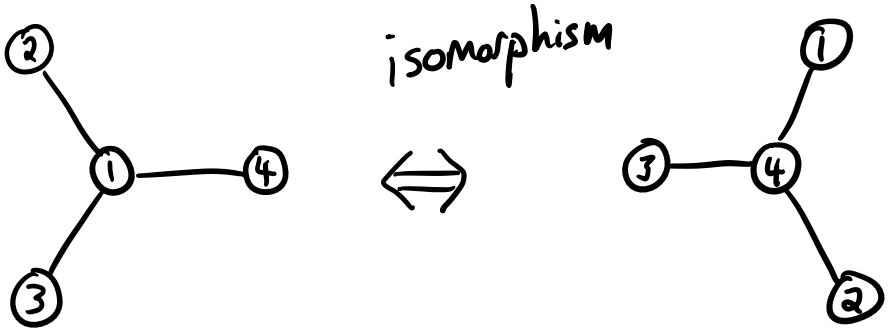
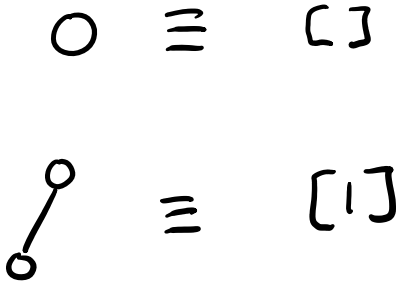
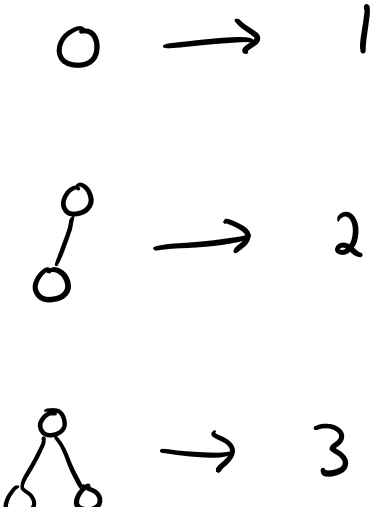
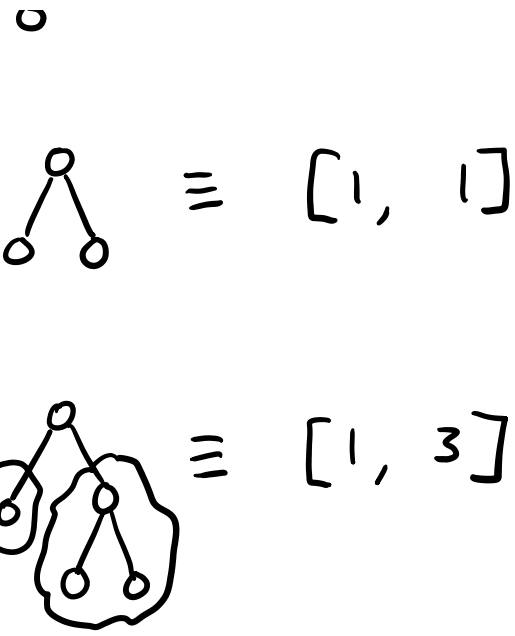
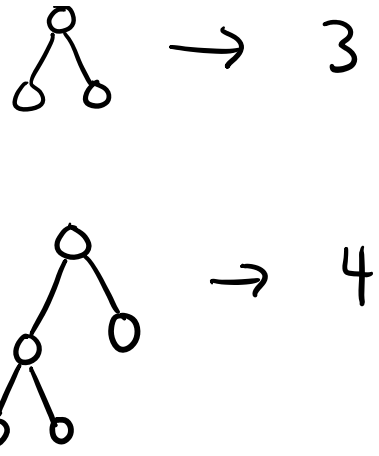
Tree Isomorphism

