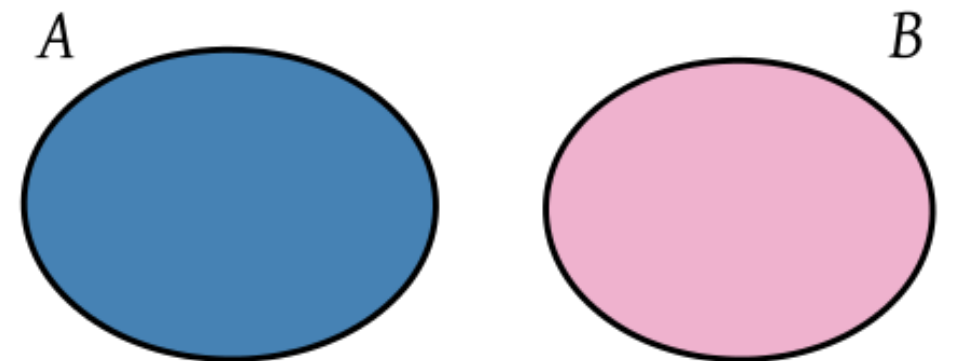


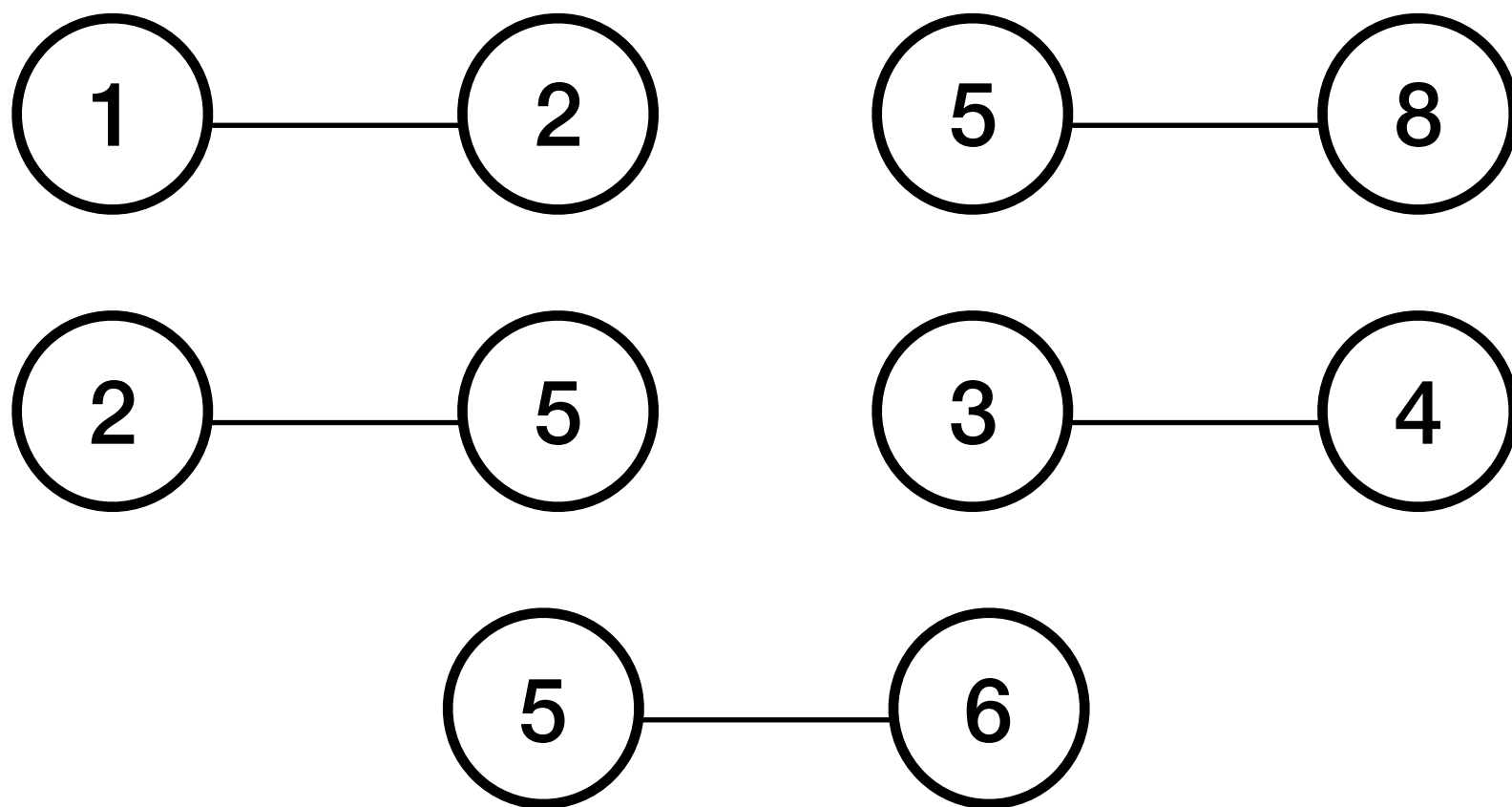
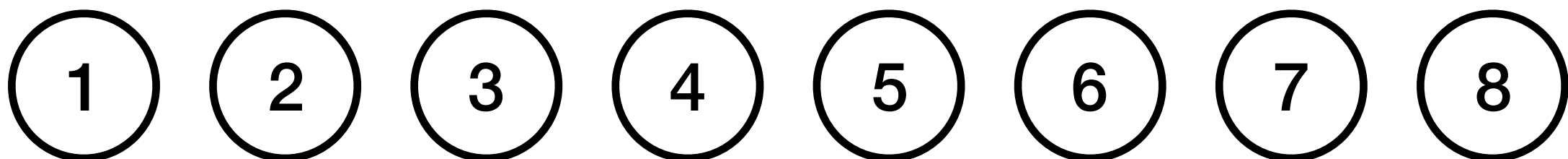
서로소 집합 (Disjoint-Set)

유니온 파인드(Union-Find), Disjoint-Set-Union(DSU)

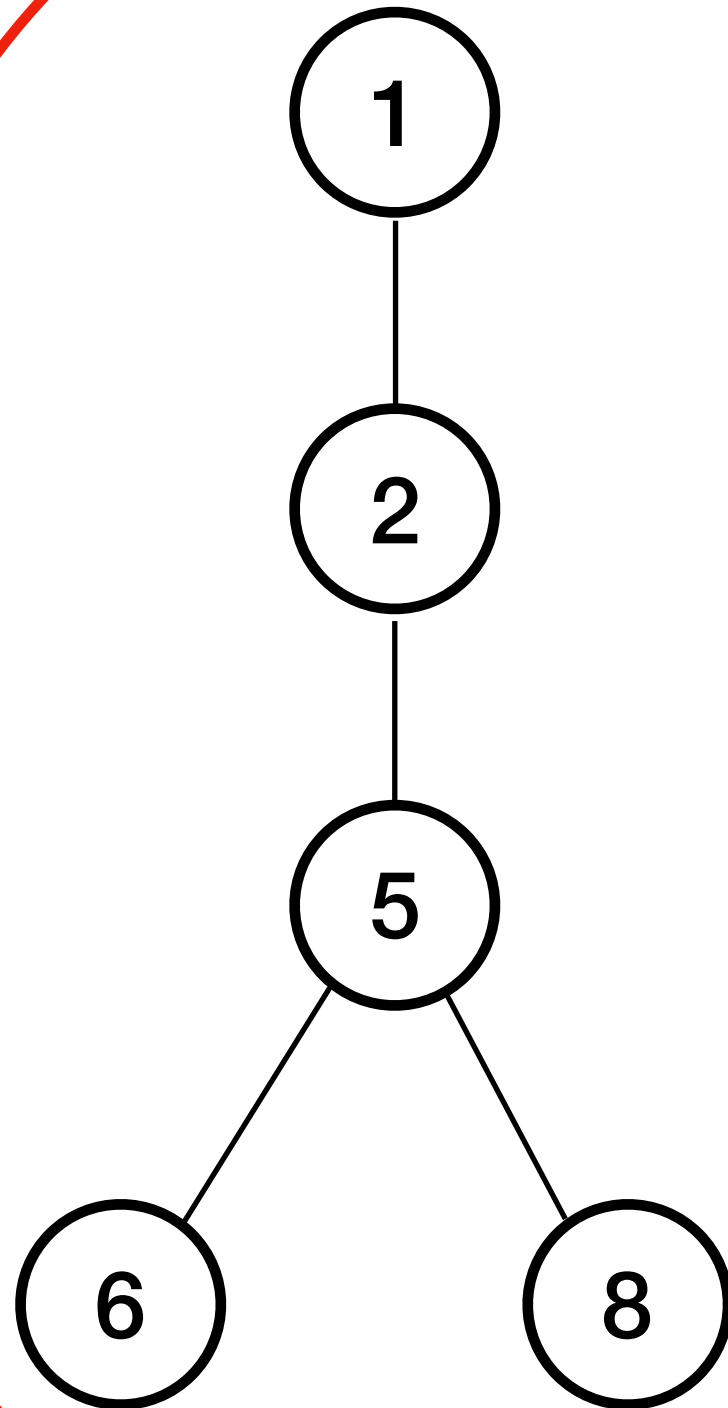
서로소 집합 (Disjoint-Set)

- 여러 서로소 집합의 정보를 저장하고 있는 자료구조
- 서로소 집합
 - 서로소(정수) : 최대 공약수가 1인 두 정수
 - 서로소(집합) : 공통 원소가 없는 두 집합 ($A \cap B = \emptyset$)

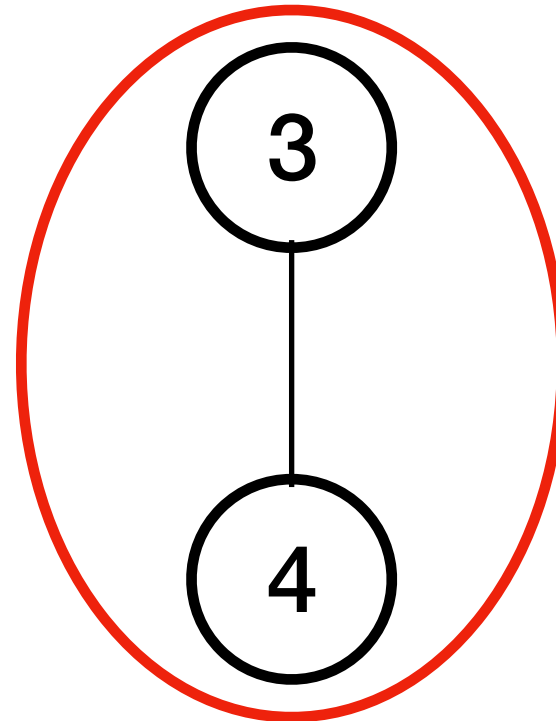




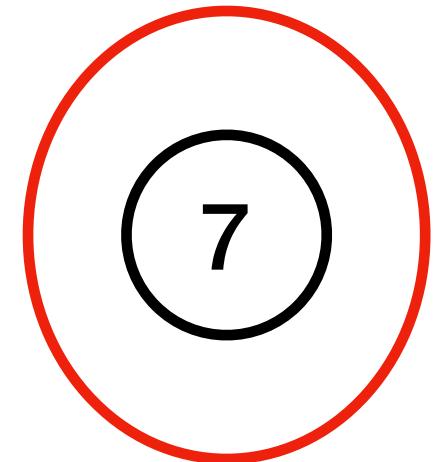
그룹 1



그룹 2



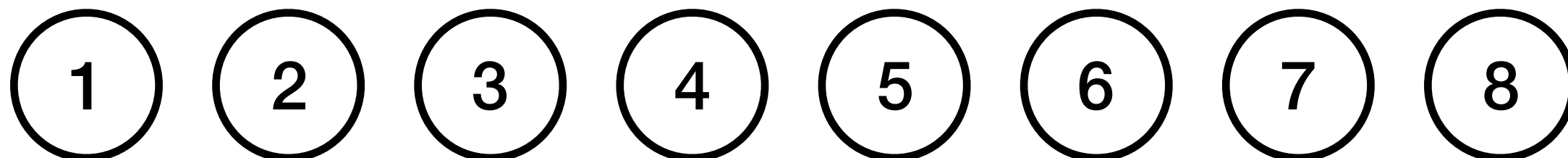
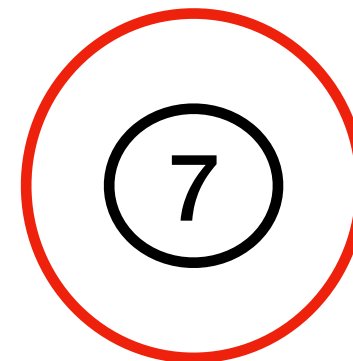
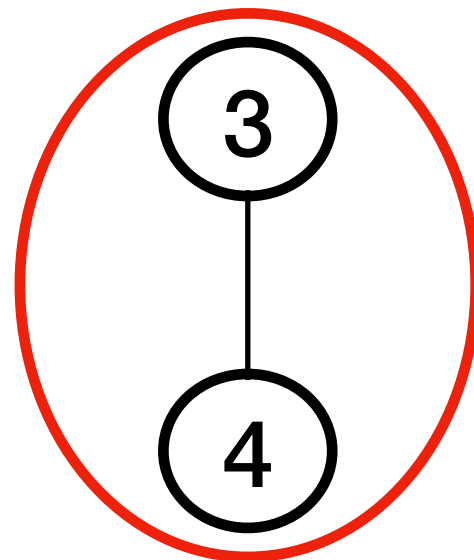
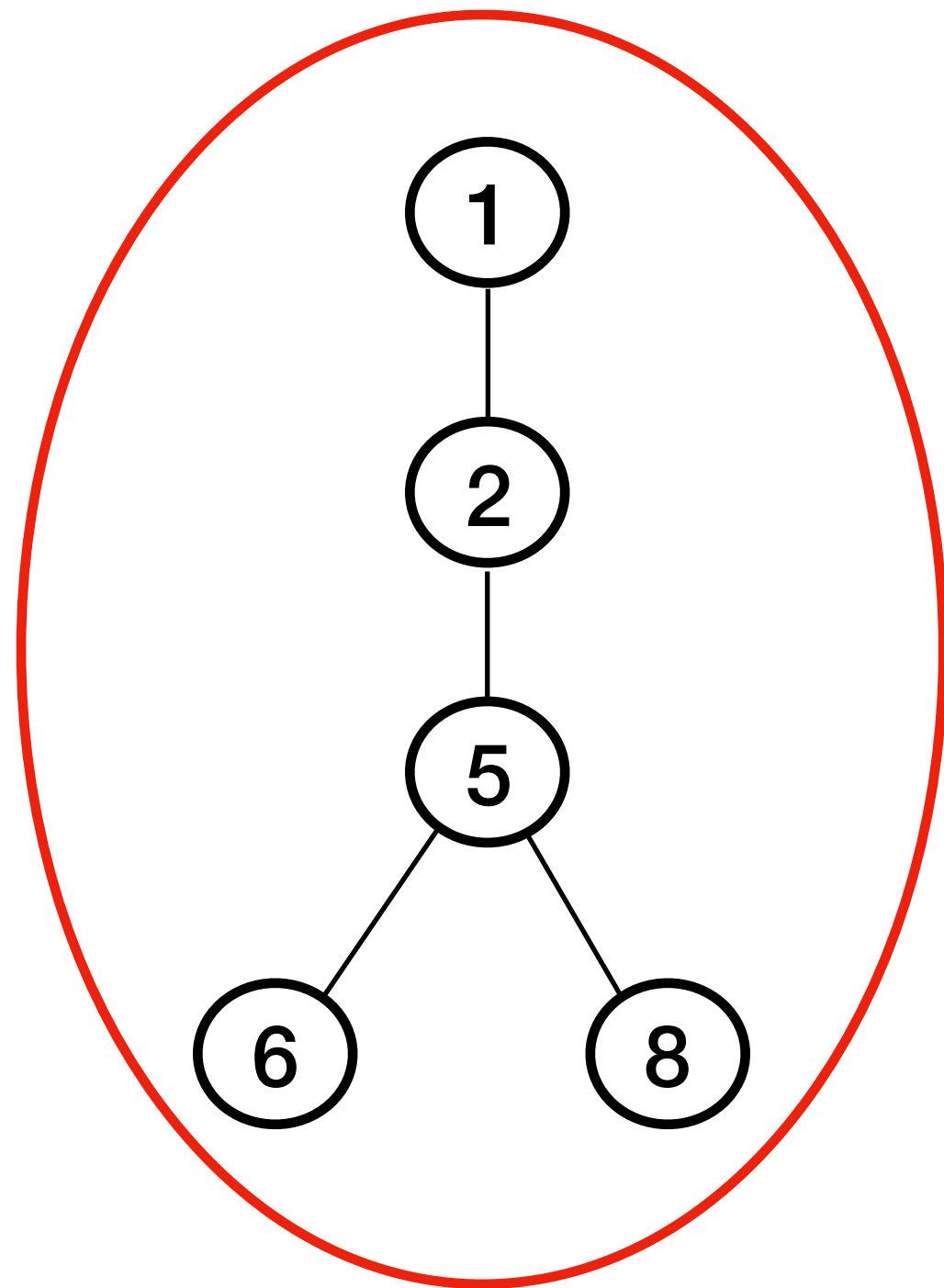
그룹 3



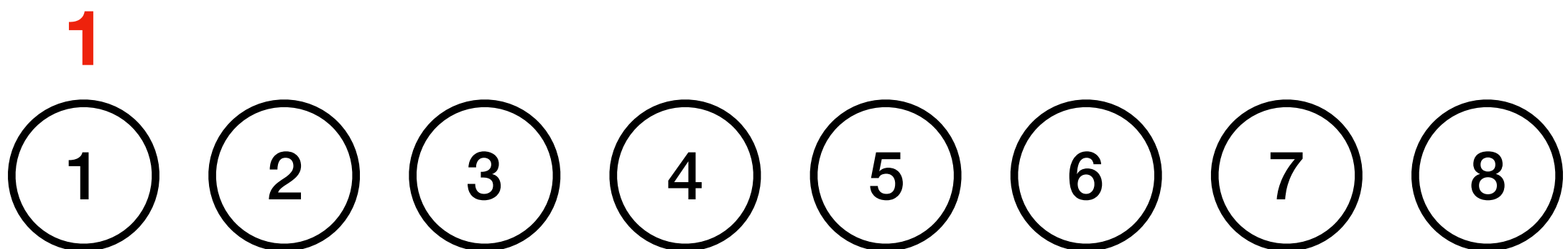
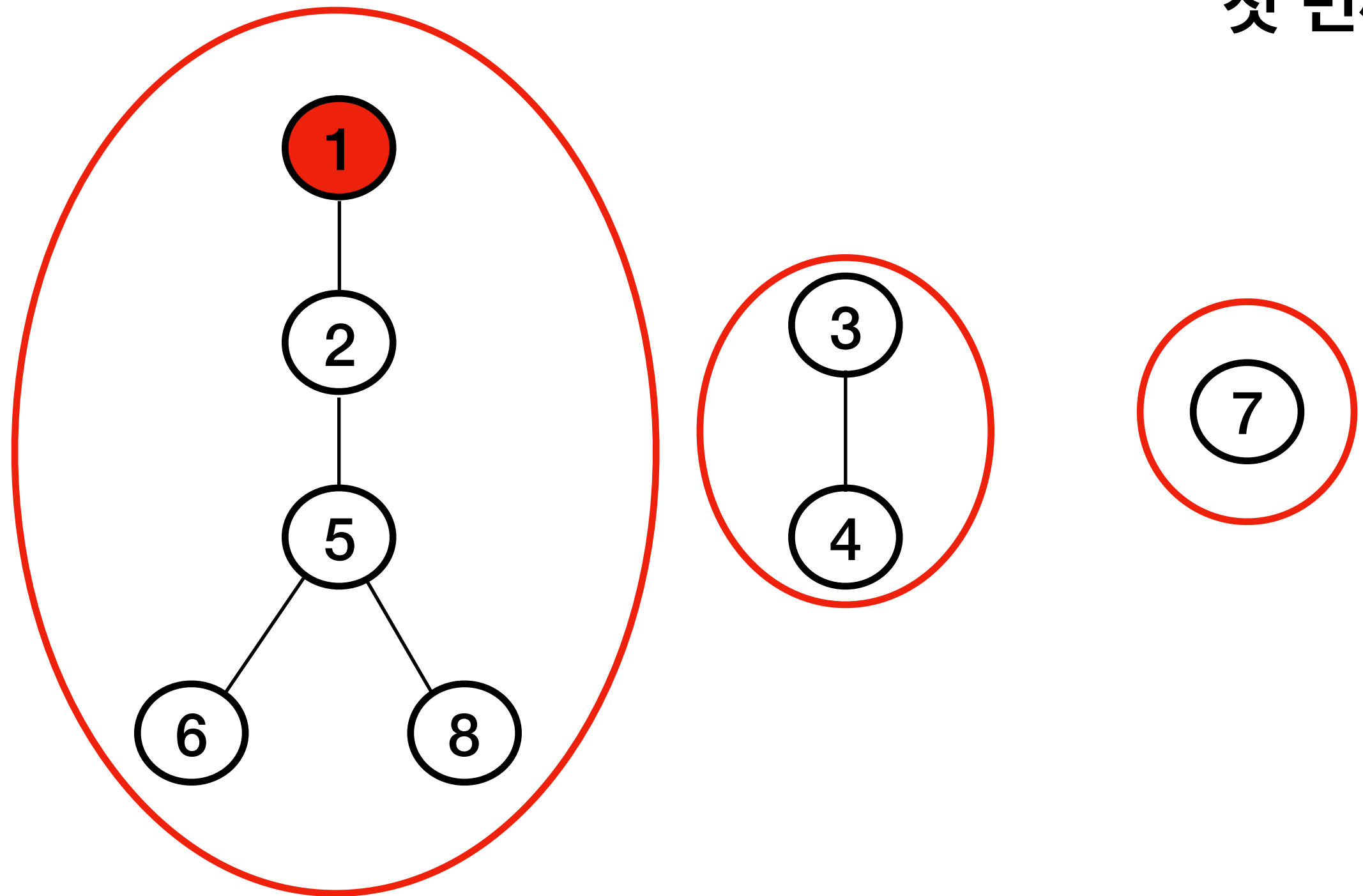
그룹 짓는 방법은?

첫 번째 방법

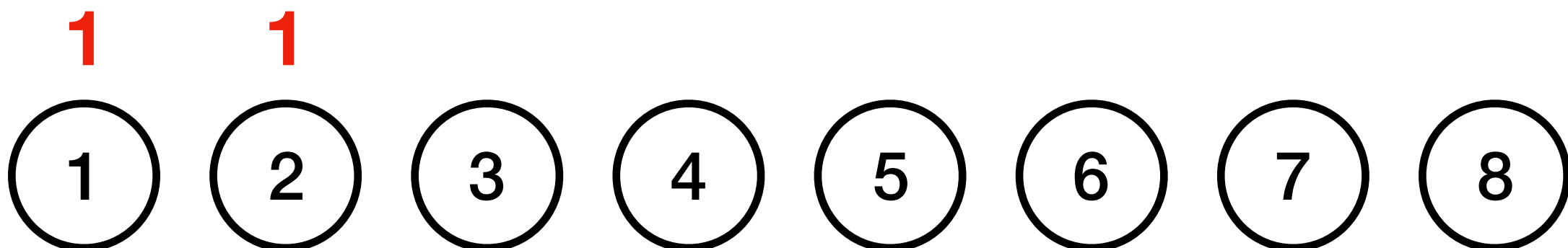
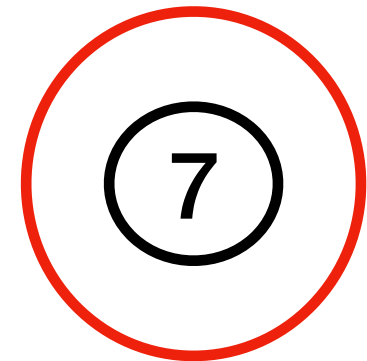
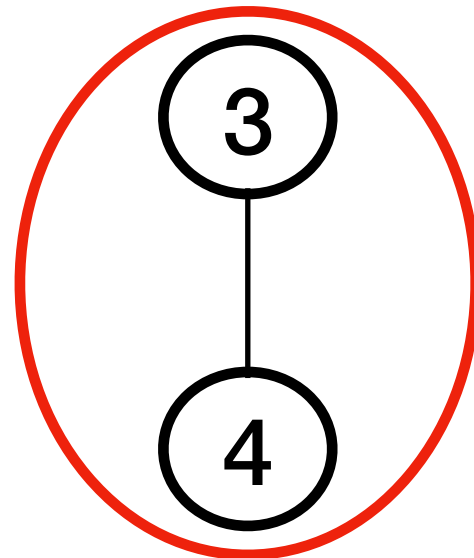
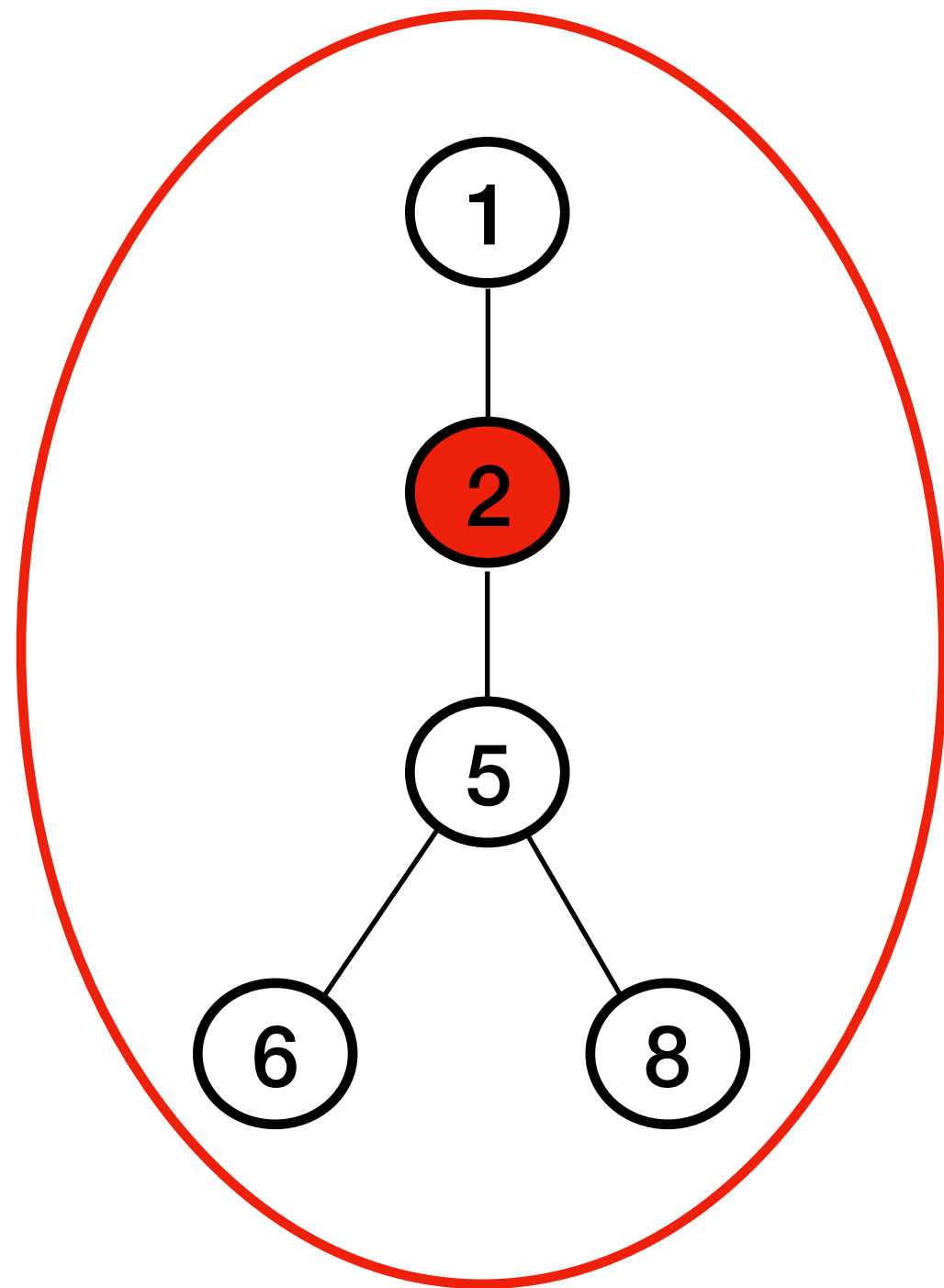
첫 번째 방법



