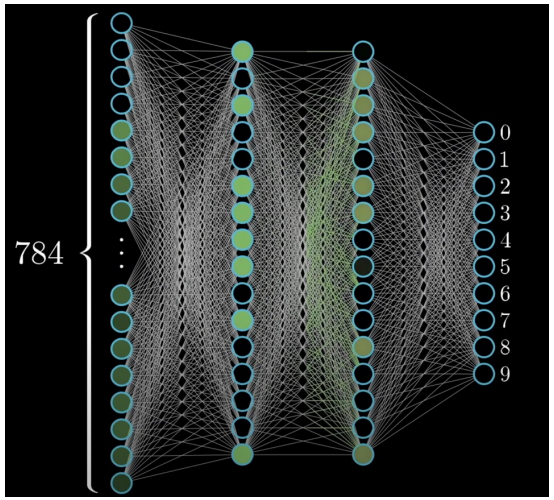
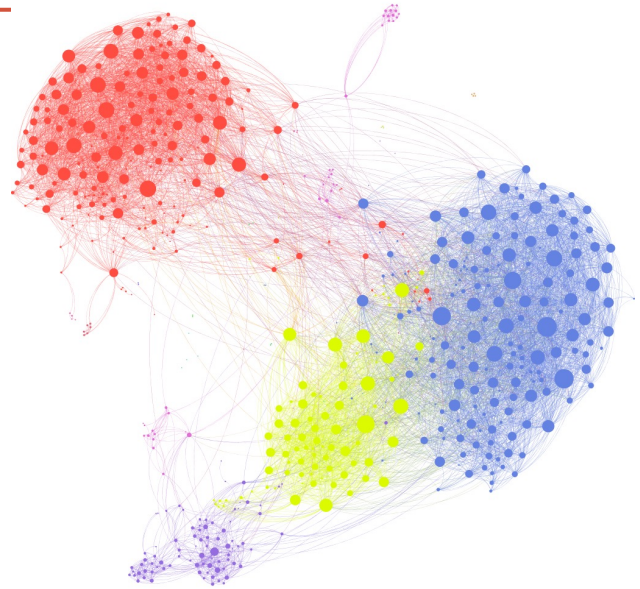
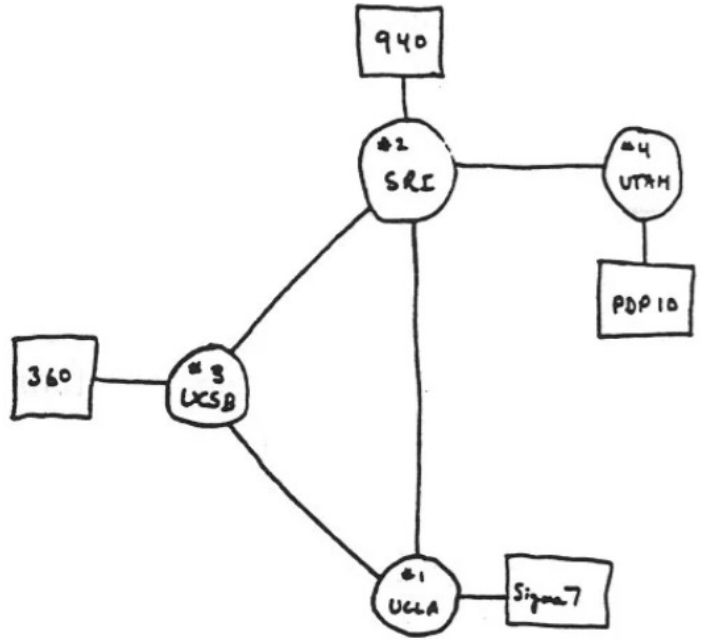
https://bit.ly/CS24-W24-Graph-Search-Complexity-Handout