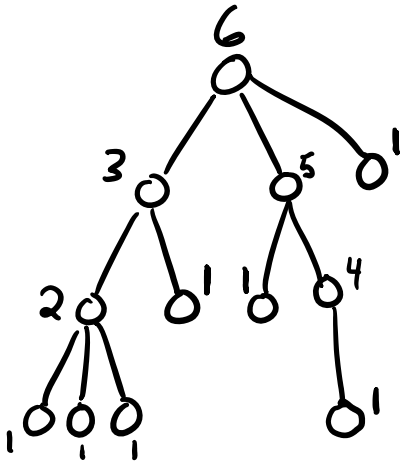


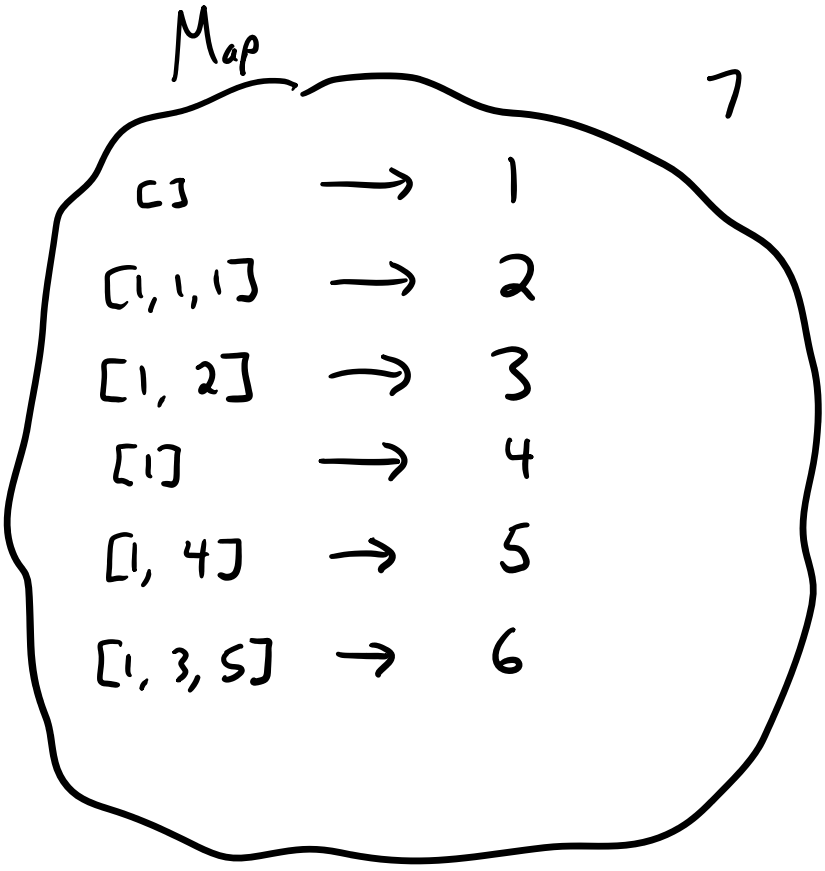




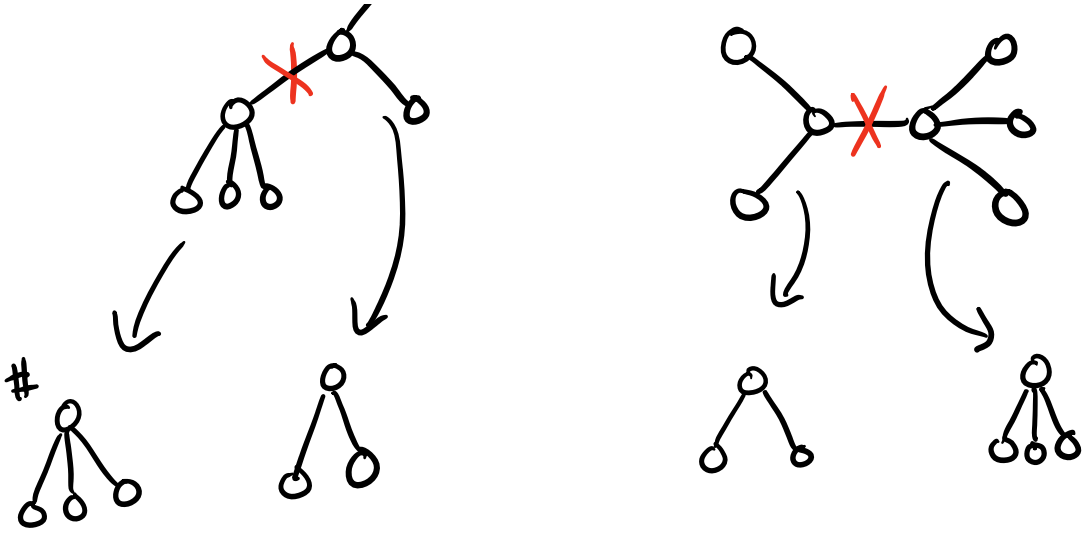






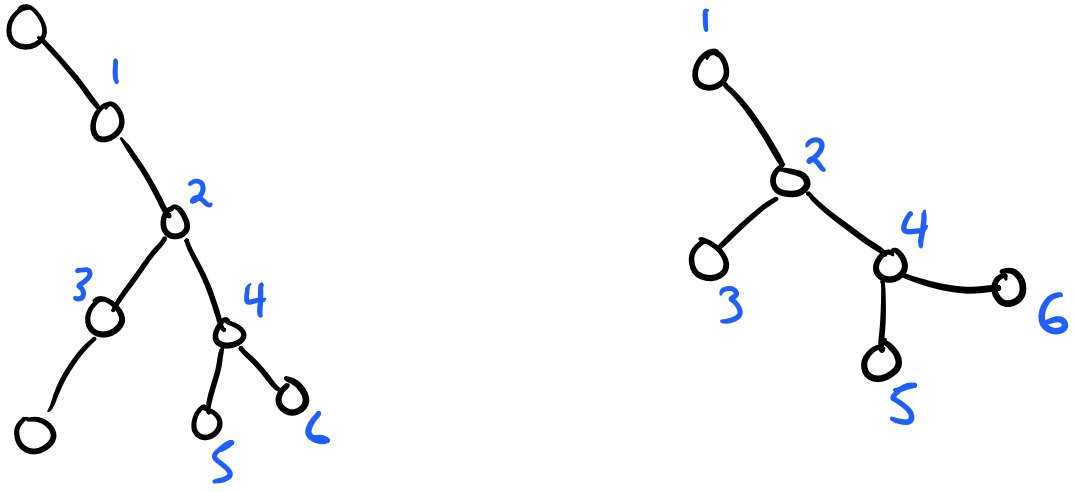


HashMap < ArrayList, Integer >

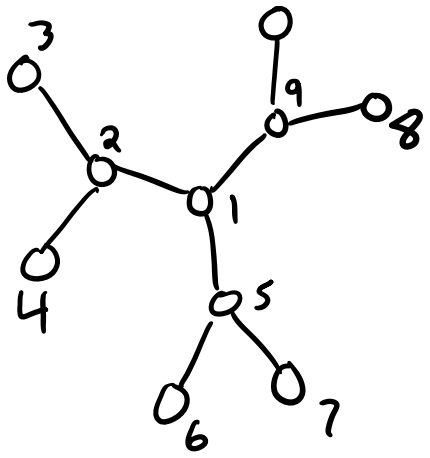


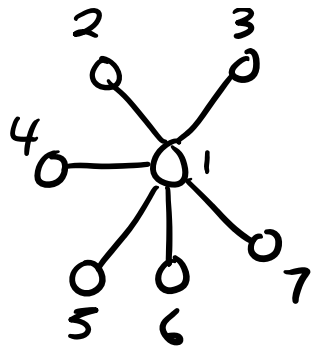
Subtree Isomorphism

2 trees $n \leq 100$

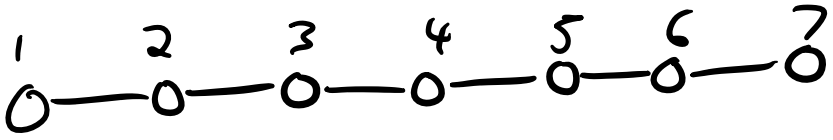


Automorphism



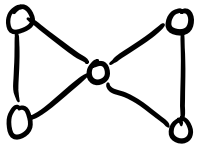


6!

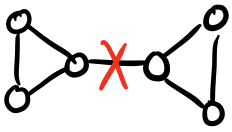


2

2-edge-connected

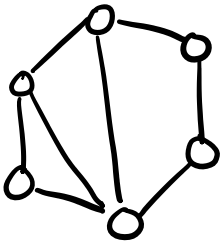


bridge

