Day 4 [LC: 1755]

Q1. Set of integers ($N \le 40$), each value $\le 10^9$ (18)
Det the max sum subset having sum $\le S$ ($S \le 10^{18}$)

[5, 3, -1, 7] → 2^4 poss subsets

0-length	2-length	3-length
{} → 0	{5,3} {5,-1} {5,7}	{5,3,-1} {5,3,7}
	Σ 8 4 12	{5,-1,7} 15
1-length	{3,-1} {3,7}	{5,-1,7} {3,-1,7}
{5} → 5	Σ 2 10	11 9
{3} → 3	{-1,7}	
{-1} → -1	Σ 6	4-length
{7} → 7		{5,3,-1,7} = 14

TC: $O(2^n)$ → $2^{40} \approx 10^{12}$

10^8 ⇒ 1 sec ⇒ $\frac{10^{12}}{10^8}$ sec = 10^4 sec = 2.77 hrs.

- maintain a min to find a number close to sum

Subsem Sum Prob → 0/1 knapsack
$O(N \times sum)$ 40×10^{18} → Even worse

Opt. steps:

i) {5, 3, -1, 7} ← N

{5, 3} ← N/2 {-1, 7} ← N/2

All poss sum of subset: [0, 3, 5, 8] ($2^{n/2}$ entries), (0, -1, 7, 6) ($2^{(n/2)}$)

for each entry ↑ it for each of this here
$2^{n/2} \times 2^{n/2} = 2^n$

2) Instead linear search, Do Binary search.

[0,5,3,8] (2,0,6,7) Sort $2^{N/2} \log_2 2^{N/2}$

$N/2 \cdot 2^{N/2}$

a

b = 13-0 = 13 → target Binary search

target = 5 = 13

$a+b \leq 5$

$a+b = 5$

$b = (5-a)$

13-0 = 13

dun

0+7 = 7

a = 5

b = 13-5 = 8 → target 5 for 8

$\log_2 2^{N/2} = \frac{N}{2}$

5+7 = 12

$O(\frac{N}{2} 2^{N/2} \times \frac{N}{2}) \Rightarrow O(2^{N/2} \cdot N)$

$\Rightarrow 2^{20} \times 40$

$\Rightarrow 4 \times 10^7 \Rightarrow$ <1sec

3+7 = 10 a = 3

b = 13-3 = 10

8+0 = 8 a = 8

b = 13-8 = 5 = 0

Closest to sum = 13

12 Ans.

LC: Range Addition (370)

③ Given stock prices for N stocks in an array initially, we keep investing on stocks @ time in a range [L,R]. Find the final investment of each stock.

(obv O(n))

n-stocks. [15, 10, 5, 20, 40] (indices 0 1 2 3 4)

↓

[15, 20, 15, 30, 40]

↓

[25, 30, 25, 30, 40]

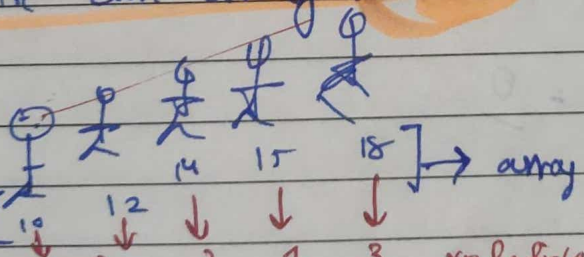
invst (1, 3, 10) (invest in a given range)

↓

(0, 2, 10) → amount

TC if iteration for all queries ⇒ O(Q·N)

④ Solve each query in O(1) Algo: Diff Array.

