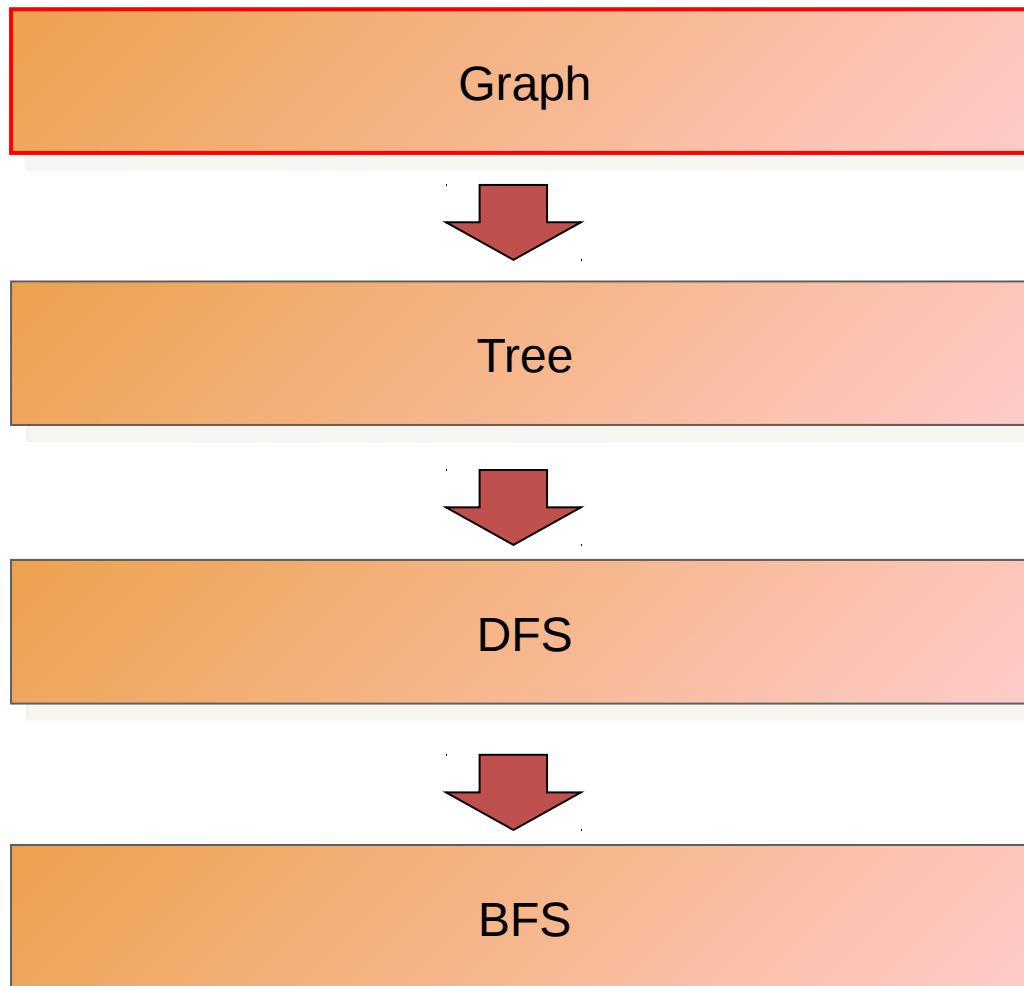

LAO CHON LAM
laochanlam@gmail.com

Department of Computer Science and Information Engineering
National Cheng Kung University
Tainan, Taiwan

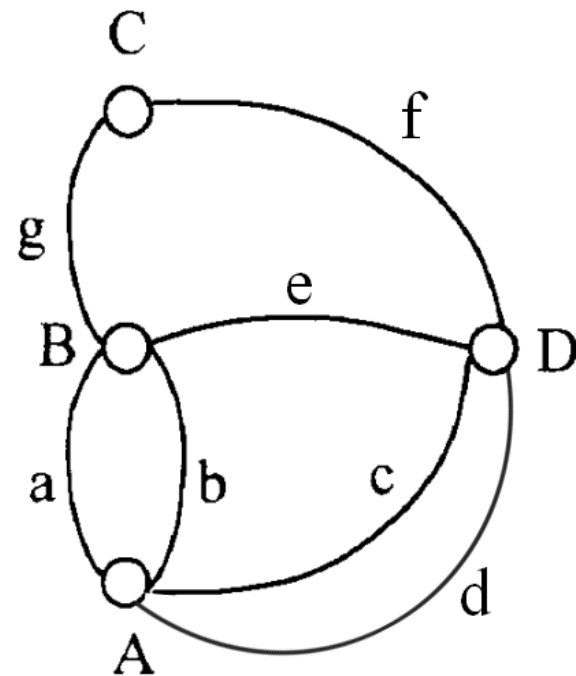


Outline



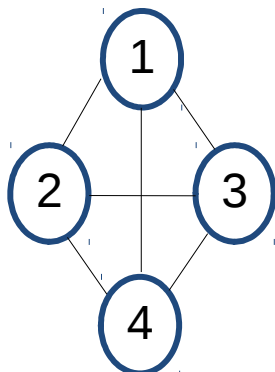
Graph

- Vertex (V)
 - A, D, B, D
- Edge (E)
 - BC, CD, ...
- degree (deg)
 - The Branch of a Vertex
- Path (P)
 - Non-duplicate Vertex Connected Sequence
 - ADCB
- Cycle (C)
 - A Cycle whose Two Ending Points are the same

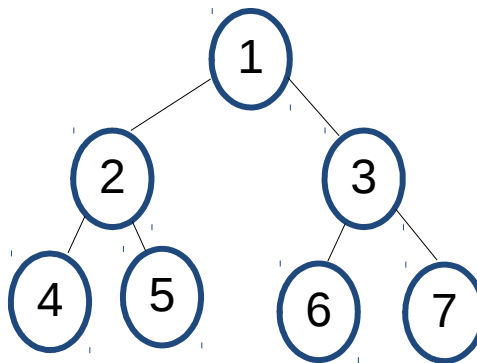


Graph

- Undirected Graph – G1, G2

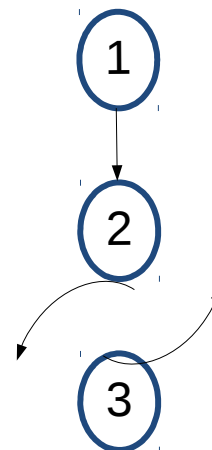


G1



G2

- Directed Graph – G3
 - deg: in-degree and out-degree

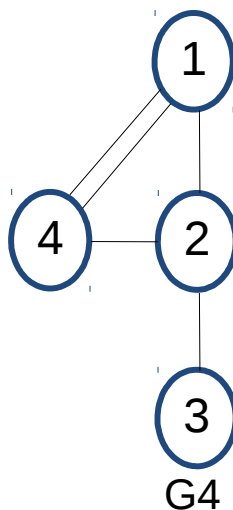


G3

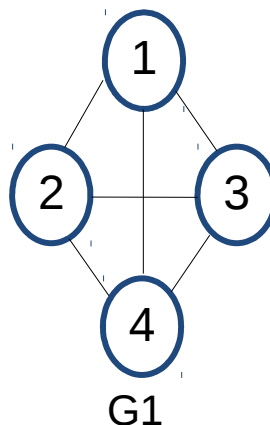


Graph

- Multiple Edge

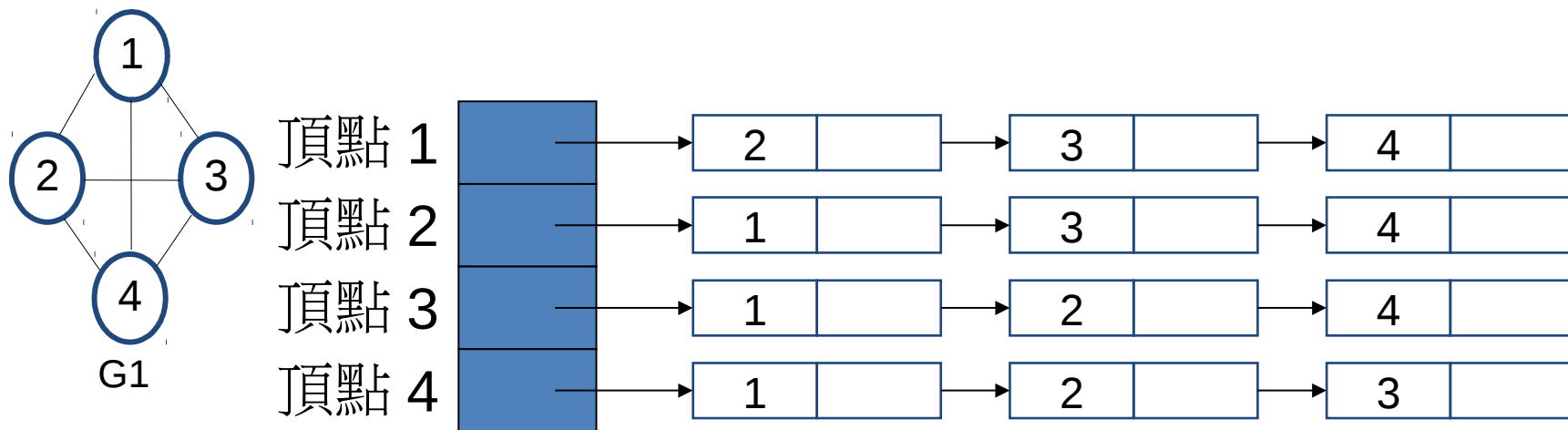


- Complete Graph



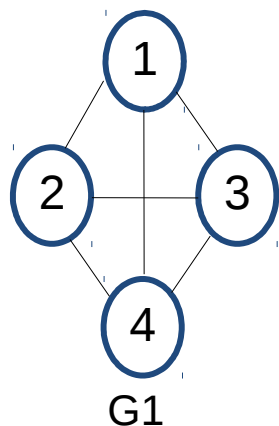
Graph

- Representation
 - adjacent list



Graph

- Representation
 - adjacent matrix



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



Outline

Graph



Tree



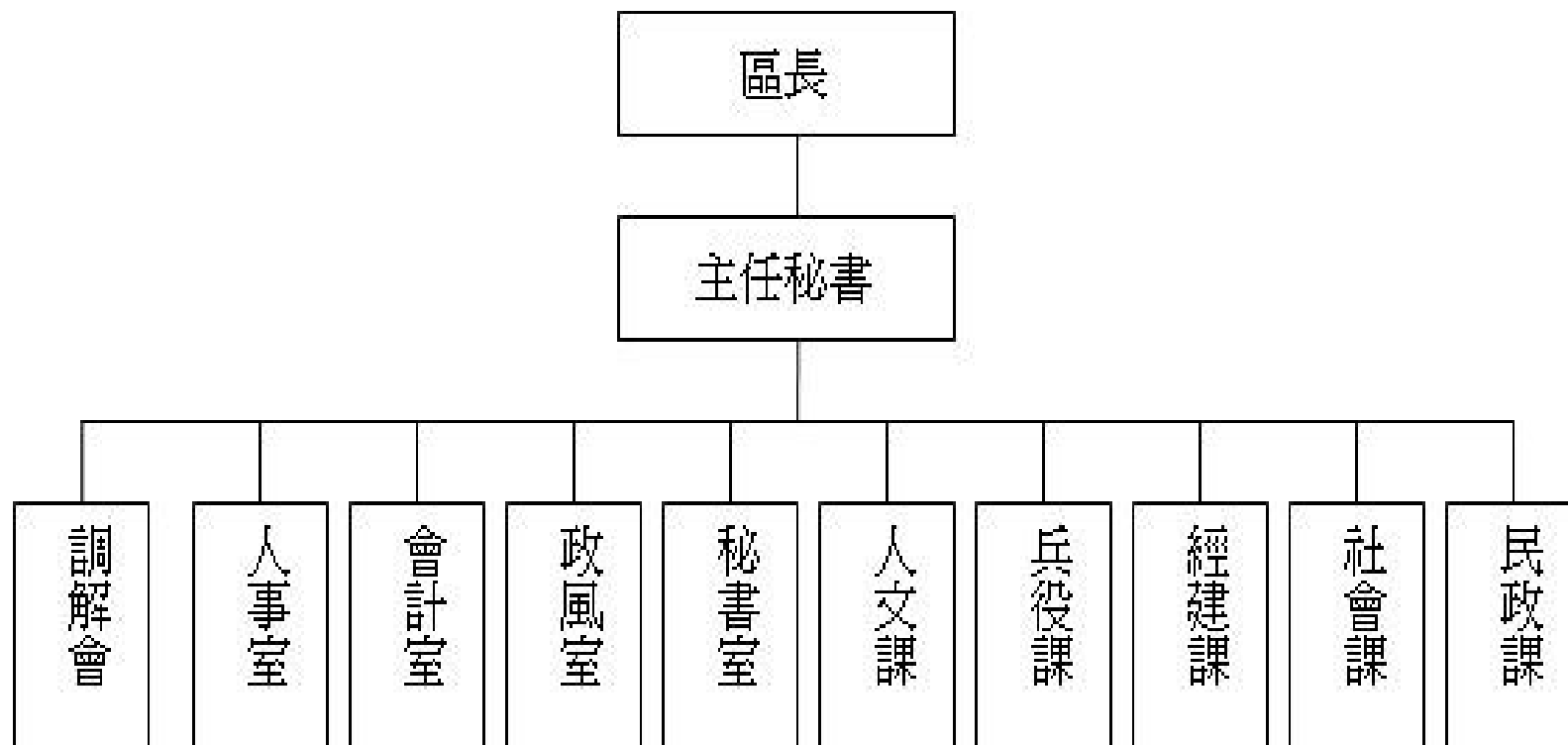
DFS



BFS

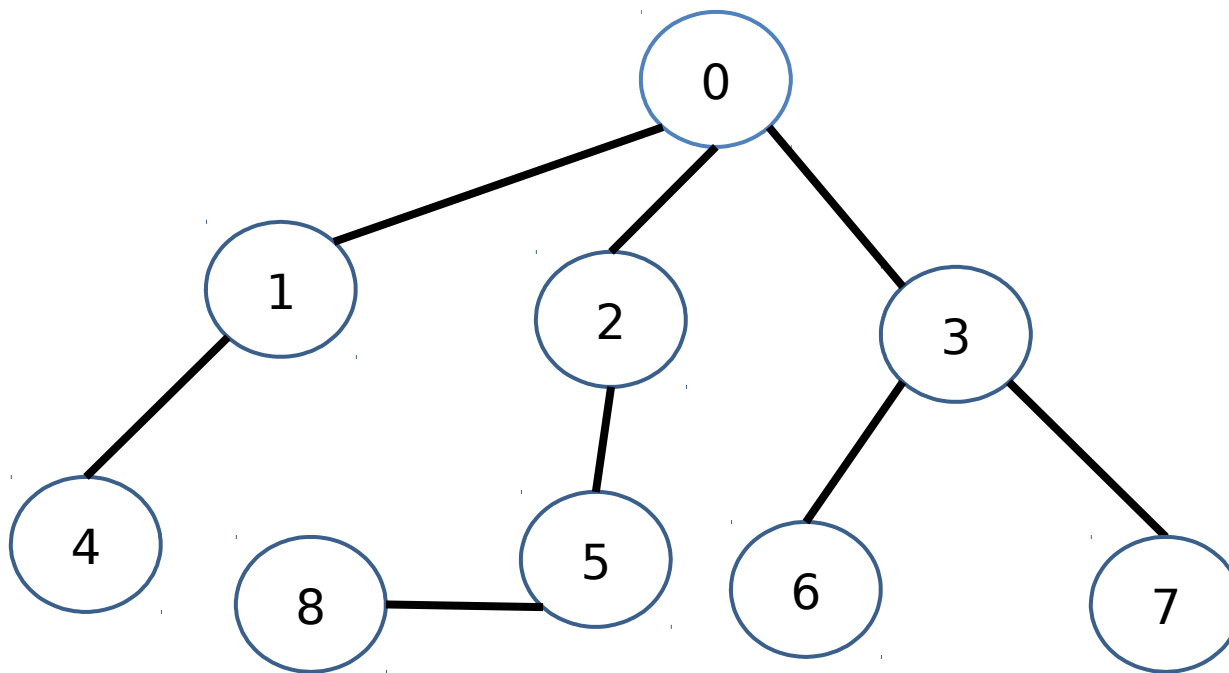






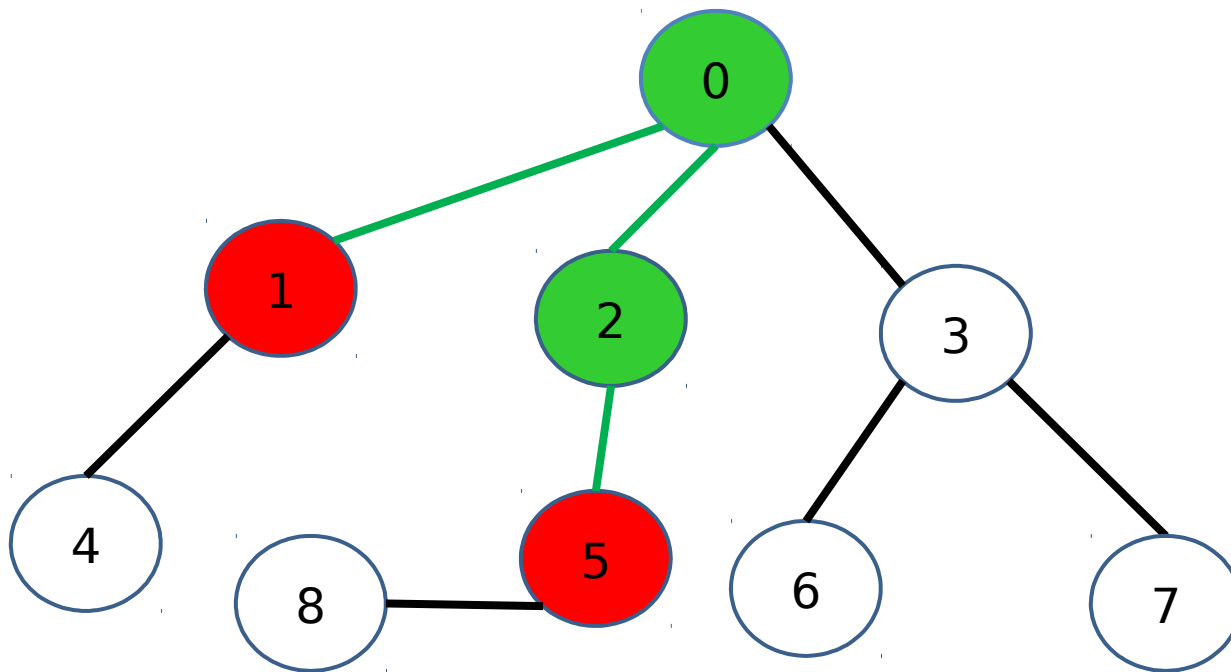
Tree

- A data structure consists of **nodes**. (at least two)



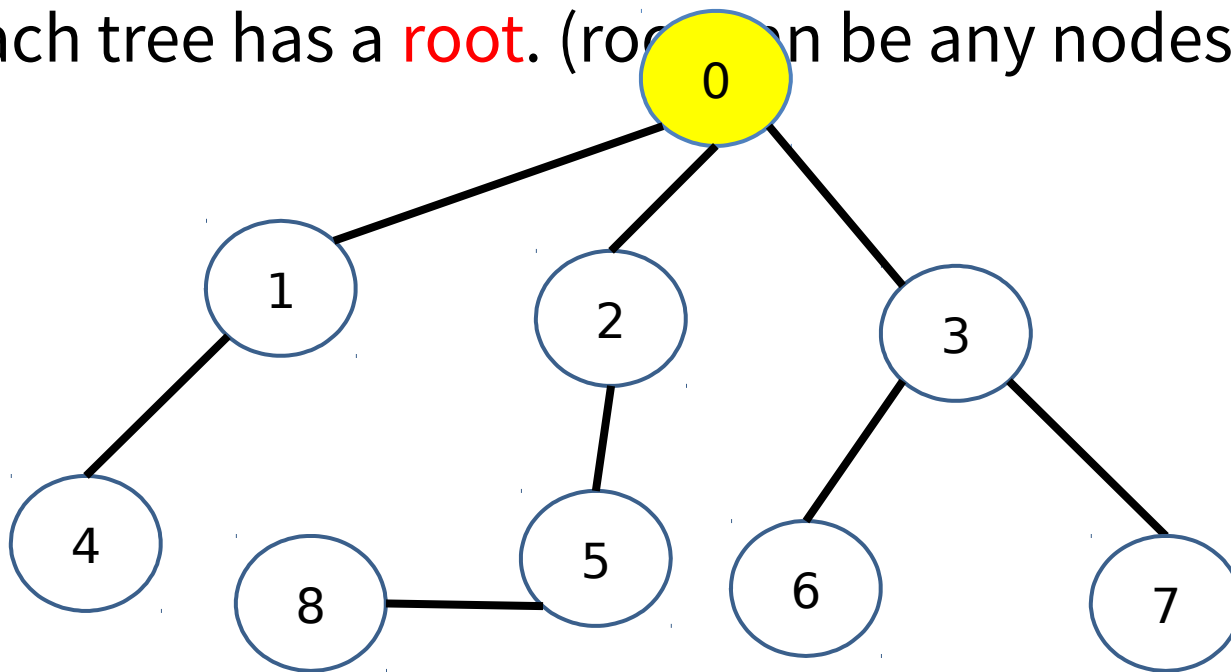
Tree

- A data structure consists of **nodes**. (at least two)
- Every pair of nodes must have **one and only one path**. (connected)



Tree

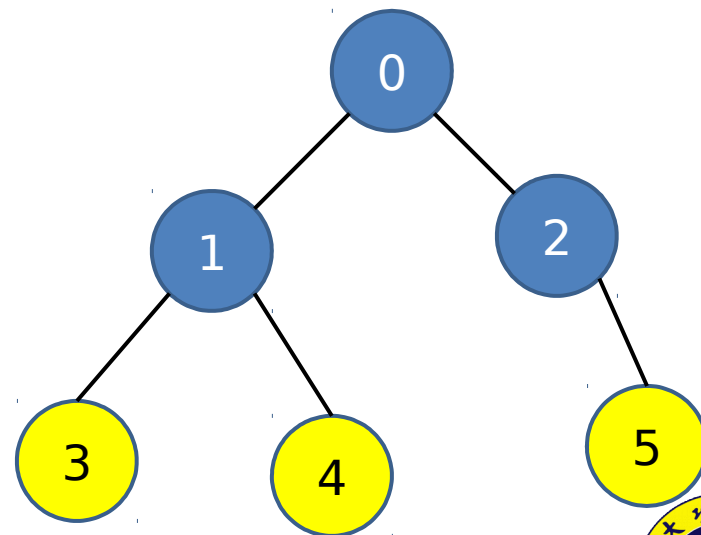
- A data structure consists of **nodes**. (at least two)
- Every pair of nodes must have **one and only one path**. (connected)
- Each tree has a **root**. (root can be any nodes)



Tree

Relations: (using node 0 as root)

-**Leaf**: nodes with no branch. (3,4,5)

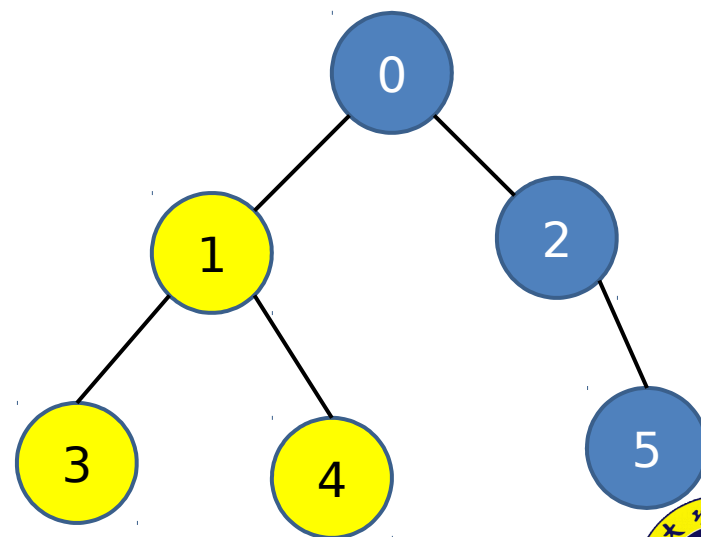


Tree

Relations: (using node 0 as root)

-**Leaf**: nodes with no branch.