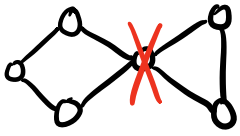


cut edge

2-vertex-connected



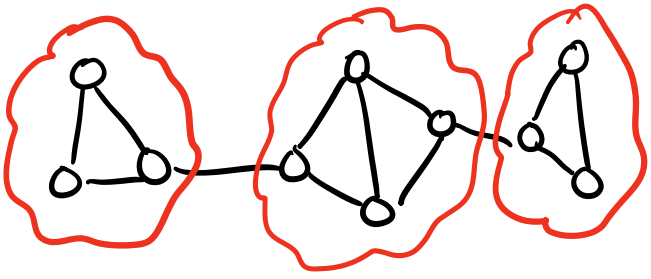
articulation point



cut vertex

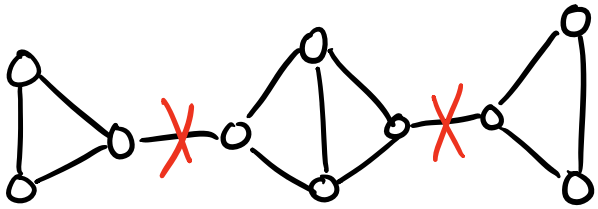
2-edge-connected components

* vertex set * (large as possible)



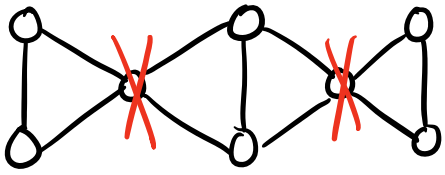
bridges

$O(E(V+E))$



articulation points

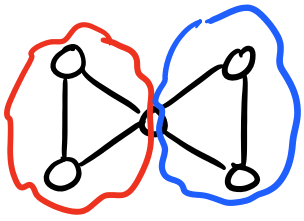
$O(V(V+E))$

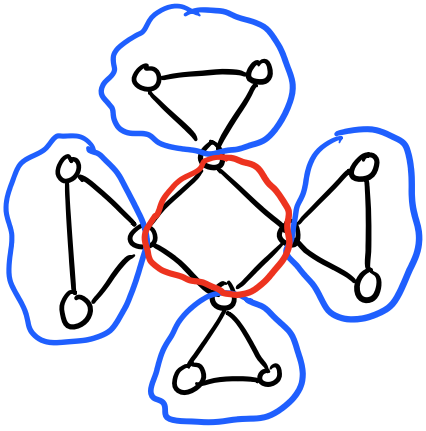


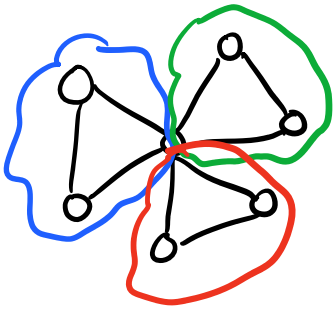
2-vertex-connected components

* edge set *

(large as possible)





