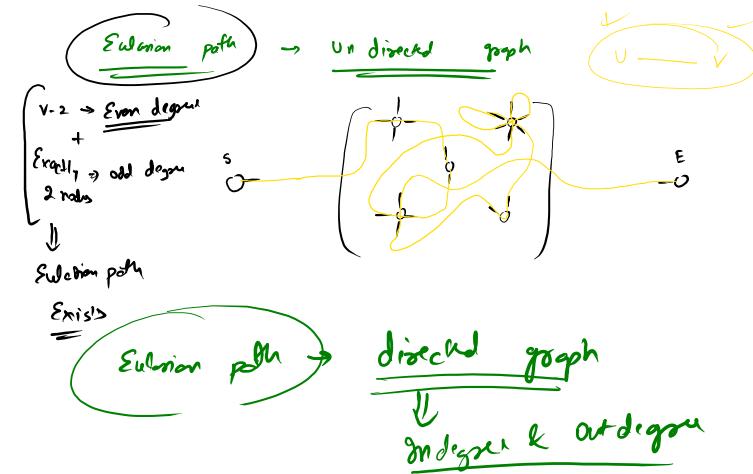
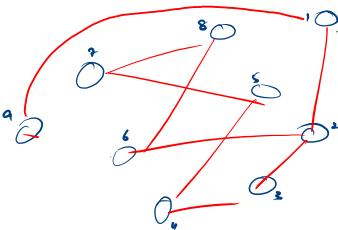
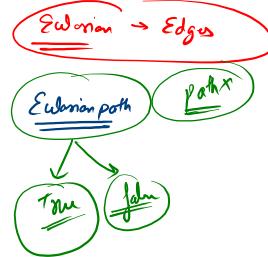
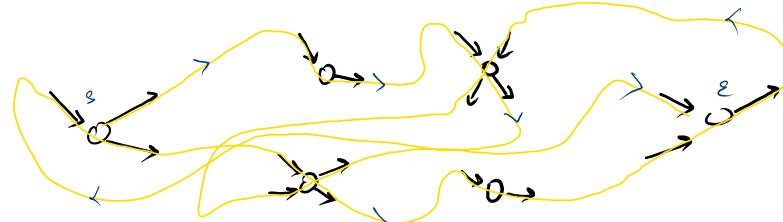


Hamiltonian Path + Direct Edge  $\Rightarrow$  Hamiltonian Cycle

- ① Every H. path is H. cycle
  - ~~② Every H. cycle is H. path~~
  - ③ group of H. cycle  $\subset$  group of H. path
  - ④ group of H. path  $\subset$  group of H. cycle
  - ⑤  $n(H. \text{cycles}) > n(H. \text{paths})$
  - ~~⑥  $n(H. \text{cycles}) > n(H. \text{paths})$~~
  - ⑦  $n(H. \text{paths}) \geq n(H. \text{cycles})$
- ~~Correct  
2,3,2~~

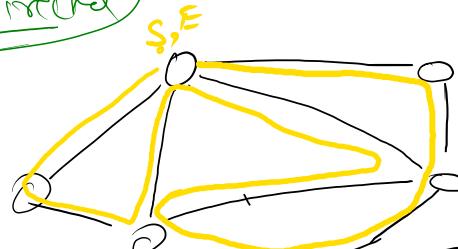


$v-2$   $\Rightarrow$  indegree == Outdegree  
Exactly 1 vertex  $\Rightarrow$  one extra outdegree (Starting)  
Exactly 2 vertices  $\Rightarrow$  one extra in-degree (Ending)



