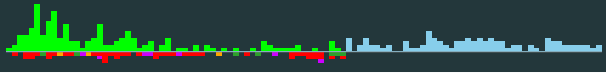
NWERC 2022 Test Session

Solutions presentation

November 26, 2022

C: Cup Covering

Problem Author: The NWERC 2022 jury



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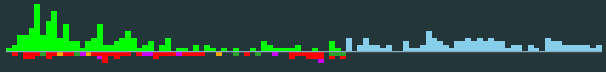

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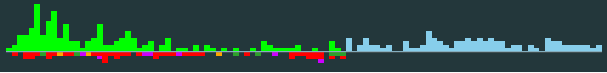

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- The area of a circle is $a = \pi r^2$, and the diameter is twice the radius, $d = 2r$.
- Rewriting this gives $d = 2\sqrt{\frac{a}{\pi}}$.

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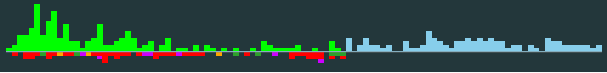

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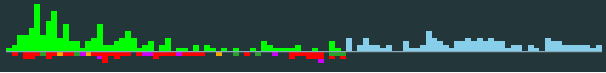

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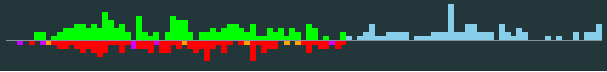
Statistics: 345 submissions, 153 accepted, 101 unknown

A: An Interactive Problem

Problem Author: Maarten Sijm



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Find the highest value in a square of unknown size with upside-down lots.

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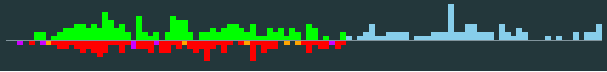

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Solution

- Start by querying the value of $(x, 1)$ for every x starting from 1, until you get "`ArrayIndexOutOfBoundsException`" as response.
  - Now you know the size of the square n: the last x for which you got an integer response.

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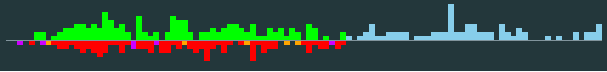

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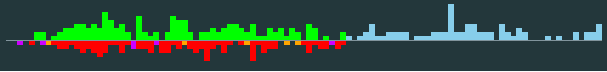

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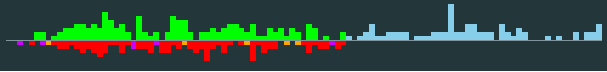

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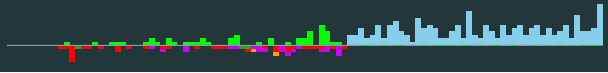
- Print the highest value found.

Statistics: 339 submissions, 138 accepted, 78 unknown

B: Brothers in Arms

Problem Author: Markus Himmel



Problem

Given $n \leq 90\,000$ medieval cities and $s \leq 300$ possible symbols, compute the friendship degree between $q \leq 10^5$ pairs of cities.

Two cities are

- directly friendly if they share a symbol at the top or share a symbol at the bottom on their coats of arms, or
- indirectly friendly through a chain of direct friendships, with *friendship degree* defined as the minimum length of that chain.

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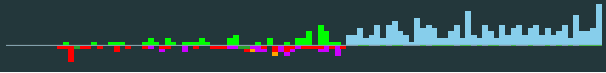

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Observations

- Treating symbols for the top and bottom differently gives at most 600 symbols in total.

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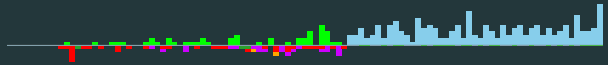

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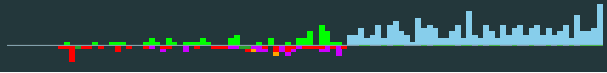

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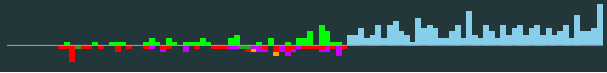

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- Treating symbols for the top and bottom differently gives at most 600 symbols in total.
  - Give each symbol a unique identifier. E.g., by adding 300 to the identifiers of the bottom symbols.
- A graph with cities as vertices and edges as direct friendships is too large to compute all queries.
  - However, there are only 600 symbols...

