

7 Real-World Applications of Graph Theory

This problem set combines multiple graph theory concepts to solve real-world problems, integrating graph representation, connectivity, coloring, matching, and planarity.

7.1 Exercise 1: Social Network Analysis

Task: Given a social network graph, find the most influential person using centrality measures (degree, closeness, betweenness).

Hint: Use NetworkX's built-in centrality functions.

7.2 Exercise 2: Optimal Delivery Routing (Shortest Path & MST)

Task: Model a city's road network as a graph and find the optimal delivery route.

Hint: Use Dijkstra's algorithm for shortest paths and Prim's/Kruskal's algorithm for MST.

7.3 Exercise 3: Scheduling Exams Using Graph Coloring

Task: Assign exam slots to courses based on student enrollment constraints.

Hint: Model this as a graph coloring problem.

7.4 Exercise 4: Internet Network Robustness (Connectivity & Cut Edges)

Task: Identify critical routers in a network whose failure would disconnect users.

Hint: Compute articulation points and bridges.

7.5 Exercise 5: Maximum Job Matching (Bipartite Matching)

Task: Match job seekers to available jobs based on qualifications.

Hint: Use the Hopcroft-Karp or Hungarian algorithm.

7.6 Exercise 6: Airline Flight Optimization (Eulerian & Hamiltonian Paths)

Task: Find an optimal path covering multiple cities while minimizing fuel costs.

Hint: Model flights as a directed weighted graph.

7.7 Bonus Challenge 1: Traffic Flow Optimization (Max-Flow)

Task: Given a city's road network, determine the maximum traffic flow possible between two locations.

Hint: Implement the Ford-Fulkerson algorithm.

7.8 Bonus Challenge 2: Planarity Testing in Circuit Design

Task: Given an electronic circuit schematic, check whether it is planar.

Hint: Apply Kuratowski's theorem.