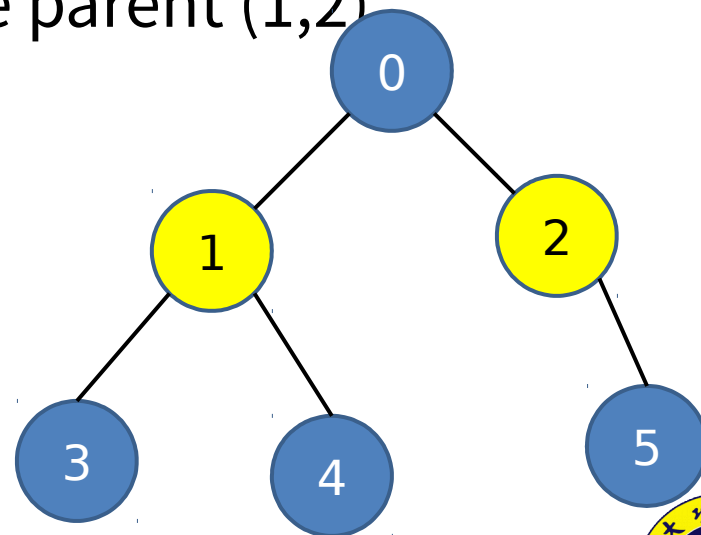
-**Parent/Children**: has successor nodes –Parent (1)
has predecessor node-children (3,4)



Tree

Relations: (using node 0 as root)

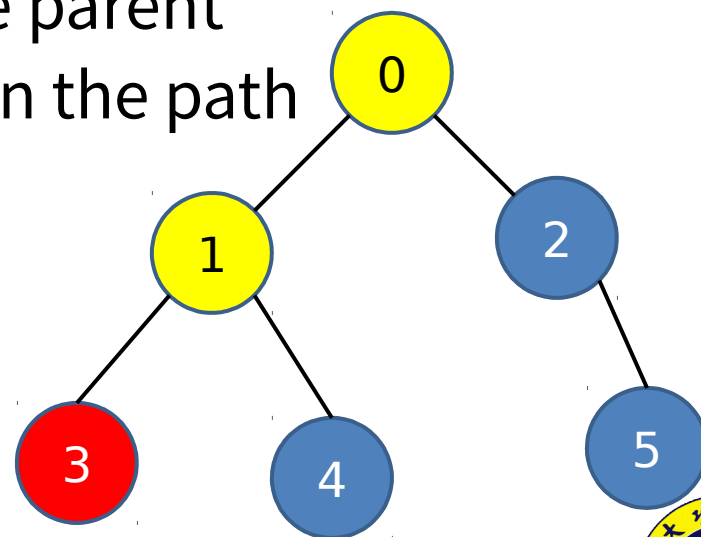
- Leaf**: nodes with no branch.
- Parent/Children**: has successor nodes -Parent
has predecessor node-children
- Sibling**: children with same parent (1,2)



Tree

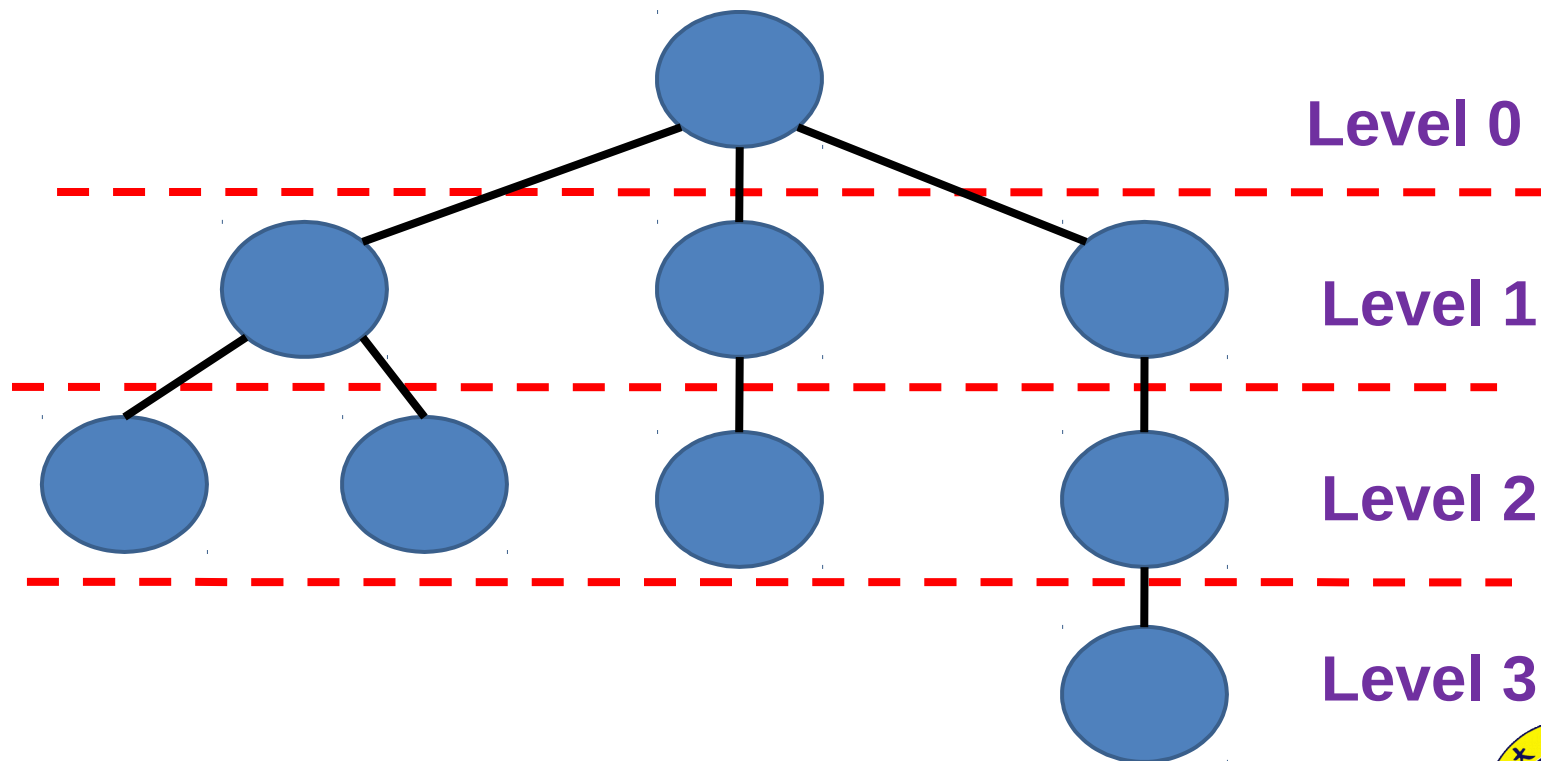
Relations: (using node 0 as root)

- Leaf**: nodes with no branch.
- Parent/Children**: has successor nodes -Parent
has predecessor node-children
- Sibling**: children with same parent
- Ancestor**: nodes that are on the path
from root to itself.
(3' s ancestor: 0,1)



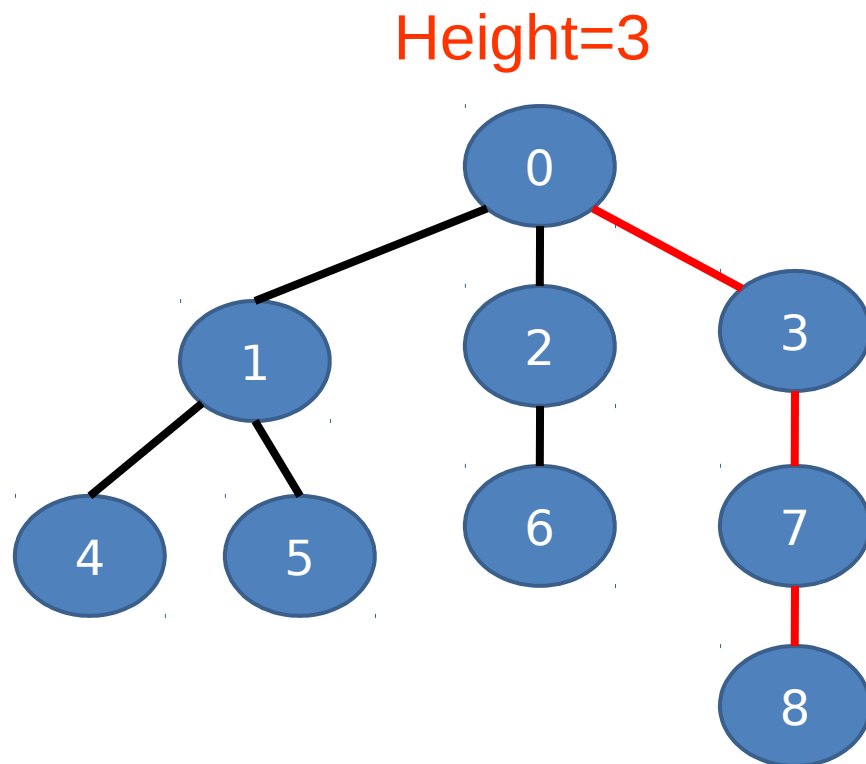
Tree

- **Tree Level:** according to the distance to the root.



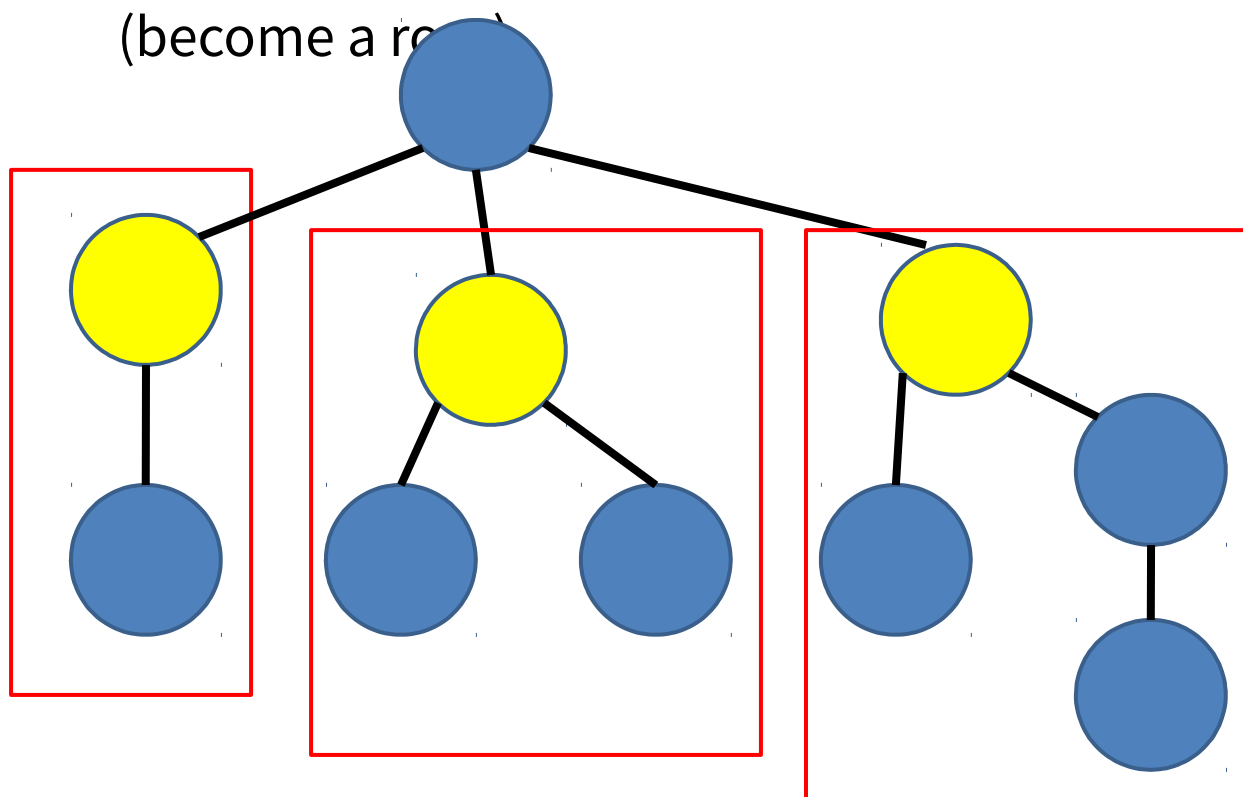
Tree

- **Tree Height(Depth):** the maximum distance from the root.



Tree

- **SubTree:** nodes that are not the root can form a subtree



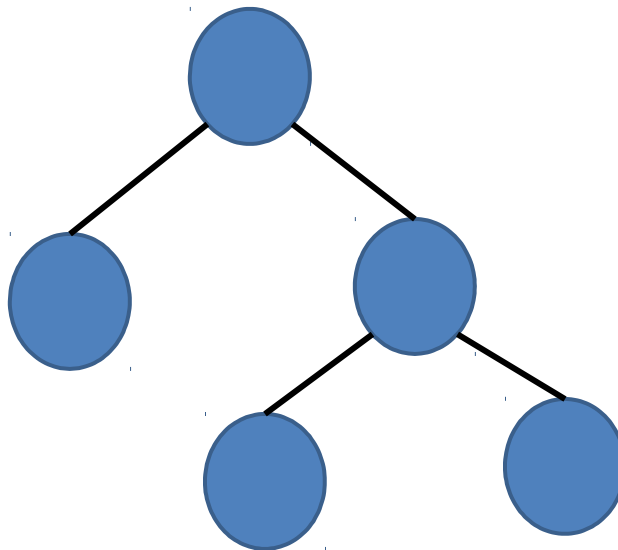
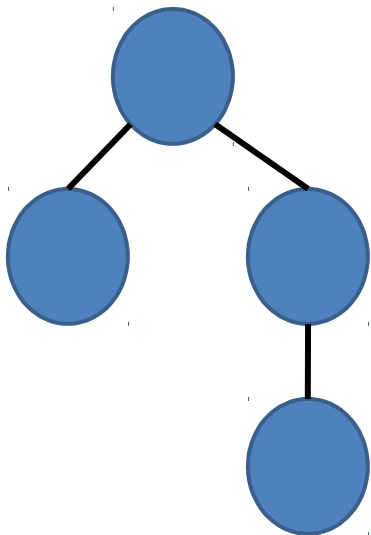
Tree

- **Feature:**
 - no cycle
 - every pair of nodes are connected
 - every pair of nodes has only one path

