Benelux Algorithm Programming Contest (BAPC) preliminaries 2025

Solutions presentation

The BAPC 2025 Jury

October 4, 2025

K: Koehandel

Problem author: Mike de Vries

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Running time: $\mathcal{O}(nq)$ for q commands.

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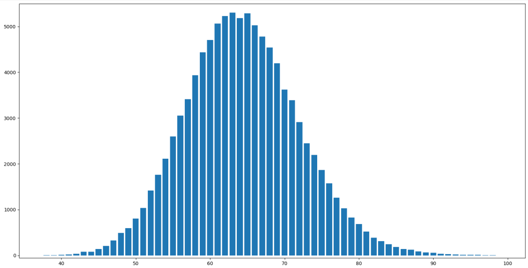
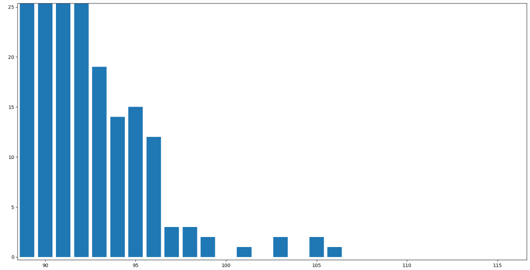
Statistical analysis: Out of 100 000 runs, the highest number of commands used is 106.
Lowest number of commands is 34.





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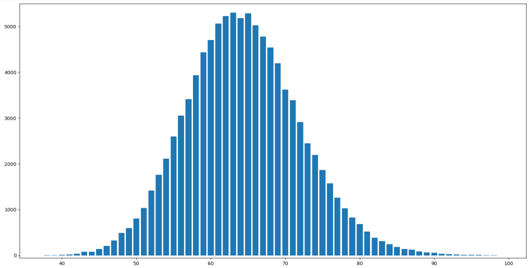

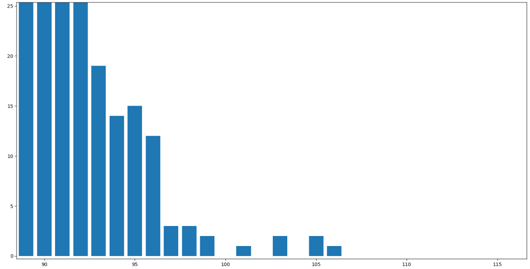

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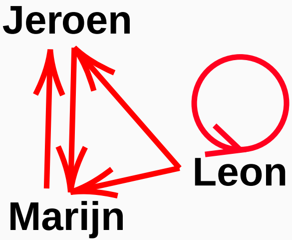

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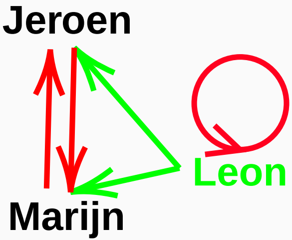

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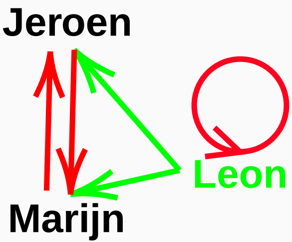

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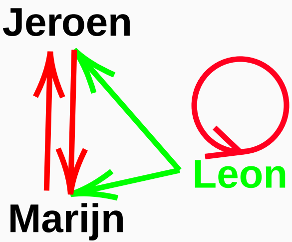

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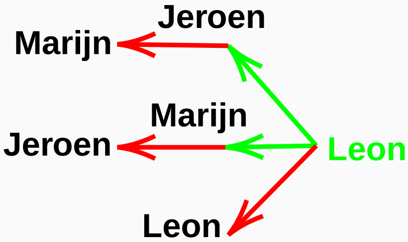

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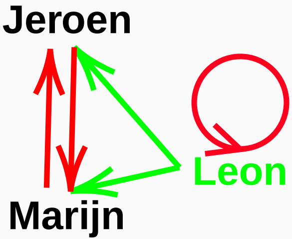

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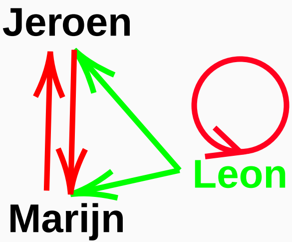

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Issue: $n = 10^5$, so we need an $\mathcal{O}(n)$-time solution.