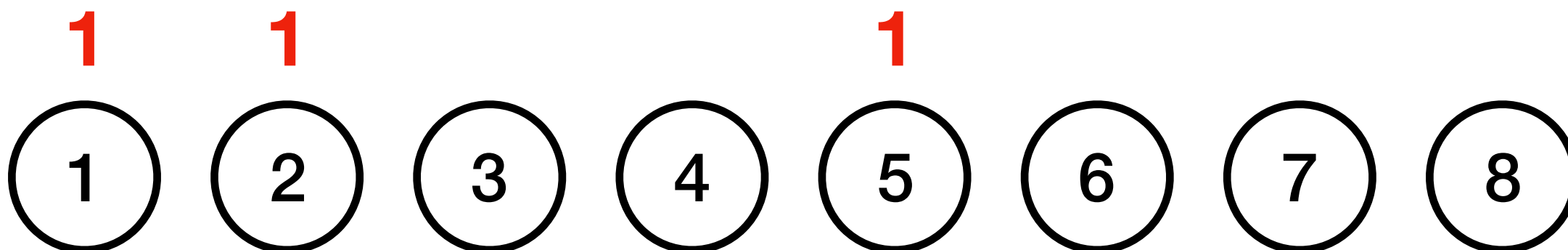
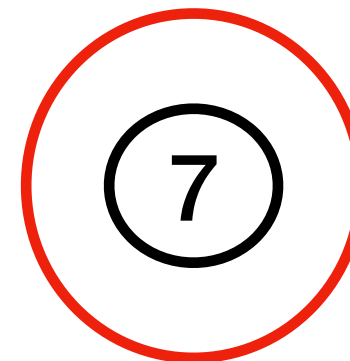
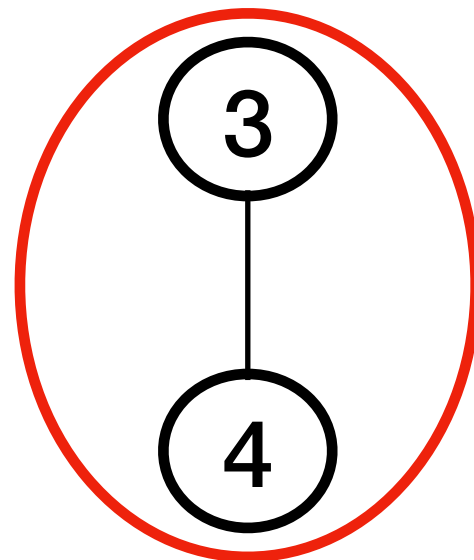
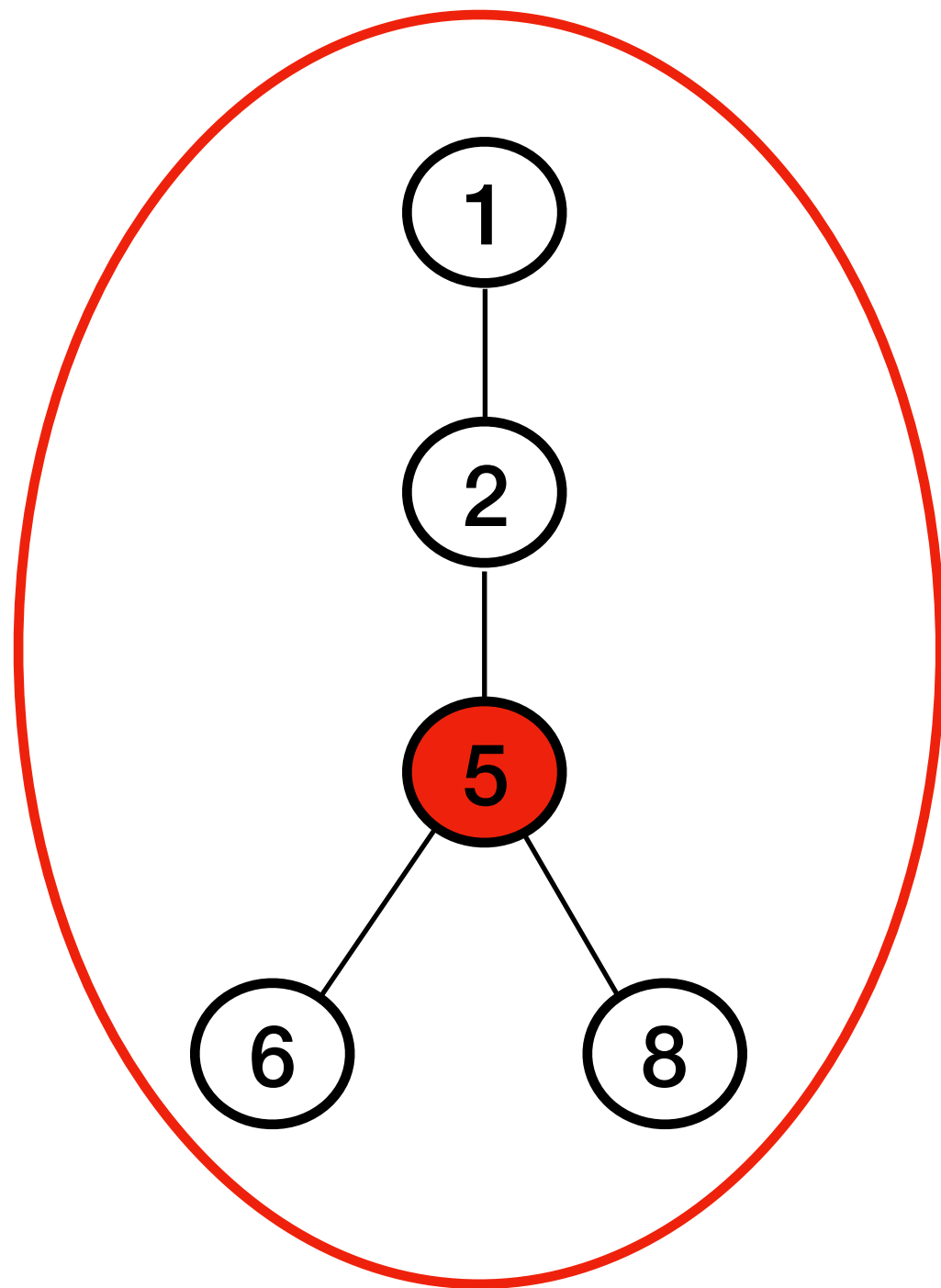
첫 번째 방법



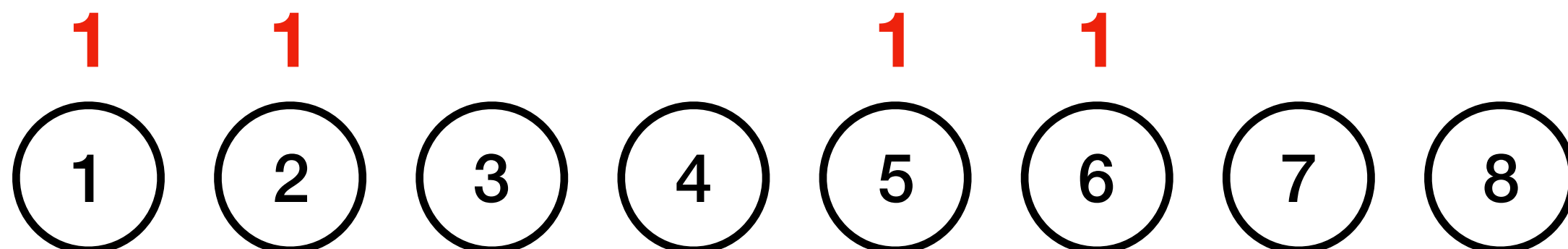
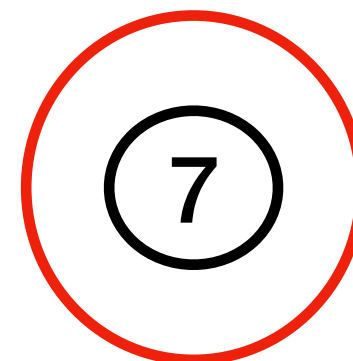
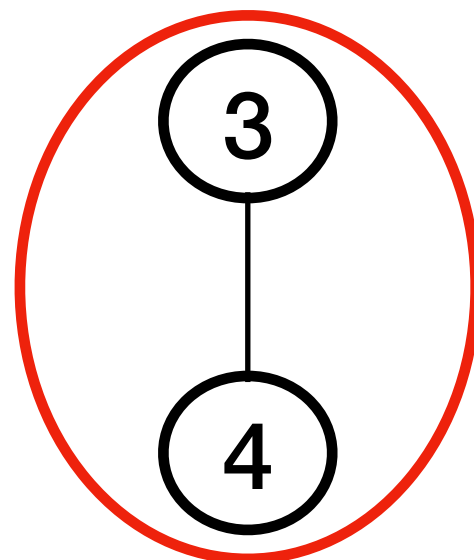
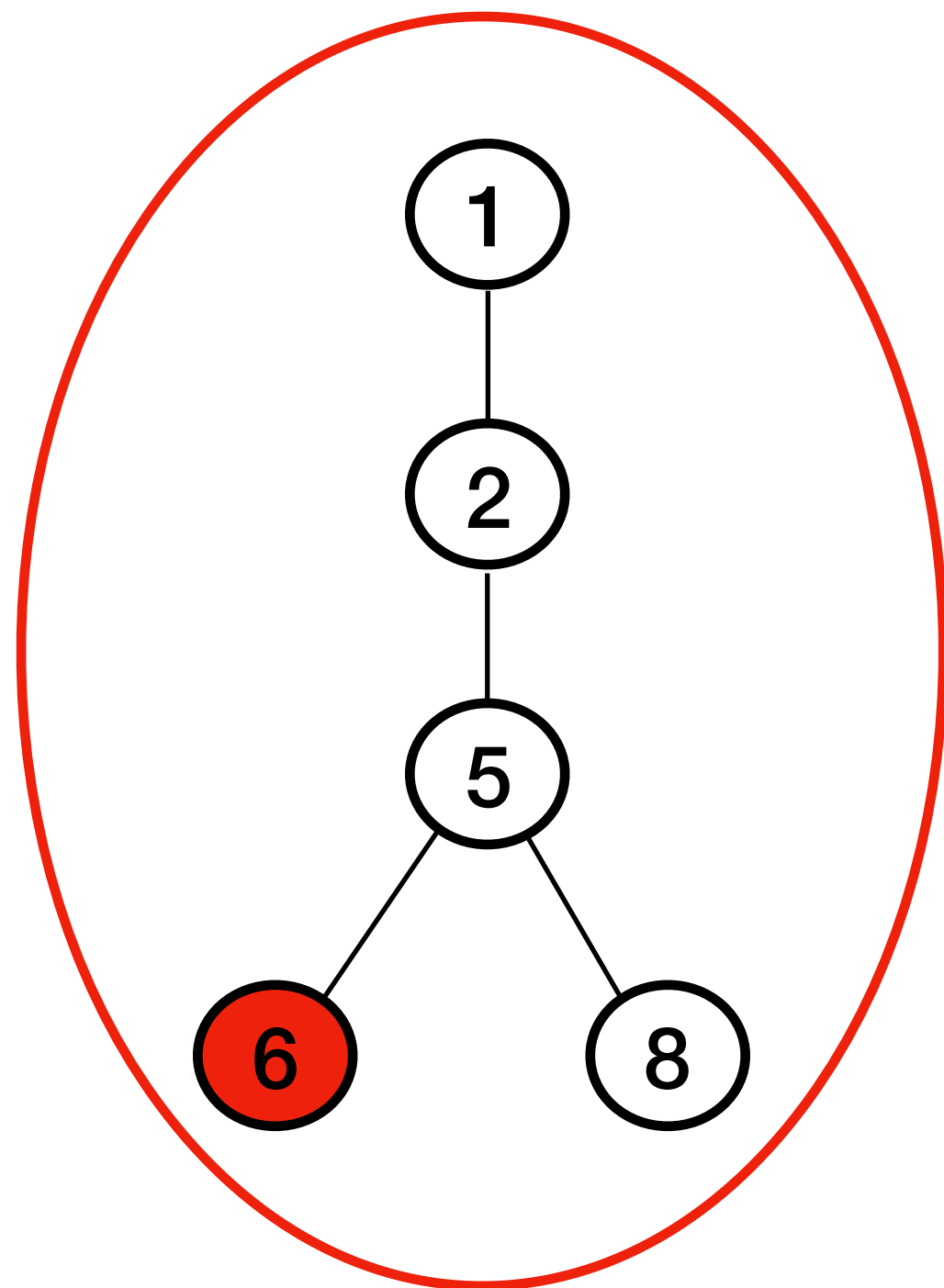
첫 번째 방법



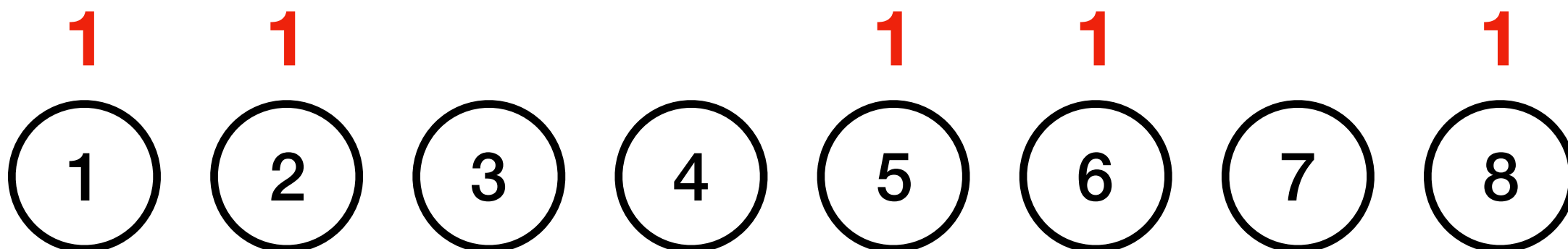
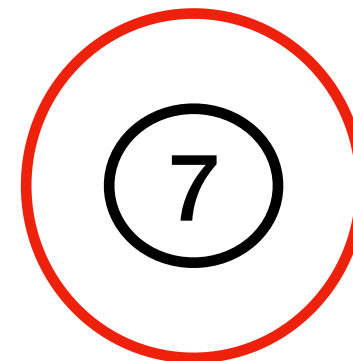
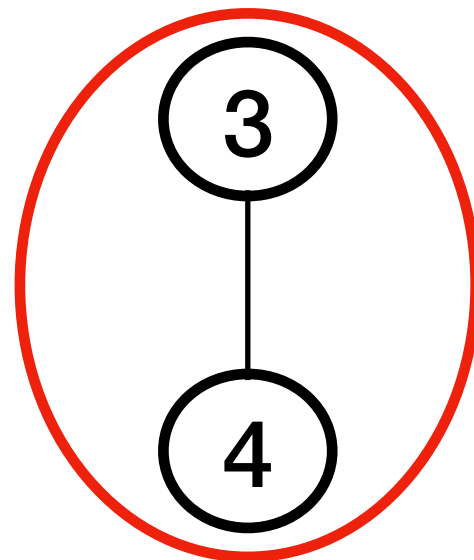
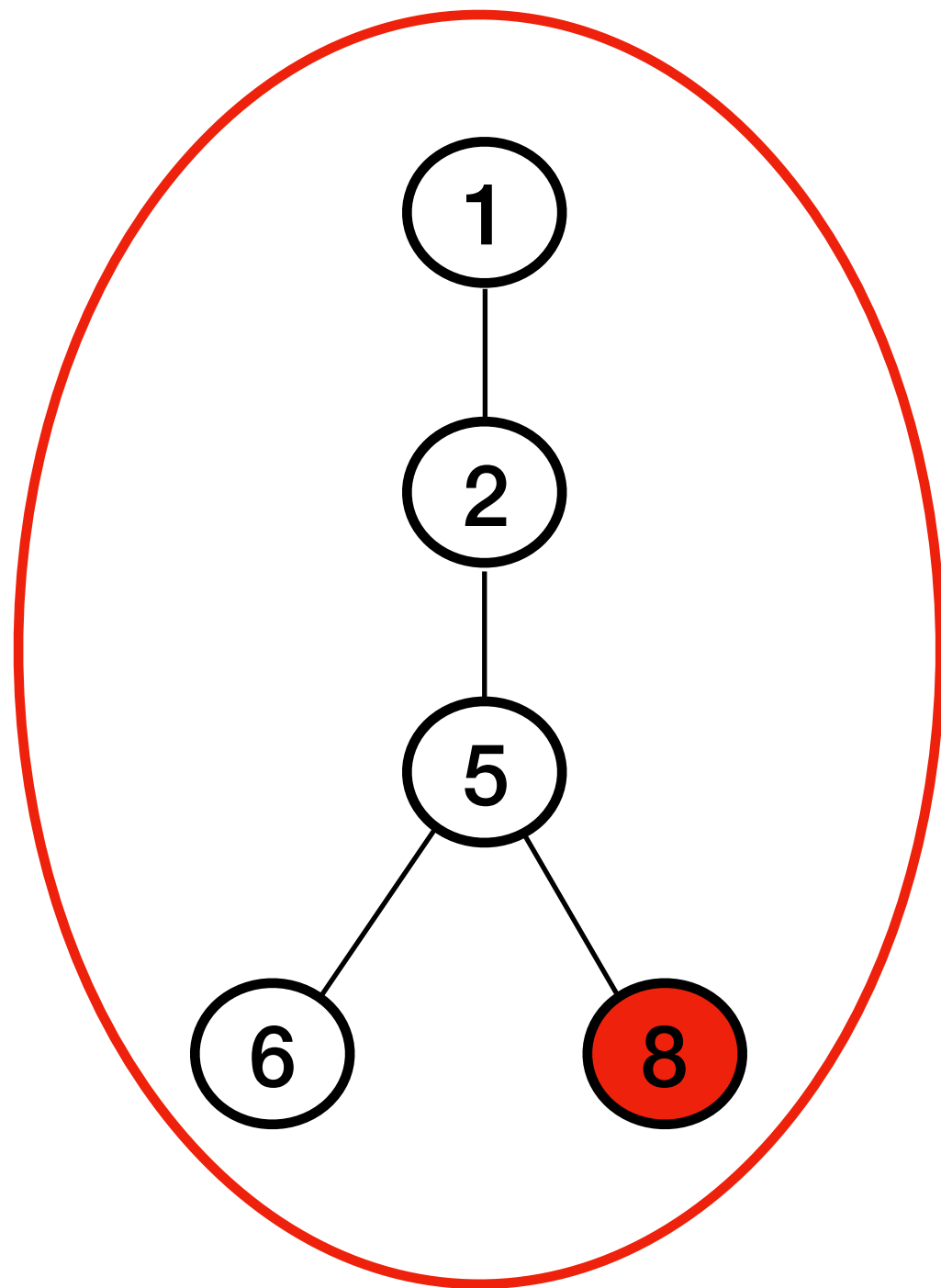
첫 번째 방법



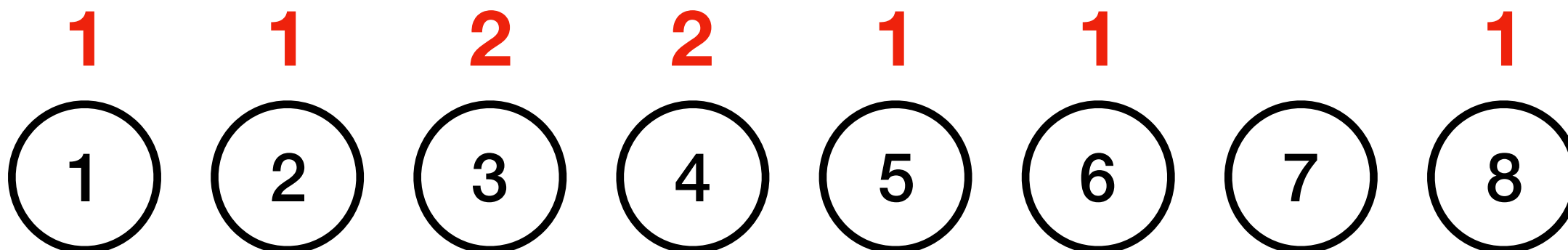
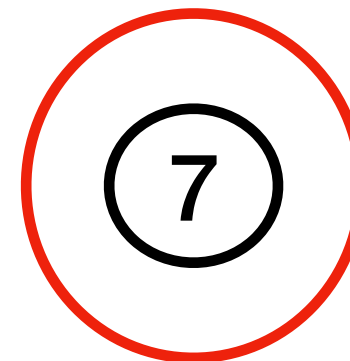
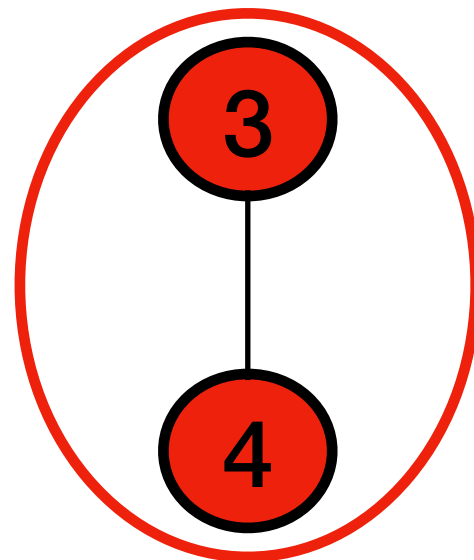
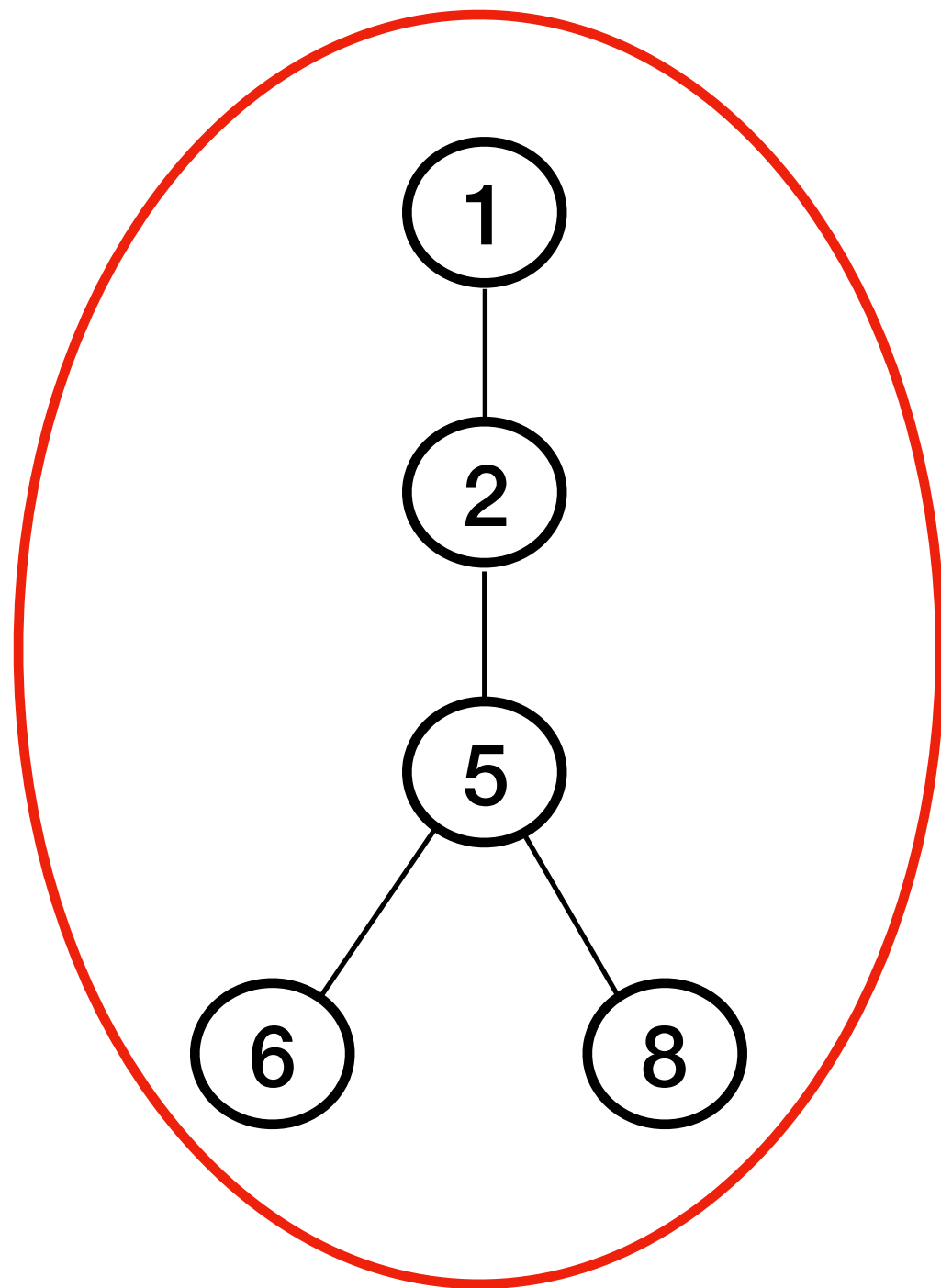
첫 번째 방법



