Freshmen Programming Contests 2025

Solutions presentation

By the Freshmen Programming Contests 2025 jury for:

- AAPJE in Amsterdam
- FPC in Delft
- FYPC in Eindhoven
- GAPC in Groningen
- Contest in Mons

May 3, 2025

Please do not post the problems online

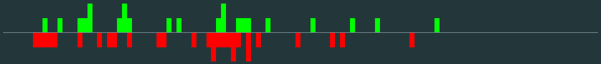
Other universities will have their contests in the coming weeks.

Please, do not post/discuss the problems online before

Saturday 17 May 2025 at 17:00

G: Gambler's Dilemma

Problem author: Wietze Koops



Problem: Determine whether two playing cards have any of the four given properties.

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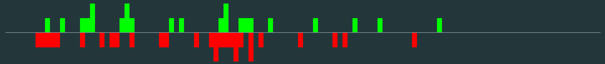

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Solution: For each property, check whether the cards match it.

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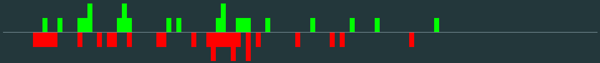

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Solution: For each property, check whether the cards match it.

Pitfall: Be careful of off-by-one errors when calculating the rank of a card.

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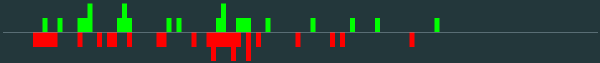

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Running time: $\mathcal{O}(1)$.

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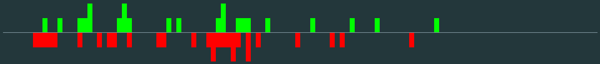

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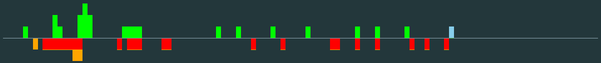
Running time: $\mathcal{O}(1)$.

Statistics: 54 submissions, 23 accepted

B: Bakfiets

Problem author: Jeroen Op de Beek



Problem: Minimize the area of one rectangle that cannot overlap with another.

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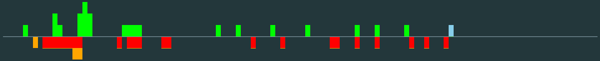

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Observation 1: The bottle packaging can be in two possible orientations.

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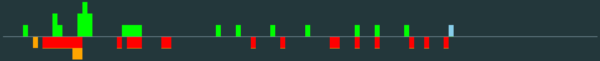

Problem: Minimize the area of one rectangle that cannot overlap with another.

Observation 1: The bottle packaging can be in two possible orientations.

Observation 2: You can have at most 10^{18} bottles, hence we need 64-bit integers.

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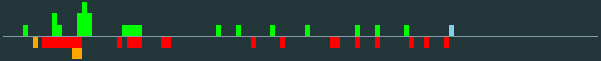

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Solution: Compute $w \cdot h - \max(\min(w, a) \cdot \min(h, b), \min(w, b) \cdot \min(h, a))$.

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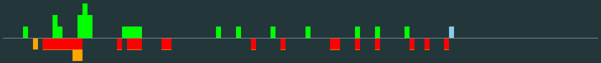

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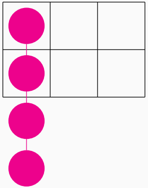

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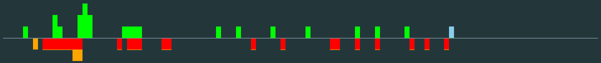

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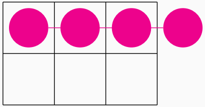

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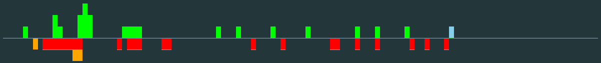

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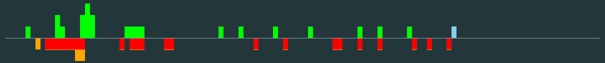

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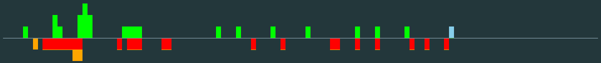

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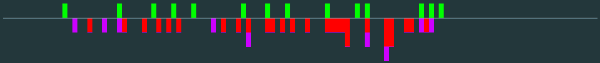
Running time: $\mathcal{O}(1)$.

Statistics: 49 submissions, 21 accepted, 1 unknown

H: Hopelessly Hungover

Problem author: Wietze Koops



Problem: Each weekday you can learn k facts, each day in the weekend you forget m facts. Given a starting day of the week, how many days do you need to wait before you know all n facts?