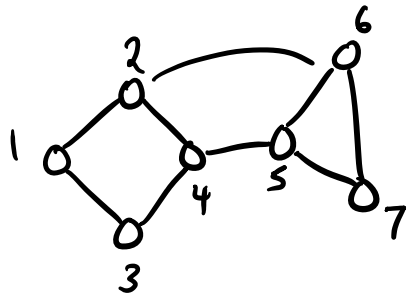


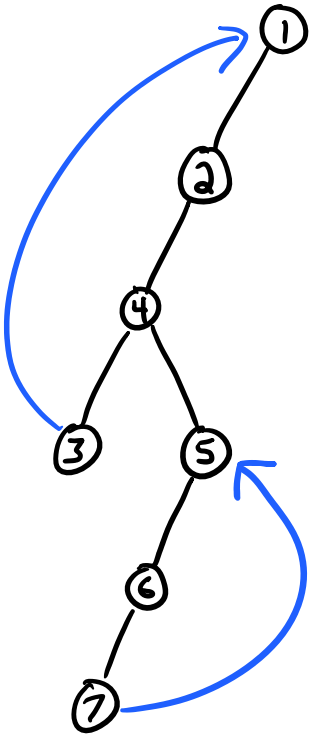
$n \leq 10^{5.5}$

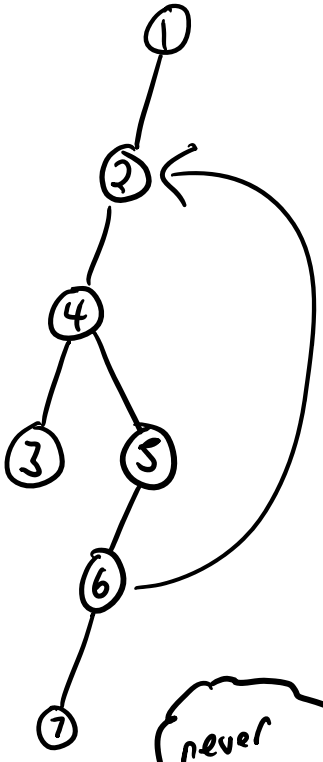
$m \leq 10^{5.5}$

$O(V+E)$ ← goal

DFS + lowlinking



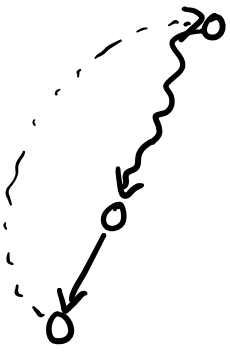




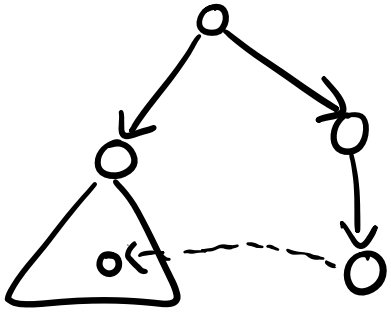
DFS (edges)

forward edge:

back edge:

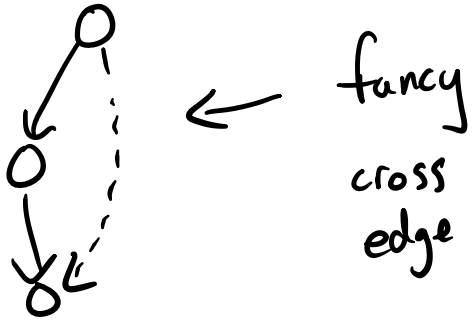


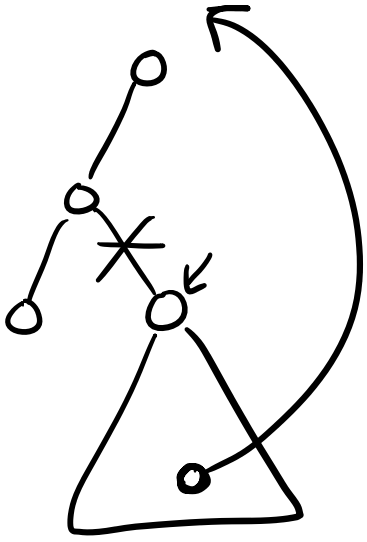
cross edge:



