Agenda.

1. Allocate Minimum No. of Pages
2. Aggressive cows
3. Capacity to ship Packages within B days
4. Minimum limit of Balls in a Bag

Binary Search over solⁿ

Hard Problems.

Basics Binary Search.

Allocate Minimum No. of Pages.

Books[] = { 34, 12, 67, 90 }   stud = 2

Requirements.

- distribute these n Books among these M Students.
- such that Each student should get minm one Book.
- books should be distributed in contegeneous manner.

minm of maxm no. of pages read by a stud.

Books[] = { 34, 12, 67, 90 }   stud = 2

way 1

S1 ⟶ 34 + 12 + 67 → 113

S2 ⟶ 90 → 90

way 2

S1 ⟶ 34 + 12 → 46

S2 ⟶ 67 + 90 → 157

way 3

S1 ⟶ 34 → 34

S2 ⟶ 12 + 67 + 90 → 169

Max^{m} Pages

113

157

169

113 pages

Brute Force

$$\begin{array}{lcccc} & 0 & 1 & 2 & 3 \\ \text{Books}[\,] = & \{34, & 12, & 67, & 90\} \end{array}$$

stud = 2

(M-1)

dividers

Books[] = { 34, 12, 67, 90 }   stud = 2

Case 1. if M = 1

way 1 → 34, 12, 67, 90 → max 203 → min 203 pages

Case 2: if M = N

way 1: S1 → 34
S2 → 12
S3 → 67
S4 → 90

→ max 90 → min 90 pages

$1 \le M \le N$

① step 1: define range

$\underline{\underline{M = 2}}$

~~90 pages~~

104

mid

~~146~~

~~117~~

103

~~203 pages~~

~~175~~

115

ans = ~~146~~

117

Books[] = { 34 , 12 , 67 , 90 }

Max^m Page = 146

S1 → 34 + 12 + 67

S2 → 90

Books[] = { 34 , 12 , 67 , 90 }

Max^m Page = 117

S1 → 34 + 12 + 67

S2 → 90

Books[] = { 34, 12, 67, 90 }

Max^m Page = 103

S1 → 34 + 12

S2 → 67

S3 → 90

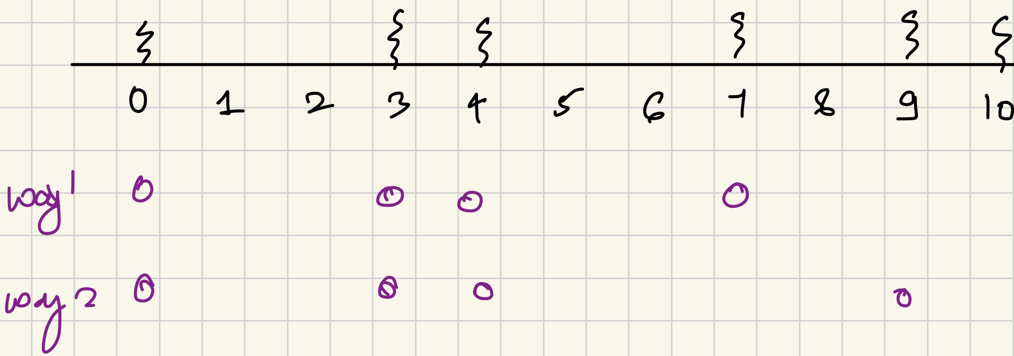
Aggressive Cows

stalls[] = {0, 3, 7, 9, 10, 4}

cows = 4

aggressive

max^m the min^m dist. b/w any two aggressive cows.

