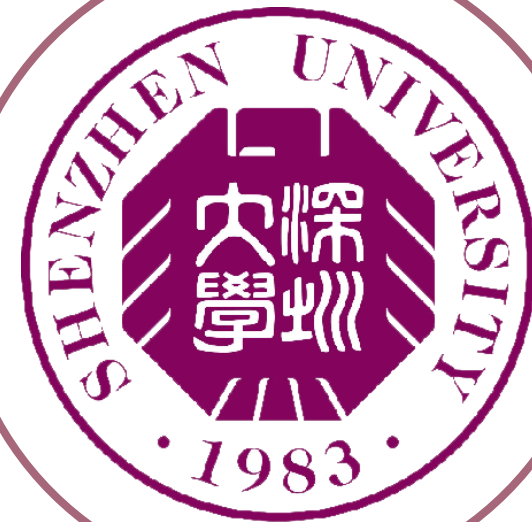


Lab 5: Graph's Bridges

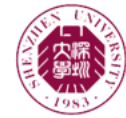
Yang Zheng

Minhan Chen

Instructor: Yanran Li



- **Problem**
- **Basic Solution**
- **Optimized Basic Solution**
- **Efficient Solution With LCA**
- **Efficient Solution With Difference**
- **Experiments**

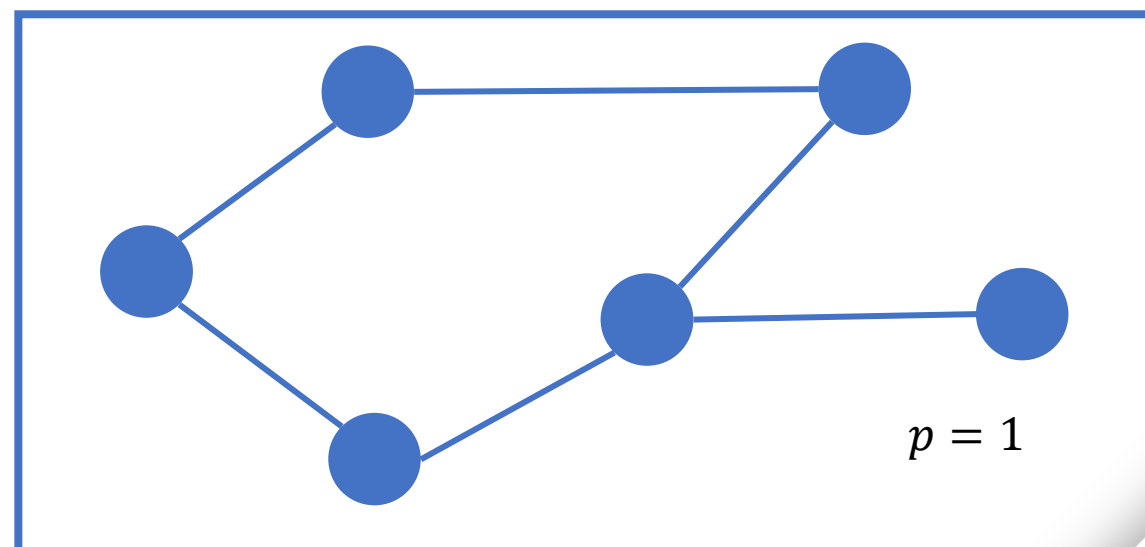
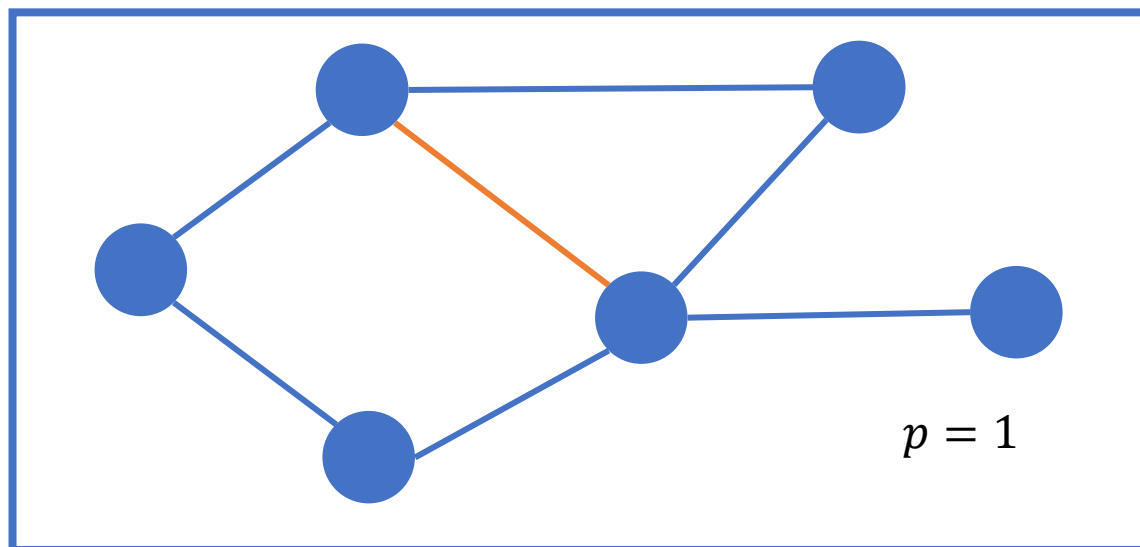
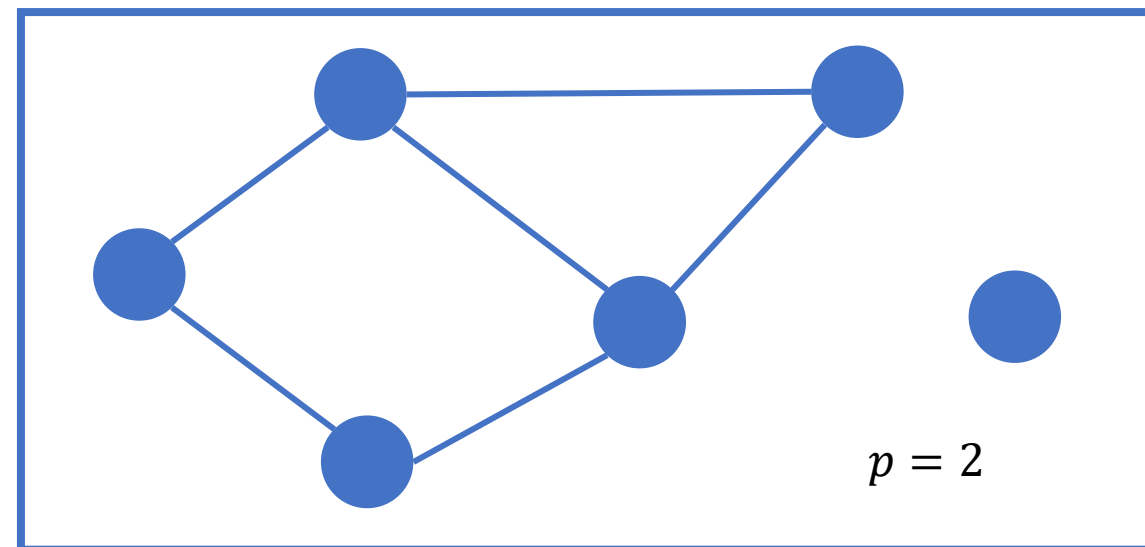
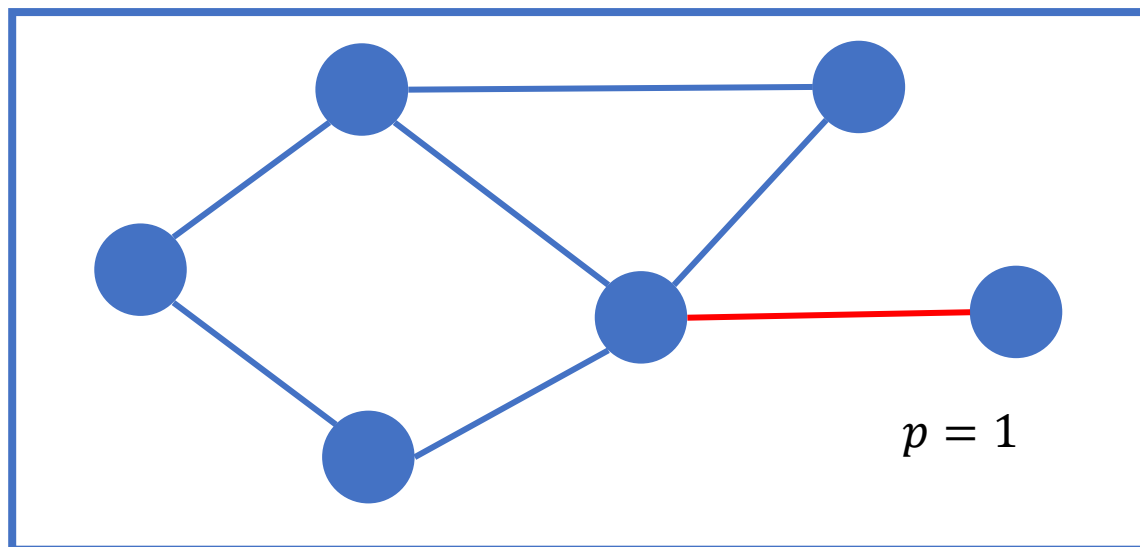