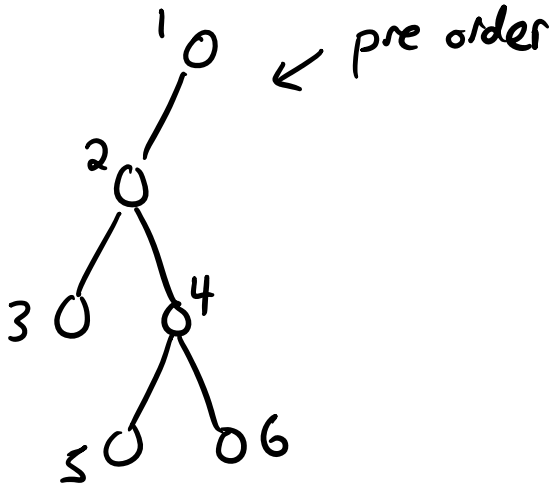
never for undirected

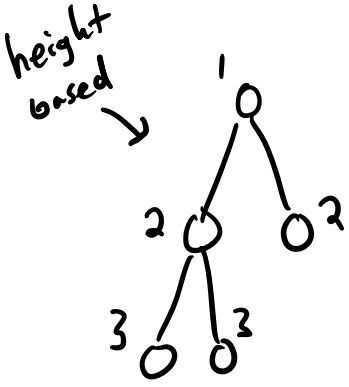
f.ncu

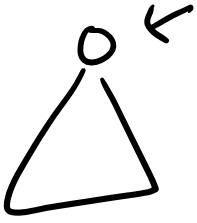


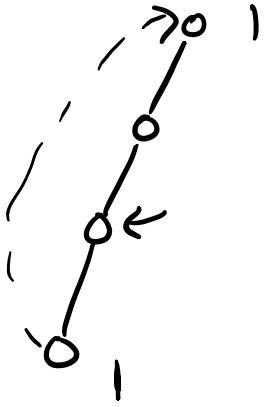


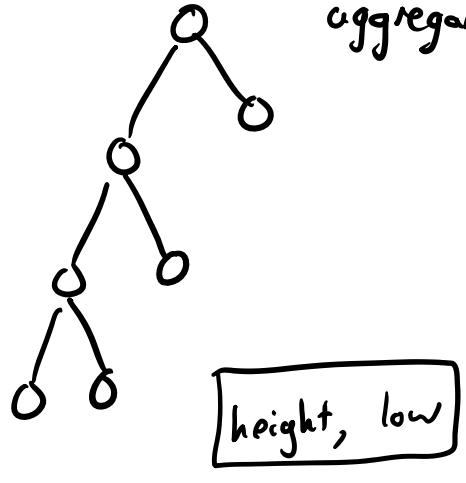
Escape the subtree

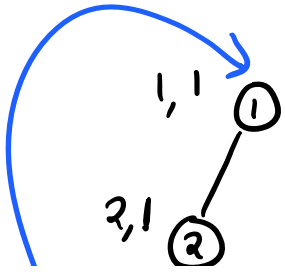


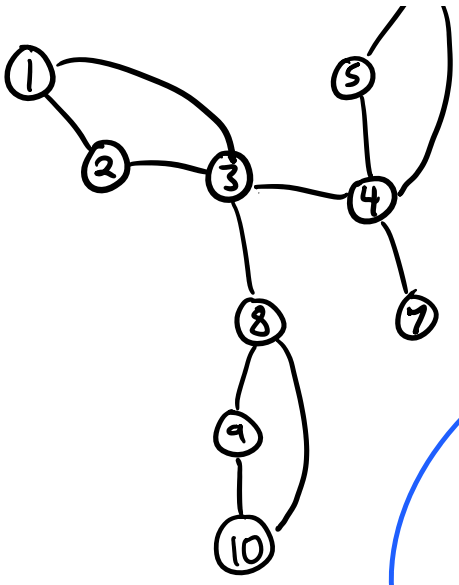


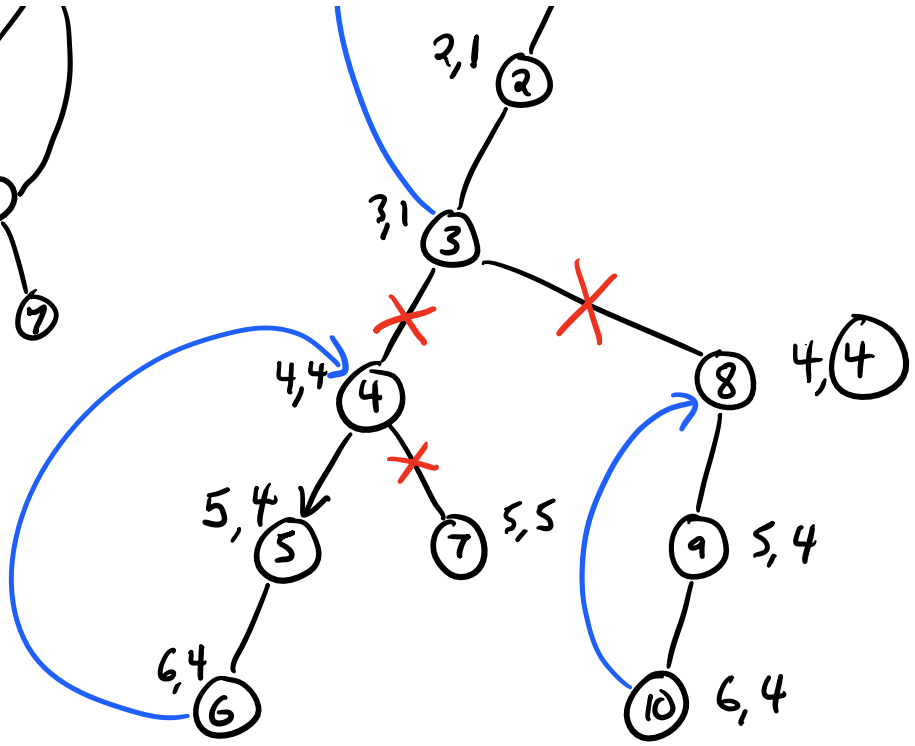


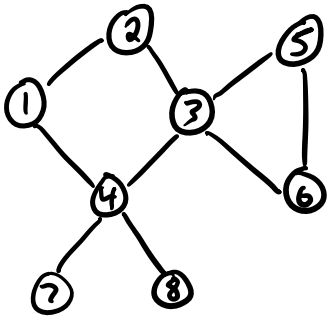




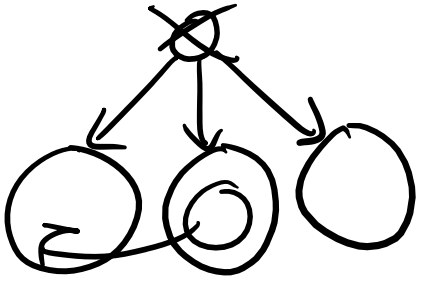