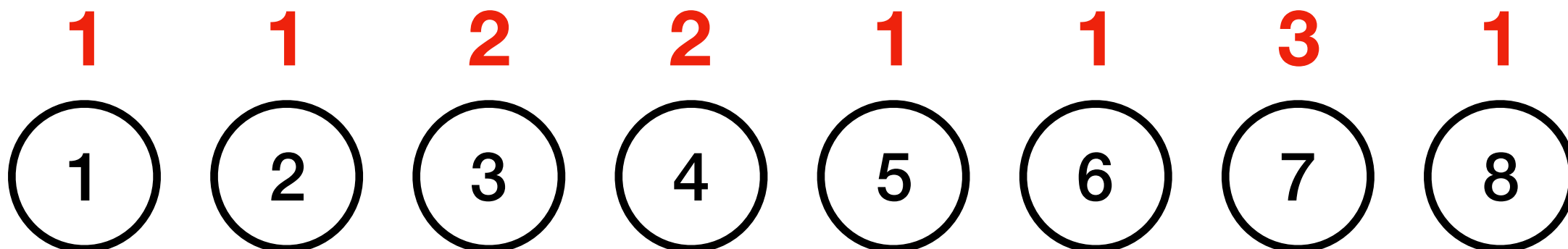
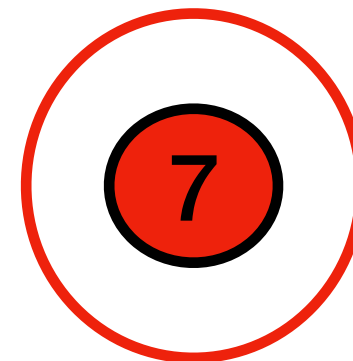
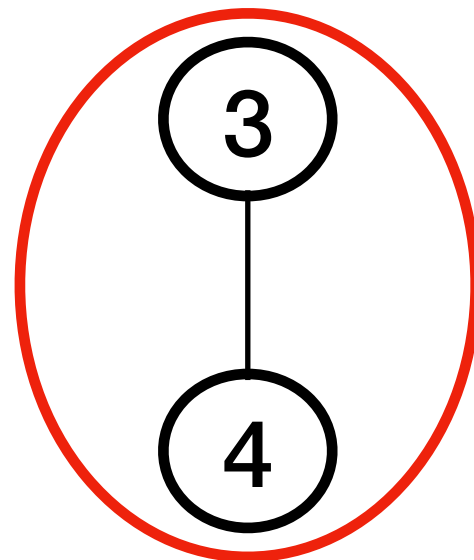
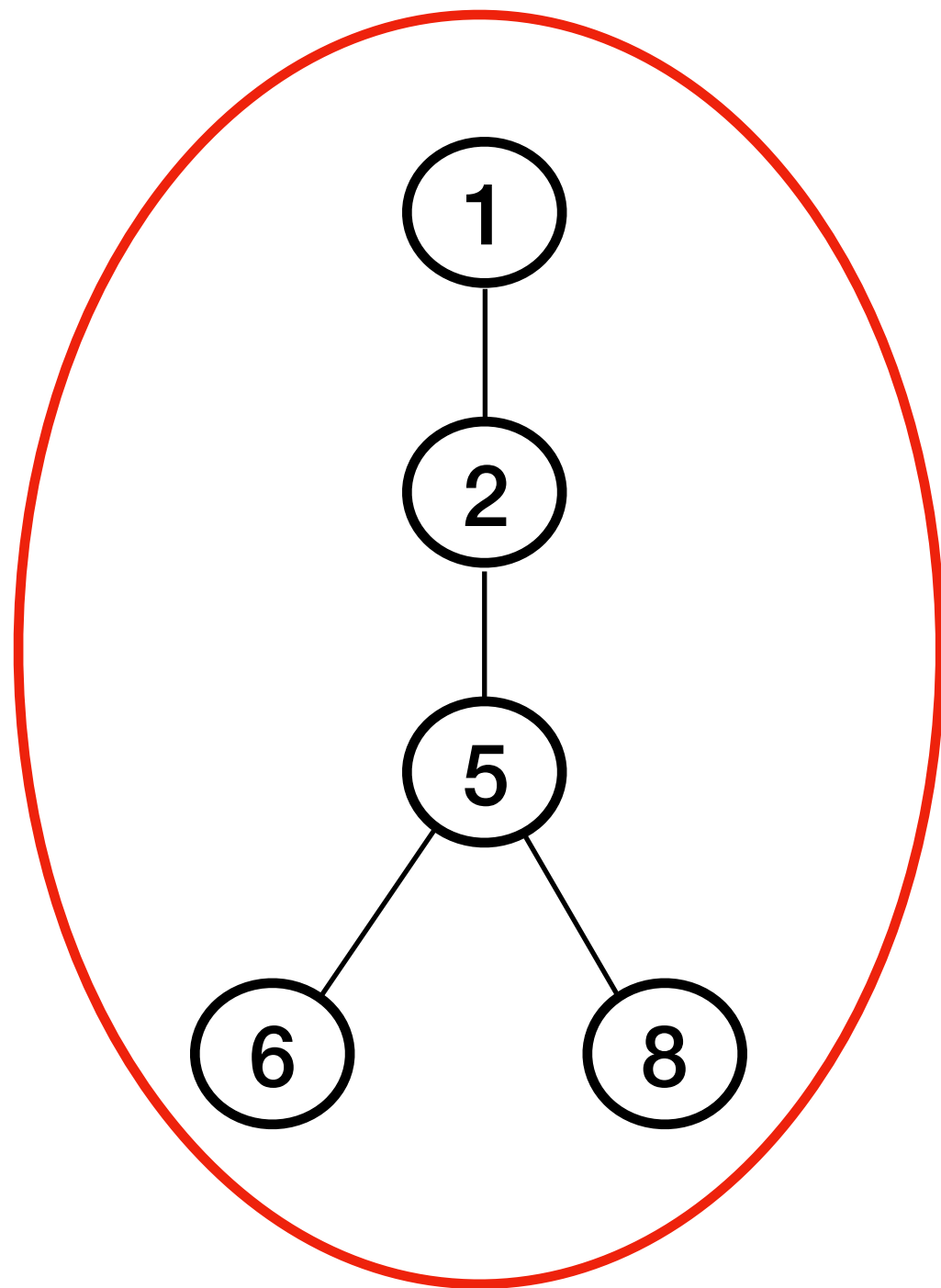
첫 번째 방법



첫 번째 방법

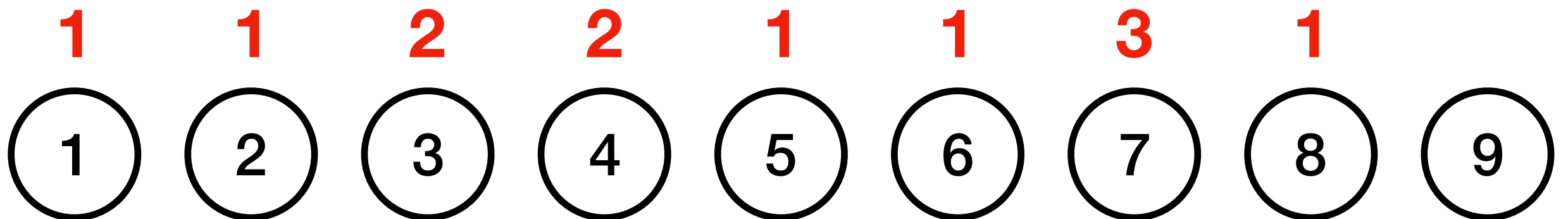
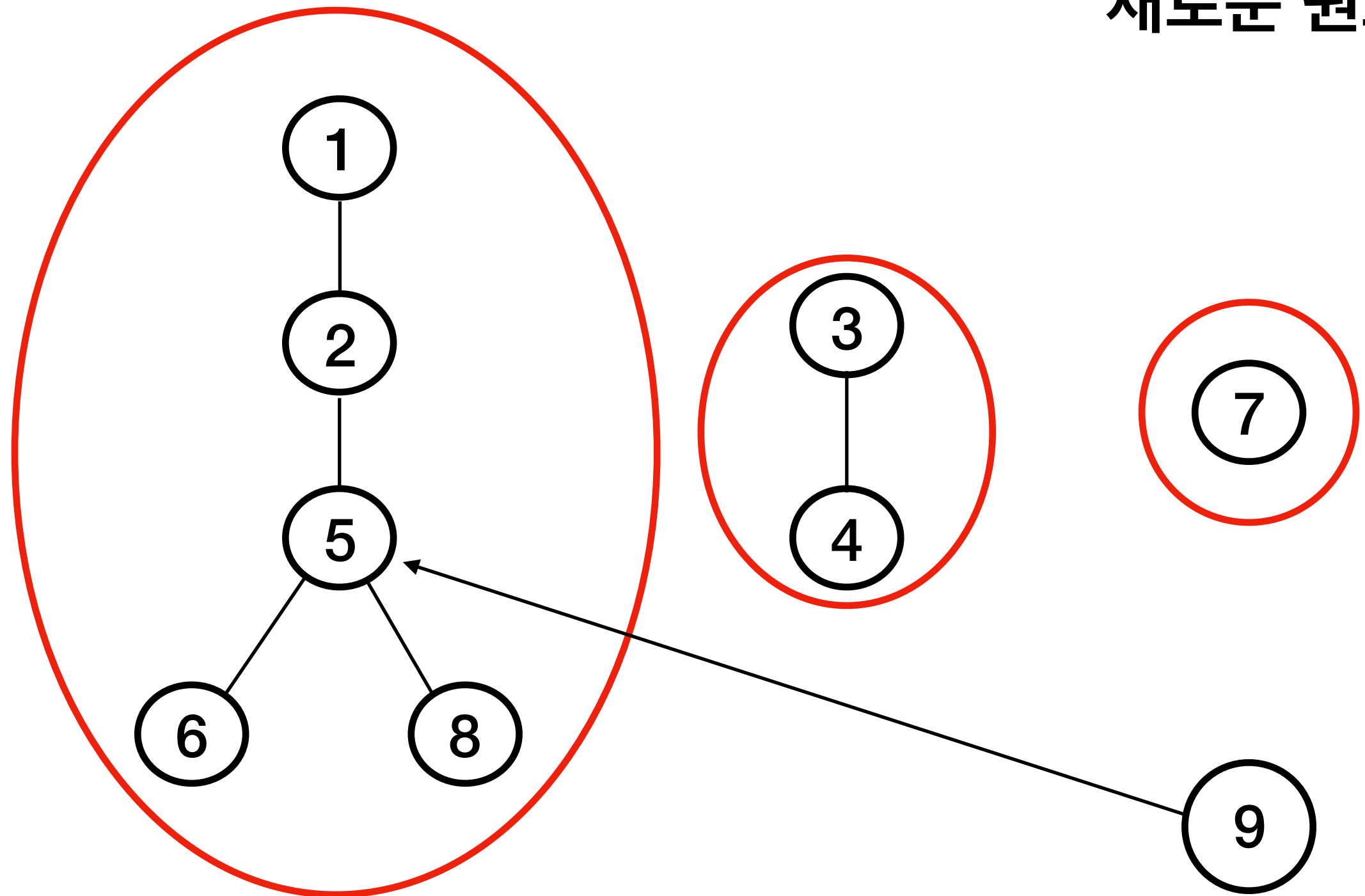


첫 번째 방법



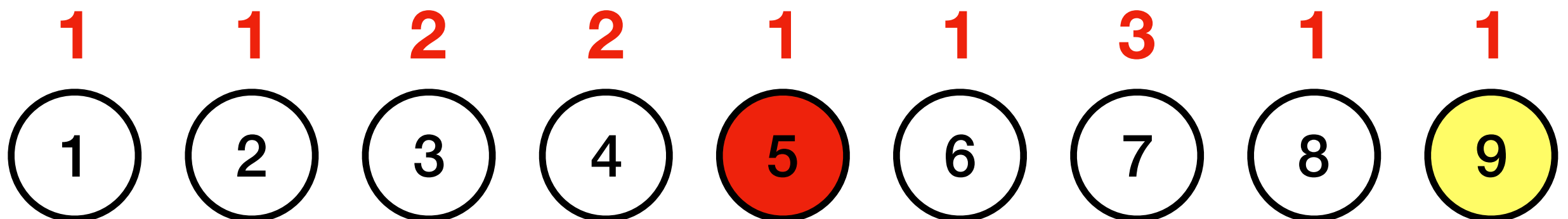
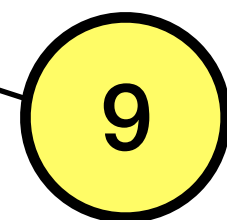
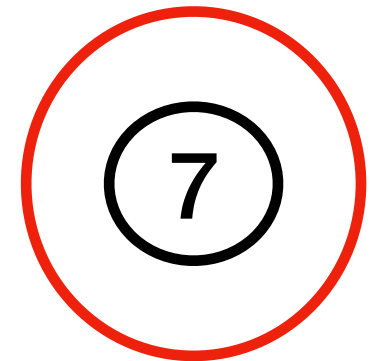
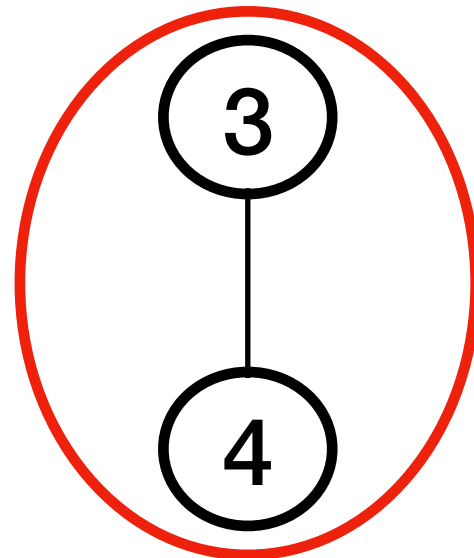
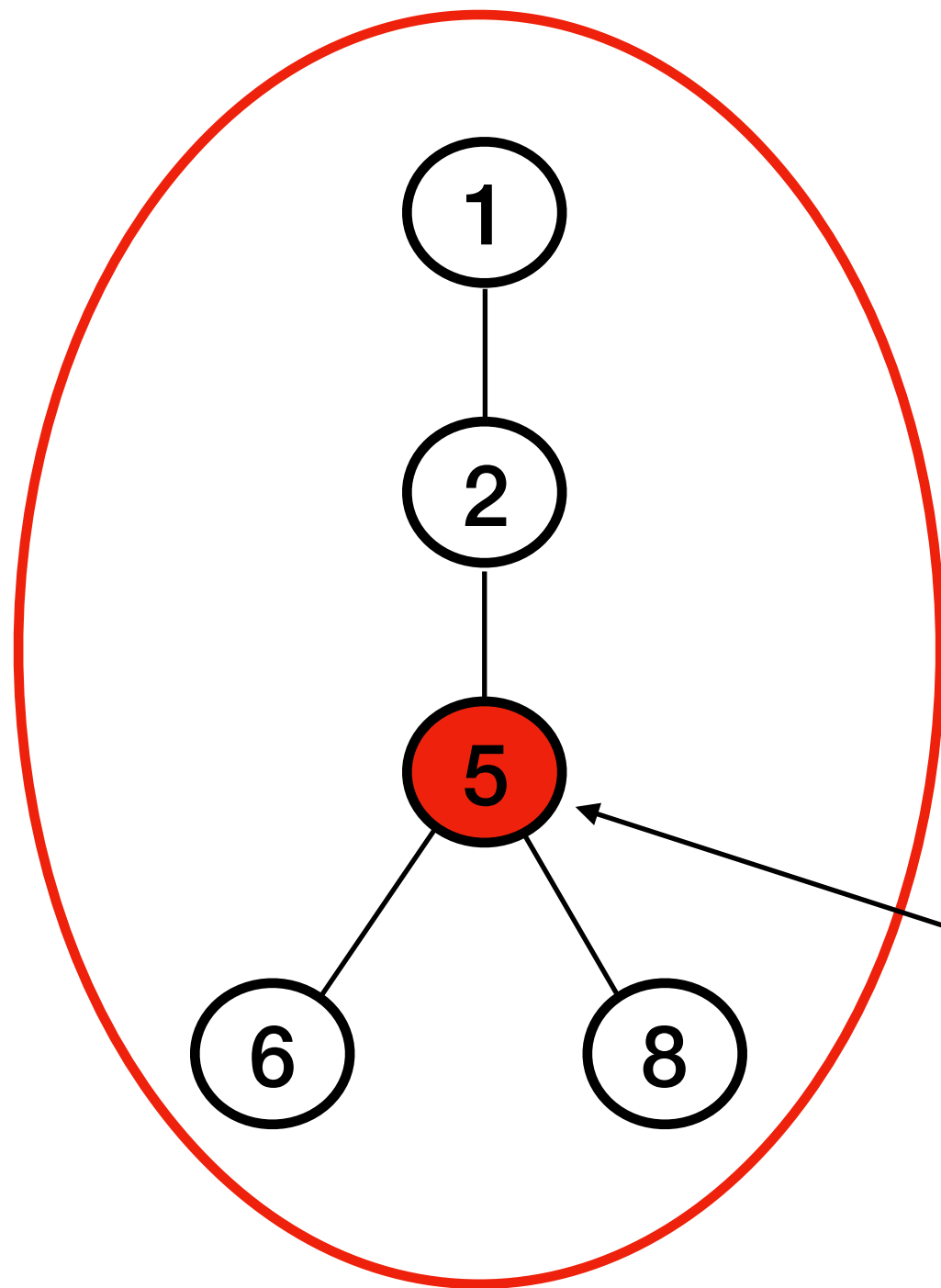
새로운 원소 추가

새로운 원소 추가



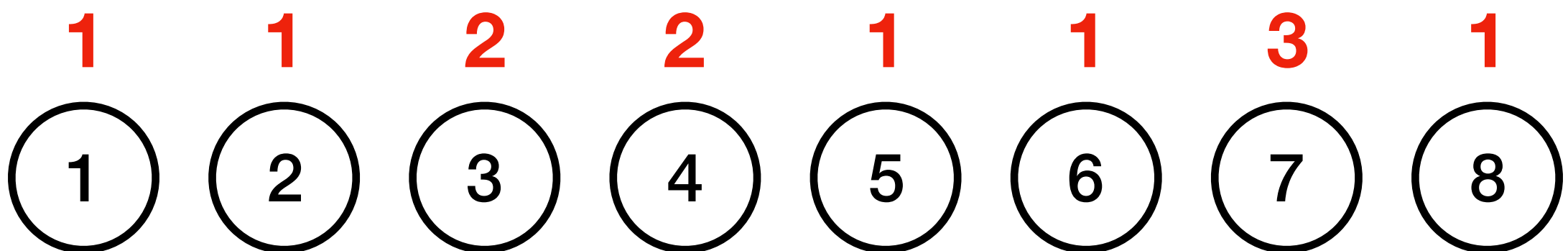
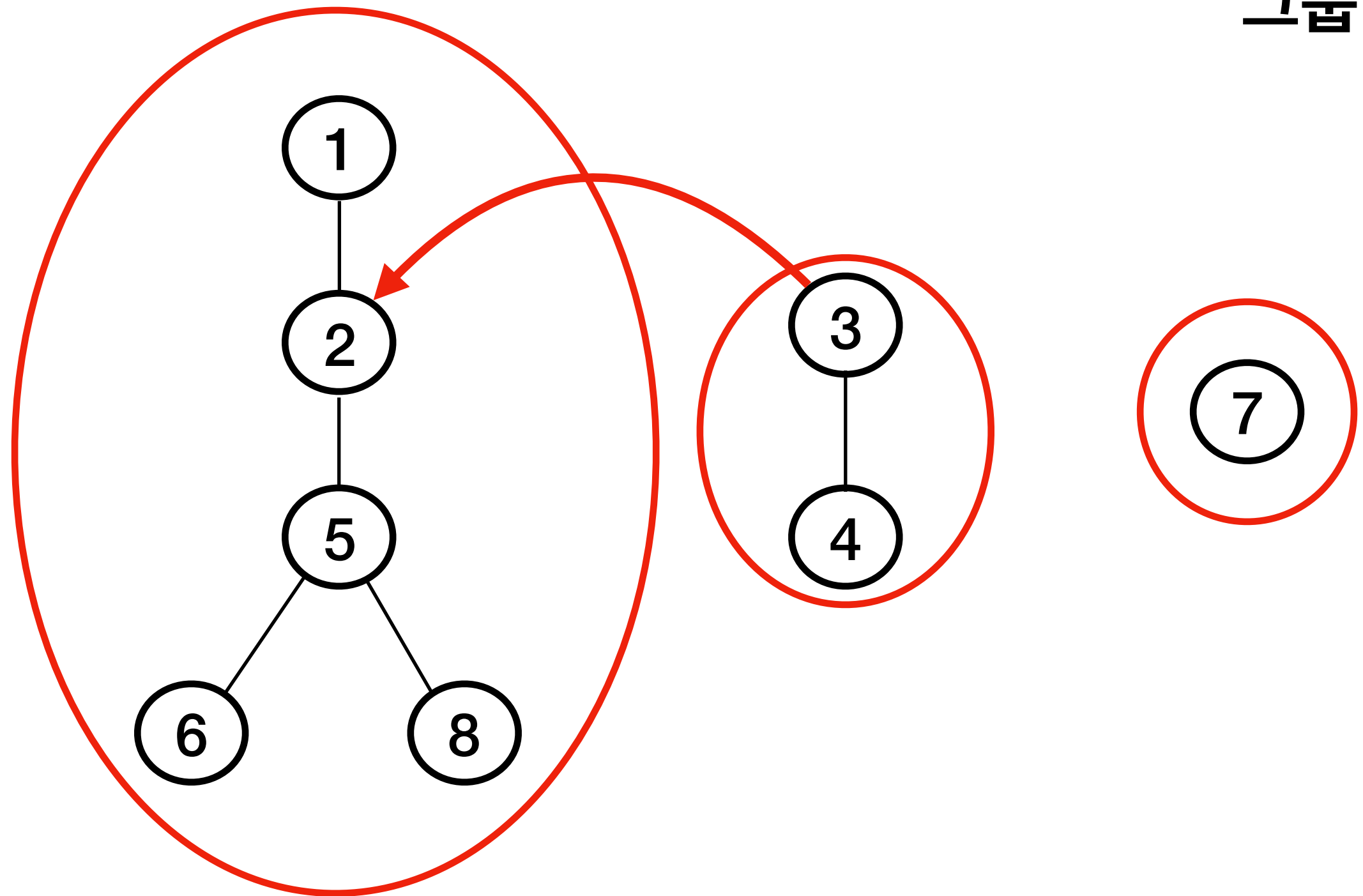
새로운 원소 추가

$O(1)$

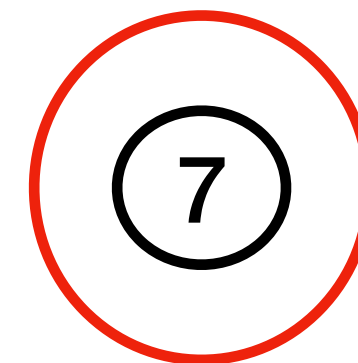
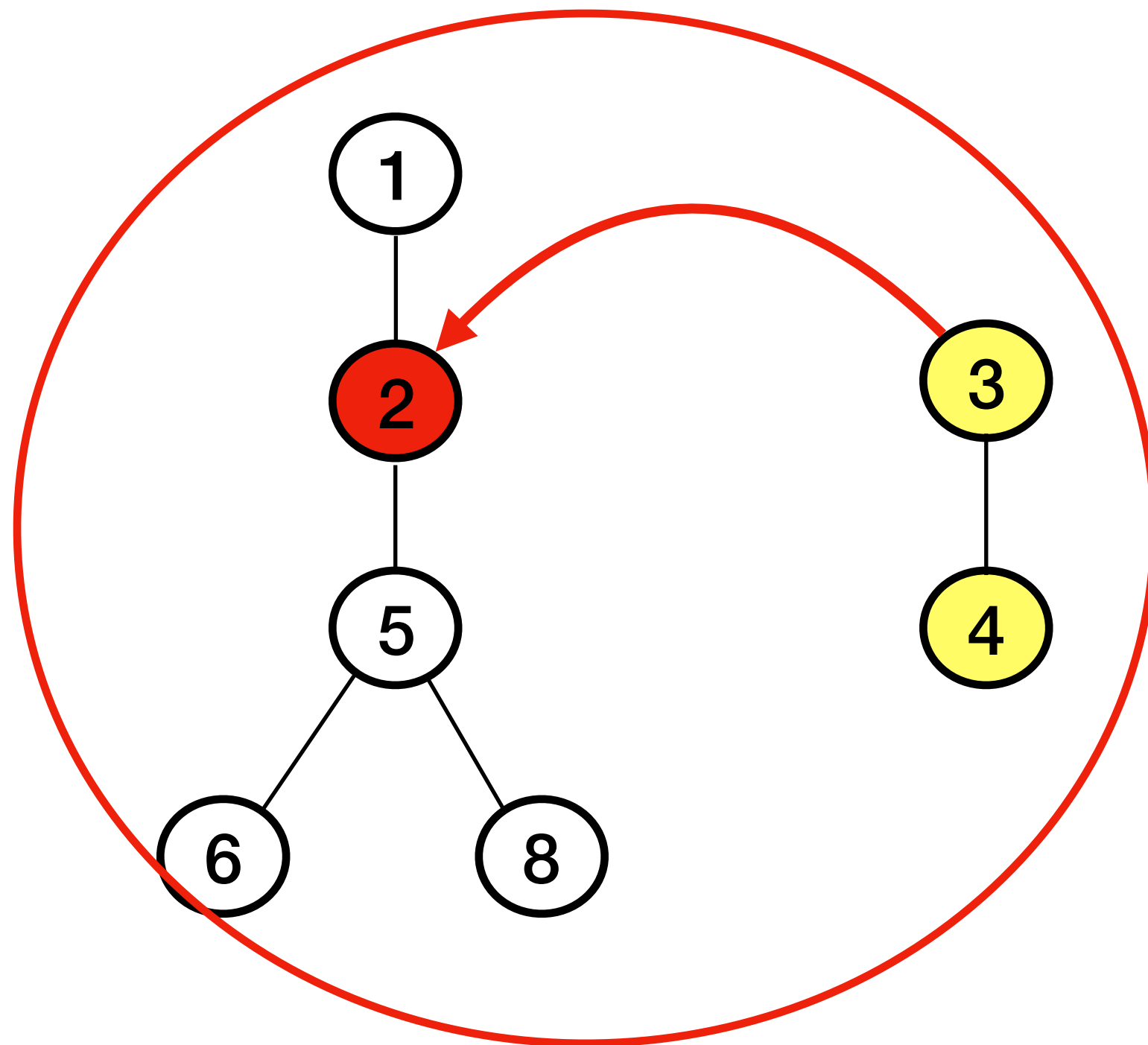


