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)

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 `<term>`)

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
- $dp1[i]$: shortest expression that is eligible as `<term>` and evaluates to i.

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

- $dp1[i] = dp2[i] =$ `11...1`.

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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