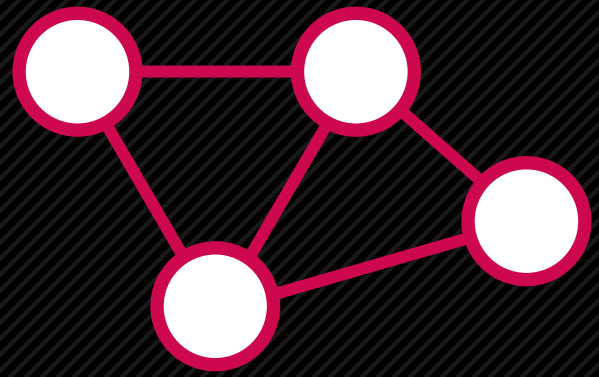
알고리즘 특강
그래프 탐색

코테 단골손님 중 하나인 그래프입니다.
DFS/BFS는 정말 능숙하게 사용할 줄 알아야 합니다!

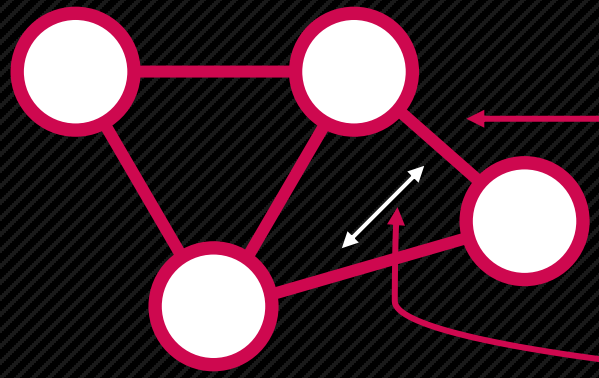
그래프



Graph

- 노드와 그 노드를 잇는 간선을 하나로 모아 놓은 자료구조.

용어 설명

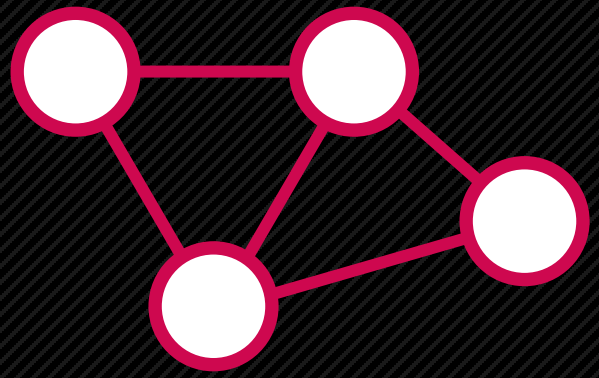


간선 (Edge)
노드와의 관계를 표현.

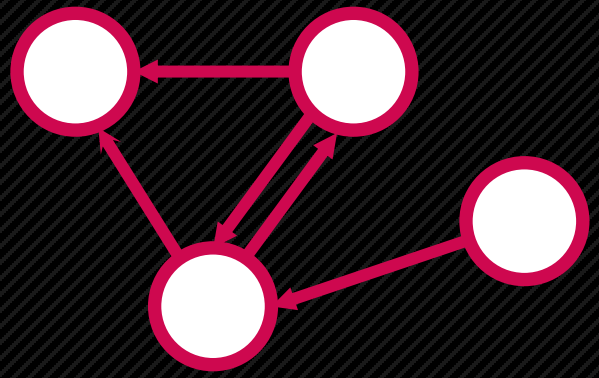
정점 (Vertex, Node)
데이터가 담기는 지점.

차수 (Degree)
하나의 정점에 인접한 정점의 수

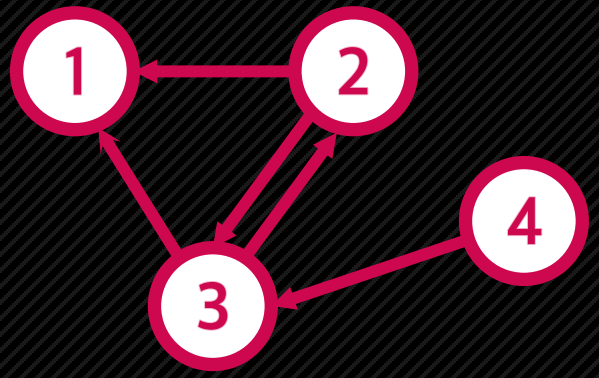
무방향/방향



- **무방향 그래프**
  간선의 방향이 없음.



- **방향 그래프**
  간선에 특정한 방향이 있음.

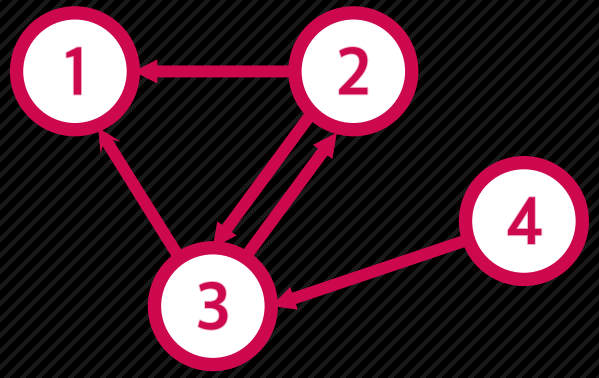


	1	2	3	4
1	0	0	0	0
2	1	0	1	0
3	1	1	0	0
4	0	0	1	0

Adjust Array

- N * N 크기의 2차원 배열을 생성해서 연결 상태를 나타내는 방법.
- 특정 노드 N_i와 N_j가 연결되어 있는지 확인: O(1)
- 특정 노드와 연결되어 있는 모든 노드를 확인: O(N)
- 공간 복잡도: O(N * N)

