2014 Rocky Mountain Regional Programming Contest

Solution Sketches

Credits

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Server

- xxx submissions, xxx correct, first correct: xxx minutes
- Straightforward
- Process each task in order, keeping track of the total number of minutes so far.

Eligibility

- xxx submissions, xxx correct, first correct: xxx minutes
- Straightforward
- Just apply the rules one at a time, stopping as soon as a decision is known.
- No need to look at month/day of a date, just the year.

Plane Ticket Pricing

- xxx submissions, xxx correct, first correct: xxx minutes
- Dynamic Programming
- Let $f(n, w)$ = the maximum revenue that can be obtained when there are n seats left and w weeks before the flight.
- Base case: $f(n, w) = 0$ when $n \leq 0$ or $w < 0$.
- Recursion:
  $f(n, w) = \max_{1 \leq i \leq K_w} \{f(n - s_{i,w}, w - 1) + p_{i,w} \cdot s_{i,w}\}$
- Minor adjustment above if $n < s_{i,w}$.
- Complexity: $O(NWK)$

Facility Locations

- xxx submissions, xxx correct, first correct: xxx minutes
- We can model this as a bipartite graph: one set of nodes are the clients, and the other set of nodes are the potential locations.
- We connect a client to a location if the cost is 0.
- The locality property implies that each connected component is a complete bipartite subgraph—so each connected component can be served by just one facility.
- i.e. If the number of connected components is at most k, then it is possible.

Repeated Substrings

- xxx submissions, xxx correct, first correct: xxx minutes
- Use suffix arrays and the Longest Common Prefix (LCP) array.
- Whenever LCP[i] $>$ LCP[$i-1$], the difference is the number of unique substrings repeated.
- Sum up all such differences.
- For the first sample input "aabaab"

Prefix	LCP
aab	0
aabaab	3
ab	1
abaab	2
b	0
baab	1

Landline Telephone Network

- xxx submissions, xxx correct, first correct: xxx minutes
- Form the weighted undirected graph as given.
- Without any insecure buildings, this is just the standard Minimum Spanning Tree problem.
- The insecure buildings must be leaves in the spanning tree, the other ones can be internal nodes or leaves.
- Compute the MST without the insecure buildings. For each insecure building, connect it to the MST using the cheapest edge.

Aquarium Tank

- xxx submissions, xxx correct, first correct: xxx minutes
- Two possible approaches (among others):
- First approach: “walk up” the polygon and figure out how high the water goes.
- Second approach: guess the height and compute the resulting volume. Use binary search to refine the height.
- Either way: need to intersect polygon with horizontal lines, and compute the area of a polygon or trapezoid.

Restaurant Ratings

- xxx submissions, xxx correct, first correct: xxx minutes
- Approach 1: make use of the fact that the number of integer solutions $x_1, \ldots, x_n \geq 0$ such that $x_1 + \cdots + x_n = r$ is $\binom{r+n-1}{r}$.
  - We can find the number of ratings less than the given total.
  - Use the above to find the number of worse ratings with the same total, but with the same first k ratings
- Approach 2: Dynamic Programming
  - State is (a, k, s) : a is rating already worse?, k rating index, s remaining rating sum.
  - $f(1, k, s) = \sum_{i=0}^{s} f(1, k+1, s-i)$
  - $f(0, k, s) = f(0, k+1, s-r_k) + \sum_{i=0}^{r_k-1} f(1, k+1, s-i)$
    $+ \sum_{i=r_k+1}^{s} f(1, k+1, s-1-i)$
  - base case $f(x, n, y) = f(x, y, 0) = 1$, answer is $f(0, 0, S)$ where S is the total rating

Locked Treasure

- xxx submissions, xxx correct, first correct: xxx minutes
- The answer is $\binom{n}{m-1}$.
- For each subset of $m - 1$ bandits, there must be at least one lock that they cannot open (lower bound).
- For each subset of $m - 1$ bandits, have one lock such that the keys are distributed to all others who are not in the subset. Any group of m bandits must have a key to every lock (upper bound).

Yet Satisfiability Again!

- xxx submissions, xxx correct, first correct: xxx minutes
- Exhaustive search.
- Just try all possible 2^n truth-value assignment to the variables and test if the clauses are all satisfied.