Q → Given an integer array of size N,
find the sum of elements from index L to R.

	0	1	2	3	4	5	6	7
A =	-6	3	2	4	5	-2	1	9

$L = 1 \quad R = 4$

Ans = 3 + 2 + 4 + 5 = 14

```
ans = 0
for i → L to R
    ans += A[i]
return ans;
```

TC = O(N)
SC = O(1)

Find sum of elements from index L to R for multiple queries.

	0	1	2	3	4	5	6	7
A =	-6	3	2	4	5	-2	1	9

I/P

	Q1	Q2	Q3
L =	1	3	0
R =	4	6	5

Q

Bruteforce → TC = O(Q * N)
SC = O(1)

3+2+4+5 = 14

4+5-2+1 = 8

-6+3+2+4+5-2 = 6

Cricket

Sairam

Over →		1	2	3	4	5	6	7	8	9	10
Scoreboard →	0	16	22	30	45	51	70	75	90	104	120

Scoreboard[i]
runs scored from 1st to i th over.

Score of 10th over = 120 − 104 = 16
Score of last 6 overs = 120 − 45 = 75
Score of 4th to 7th over = 75 − 30 = 45

TC = O(1) per query

	0	1	2	3	4	5	6	7
A =	-6	3	2	4	5	-2	1	9
Prefix Sum =	-6	-3	-1	3	8	6	7	16

	Q1	Q2	Q3
L =	1	3	0
R =	4	6	5

P[i] = sum of elements from start till i th index.

$\boxed{P[i] = P[i-1] + A[i]}$

TC per query = $\underline{O(1)}$

TC = $\underline{O(N)}$ SC = $\underline{O(N)}$

$\underline{A[i] = P[i] - P[i-1]}$

$Q_1 \rightarrow (1, 4) \rightarrow P[4] - P[1-1] = 8 - (-6) = \underline{14}$

$Q_2 \rightarrow (3, 6) \rightarrow P[6] - P[3-1] = 7 - (-1) = \underline{8}$

$Q_3 \rightarrow (0, 5) \rightarrow P[5] = \underline{6}$

index → 0 1 2 3 4 5 6

x

→ P[0] = A[0] // P[] size N

for i → 1 to (N-1)

P[i] = P[i-1] + A[i]

TC = $\underline{O(N)}$ SC = $\underline{O(N)}$

L[i] —— R[i]

for i → 0 to (Q-1)

l = L[i]

r = R[i]

if (l == 0)

print(P[r])

else

print(P[r] - P[l-1])

TC = O(Q) SC = O(1)

Total TC = O(N+Q)

SC = $\underline{O(N)}$

		modify input
TC = O(Q * N) →	TC = O(N + Q) →	TC = O(N+Q)
SC = O(1)	SC = O(N)	SC = O(1)

	0	1	2	3	4	5	6	7
A =	[-6	3	2	4	5	-2	1	$\boxed{9}$]
↳	-6	-3	-1	3	8	6	7	16

A[i] = sum of elements from start till i^{th} index.

$\underline{A[i] = A[i-1] + A[i]}$

for i → 1 to (N-1)

A[i] = A[i-1] + A[i]

$\underline{TC = O(N) \quad SC = O(1)}$

$$\begin{array}{ccccccccc} & 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ A = & [-6 & 3 & 2 & 4 & 5 & -2 & 1 & 9] \\ \boxed{\text{Prefix Sum}} = & [-6 & -3 & -1 & 3 & 8 & 6 & 7 & 16] \end{array}$$

$P[i]$ = sum of elements from start till i^{th} index.

$$\begin{array}{ccccccccc} & 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ A = & [-6 & 3 & 2 & 4 & 5 & -2 & 1 & 9] \\ \text{Suffix Sum} = & [16 & 22 & 19 & 17 & 13 & 8 & 10 & 9] \end{array}$$

$S[i]$ = sum of elements from i^{th} index till end.

$\boxed{S[i] = S[i+1] + A[i]}$

$\boxed{10:30 \text{ PM}}$

$S[N-1] = A[N-1]$

for $i \longrightarrow (N-2)$ to 0

$S[i] = S[i+1] + A[i]$

Q→ Given an integer array of size N, find the first (smallest) equilibrium index.