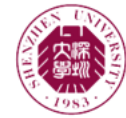
Problem



Problem

$$G(V, E, p)$$





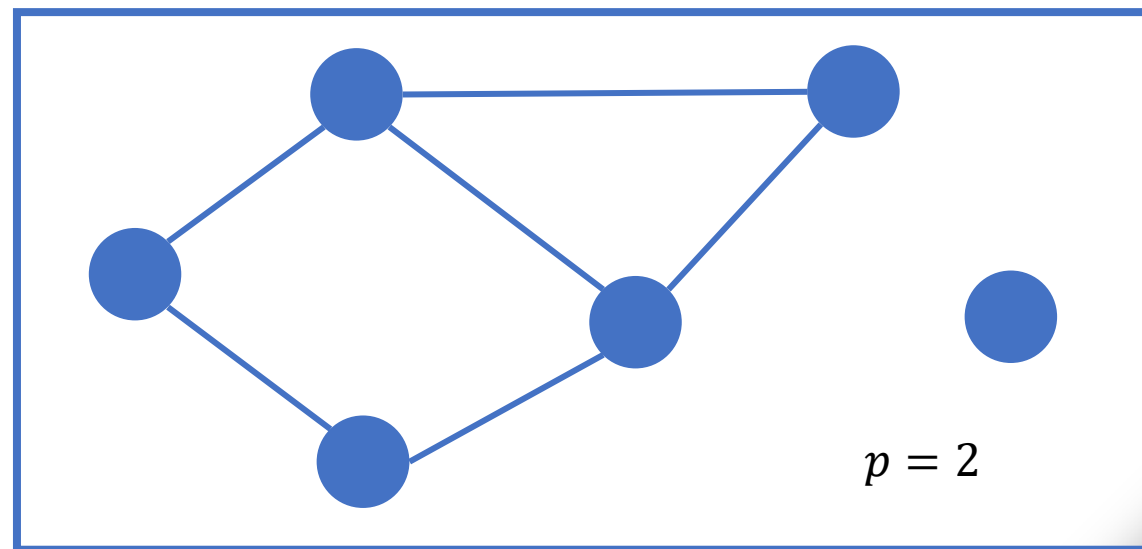
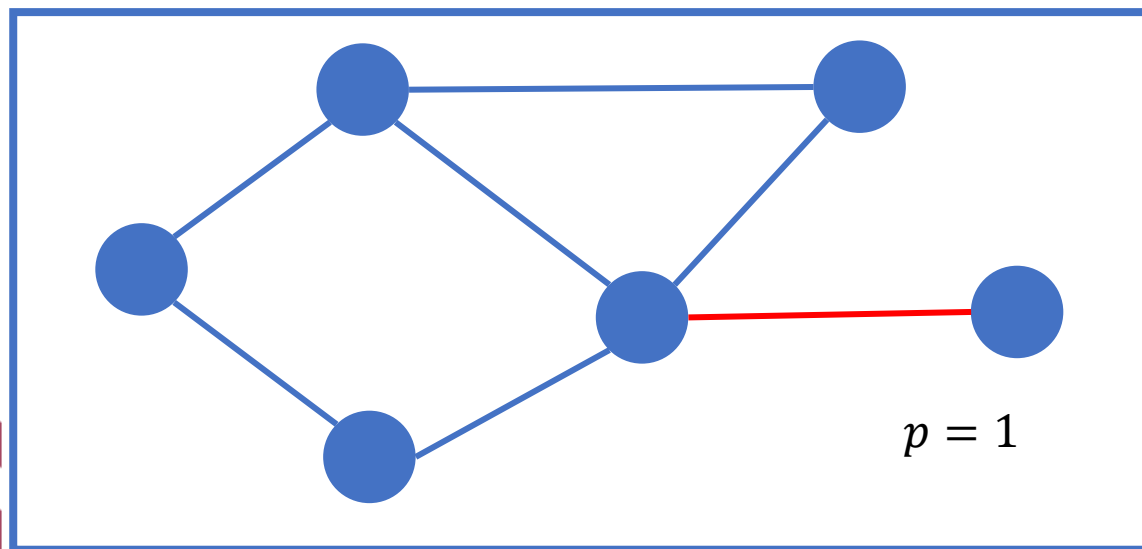
Basic Solution

Basic Solution

● Solution1

● Idea $G(V, E, p)$

- Enumerate each $e \in E$
- delete e from E get $G(V, E - \{e\}, p')$
- if $p' > p$ then e is a bridge



Basic Solution

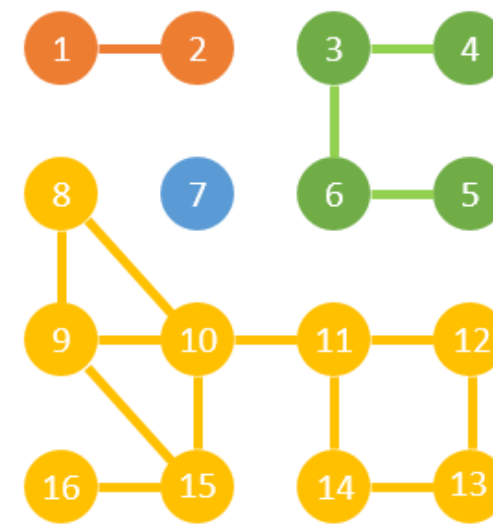
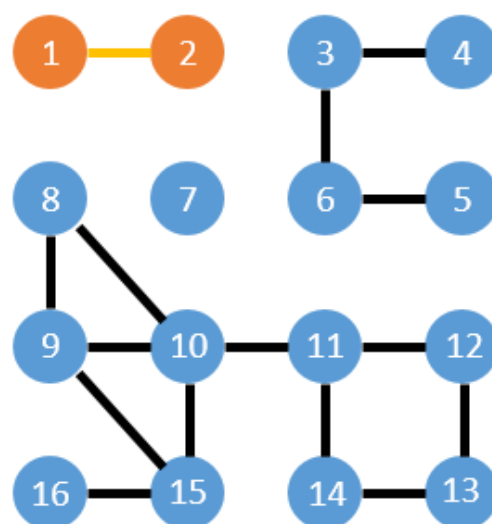
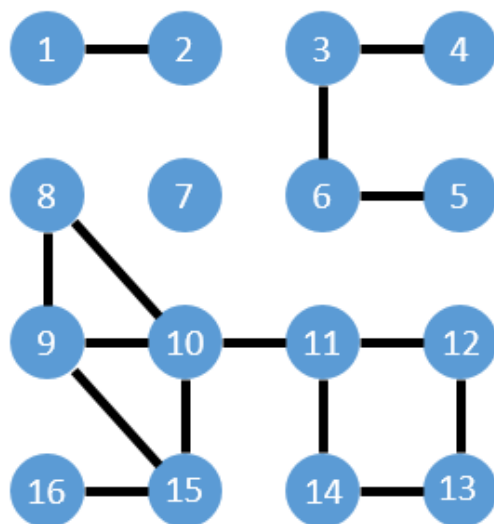
● Solution1