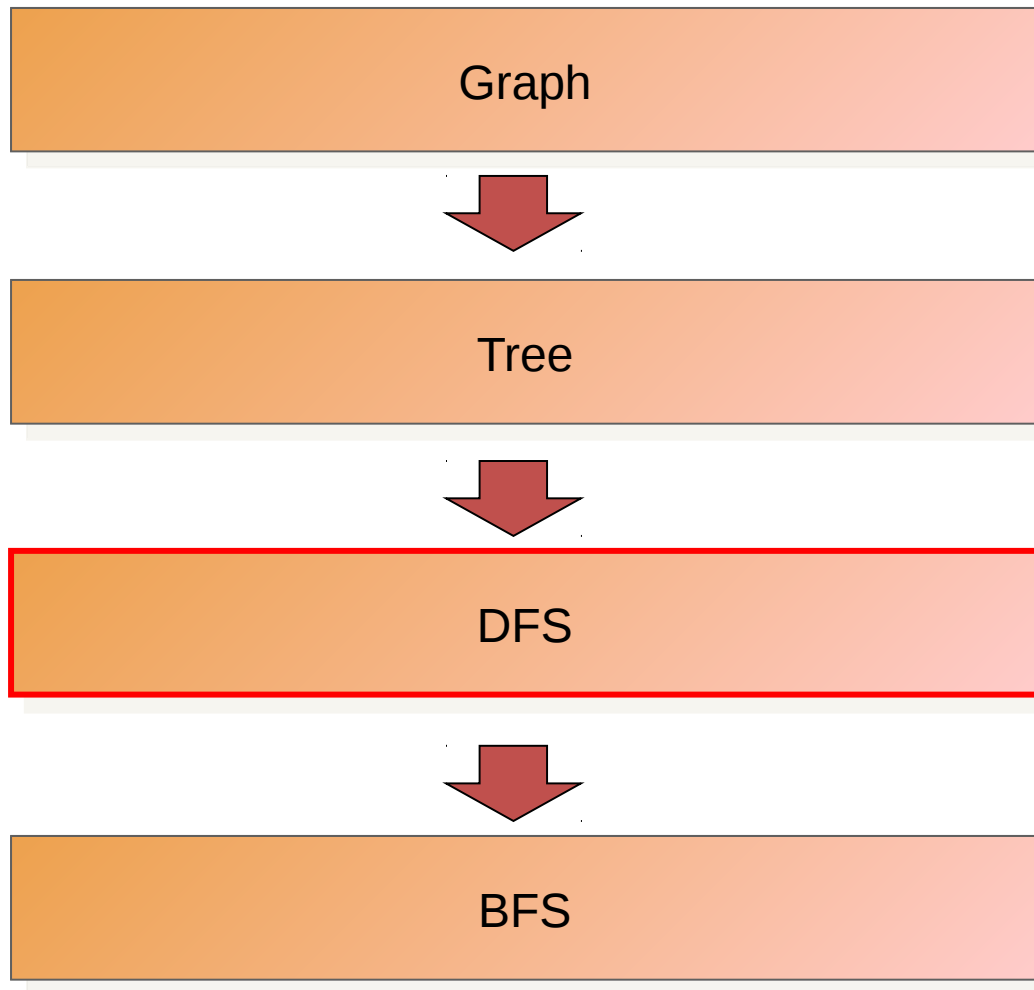


Tree

- **Forest:** n trees are disjoint ($n \geq 0$)
 ☒ can be empty



Outline



DFS

(D)epth-(F)irst-(S)earch



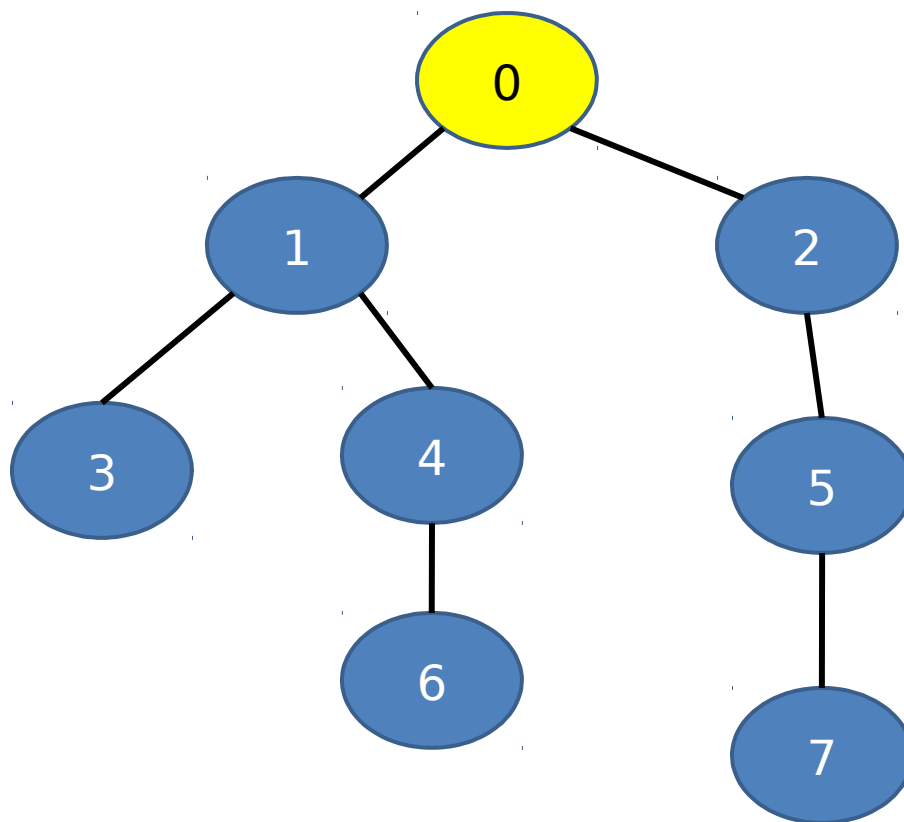
DFS

(D)epth (F)irst (S)earch

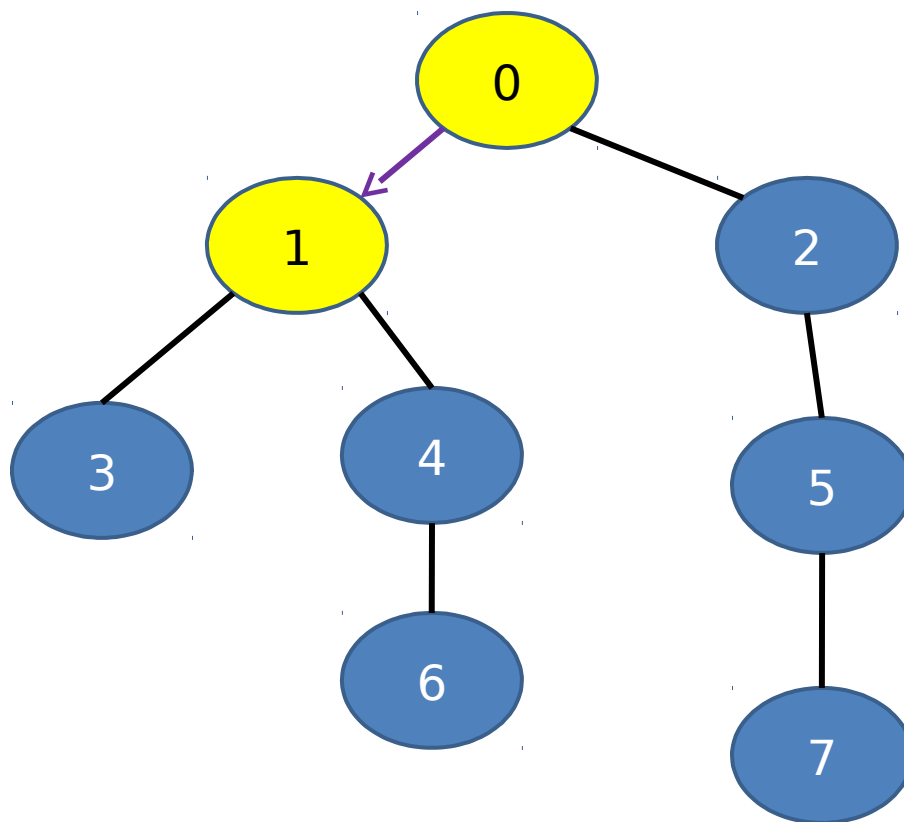
Stack



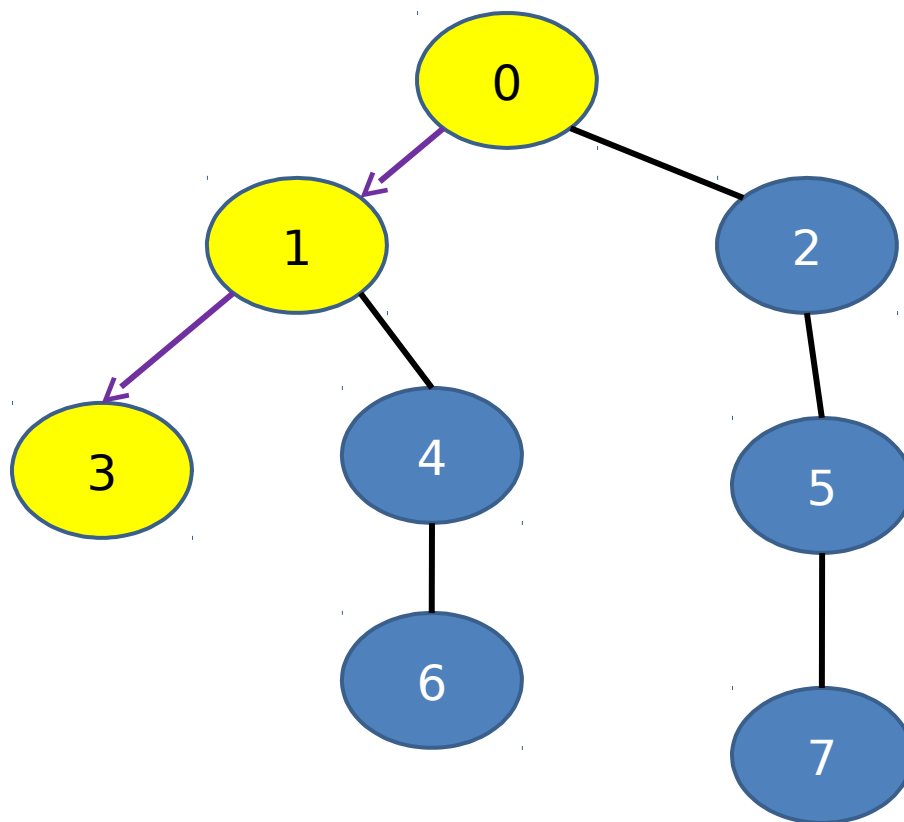
DFS



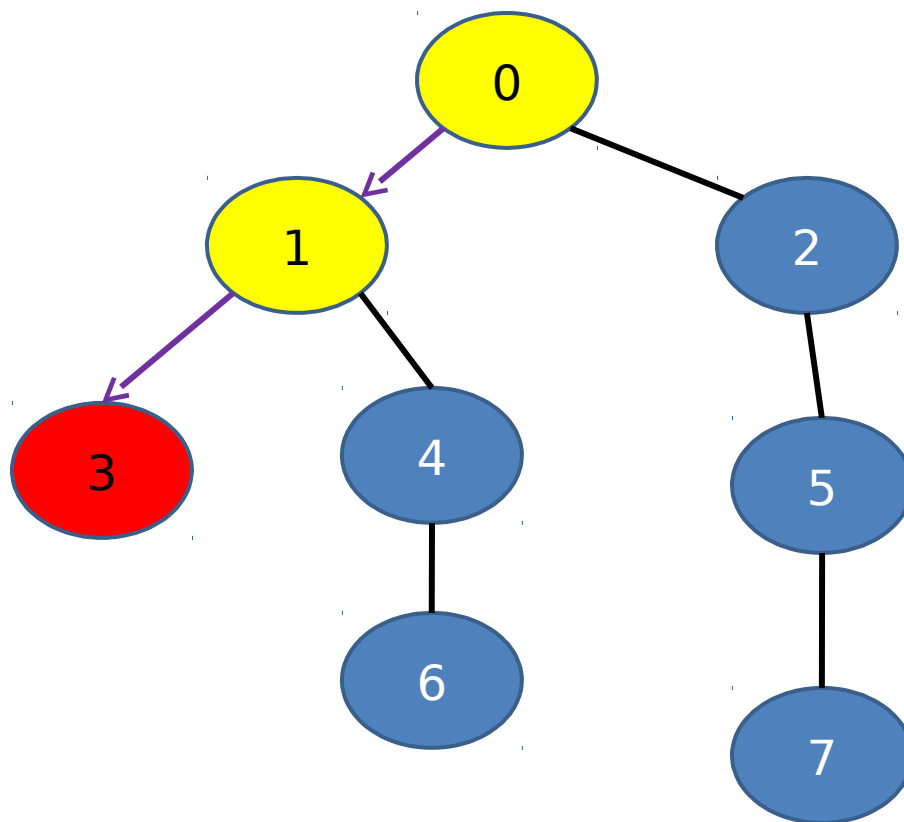
DFS



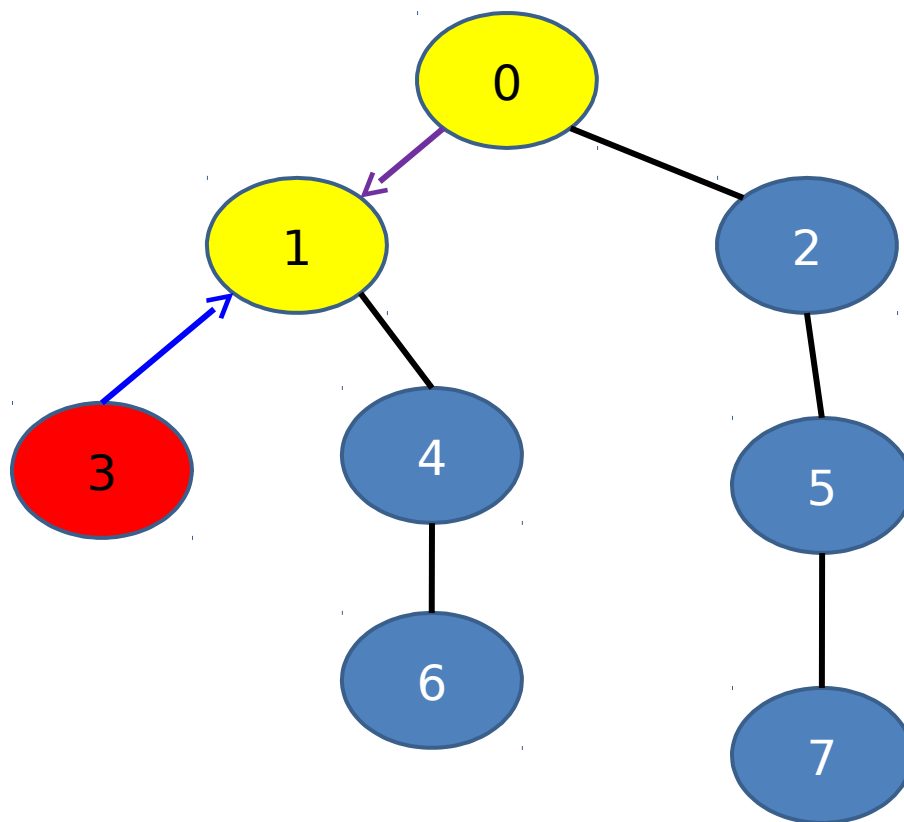
DFS



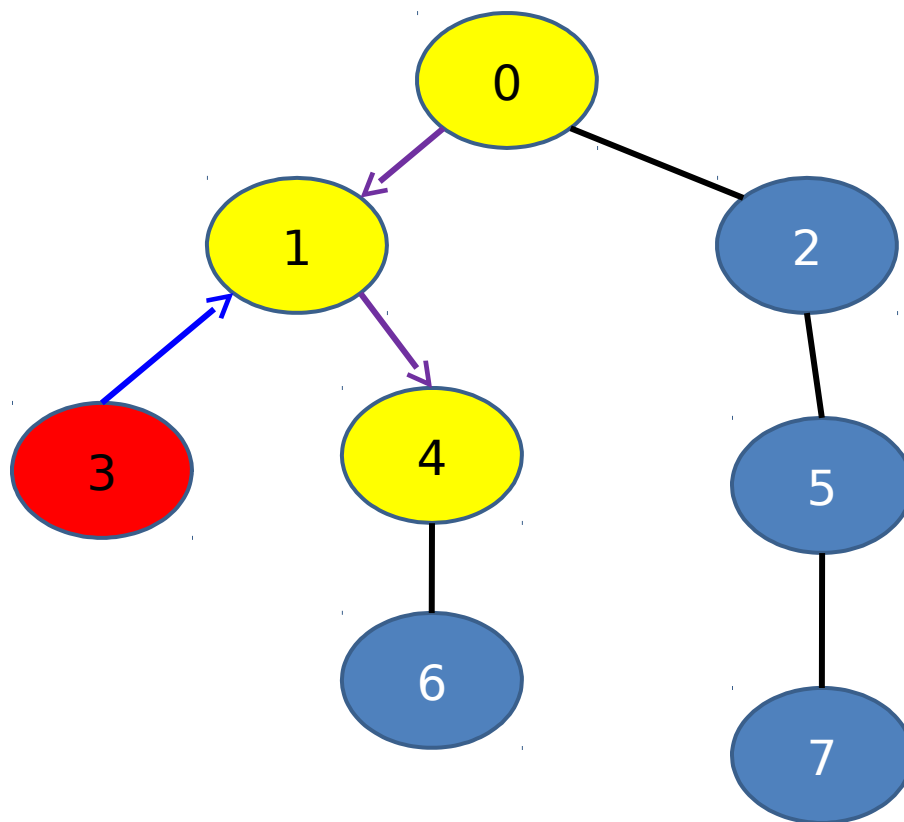
DFS



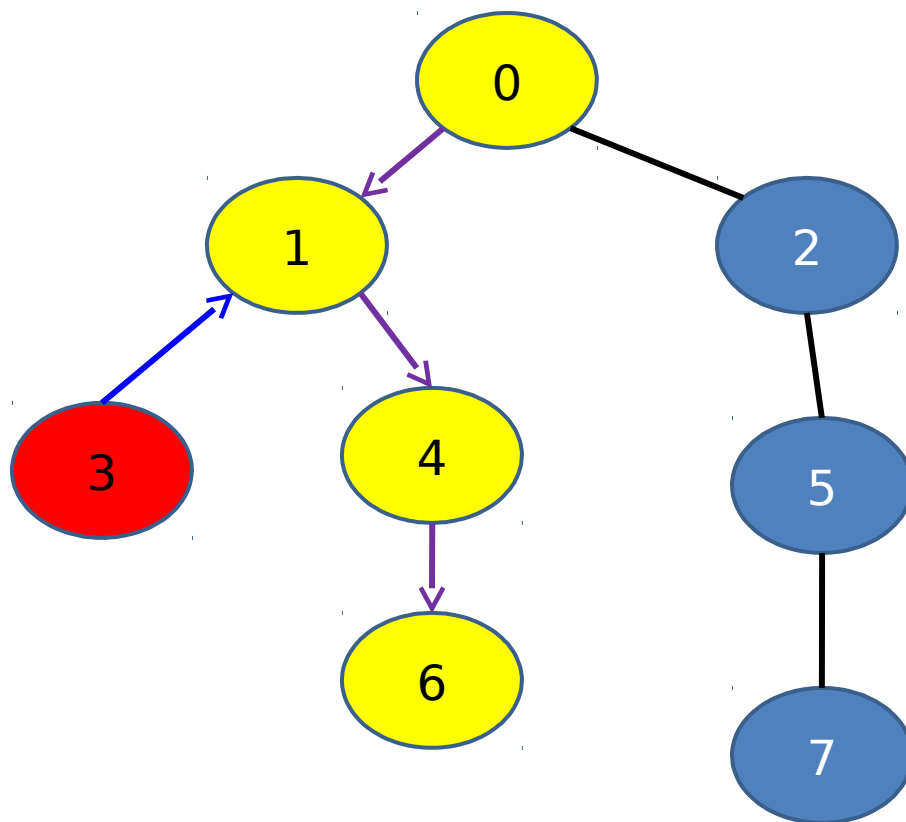
DFS



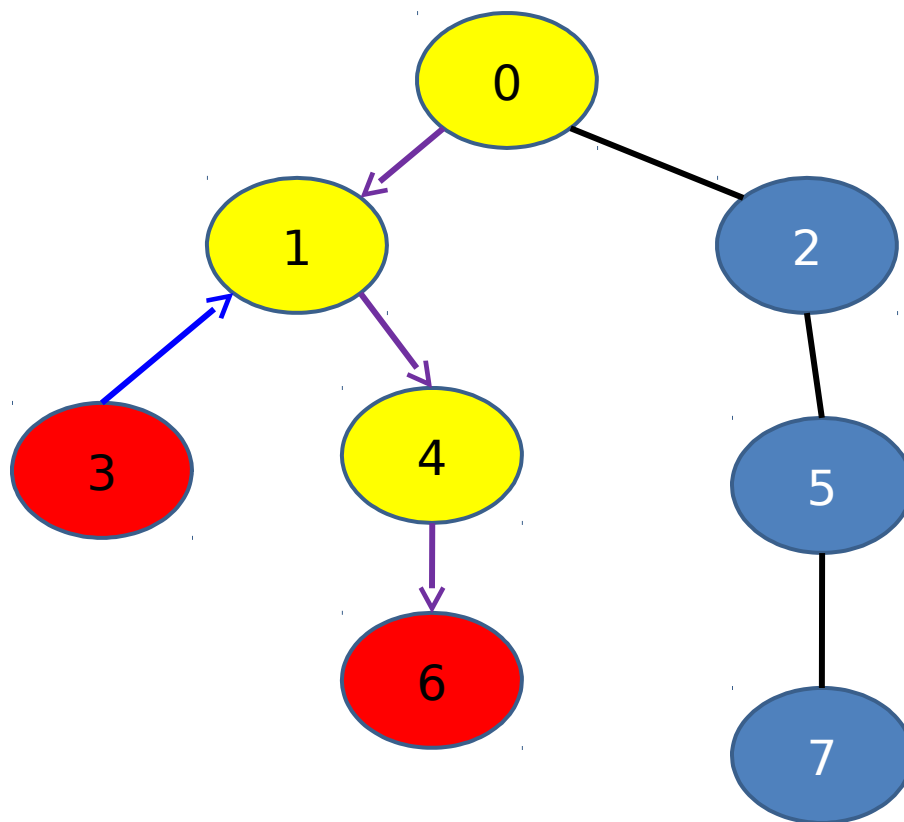
DFS



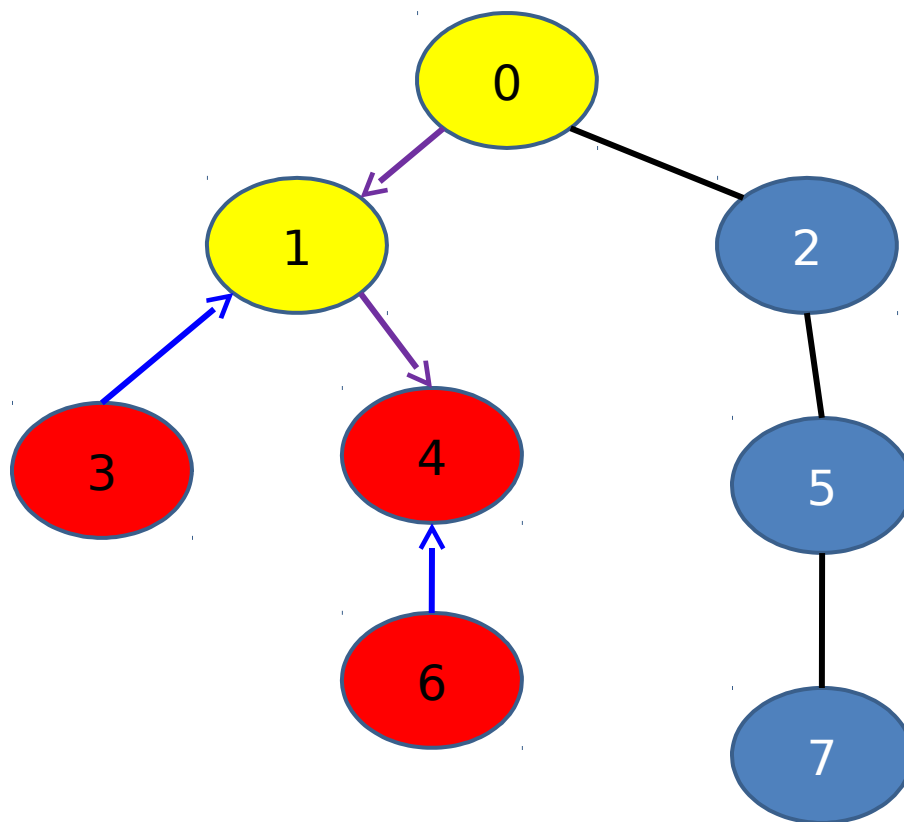
DFS



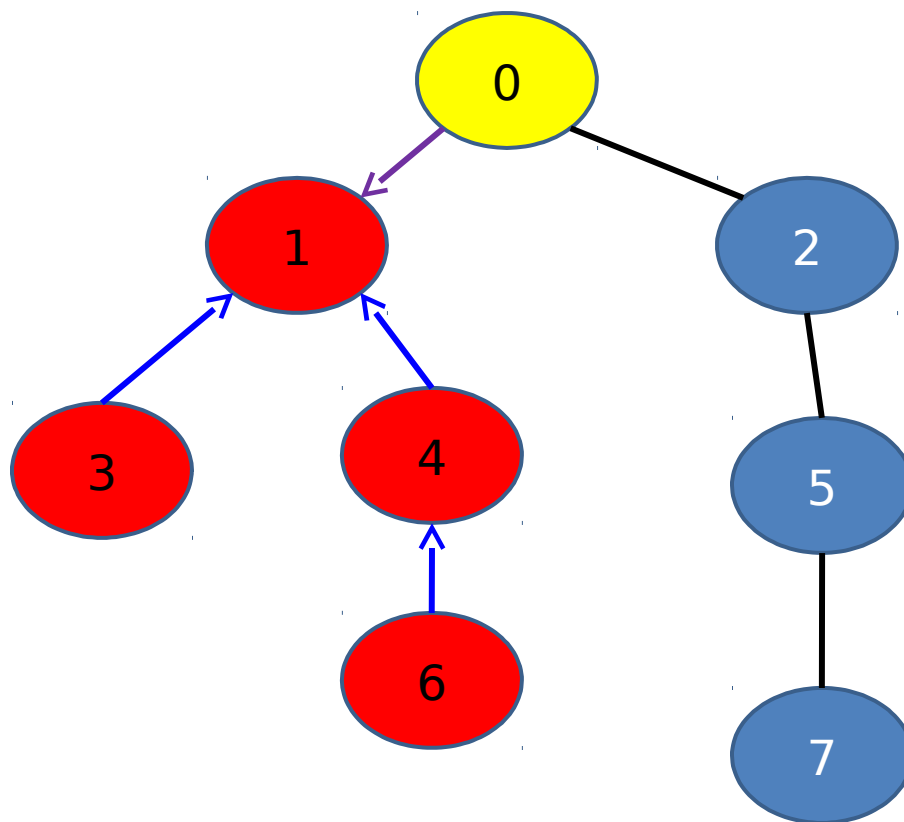
DFS



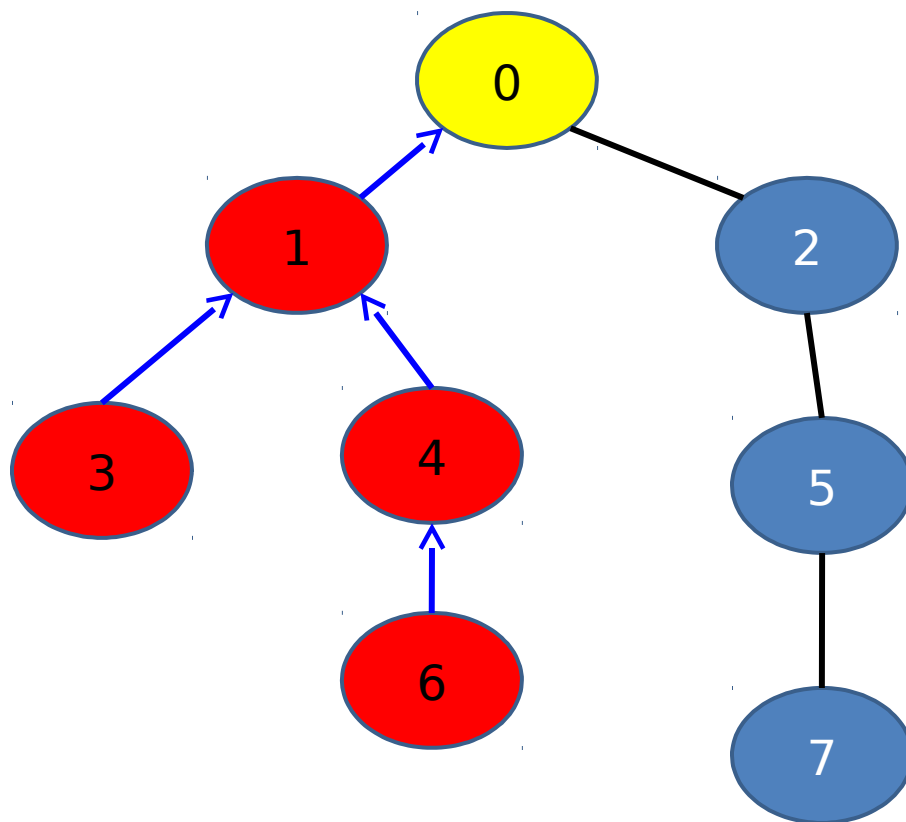
DFS



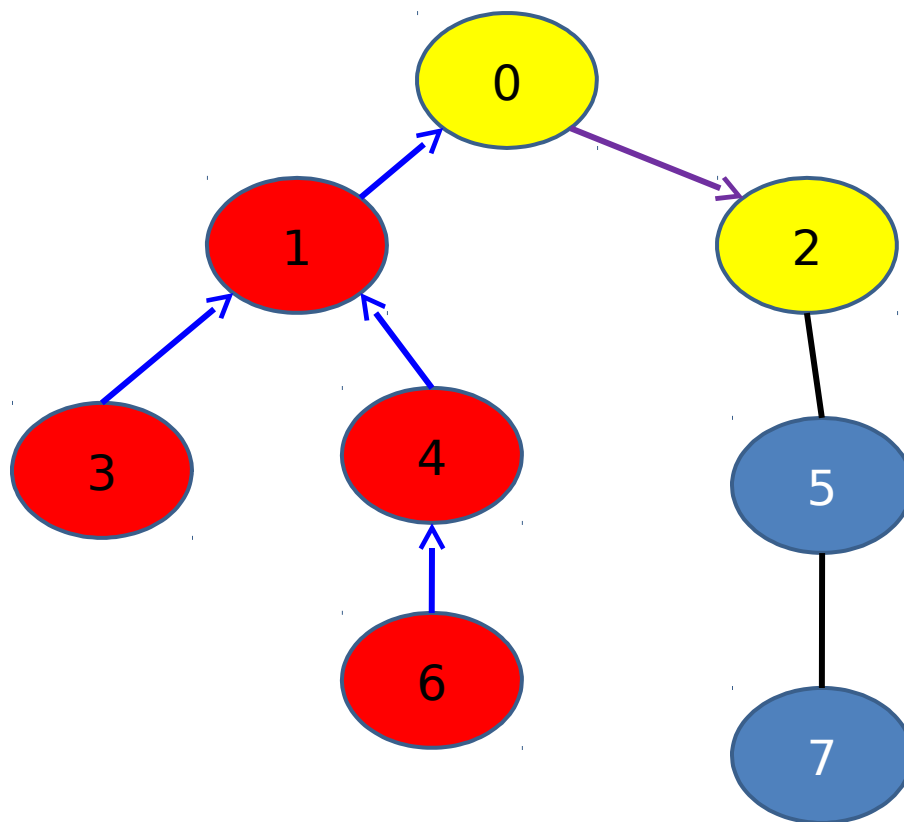
DFS



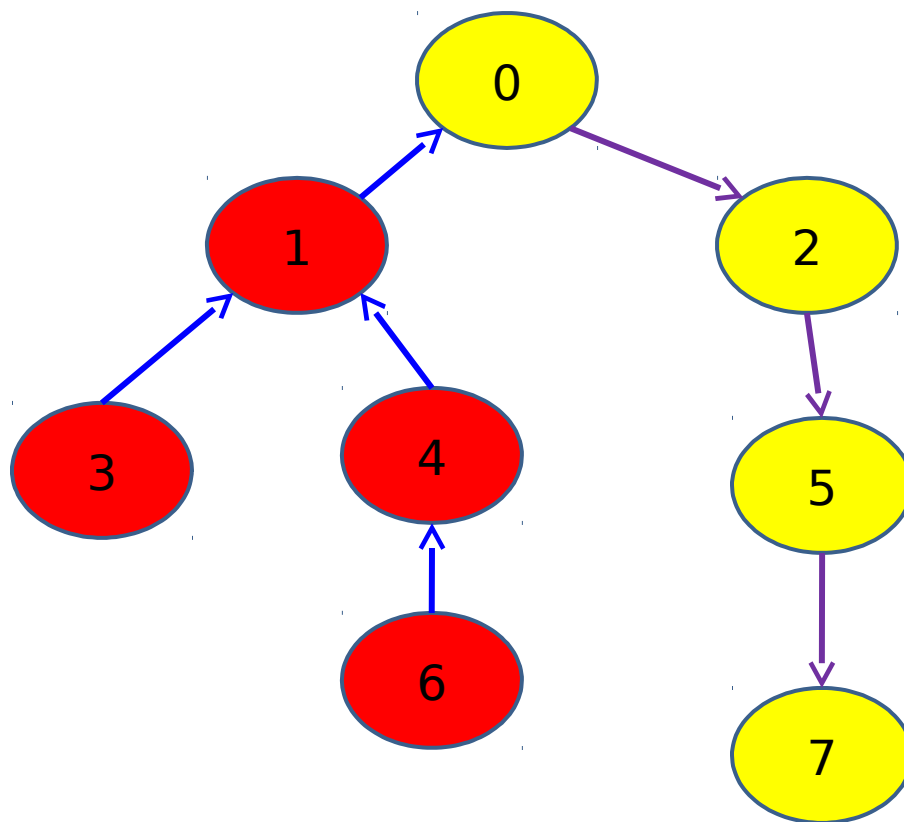
DFS



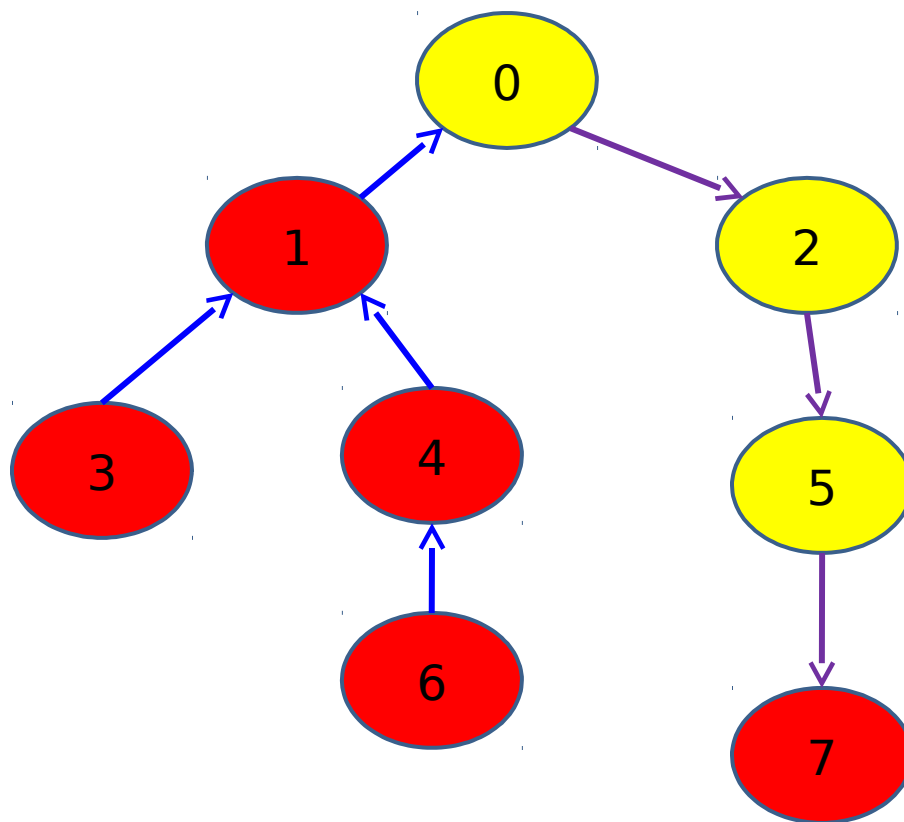
DFS