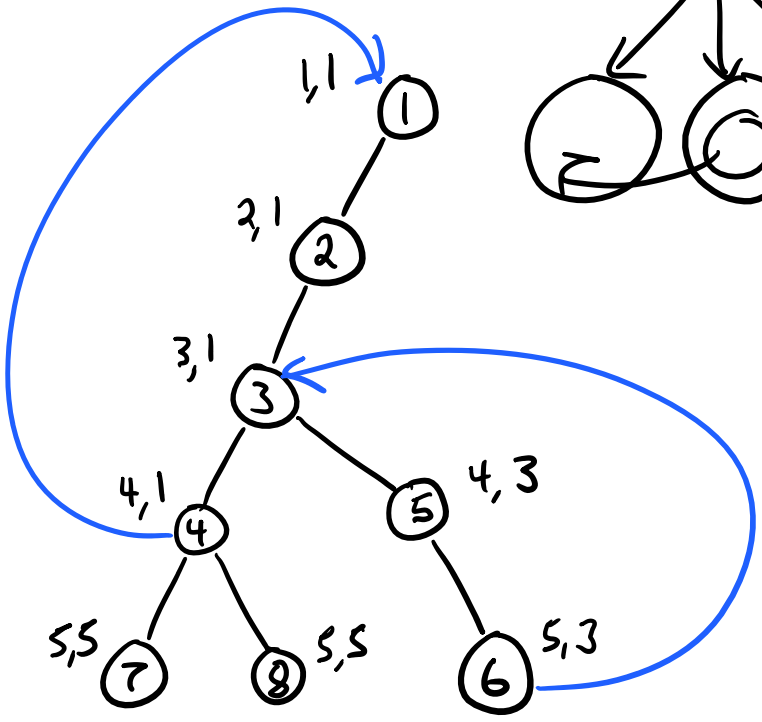




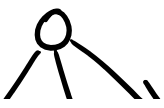


{4, 3}

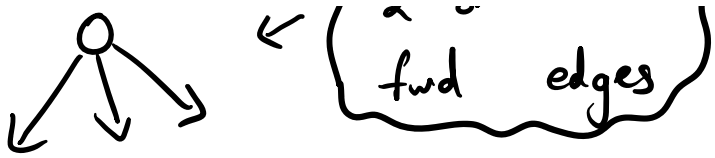


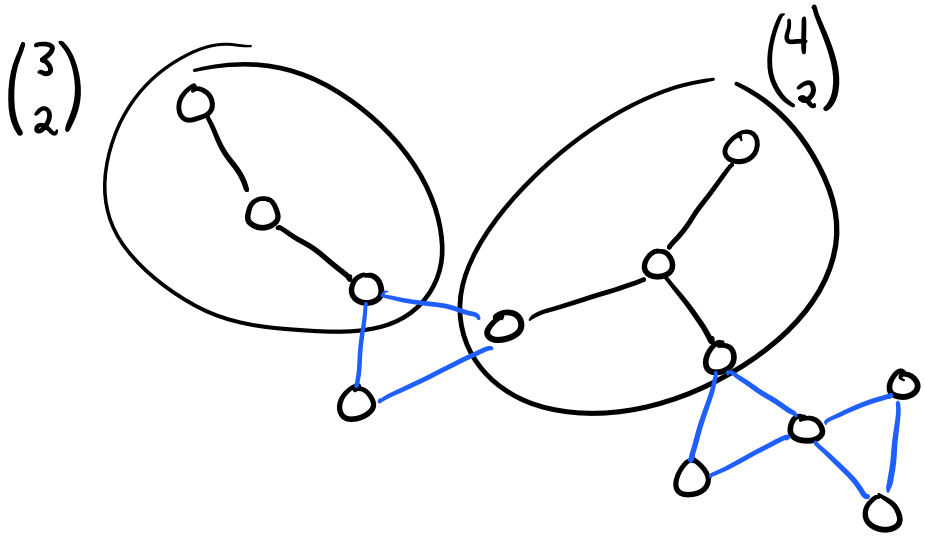


* root node is special *

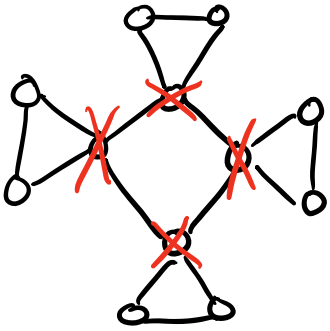


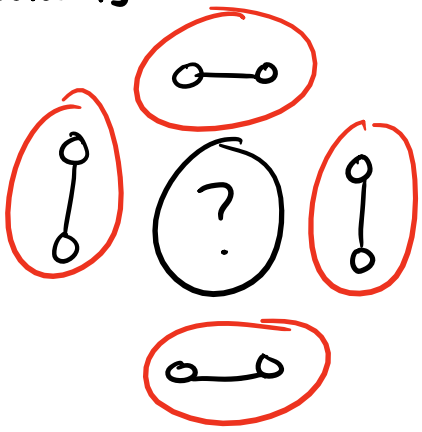
← 2 or more fwd edges

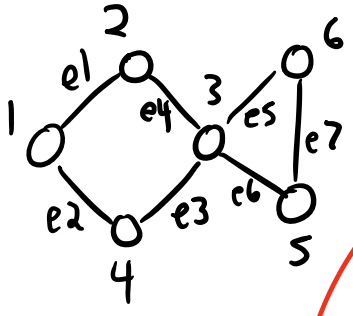


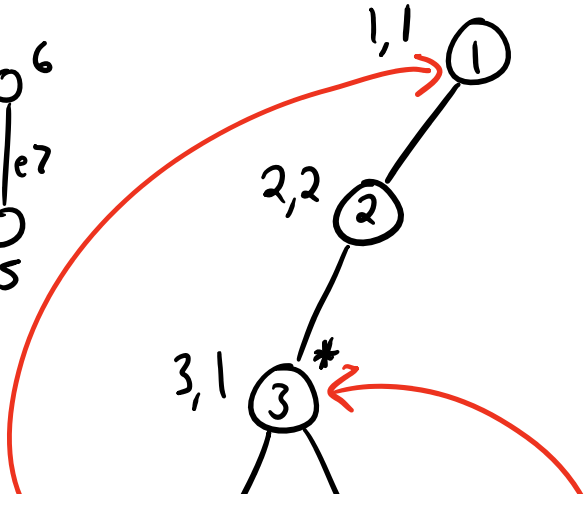


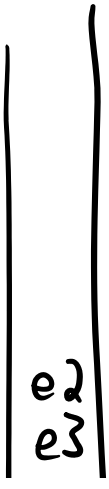
2-vertex-connected components