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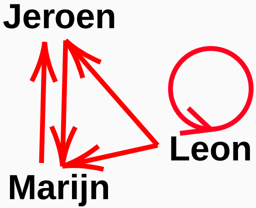

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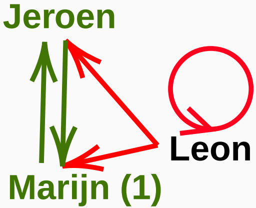

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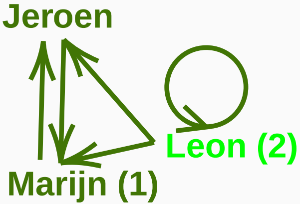

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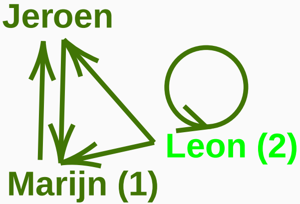

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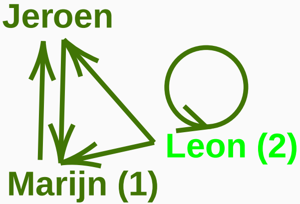

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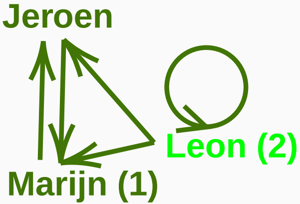
- Once we reach a "good" node, all nodes are marked as visited.
- If a "good" node exists, the last node where we started a DFS is "good".



- Check whether this is true using a DFS, starting from this last node.

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

Alternative solution: Using strongly connected components.

G: Genealogy Gumbo

Problem author: Lammert Westerdijk

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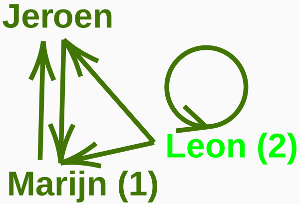

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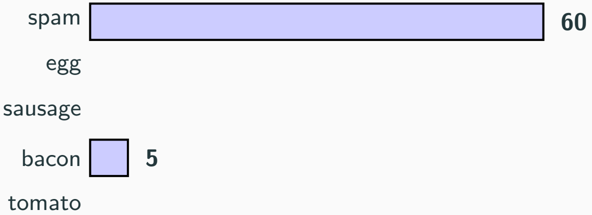
I: Ingredient Intervals

Problem author: Mike de Vries

Problem: There is a sequence of real numbers $a = (a_1, \ldots, a_n)$ with $a_1 + \cdots + a_n = 100$ and $a_1 \geq \cdots \geq a_n \geq 0$. Given a subset $\{a_i\}_{i \in S}$ of these numbers, determine maximal lower bounds $l_1, \ldots, l_n$ and minimal upper bounds $r_1, \ldots, r_n$ such that

$$l_i \leq a_i \leq r_i \quad \text{for } 1 \leq i \leq n\,.$$

E.g., with $a = (60, ?, ?, 5, ?)$:



I: Ingredient Intervals

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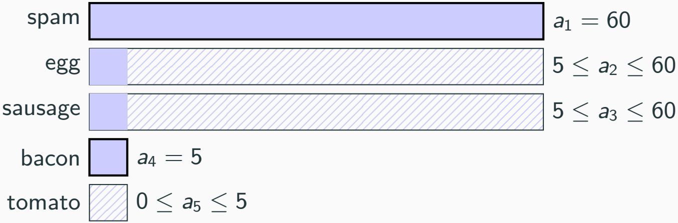
First observation: Since a is nonincreasing, it is immediate that a_i satisfies $l'_i \leq a \leq r'_i$ with

$$l'_i = \max\{\, a_j : j \geq i, j \in S \,\} \qquad r'_i = \min\{\, a_j : j \leq i, j \in S \,\}\,.$$



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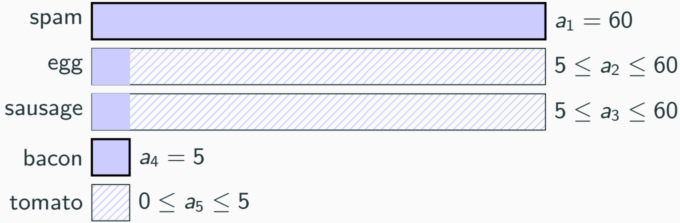

Implementation: These values can be computed in linear time by first computing

$$\text{prev}(i) = \max\{\, j \in S : j < i \,\}, \qquad \text{next}(i) = \max\{\, j \in S : j > i \,\}\,,$$

preferably with useful boundary values, for instance by introducing $a_0 = 100$ and $a_{n+1} = 0$. Then, for $i \notin S$ we have $l'_i = a_j$ with $j = \text{next}(i)$ because a is decreasing.

