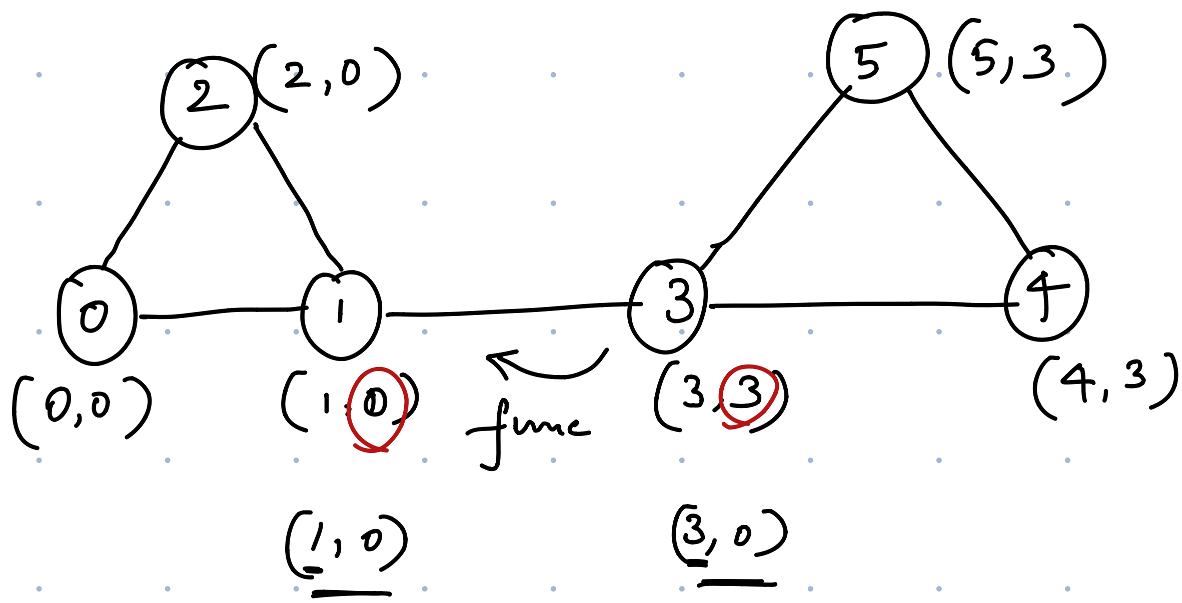






Lowest node that can be discovered from 1 is 0 and 2 is 0.

5) A critical connection is when the func call returns and the parent's LN is less than the child's LN.



dfs(0)

