CPSC 320 2016W2: Quiz 2 Pre-Release Information

January 22, 2017

This week's quizzes will follow up on the problem domains described below. It's worth spending a few minutes reading and understanding each domain before your tutorial!

Note that if you collaborate on understanding this information, you should follow the academic conduct guidelines. Among other rules, take down the GradeScope student #s or account names of collaborators for acknowledgment, but take **no other notes** away from those collaborations!

NOTE: The names of problems and (on the quiz and assignment) subproblems are often intended to be fun and are completely irrelevant. Feel free to ignore them here, on the quiz, and on the assignment!

1 Cluedo Something to Me

The new game Clue II (CII, for short) is about a group of n people, each intent on stealing one of n objects. Each person moves about a mansion picking up and putting down objects but never holding the same object twice or holding any one object more than once. When they reach the object they want to steal, they pick it up and immediately flee the mansion with it, picking up no more objects.

Crucially, however, no one discovers anyone else has stolen anything. So, no one ever goes to pick up an object, only to find it missing.

As a player, you receive a list of clues, each of which is in one of two forms:

- "person" clues: person p_i was supposed to hold object o_j before object o_k, and
- "object" clues: object o_i was supposed to be held by person p_j before person p_k

(The clues describe what happens up to the point where a person steals an item; from that point on, the person picks up no more items, no matter what the clues say.)

So, an instance of the game is a value n, a list of person clues (i, j, k), and a list of object clues (i, j, k). No clue is repeated. No set of clues for a particular person (or a particular object) is inconsistent in the sense that it demands (directly or indirectly via a chain of clues) that person p_i hold o_j both before and after o_k (and similarly for object clues).

Your goal is to propose an item for each person to steal so that the thefts could have happened without anyone discovering that any other item was stolen.

For example, with the object clue "the candle was supposed to be held by Squirrel Girl before Koi Boy" and the person clue "Koi Boy was supposed to hold the candle before the pipe", it could **not** be the case that Squirrel Girl stole the candle and Koi Boy stole the pipe because:

- before Koi Boy can pick up and steal the pipe, Koi Boy must pick up the candle, and
- before Koi Boy can pick up the candle, Squirrel Girl (who held it first) must have already stolen it,
- but then Koi Boy would discover the theft of the candle.

You may use the topological sort algorithm (topo-sort) as needed in this problem. Topological sort takes a directed graph with no cycles (a directed, acyclic graph) and produces a left-to-right ordering of the vertices in the graph such that all edges point to the right. It runs in $O(m + n)$ time (where $m = |E|$ and $n = |V|$).

2 Labour of Love

We define an undirected, positive-integer-weighted graph to be $G = (V, E, W)$, where V is a set of vertices, E is a set of edges (u, v) where $u, v \in V$ and we consider the tuples to be unordered, and W is a function that maps edges (u, v) to their positive, integer weights w. (The graph may not have self-loops.)

We define the result of contracting an edge (u, v) in such a graph to be the new graph $G' = (V - \{v\}, E', W')$. E' contains all "uninvolved" edges (s, t), those where neither s nor t is u or v. The weights of these edges under W' are unchanged from their weights under W. Furthermore, E' contains an edge (t, u) (for t not equal to u or v) exactly when E contains an edge (t, u) or (t, v) or both. If E only has (t, u) and not (t, v) or if E only has (t, v) and not (t, u), then the weight of (t, u) under W' is the same as that one corresponding E edge's weight under W. If E contains both (t, u) and (t, v), then the weight of (t, u) under W' is the sum of the weights of (t, u) and (t, v) under W.

In other words, when we contract an edge, we merge the two vertices on either side of the edge into one, remove the edge that connected them, and "sum" pairs of edges that used to lead from one other vertex to each of the now-merged vertices into a single edge with the total weight of the two old edges.

3 The Biggest Slice of Π

You have been given an array of daily gains G for a stock over the course of n days. A gain of 1.35 for a day, for example, means that \$1.00 invested in the stock at the start of the day would be worth \$1.35 at the end of the day (and the start of the next day). A "gain" of 0.5 would mean that \$1.00 invested at the start of the day would be worth only \$0.50 at the end of the day. All gains are positive numbers. You are reviewing potential earnings from investments in this stock.

4 Access Allowed

Based on accessibility guidelines, an institution has classified all of its campus's pathways connecting points of interest into three groups, those that are: at recommended specifications (R), at minimum specifications (M), and below minimum specifications (X). For each pathway that is rated M or X, you also have a cost to upgrade to the higher specification(s). Occasionally, that cost is indicated at ∞ where it's considered impossible to perform the upgrade.

Note that a "pathway" may take any of various forms (e.g., a flight of steps), but that it will always connect exactly two points of interest. Furthermore, although two points of interest may be physically connected "in the real world" by multiple pathways (e.g., a flight of stairs and an elevator), the "logical" pathway will appear only once in the data rated according to the most accessible of the physical pathways connecting the two points.