↳ index k

sum of elements from index 0 to (k-1) = sum of elements from index (k+1) to (N-1)

Left Sum   Right Sum

$$\begin{array}{cccccccc} & 0 & 1 & 2 & 3 & 4 & 5 & 6 \\ A = & [-7 & 1 & 5 & 2 & -4 & 3 & 0] \end{array}$$

$-7+1+5 = \underline{-1}$ $-4+3+0 = \underline{-1}$

Ans = $\underline{3}$

$$\begin{array}{cccccccc} & 0 & 1 & 2 & 3 & 4 & 5 & 6 \\ A = & [-7 & 1 & 5 & 2 & -4 & 3 & 0] \end{array}$$

$-7+1+5+2-4+3 = 0$ $\underline{0}$

$$\begin{array}{cccccccc} & 0 & 1 & 2 & 3 & 4 & 5 & 6 \\ \rightarrow A = & [5 & 1 & 3 & -6 & 5 & -2 & -1] \end{array}$$

$\underline{0}$ $1+3-6+5-2-1 = \underline{0}$

Bruteforce → First index K s.t $\underbrace{\text{sum}(0 \_\_ (K-1))}_{P[K-1]} = \underbrace{\text{sum}((K+1) \_\_ (N-1))}_{S[K+1]}$.

$$\begin{array}{ccccccccc} & 0 & 1 & 2 & 3 & 4 & 5 & 6 \\ A = [& -7 & 1 & 5 & 2 & -4 & 3 & 0\ ] \\ P = [& -7 & -6 & -1 & 1 & -3 & 0 & 0\ ] \\ S = [& 0 & 7 & 6 & 1 & -1 & 3 & 0\ ] \end{array}$$

Steps → 1) calculate P[] & S[]. → $\left.\begin{array}{l} TC = O(N+N) = O(N) \\ SC = O(N+N) = O(N) \end{array}\right\}$

2) Find first K s.t $P[K-1] = S[K+1]$. → $TC = O(N)$, $SC = O(1)$

Total $TC = O(N)$ ✓
$SC = O(N)$

corner cases → $K = 0$ or $(N-1)$

$P[K-1] = S[K+1]$
$+ A[K] \qquad + A[K]$

$\boxed{P[K] = S[K]}$

$S[K]$: K — $(N-1)$

$\underbrace{P[N-1] - P[K-1]}$ ✓

$$\begin{array}{ccccccccc} & 0 & 1 & 2 & 3 & 4 & 5 & 6 \\ A = [& -7 & 1 & 5 & 2 & -4 & 3 & 0\ ] \\ P = [& -7 & -6 & -1 & 1 & -3 & 0 & 0\ ] \\ S = [& 0 & 7 & 6 & 1 & -1 & 3 & 0\ ] \end{array}$$

$P[6] - P[3-1]$

$\forall i$ check if $\boxed{P[K] == P[N-1] - P[K-1]}$ ←

modify i/p → $\left.\begin{array}{l} TC = O(N) \\ SC = O(1) \end{array}\right\}$ H.W → Solve with same TC & SC without modifying i/p.

Q → Given an integer array of size N, find sum of elements for queries →

Type	L	R
1/2	start	end

Type 1 → sum of even index elements from L to R

Type 2 → sum of odd index elements from L to R

	0	1	2	3	4	5	6
A =	8	-3	5	-7	1	4	2
evenP =	8	8	13	13	14	14	16
oddP =	0	-3	-3	-10	-10	-6	-6

	Q1	Q2	Q3	Q4
Type →	1	2	2	1
L →	1	2	4	3
R →	4	6	5	3

$5+1=\underline{6}$ $\quad -7+4=\underline{-3}$ $\quad \underline{4}$ $\quad \underline{0}$

	0	1	2	3	4	5	6	7
A =	2	3	1	-1	0	8	5	4
evenP =	2	2	3	3	3	3	8	8
oddP =	0	3	3	2	2	10	10	14

	0	1	2	3	4	5	6
A =	8	-3	5	-7	1	4	2
evenP =	8	8	13	13	14	14	16
oddP =	0	-3	-3	-10	-10	-6	-6

	Q1	Q2	Q3	Q4
Type →	1	2	2	1
L →	1	2	4	3
R →	4	6	5	3

oddP[6] − odd[2−1]

TC = O(N) $\quad$ SC = O(N)

TC = O(1) per query

evenP[4] − evenP[1−1] = 14 − 8 = $\underline{6}$

= −6 − (−3) = $\underline{3}$

Total TC = $\underline{O(N+Q)}$ $\quad$ SC = $\underline{O(N)}$

	0	1	2	3	4	5	6
A =	8	-3	5	-7	1	4	2
even/odd } → P =	8	-3	13	-10	14	-6	16

P[0] = A[0] $\quad$ P[1] = A[1]

$\boxed{P[i] = P[i-2] + A[i]}$ → i > 1

Type
- 1) even → R or (L−1) is odd then do (R−1) or ((L−1)−1)
- 2) odd → R or (L−1) is even then do (R−1) or ((L−1)−1)

$\approx \underline{2*10^9}$ $\quad$ long