그룹 합치기

그룹 합치기

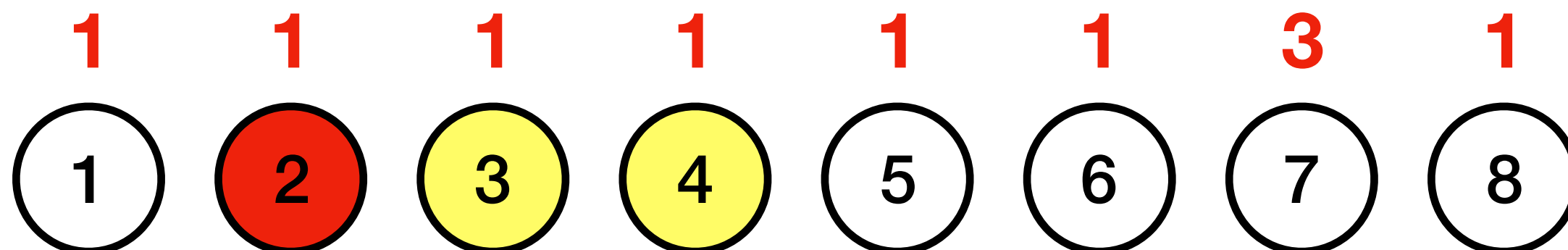


그룹 합치기



n = 그룹 크기

$$O(n)$$

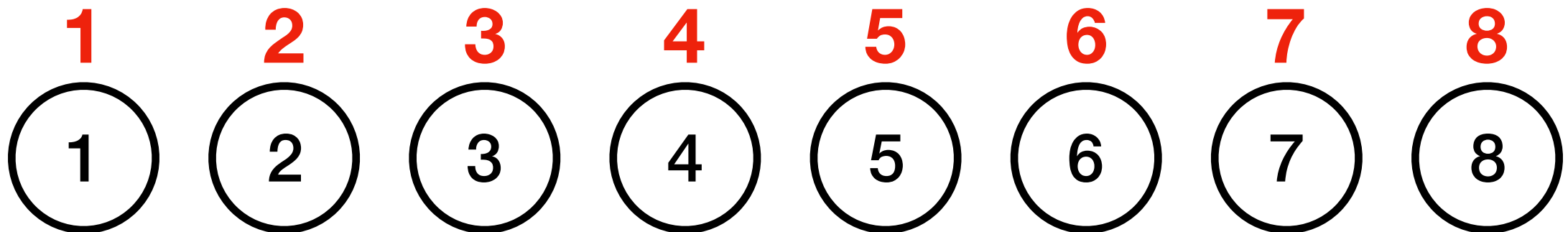


알고리즘 개선 아이디어

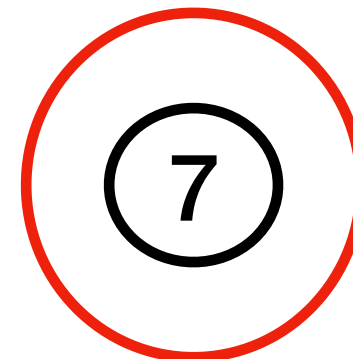
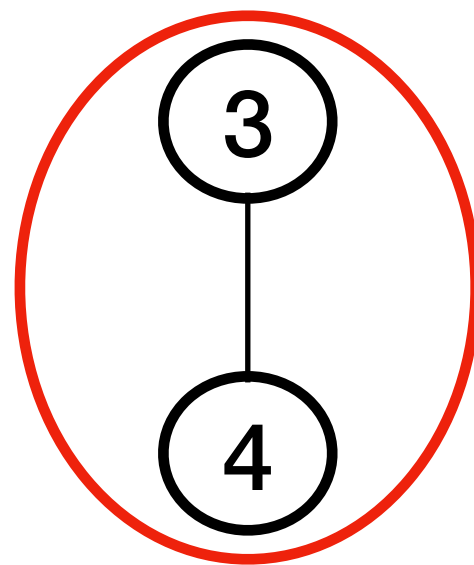
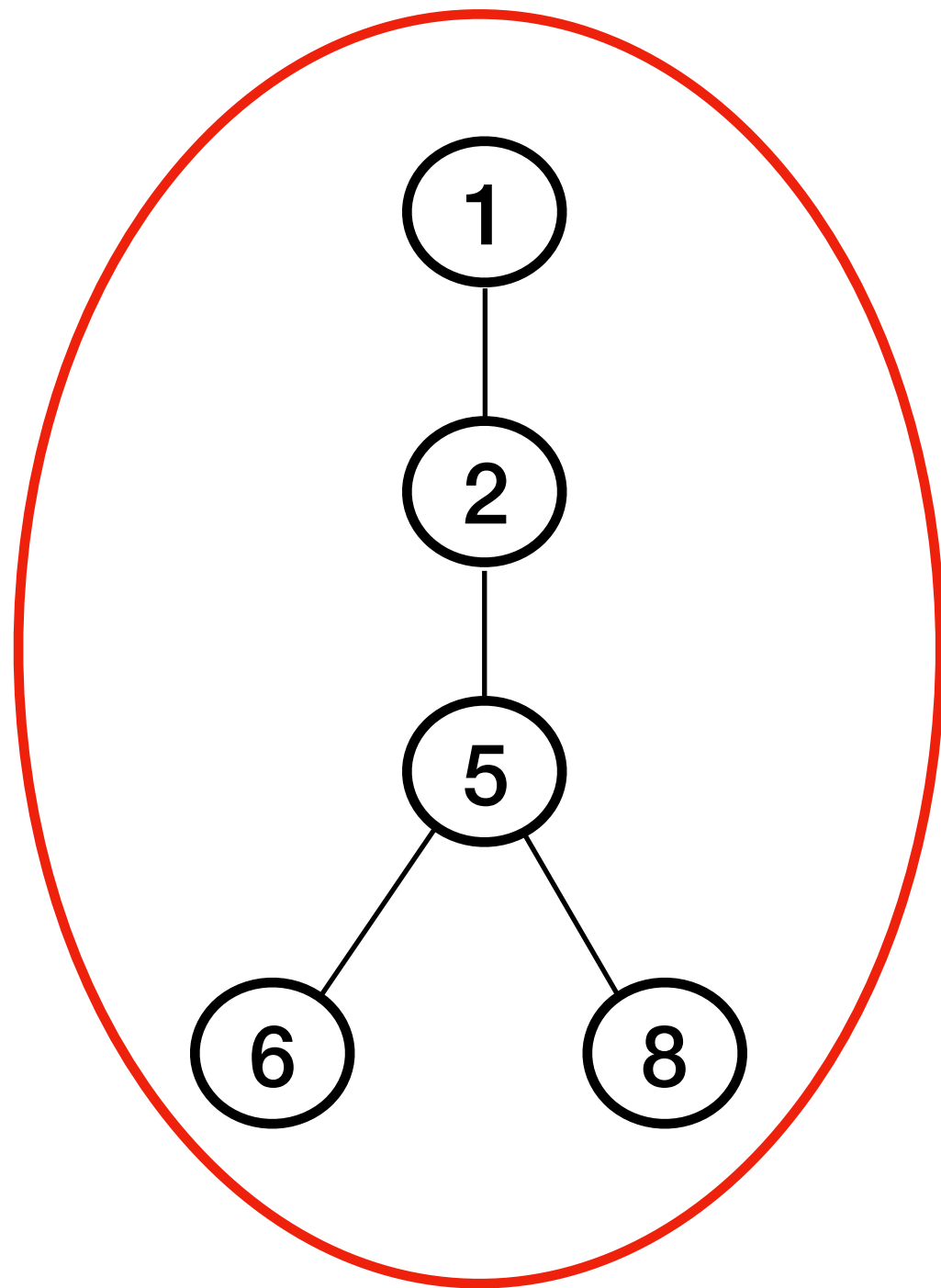
- **문제점** : 새로운 원소가 추가될 때는 문제가 없지만, 기존에 만들어진 그룹끼리 합칠 때 그룹에 포함된 원소들의 그룹 번호를 전부 바꿔야한다.
- **개선점** : 자신의 그룹 번호가 아닌 부모 정보만 저장하도록 변경

두 번째 방법

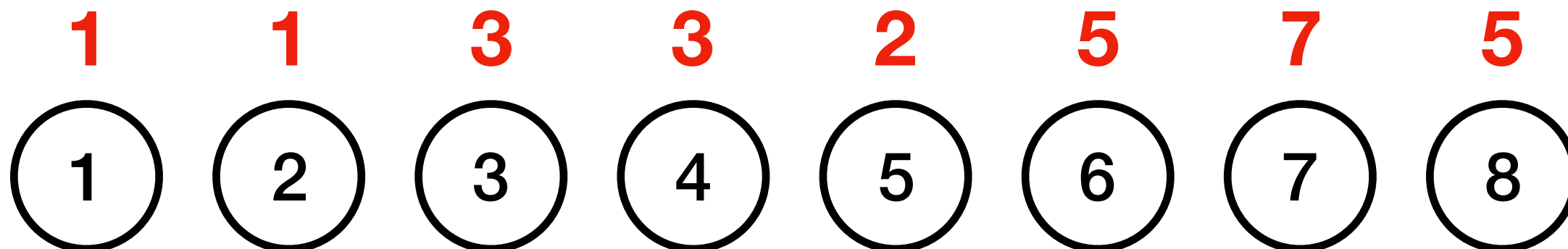
초기 부모는 자기 자신



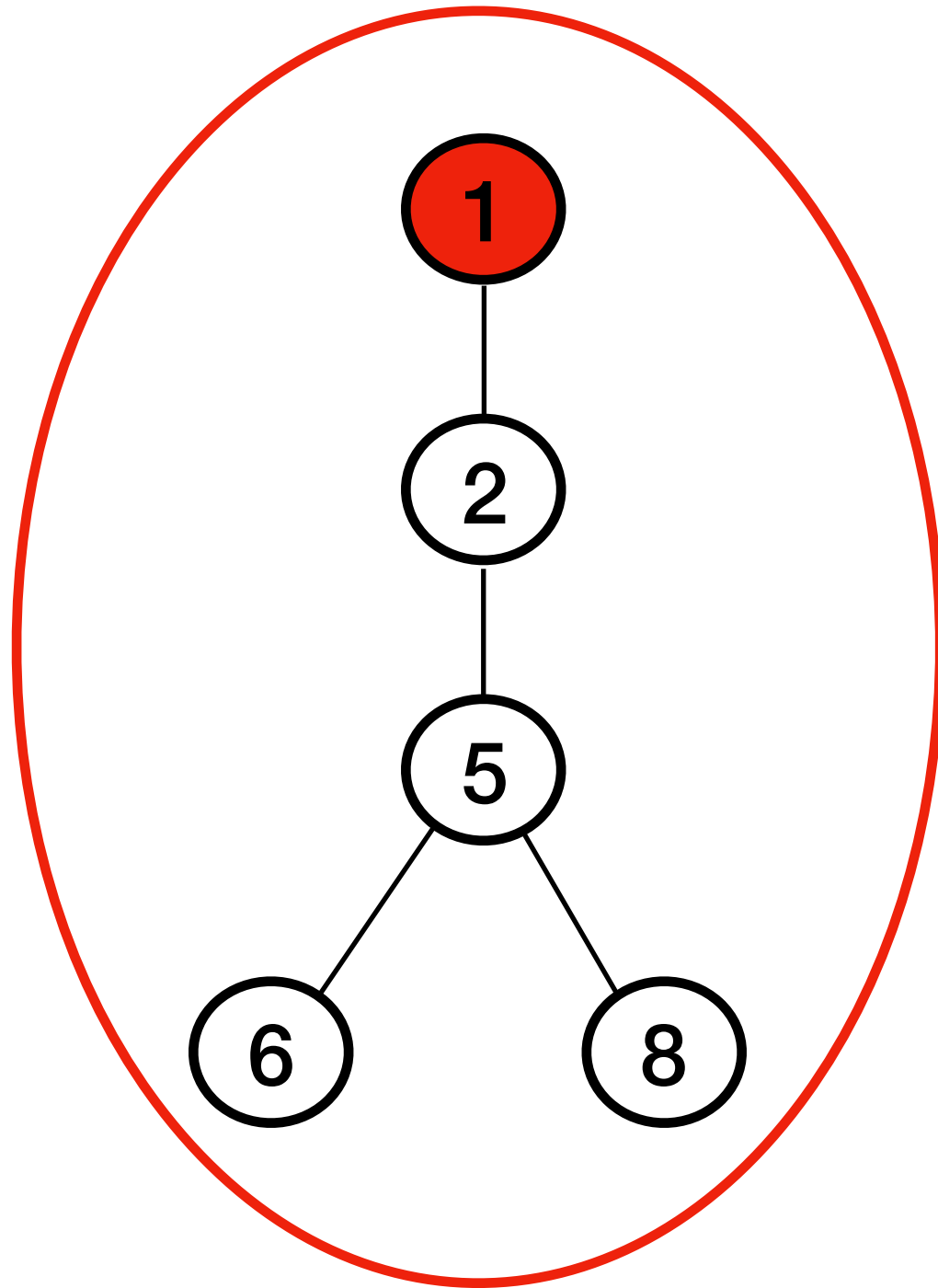
두 번째 방법



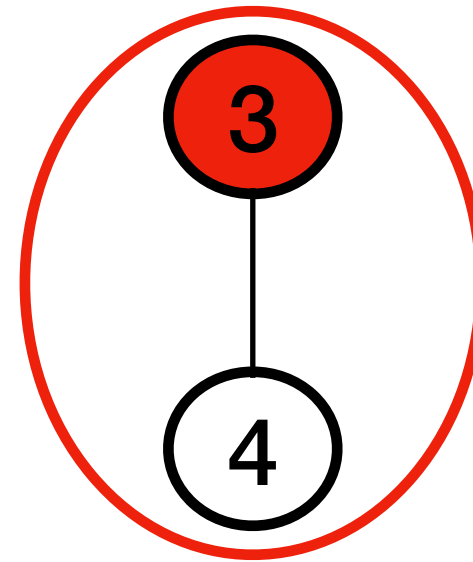
자신의 부모 번호 저장



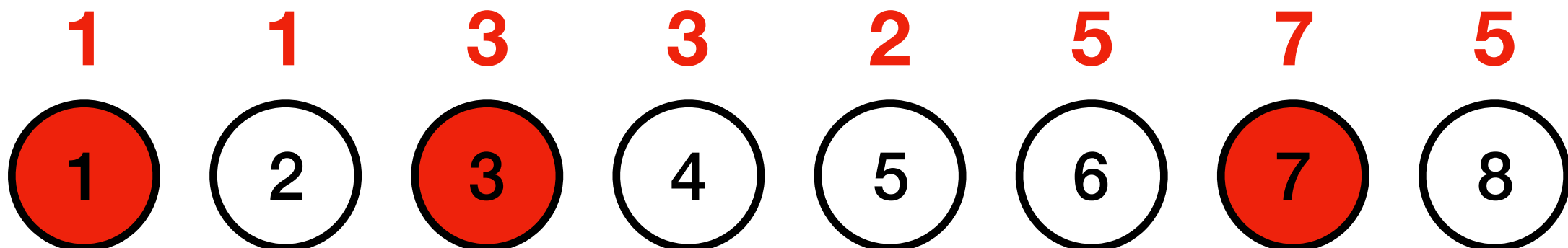
그룹 번호 1



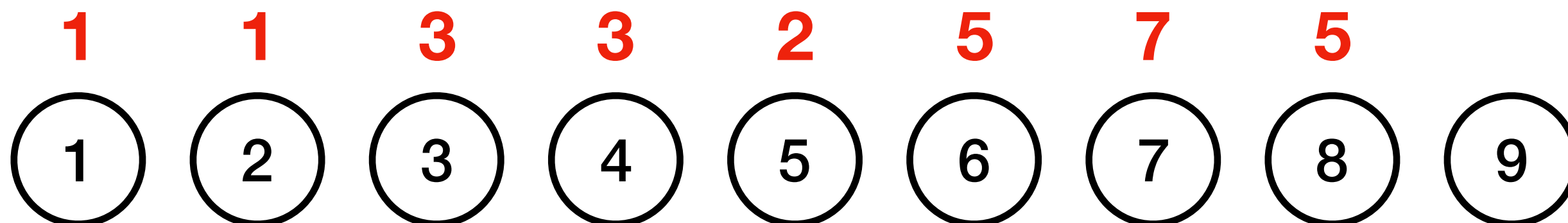
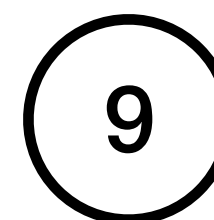
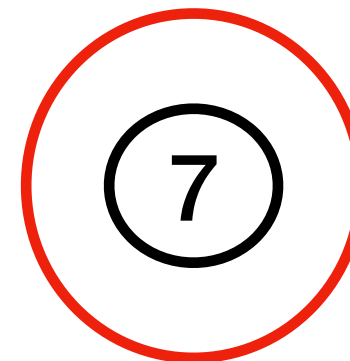
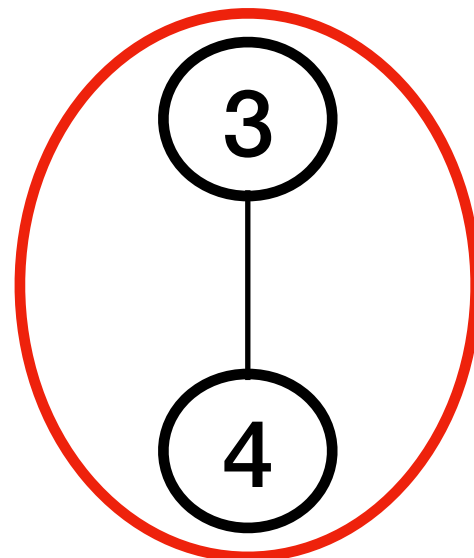
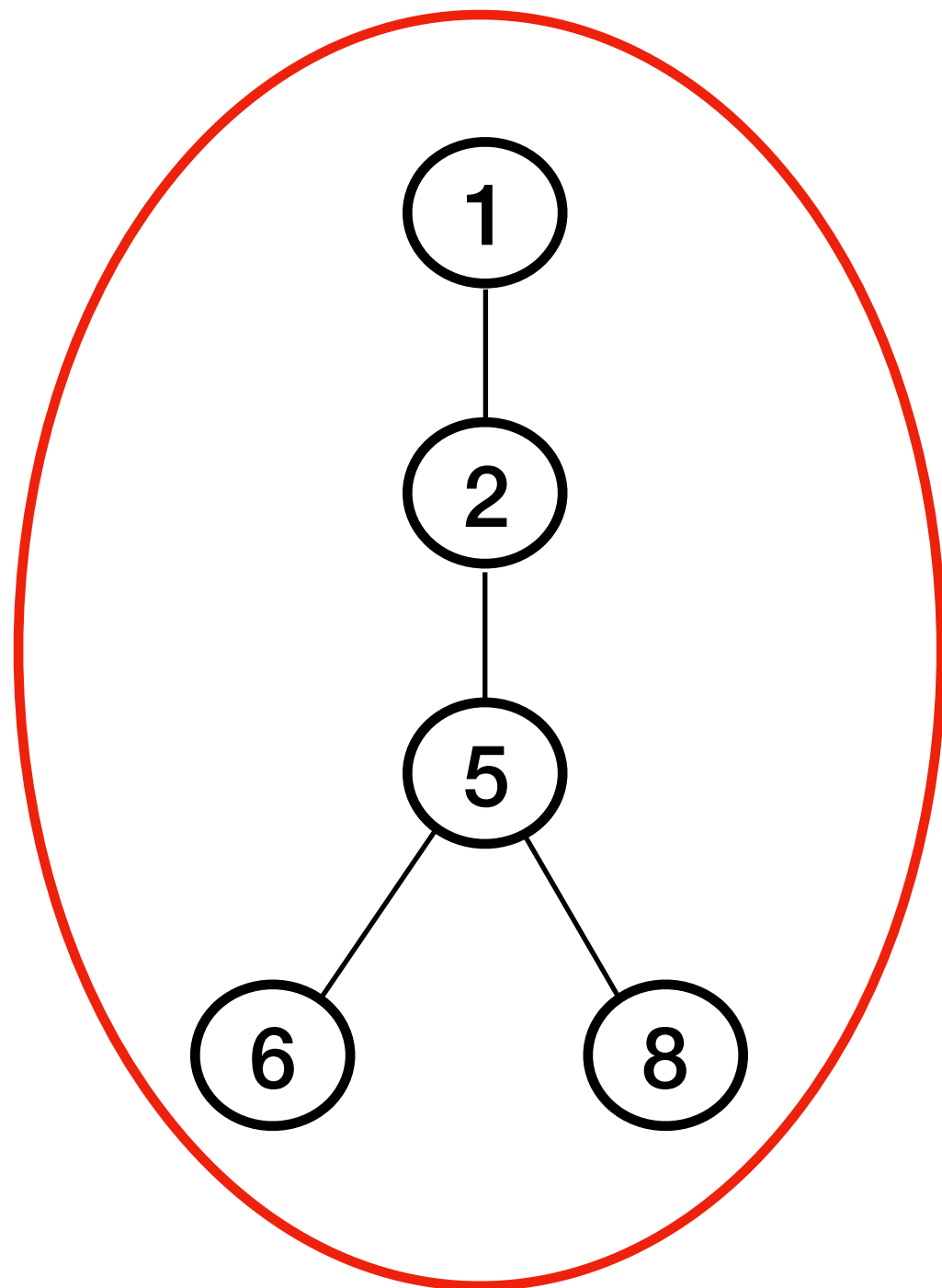
그룹 번호 3



그룹 번호 7

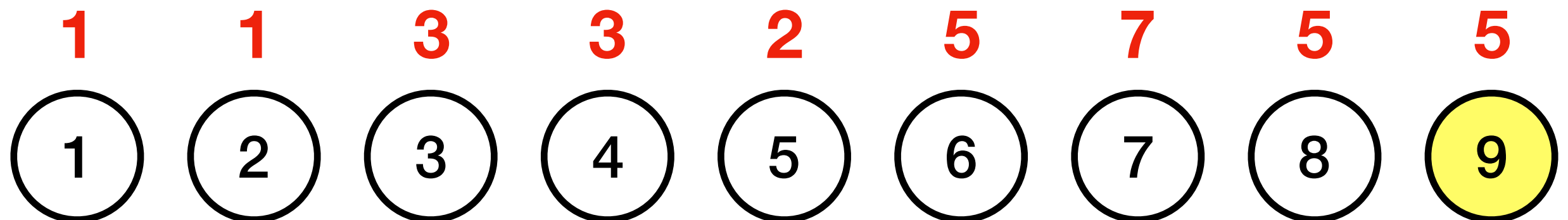
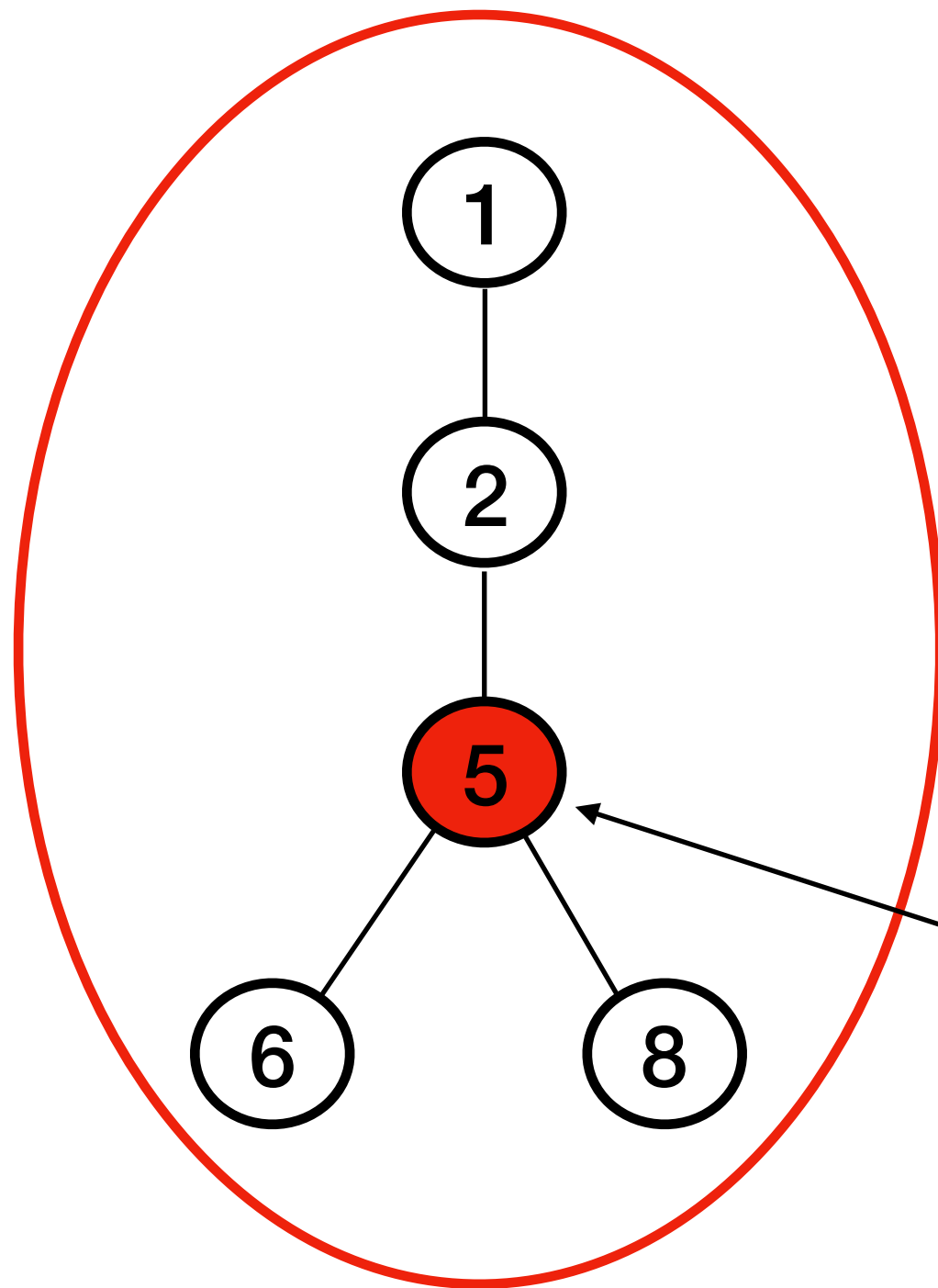