구현

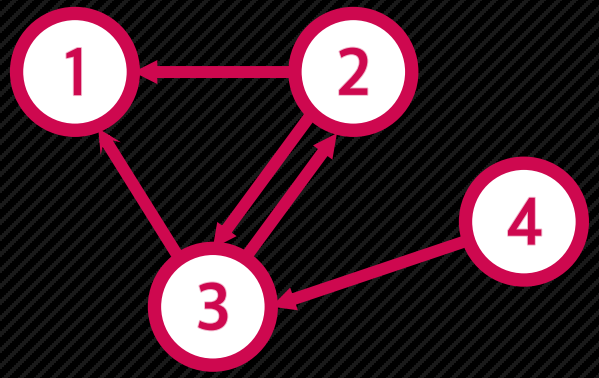


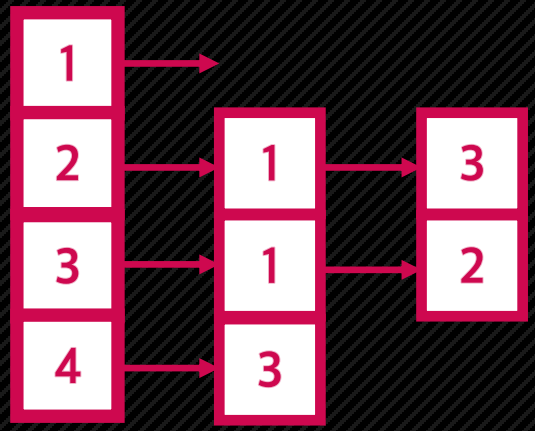

```cpp
#include <iostream>
using namespace std;

int main() {
    int graph[5][5];

    graph[2][1] = 1;
    graph[2][3] = 1;
    graph[3][1] = 1;
    graph[3][2] = 1;
    graph[4][3] = 1;
}
```

구현

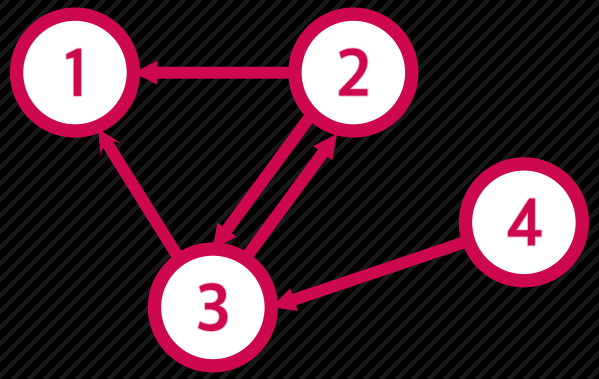




Adjust List

- N개의 **리스트**를 생성해서 연결 상태를 나타내는 방법.
- 특정 노드 N_i와 N_j가 **연결되어 있는지** 확인: $O(\min(Degree(N_i), Degree(N_j))$
- 특정 노드와 연결되어 있는 **모든 노드를 확인**: $O(Degree(N_i))$
- 공간 복잡도: $O(M)$

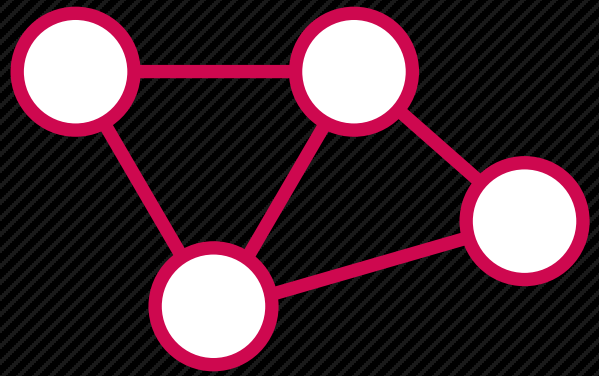
구현

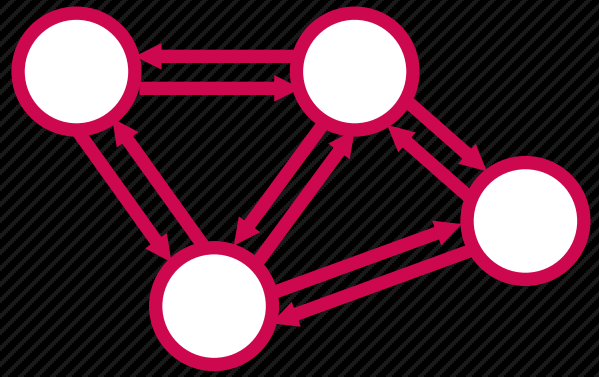



```cpp
#include <iostream>
#include <vector>
using namespace std;

int main() {
    vector<int> graph[5];
    graph[2].push_back(1);
    graph[2].push_back(3);
    graph[3].push_back(1);
    graph[3].push_back(2);
    graph[4].push_back(3);
}
```