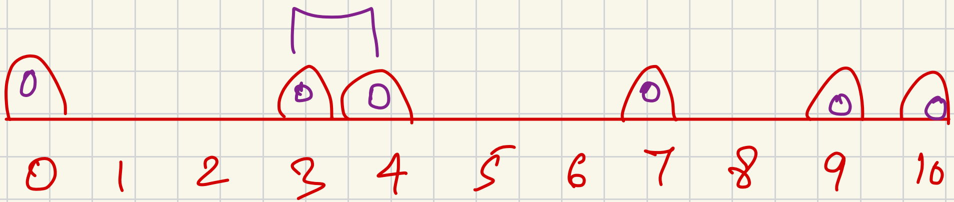


min — { max }

$^6C_4$ ways

Case 1

cows = N



min dist = 1 → max = 1

Case 2

cow = 2

$^6C_2$ way total

cow at first & last stall → 10 units

$2 \le cow \le N$

cows = 7

Range

0 — 1 — 0

~~1 unit~~

~~3~~

4

mid

↳ ~~5~~

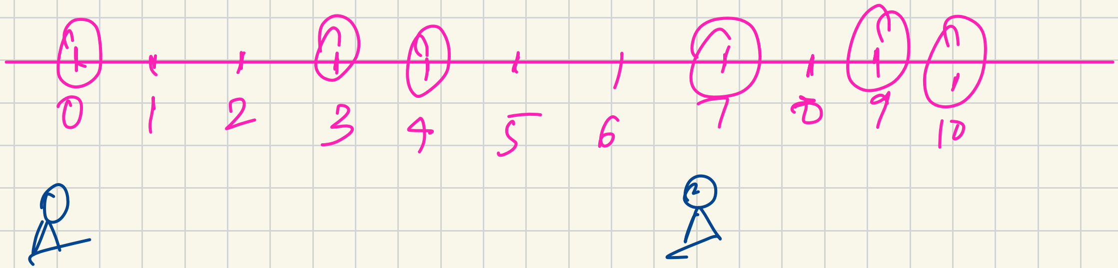
~~2~~ ~~3~~ ~~4~~

~~10 unit~~

~~4~~ 3

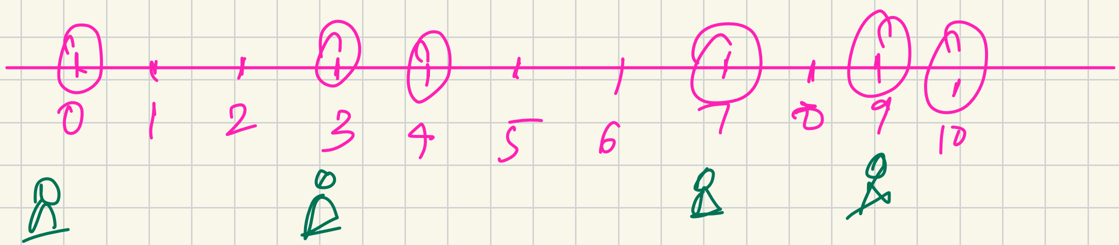
pave = ~~1~~ ~~2~~ 3 ✓

min Dist = 5



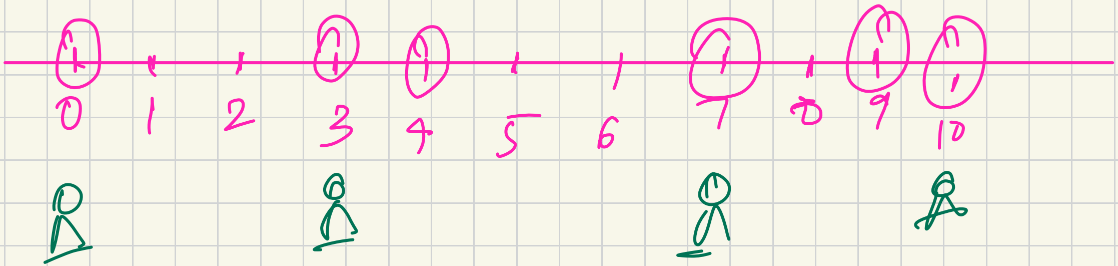
cows = 2

min Dist = 2



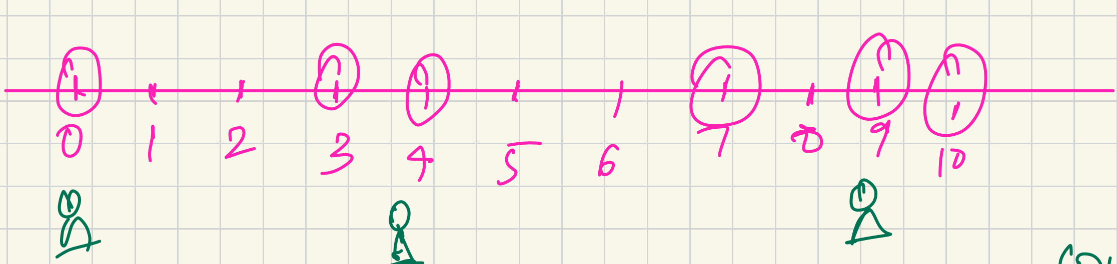
cows = 4

min Dist = 3



cows = 4

min Dist = 4



cows = 3

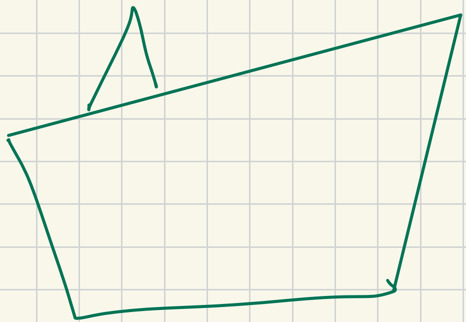
min

✓ nearest stall will be the max^m threat

① compare with nearest stall.

Capacity to ship Packages within B days.

int[] A = { 3, 2, 2, 4, 1, 4 } day = 3



min^m { max^m Capacity of the ship

int[] A = {3, 2, 2, 4, 1, 4}   day = 3

day1   3, 2, 2, 4

day2   1

day3   4

11kg

$\boxed{\text{min}}$

day1   3, 2, 2

day2   4, 1

day3   4

7kg

$\log_2(10^4) = 4 \times 3.1 \approx 13$ steps

Range

$\log_2(10^8) = 8 \times 3.1 = 24$ steps

Binary Search over an infinite array

infinite sorted array

{ 1, 3, 10, 11, 15, 17, 20, 25, ... }