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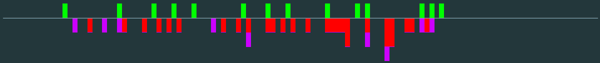

Problem: Each weekday you can learn k facts, each day in the weekend you forget m facts. Given a starting day of the week, how many days do you need to wait before you know all n facts?

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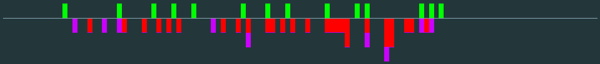

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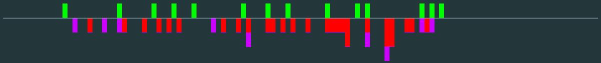

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Solution: We can simulate the process for $7n + 14$ days. Whenever the number of facts is n we stop. After $7n + 14$ days we can be sure that we will never learn all n facts.

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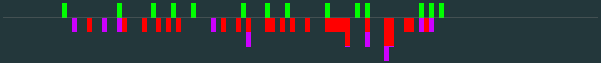

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Fun fact: The actual maximum number of days you have to wait is 6976.

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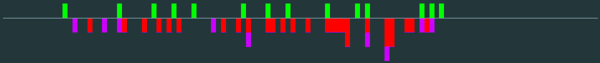

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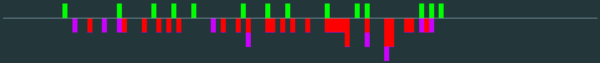

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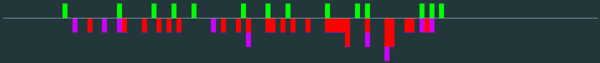

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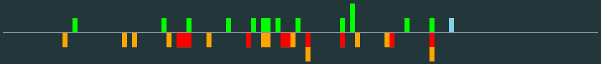
Statistics: 53 submissions, 14 accepted

J: Jumbled Keys

Problem author: Arnoud van der Leer



Problem: Decipher a message, using a series of mapped words.

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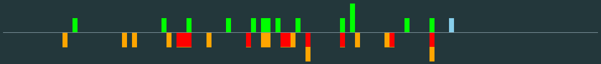

Problem: Decipher a message, using a series of mapped words.

Solution: Use a map! Process every pair of words, and map every letter in the first word to the letter it corresponds to in the second word.

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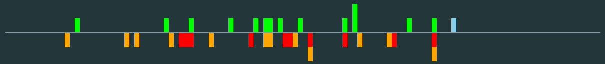

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Edge case: If 25 letters are mapped, the 26th letter maps to the only letter that has no other letter mapped to it.

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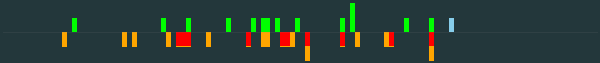

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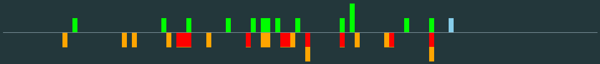

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Statistics: 38 submissions, 14 accepted, 1 unknown

A: Array Annihilation

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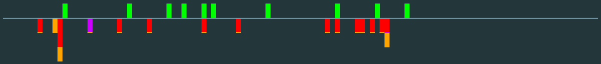

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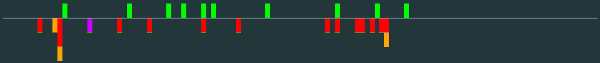

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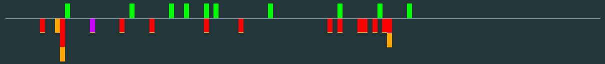

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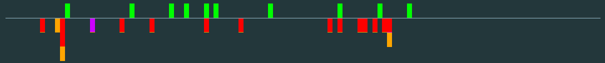

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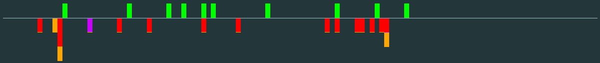

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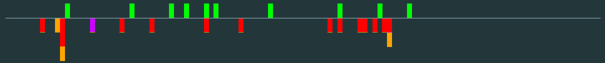

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Proof: It's clear the condition is necessary. We need to show that it's sufficient.