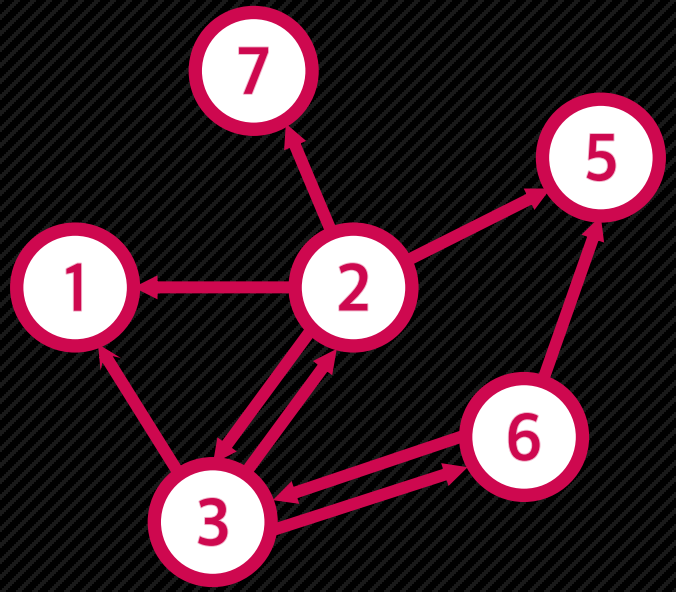
구현에서의 무방향과 방향





- 결국, 무방향 그래프는 모든 간선이 왕복간선 → 양방향을 다 만들어주면 된다!

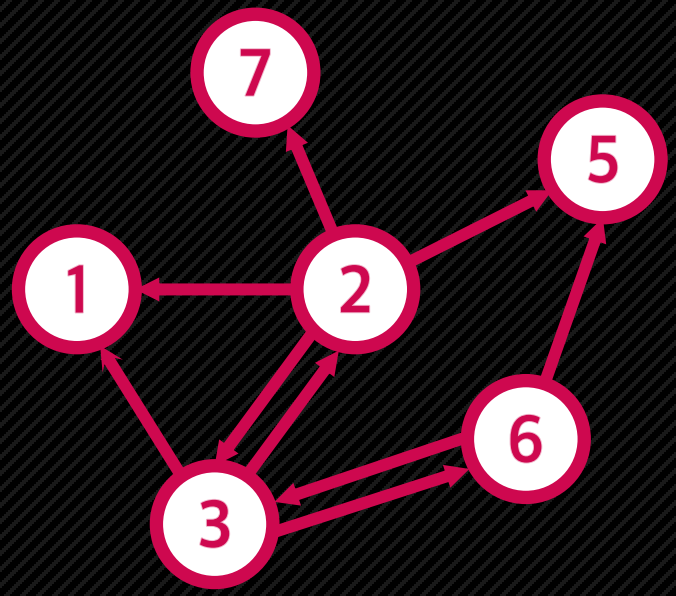
그래프 탐색



Graph Traversal

- 그래프의 모든 노드를 탐색하기 위해 간선을 따라 순회하는 것.
- 탐색 방법에 따라 BFS (Breadth First Search), DFS (Depth First Search)로 나뉜다.
- 그래프의 다양한 응용문제는 탐색을 기반으로 이뤄짐!

그래프 탐색



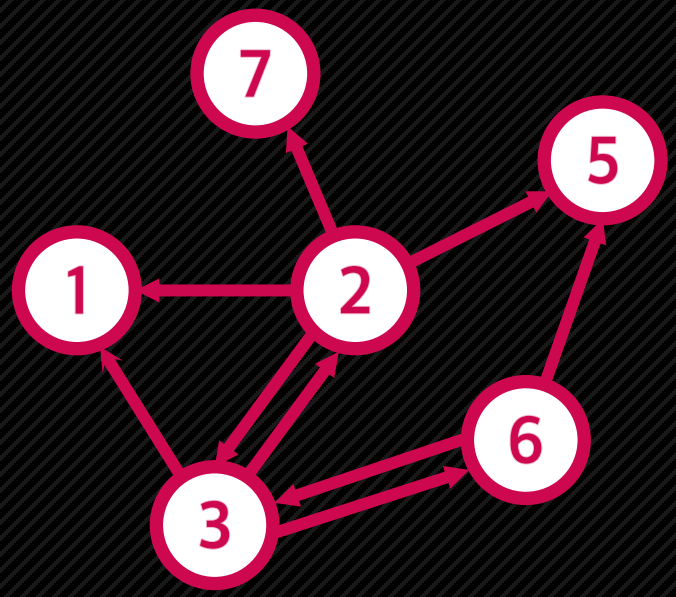
Breadth First Search

- 너비 우선 탐색이라고도 하며, 자신의 자식들부터 순차적으로 탐색.
- 순차 탐색 이후 다른 자식 노드의 자식을 확인하기 위해 큐를 사용.

Depth First Search

- 깊이 우선 탐색이라고도 하며, 최대한 깊게 탐색 후 빠져 나옴.
- 백트래킹의 일종이며, 재귀를 활용함.