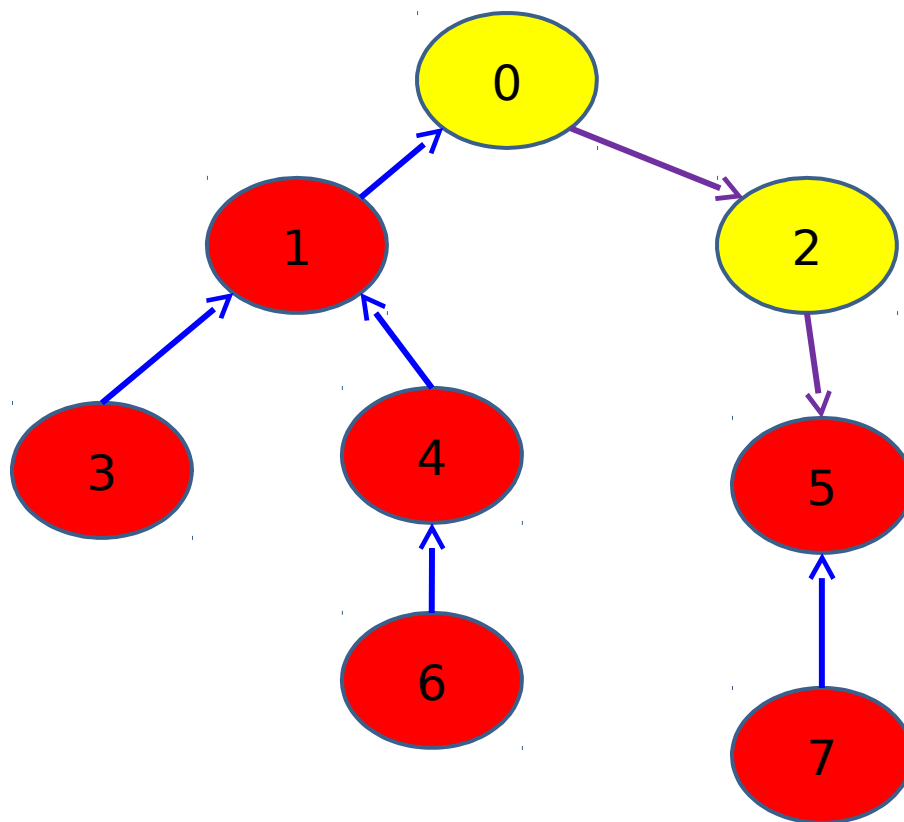
DFS



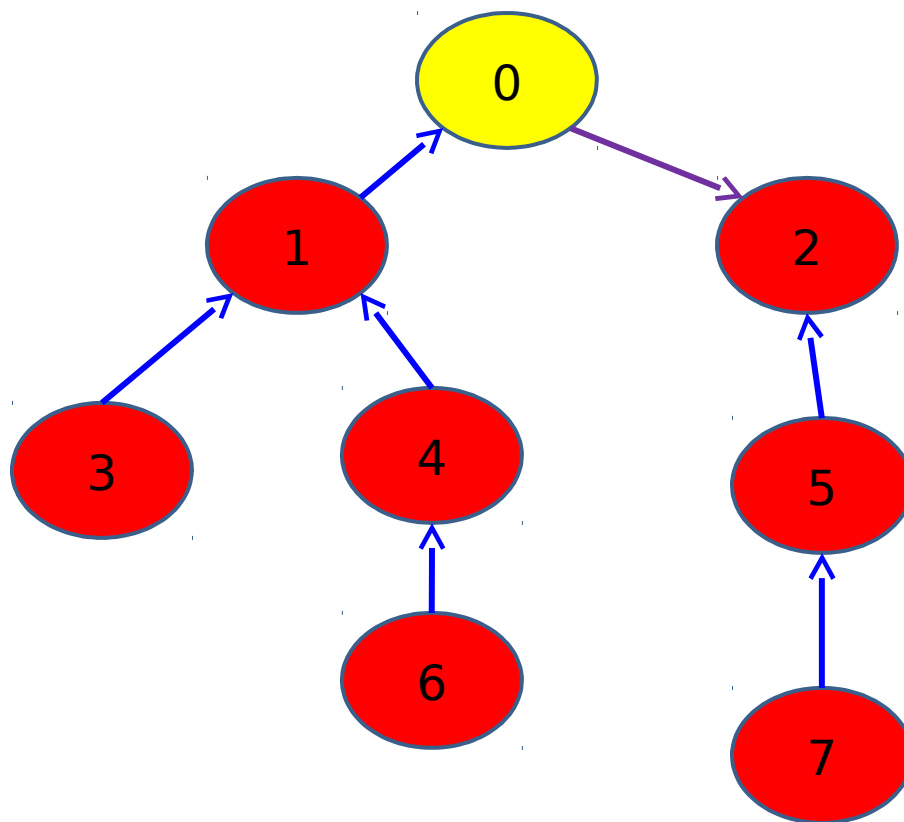
DFS



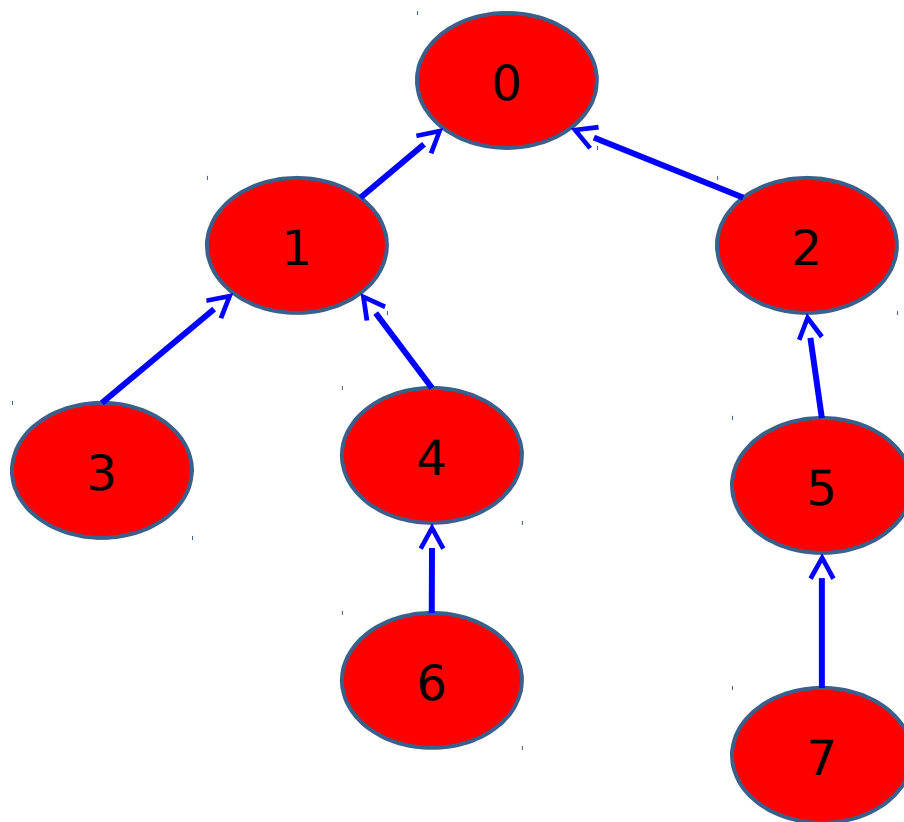
DFS



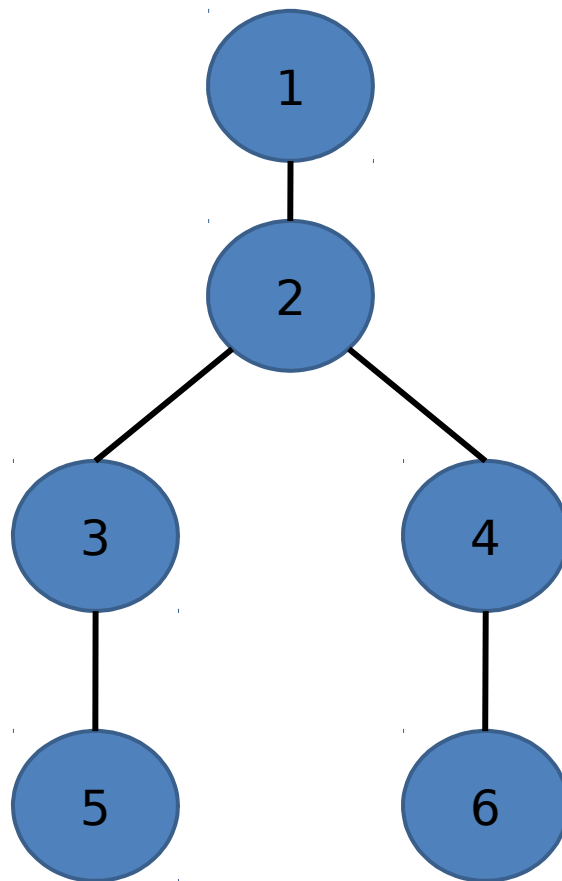
DFS



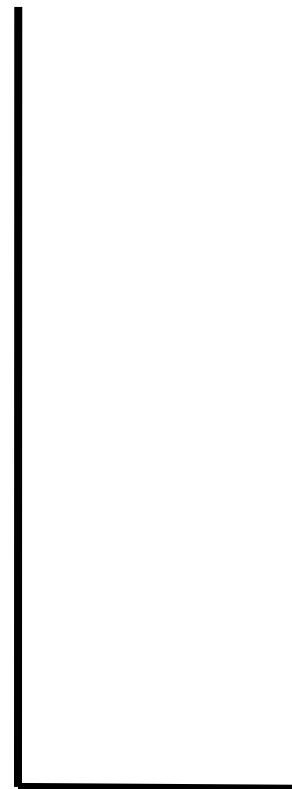
DFS



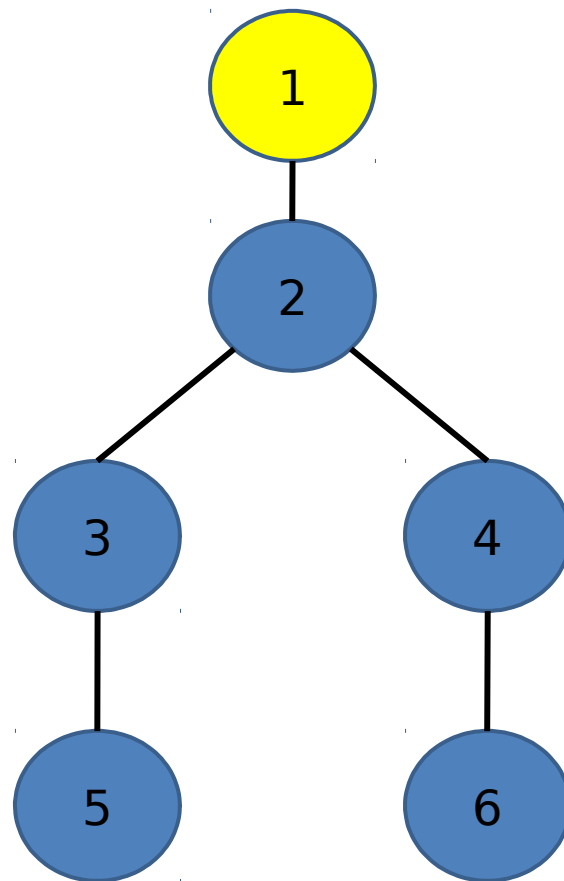
DFS



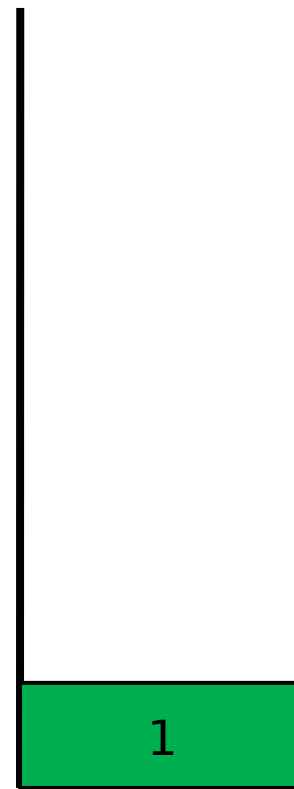
Stack



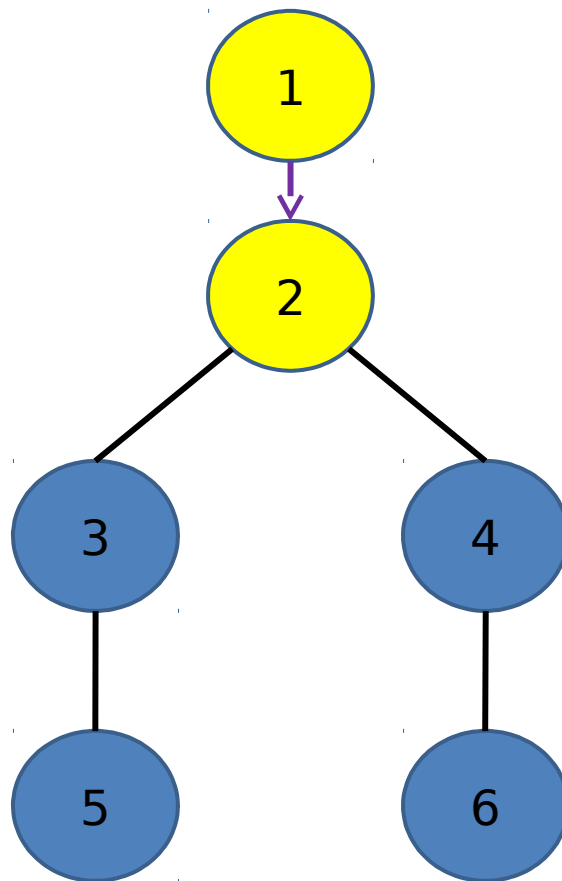
DFS



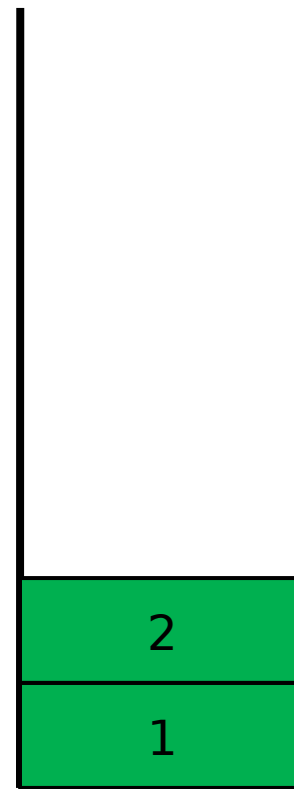
Stack



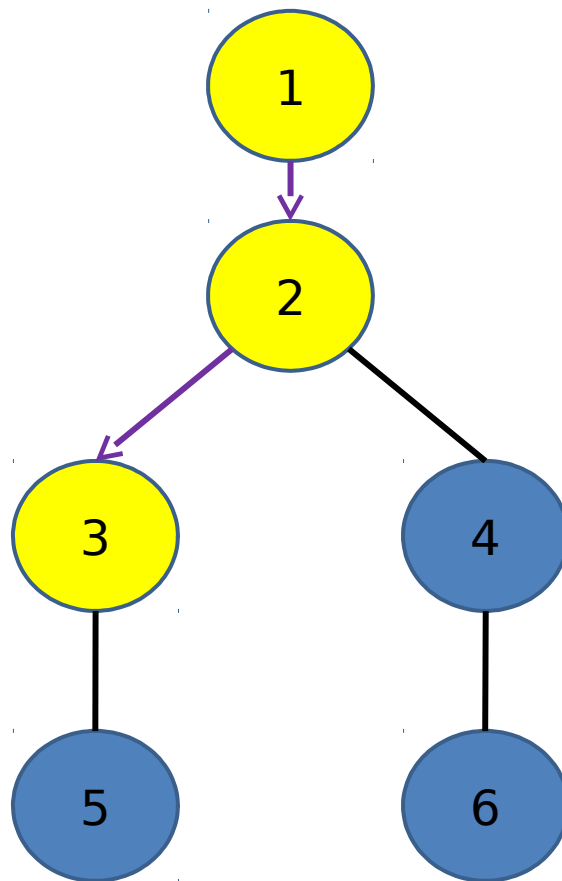
DFS



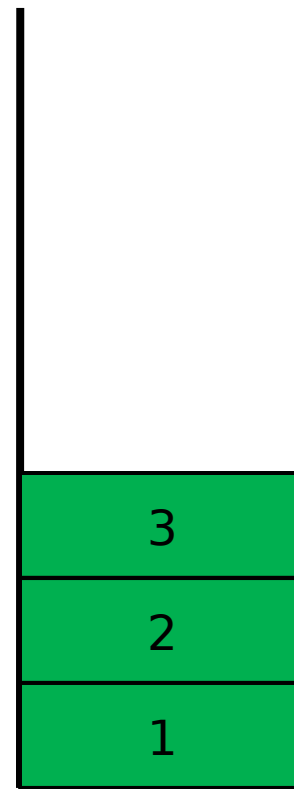
Stack



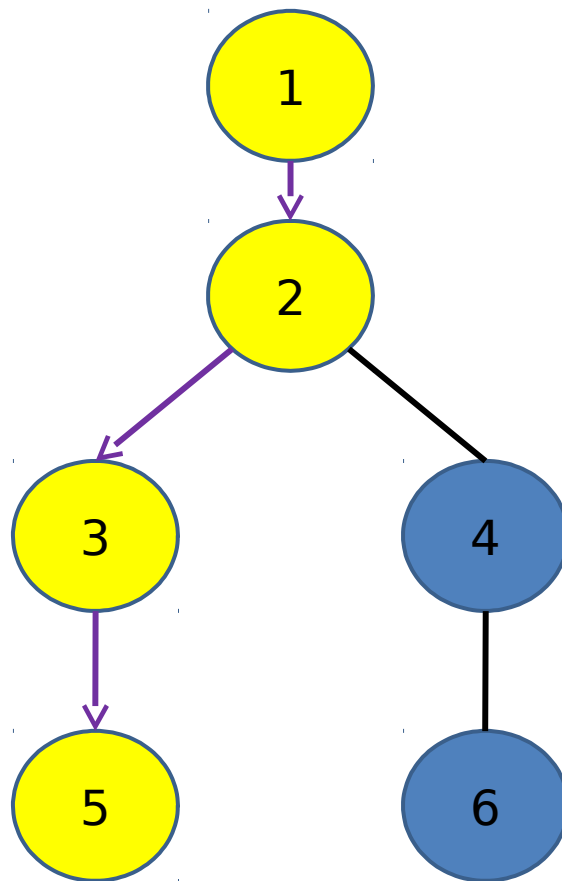
DFS



Stack



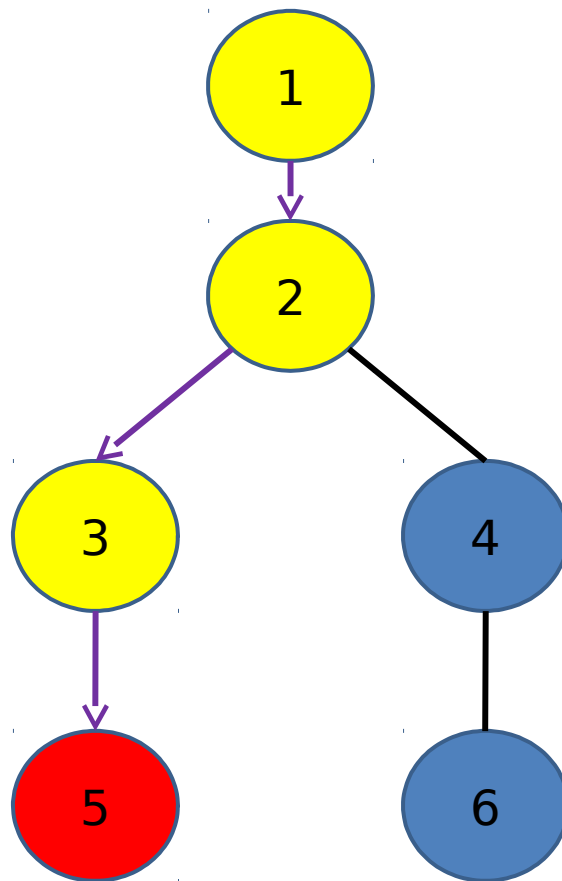
DFS



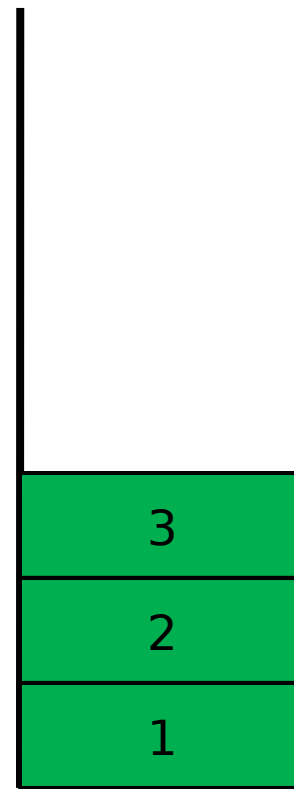
Stack



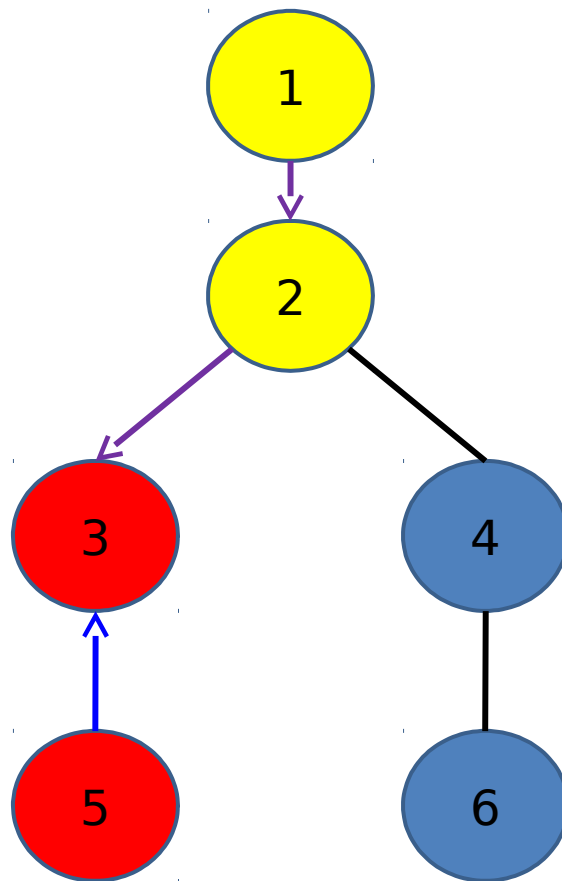
DFS



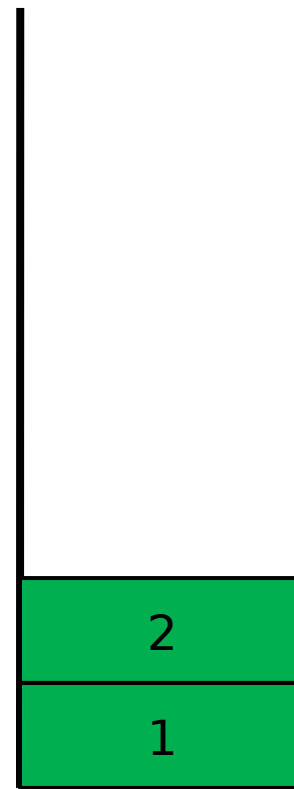
Stack



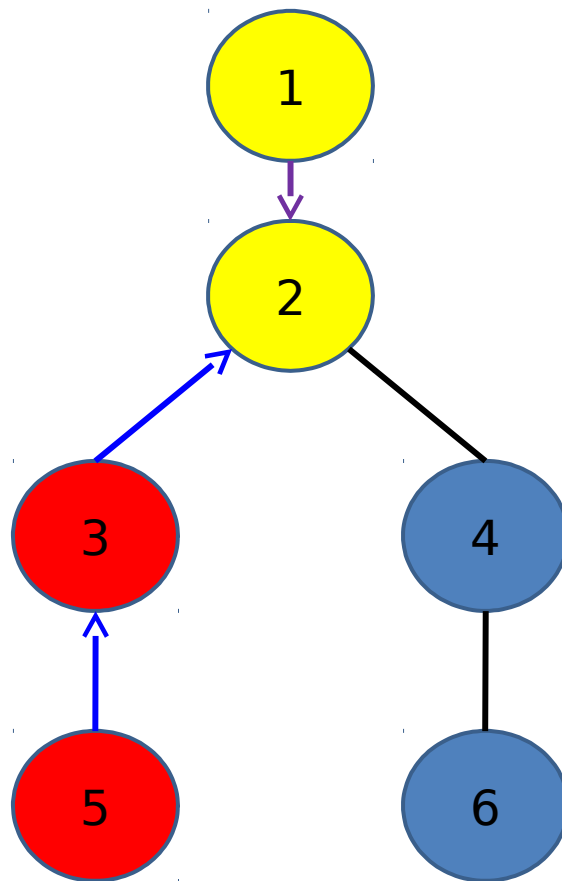
DFS



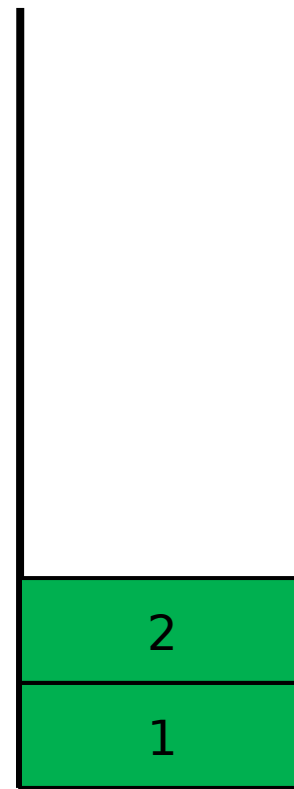