새로운 원소 추가

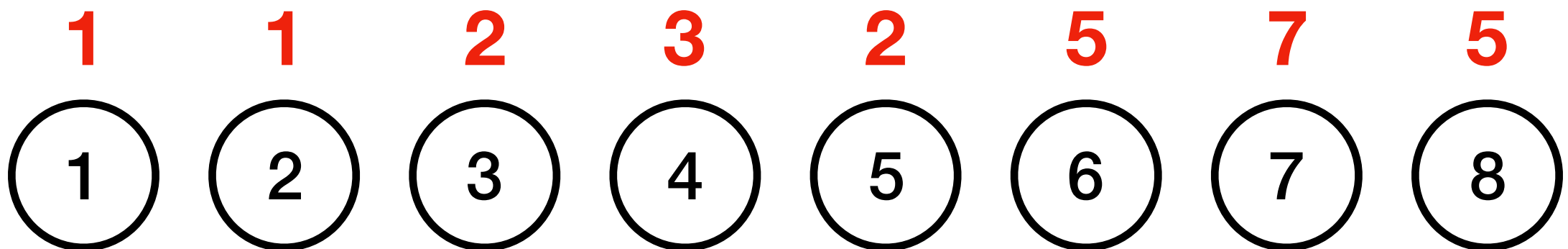
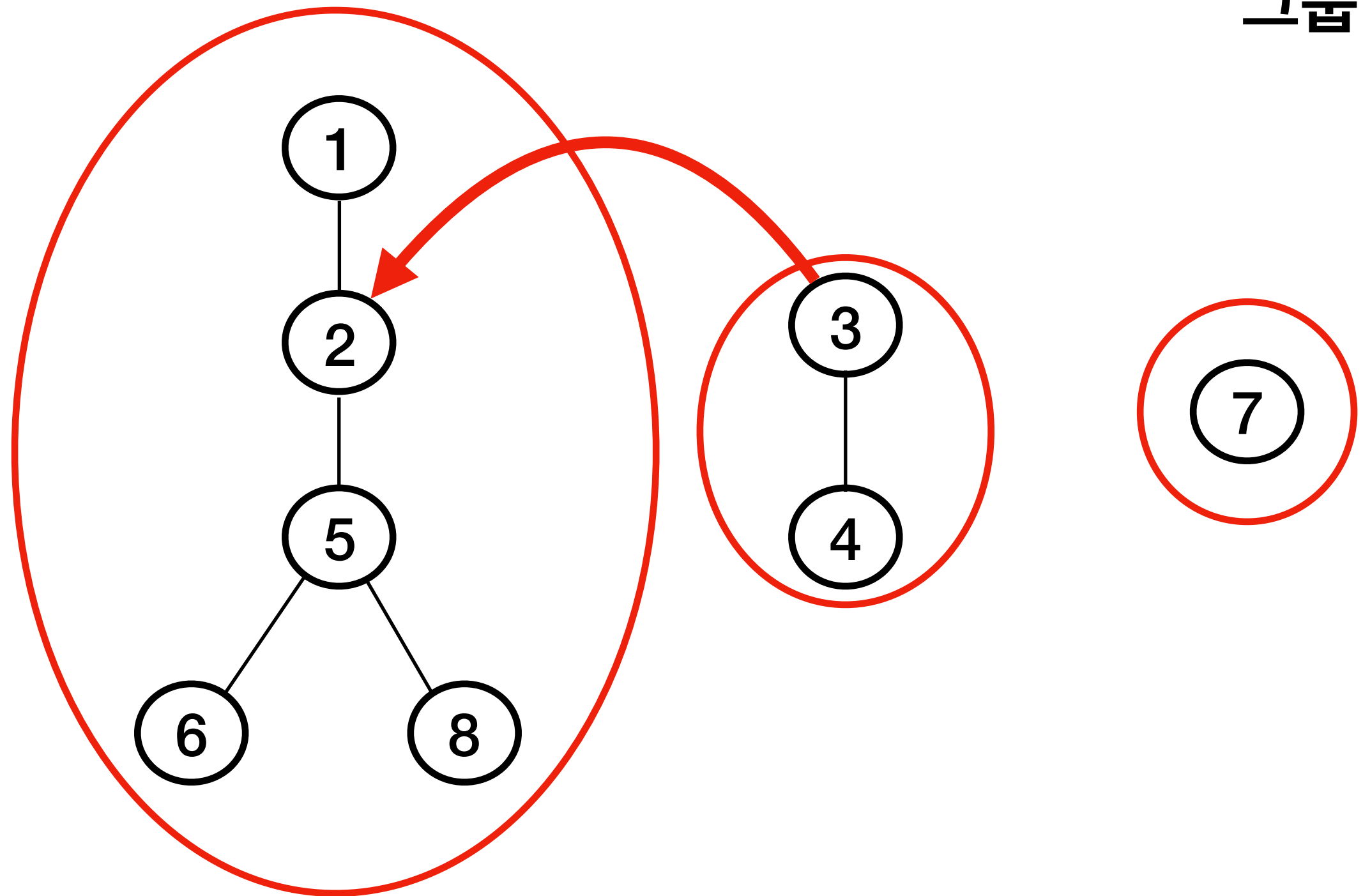


새로운 원소 추가

$O(1)$

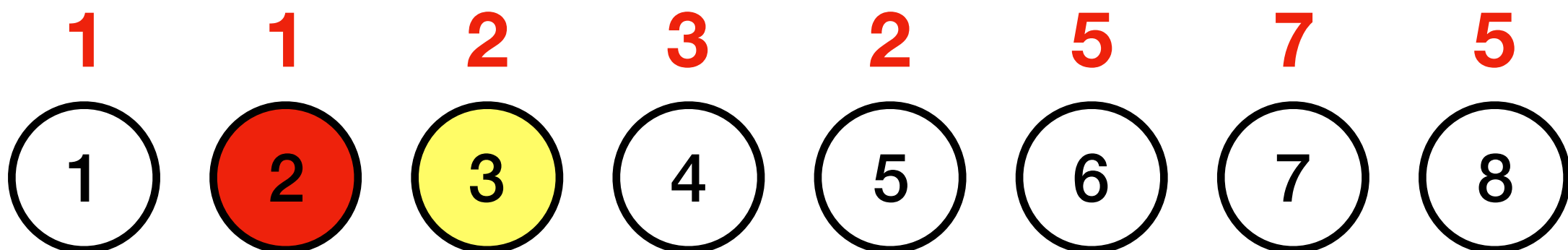
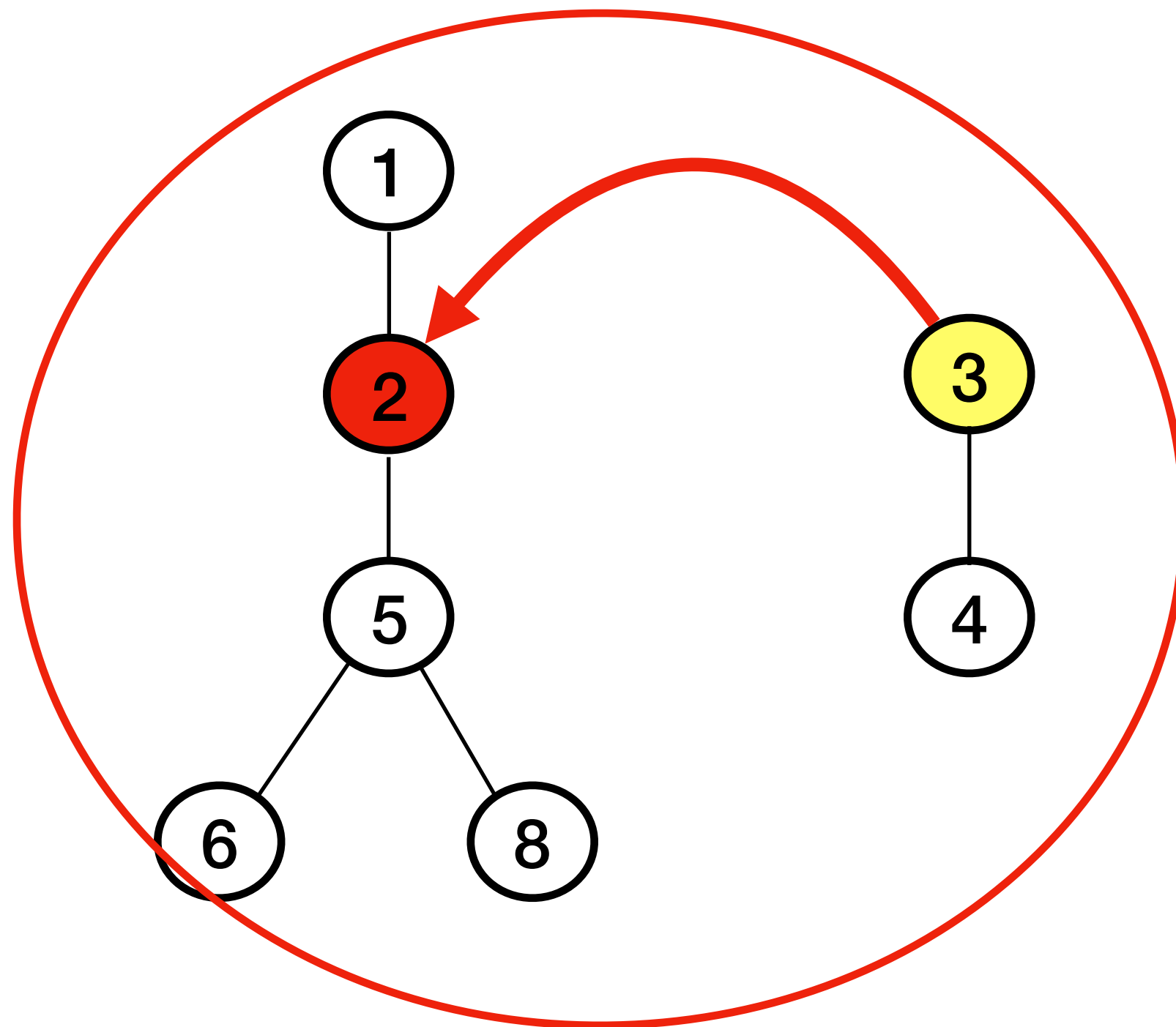


그룹 합치기

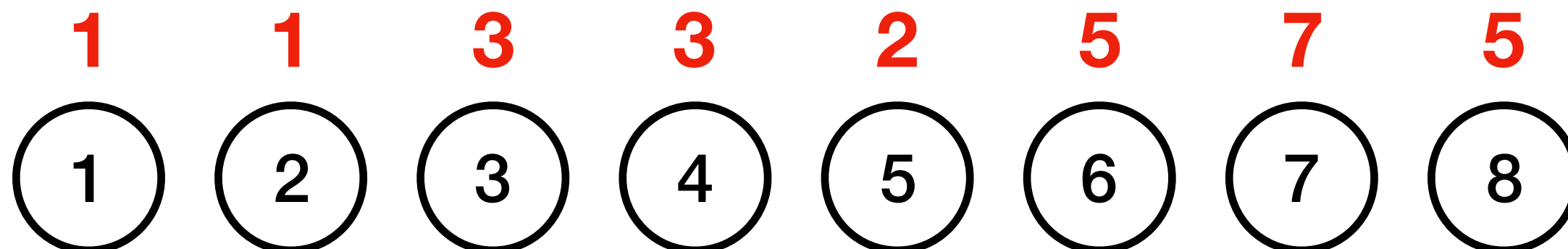
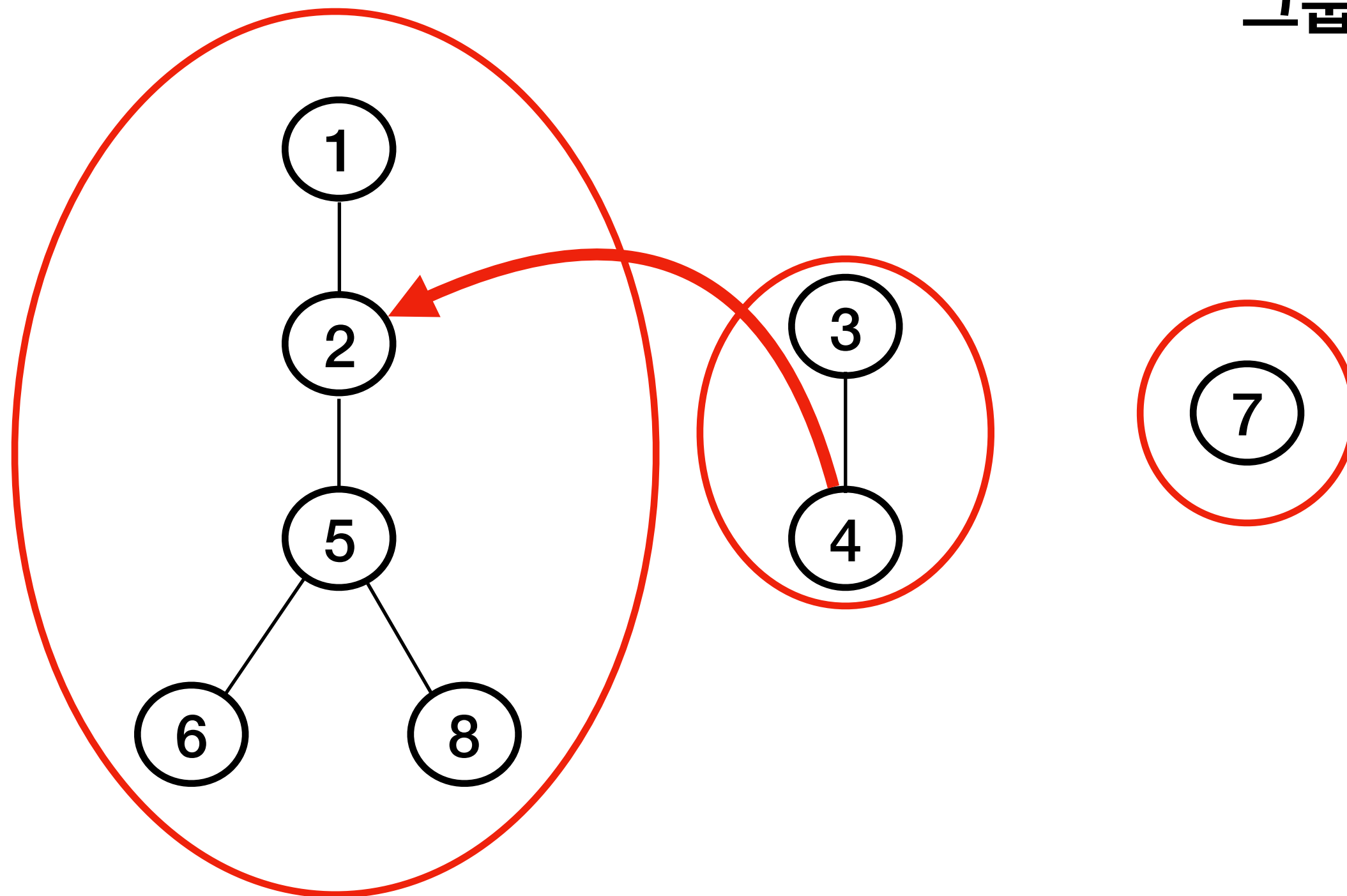


그룹 합치기

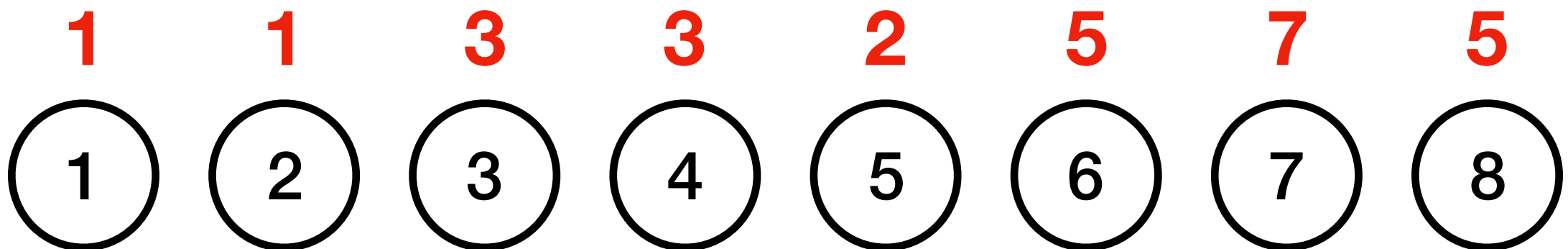
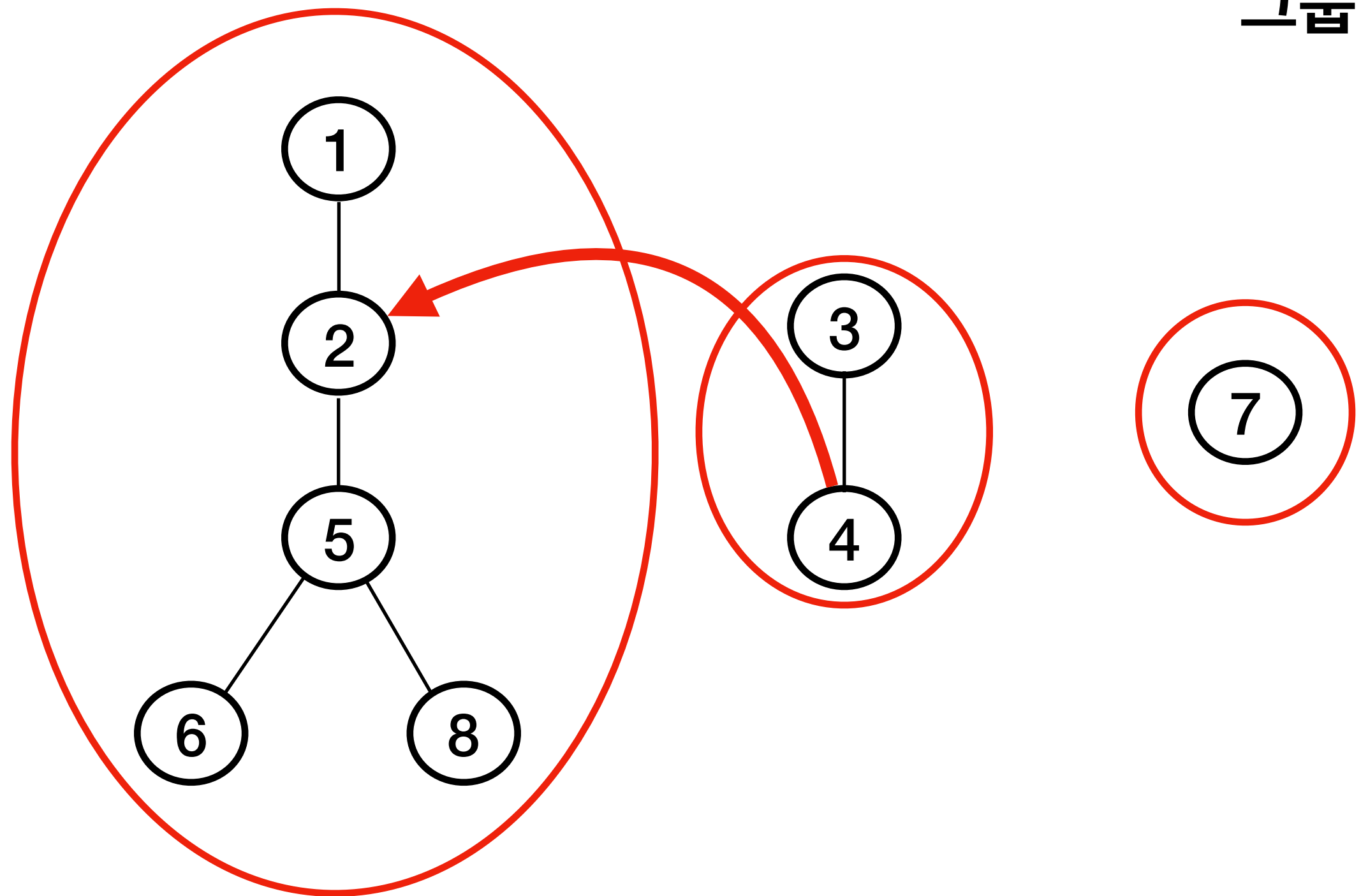
$O(1)$



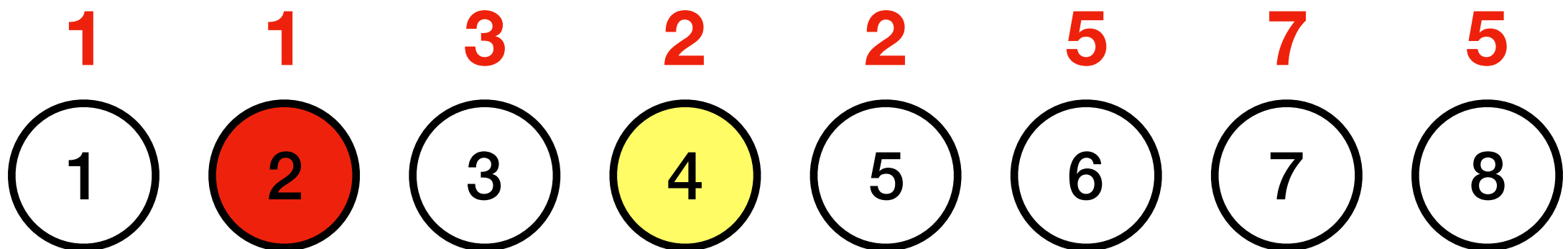
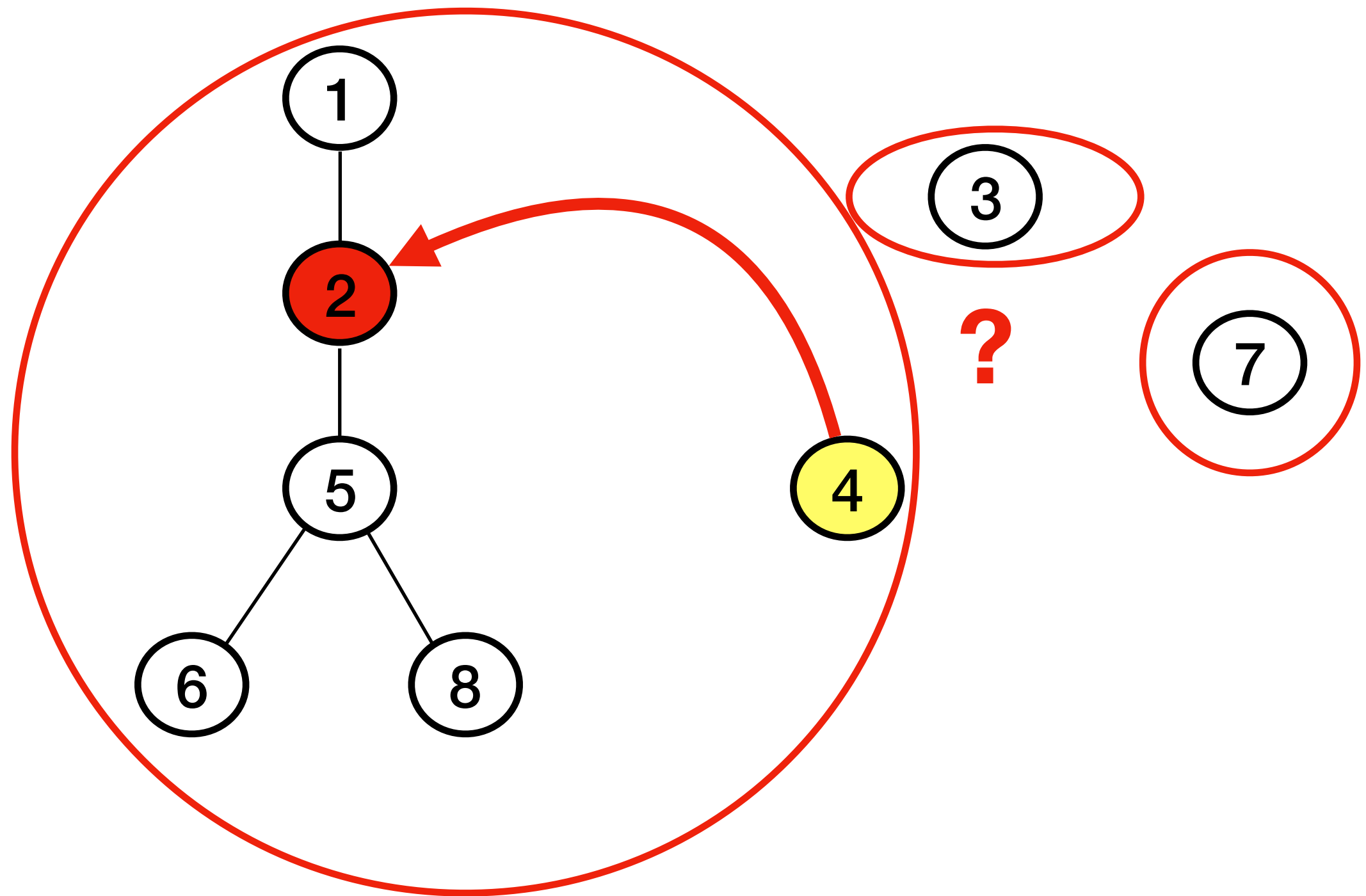
그룹 합치기