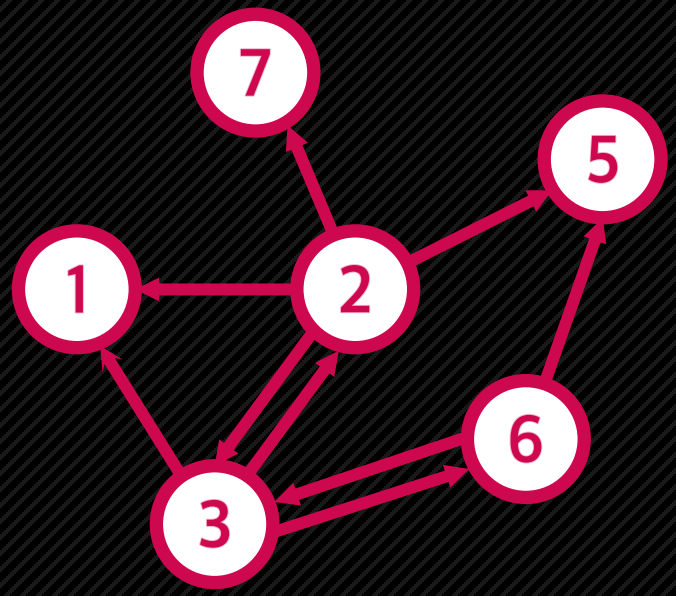
그래프 탐색




```
function bfs(pos) {
    set Q = Queue
    pos -> Q
    while Q is not empty
        set node = popped element of Q
        for children of pos
            if each child has not been visited
                visit child
                child -> Q
}

function dfs(pos) {
    visit pos
    for children of pos
        if each child has not been visited
            dfs(pos)
}
```

BFS

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유의: 탐색을 꼭 1번부터 할 필요는 없습니다. 다만 일반적인 문제에선 특정 노드부터 방문할 것을 암시적으로 드러냅니다!

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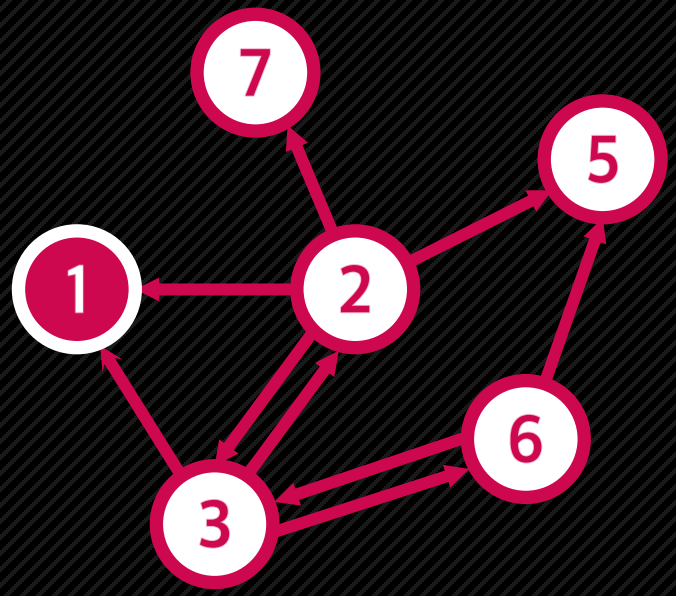


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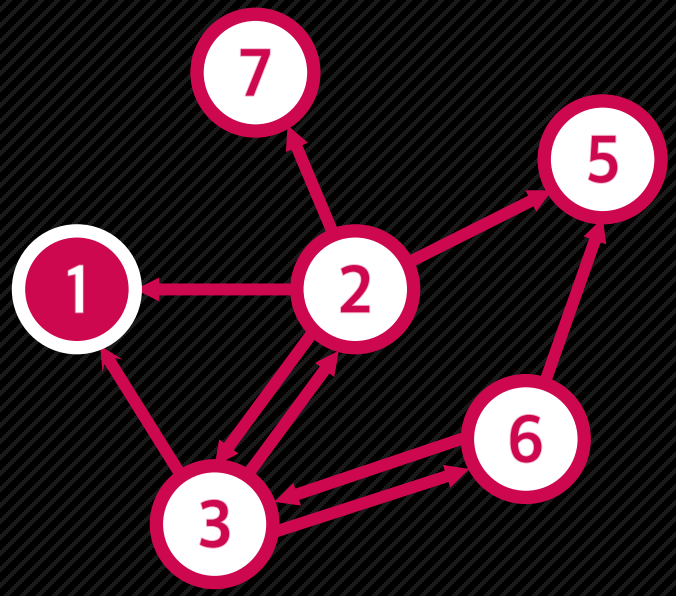


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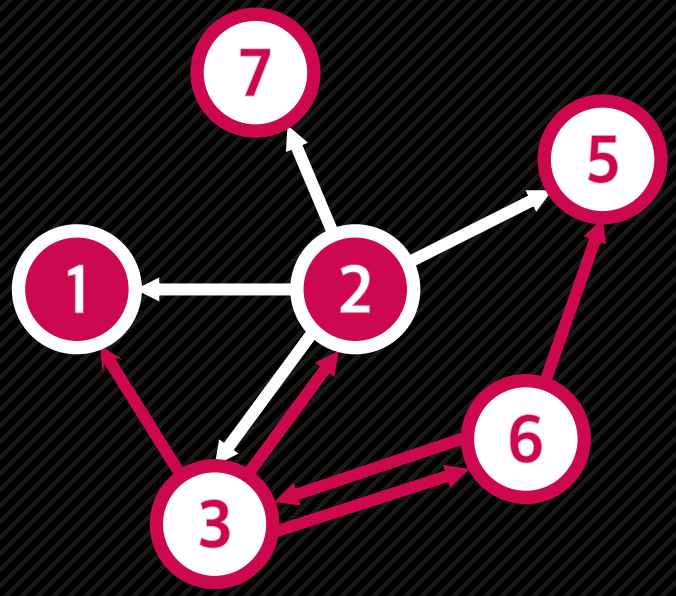


