

Lottery

First AC: Mariusz Trela, Poland (24:13)

#AC = 15

problem author: Juliusz Straszyński

Lottery

Let's focus on one query.

Computing the distance naively is $O(L)$.

There are $O(n^2)$ pairs of intervals.

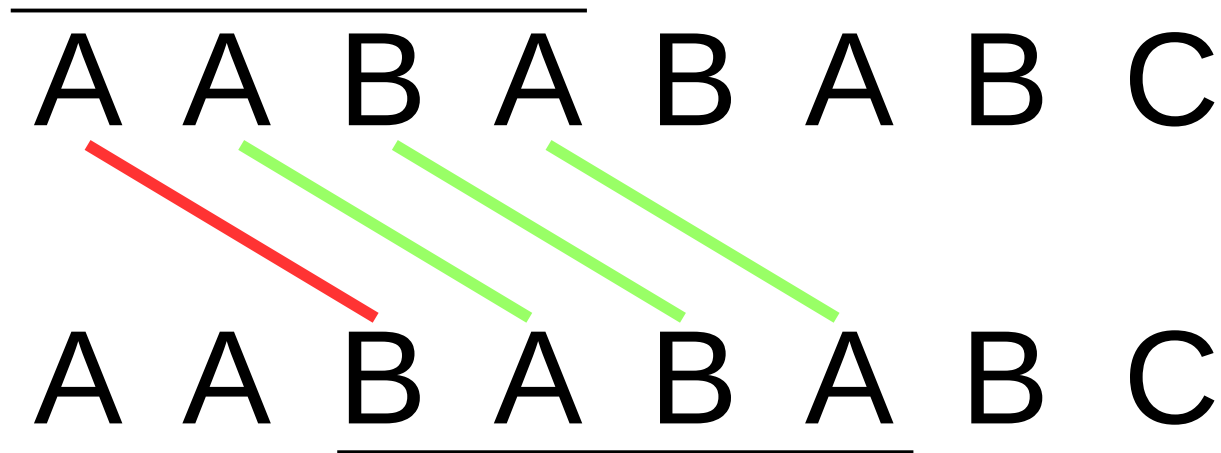
So, the brute force is $O(n^2 \times L) = O(n^3)$.

