

Contest Duration: 2025-04-27(Sun) 08:00 (<http://www.timeanddate.com/worldclock/fixedtime.html?iso=20250427T2100&p1=248>) - 2025-04-27(Sun) 09:40 (<http://www.timeanddate.com/worldclock/fixedtime.html?iso=20250427T2240&p1=248>) (local time) (100 minutes)

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Official

F - Shortest One Formula

(/contests/abc403/tasks/abc403_f) Editorial by en_translator (/users/en_translator)

For two expressions s and t that evaluate to a and b , respectively, the following strings are also valid expressions. (“+” denotes a string concatenation.)

- $(+ s +)$ (evaluates to a)
- $s + + + t$ (evaluates to $a + b$)
- $s + * + t$ (evaluates to $a \times b$. s and t both need to be $\langle \text{term} \rangle$)

Under these construction rules, we seek for the shortest expression that evaluates to N with DP (Dynamic Programming). Define

- $dp1[i]$: shortest expression that evaluates to i , and
- $dp2[i]$: shortest expression that is eligible as $\langle \text{term} \rangle$ and evaluates to i .

Values that can be represented as repeated 1s can be initialized as:

- $dp1[i] = dp2[i] = 11\dots1$.

The transitions are as follows. (\leftarrow is executed only when applicable; in other words, only when the right-hand-side string is shorter.)

- $dp1[i] \leftarrow dp1[j] + + + dp1[k] \ (j + k = i)$
- $dp1[i] \leftarrow dp2[j] + * + dp2[k] \ (j \times k = i, j \neq 1, k \neq 1)$
- $dp2[i] \leftarrow (+ dp1[j] + + + dp1[k] +) \ (j + k = i)$
- $dp2[i] \leftarrow dp2[j] + * + dp2[k] \ (j \times k = i, j \neq 1, k \neq 1)$

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One can prove that each expression has an $O(\log N)$ length, so this DP runs in $O(N^2 \log N)$ time. If we maintain the shortest length instead of the string itself in DP, the complexity reduces to $O(N^2)$.

posted: a day ago

last update: a day ago

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