📘 Graph Algorithm Topics Roadmap

A structured list of graph topics from beginner to advanced. Ideal for interview prep, competitive programming, or academic learning.

🌱 Level 0: Basics

1. **Graph Representations**
    - Adjacency Matrix
    - Adjacency List
    - Edge List
2. **Graph Types**
    - Directed vs Undirected
    - Weighted vs Unweighted
    - Cyclic vs Acyclic
    - Connected vs Disconnected
    - Trees vs DAGs
    - Bipartite Graphs

🌿 Level 1: Graph Traversal

3. **Breadth-First Search (BFS)**
    - Shortest path in unweighted graph
    - Level-order traversal (trees)
4. **Depth-First Search (DFS)**
    - Recursive and iterative
    - Connected components
    - Detecting cycles (directed & undirected)
    - Coloring method (WHITE/GRAY/BLACK)

🌾 Level 2: Topological Concepts

5. **Topological Sort**
    - DFS-based
    - Kahn's algorithm (BFS + indegree)
    - Applications: course schedule, build systems
6. **Cycle Detection**
    - In undirected graphs (Union-Find / DFS)

- In directed graphs (DFS with colors or Kahn's)

7. **Strongly Connected Components (SCC)**
   - Kosaraju's Algorithm
   - Tarjan's Algorithm (low-link values)

🌿 Level 3: Shortest Paths

8. **Dijkstra's Algorithm**
   - For weighted graphs with non-negative weights
9. **Bellman-Ford Algorithm**
   - Handles negative weights
   - Detects negative cycles
10. **Floyd-Warshall Algorithm**
    - All-pairs shortest path (DP)
11. **0-1 BFS / Dial's Algorithm**
    - Optimized for edge weights 0 or 1

🌴 Level 4: Trees and Special Graphs

12. **Tree Traversals (DFS/BFS)**
13. **Lowest Common Ancestor (LCA)**
    - Binary Lifting / Euler Tour
14. **Diameter of Tree**
15. **Centroid Decomposition**
16. **Binary Tree to Graph Conversion**

🌳 Level 5: Minimum Spanning Tree (MST)

17. **Prim's Algorithm**
18. **Kruskal's Algorithm**
    - Union-Find (Disjoint Set Union)

🧠 Level 6: Advanced Graph Concepts

19. **Disjoint Set Union (Union-Find)**
    - With path compression and union by rank
20. **Bridges and Articulation Points**

- Tarjan's Algorithm
- Cut vertices and edges

21. **Eulerian Path and Circuit**
    - Hierholzer's Algorithm
    - Fleury's Algorithm
22. **Hamiltonian Path and Cycle**
    - NP-complete (backtracking or bitmask DP)

🚀 Level 7: Very Advanced / Competitive Topics

23. **Network Flow**
    - Ford-Fulkerson
    - Edmonds-Karp
    - Dinic's Algorithm
24. **Matching in Bipartite Graphs**
    - Hopcroft–Karp
    - Kuhn's Algorithm
25. **Heavy-Light Decomposition (HLD)**
26. **2-SAT Problems**
27. **Dynamic Connectivity**
    - Link-Cut Trees
    - Euler Tour Trees

🧭 Recommended Progression

> Start at Level 0 and go in order.
>
> - For Interviews: Level 0–5 is usually enough.
> - For CP or Research: Continue through Level 6–7.