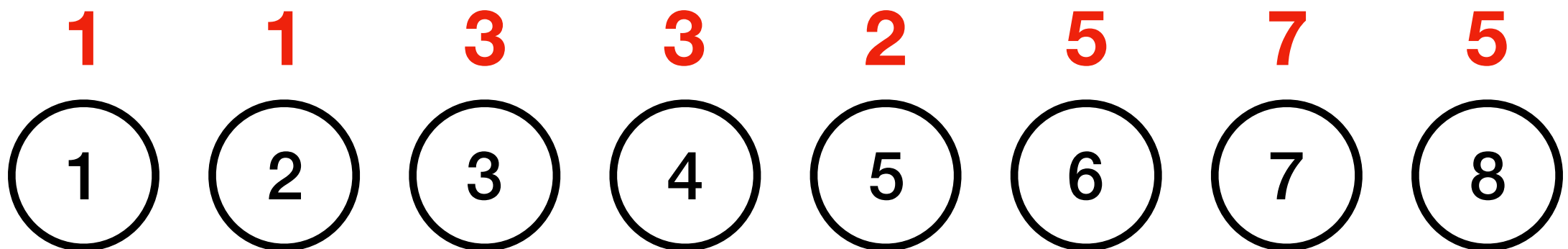
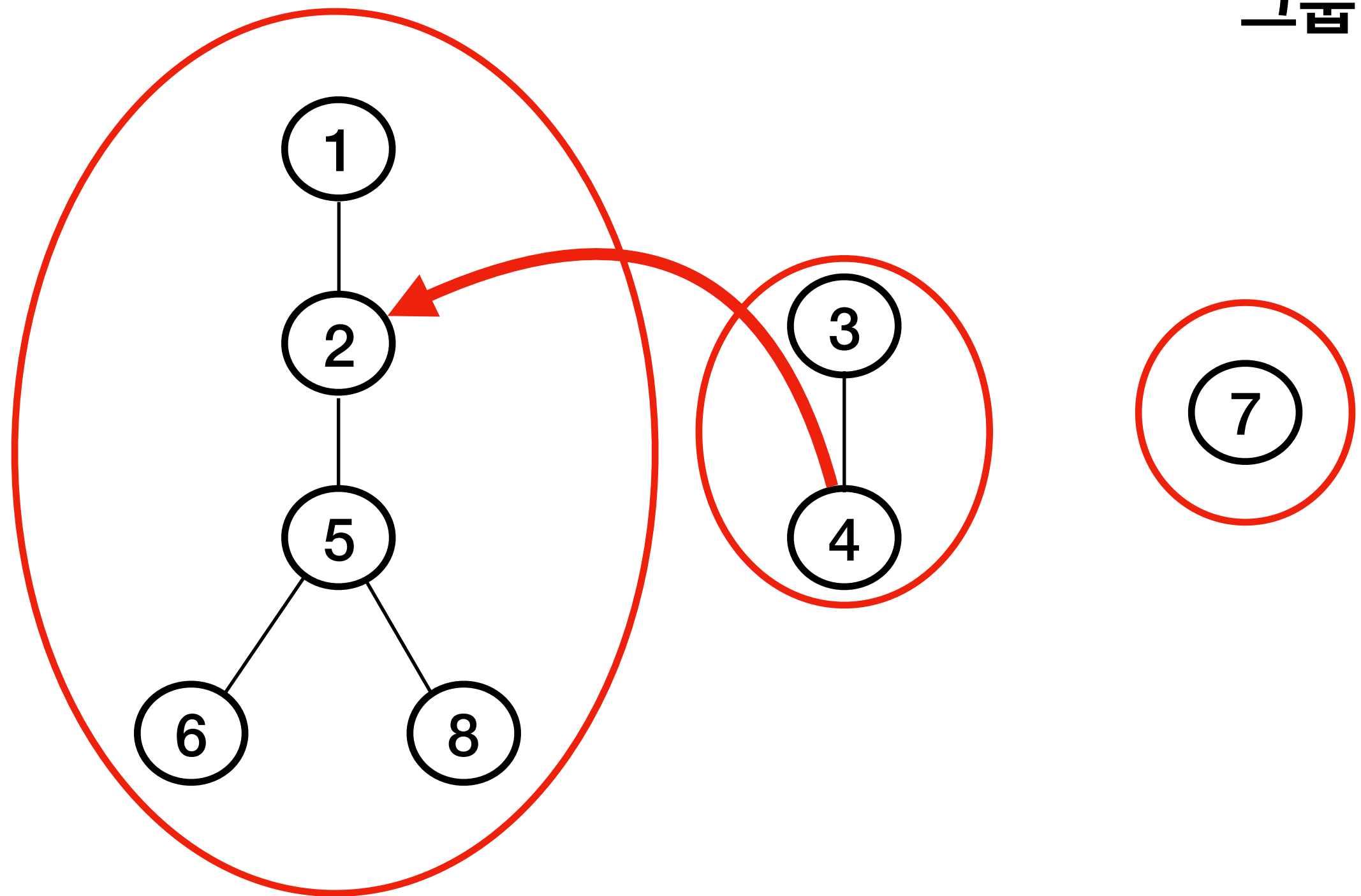
그룹 합치기



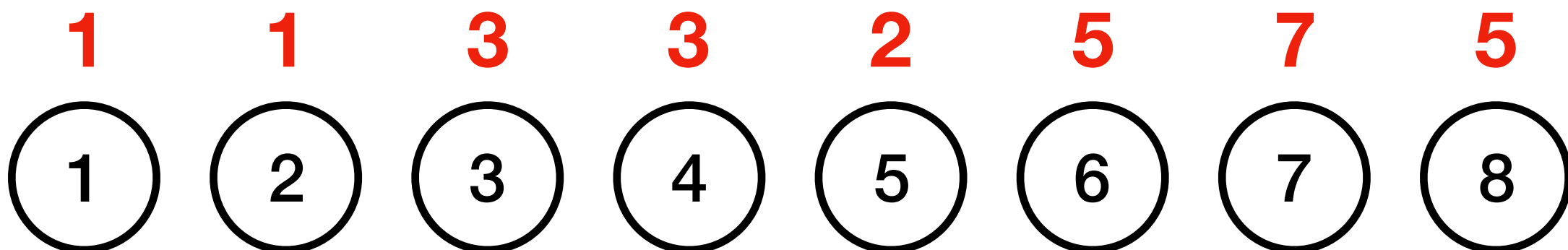
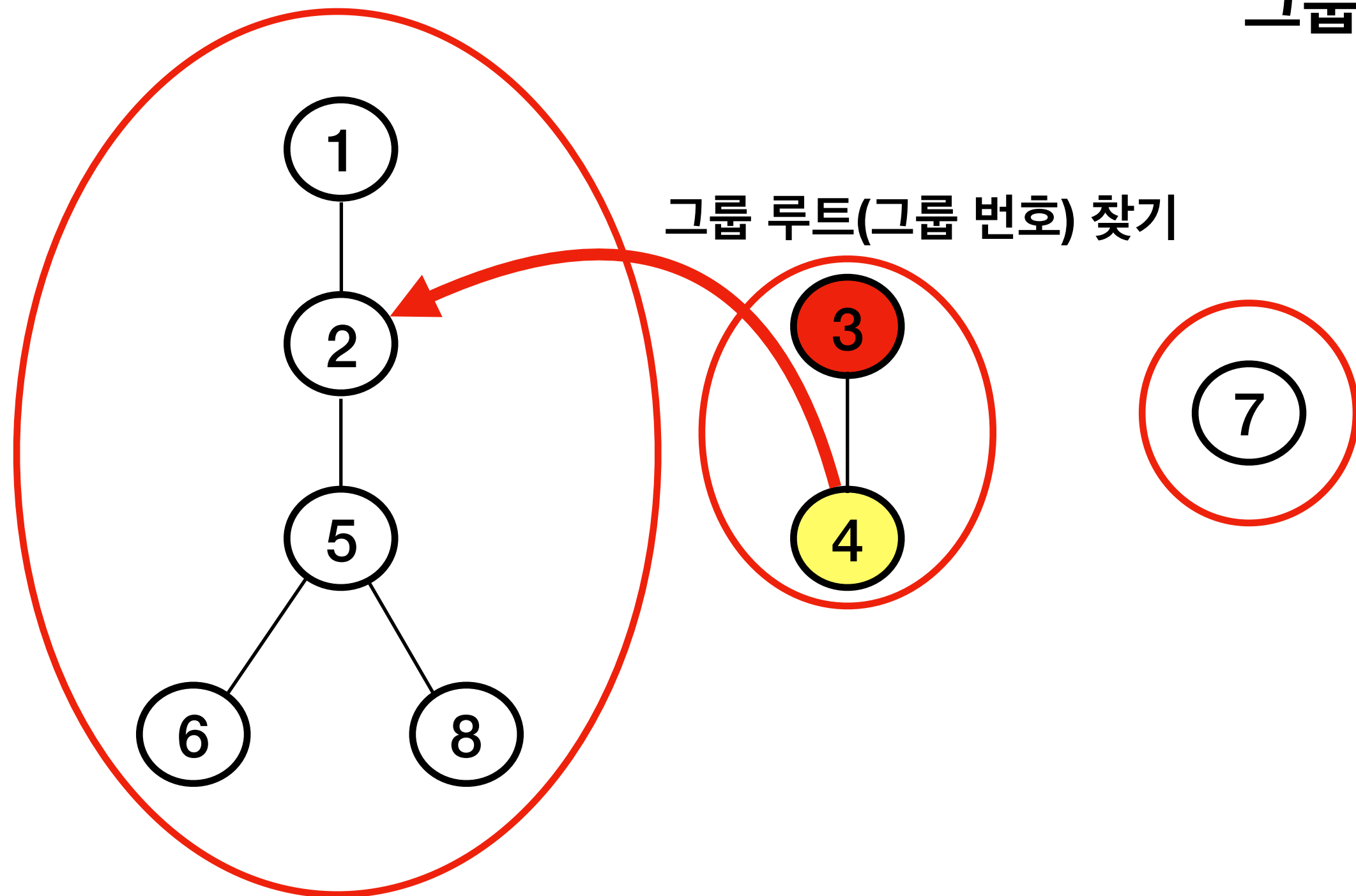
그룹 합치기



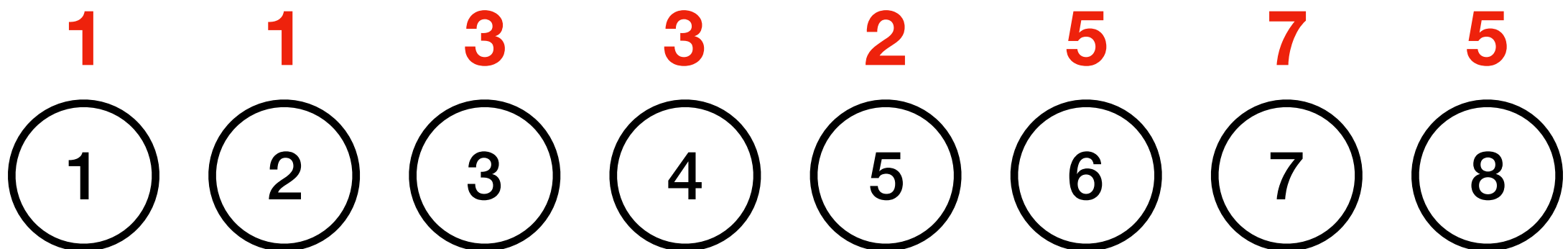
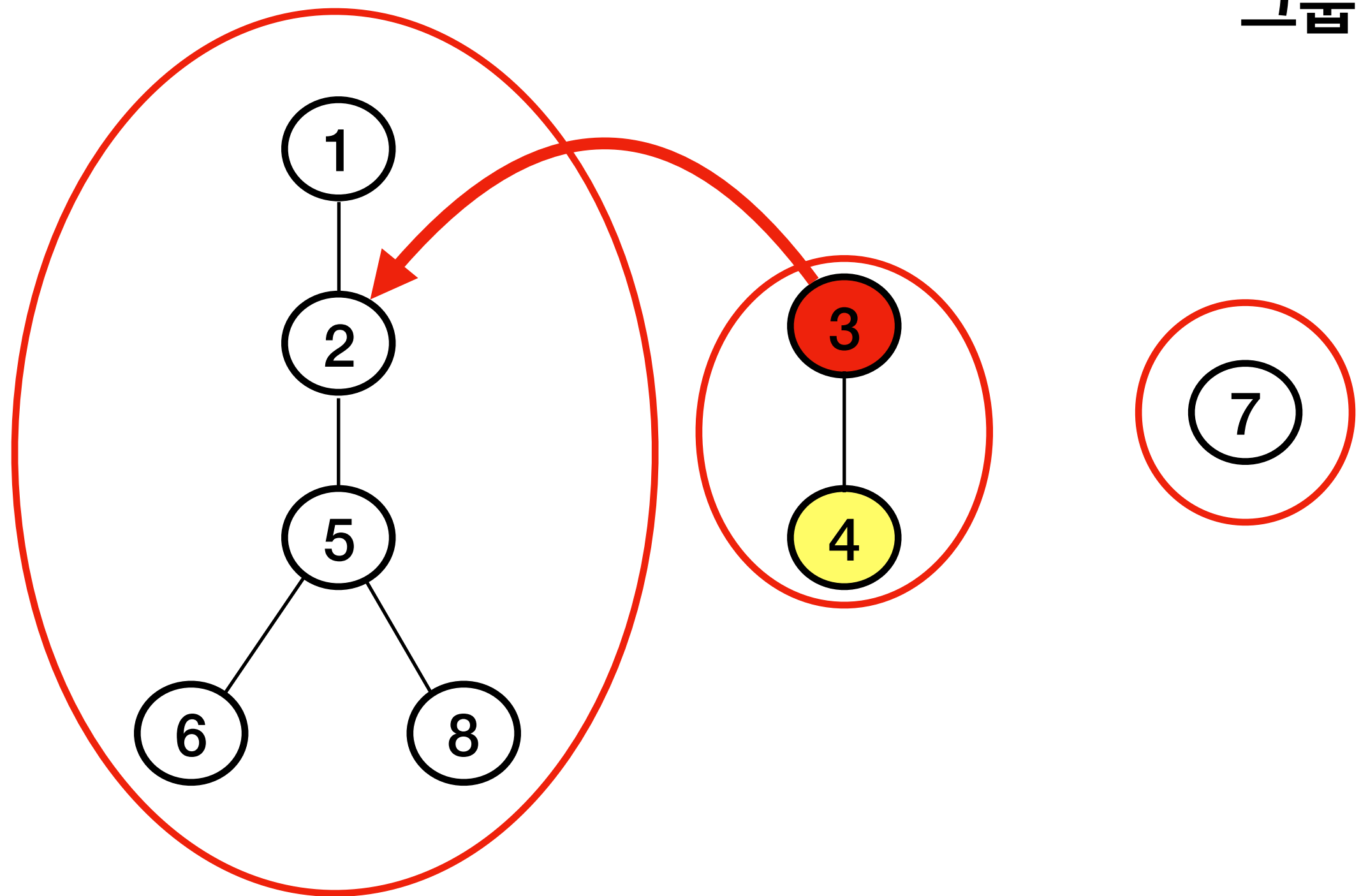
그룹 합치기



그룹 합치기

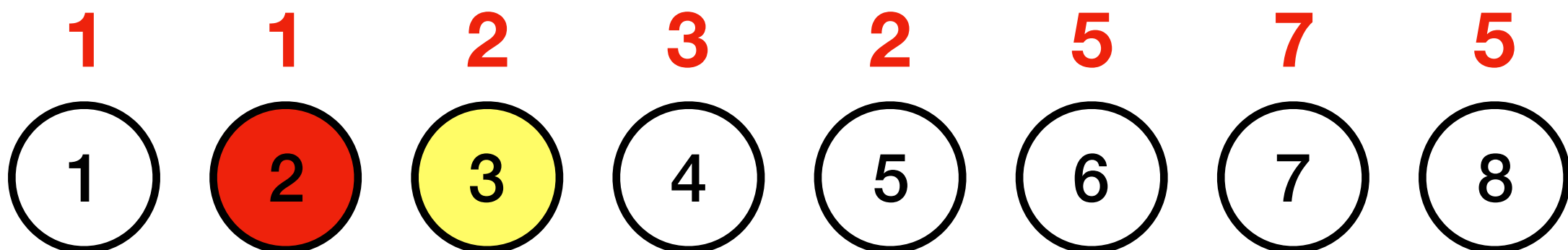
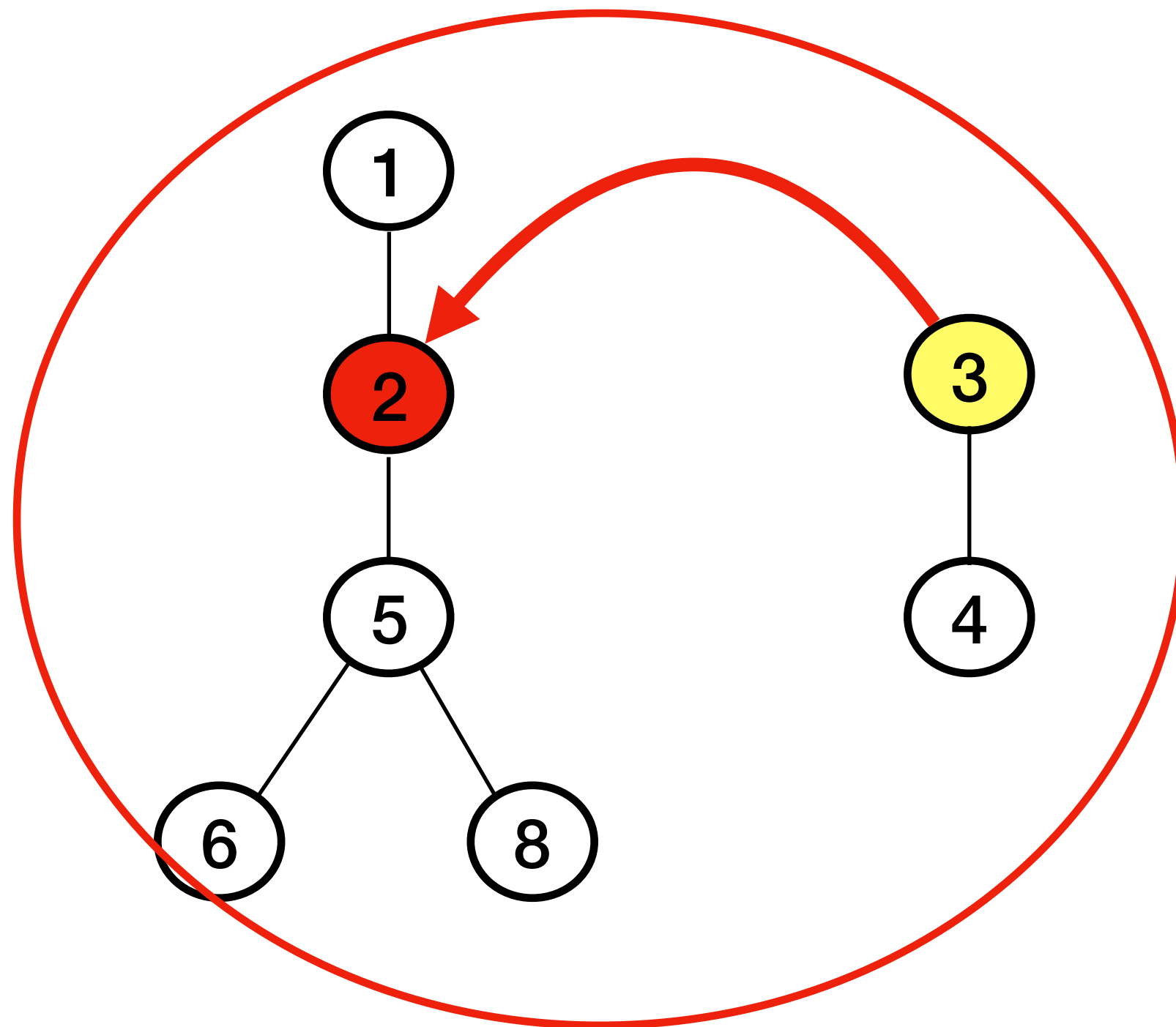


그룹 합치기

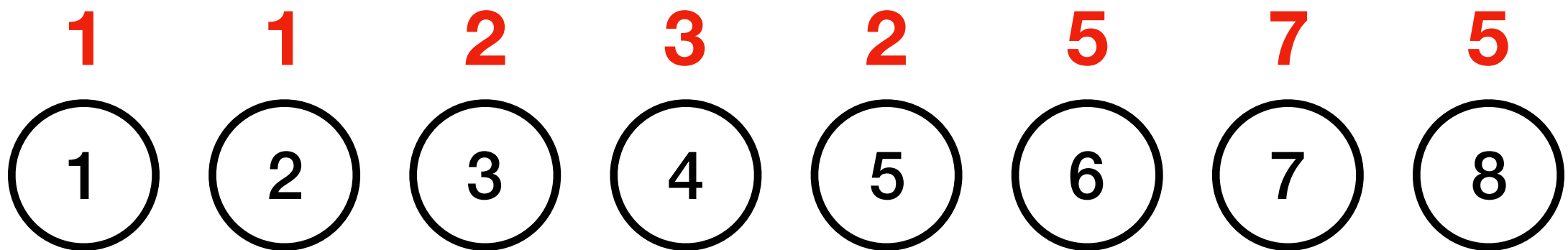
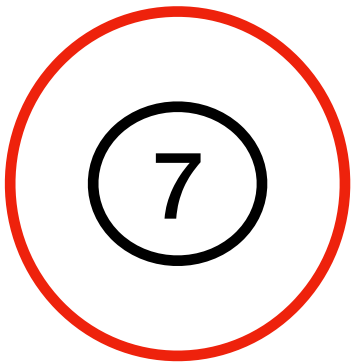
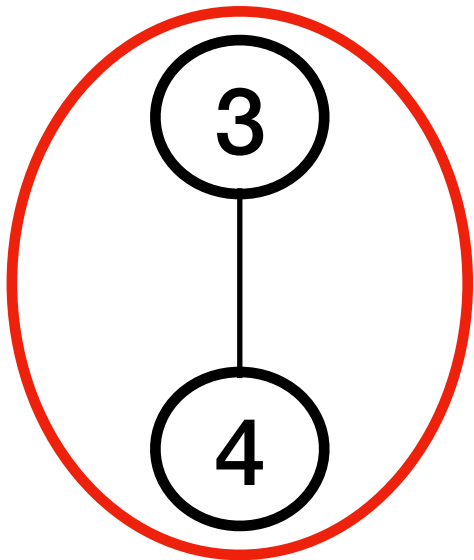
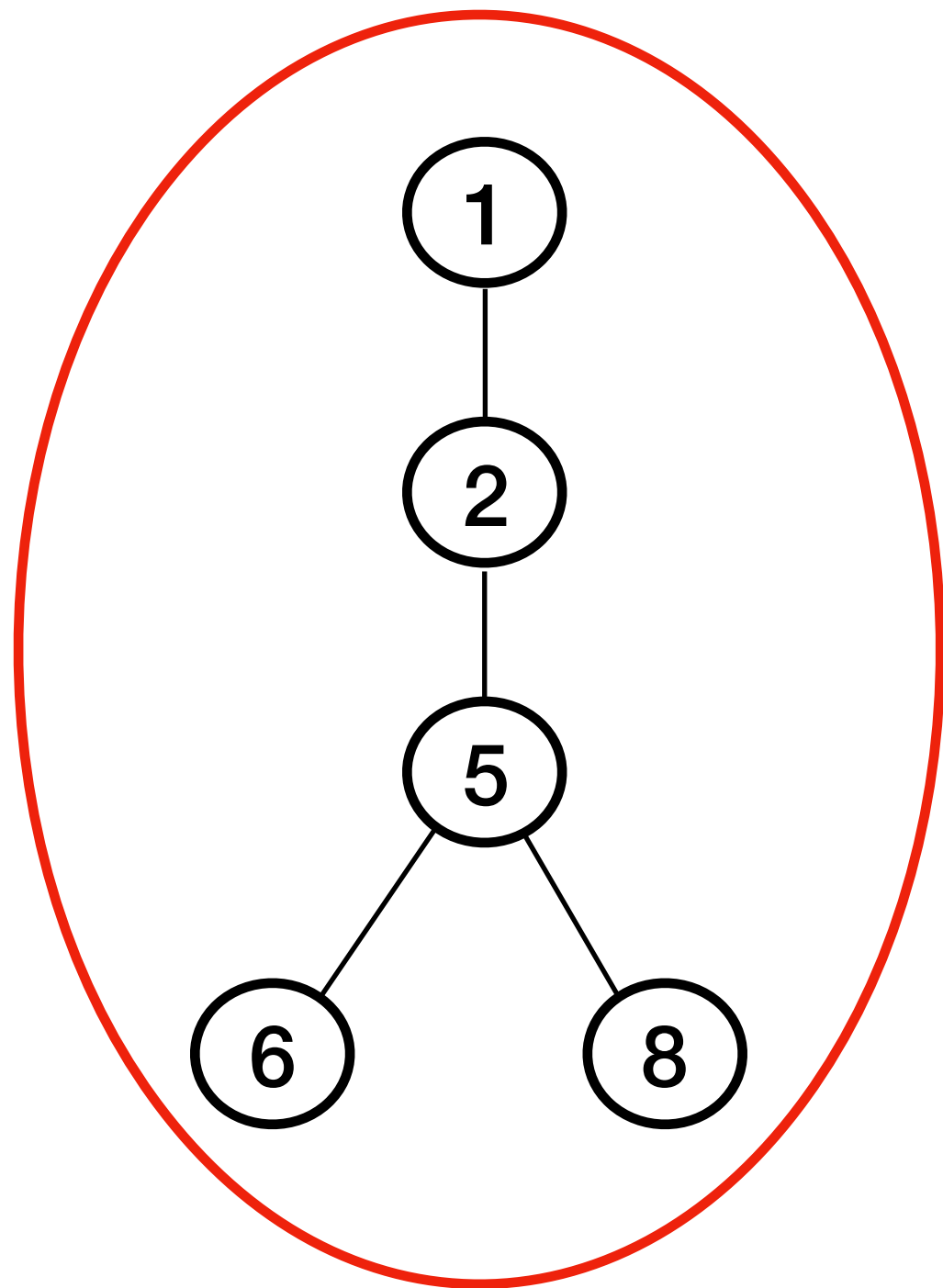