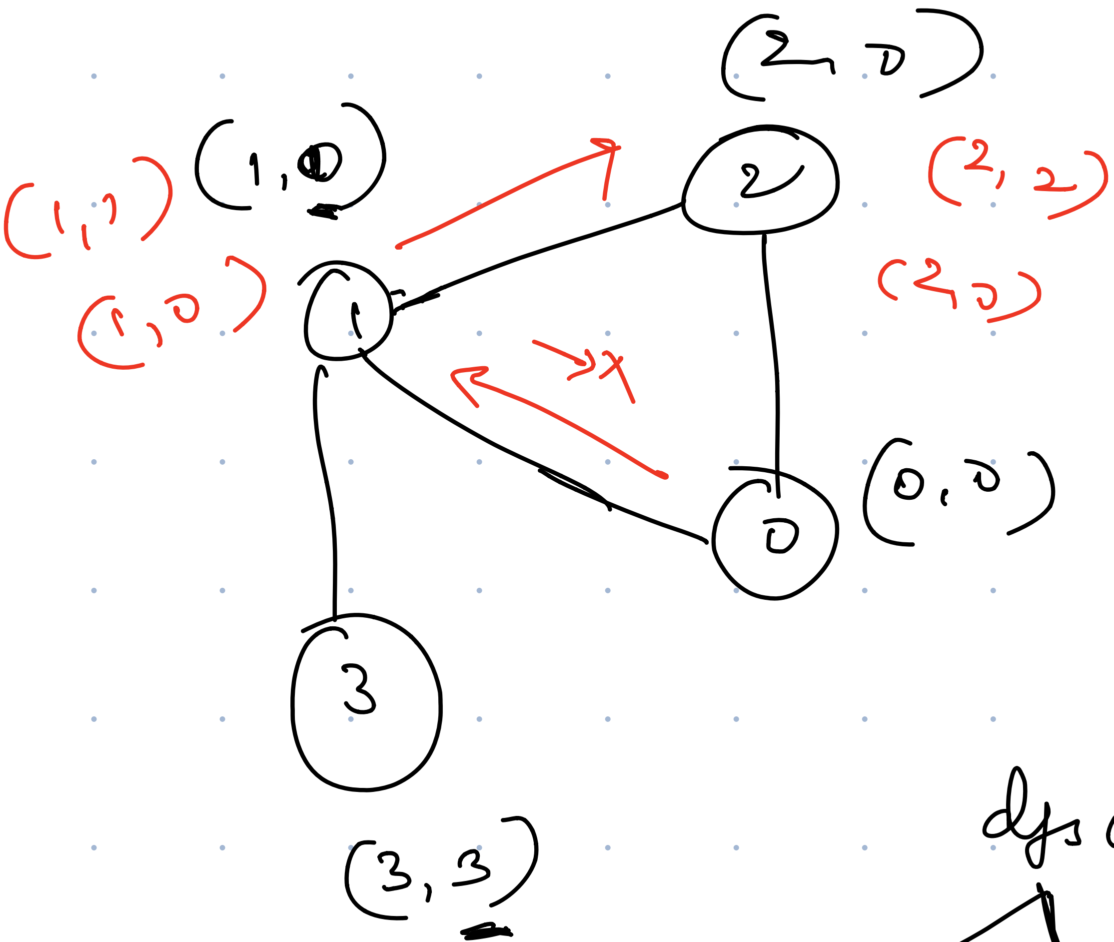
↓

dfs(1)

↓

dfs(2)

id = 3



dfs(0)

dfs(1) dfs(2)

dfs(2)

0

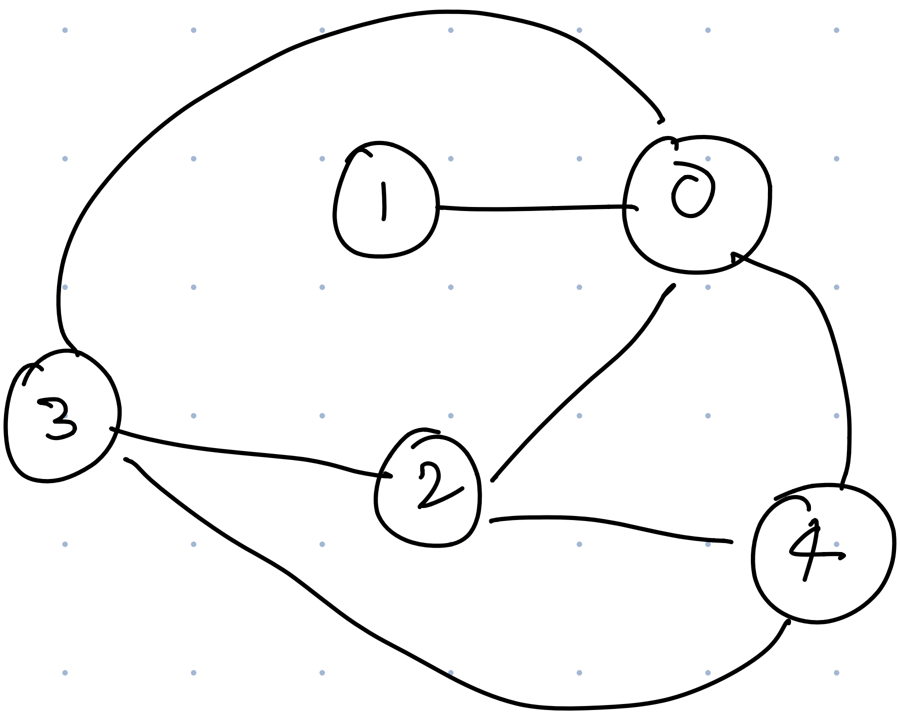
(1, 0) (0, 1)

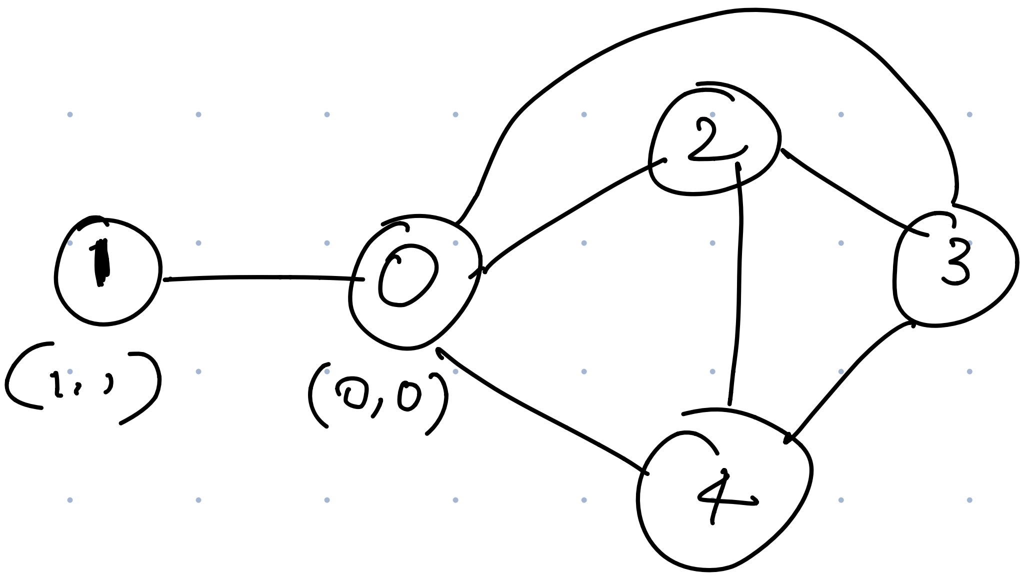
0 : [0, 0]

1 : [1 : 0]

2 : [2, 0]

3 : [2, 3]




1
0
2
3
4
(1,)
(0,0)