# COMPLEXITY ANALYSIS GRAPH SEARCH ALGO






THE ARPA NETWORK

DEC 1969

4 NODES

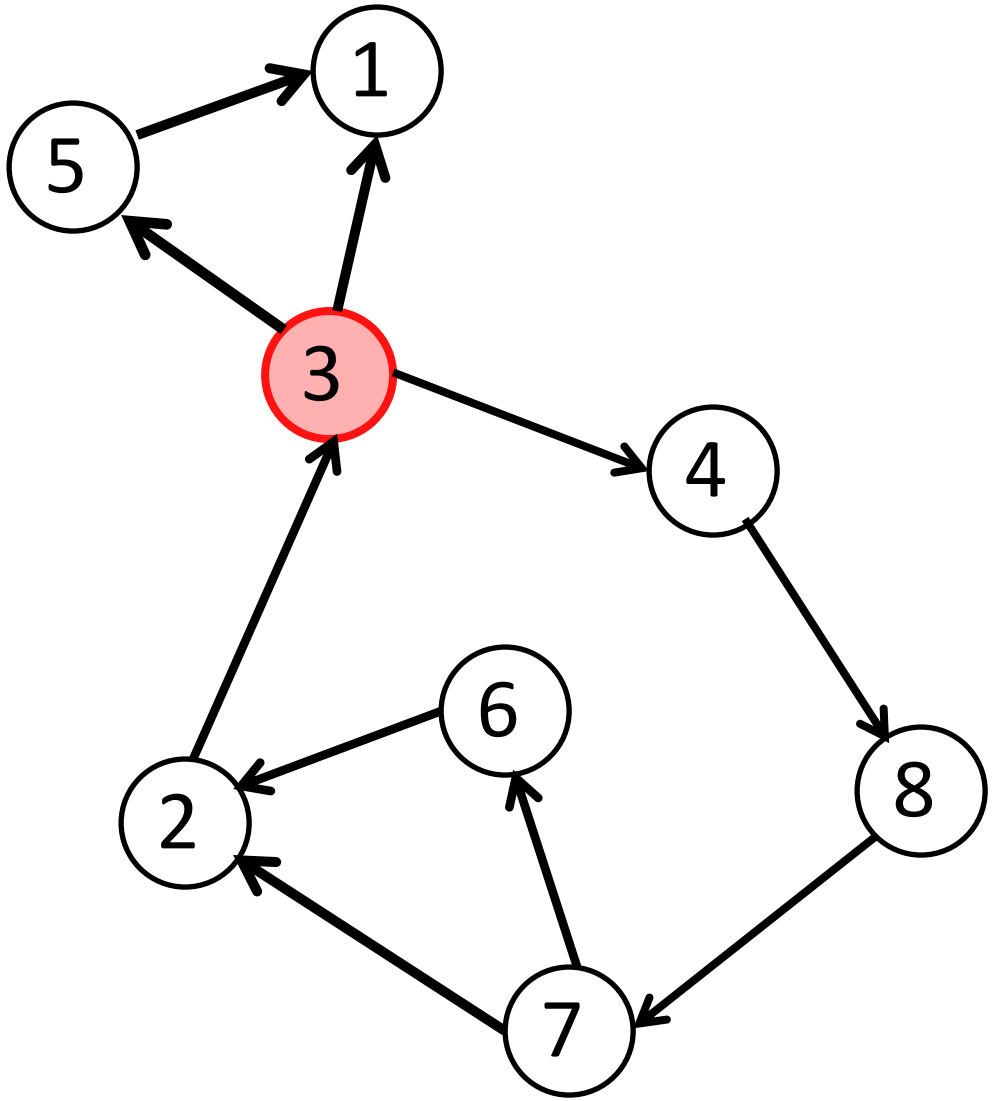
# BFS Traverse: Time Complexity

```
Algo exploreBFS(v):
  Mark all the vertices as “not visited”
  v.visited ← true
  Push v into a queue
  While queue is not empty:
    Pop the vertex from the front of the queue (v)
    For each edge (v,w)
       If not w.visited
          w.visited ← true
          Push w into the queue
```

n: number of vertices
m: number of edges

What is the time complexity of exploreBFS?
A. O(n)
B. O(m)
C. O(n + m)
D. O(n^2)
E. None of the above

# Breadth First –The Game

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# BFS Traverse: Space Complexity

```
Algo exploreBFS(v):
  Mark all the vertices as “not visited”
  v.visited ← true
  Push v into a queue
  While queue is not empty:
    Pop the vertex from the front of the queue (v)
    For each edge (v,w)
       If not w.visited
          w.visited ← true
          Push w into the queue
```

n: number of vertices
m: number of edges

What is the Big -O auxiliary space complexity of exploreBFS?

A. O(n)
B. O(m)
C. O(n + m)
D. O(n^2)
E. None of the above

- Auxiliary Space complexity: Additional space usage (not including input and output)

# exploreDFS: Time Complexity

```
exploreDFS(v)

  v.visited ← true

  For each edge (v,w)

    If not w.visited

      exploreDFS(w)
```

n: number of vertices
m: number of edges

What is the time complexity of exploreDFS?
A. O(n)
B. O(m)
C. O(n + m)
D. O(n^2)
E. None of the above

Slide credits: Professor Daniel Kane, UCSD

# Depth First Search: Time Complexity

```
DepthFirstSearch(G)

  Mark all v ∈ G as unvisited

  For v ∈ G

    If not v.visited, exploreDFS(v)
```

n: number of vertices
m: number of edges

What is the time complexity of Depth First Search?
A. O(n)
B. O(m)
C. O(n + m)
D. O(n^2)
E. None of the above

Slide credits: Professor Daniel Kane, UCSD

# exploreDFS: Space Complexity

```
exploreDFS(v)

  v.visited ← true

  For each edge (v,w)

    If not w.visited

      exploreDFS(w)
```

n: number of vertices
m: number of edges

What is the worst-case space complexity of exploreDFS?
A. O(n)
B. O(m)
C. O(n + m)
D. O(n^2+ n.m)
E. None of the above