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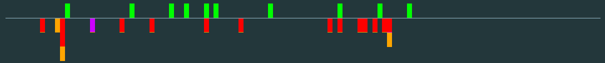

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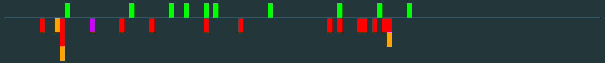

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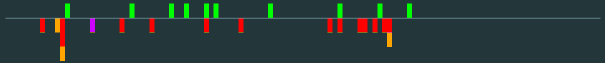
A: Array Annihilation

Problem author: Leon van der Waal



Problem: Given an array, is it possible to make all values equal to 0 when repeatedly decrementing two or more consecutive values in the array.

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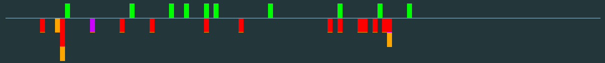

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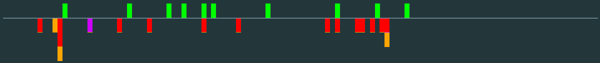

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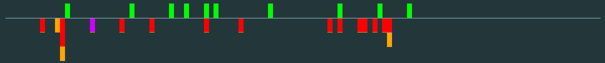

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Statistics: 28 submissions, 10 accepted

Problem: Recover the coefficients of a hidden polynomial $P(x)$ using at most 9 queries.

E: Equation Extrapolation

Problem author: Jeroen Op de Beek

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Observation: Since each coefficient a_i satisfies $0 \leq a_i \leq 9$, querying at any $x > 9$ returns all coefficients directly in base-x.

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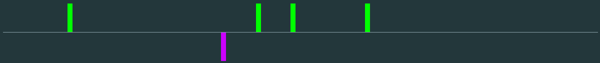

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F: Frog and Princess

Problem author: Wietze Koops

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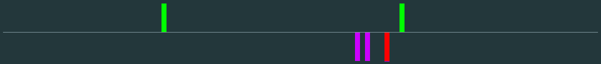
Statistics: 14 submissions, 3 accepted

K: Kite Construction

Problem author: Jeroen Op de Beek



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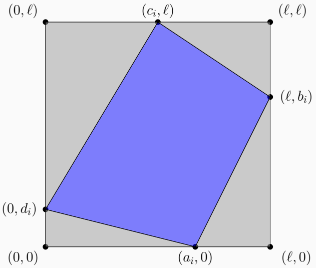
Solution: Let $(a_i, 0)$, (ℓ, b_i), (c_i, ℓ) and $(0, d_i)$ be the coordinates of the corners of the ith quadrilateral. Then we can compute the sum of the areas by considering how much is cut off from the full $\ell \times \ell$ square:

$$\sum_{i=1}^{n} \left(\ell^2 - \tfrac{1}{2} a_i d_i - \tfrac{1}{2}(\ell - a_i) b_i - \tfrac{1}{2}(\ell - b_i)(\ell - c_i) - \tfrac{1}{2} c_i (\ell - d_i)\right).$$



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Proof: Suppose that $i < j$ (and hence $a_i < a_j$), but $d_i < d_j$. Then

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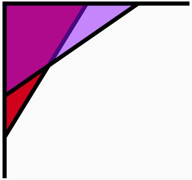

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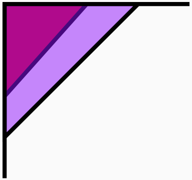

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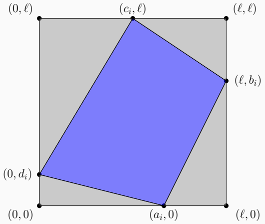

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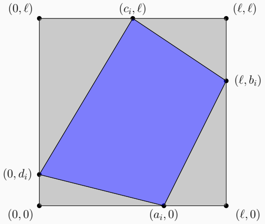

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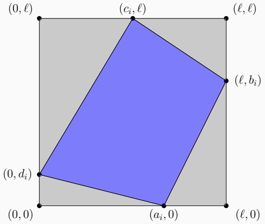

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Problem author: Jeroen Op de Beek

Problem: Given are $4n$ points on the perimeter of a square (with sidelength ℓ), with n points on each side. Divide these points into n quadrilaterals maximizing the sum of their areas

$$\sum_{i=1}^{n} \left(\ell^2 - \tfrac{1}{2}a_i d_i - \tfrac{1}{2}(\ell - a_i)b_i - \tfrac{1}{2}(\ell - b_i)(\ell - c_i) - \tfrac{1}{2}c_i(\ell - d_i)\right).$$

over all possible ways to order the points on each side of the square.
Without loss of generality assume $a_1 < \ldots < a_n$.