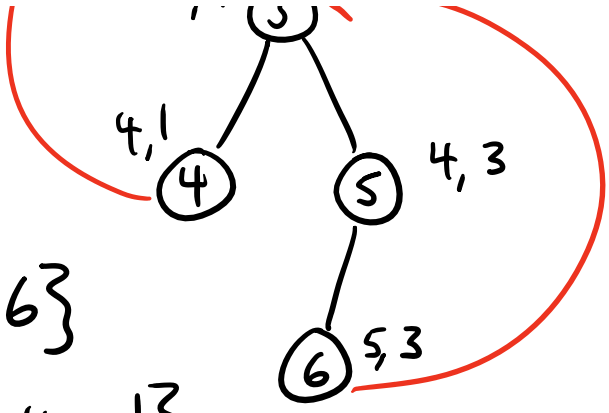








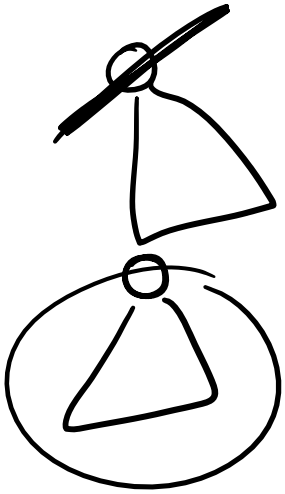




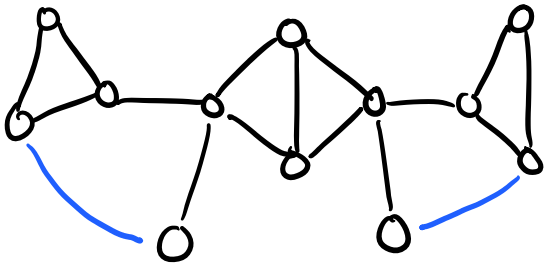
e3
e4
e1

{e5, e7, e6}

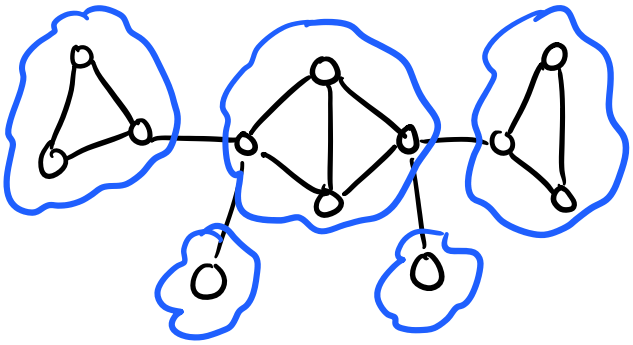
{e2, e3, e4, e1}



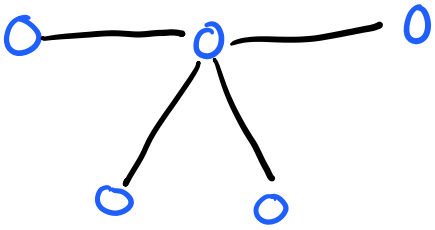
Min edges to make 2-edge-connected



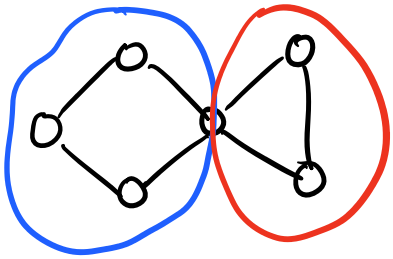
Metagraph

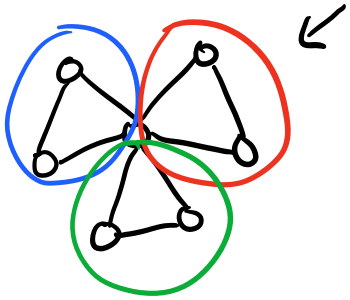


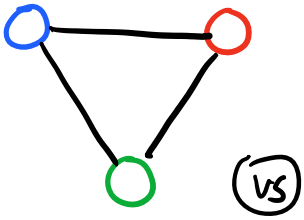
Graph		Tree
2ECC	→	node
bridge	→	edge