그룹 합치기

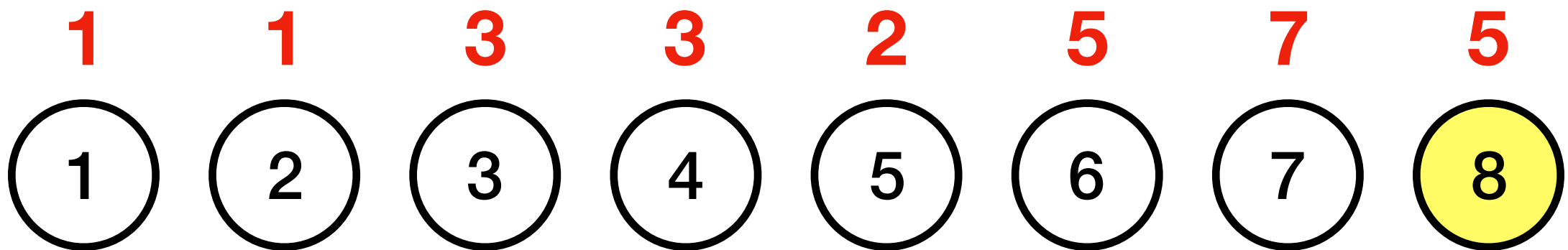
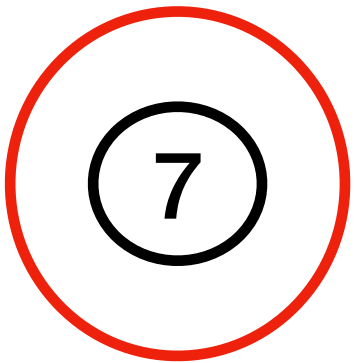
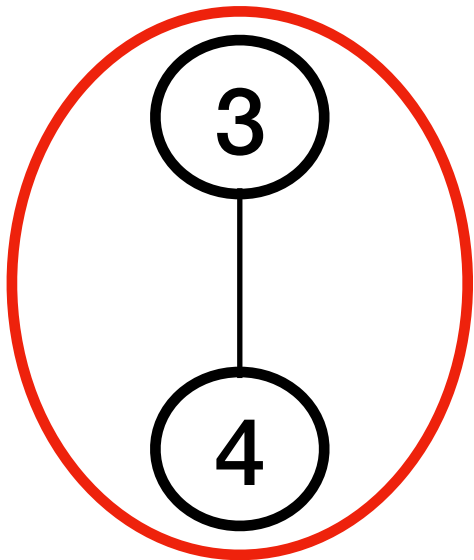
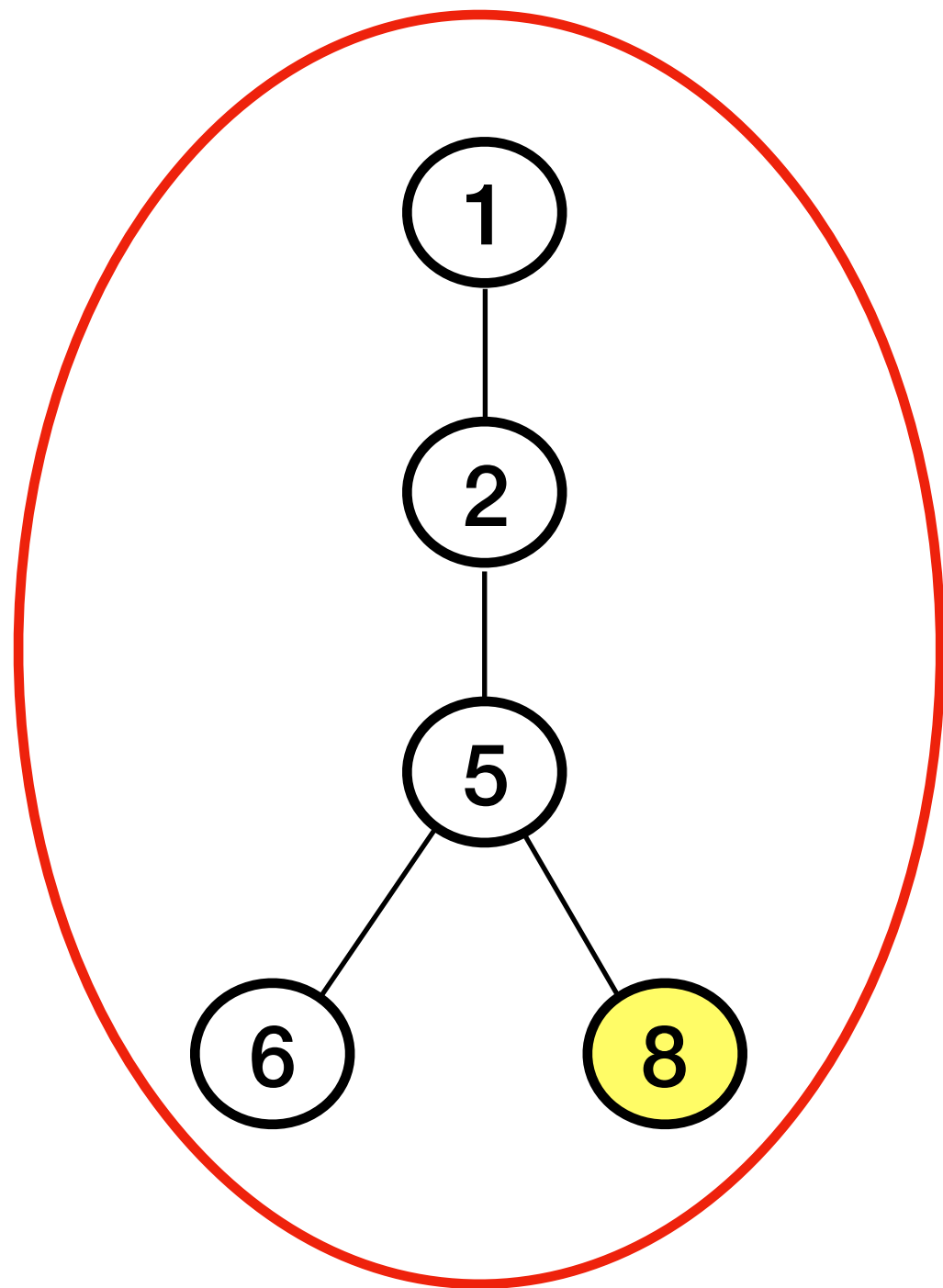
$O(1)$



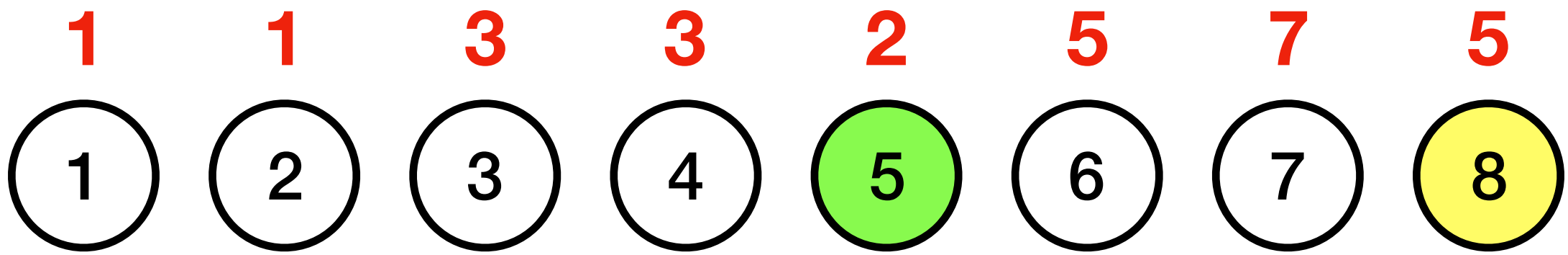
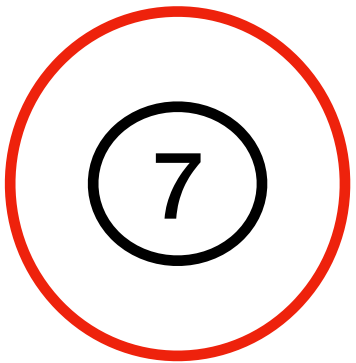
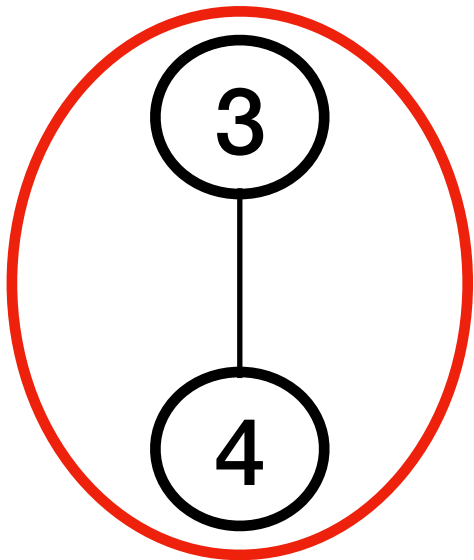
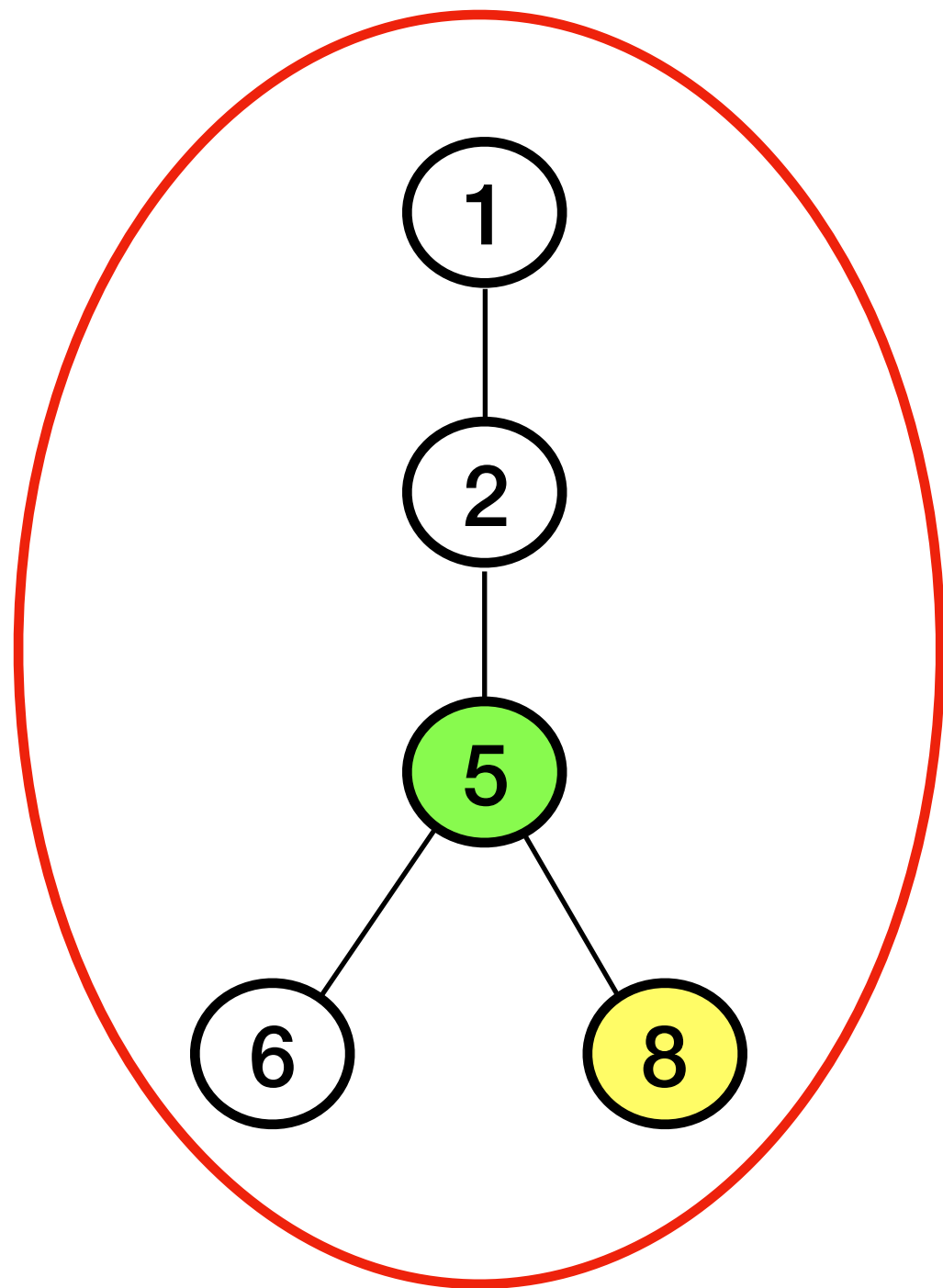
그룹 루트(그룹 번호) 찾기



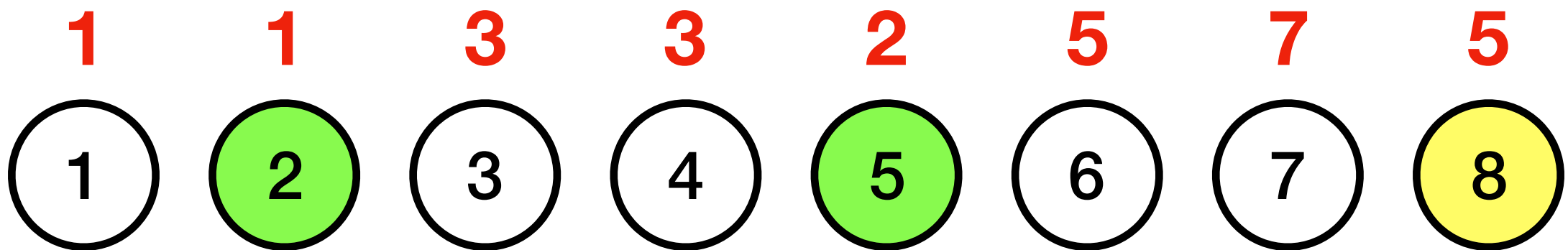
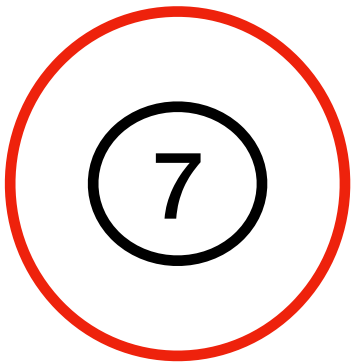
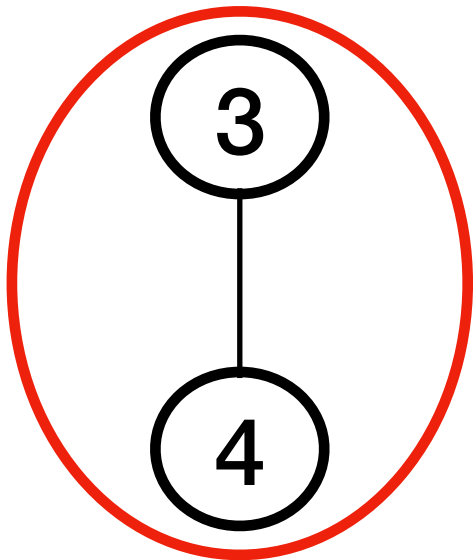
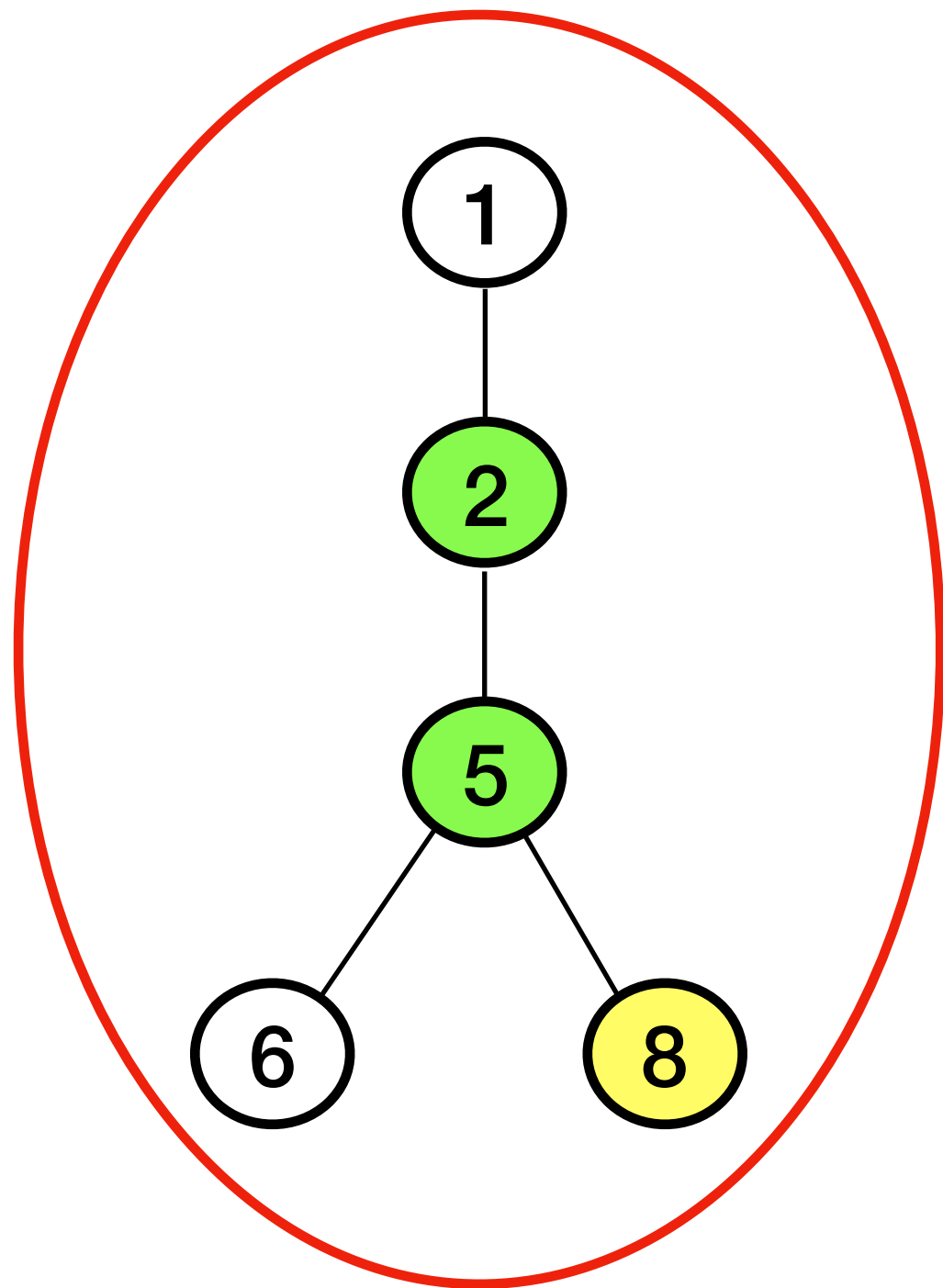
그룹 루트(그룹 번호) 찾기



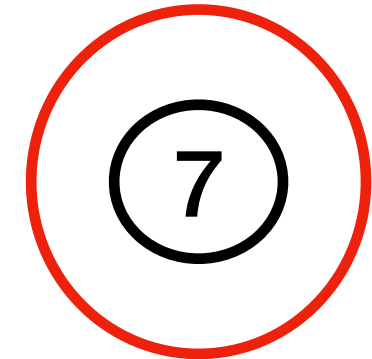
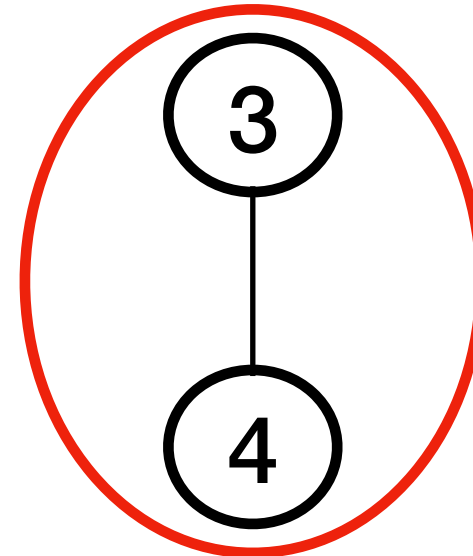
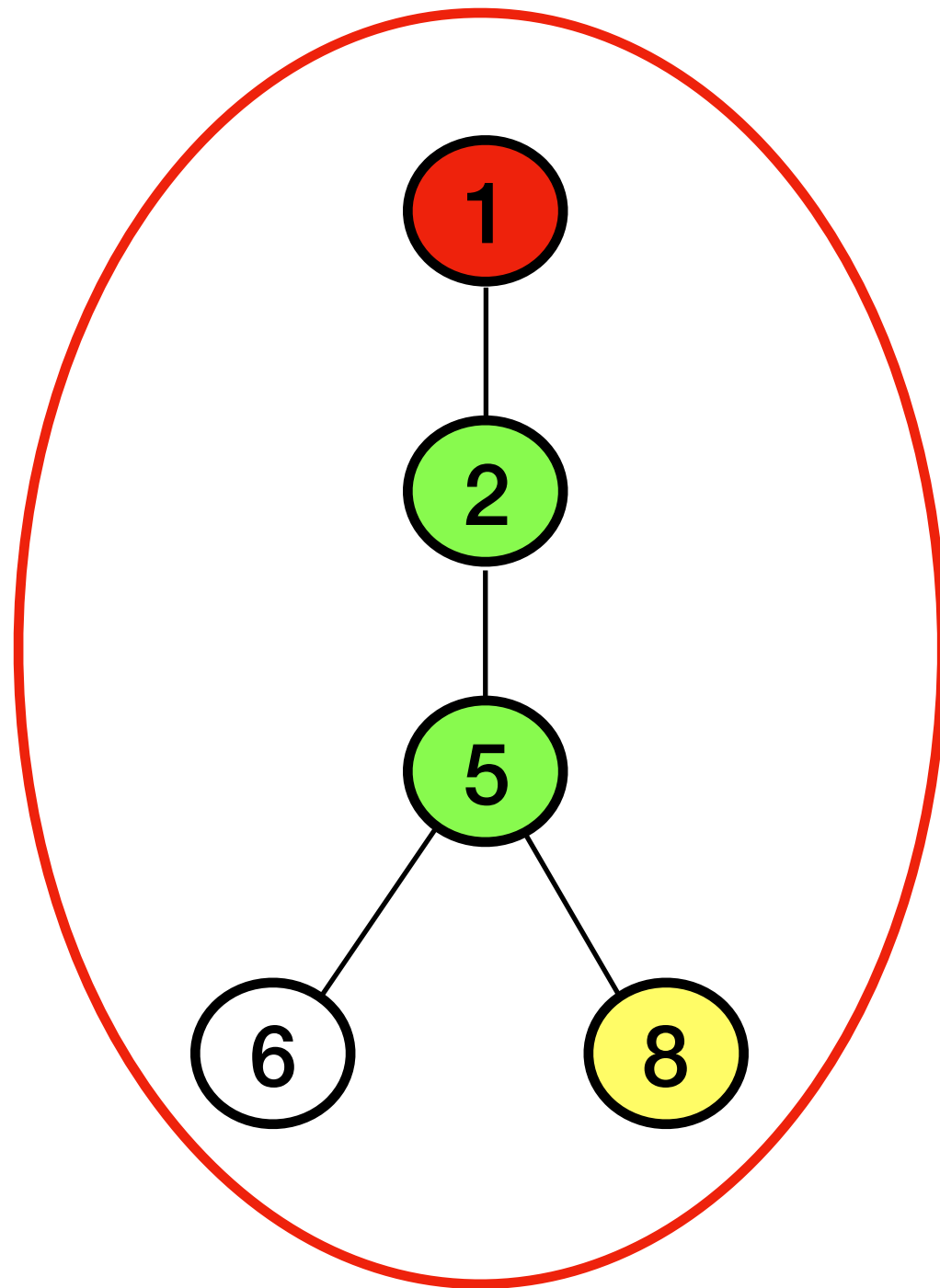
그룹 루트(그룹 번호) 찾기



그룹 루트(그룹 번호) 찾기

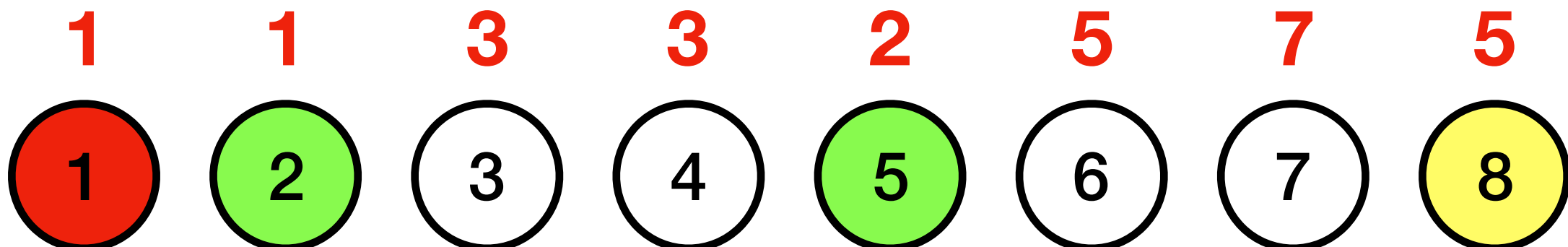


그룹 루트(그룹 번호) 찾기



h = 그룹 트리 높이

$$O(h)$$



알고리즘 개선 아이디어

- 문제점 : 새로운 원소가 추가될 때도 문제가 없고, 기존 그룹끼리 합칠 때도 그룹의 루트랑 합칠 때는 $O(1)$ 의 시간복잡도를 가지지만, 루트가 아닐 경우에는 먼저 루트를 찾고 합쳐야 해서 $O(h)$ 의 시간복잡도를 가진다.
- 개선점 : 루트를 찾는 과정을 **경로 압축 최적화**를 이용해서 개선

세 번째 방법

세 번째 방법

- 아래 두 가지 작업으로 집합을 구성하고 합칠 수 있다.