Eulerian Cycle

Undirected

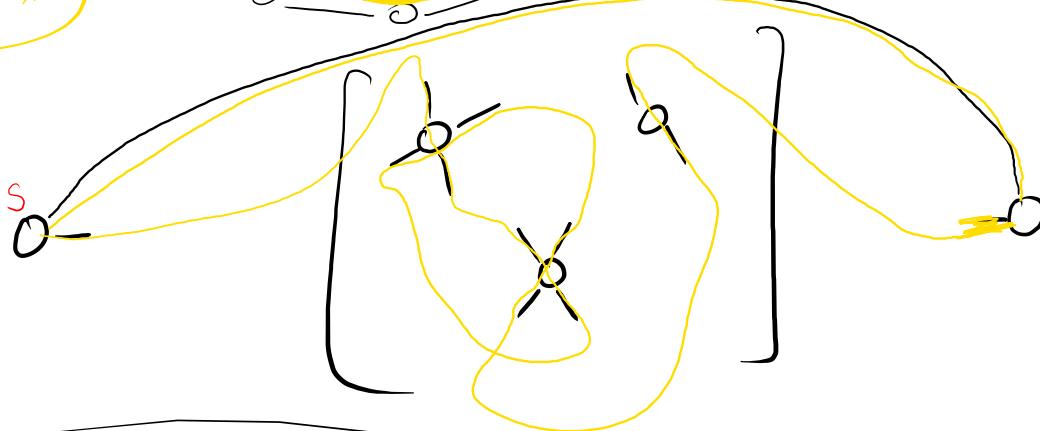


Circuit

$$S \cdot \text{Vd}x = E \cdot \text{Vd}x$$

Vtcs  $\Rightarrow$  Even degree

Circuit



Eulerian Circuit  $\Rightarrow$  Directed Graph

All vertices should have Indegree = Outdegree

Circuit

Eulerian

Undirected

Smin

- ① Circuit  $\Rightarrow$  all vertices must have even degree  
② Path  $\Rightarrow$  V-2 vertices must have even degree

+

Exactly 2 vertices must have odd degree

Directed

- ① Circuit  $\Rightarrow$  all vertices must have indegree  $\geq$  outdegree  
② Path  $\Rightarrow$  V-2 vertices have indegree = outdegree

+

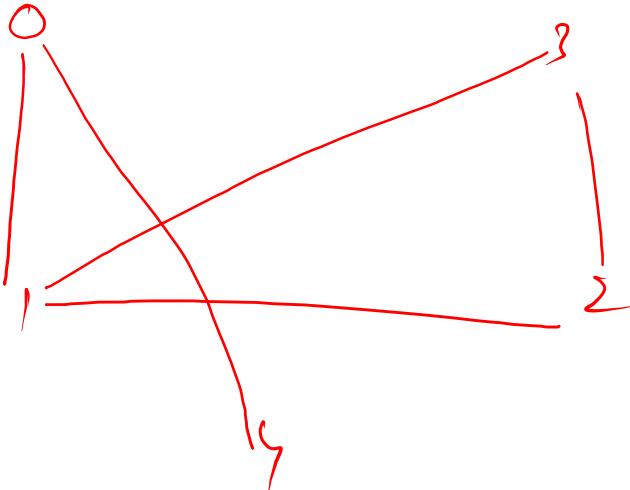
Exactly 2 vertices must have extra indegrees  $\neq$  outdeg.

$N \rightarrow V$

$\rightarrow 0$   
 $\rightarrow 1$   
 $\rightarrow 2$   
 $\rightarrow 3$   
 $\rightarrow c$

	0	1	2	3	c
0	{0, 1, 0, 0, 1},				
1	{1, 0, 1, 1, 0},				
2	{0, 1, 0, 1, 0},				
3	{0, 1, 1, 0, 0},				
c	{1, 0, 0, 0, 0}				

odd  $\Rightarrow 1$   
even  $\Rightarrow 0$



	0	1	2	3	c
T.C. $\Rightarrow N^2$	2	3	2	2	1

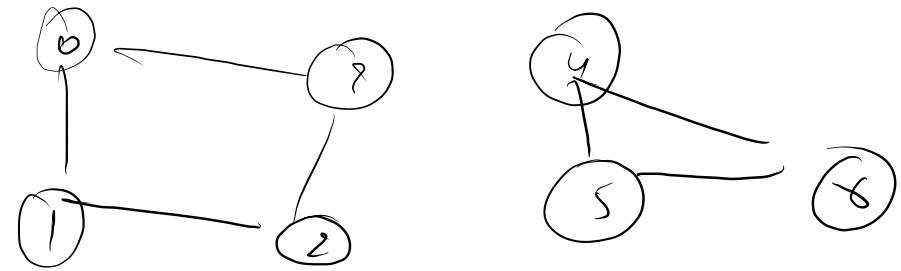
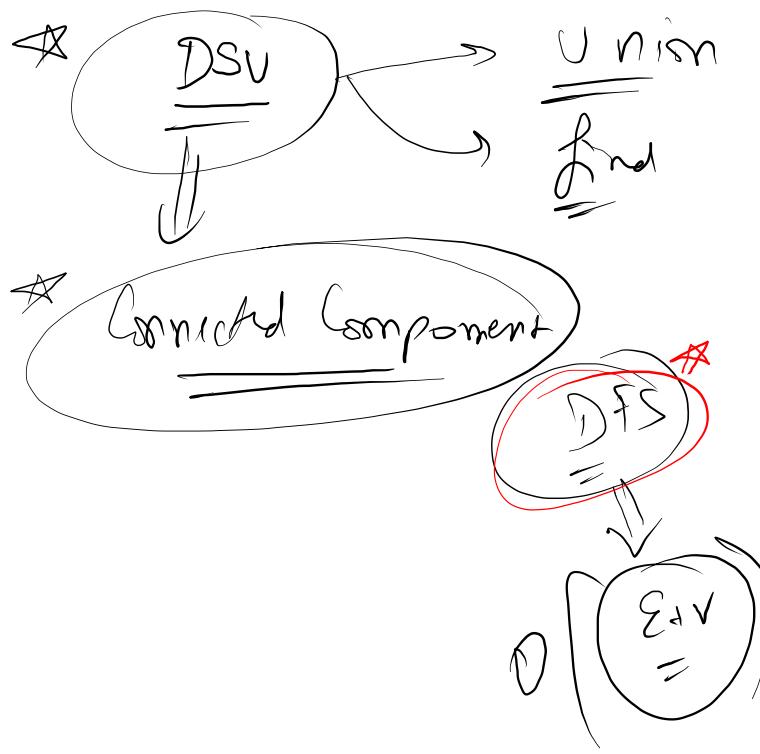
$S.C. \Rightarrow N$