target = 1014

Brute force:

↳ Linear Search

TC: O(M)

↳ index of Element.

$$\begin{array}{cccccccccccccc} 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & & & & 16 \\ \{1, & 3, & 10, & 11, & 15, & 17, & 20, & 25, & 30, & 45 & \circ & \circ & \circ & 103 & \circ & \circ\} \\ & & & & & & & & & \uparrow & & & & \uparrow \\ & & & & & & & & & lo & & & & hi \end{array}$$

target = 90

~~Range [0, 1] → x 2~~

Range [2, 2] → 1 → 2^0

Range [3, 4] → 2 → 2^1

Range [5, 8] → 4 → 2^2

Range [9, 16] → 8 → 2^3

$$\begin{cases} target \geq arr[lo] \;\&\& \\ target \leq arr[hi] \end{cases}$$

$lo = hi' + 1$

$hi = 2 \times hi'$

$\{a, b, c, d \; . \; . \; . \; . \; . \; . \; . \}$

$(k-1)$ $\quad$ $\boxed{k^{th}}$

lo $\quad\quad$ hi

$2(k-1)$

$lo = k^{th}$

$hi = 2(k-1)^{th}$

$\boxed{\log_2 k}$ → time complexity to search in the range

total Ele $= 2(k-1) - K$

$= (k-2)$ Elements

1^{st} Range $= 1$

2^{nd} Range $= 2$

⋮

p^{th} Range $= 2^{p-1}$

$$2^{p-1} = k-2$$

$$p-1 = \log_2 (k-2)$$

$$p = \log_2 (k-2) + 1$$

$$\boxed{p \approx \log_2 k}$$

Overall TC

$\log_2 k + \log_2 k = TC: O(\log_2 k)$

I can find an Ele

TC: $\log_2(k)$

$\cancel{\log_2 1000}$

$\log_2 100$