Stack



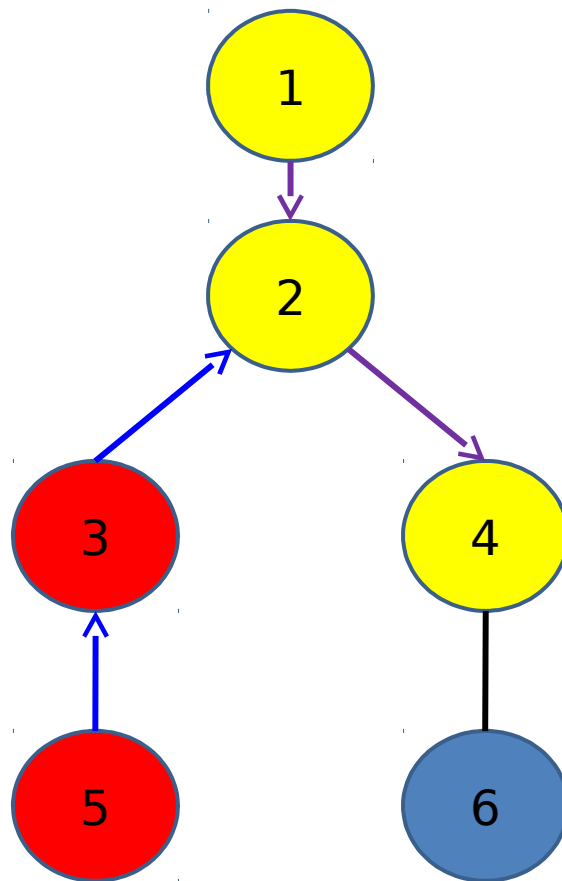
DFS



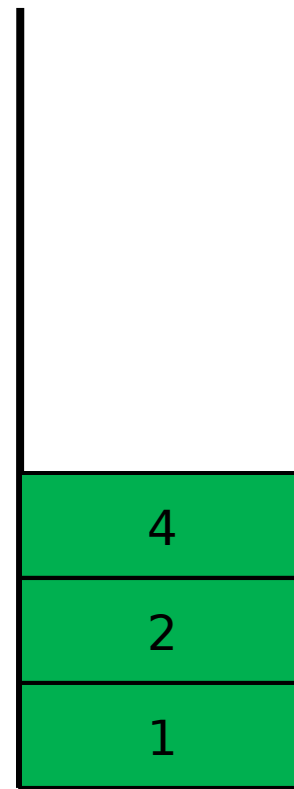
Stack



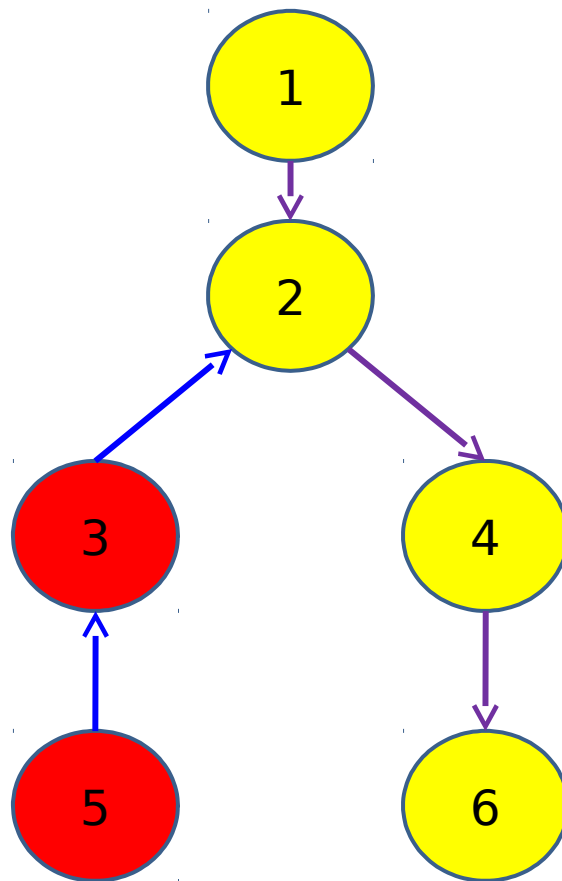
DFS



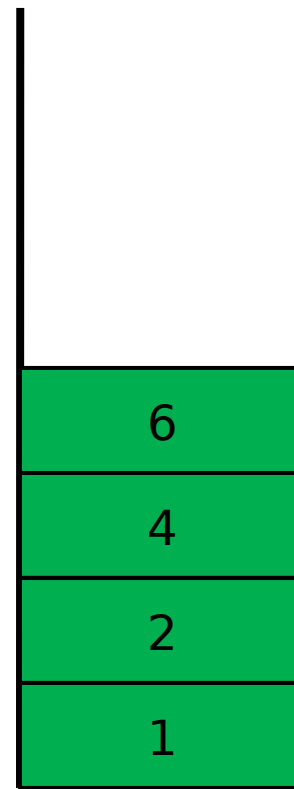
Stack



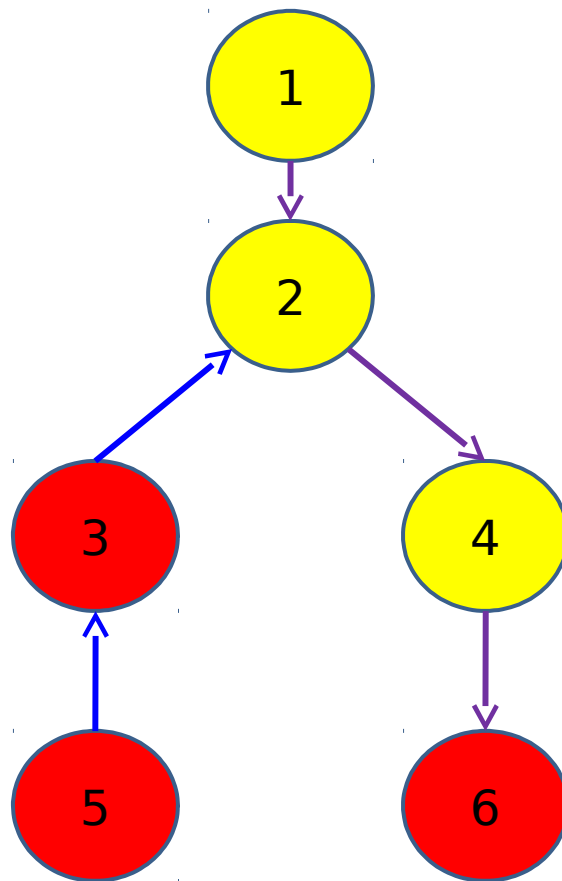
DFS



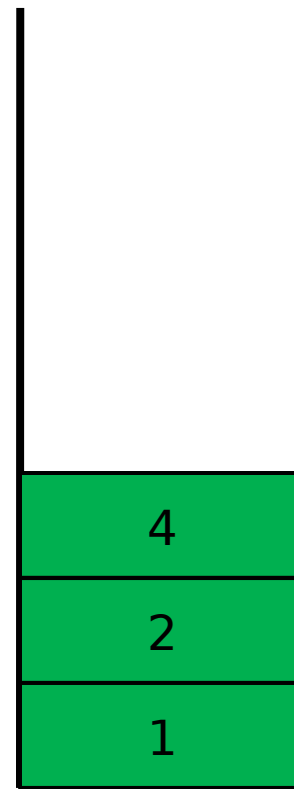
Stack



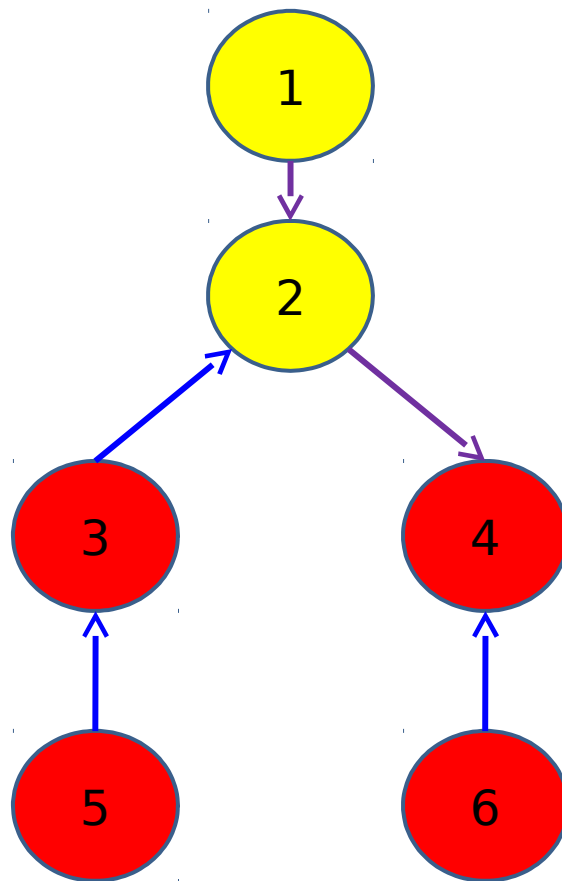
DFS



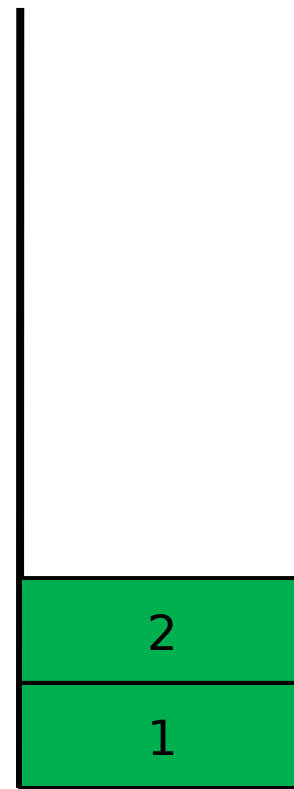
Stack



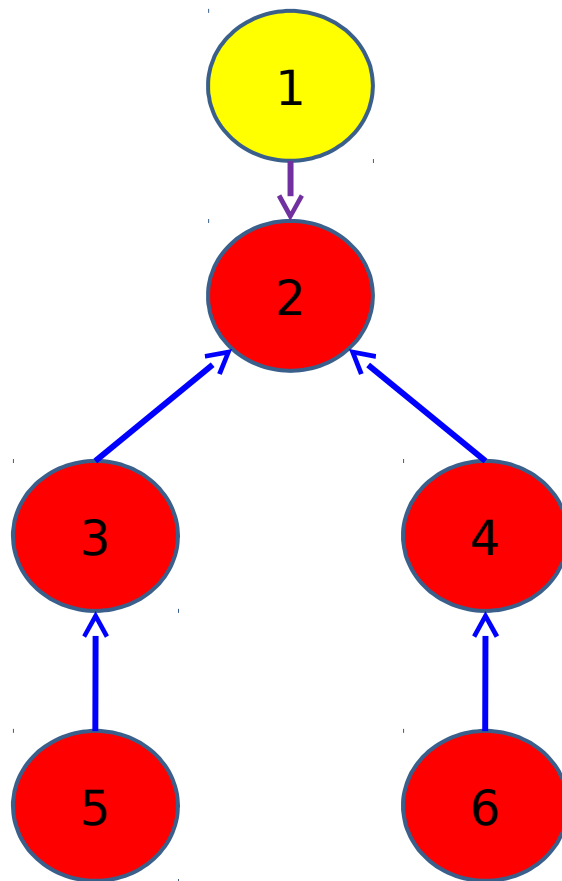
DFS



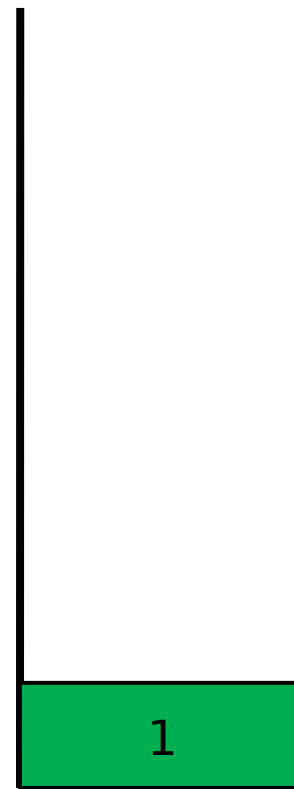
Stack



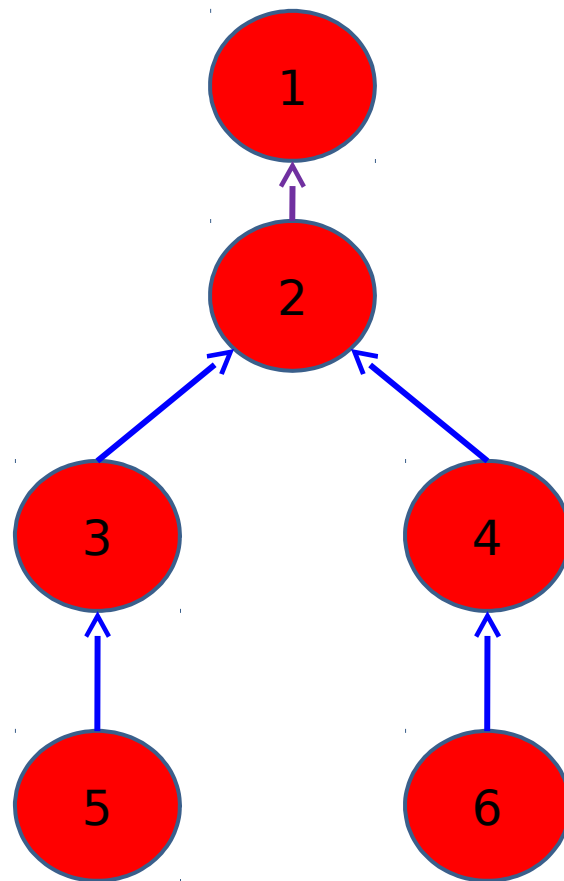
DFS



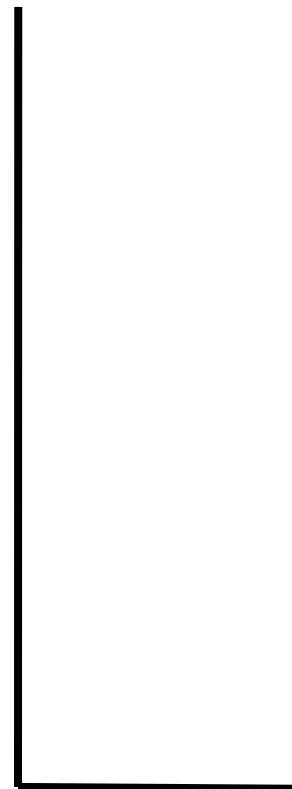
Stack



DFS



Stack



DFS

- Source Code(adjacency list)

```
void DFS(int cur)
{
    vis[cur]=true;

    for(int i=0;i<adj[cur].size();i++)
    {
        int next=adj[cur][i];
        if(!vis[next])
            DFS(next);
    }
    return;
}
```



