Introduction to Graphs in CP

-KDVinit

Note:

- Do **consider watching youtube and lecture at 1.5x or 2x.**
- The youtube links for basic concepts are repeated, so see the one that suits you.
- All the code are taken from the best website for CP, **CP Algorithm**.
- Link to the main lecture (To get started) - **Basic-Graph-Theory**
- DFS Template From The Lecture can be found here - **DFS-Template**

General Description: Introduction to Graph Theory

- Directed or Undirected
- Weighted or not (each = 1)

Special Types:

1. Trees
    - Introduction to Trees
    - Terminology in Trees

2. Directed Acyclic Graphs (DAG)
    - Basic and Topological Sort
    - Application of Topological Sort

3. Bi-Partite Graphs
    - Bipartite Matching

Basic Concepts:

1. DFS - Depth-First Search
    - Depth First Search Algorithm
    - DFS and BFS Examples
    - Depth First Traversal for a Graph | GeeksforGeeks
    - **Code** - Depth First Search - Competitive Programming Algorithms

2. BFS - Breadth-First Search
    - Breadth First Search Algorithm
    - Breadth First Traversal for a Graph | GeeksforGeeks
    - **Code** - Breadth First Search - Competitive Programming Algorithms

3. Finding Cycles - DSU
    - Disjoint Sets
    - Union-Find Algorithm - **Cycle Detection** | GeeksforGeeks
    - Union Find Introduction
    - Union Find - Union and Find Operations
    - Union Find Path Compression
    - **Code** - Disjoint Set Union - Competitive Programming Algorithms

4. Shortest Path -
    - Dijkstra
        - Dijkstra's Shortest Path Algorithm | Graph Theory
        - Dijkstra Algorithm - Single Source Shortest Path - Greedy Method
        - Dijkstra Algorithm- single source shortest path| Example
        - **Code** - Dijkstra Algorithm - Competitive Programming Algorithms

    - Floyd-Warshall
        - Floyd Warshall All Pairs Shortest Path Algorithm
        - All Pairs Shortest Path (Floyd-Warshall) - Dynamic Programming
        - Floyd Warshall Algorithm
        - **Code** - Floyd-Warshall algorithm - CP Algorithms

    - Bellman Ford
        - Bellman Ford Algorithm | Shortest path & Negative cycles
        - Bellman Ford Algorithm-Single Source Shortest Path | DP
        - Bellman Ford Algorithm
        - **Code** - Bellman-Ford Algorithm | CP Algorithm

5. MST - Minimum Spanning Tree
    - Kruskal
        - Prims and Kruskals Algorithms - Greedy Method
        - Union Find Kruskal's Algorithm
        - Kruskal’s Algorithm for Minimum Spanning Tree | GeeksforGeeks
        - **Code -** Minimum spanning tree - Kruskal

    - Prim
        - Prim's Minimum Spanning Tree Algorithm | Graph Theory
        - Prim's Algorithm for MST(with Code Walkthrough) | GeeksforGeeks
        - Spanning Tree | MST | Graph Theory
        - **Code -** Minimum spanning tree - Prim's algorithm

6. Topological Sort Code: Topological Sorting - Competitive Programming Algorithms

Some Advanced Topics:

- Fenwick Tree
- Sqrt Decomposition
- Segment Tree
- Sqrt Tree
- Randomized Heap
- Suffix tree. Ukkonen's algorithm
- D´Esopo-Pape algorithm
- Kirchhoff's Theorem
- Prüfer code
- Finding the Eulerian path in O(M)
- Negative Cycle Search
- Lowest Common Ancestor
- Lowest Common Ancestor - Binary Lifting
- Maximum flow - Ford-Fulkerson and Edmonds-Karp
- Check whether a graph is bipartite
- Kuhn's Algorithm for Maximum Bipartite Matching
- Heavy-light decomposition

Codeforces Problems on DFS: (To Get Started)

(Some problems can be done without DFS aswell, so catch them)

- New Year Transportation
- Bmail Computer Network
- Xor-tree
- Send the Fool Further! (easy)
- Kefa and Park
- Brain Network (easy)
- Brain Network (medium)
- Andryusha and Colored Balloons
- Military Problem
- Kuro and Walking Route
- Also try the problems in the end of the code at CP Algorithm, for basic problems, they will be really nice
- Best way to find problems is go to codeforces and search by tag, but make sure you start with the problems with lower rating and gradually go up.
- Also if for some concept you are not able to find tag, just search - “<Concept Name> Codeforces” on Google and you will definitely fine some amazing blog on codeforces with problems about that topic from all over the internet.

Best Codeforces Blogs for Graph Theory:

- Algorithm Gym :: Graph Algorithms
- Graphs Problems
- Graph Theory Course For Beginners : CodeNCode (YouTube)