Slide credits: Professor Daniel Kane, UCSD

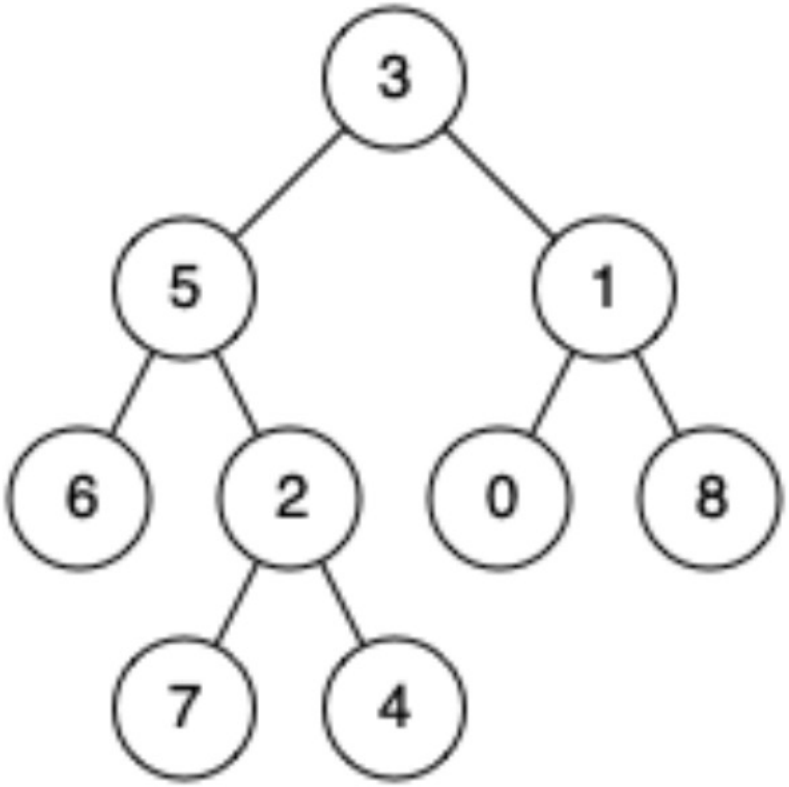
# Leetcode: Lowest Common Ancestor (LCA) of a binary tree

What is the LCA of each of the following?

5 and 1:

5 and 4:

3 and 1:




Discuss how you would solve the problem with your neighbor, implement in leetcode to check your answer

https://leetcode.com/problems/lowest-common-ancestor-of-a-binary-tree/

# Implement these functions from last week's handout

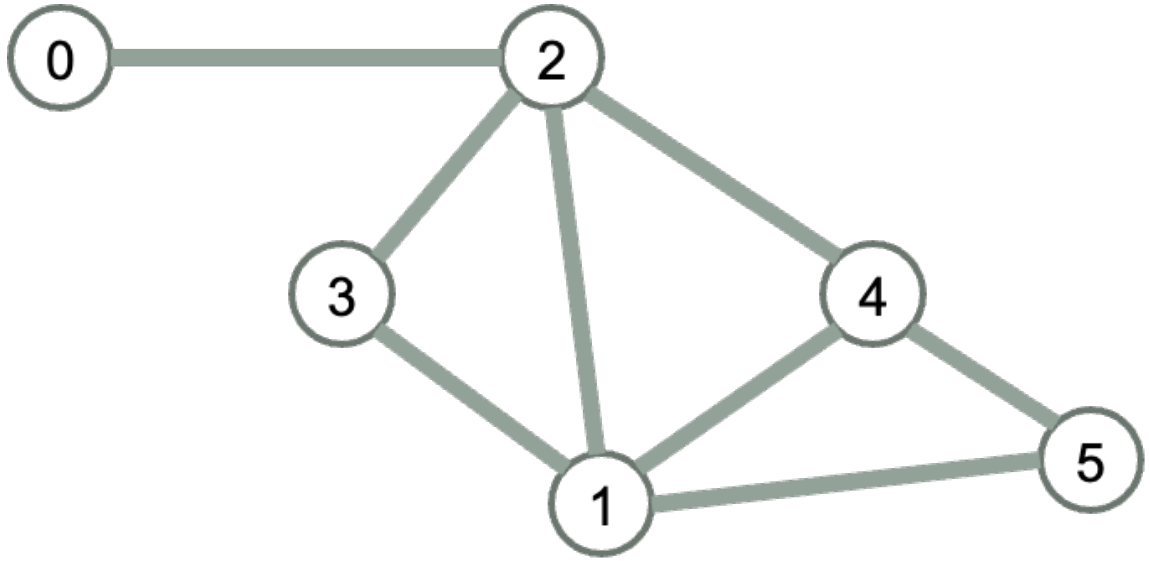
```
class graph{

  public:

      graph(int n = 0) { // n is the number of vertices

          _____________________________________

      }
A     void addEdge(int from, int to);   bool hasEdge(int i, int j) const;
B     vector<bool> bfs(int source) const;
C     bool isValidPath(const vector<int> & path) const; // returns true if the input path exists
D     bool isReachable(int source, int dest) const;  // returns true if a path exists from source to dest
  private:
      vector<_____________________________________> adjList;
};
```




Link to hand out: https://bit.ly/CS24W24-GraphsHandout