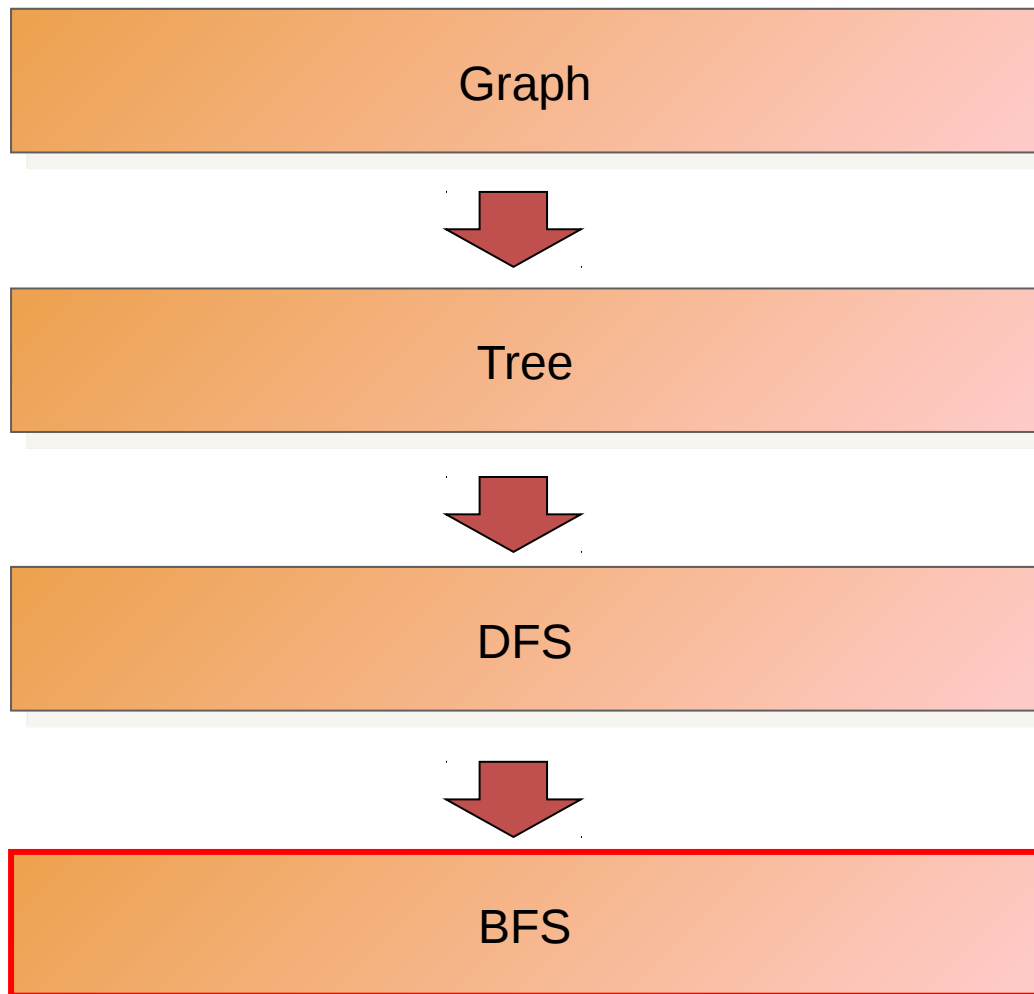
DFS

- Practice

[UVA-572] Oil Deposits



Outline



BFS

(B)readth-(F)irst-(S)earch



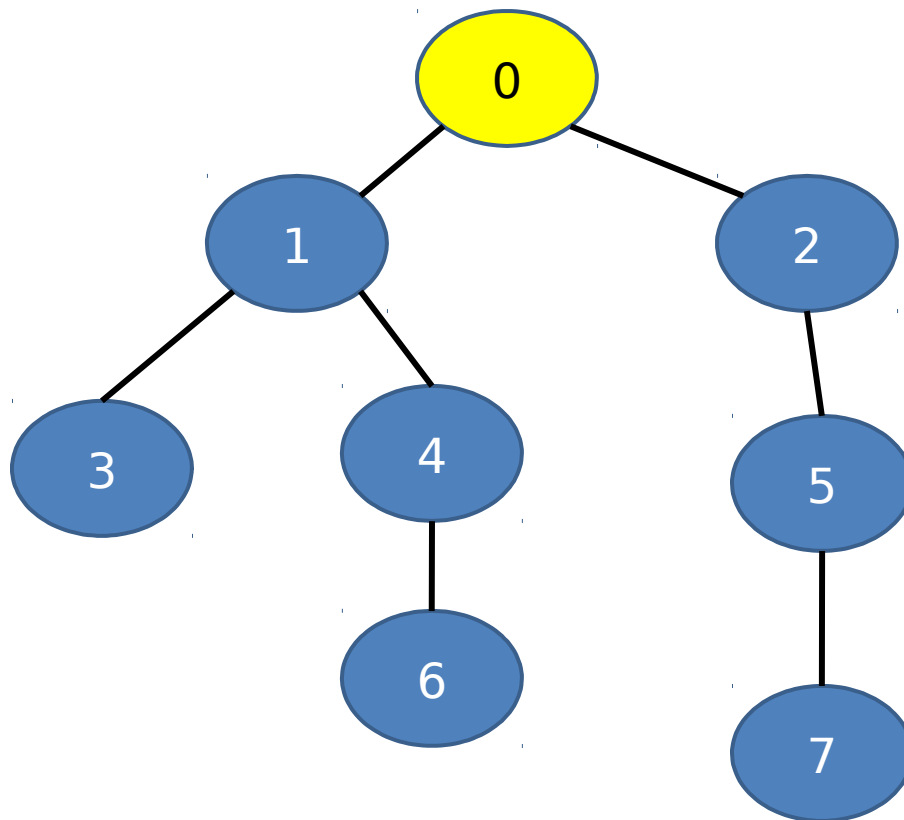
BFS

(B)readth-(F)irst-(S)earch

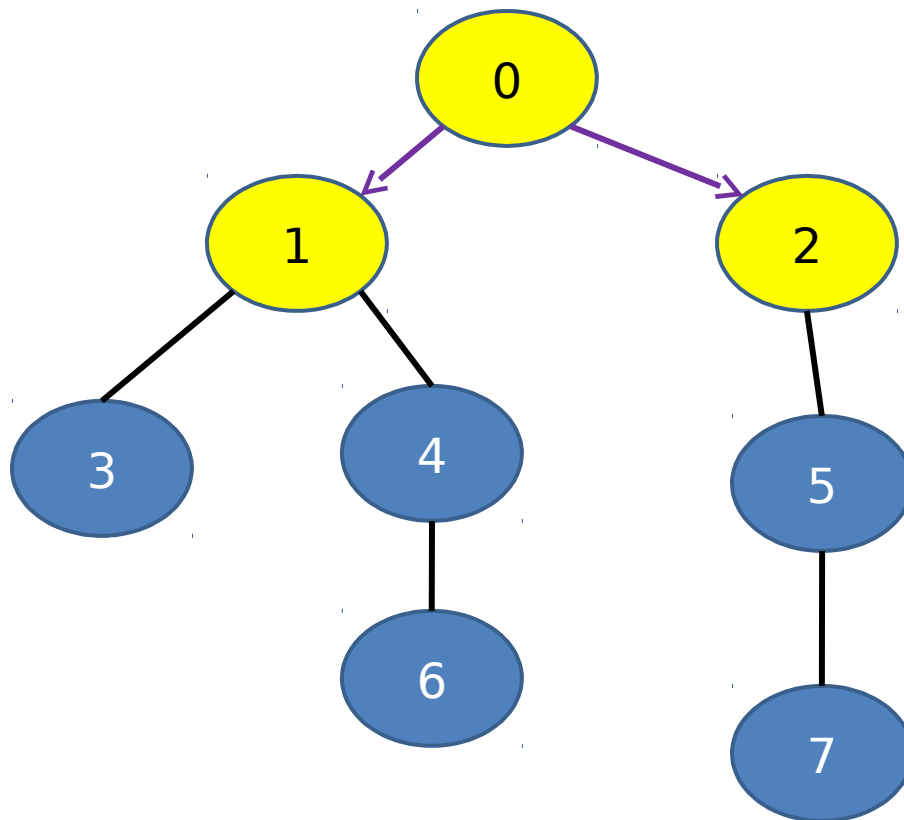
Queue



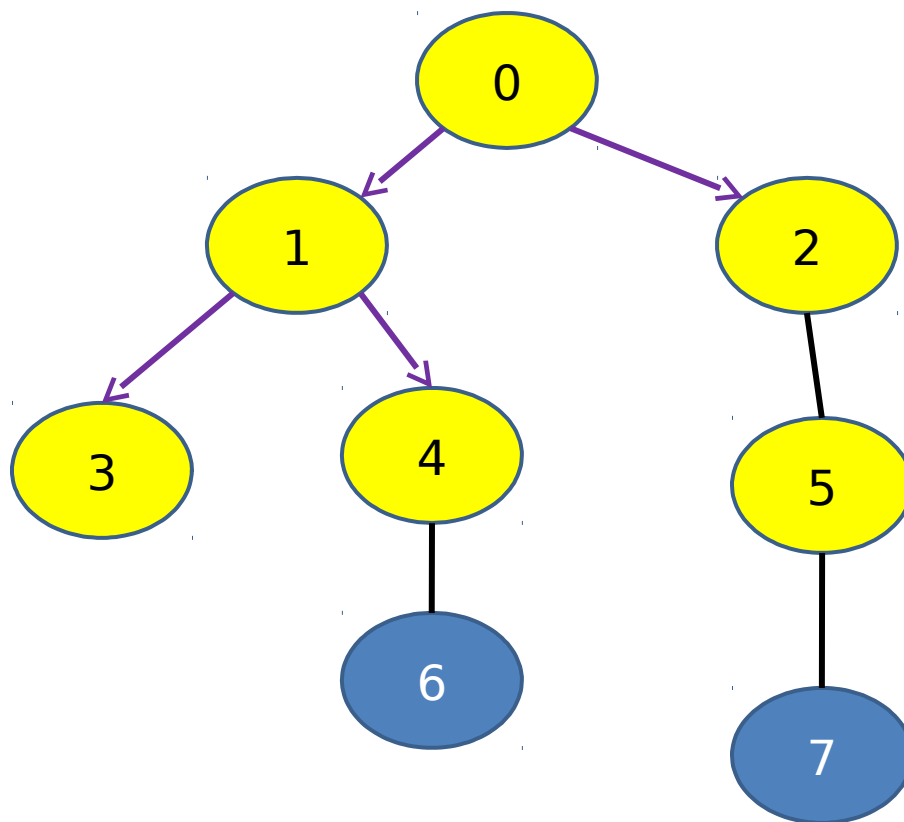
BFS



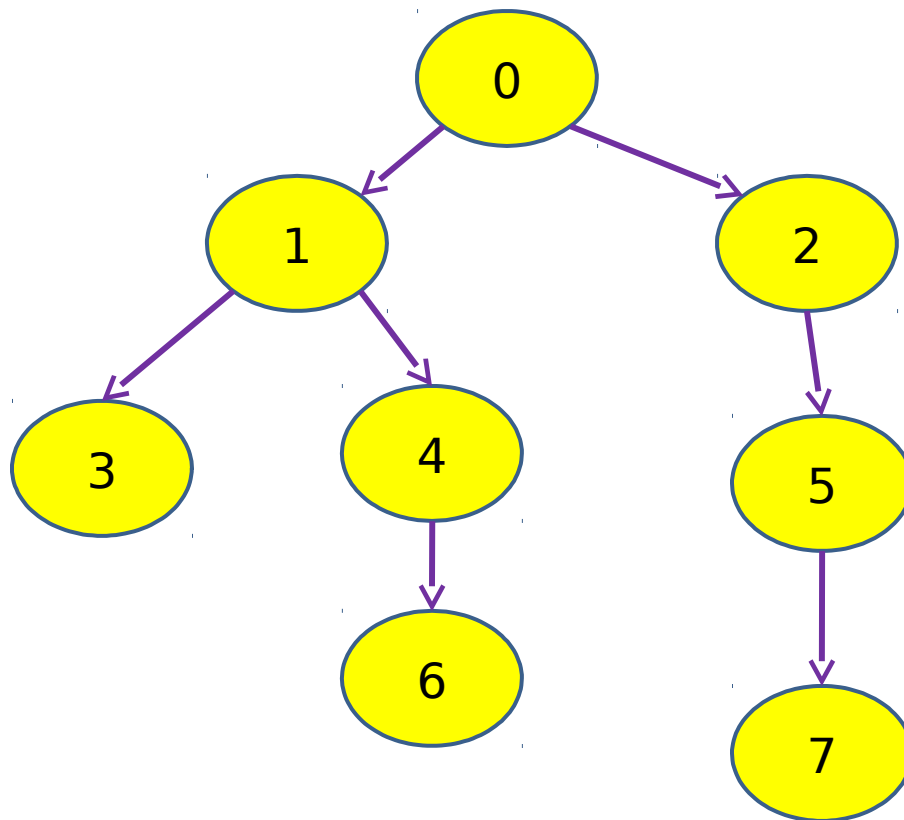
BFS



BFS

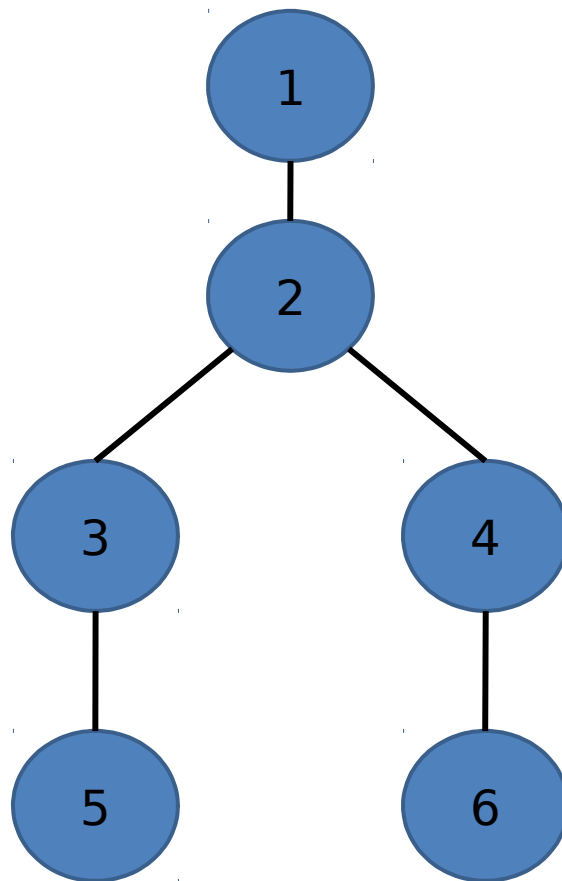


BFS

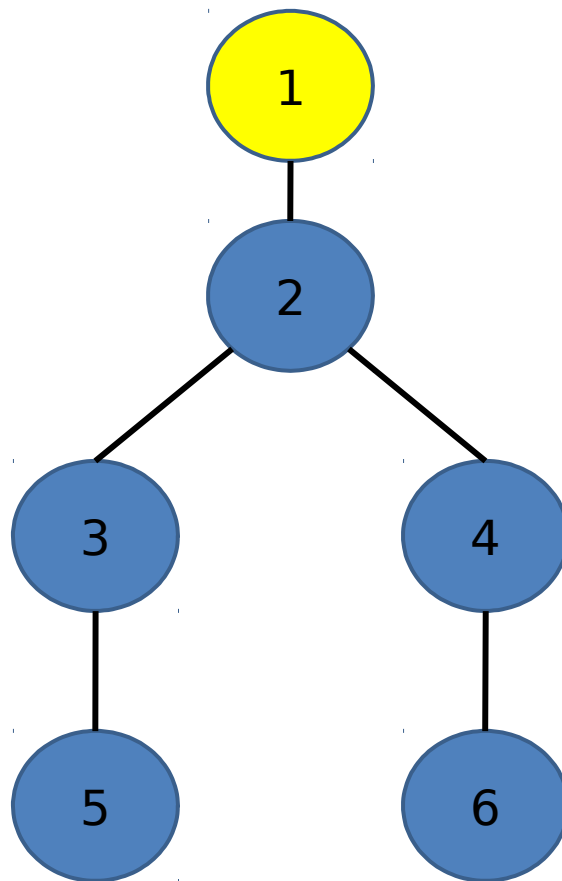


BFS

Queue



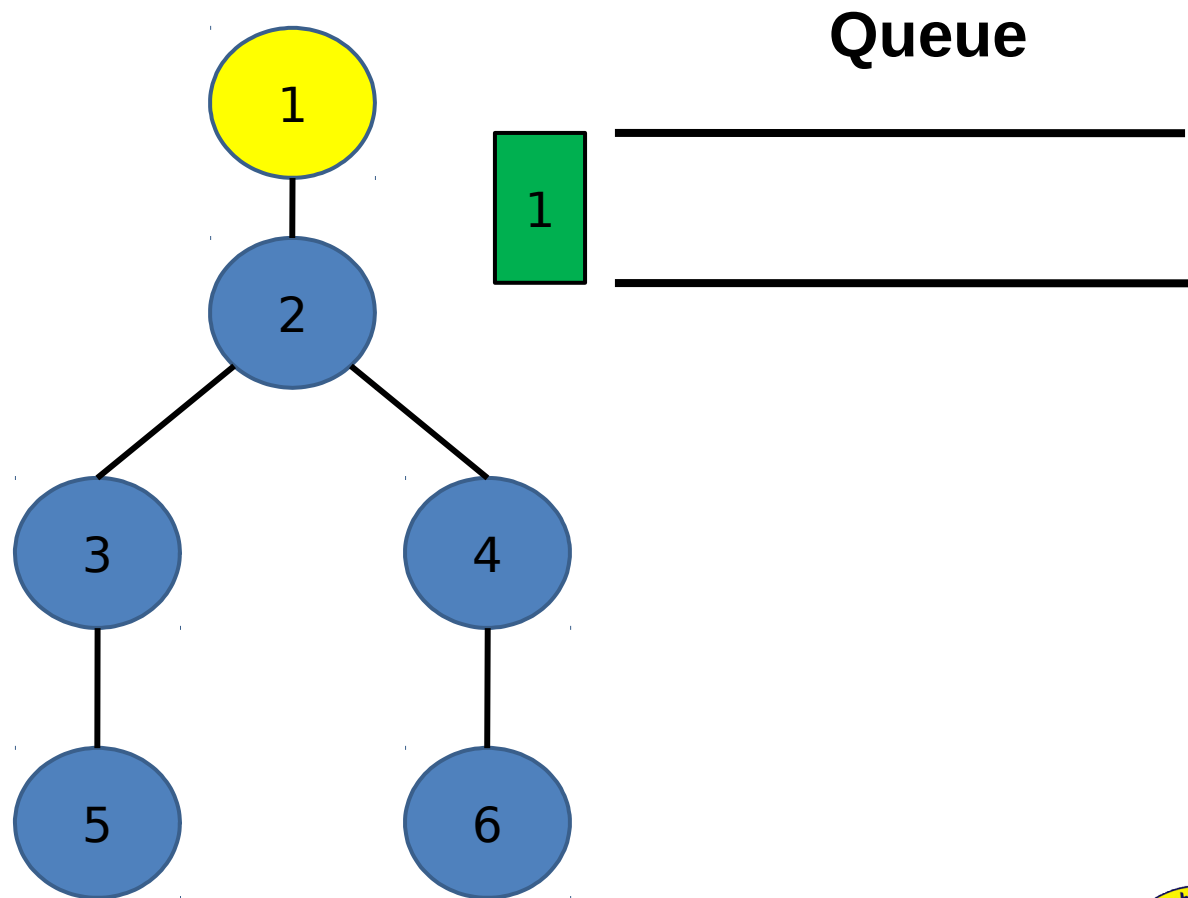
BFS



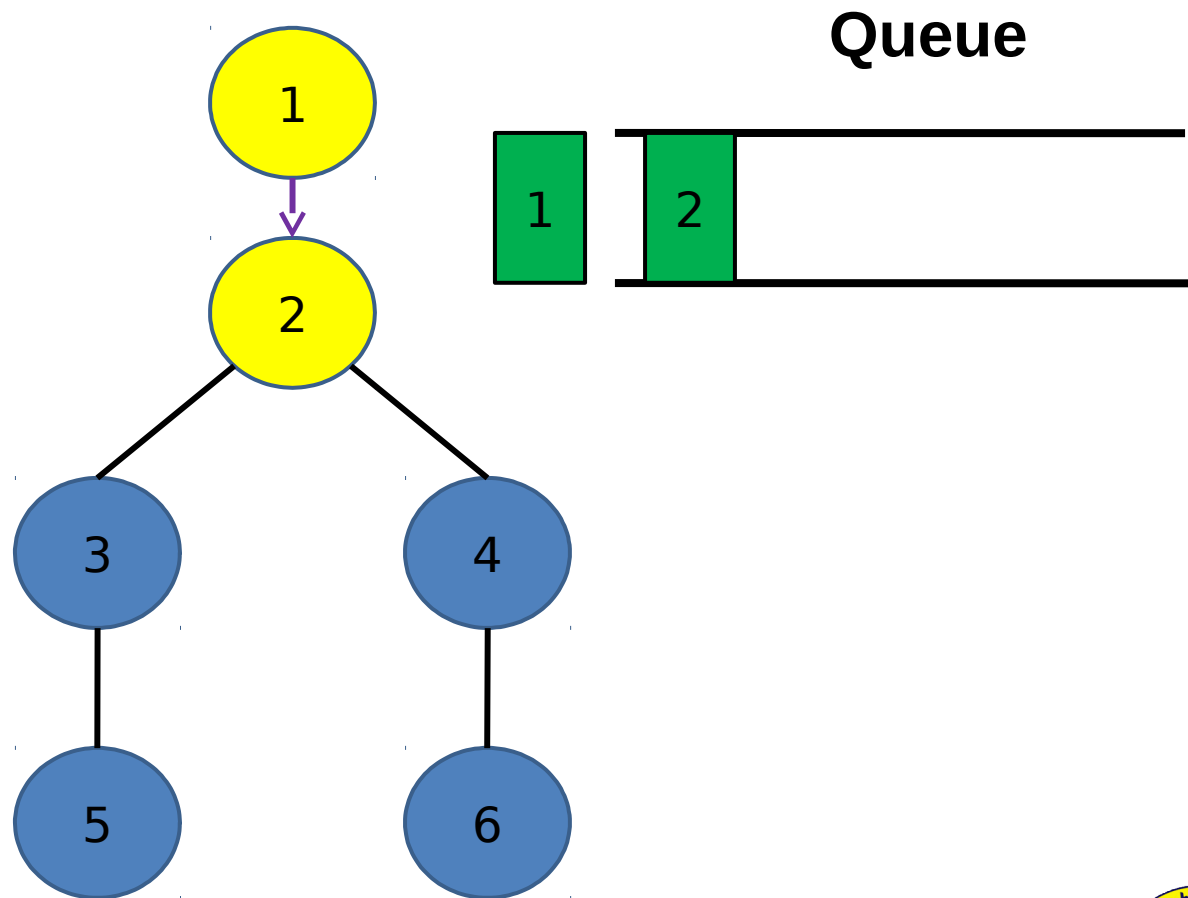
Queue



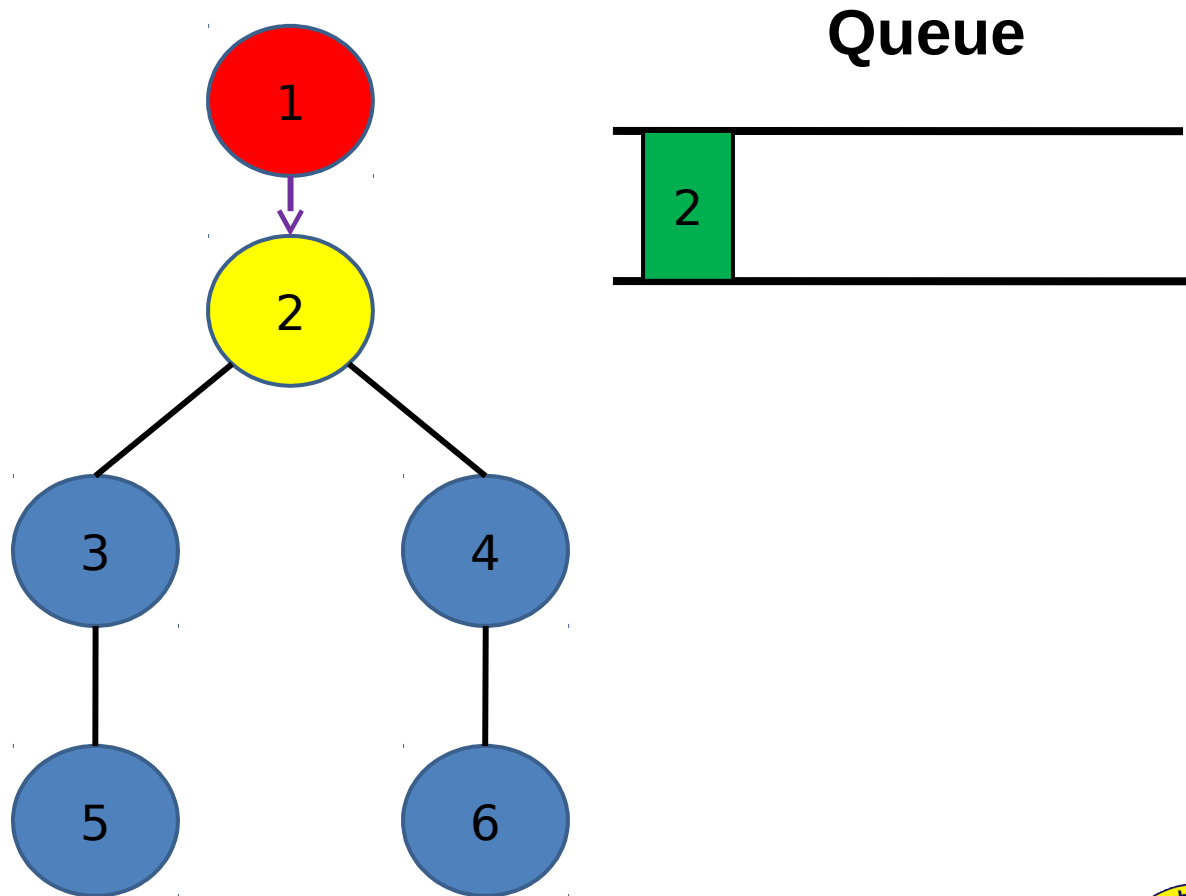
BFS



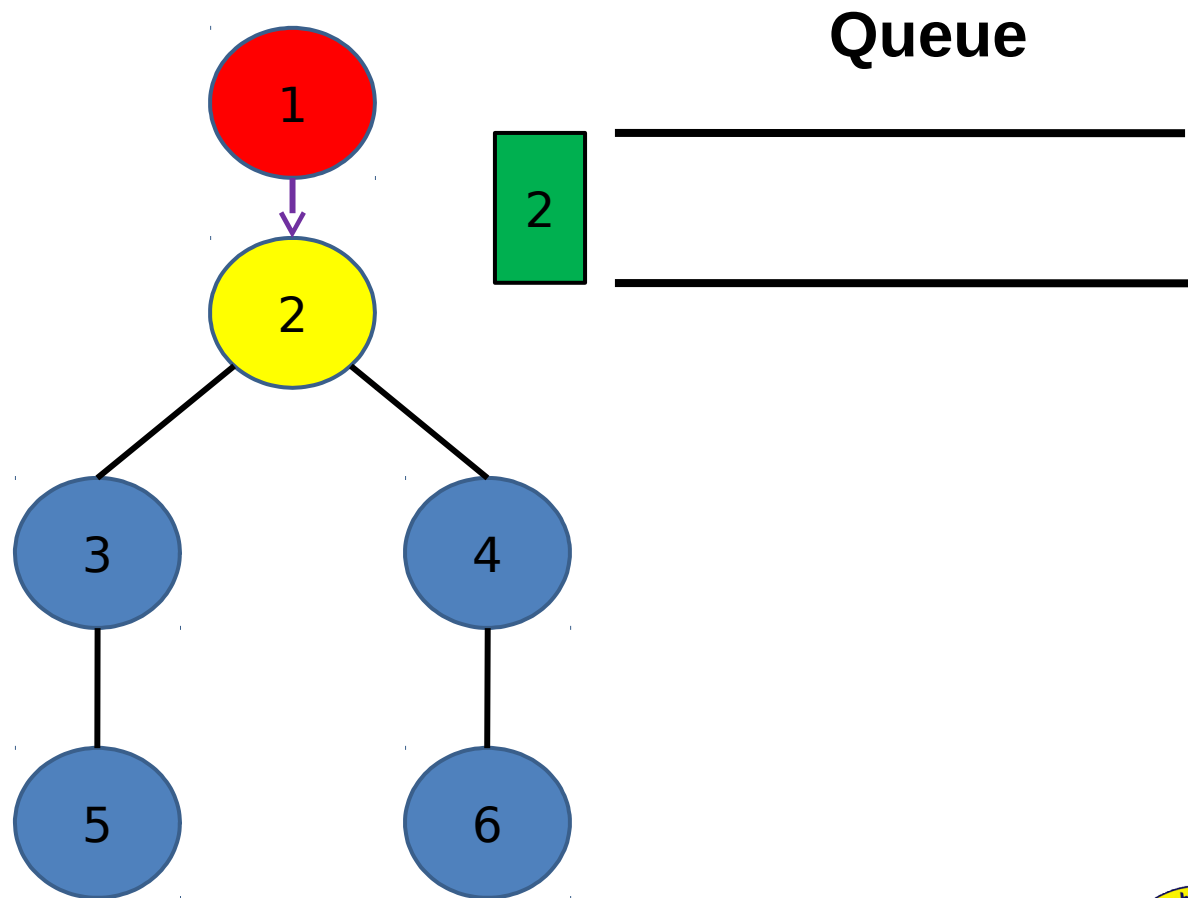
BFS



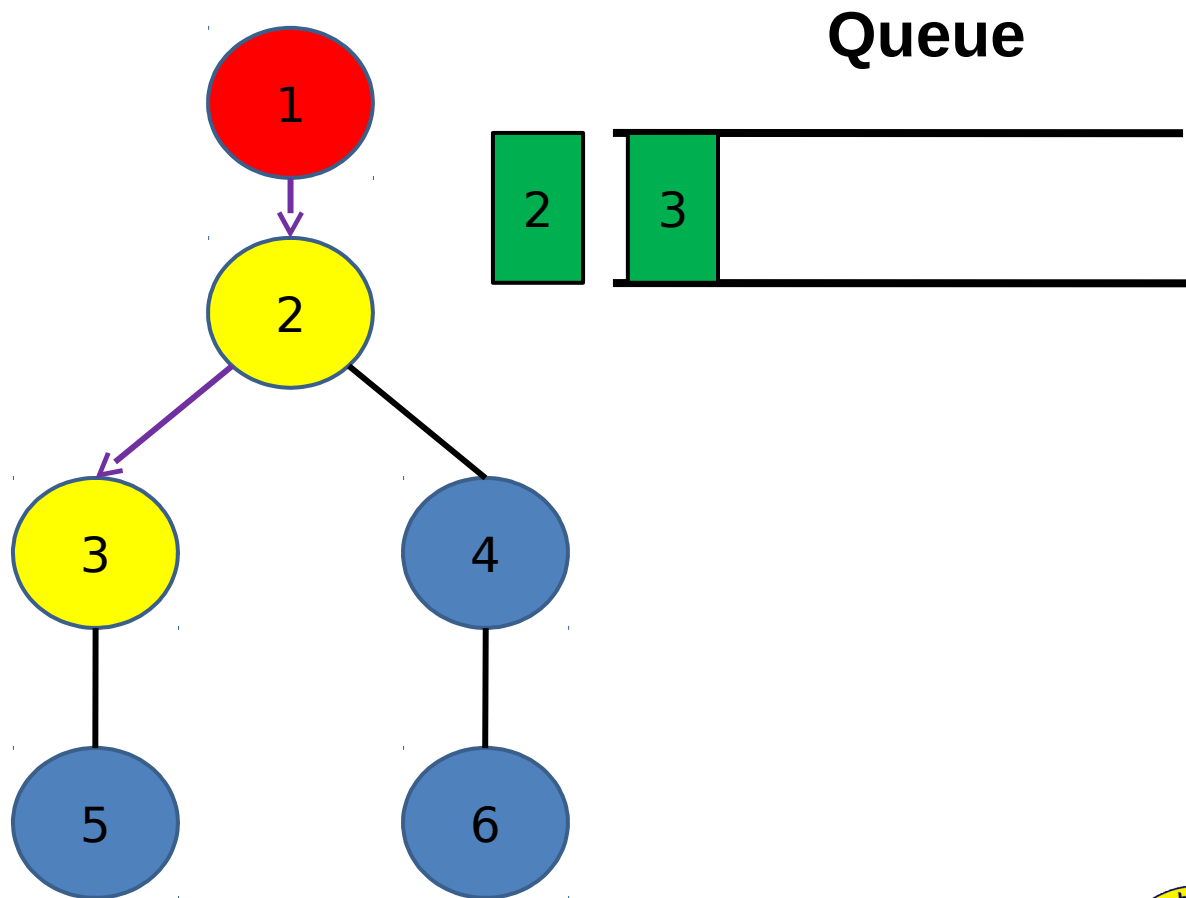
BFS



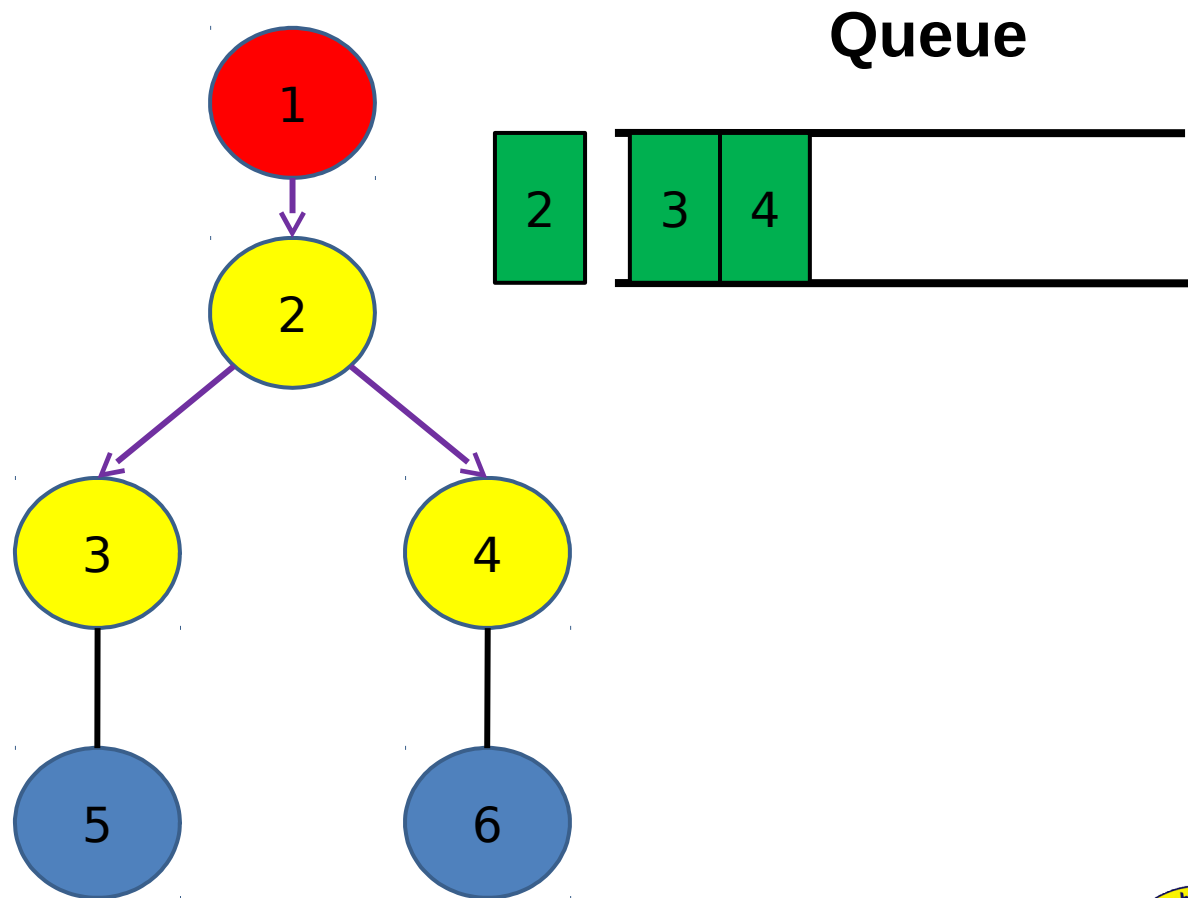
BFS



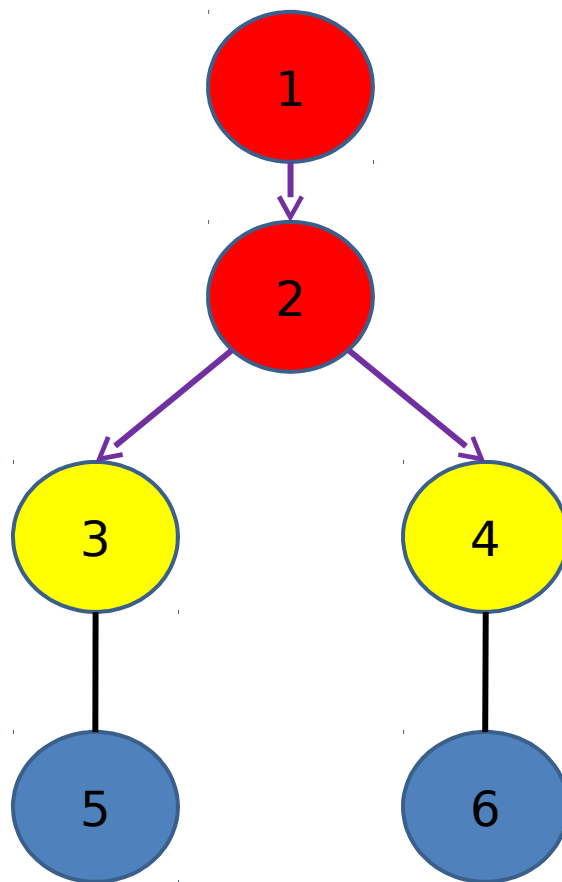
BFS



BFS



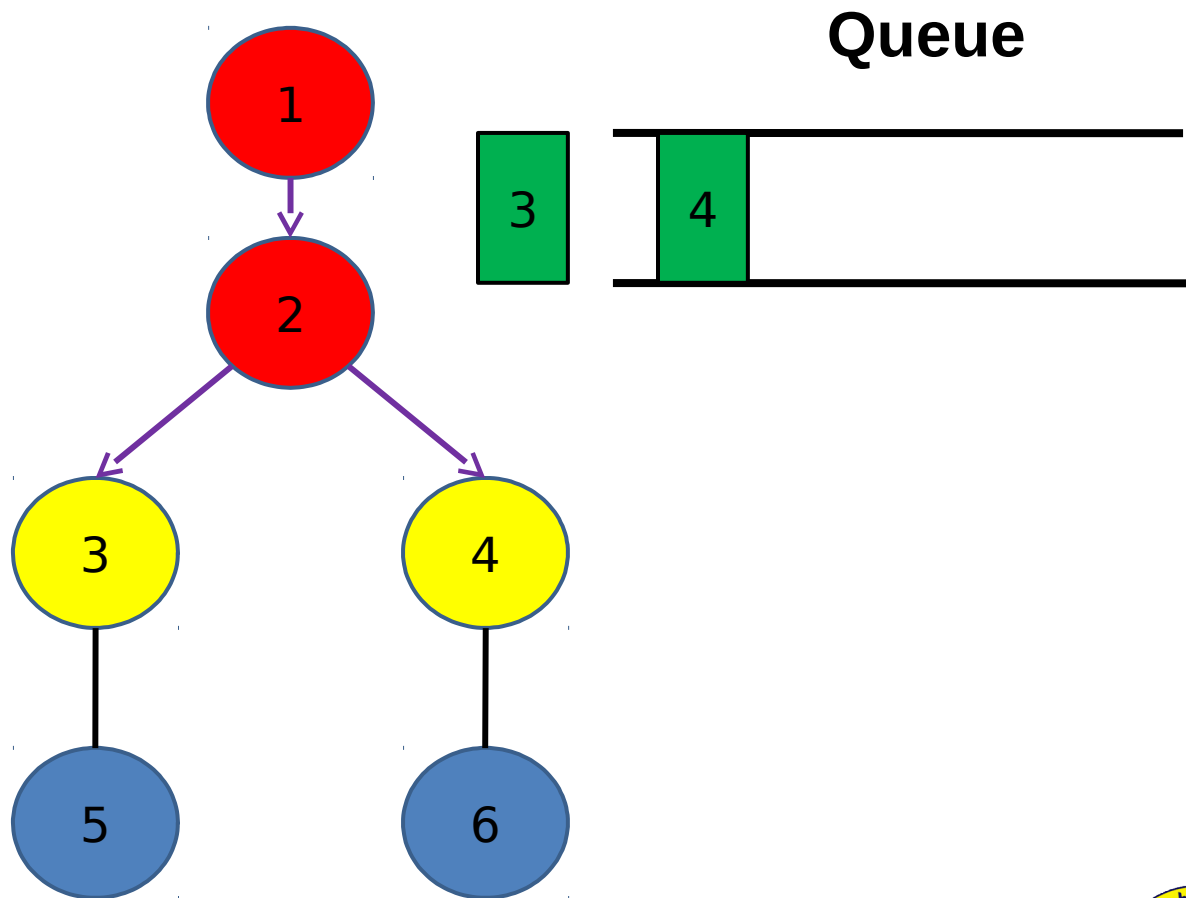
BFS



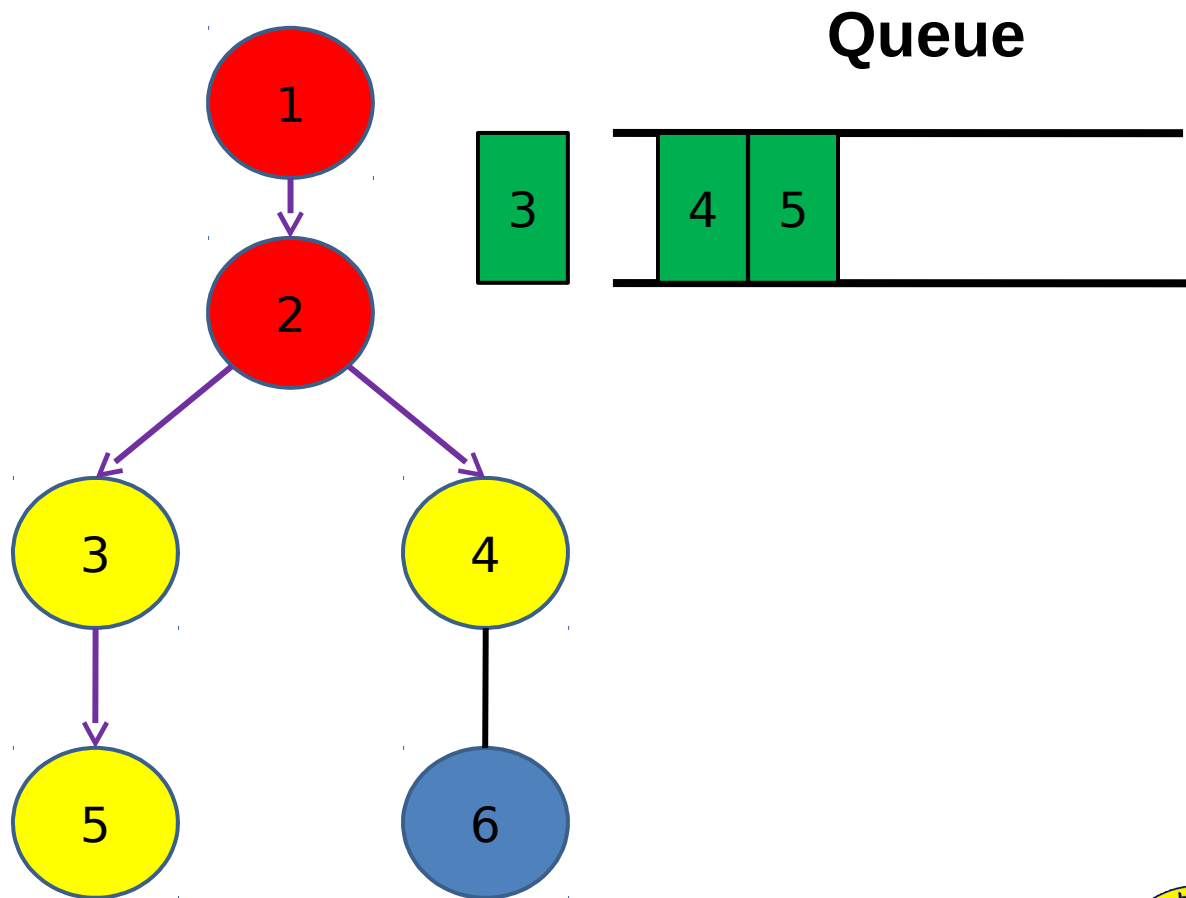
Queue



