



Problem :- Life guards

Key points from Problem Statement

→ To keep pool safe, he hires N lifeguards.

→ Each life guard works during time interval

→ Start time

→ end time

→ But farmer hired 1 extra lifeguard.

Goal :- Remove one lifeguard

But who?

*

remove that lifeguard, the pool

should still be watched for.

maximum time

Approach - 1 :- Remove one lifeguard and check time coverage by other guards.

→ Do similar thing to every lifeguard.

Let's see theoretically! -

Sample input :- 3 → number of lifeguards

5 9
1 4
3 7

Each lifeguard Start & end time

Final output :- MaxCoverageTime = ?

Case-i! - Removing 1st lifeguard 5-9. = 6 time.

booleans array.

2nd life guard

2nd life

2nd life

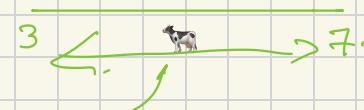
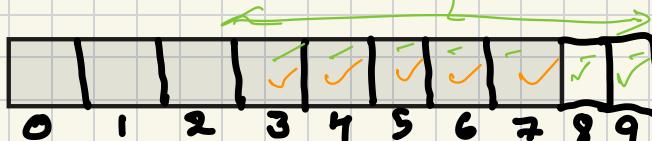


$$7-1 = \textcircled{6}$$

Case-ii! - Removing 2nd lifeguard 1-4

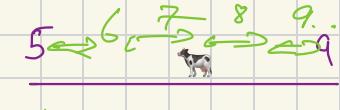
$$9-3 = \textcircled{6}$$

6 time



Case-iii! - Removing 3rd lifeguard 3-7

7 units



$$9-1 = \textcircled{8}, \textcircled{1}$$

7

6 6 7

Time Complexity!:- $(n \times (n-1))$ → (n^2) time.

Space Complexity!:- $\rightarrow O(n) \rightarrow$ Array

→ How to optimize? → Total Covered time - Least alone time.
 → We are checking again and again every time

Solution!:- Can we check in one go?

$O(n \log n) < O(n^2)$

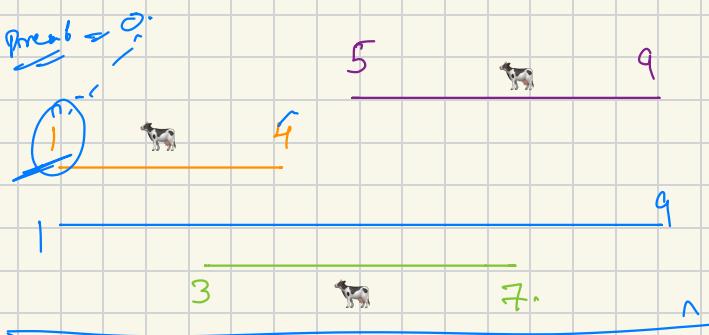
↳ $x \rightarrow$ why?

They are not in order.

$O(n) + O(n \log n)$
once

Let's put them in order ↴

↳ Sorting using Start time.



Time Complexity
 $O(n^2) \rightarrow O(n \log n)$

→ Go from Left to Right one pass.

what we need ? total time covered = ? -
min alone time = ?

1st Cow life guard :-

Prev end = 0

time covered by 1st cow = ?

alone time covered by cow = ?

Max

time covered = $(0, \text{cow.end.time.} - \underline{\text{Max(cow.start.time,}} \underline{\text{Prev end time)}})$

Prev end time

$$= \max(0, 4 - \max(1, 0))$$

$$= \max(0, (4-1))$$

Time covered = 3 → 3 units.