● Calculate p

$G(V, E, p)$

● $dfs(v)$

● Example

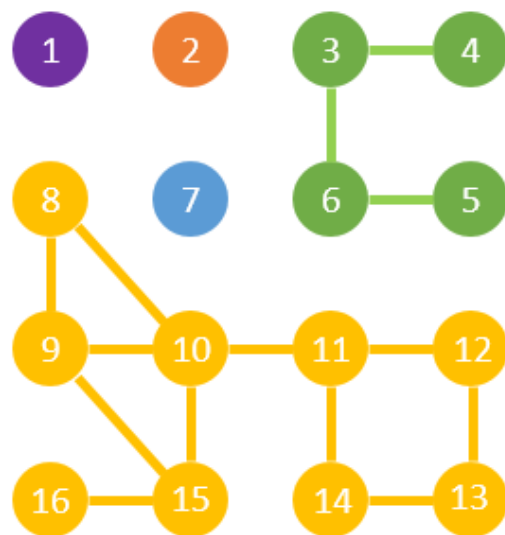
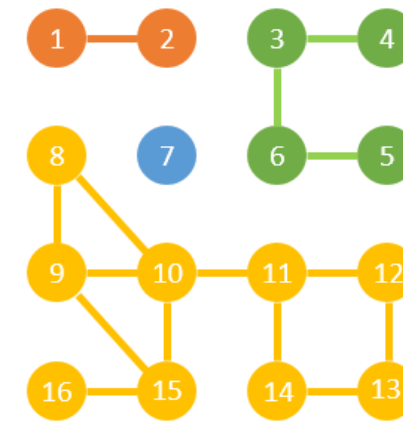
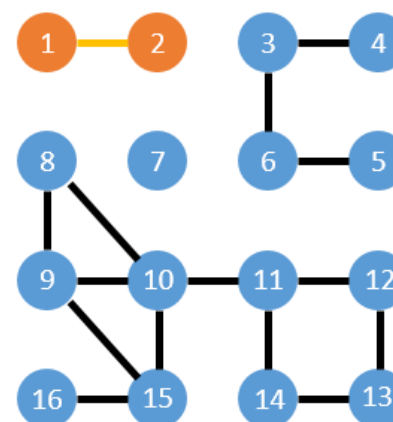
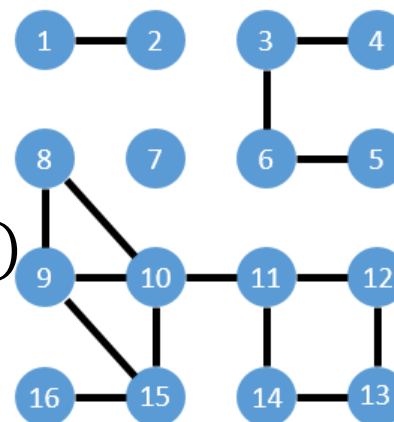




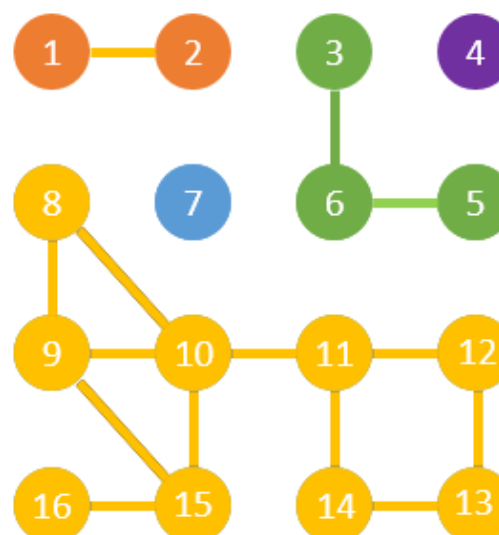
Basic Solution

● Solution1

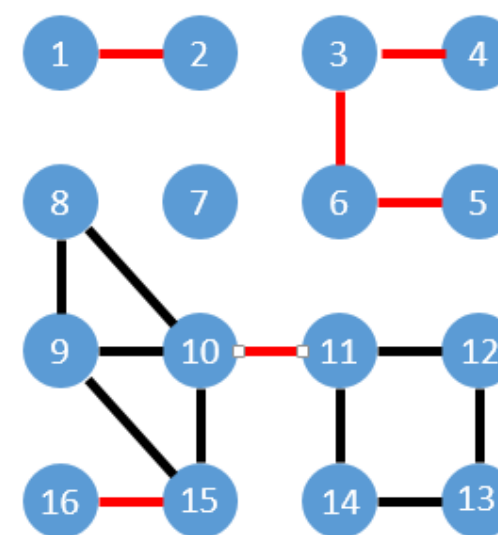
● Example $G(V, E, p = 4)$



$p' = 5$



$p' = 5$





Basic Solution

- Solution1
 - Complecity $G(V, E) \quad |V| = n, |E| = m$
Calculate $p \text{-----} O(n + m)$
 $Time: O(m(n + m)) = O(mn + m^2)$

