COMP4128 Week 09 Tutorial

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https://github.com/hharryyf/COMP4128-23T3-tutoring

Outline

- Soldier and Traveling
- Exploration plan
- Problem Set 7 hints by email

Soldier and Traveling

In the country there are n cities and m bidirectional roads between them. Each city has an army. Army of the i-th city consists of a_i soldiers. Now soldiers roam. After roaming each soldier has to either stay in his city or to go to the one of neighboring cities by at moving along at most one road. Check if is it possible that after roaming there will be exactly b_i soldiers in the i-th city. ($n \leq 100$, $m \leq 200$)

Soldier and Traveling

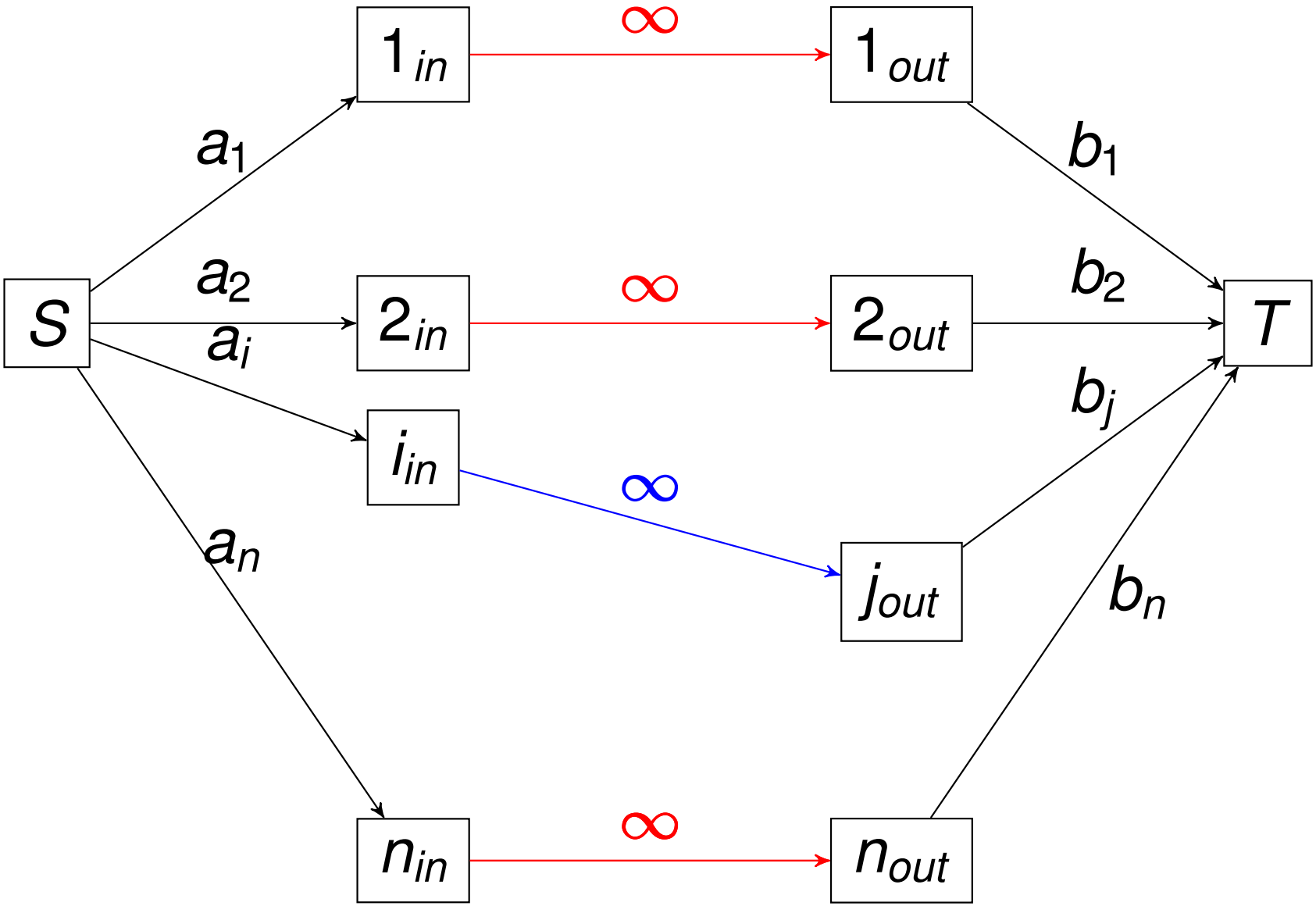
- Classic matching problem
- Design a flow network such that the answer is yes if and only if the maximum flow in the network is equal to $\Sigma_{i=1..n}\ a_i$ and $\Sigma_{i=1..n}\ b_i$
- What is the source?
- What is the sink?
- How to connect the source(s) and sink(s)?

Soldier and Traveling

Solution

- Each city i is a source
- Each city i' is a sink
- Connect super source s to i with capacity a_i
- Connect i' to super sink t with capacity b_i
- Connect i and j' if and only if $i = j'$ or there's an edge between i and j', capacity ∞

Soldier and Traveling



Soldier and Traveling

Demo

Exploration plan

There are V cities and E bi-directional roads, each road has a weight t_i meaning the time needed to cross that road. There are N teams and the competitors came up with the following plan: each of the N teams will start their journey in one of the V cities. Teams can share the same starting position. Find the shortest time T, such that every team can move in these T minutes, and the number of different cities they end up in is at least K. A team doesn't have to be on the move all the time.
($T \leq 1731311, V \leq 600, E \leq 20,000, N \leq min(V, 200)$)

Exploration plan

Hints

- Why the problem says $T \leq 1731311$?

Exploration plan

Hints

- Why the problem says $T \leq 1731311$?
- For a T, do you know if the number of distinct cities the team ends up with is at least K?

Exploration plan

Hints

- Why the problem says $T \leq 1731311$?
- For a T, do you know if the number of distinct cities the team ends up with is at least K?
- Have we seen something similar?

Exploration plan

Hints

- Why the problem says $T \leq 1731311$?
- For a T, do you know if the number of distinct cities the team ends up with is at least K?
- Have we seen something similar?
- Minimization problem to validation problem.
- Binary search!

Exploration plan

Solution

- Run Floyd to find the all pair shortest path
- Binary search to find the smallest T
- Construct a bipartite graph
- Add an edge between i and j' if and only if $dist(i,j) \leq T$
- T is valid if the maximum bipartite matching $\geq K$
- Time complexity $O(V^3 + V^{5/2} log(T))$

Exploration plan

Demo

Reminder

- The “coverage” of tutorial problems and problem set 7 problems is unsatisfactory
- Very important problems in the lecture slide
  - project selection
  - magic hours
- Critical but not in the practice problems
- Additional practice problems:
  - Flood Fill [1] (SEERC 2021 problem I)
  - Bilingual [2] (2015 Code Jam)
- Do them before the final exam!

[1] https://codeforces.com/gym/103438/problem/I

[2] https://codeforces.com/gym/100692/problem/C