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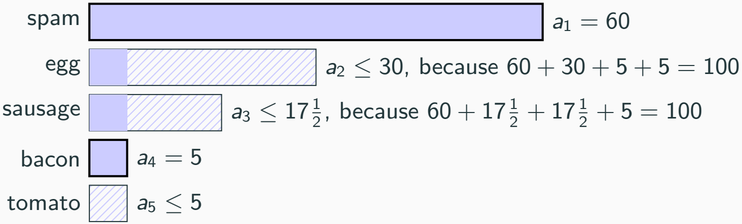
Fix upper bounds: For $i \notin S$, the (unknown) amount a_i satisfies $l'_i \leq a_i \leq r'_i$, but we know more: Assuming all other amounts attain their *lower* bound, then their sum cannot exceed 100, so we have the constraint

$$\left(\sum_{j<i} \max(a_i, l'_j)\right) + a_i + \sum_{j>i} l'_j \leq 100\,,$$

Can solve for the largest a_i.



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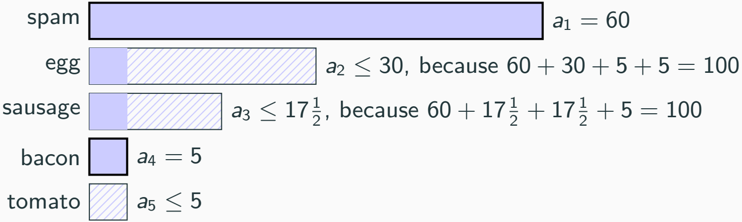

Implementation: To determine $\max a_i$, use binary search in the interval $[l'_i, r'_i]$ or rewrite the constraint for closed formula.

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Problem author: Mike de Vries

Fix lower bounds: Symmetrically, assuming all other amounts attain their *maximum* bound, then their sum must be at least 100, so we have the constraint

$$\left(\sum_{j<i} r'_j\right) + a_i + \sum_{j>i} \min(a_i, r'_j) \geq 100\,,$$

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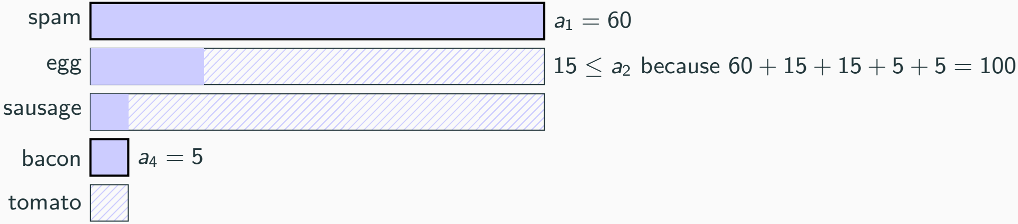

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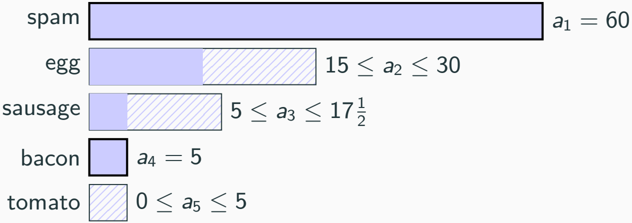

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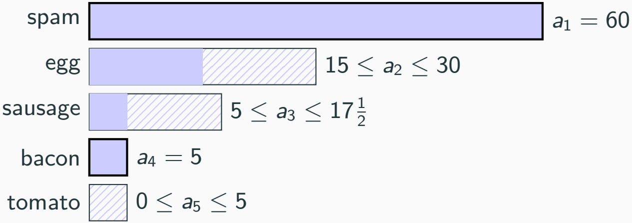

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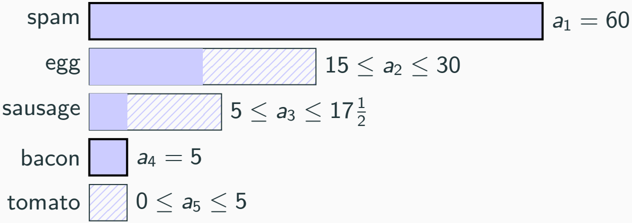

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Problem: By transposing notes to fit your vocal range, maximize the shortest interval of equally transposed notes.