$T.C. \Rightarrow O(N^2)$   
 $S.C. \Rightarrow O(1)$

Eulerian path?

$T_m$

↑



add Edge  $O-1$

0

3

5

1

4

6



n edges

Component

[0][1][2][3] [4][5][6]

DFS  
 $O(E + V)$

[0,1][2][3][4][5][6]

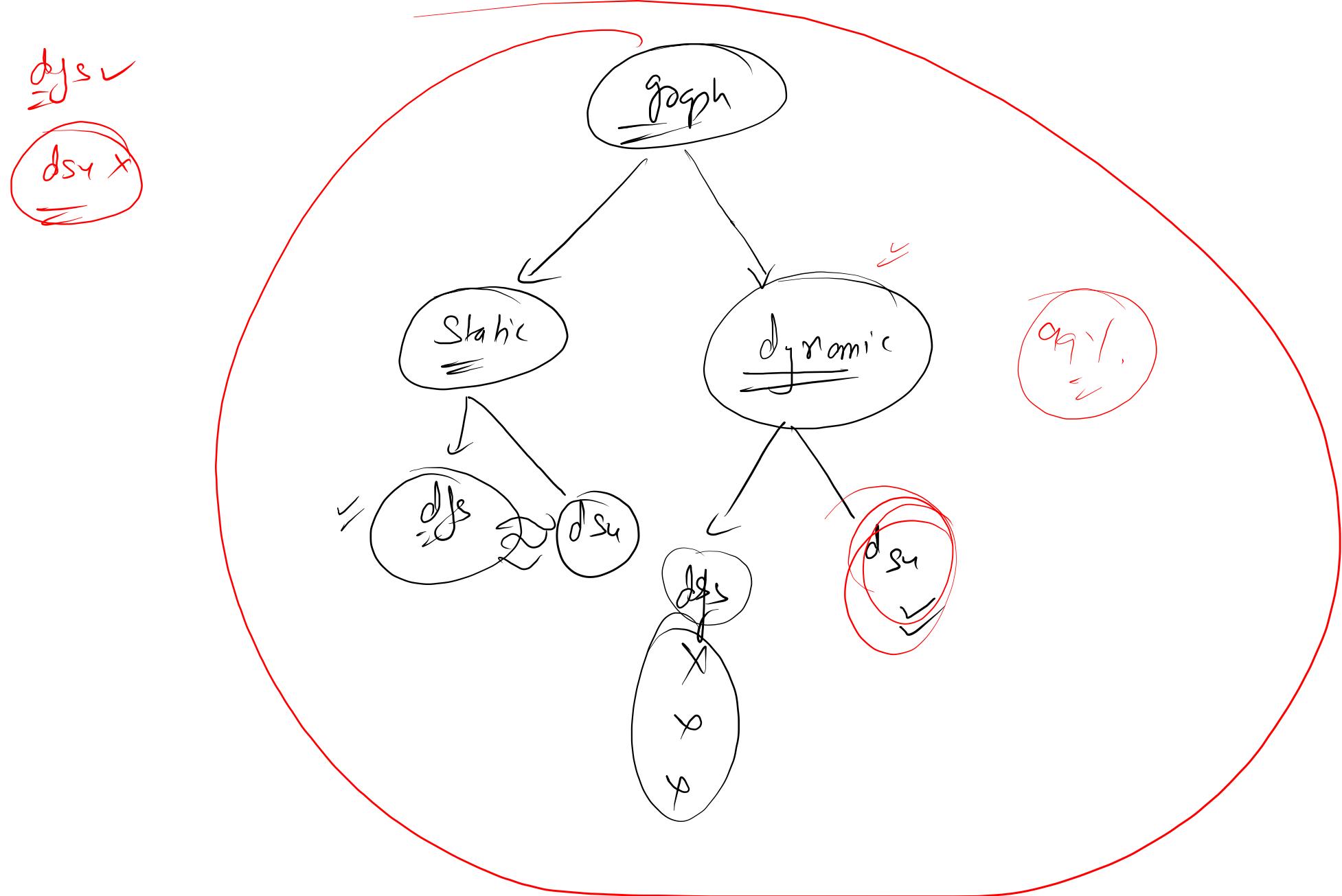
DFS  
 $O(E + V)$

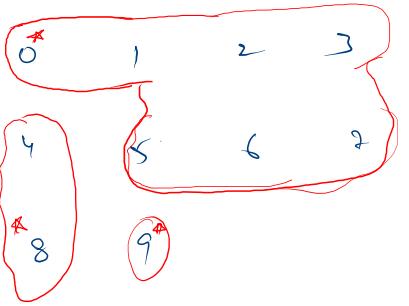
DSU

Dynamically

T.C.  $\Rightarrow \underline{n} \cdot [E + V]$

graph





Answers

✓ (0,1) ✓

✓ (0,2)

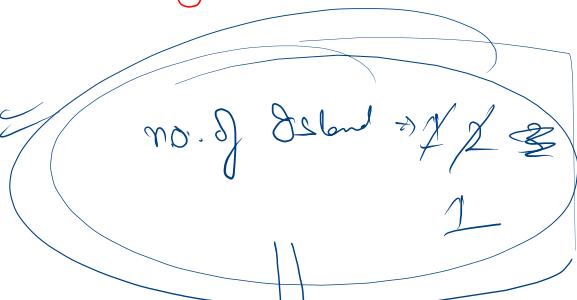