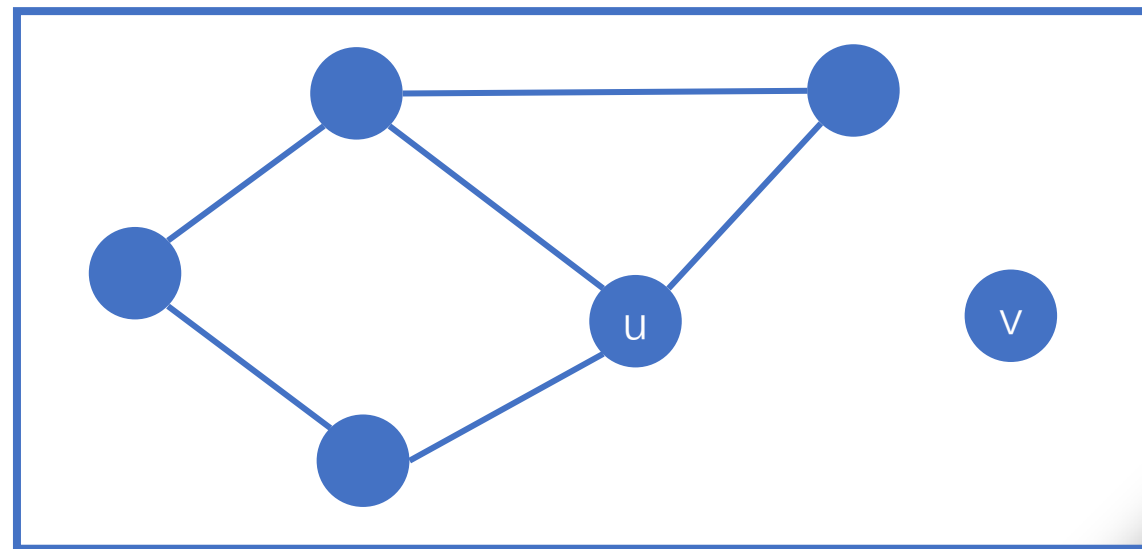
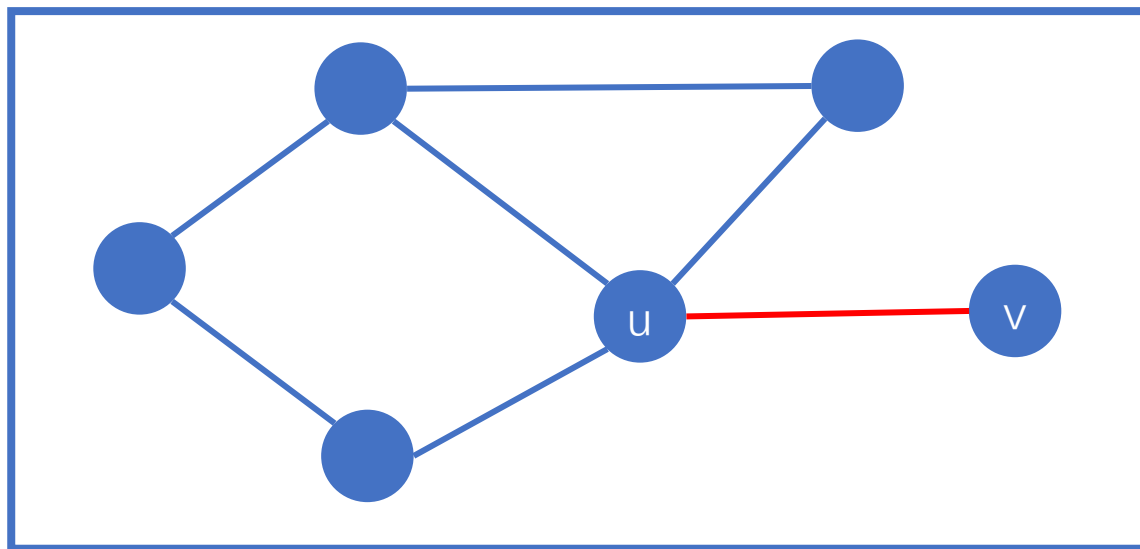


Basic Solution

● Solution2

● Idea $G(V, E)$

- Enumerate each $(u, v) \in E$
- delete (u, v) from E get $G(V, E - \{(u, v)\})$
- if u is not connected with v then (u, v) is a bridge

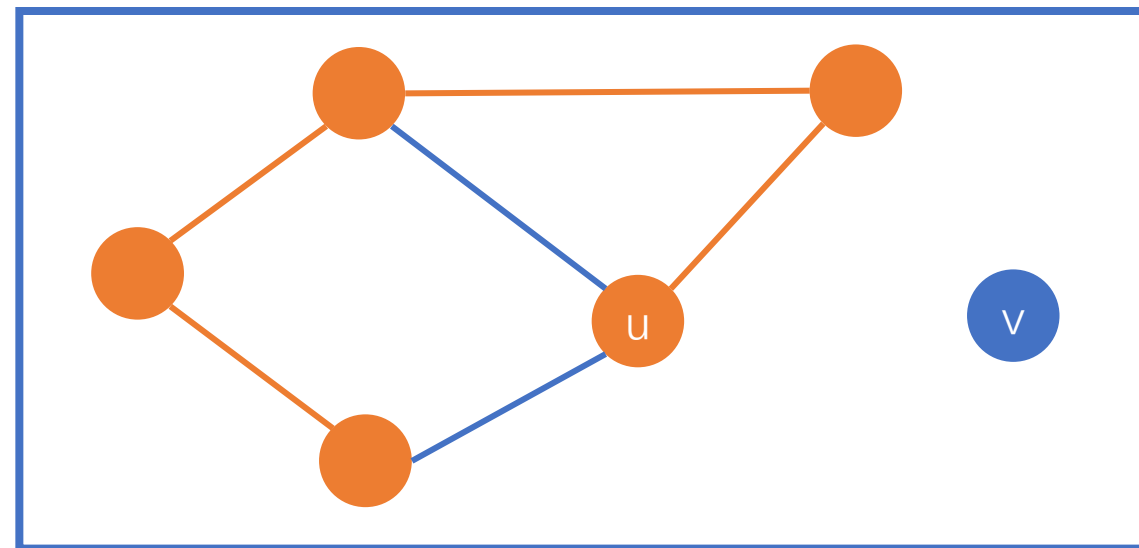
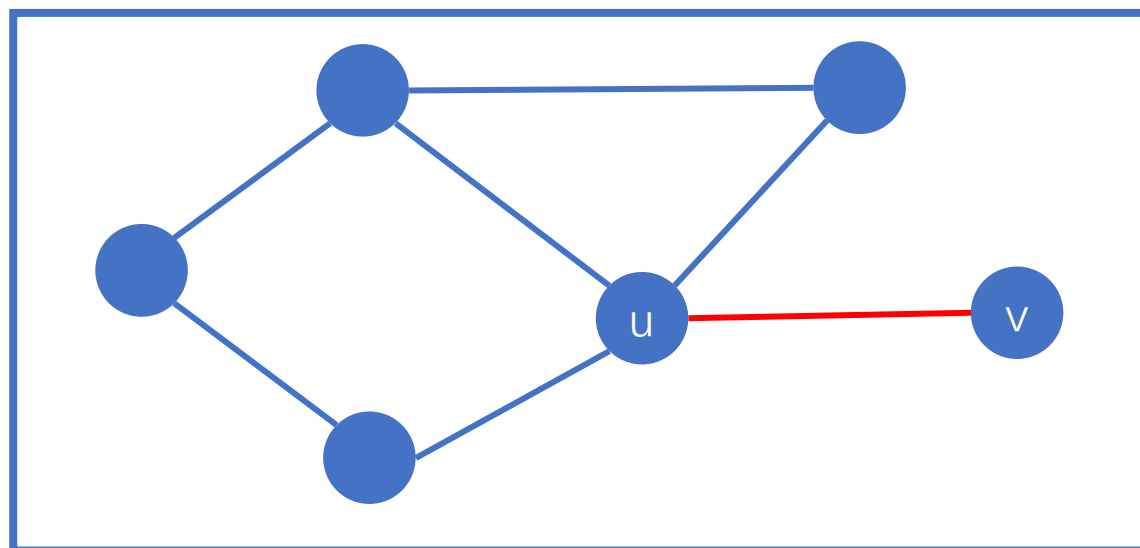