Alone time = ? → Check left and Right overlap @ not

left overlap = $\boxed{1 \times 0}$? cow.start : $\max(\text{cow.start}, \text{Prev end})$

left overlap = 1 s

Right overlap = $\boxed{1 > n-1}$? cow.end : $\min(\text{cow.end}, \text{next cow start})$

$$= \min(4, 3)$$

$$\rightarrow 3$$

$$\text{Alone time} = \text{Right overlap} - \text{left overlap}$$

$$= 3 - 1$$

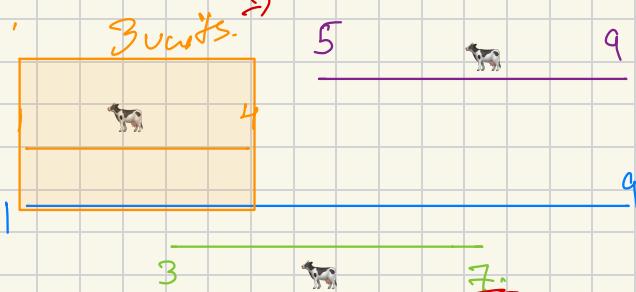
$$\boxed{\text{Alone time} = 2 \text{ units}} \rightarrow \begin{array}{l} \text{1st life guard} \rightarrow 2 \text{ units} \\ \hline \text{3 units} \end{array}$$

total time covered \neq time covered.

$$\text{min Alone time} = \min(\text{min alone time}, \text{alone time}) ;$$

$$\text{Pre end} = \max(\text{Pre end}, \text{Goe.end}) ;$$

~~1st lifeguard~~ \backslash
~~2 units~~ \rightarrow unique time
~~total time covered by 1st lifeguard.~~



$$\left(7 - \max(\text{Pre end}, \text{Goe.start}) \right)$$

$$7 - \max(4, 3)$$

$$7 - 4 \Rightarrow 3$$

2nd Cow life guard :- Prev end = 4
 time covered by 2nd cow = ? ✓
 alone time covered by cow = ? ✓

Max
 $\text{time covered} = (0, \text{cow.end time.} - \text{Max(cow.start time,}$

Prev end
 end time))

$$= \max(0, 7 - \max(3, 4))$$

$$= \max(0, 7 - 4)$$

jotful corrob
by 2nd = 3

Alone time = ? → Check left and Right overlap @ not

$$\text{left overlap} = \min(\text{cow.start}, \text{Prev end}) - \max(\text{cow.start}, \text{Prev end})$$

$$= \max(4, 3)$$

$$= 4$$

$$\text{Right overlap} = \min(\text{cow.end}, \text{next cow start}) - \max(\text{cow.end}, \text{prev cow start})$$

$$= \min(7, 5)$$

$$\Rightarrow 5$$

Above time = Right overlap - left overlap.

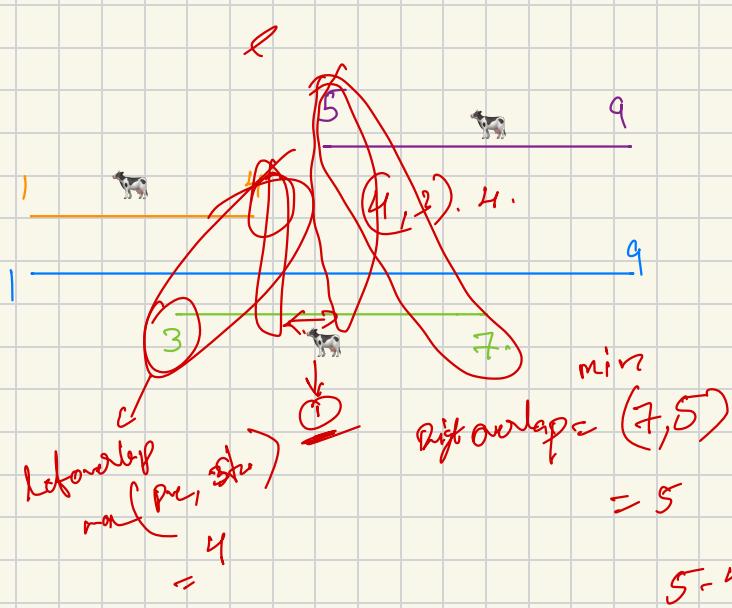
$$= 5 - 4$$

flanking \Rightarrow 1 unit -

Total time covered \leftarrow time covered. $\rightarrow 3 + 3 \Rightarrow 6$ total time

min Alone time $\leftarrow \min\left(\frac{\text{min alone time}}{2}, \frac{\text{alone time}}{2}\right) \Rightarrow 1$

Preend $\leftarrow \max(\text{Pre end}, \text{Coc. end}) \Rightarrow 7$



3rd Cow life guard :-

PrevEnd =

time covered by 3rd cow = ?

alone time covered by cow = ?