Lottery

A A B A B A B C

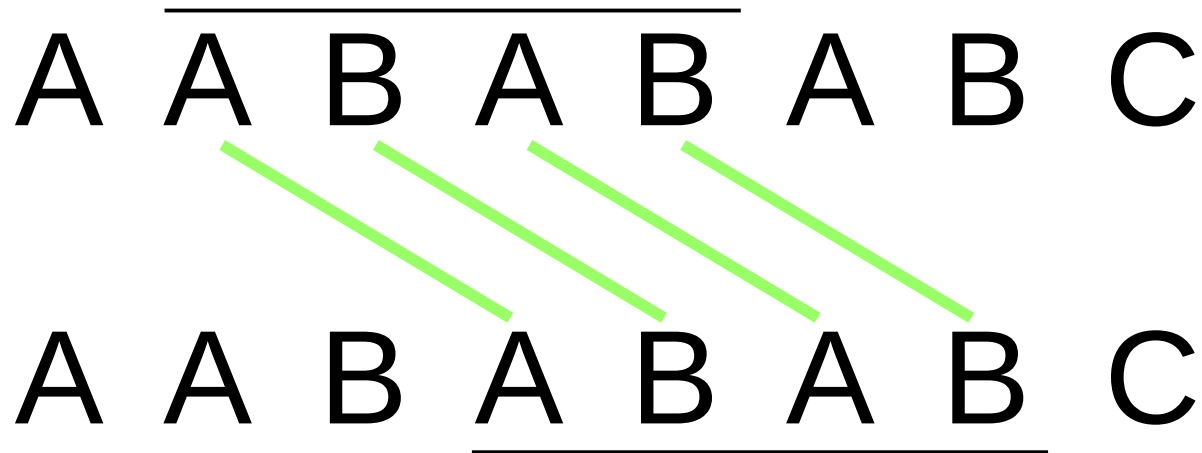
distance(1, 3) = 1

Lottery



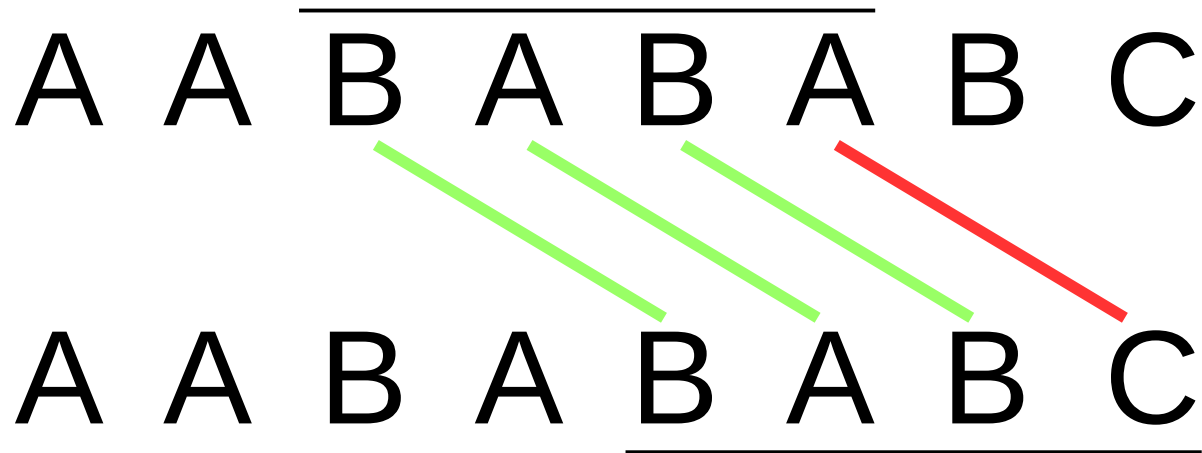
$$\text{distance}(1, 3) = 1$$

Lottery



$$\text{distance}(2, 4) = 0$$

Lottery



$$\text{distance}(3, 5) = 1$$

Lottery

$O(n)$ for every shift.

$O(n^2)$ in total to find all the distances.

How to avoid the q factor in answering queries?

We can't store the $O(n^2)$ array!

Lottery

Queries: 2, 4, 7

0 → 2

1 → 2

2 → 2

3 → 4

4 → 4

5 → 7

6 → 7

7 → 7

Lottery

Time complexity: $O(n^2)$
Memory complexity: $O(nq)$

Cloud Computing

First AC: Costin-Andrei Oncescu, Romania (31:07)
#AC = 16

problem author: Karol Pokorski

Cloud Computing

Easiest possible version

$$F_i = 1, f_i = 1$$

$$C_i = 1, c_i = 1$$

$$n = 1 \text{ (one machine)}$$

(consider the most profitable order)

Cloud Computing

Standard version

$$F_i = 1, f_i = 1$$

$$\cancel{C_i = 1}, \cancel{c_i = 1}$$

$n = 1$ (one machine)

$$O(m \times c_1)$$

$dp[\text{cores}]$ – the largest profit to have so many cores

Cloud Computing

Double version

$$F_i = 1, f_i = 1$$

$$\cancel{C_i = 1, c_i = 1}$$

$$\cancel{n = 1 \text{ (one machine)}}$$

two knapsacks

$$O(n \times (n \times C) + m \times (m \times C))$$

Cloud Computing

Double version

$$F_i \leq f_i \quad \leftarrow \text{works too}$$

$$\cancel{C_i = 1}, \cancel{c_i = 1}$$

$$\cancel{n = 1 \text{ (one machine)}}$$

two knapsacks

$$O(n \times (n \times C) + m \times (m \times C))$$

Cloud Computing

One knapsack with modified items, e.g.:

- a task with weight 5 and value 20
- a machine with weight -7 and value -15

We must end with total weight 0 or smaller.

$$O((n + m) \times (n \times C))$$

Cloud Computing

Sort by f_i , F_i decreasingly.

Then just guarantee that the total weight is 0 or smaller **at every moment of time.**

$$O((n + m) \times (n \times C))$$

Cloud Computing

The alternative knapsack

$$V_i = 1, v_i = 1$$

dp[cores] \rightarrow dp[money]

$$O((n + m) \times n)$$

Global Warming

First AC: Kacper Kluk, Poland (26:04)
#AC = 27

problem author: Kamil Dębowski

Global Warming

$$0, 3, \overbrace{1, 5, 2, 4, 6}^{+3}, 0, 7 \rightarrow 0, 3, \overbrace{4, 8, 5, 7, 9}, 0, 7$$

$$0, 3, \overbrace{1, 5, 2, 4, 6}^{+3}, 0, 7 \rightarrow 0, 3, \overbrace{4, 8, 5, 7, 9}, 0, 10$$

suffix can only improve the answer!

Global Warming

$$1, \overline{5, 7}, 6, 9 \xrightarrow{-2} 1, \overline{3, 5}, 6, 9$$
$$\overline{1, 5, 7}, 6, 9 \xrightarrow{-2} \overline{-1, 3, 5}, 6, 9$$
$$1, 5, 7, \overline{6, 9} \xrightarrow{+2} 1, 5, 7, \overline{8, 11}$$

It's enough to consider suffixes!

$$d = x$$

Global Warming

Modifying the standard LIS algorithm.

