

Algorithms for Programming Contests SS20 - Week 05

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A: Railroad Network - Sample Solution

Problem

Find out how many goods can be transported between two cities.

A: Railroad Network - Sample Solution

- ▶ Nodes: cities.
- ▶ Edges: railroad connections.
- ▶ Capacities: as given in the input.
- ▶ Output: value of a maximum flow.
- ▶ There is always a maximum flow with integral values if the capacities are integral.

B: Fine Dining - Sample Solution

- ▶ Given: exactly one of each food and drink
- ▶ Given: preferences of friends for one of each
- ▶ Find the maximum amount of preferences that can be satisfied

B: Fine Dining - Sample Solution

- ▶ Make a bipartite graph with main dishes on one side and beverages on the other.
- ▶ Add an edge between a main dish and a beverage if one of the people wants to order that combo.
- ▶ The maximum amount of satisfied people is a *maximal matching*.
- ▶ Compute the maximal matching using for example Maximum Flow algorithms.

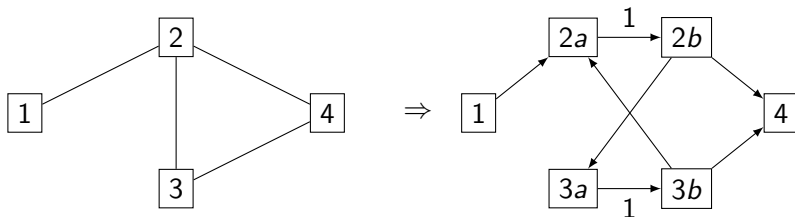
C: Connectivity - Sample Solution

Problem

Find the minimum amount of devices that have to fail for Lea to lose her connection to the internet.

C: Connectivity - Sample Solution

- ▶ Problem is a minimum s - t vertex cut.
- ▶ Split nodes to transform to a minimum s - t edge cut.
- ▶ Apply the max-flow min-cut theorem: maximum flow is equal to the minimum cut.
- ▶ Use Push-Relabel or Dinic's algorithm to determine this value.
- ▶ As maximum flow is bounded by n , Ford-Fulkerson also works.



D: Football Champion - Sample Solution

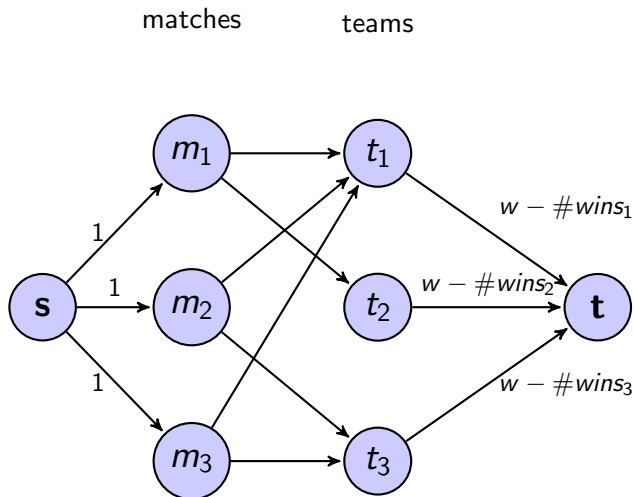
Problem

Find out if a given team can still win the Football Tournament.

D: Football Champion - Sample Solution

- ▶ Flow problem (also known as the Baseball elimination problem)
- ▶ Choose a team T , set all its matches to be won, resulting in w wins.
- ▶ Model matches as sources, capacity: 1 (win).
- ▶ Model teams as sinks, capacity: $w - \text{\#wins}$.
- ▶ Find maximum flow.
- ▶ Team T can win the cup iff the maximum flow has a value of \#matches .

D: Football Champion - Sample Solution



E: Goat Riders - Sample Solution

Problem

Given a grid of locations, move goat riders in it in such that they do not freeze to death.

E: Goat Riders - Sample Solution

Solution

Model as a Maximum Flow Problem

- ▶ For every timestep:
 - ▶ Add one node per grid location with node capacity of 1.
 - ▶ Remove grid locations that are inaccessible at this timestep.
 - ▶ Add edges between timesteps if a rider can move from grid location a to grid location b .

E: Goat Riders - Sample Solution