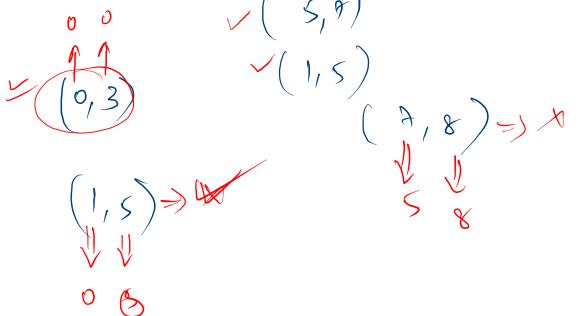
✓ (1,3)

✓ (4,8)

✓ (5,6)

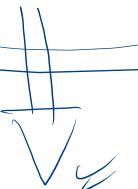
✓ (5,9)

✓ (1,5)



1

Dfs



0	0	0	0	0
0	0	1	0	0
0	0	1	0	1
0	0	0	1	0
0	0	0	0	0

0

1

2

3

4

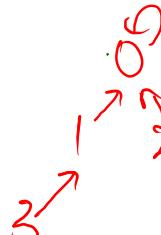
5

6

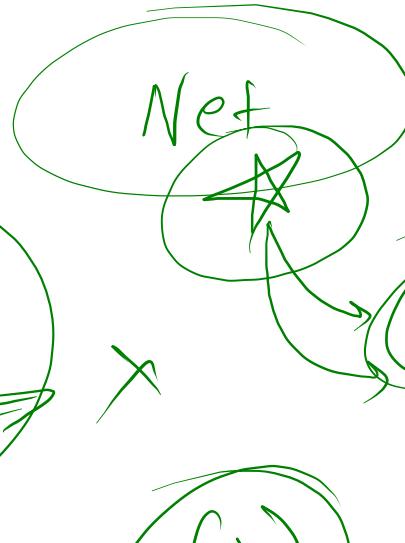
7

8

9



0	0	0	1	8	4	5	6	5	5	4	9
0	1	2	3	4	5	6	7	8	9		



- (0, 1)
- (0, 2)
- (1, 3)
- (4, 8)
- (5, 6)
- (5, 8)



4:30

2:30