Solution: Sort the given points such that $a_1 < \ldots < a_n$, $b_1 < \ldots < b_n$, $c_1 > \ldots > c_n$, and $d_1 > \ldots > d_n$, and then compute the area with the above formula.

Running time: $\mathcal{O}(n \log n)$.

Statistics: 5 submissions, 2 accepted

D: Delicious Trees

Problem author: Jeroen Op de Beek

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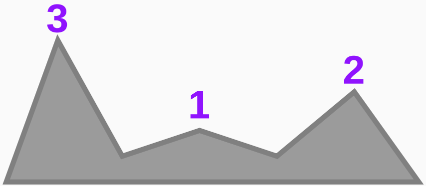

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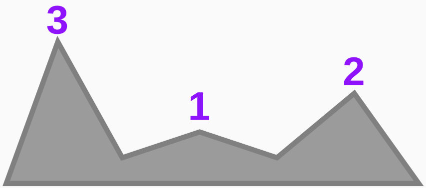

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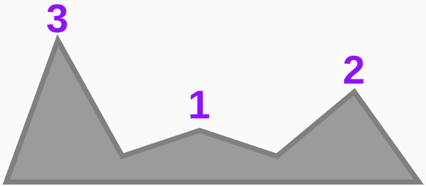

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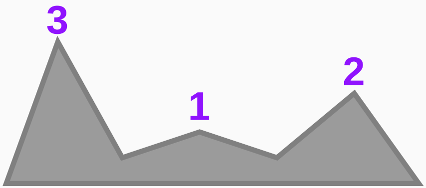

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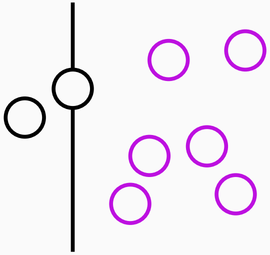

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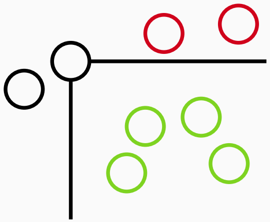

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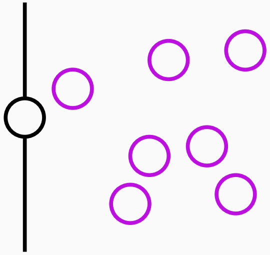

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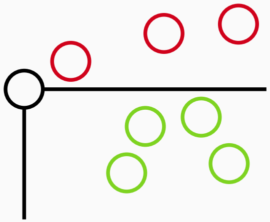

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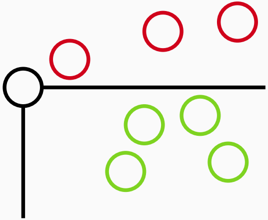
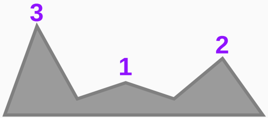


Using Fenwick tree or segment tree, $\mathcal{O}(\log(n))$ per query / update.



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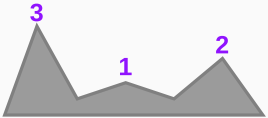

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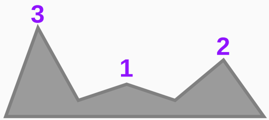

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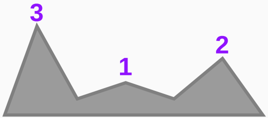

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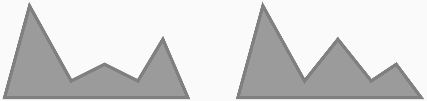

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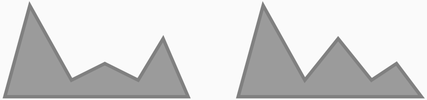

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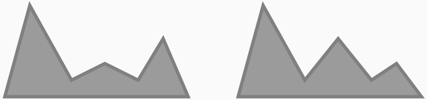

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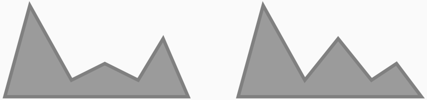

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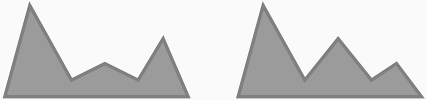

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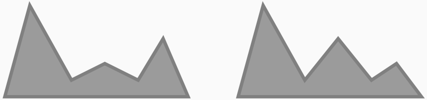