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F: Friendly Formation

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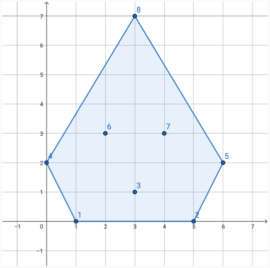

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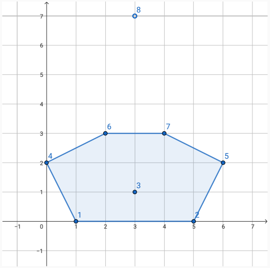

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Possible solution: Create k numbers/variables using single characters, starting with zeros. Put the remaining characters in the last token, making sure to start with letters, then non-zero digits. Sorting makes it easier, but is not strictly necessary.

$$\texttt{00123abcd} \to \texttt{0, 0, 1, 2, dcba3}$$
$$\texttt{000000001} \to \texttt{0, 0, 0, 0, 10000}$$

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Observation: Parentheses are only allowed when multiplying a sum (e.g. `(a+b)*c`).

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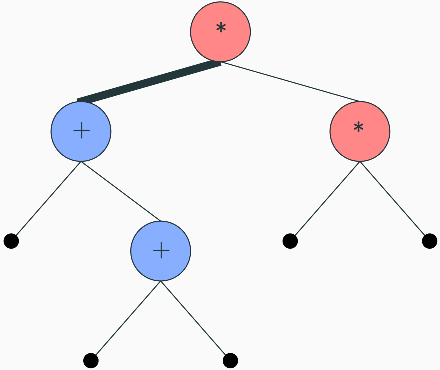

$$(\ \ldots \ + \ \ldots \ + \ \ldots \ ) * \ldots * \ldots$$

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Observation: Since each operator can have at most one parent, and has two children, if there are M multiplication operators and P plus operators, we can place no more than $2M$ or A pairs of non-redundant parentheses.

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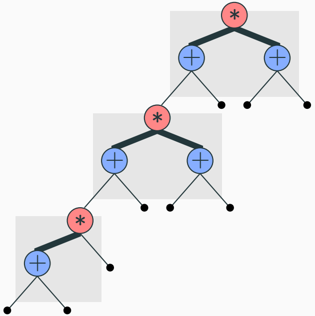
Solution: Greedily construct as many `(_+_)*(_+_)` patterns as possible, use `(_+_)*_` to get rid of a single pair of parentheses, and put all remaining operators at the end.



`( ( (_+_)*_ )*(_+_) )*(_+_) +_+_+_*_*_`

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Complete solution: Count the parentheses, operators, zeros, and other digits/letters, and check all edge conditions. Construct tokens. Then greedily construct the expression's structure, and fill in the tokens.

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Statistics: ... submissions, ... accepted, ... unknown

Random facts

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- 221 jury + proofreader solutions (last year: 236)
- The minimum[1] number of lines the jury needed to solve all problems is

$$4 + 2 + 6 + 1 + 4 + 11 + 3 + 2 + 5 + 2 + 1 + 7 = 48$$

  On average 4 lines per problem, down from $16\frac{1}{4}$ in last year's preliminaries[2]

[1] With mostly™ PEP 8-compliant code golfing
[2] But we did way less golfing last year

Thanks to:

The proofreaders

Arnoud van der Leer
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Michael Zündorf
Pavel Kunyavskiy Kotlin Hero 🎈
Tobias Roehr 🎈
Thomas Verwoerd
Wendy Yi 🎈

The jury

Ivan Fefer
Jeroen Op de Beek
Jonas van der Schaaf
Lammert Westerdijk
Leon van der Waal
Maarten Sijm
Marijn Adriaanse
Mike de Vries
Ragnar Groot Koerkamp
Reinier Schmiermann
Thore Husfeldt
Wietze Koops

Want to join the jury? Submit to the Call for Problems of BAPC 2026 at:

`https://jury.bapc.eu/`