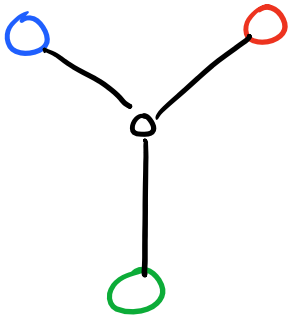


2VCC → tree ?









Graph → Tree

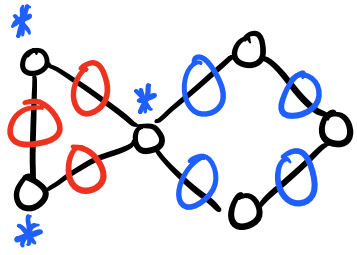
2VCC + Art pts → nodes

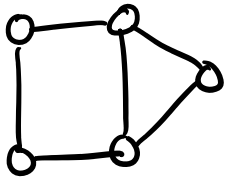
2VCC ⟷ Art pts → edges

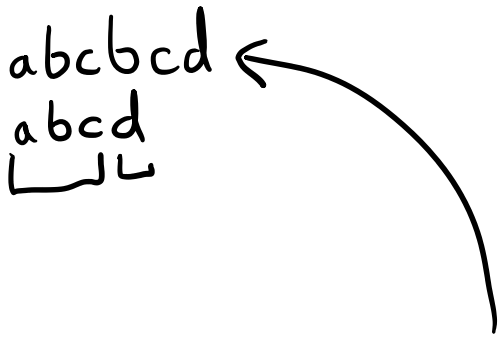
Lucky Cities

2VCC ⇔ cycles

2ECC ⇔ circuits

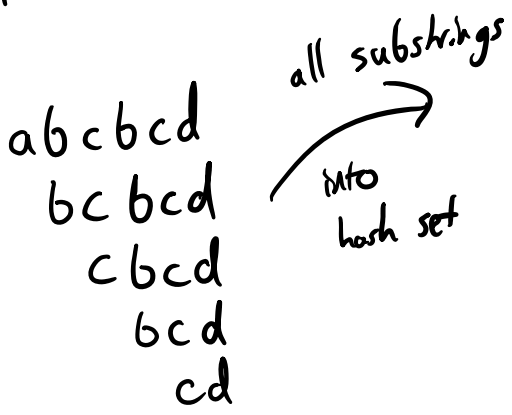






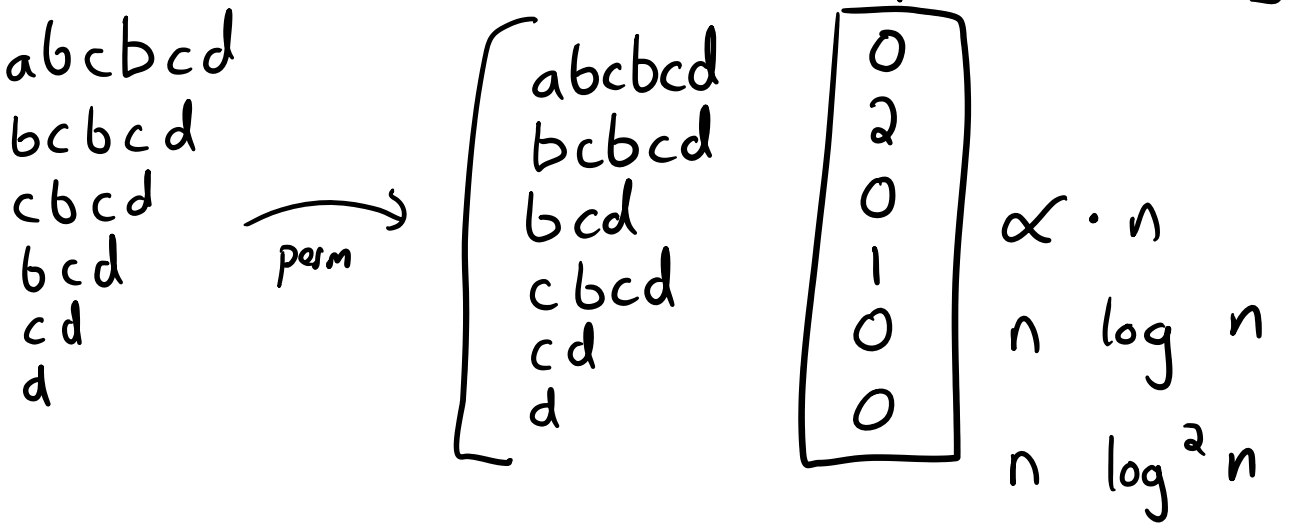
$1 \le |A| \le 1000$

$1 \le |B| \le 1000$



Suffix Tree

Suffix Array



abcd $ abcbcd