30, 60, 10, | 50, ...

1 – 10

2 – 60

Global Warming

Modifying the standard LIS algorithm.

30, 60, 10, 50, | ...

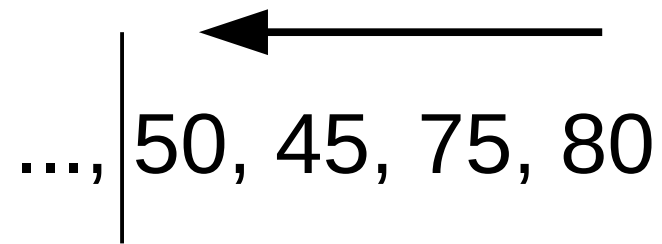
1 - 10

2 - ~~60~~ 50

Global Warming

The LDS from the right.

...., | 50, 45, 75, 80

A diagram showing a sequence of numbers: "..., | 50, 45, 75, 80". A vertical line is positioned after the first number (50). Above the line, a horizontal arrow points to the left, starting from the right and ending at the vertical line.

1 – 45

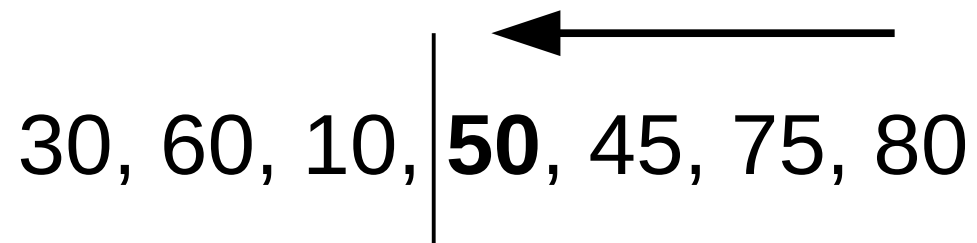
2 – 50

3 – 50

Global Warming

The LDS from the right.

30, 60, 10, **50**, 45, 75, 80



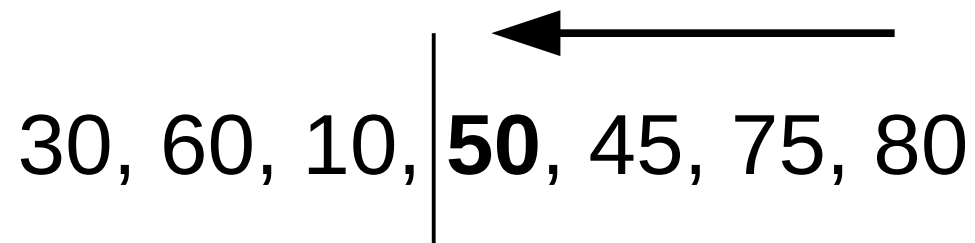
1 – 10

2 – 60

Global Warming

The LDS from the right.

30, 60, 10, | **50**, 45, 75, 80

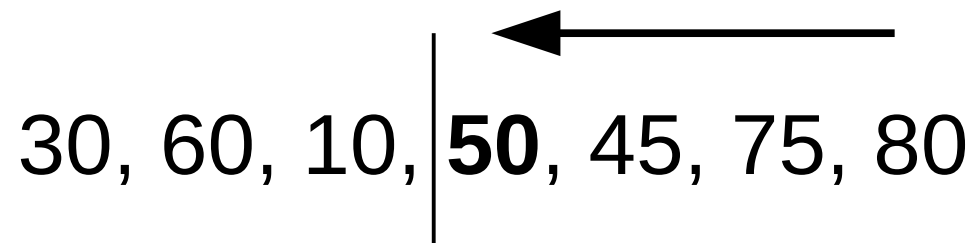
A diagram illustrating the Longest Decreasing Subsequence (LDS) from the right. The sequence of numbers is 30, 60, 10, 50, 45, 75, 80. A vertical line is placed between 10 and 50. An arrow points from the right towards the number 50, indicating the starting point of the LDS.

1 – 10 ← longest ending with
2 – 60 a number 49 or smaller

Global Warming

The LDS from the right.

30, 60, 10, | **50**, 45, 75, 80

A horizontal sequence of numbers: 30, 60, 10, followed by a vertical line, then 50, 45, 75, 80. The number 50 is bolded. A horizontal arrow points from the right towards the vertical line.

1 – 10

2 – 60 ← ok if $x \geq 11$

Global Warming

When first going from left, just before “50”
remember the length of LIS ending with
a number $50+x-1$ or smaller.

→
30, 60, 10, | 50, ...

1 – 10

2 – 60

Thank you for your attention.

Good luck on Thursday!