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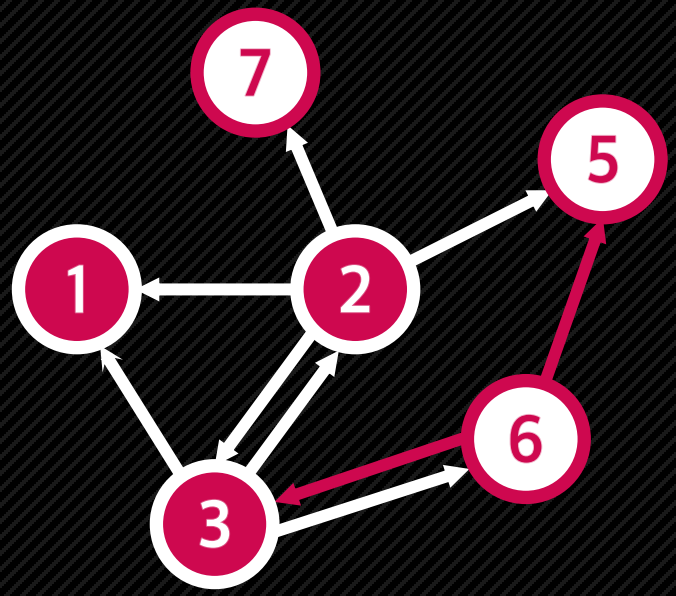


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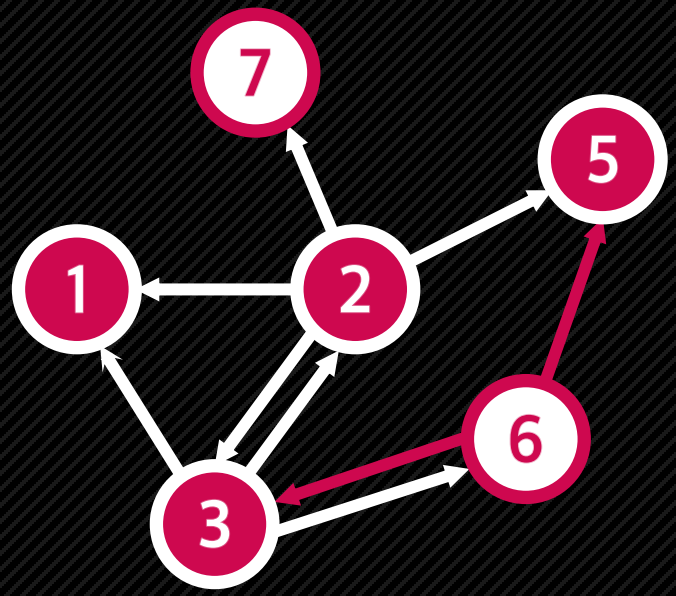


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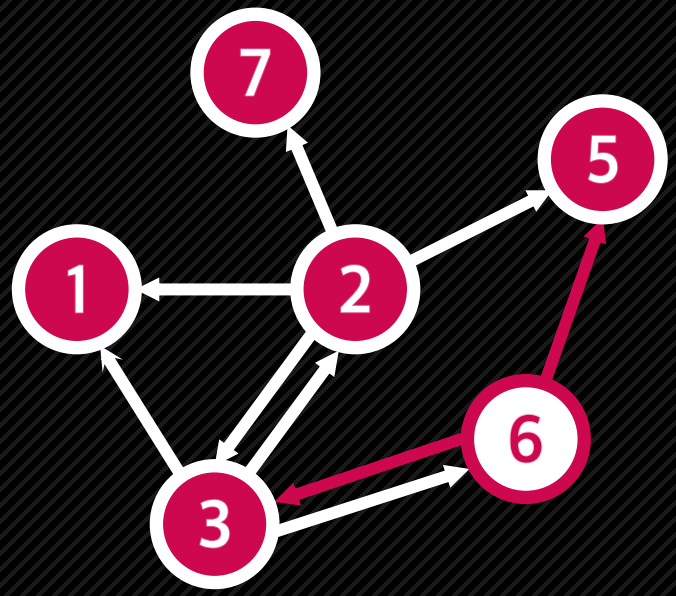


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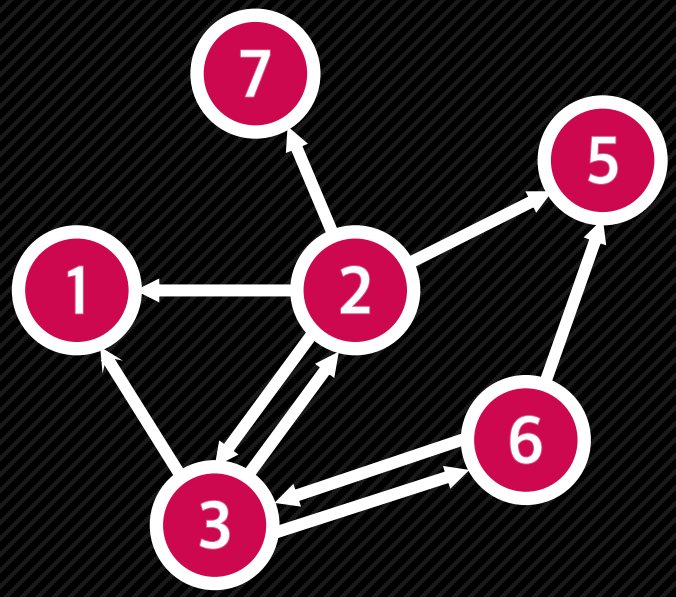