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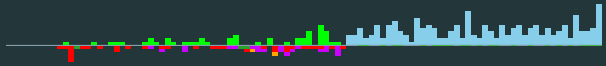

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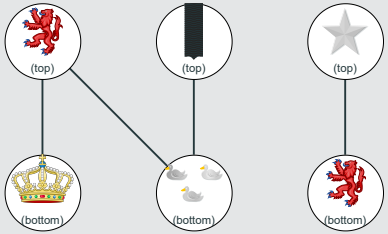
- Create a graph where the vertices represent symbols and the edges represent cities: for every city, add a bidirectional edge between its top and bottom symbol.



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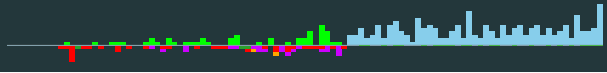

Solution

- Create a graph where the vertices represent symbols and the edges represent cities: for every city, add a bidirectional edge between its top and bottom symbol.
- Store as distance matrix with entries:
  - $d(a, a) = 0$ for every symbol a,
  - $d(a, b) = d(b, a) = 1$ for every city with symbols a and b,
  - $d(x, y) = \infty$ else.

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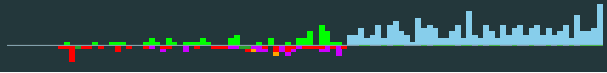

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- Find the distances between all pairs of symbols using the Floyd–Warshall algorithm ($\mathcal{O}(s^3)$).

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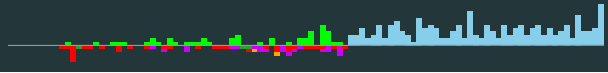

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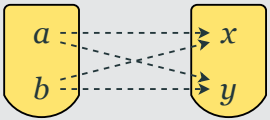
- For every query of a city with symbols a and b and a city with symbols x and y:
  - Compute $\min(d(a, x), d(a, y), d(b, x), d(b, y))$ to get their friendship degree ($\mathcal{O}(1)$ per query).
  - If the minimum distance is ∞, print -1.



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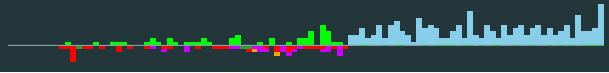

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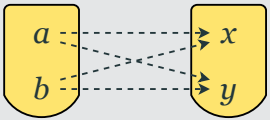
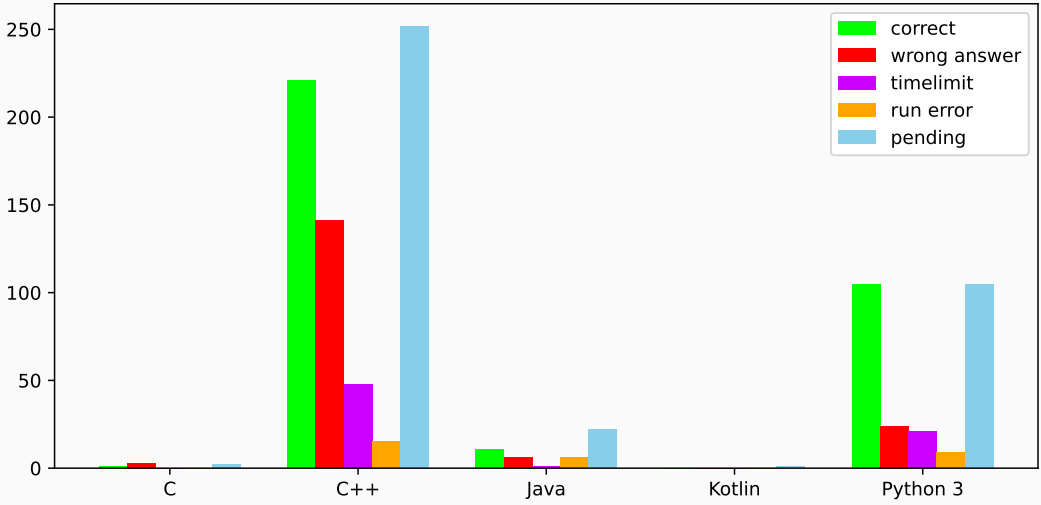


Statistics: 331 submissions, 47 accepted, 203 unknown

Language stats



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