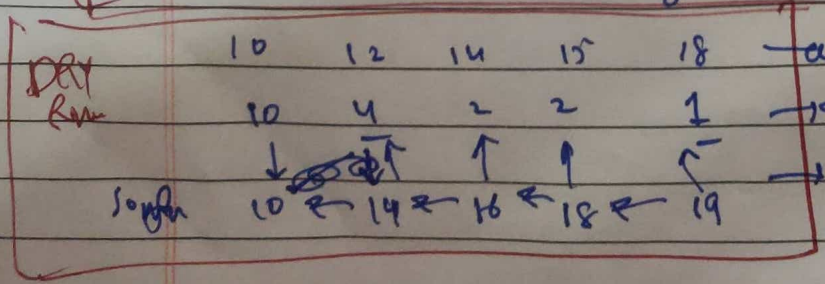


Subtraction of int.

index: 0 1 2 3 4

incRR (1, 3, 2) ⇒ grd[L] += x
grd[R+1] -= x

Logic step



Dry run

ind	0	1	2	3	4	
	15	10	5	20	40	
	[15	-5	-5	15	20	0]

a) Q(1, 3, +10)

-5 + 10 = 5

20 - 10 = 10

	15	5	-5	15	10	0

Grad after a

b) Q(0, 2, 10)

25 ... 5

[25 5 -5 5 10 0] Grad after b

ht[] 25 30 25 30 40 x .

2nd step

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for(i=1; i<N; i++)
    g[i] = g[i] + g[i-1]
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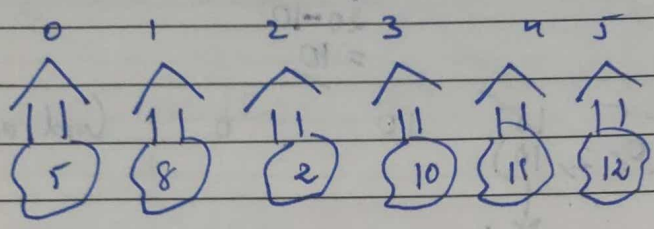
TC: O(1×N)

(3) Binary Search

(1) Sorted Array ✓
(2) Rotated Sorted Array. ✓
(3) Peak Ele. ✓

(4) BS on Assignment Prob



- Villas & gardens in front
- has processing time

i am hiring worker to do the jobs → there min no. of workers to get job done.

i) All workers are identical
ii) ~~they can't work parallely~~ (1 worker can only work on 1 garden).
(No 2 workers can work on same garden)
iii) A worker can only work on adj garden

N villas ($k \leq N$)
K → workers
Goal: minimize the time to complete all gardens work.

for

time: min → max(Arr) = 12 ⇒ 6 ≤ = N
max → sum of Arr = 48 ⇒ k = 1

We can say, Now, ans ∈ [12, 48]

Given in Q ⇒ N = 6, K = 3 ⇒ Apply Binary Search on range of answers.

① l = 12, h = 48 — m = 12 + (48−12)/2 = 30

5, 8, 2, 10 | 11, 12
w_1 | w_2

workers req = 2
ie 2 <= K ⇒ this arrangement works.

① Store the answer — min(∞, 30) = 30
② h = mid − 1 — try is less time now.

③ l = 12, h = 29 — m = 12 + (29−12)/2 = 20

5, 8, 2, 10 | 11, 12
w_1 | w_2 | w_3 | w_4

workers req = 4
ie 4 <= K ✗ ⇒ this arrangement not works.

② Do not store answer
② ↑ time ⇒ l = m + 1

30

③ l = 21, h = 29 — m = 21 + (29−21)/2 = 25
h = m − 1

5, 8, 2, 10 | 11, 12
w_1 | w_2

workers req = 2
ie 2 <= K ✓ ⇒ Arrangement works.

① — min(30, 29) = 29
② h = m − 1 = 24

(4) $l = 21$ $\quad m = \frac{21 + (3)}{2} = 22$

$h = 24$

5, 8, 2 | 10, 11 | 12

w_1 $\quad w_2$ $\quad w_3$

workers req = 3

ie $3 <= K$ ✓ ⇒ Arrangement work

① $\quad \min(25, 22) = 22$

② ~~h = m+1~~ $\quad h = m - 1 = 21$

(5) $l = 21$ $\quad m = 21 + 0/2 = 21$

$h = 21$

$m = 21$

5, 8, 2 | 10, 11 | 12

w_1 $\quad w_2$ $\quad w_3$

workers req = 3

ie $3 <= K$ ⇒ Arrangement works.

① $\quad \min(25, 21) = 21$

② $h = m - 1 = 20$

(6) $l = 21$

$h = 20$

Stop / while (low <= high)

then only operate.