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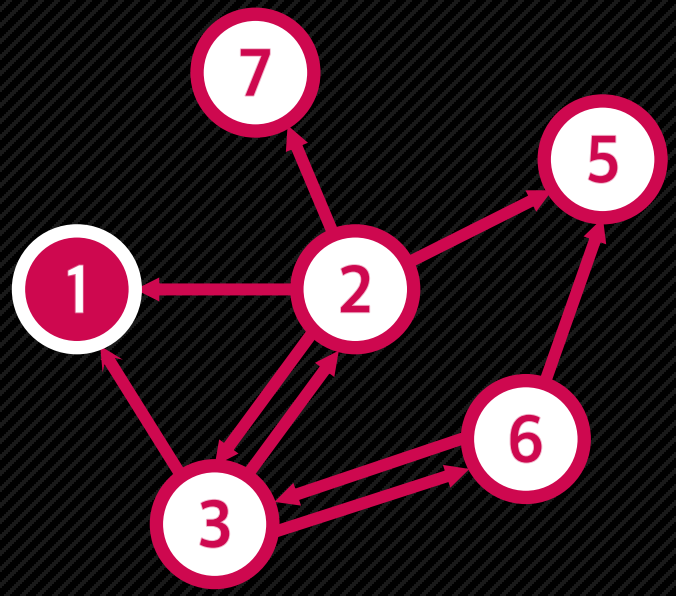
DFS

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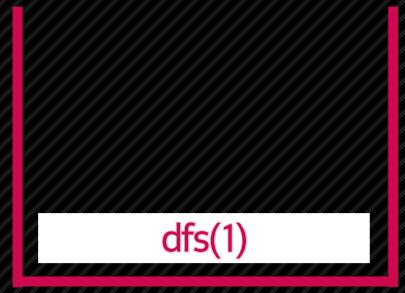

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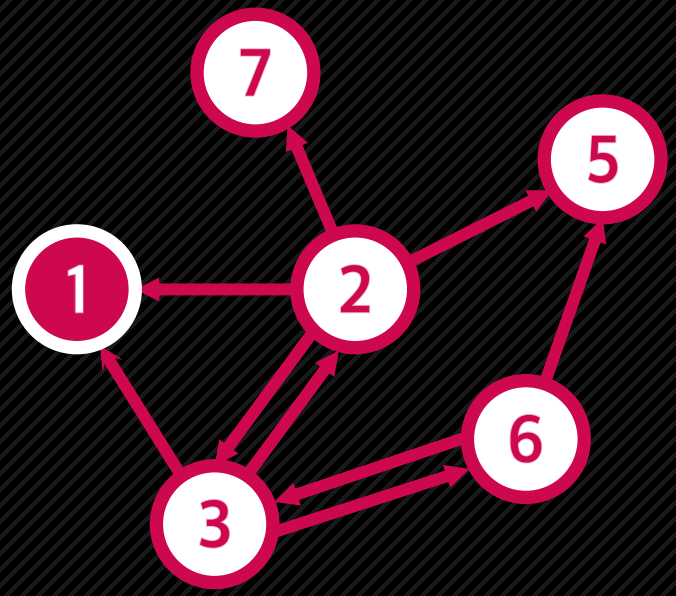
DFS

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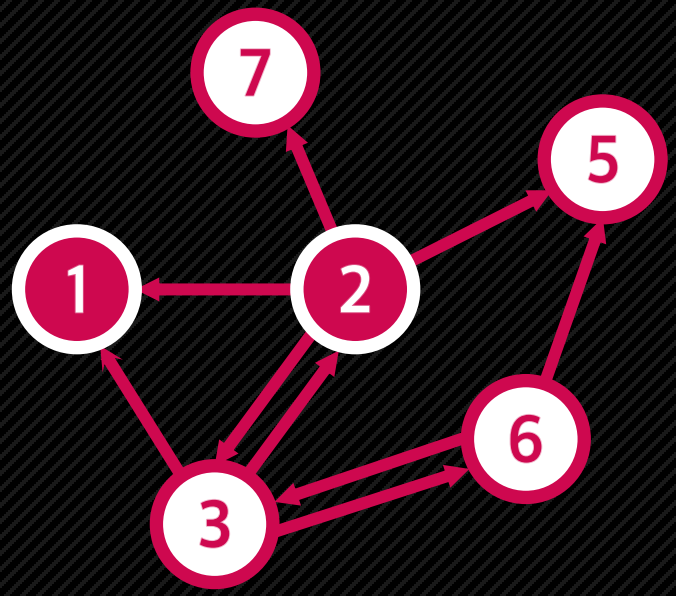


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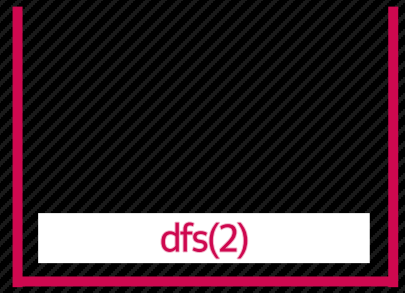