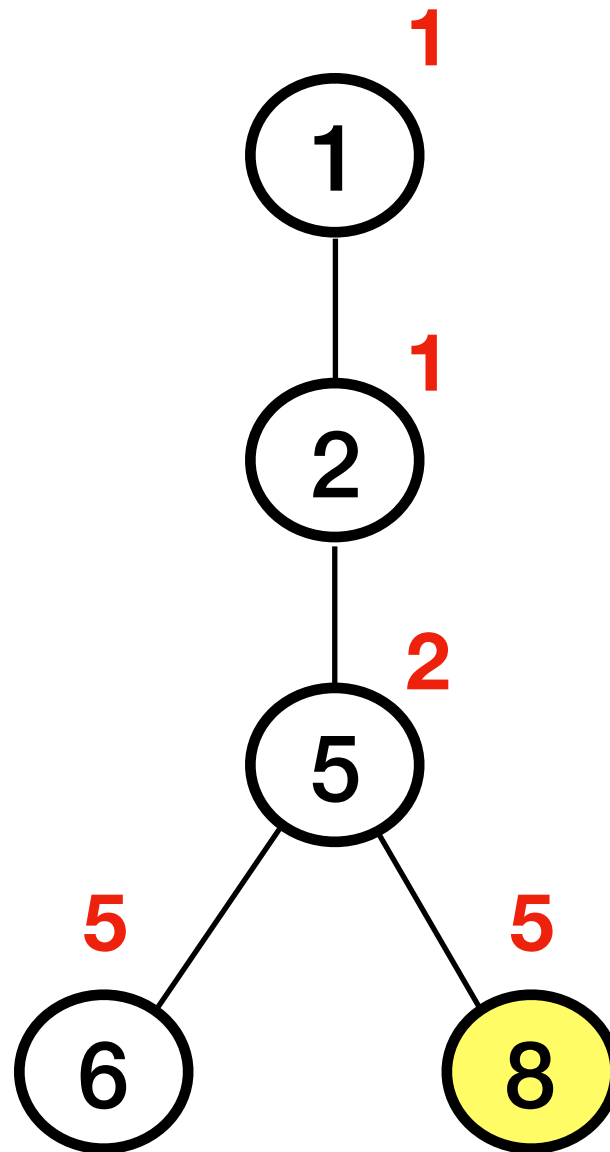
1. find

- 내가 속한 그룹의 루트를 찾는 과정 (경로 압축 최적화)

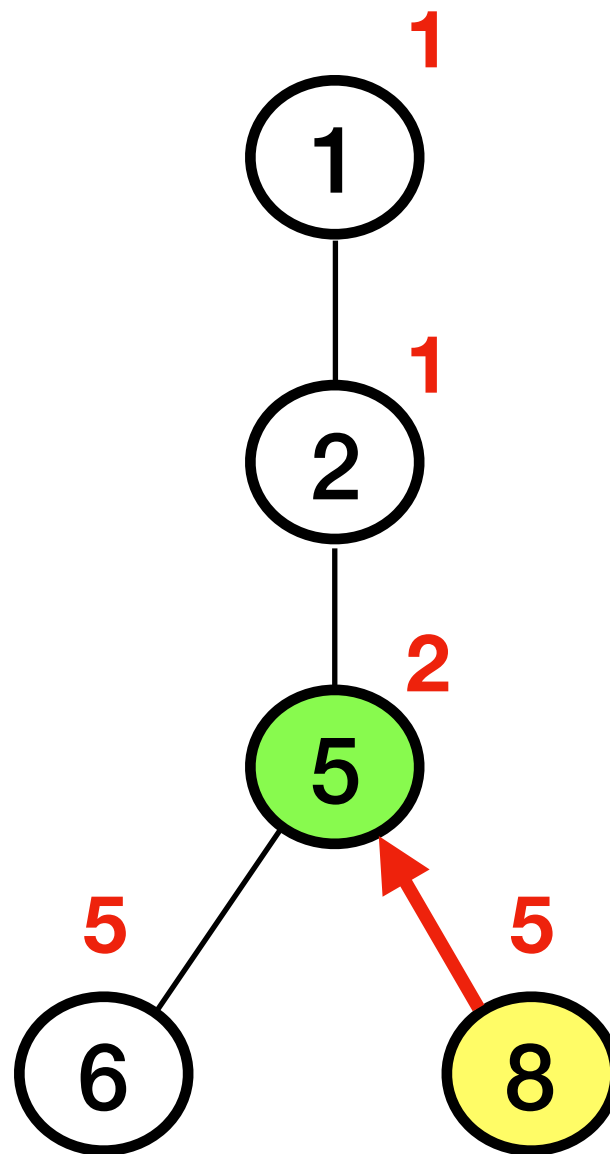
2. union

- 두 그룹의 루트를 찾은후(find) 번호가 작은 루트를 번호가 큰 루트의 부모로 설정하기

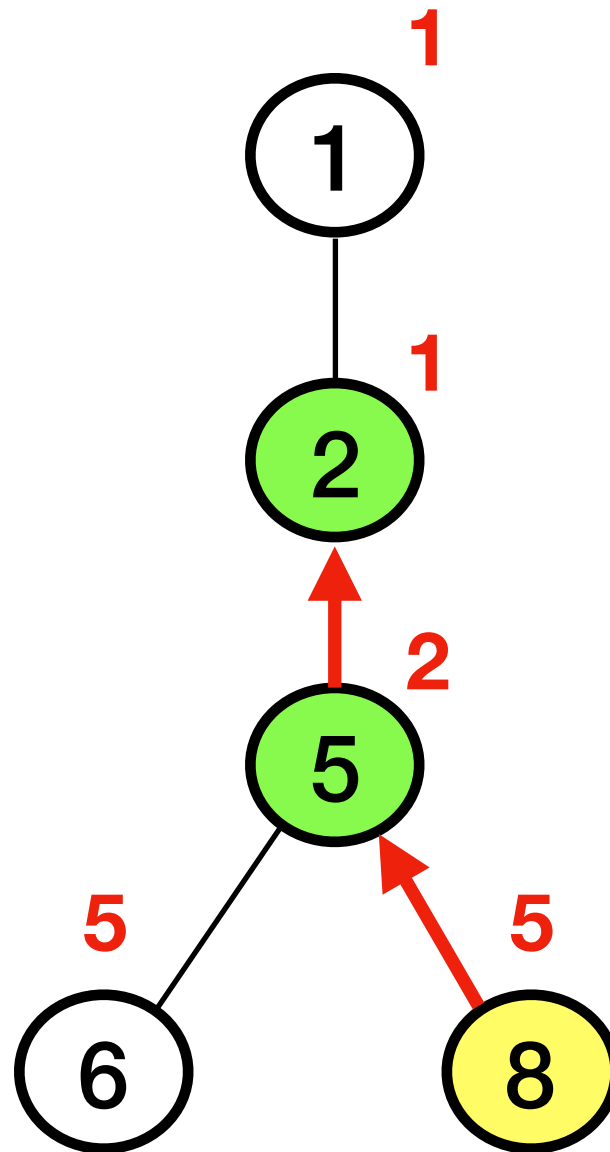
경로 압축 최적화



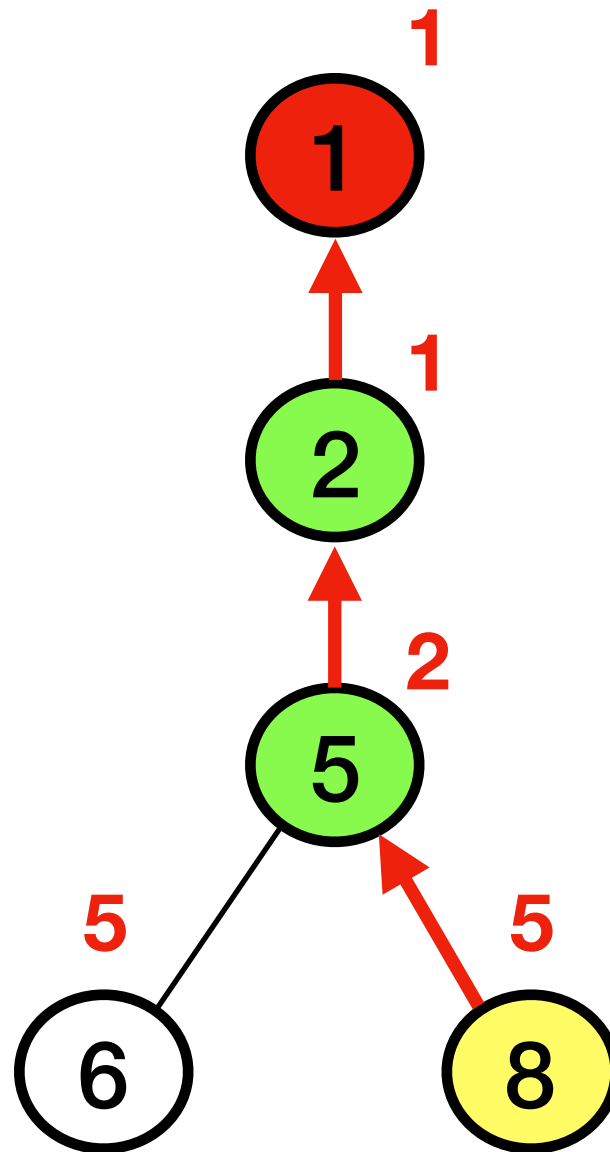
경로 압축 최적화



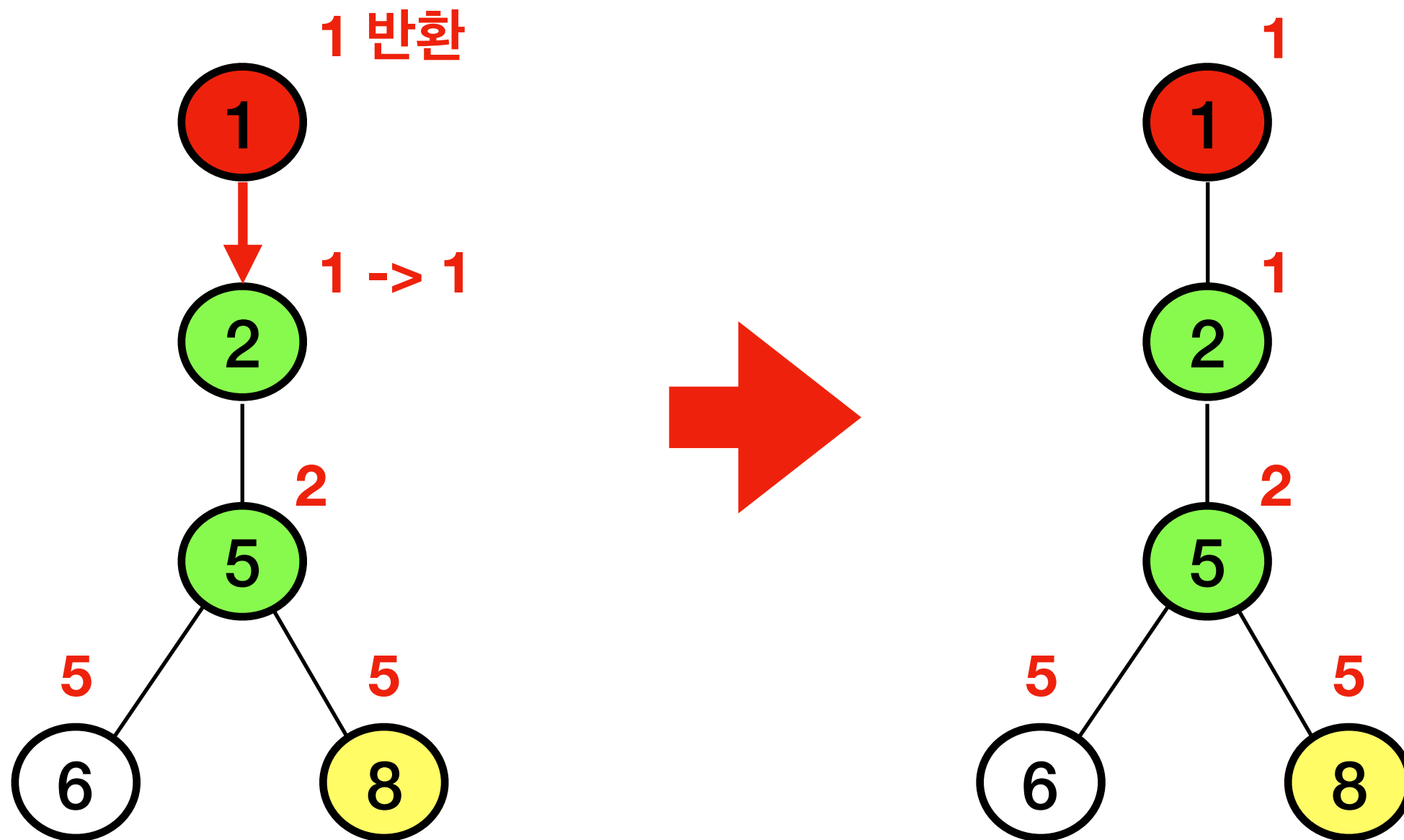
경로 압축 최적화



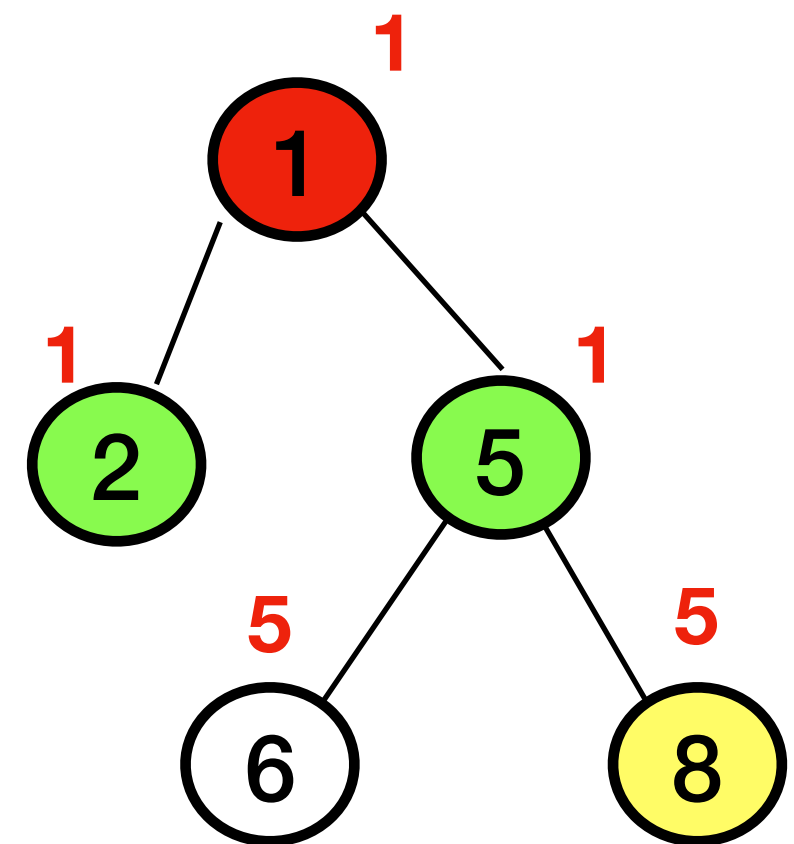
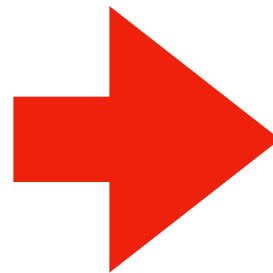
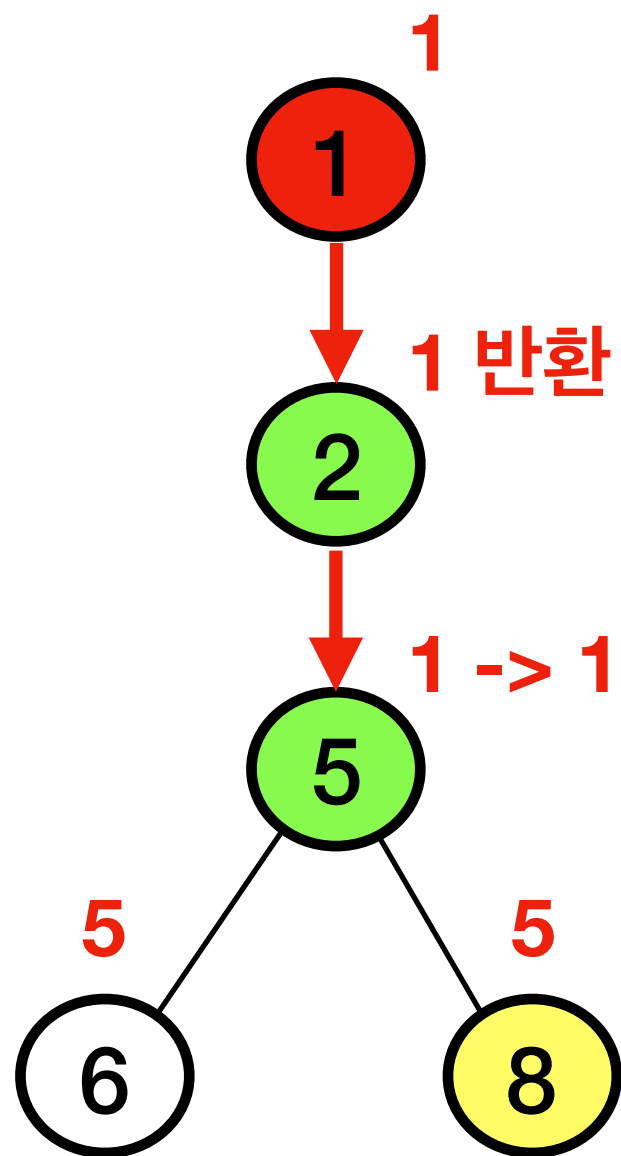
경로 압축 최적화



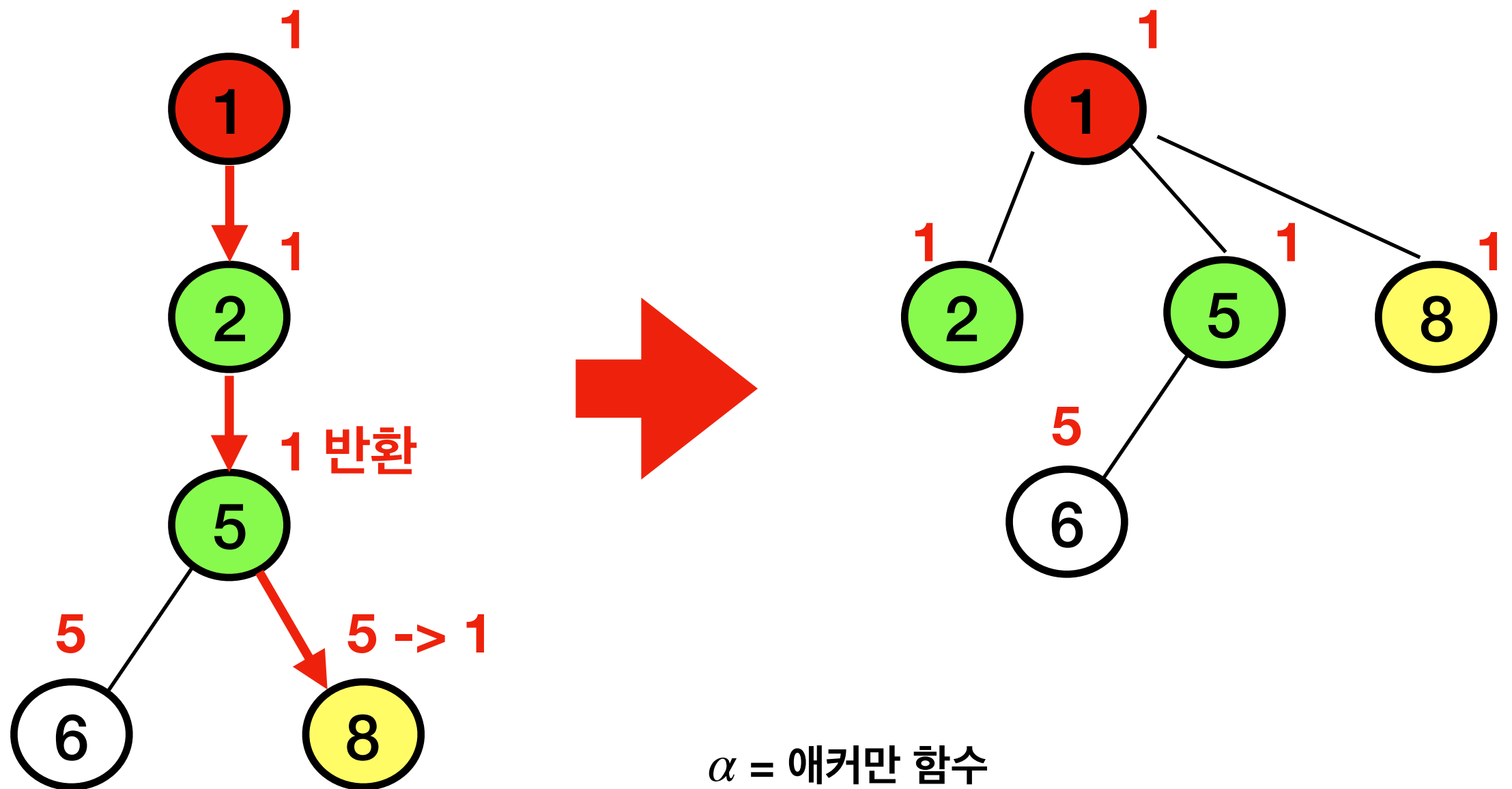
경로 압축 최적화



경로 압축 최적화



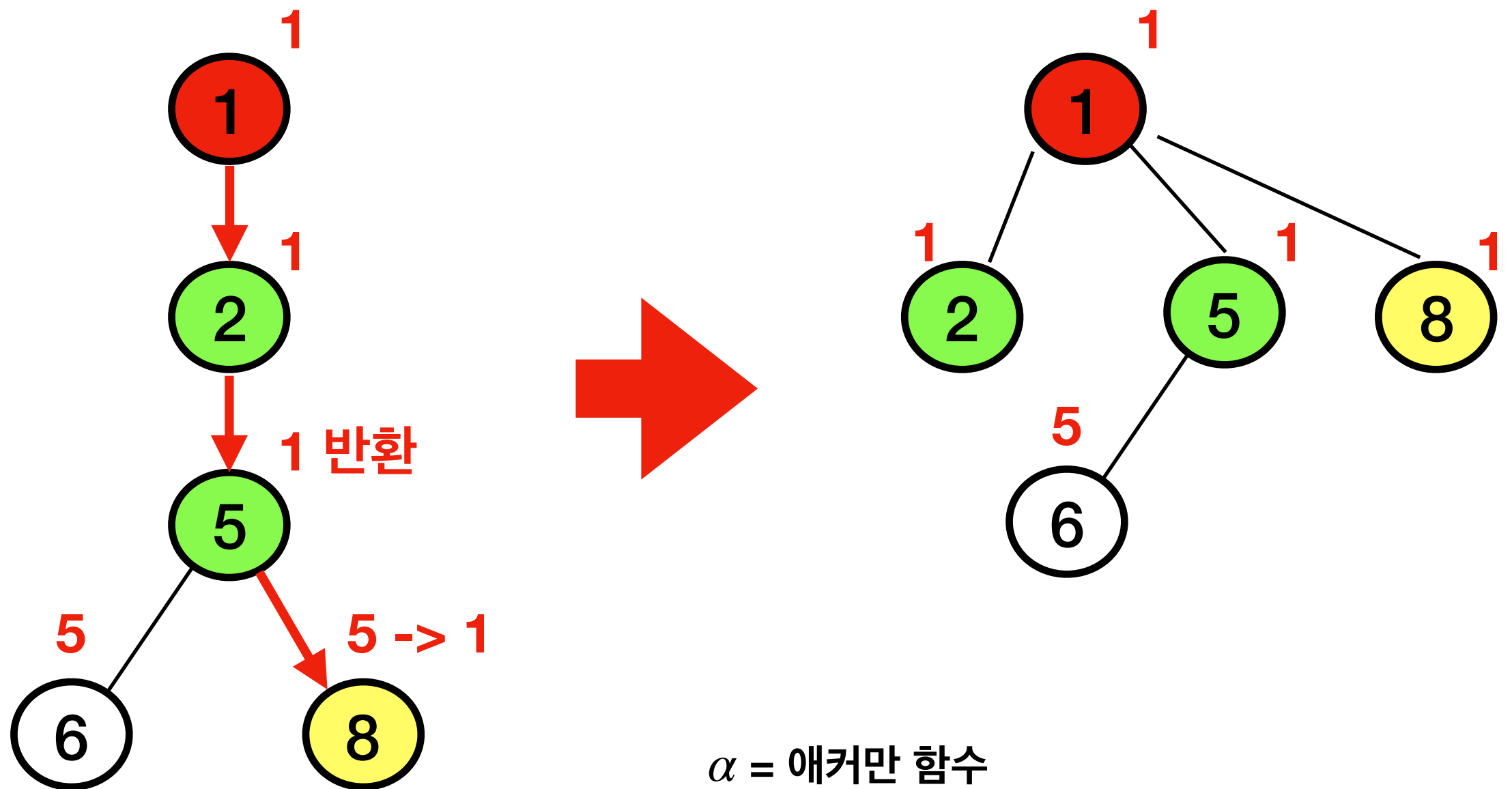
경로 압축 최적화



α = 애커만 함수

$$O(\alpha(n)) \approx O(\log n)$$

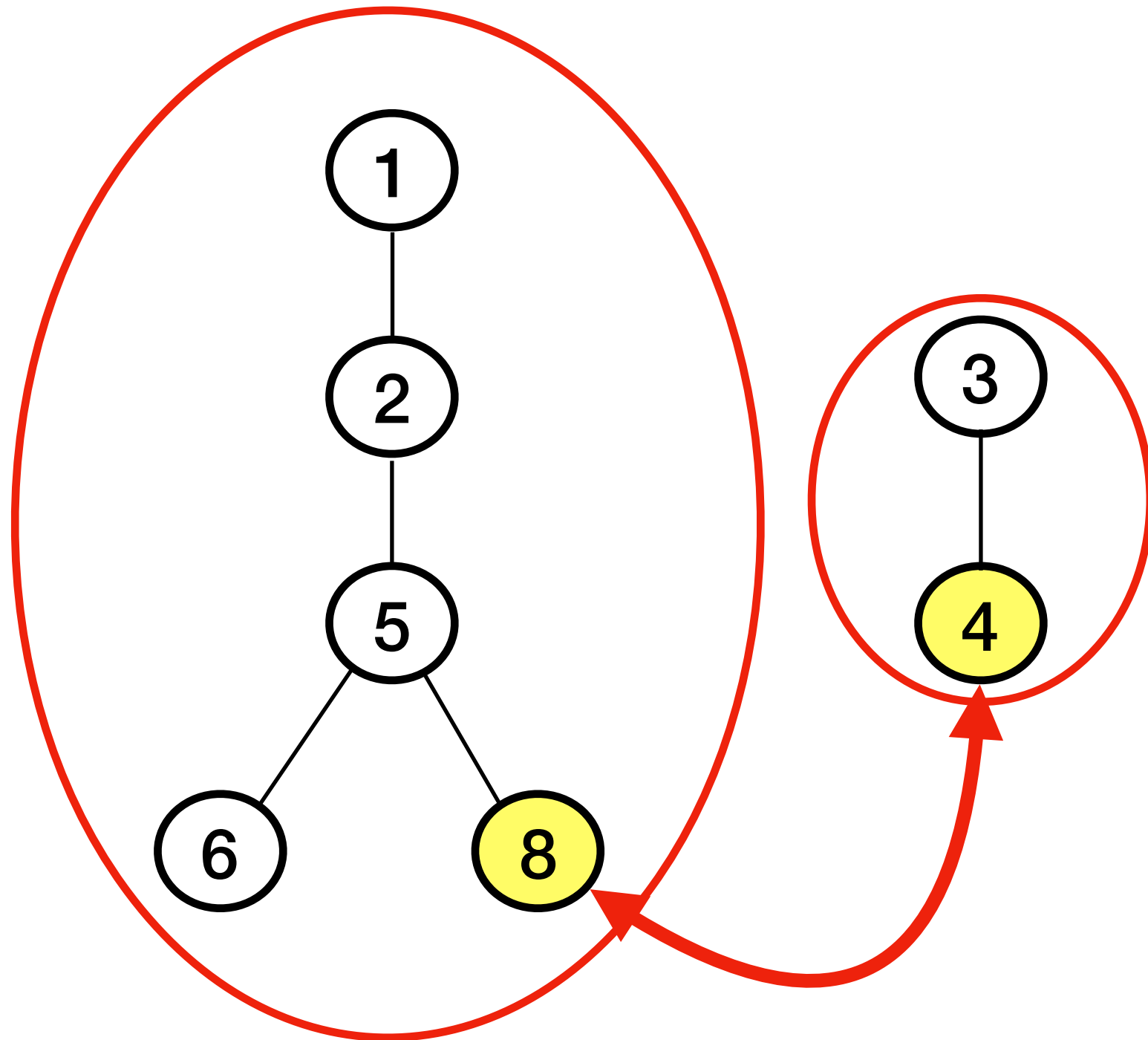
경로 압축 최적화



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$$O(\alpha(n)) \approx O(\log n)$$

세 번째 방법



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