2017 Rocky Mountain Regional Programming Contest

Solution Sketches

Credits

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A - Hissing Microphone (52/52)

- Check if the string contains “ss” as substring

- The computation of calculated BPM is straightforward—just use the given formula $\frac{60b}{p}$.
- For the minimum actual BPM, we find the maximum time between two beats based on the given measurement.
  - This is $\frac{p}{b-1}$
  - This happens when a beat is detected at the very beginning and the very end of the measurement period p.
- Similarly, for the maximum actual BPM, the minimum time between two beats is $\frac{p}{b+1}$ — if a beat occurs just before the measurement period and another beat occurs just after.

- Sort both tasks and quiet intervals.
- For each quiet interval, find the longest task that can fit - greedy works (do not consider already checked tasks again).

E - Palindromic Password (39/52)

- Observation (hinted in statement) - six digit palindromes are relatively close to each other (e.g. 234432 - 235532).
- For each difference d(starting with 0) check if $N - d$ or $N + d$ are palindromes.
- $N = 100000$ is a special case

G - Decisions, Decisions (11/14)

- This can be approached top-down or bottom-up.
- Top-down approach:
  - If the root is a leaf, then it can be represented as one node (with the labelled value);
  - Otherwise, recursively inquire the left and right subtree.
  - If both subtrees can be represented as one node and their values are the same, then the entire tree can be merged.
- Can be done in $O(2^n)$ steps.

J - Particle Collision (6/13)

- If a circle centered at (x_1, y_1) with radius r is moving in the direction (x_v, y_v), we can determine if the circle centered at (x_2, y_2) is hit by solving:

$$||(x_1 + t \cdot x_v - x_2, y_1 + t \cdot y_v - y_2)|| = 2r$$

  This is a quadratic equation in t.

- Find first point of intersection (smallest $t > 0$), determine the next direction.
- Just try all the cases and simulate.

C - Multiplication Game (6/16)

- Two parts
- First part - factor N
- Second part - minimax algorithm
- Alternatively - case analysis (odd/even number of primes, who cannot win and what can they try in order to draw?)

F - Flow Free (4/6)

- Try all colorings of the grid (4^8 or 3^{10}, depending on the number of colors)
- For each fully colored board, for each color, try to find a path between given cells that contains all cells of the same color.
- Or just try paths of each colour at the same time.

D - Polyline Simplification (3/17)

- The main task is to repeatedly find the interior point with the smallest associated triangle and remove it.
- Removing a point removes one triangle but changes the two neighbouring triangles.
- Use a priority queue (heap) to find the next point to remove.
- Care has to be taken to invalidate neighbouring triangles when a point is removed (many approaches).
- Complexity is $O(n \log n)$.

I - Initials (0/9)

- DP - State is current student and the number of added characters to the previous one's initials, such that order matches their full names (minimize added characters).
- DP state can also contain current student and number of removed characters such that order is preserved (maximize removed characters).

B - Open-Pit Mining (0/11)

- For each block, represent it as a vertex with a value $w_i = v_i - c_i$.
- For each relationship "i blocks j", add an edge $j \to i$ with infinite capacity.
- Add a source node, connecting source to all blocks with $w_i \geq 0$ with capacity w_i.
- Add a sink node, connecting all blocks with $w_i < 0$ to the sink, with capacity $-w_i$.
- If m is the minimum cut separating source and sink, then the answer is $\left(\sum_{w_i>0} w_i\right) - m$.
- m can be found by a maximum flow algorithm.