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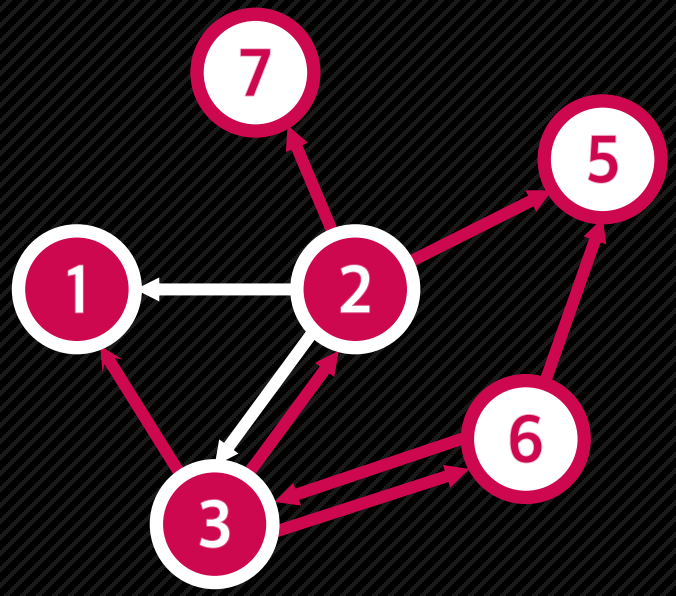


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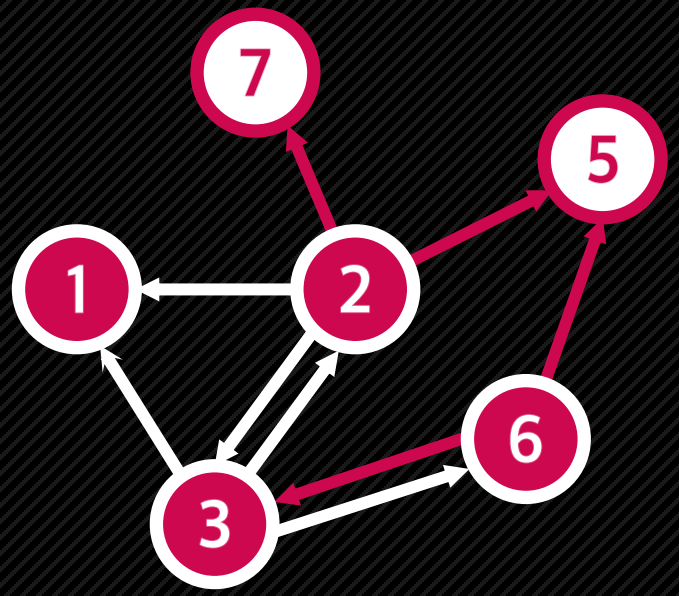


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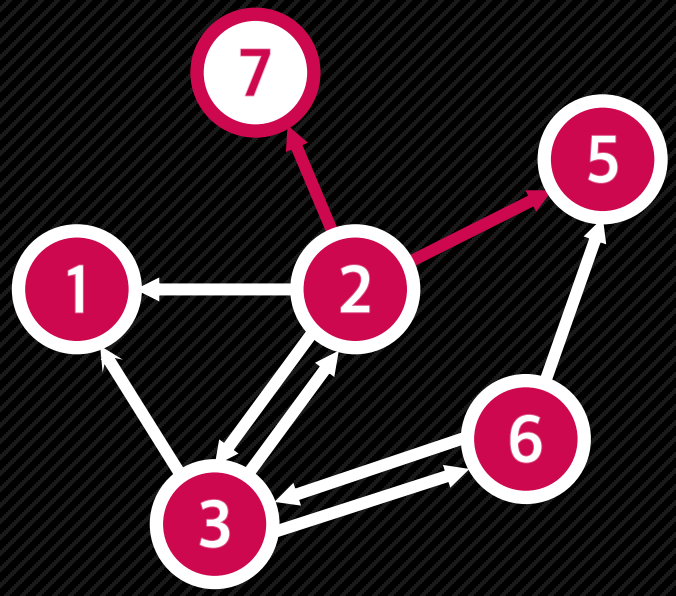


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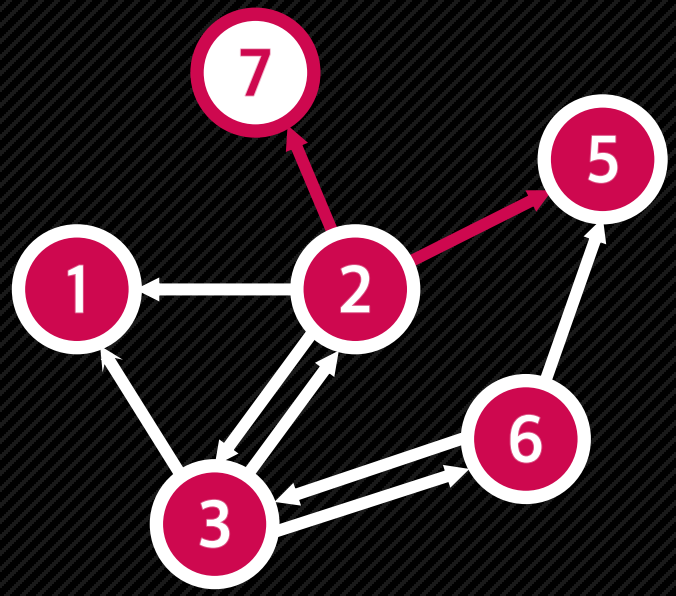