Max

$$\text{time covered} = (0, \text{cow.end time.} - \text{Max(cow.start time,}$$

PrevEnd
end
time))

$$= \max(0, 9 - \max(5, 7))$$

$$= \max(0, 9 - 7)$$

$$\Rightarrow 2$$

Alone time = ? \rightarrow Check left and Right overlap @ not

$$\text{left overlap} = \frac{x}{\text{cow.start}} ? \text{cow.start} : \text{Max}(\text{cow.start}, \text{PrevEnd})$$

$$= \max(5, 7) \Rightarrow 7$$

$$\text{Right overlap} = \frac{i > n-1}{?} \text{cow.end} : \min(\text{cow.end}, \text{nextcow.start})$$

$$= 9.$$

Alive time = Right overlap - left overlap.

=

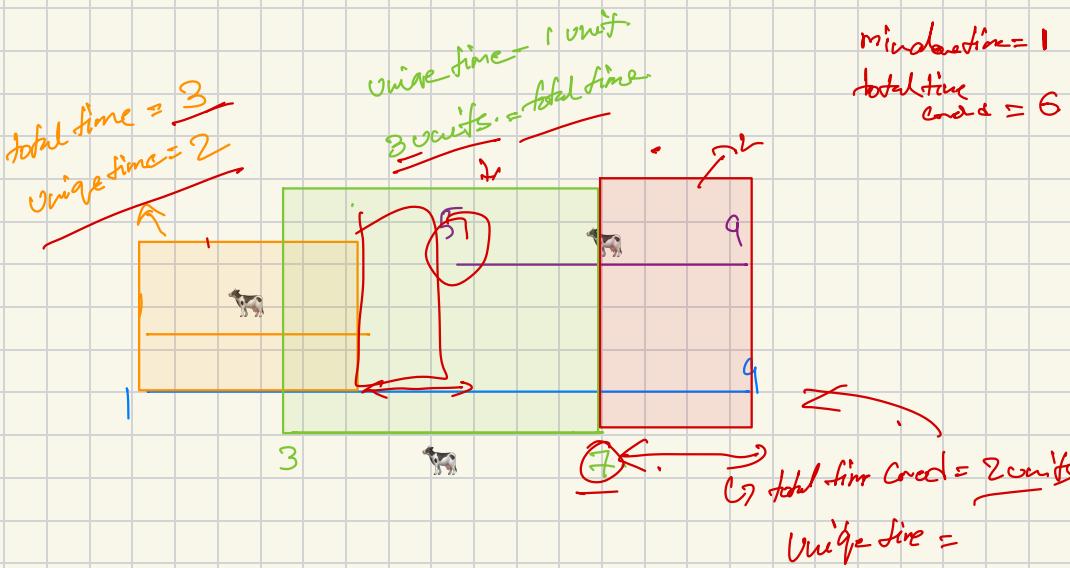
9 - 7

Alone time \Rightarrow 2 units

Total time covered \neq time covered. ; \Rightarrow

min Alone time = min(min alone time, alone time);

Pre end = max(Pre end, Coco.end);



Final Output:- $3 + 2 \Rightarrow \underline{\underline{8 \text{ units}}} \rightarrow \text{Total Time Covered}$

1st life = 2

2nd life = 1 \Rightarrow min alone = 1.

3rd life = 2

$$= 8 - 1$$

$\Rightarrow T \cdot N$

Time complexity :-

$$O(n) + O(n \log n)$$

$$O(n \log n) \checkmark$$

V.

$$O(n^2) \Rightarrow O(n \log n)$$

Space

$$O(n) \rightarrow \text{size}.$$