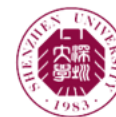
Basic Solution

- Solution2

- Judge if u is connected with v $G(V, E)$

- *dfs from u*





Basic Solution

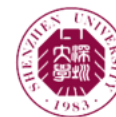
- Solution2

- Complecity $G(V, E) \quad |V| = n, |E| = m$

Judge if u is connected with v----- $O(n + m)$

Time: $O(m(n + m)) = O(mn + m^2)$



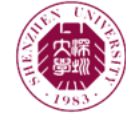


Basic Solution

- Conclusion
- Complecity $G(V, E) \quad |V| = n, |E| = m$

Time: $O(mn + m^2)$

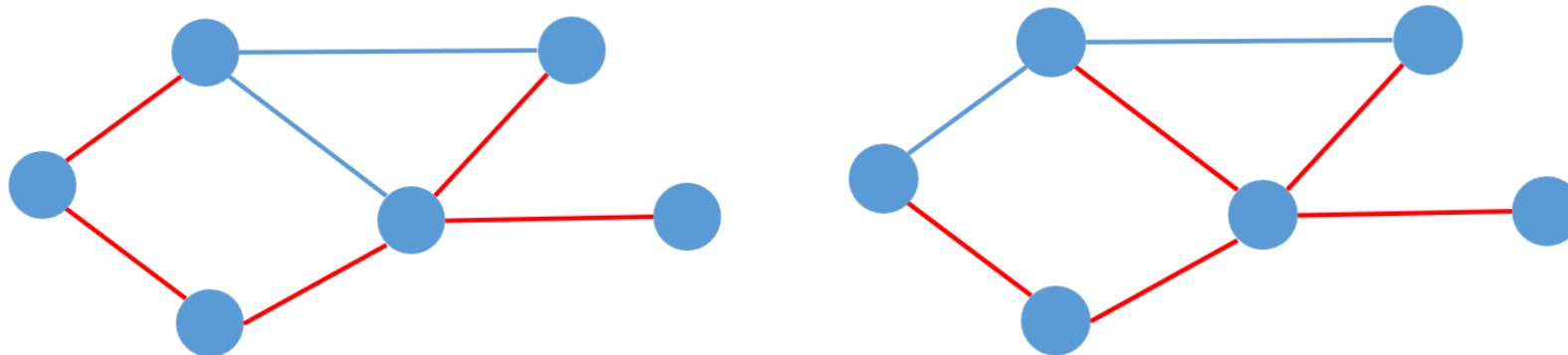




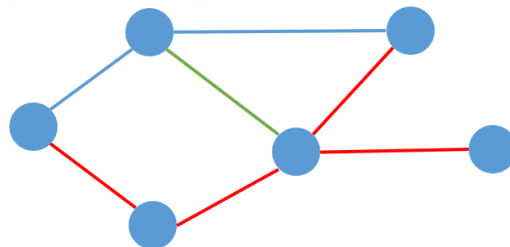
Optimized Basic Solution

Optimized Basic Solution

- Idea Spanning Tree
 - Spanning Tree Contains All Bridges



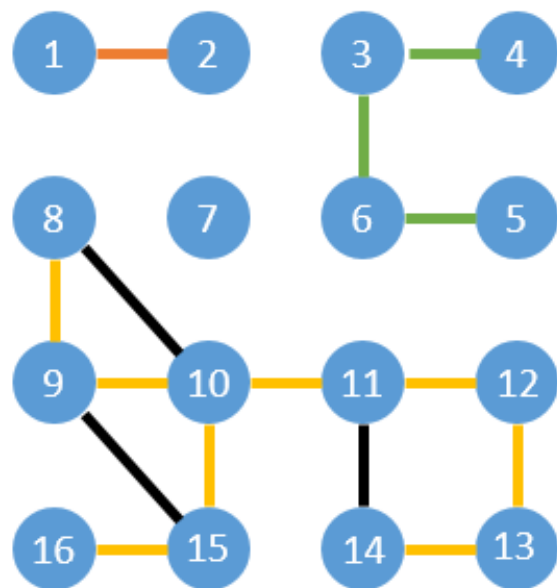
- Not All Edges in Spanning Tree is Bridges



- Just Enumerate Edges in Spanning Tree

Optimized Basic Solution

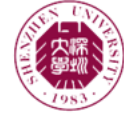
- Solution $G(V, E)$
 - Enumerate each $e \in T, T \subset E$
 - judge if e is a bridge use basic solution
- Example