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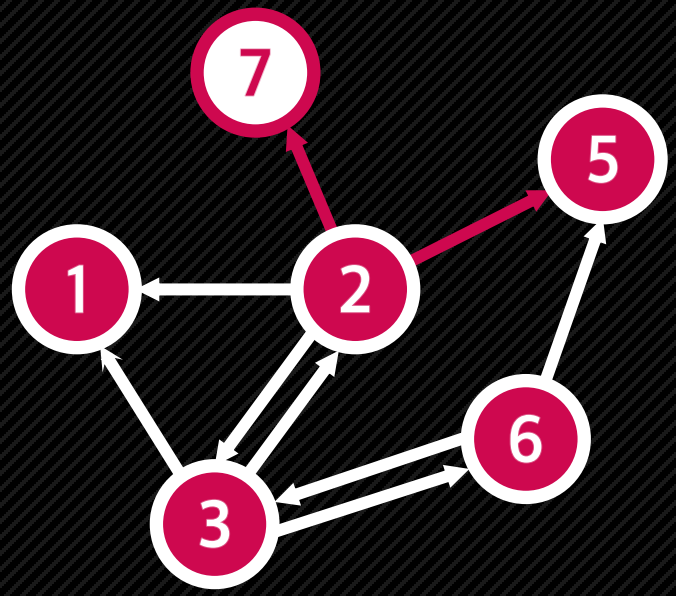


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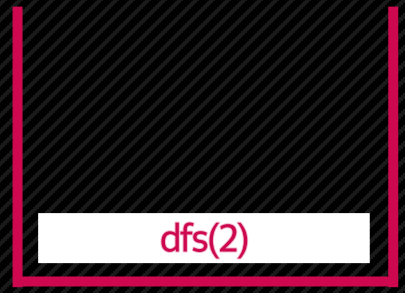
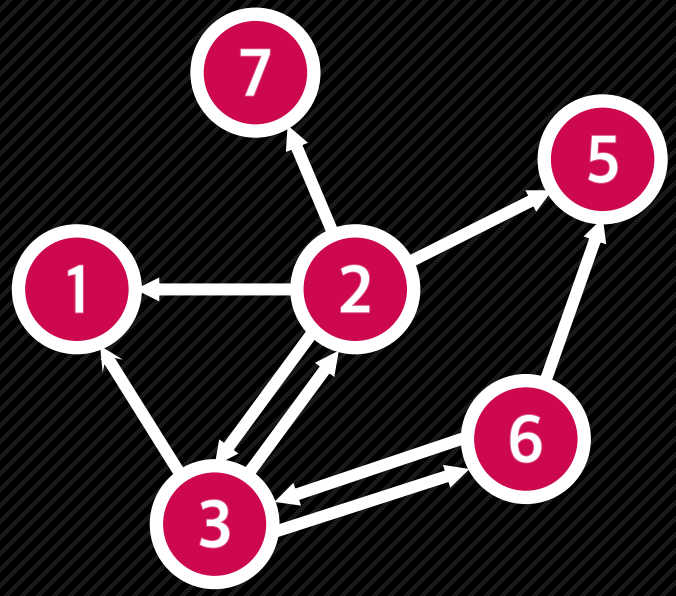


DFS

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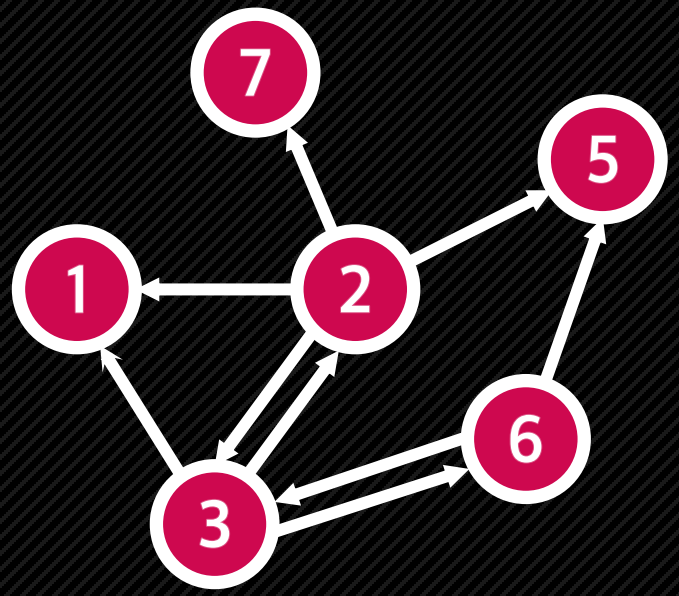
```

DFS




```
function dfs(pos) {
    visit pos
    for children of pos
        if each child has not been visited
            dfs(pos)
}
```

연습해보자!

Silver 2 - BFS와 DFS (#1260)

요약

- 그래프를 BFS와 DFS로 탐색한 결과를 출력하는 프로그램을 작성하시오.
- 단, 방문할 수 있는 정점이 여러 개 인 경우 번호가 작은 정점을 먼저 방문한다.

제약조건

- 정점의 수의 범위는 1 <= N <= 1,000 이다.
- 간선의 수의 범위는 1 <= M <= 10,000 이다.

“To be continue,,,”