ACPC 2018

Solutions Presentation

October 27, 2018

Announcement

Please complete the survey:
https://goo.gl/forms/POfpZAPRWQcsxrWp2

Author: Tony Cai

- Just do it.

Early Winter

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- What else is there to say?

Early Winter
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- Statistics; 59 solves / 126 attempted

Eating Out

Author: Tony Cai

Problem

Given m objects, assign a, b, and c objects to person 1, 2, and 3 respectively such that no object is assigned to all 3 people

Statistics

51 solves / 254 attempted

Solution

Possible iff $a + b + c \leq 2 \cdot m$

PUBNite

Author: Tony Cai

Problem

Calculate the minimum amount of time a moving point is outside a circle

Statistics

20 solves / 192 attempted

Solution

Case analysis:

- Safety zone may stop shrinking before Anthony is in danger
- Anthony may be in danger and catch up to safety zone
- ...

Exploding Kittens

Author: Tony Cai

Problem

Simulate a card game where on a player's turn, she either gets knocked out or gets another life.

Statistics

12 solves / 139 attempted

Exploding Kittens

Problem

Simulate a card game where on a player's turn, she either gets knocked out or gets another life.

Solution

Suppose k players are active, the current player is p, the current turn number is t_1, and the next turn number is t_2. The next player to draw a card is $(p + t_2 - t_1) \bmod k$.

Exploding Kittens

Problem

Simulate a card game where on a player's turn, she either gets knocked out or gets another life.

Solution

Keep track of active players in an array, and update the array when a player is knocked out.

Time Complexity: $O(n^2 + |E| + |D|)$

Homework

Author: Modan Han

Problem

Given strings s, s_1, s_2, check if s can be partitioned into sub-sequences s_1 and s_2.

Statistics

17 solves / 197 attempted

Homework

Solution

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Homework

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- Dynamic programming. Similar to the classical problem longest common sub-sequence (LCS).
- Let $f(i, j)$ return whether it is possible to partition $s[i + j :]$ into $a[i :]$ and $b[j :]$.
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- Base case $f(|s_1|, |s_2|) = \text{True}$. Want to compute $f(0, 0)$.
- Recurrence relation is as follows:

$$\begin{aligned} f(i, j) &= (f(i + 1, j) \wedge s[i + j] = s_1[i]) \\ &= \vee(f(i, j + 1) \wedge s[i + j] = s_2[j]). \end{aligned}$$

Arachnophobia

Author: Tony Cai

Problem

Find a path between s and t in a graph that maximizes the minimum distance between a set of vertices and any vertex on the path. The length of the path is also constrained.

Arachnophobia

Solution

- Complex graph problem involving multiple algorithms in multiple steps. As a high level overview, the intended solution mainly uses Dijkstra's SSSP and binary search.

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- First of all, for every node, compute its min distance to any spider. Sounds difficult, but is not any harder than Dijkstra's. Imagine there's only one spider/source, this step is easy for anyone who can implement Dijkstra's. When there are multiple spiders/sources, simply push them all into heap in the beginning and mark their distances to be 0. The rest is identical to normal Dijkstra's.

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- 2. Anthony is staying too close to spiders, i.e. Anthony's avoiding all and only vertices v such that $s(v) < K$ for some constant K, however, Anthony could be avoiding more vertices than he is in order to increase his min distance to any spider, yet still making it in time.

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- a. if Anthony avoids v such that $s(v) < K + 1$, this results in scenario 1. where Anthony avoids too many spiders. i.e. K is too large.
- b. if Anthony avoids v such that $s(v) < K - 1$, this results in scenario 2. where Anthony avoids too few spiders. i.e. K is too little.

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- For each K, use normal Dijkstra's from s to t on the sub-graph, where vertices v such that $s(v) < K$ are ignored. The failure condition is if Anthony does not make it in time.

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Trimming Polygon

Author: Zachary Friggstad

Problem

Given a convex polygon P, create a smaller polygon Q using a subset of points vertices from P and maximize area(Q) + sum of values of vertices not in Q.

Statistics

0 solves / 14 attempted

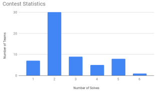
Trimming Polygon

Problem

Given a convex polygon P, maximize M

Solution

Let $f(i, j)$ denote the maximum possible score using only the vertices between $v[i]$ and $v[j]$ (inclusive)



Trimming Polygon

Problem

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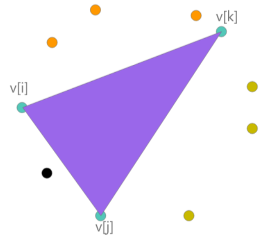
Solution

Suppose $v[k] \in Q$. Then maximum possible score is $f(i,k) + f(k,j) + area(v_i, v_k, v_j)$.



Trimming Polygon

Problem

Given a convex polygon P, maximize M

Solution

- Memoize recursion result
- Compute triangle area with cross product
- Time complexity: $O(n^3)$

Dog Trouble

Author: Kent Williams-King

Problem

Assign n dogs to m bowls while minimizing total waiting time.

Statistics

0 solves / 6 attempted

Solution

- Suppose all dogs finish eating at time t. Calculate the waiting time from assigning dog i to bowl j. The minimum total waiting time can then be calculated using min-cost bipartite matching.
- Iterate through all possible end time.

Acknowledgement

Jury:

- Tony Cai
- Modan Han (Google)
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- Kent Williams-King (Brown University)
- Wen Li Looi (Google)
- Darko Aleksic (Assistant Coach, Microsoft)

Closing Remarks

- Awesome job!
- CPC has meetings every Wednesday (6pm to 8pm) and Saturday (10am to 3pm)
- Next major contest: Calgary Collegiate Programming Contest (March 2019)