- Complexity

$$G(V, E, p) \quad |V| = n, |E| = m$$

$$\text{Time: } O((n + m)(n - p)) \\ = O(n^2 + mn)$$



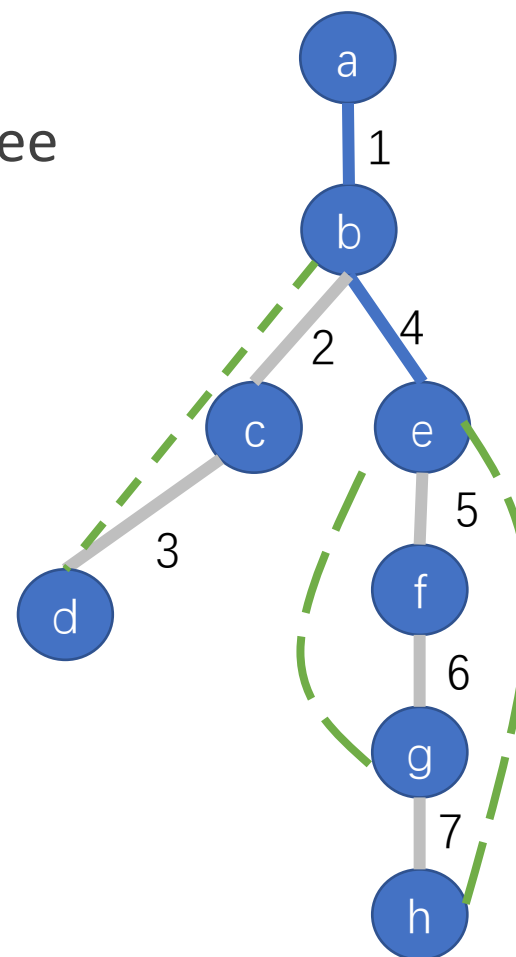
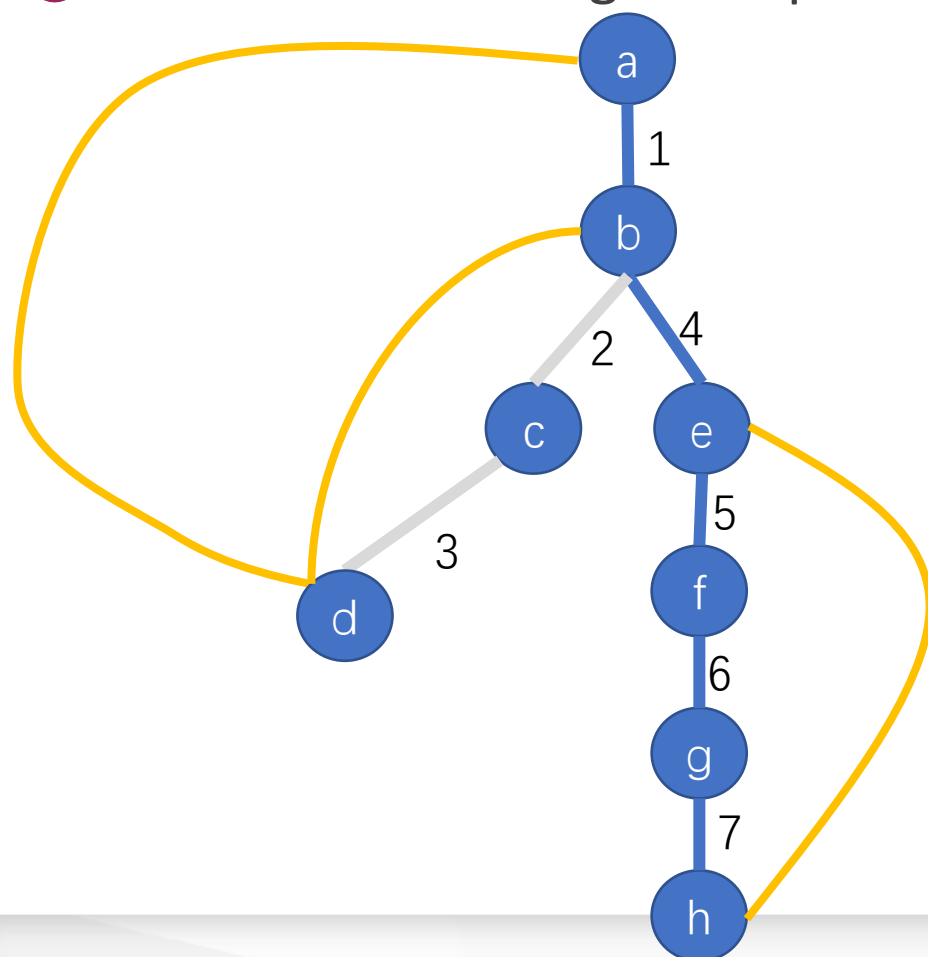
Efficient Solution With LCA

