Graph Representation and Traversal

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Introduction to Graphs:

- Graphs are mathematical structures used to represent relationships between pairs of objects.
- They consist of vertices (nodes) connected by edges (links).

Graph Representation:

1. **Adjacency Matrix:**
    - A 2D array where the presence of an edge between two vertices is indicated by a 1, and absence by 0.
    - Suitable for dense graphs with many edges.
2. **Adjacency List:**
    - Each vertex maintains a list of its neighboring vertices.
    - Efficient for sparse graphs with fewer edges.

Graph Traversal Techniques:

1. **Depth-First Search (DFS):**
    - Explores as far as possible along each branch before backtracking.
    - Uses a stack or recursion to keep track of visited nodes.
    - Useful for topological sorting, connected components, and cycle detection.
2. **Breadth-First Search (BFS):**
    - Explores all neighbors at the present depth before moving to the next level.
    - Uses a queue to maintain the order of visited nodes.
    - Ideal for finding shortest paths and connected components.

Applications of Graph Traversal:

- **Shortest Path Algorithms:** Dijkstra's Algorithm, Bellman-Ford Algorithm.

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- **Minimum Spanning Tree Algorithms:** Prim's Algorithm, Kruskal's Algorithm.
- **Network Routing Protocols:** OSPF, BGP.
- **Social Network Analysis:** Finding influencers, detecting communities.
- **Web Crawling:** Discovering and indexing web pages.

Conclusion: Understanding graph representation and traversal techniques is fundamental in solving various real-world problems efficiently. Mastery of these concepts enables the development of algorithms for a wide range of applications in computer science and beyond.