NWERC 2015
Presentation of solutions

The Jury

2015-11-29

NWERC 2015 Jury

- Per Austrin (KTH Royal Institute of Technology)
- Gregor Behnke (Ulm University)
- Jeroen Bransen (Utrecht University)
- Egor Dranischnikow (CST AG, Darmstadt)
- Tommy Färnqvist (Linköping University)
- Florin Ghesu (Siemens Healthcare/FAU Erlangen-Nürnberg)
- Robin Lee (Google)
- Lukáš Poláček (Spotify)
- Stefan Toman (TU München)
- Tobias Werth (FAU Erlangen-Nürnberg)
- Paul Wild (FAU Erlangen-Nürnberg)

Big thanks to our test solvers

- Michal Forišek (Comenius University)
- Jan Kuipers (AppTornado)

J – Jumbled Communication

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Assume the equation `s = x ^ (x << 1)`. Given `s` determine `x`.

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Statistics: 131 submissions, 92 accepted

I – Identifying Map Tiles

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Given quadkey such as 130, output zoom level and coordinates.

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   - Multiply x and y by 2

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Possible pitfalls

1. Reading in the quadkey as integer

Statistics: 119 submissions, 94 accepted

A – Assigning Workstations

Problem

Schedule jobs minimizing the number of machines used such that no machine locks between consecutive jobs, i.e. it is unused for more than m minutes.

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Statistics: 258 submissions, 63 accepted

E – Elementary Math

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Possible pitfalls

1. Result does not fit in an `int`
2. Greedy or brute force approach will not work

Statistics: 194 submissions, 45 accepted

K - Kitchen Combinatorics

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How many ways to pick three non-conflicting dishes and brands for the ingredients included?

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Statistics: 186 submissions, 46 accepted

D – Debugging

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- r - time needed to compile+run the program
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Solution (greedy part)

1. best strategy for inserting k `printf` statements in n LoC - equidistant, every $\left\lceil \frac{n}{k+1} \right\rceil$ lines - minimizing the number of LoCs in the next step.
2. for n LoC the best strategy could be to insert 1, 2, … or $n-1$ `printf` statements.

D – Debugging

Solution (recursive part)

Boils down to calculating the recursion:

$$T(1) = 0$$
$$T(n) = \min_{1 \leq k < n} \left\{ k \cdot p + T\left(\left\lceil \frac{n}{k+1} \right\rceil \right) \right\} + r$$

1. naive recursion - way too slow
2. naive DP calculates too many not needed states (e.g. $n-1$, $n-2$, $\ldots$) $\rightarrow O(n^2)$ - too slow
3. memoization calculates only the needed states $\rightarrow O(n \log n)$ - good enough
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Statistics: 142 submissions, 25 accepted

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Given a set of lines (with one end called "origin" or well). Is there a subset L of the lines such that for every intersection of two lines exactly one of the pipes intersection is in L?

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G – Guessing Camels

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- If x, y appear in the same order everywhere, they don't form any inversions.

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- Counting the number of inversions can be done in $O(n \log n)$.

Statistics: 97 submissions, 13 accepted

H – Hole in One

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Statistics: 14 submissions, 3 accepted

B - Better Productivity

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2. Partition the bad workers using following DP scheme:
   $d(i, j)$ - answer using first i intervals partitioned to j groups
3. Observation: good workers do **not** affect the current partition

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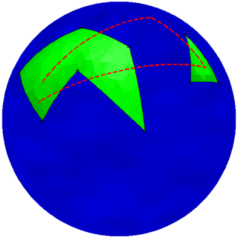
Statistics: 8 submissions, ?? accepted

F - Flight Plan Evaluation

Problem

Given some spherical arcs and spherical polygons, how much of the arcs is contained in the polygons?



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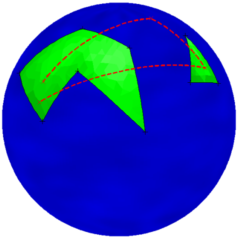

Solution

1. For each route segment, find all points at which we switch between land and water.
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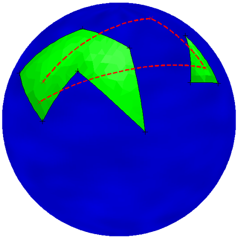

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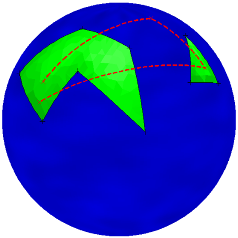

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2. Sort points by distance from start of segment
3. Alternate between land and water (we know that we start on land)

Flight Plan Evaluation

Sub-problem

Find intersection of two spherical arcs $P_1 \curvearrowright P_2$ and $Q_1 \curvearrowright Q_2$.

Solution

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1. The great circle on which the arc from P_1 to P_2 runs are the unit vectors orthogonal to $P_1 \times P_2$

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Find intersection of two spherical arcs $P_1 \curvearrowright P_2$ and $Q_1 \curvearrowright Q_2$.

Solution

1. The great circle on which the arc from P_1 to P_2 runs are the unit vectors orthogonal to $P_1 \times P_2$
2. Intersection of $P_1 \curvearrowright P_2$ and $Q_1 \curvearrowright Q_2$ (if it exists) must lie on both great circles $\Leftrightarrow$ orthogonal to both $P_1 \times P_2$ and $Q_1 \times Q_2$.

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3. Only two possible candidate intersection points:
$$\pm \frac{(P_1 \times P_2) \times (Q_1 \times Q_2)}{\|(P_1 \times P_2) \times (Q_1 \times Q_2)\|_2}$$
Watch out for division by zero (cocircular arcs).

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4. To test if candidate point R is on $P_1 \curvearrowright P_2$: check if $d(P_1, R) + d(R, P_2) = d(P_1, P_2)$.

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Statistics: 9 submissions, 2 accepted

Random numbers produced by the jury

1217 number of posts made in the jury's forum.
(NWERC 2014: 1087)

915 commits made to the problem set repository.
(NWERC 2014: 671)

416 number of lines of code used in total by the shortest judge solutions to solve the entire problem set.
(NWERC 2014: 380)

16.6 average number of jury solutions per problem, including incorrect ones.
(NWERC 2014: 16.7)

62.5% fraction of judge solutions to problem B that were successfully challenged by a single test case 4 days before the contest.