Efficient Solution With LCA

Idea

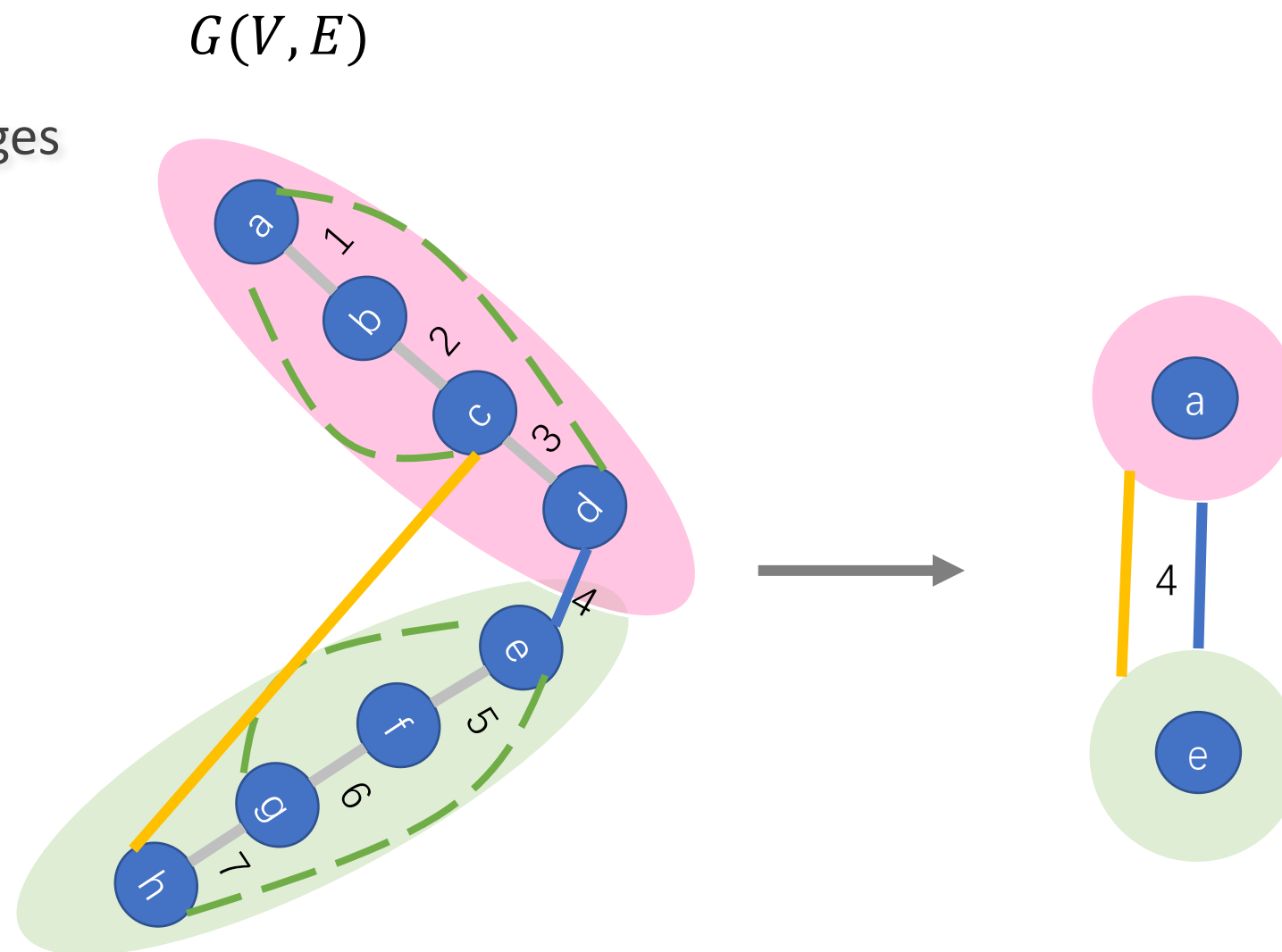
$G(V, E)$

Exclude Circle Edges of Spanning Tree



Efficient Solution With LCA

- Solution
- Find Circle Edges

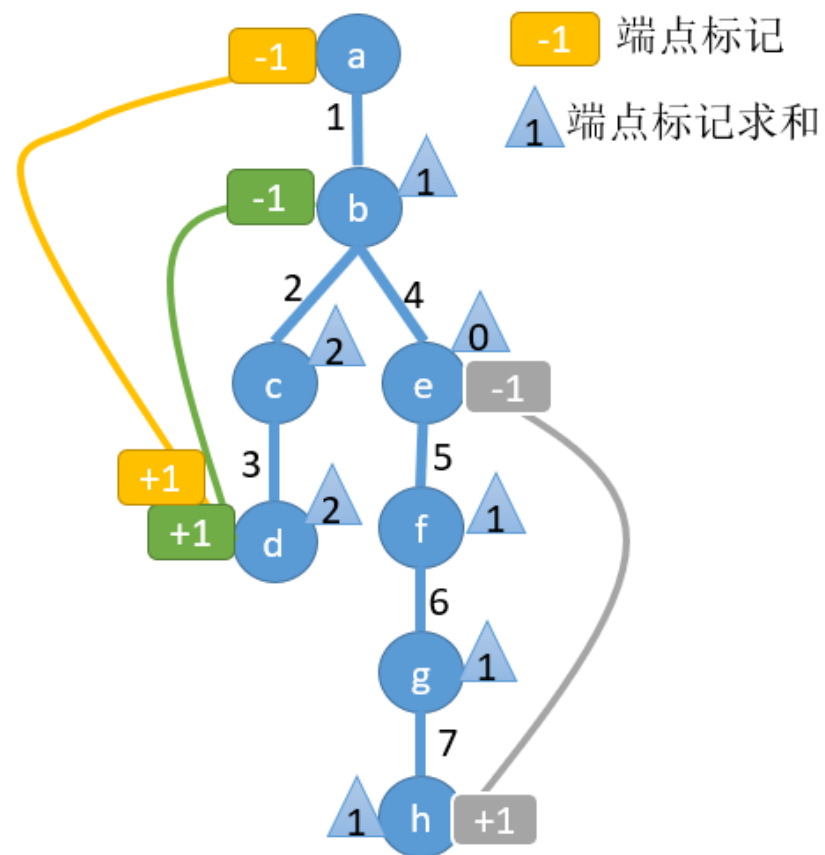


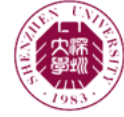


Efficient Solution With Different

Efficient Solution With Different

Idea





Experiment

Experiment



深圳大学
SHENZHEN UNIVERSITY

mediumG	tree	bruce	tree+简单压缩	tree+并查集	tree+差分
	42.930ms	4.043ms	41.910ms	40.411ms	42.847ms

largeG	tree+简单压缩	tree+并查集	tree+差分
	7.90s	1.40s	1.36s



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THANKS

2022.6.20