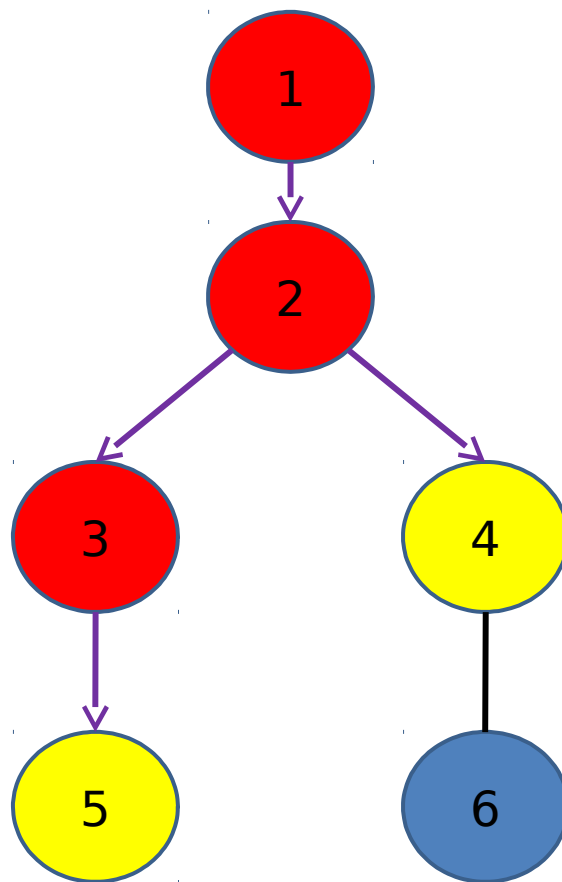
BFS



BFS



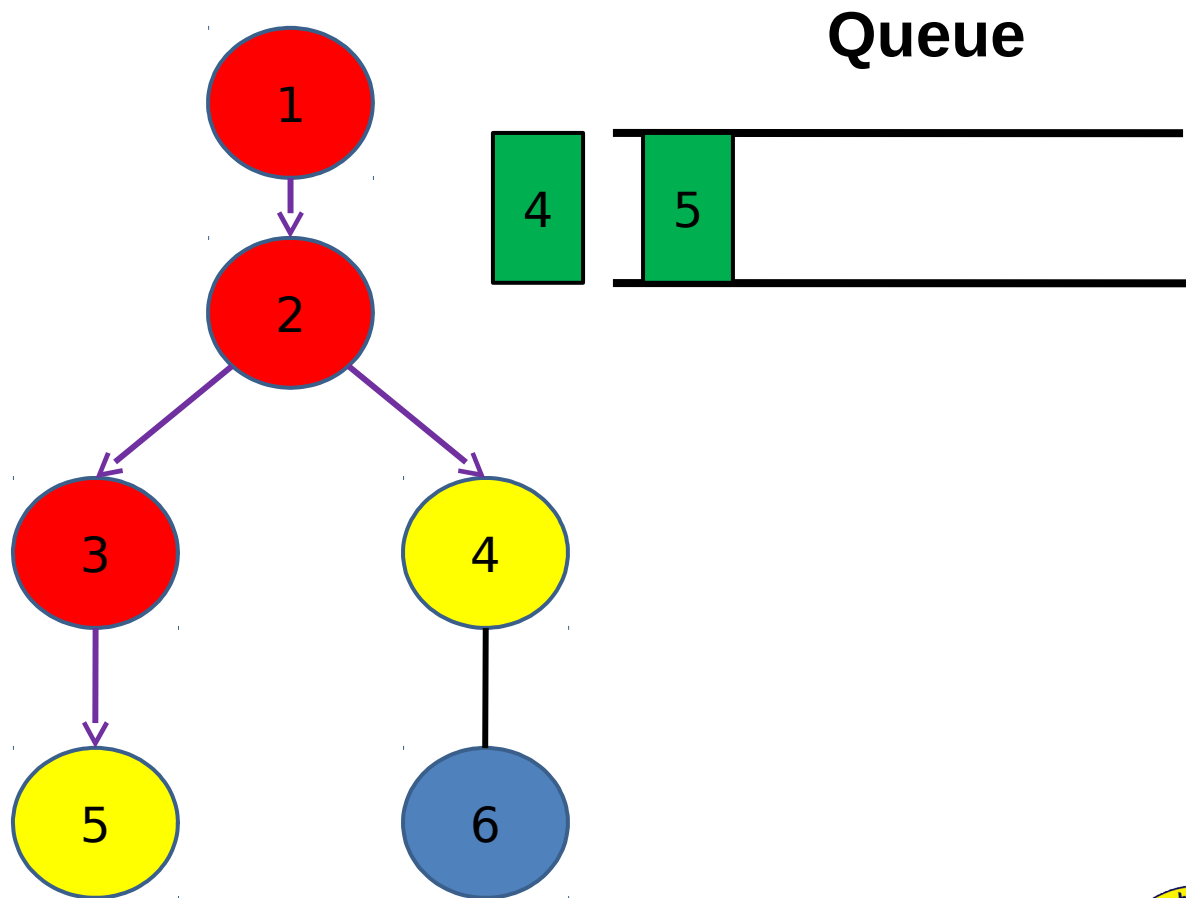
BFS



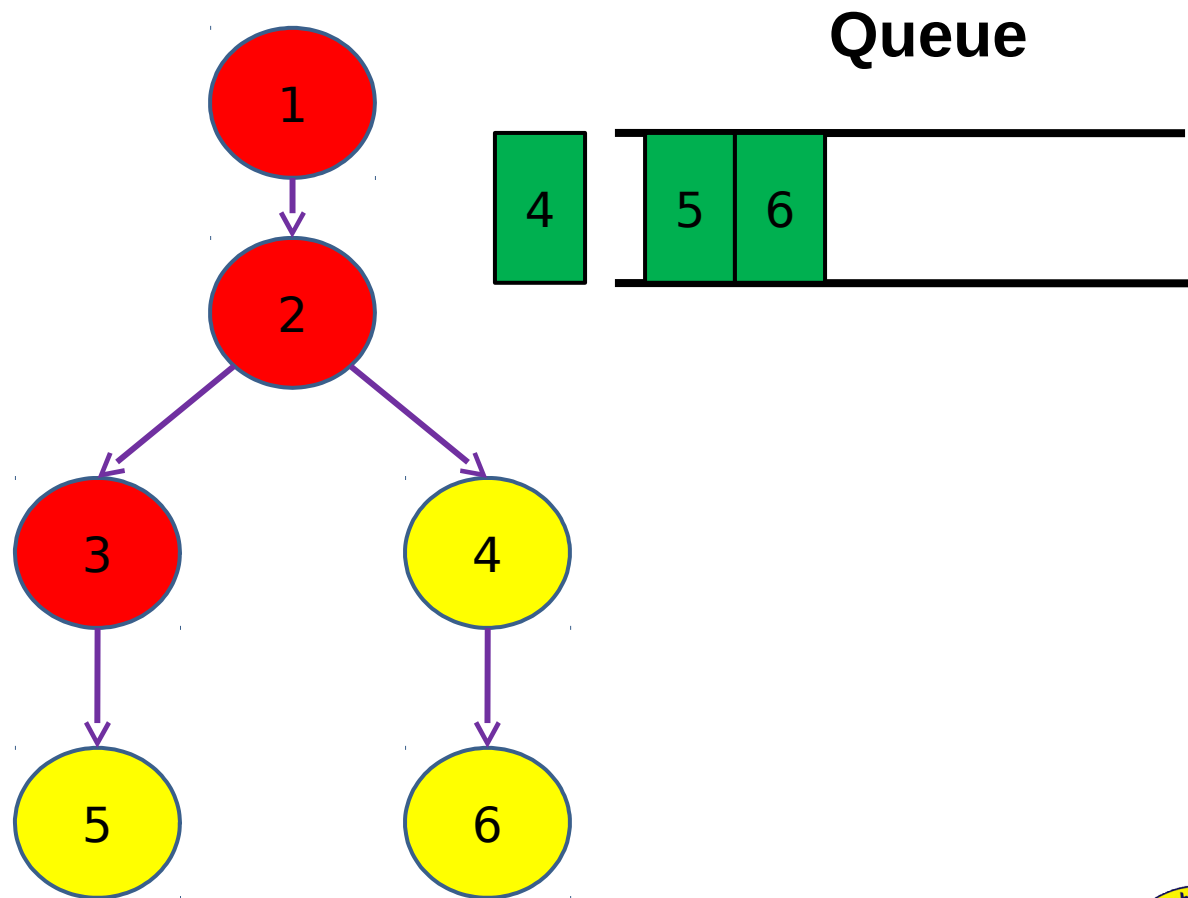
Queue



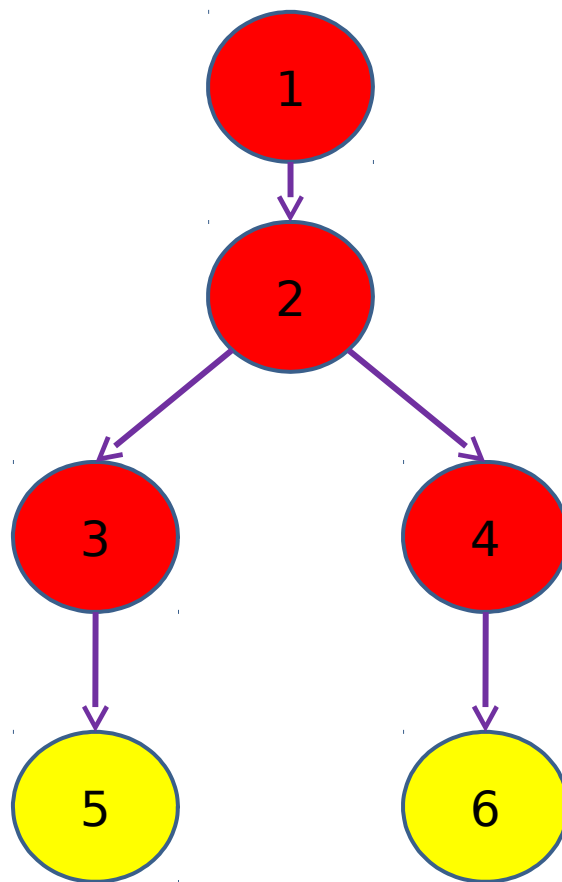
BFS



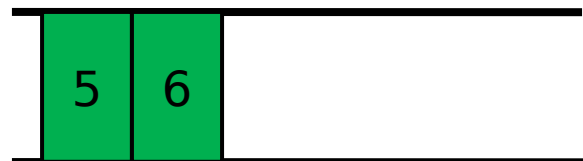
BFS



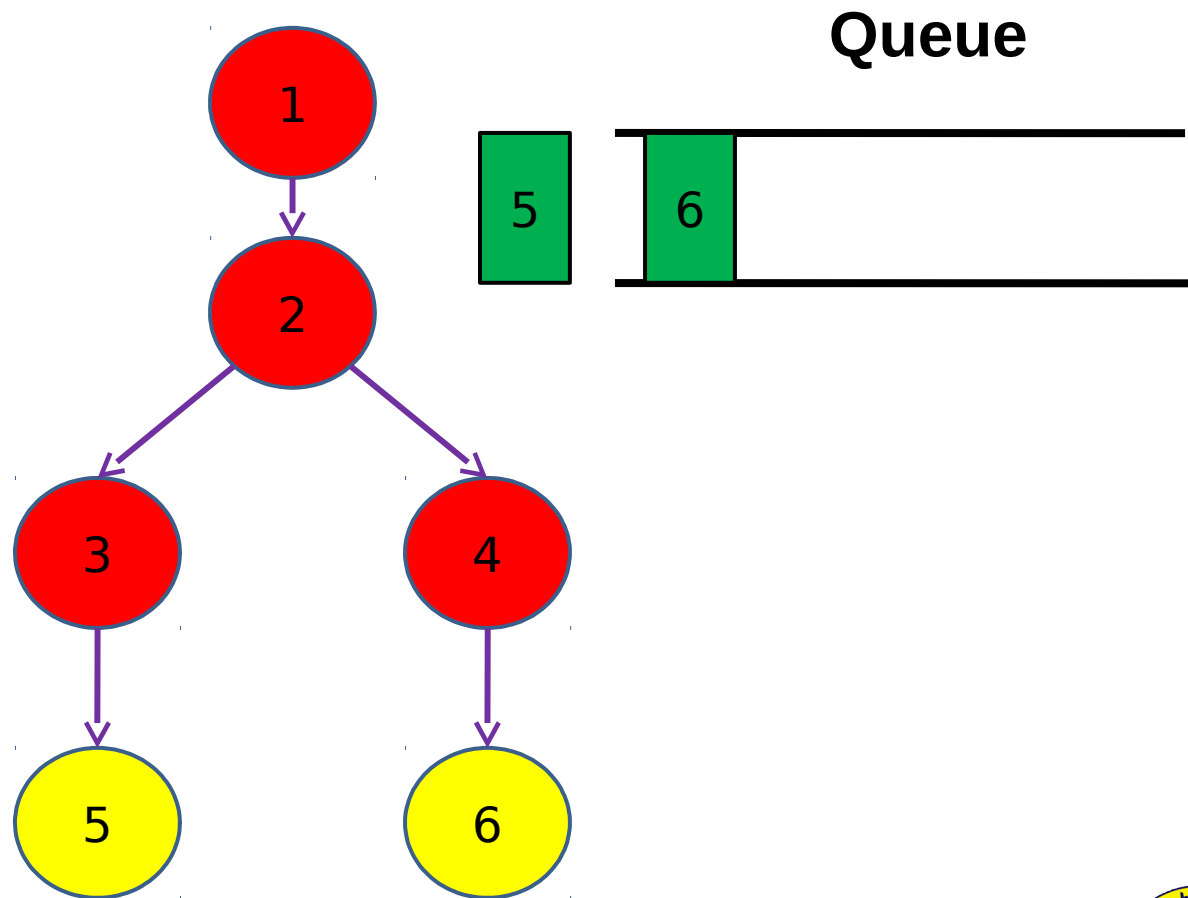
BFS



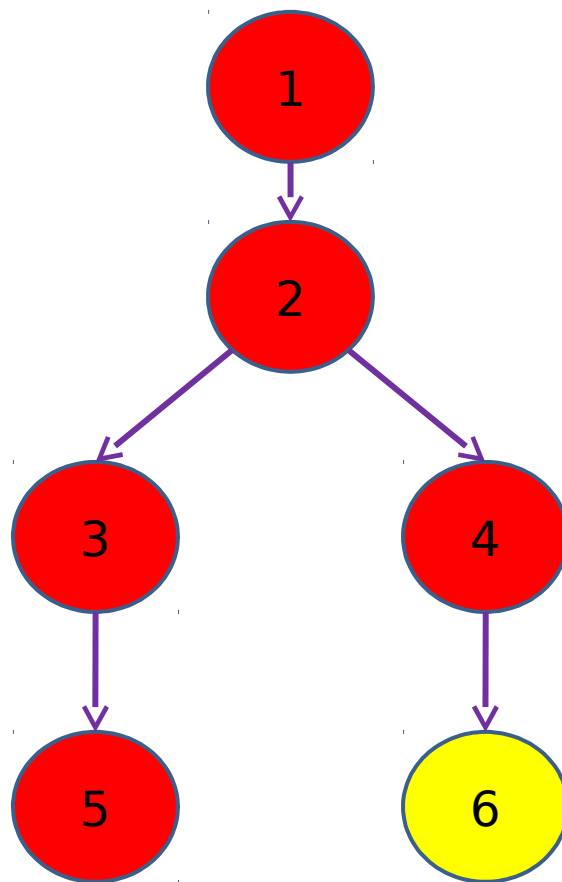
Queue



BFS



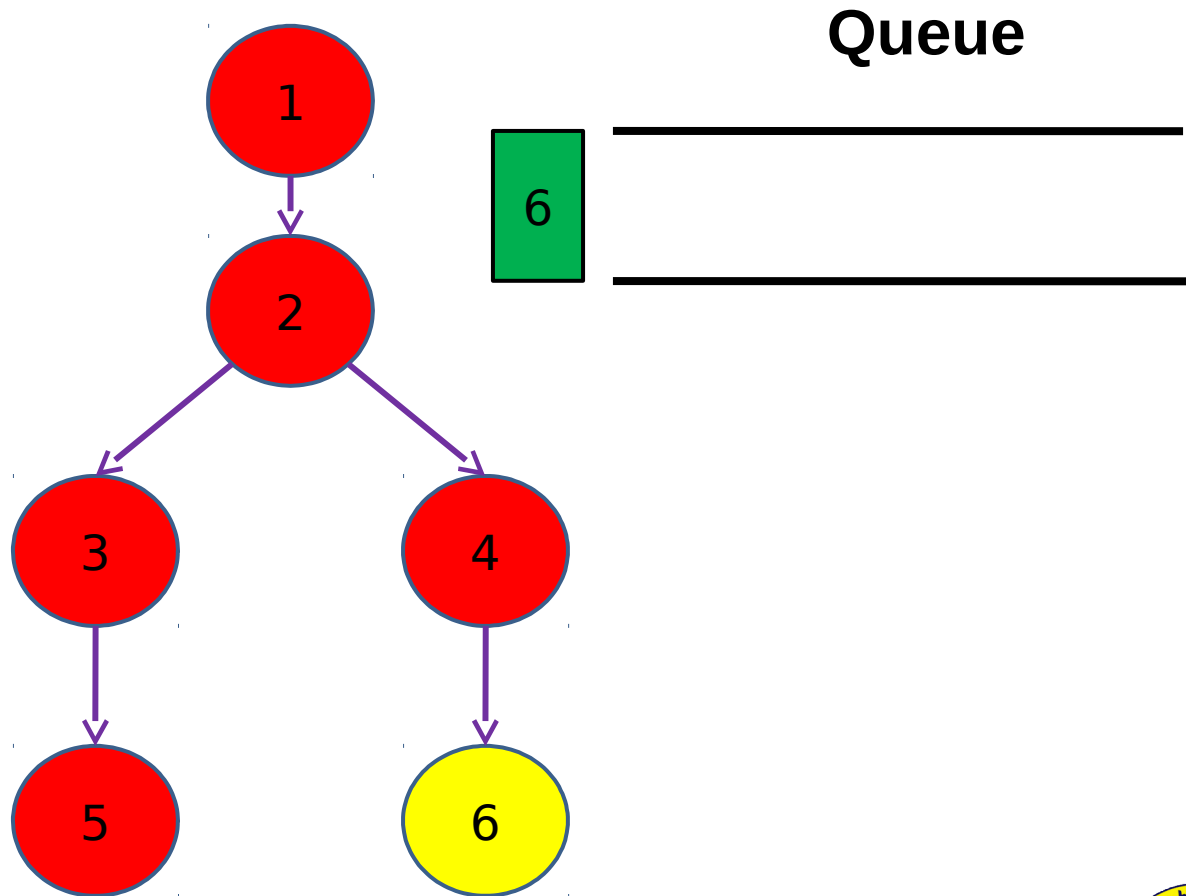
BFS



Queue

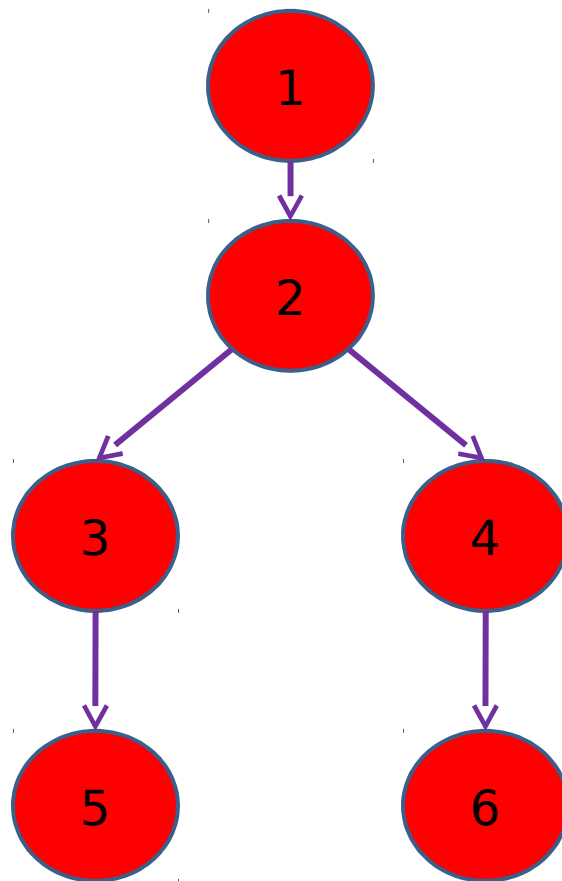


BFS



BFS

Queue



BFS

- Source Code (adjacency list)

```
void BFS(int root)
{
    queue<int> que;
    que.push(root);
    visited[root]=true;

    while(!que.empty())
    {
        int cur=que.front();
        que.pop();

        for(int i=0;i<adj[cur].size();i++)
        {
            int next=adj[cur][i];
            if(!visited[next])
            {
                visited[next]=true;
                que.push(next);
            }
        }
    }
    return;
}
```



BFS

- Practice

[UVA-532] Dungeon Master



- Skill:

```
int dir[4][2]={ {1,0},{-1,0},{0,1},{0,-1} }
```

☒ search four directions



- Skill:

```
int dir[4][2]={ {1,0},{-1,0},{0,1},{0,-1} };

void DFS(int cur_x,int cur_y)
{
    vis[cur_x][cur_y]=1;

    for(int i=0;i<4;i++)
    {
        int nx=cur_x+dir[i][0];
        int ny=cur_y+dir[i][1];

        //watch for boundary
        if( !vis[nx][ny])
            DFS(nx,ny);
    }
}
```



Time Complexity

DFS $O(V + E)$

BFS $O(V + E)$

V: the number of nodes

E: the number of edges

(adjacency list)



Time Complexity

DFS $O(V^2)$

BFS $O(V^2)$

V: the number of nodes

E: the number of edges

(adjacency matrix)



HW3

Totally 28 problems

UVa:

260,336,352,383,439,532,539,567,571,601,705,

762,10004,10009,10474, 10505,10592,10603, 10946, 11624

POJ:

1129,1154,1416,1606,1753,1915,1979,2243



Thank for Your Attention