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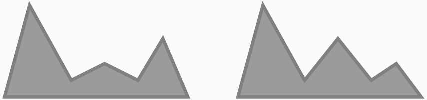

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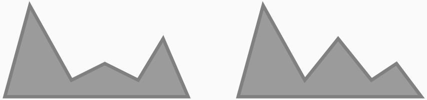

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Problem author: Jeroen Op de Beek

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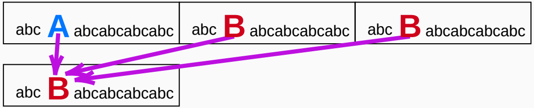

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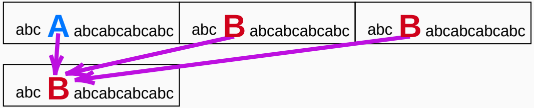

- Then count how many letters we must have changed.

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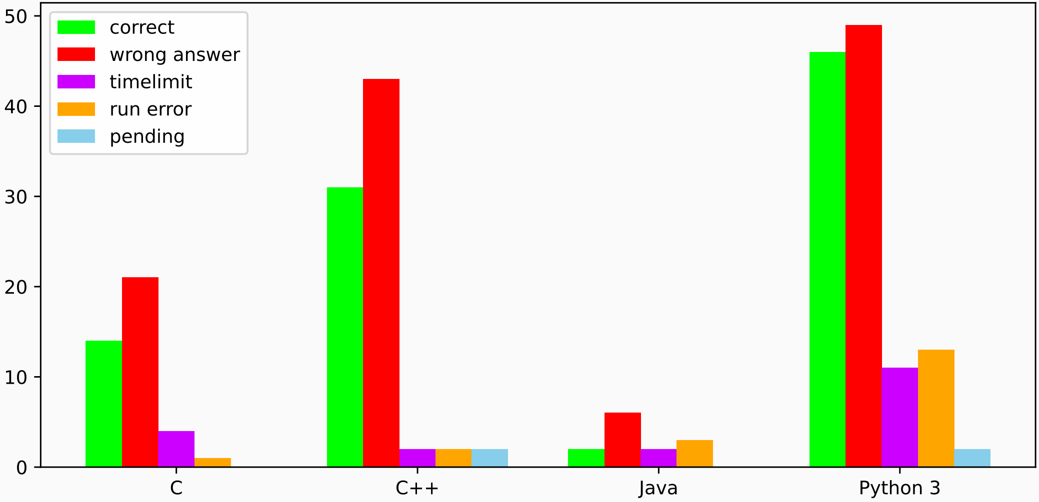
Language stats



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- The minimum[1] number of lines the jury needed to solve all problems is

$$2 + 1 + 6 + 5 + 1 + 5 + 2 + 2 + 6 + 3 + 6 = 39$$

On average 3.5 lines per problem, down from 6.0 last year

[1] *After* codegolfing

Thanks to the proofreaders:

- Arnoud van der Leer (TU Delft)
- Dany Sluijk (TU Delft)
- Davina van Meer (Delft)
- Mattia Marziali (RU Groningen)
- Michael Zündorf 🎈
  (KIT Karlsruhe / NWERC jury)
- Pavel Kunyavskiy (JetBrains Amsterdam)
- Pierre Vandenhove (UMons)
- Thomas Verwoerd
  (TU Delft, Kotlin Hero 🎈)
- Thore Husfeldt (ITU Copenhagen / BAPC Jury)
- Wendy Yi (KIT Karlsruhe / NWERC jury)

Thanks to the Jury for the Freshmen Programming Contests:

- Alice Sayutina (VU Amsterdam)
- Angel Karchev (TU Delft)
- Bálint Kollmann (TU Delft)
- Jeroen Op de Beek (TU Delft)
- Leon van der Waal (TU Delft)
- Liudas Staniulis (VU Amsterdam)
- Maarten Sijm (TU Delft)
- Mihail Bankov (TU Delft)
- Moham Balfakeih (TU Delft)
- Wietze Koops (Radboud Nijmegen / RU Groningen)

Open online contest

Want to solve the problems you could not finish?
Or have friends that like to solve algorithmic problems?

`https://fpcs2025.bapc.eu/`

Saturday 17 May 2025 13:00–17:00

Please, do not post/discuss the problems online before this time!

Future contest fun

Excited to participate in the next contest?

Register for the BAPC Preliminaries in September!

Want to organize these contests?

Join the organizing committee!

Want to create programming problems for FPCs next year?

Either join the committee, or contact Maarten Sijm