

Q2) Given N array elements & Q queries, for each query calculate sum of all even index in given range

// Note: All Queries on Same Array

| | | | | | | | | |
|-----------|---|---|----|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| $ar[8]$: | 3 | 4 | -2 | 8 | 6 | 2 | 1 | 3 |

4 Queries

| | Sum | For every query iterate and only add even index. |
|-----------------|-----|--|
| $[2 \dots 5]$: | 4 | |
| $[3 \dots 7]$: | 7 | $sum = 0$ |
| $[0 \dots 7]$: | 8 | $q = L; q_L = R; q_{-1} \{$ |
| $[7 \dots 7]$: | 0 | $\} q \% 2 == 0 \{$ |
| $[4 \dots 4]$: | 6 | $\} sum = sum + ar[q] \}$ Return Ans; |

T_C : For single Query
 $\Rightarrow O(N)$
 } For Q queries
 T_C : $Q \times N$
 S_C : $O(1)$

// Optimization: 1

: Increment i by 2 : $(N/2) = O(N)$

// Optimization: 2

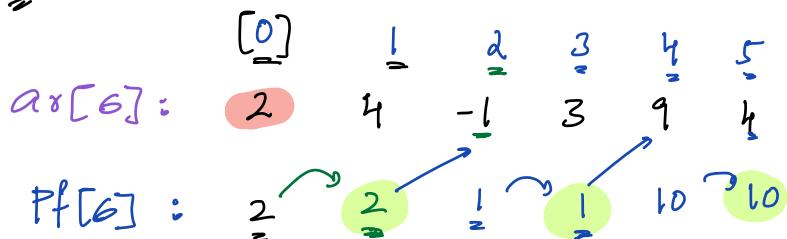
// $Pf[p] = \{ // \text{Sum of all even index from } [0-p]\}$

Ex:

$$ar[8] : \underline{0} \quad 1 \quad 2 \quad \textcircled{3} \quad 4 \quad \textcircled{5} \quad \textcircled{6} \quad \textcircled{7}$$
$$ar[8] : 3 \quad 4 \quad -2 \quad 8 \quad 6 \quad 2 \quad 1 \quad 3$$

$$Pf[8] : 3 \quad 3 \quad 1 \quad 1 \quad 7 \quad 7 \quad 8 \quad 8$$

Ex:



// Pseudocode

Pferen[N];

Pferen[0] = ar[0]

i = 1; i < N; i++ {

 if (i % 2 == 1) {

 |
 | Pferen[i] = Pferen[i-1]

 else { // i is even

 | Pferen[i] = Pferen[i-1] + ar[i]

 | i >= 0 // corr

TC: O(N) SC: O(N)

Answering Queries:

[4 8]:

0 1 2 3 4 5 6 7 8

$Pf[8] \Rightarrow \text{Sum f all even index from } [0-8]$

$\Rightarrow \text{Sum f all even index from } [0-3] + Pf[3]$

$\text{Sum f all even index from } [4-8]$

$Pf[8] = Pf[2] + \text{sum f all even index from } [4-8]$

$[4-8] = Pf[8] - Pf[3]$

// Query $[L R]$ get sum f all even indices

$\text{SumEven}[L-R] = Pf[R] - Pf[L-1] \quad \} \text{ if } L == 0 \times$

Given $L \leq R$

if ($L == 0$) {

| SumEven[L-R] = Pf[R]

}

else

| SumEven[L-R] = Pf[R] - Pf[L-1]

}

1 For Each Range

$O(1)$

TC: $O(N + O_1)$

SC: $O(N)$

Q2) Given N array elements & Q queries, for each query calculate sum of all odd index in given range

TODO:

$\text{Pfodd}[i] = \text{sum of all odd index elements from } [0-i]$

Ex:

$0 \quad 1 \quad 2 \quad 3 \quad 4 \quad 5$

$ar[6] = -3 \quad -1 \quad 2 \quad 2 \quad 4 \quad 5$

$\text{Pfodd}[6] = 0 \quad -1 \quad -1 \quad 1 \quad 1 \quad 6$

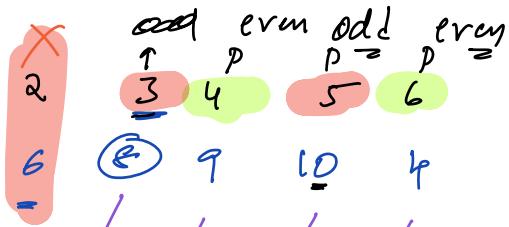
$ar[5] = 0 \quad 1 \quad 2 \quad 3 \quad 4$

$\text{Pfodd}[5] = 0 \quad 4 \quad 4 \quad 4 \quad 5 \quad 5$

Delete index

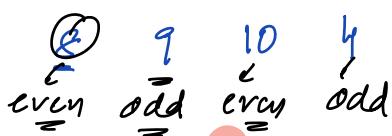
Ex1:

$$ar[7] \Rightarrow 3 \quad -2$$



// Delete 2nd index

$$ar[6] \Rightarrow 3 \quad -2$$



Ex2:

$$ar[8] \Rightarrow 0 \quad 1 \quad 2 \quad 3 \quad 9 \quad 6 \quad 4 \quad -2 \quad 1 \quad 8$$

// Delete 3rd index

$$ar[7] \Rightarrow 2 \quad 3 \quad 9 \quad 4 \quad -2 \quad 1 \quad 8$$

Ex3:

$$ar[6] \Rightarrow -1 \quad 0 \quad 1 \quad 2 \quad 3 \quad 4 \quad 5$$

// Delete 0th index

$$ar[5] \Rightarrow 6 \quad 3 \quad 8 \quad 0 \quad 7$$

Observations:

All Elements after deleted index after shifting to the left side by 1 step

Spectral Index { Above Median }

An Inden is said to be special, if after deleting

the element Sum of All Even indices = Sum of all odd indices

Count how many special index are there?

$$\text{Sum: } \begin{array}{r} 0 \\ = \\ 4 & 3 & 2 & \cancel{3} & 4 & 5 \\ \hline & & & 7 & 6 & -2 \end{array} \quad \left. \begin{array}{l} \text{Sum even} = 12 \\ \text{Sum odd} = 8 \end{array} \right\} \Rightarrow 1$$

Check index = 0 ?

Delete index 0

$$\begin{array}{r}
 0 & 1 & 2 & 3 & 4 \\
 3 & 2 & 7 & 6 - 2 \\
 & & \hline
 & & \hline
 \end{array}$$

Sum of all even: 8

Sum of all odd : Q

Inden 0 is special

chunk order = 1?

Doktoranden

$$\begin{array}{r} 0 \\ 4 \\ - \end{array} \quad \begin{array}{r} 1 \\ 2 \\ - \end{array} \quad \begin{array}{r} 2 \\ 7 \\ - \end{array} \quad \begin{array}{r} 3 \\ 6 \\ - \end{array} \quad \begin{array}{r} 4 \\ 2 \\ - \end{array}$$

sum fall even : 9

Sum f all odd : R

Golden 1 *

check index = 2

Deletz Indca 2

| | 0 | 1 | 2 | 3 | 4 |
|--|---|---|---|---|----|
| | 4 | 3 | 7 | 6 | -2 |
| | | | | | |

Sum f der Even: 9

Sums of the Odd, 9

Index 2 91 special ✓

$\rightarrow \text{Enden} = 3 x$

$$\Rightarrow \text{Radius} = 4x$$

→ Index = 5 *

7 // 2 indices are special

0 a 2

Approach:

Check if every index is special or not?
 Delete that index
 get Sum of even =
Sum of odd

$$TC: \frac{N}{2} \times \left\{ \frac{N}{2} + \frac{N}{2} \right\}$$

N chunks

To delete
a index

Sum of Even Index
 & Sum of Odd Index

$$TC: \underline{\underline{\Theta(N^2)}}$$

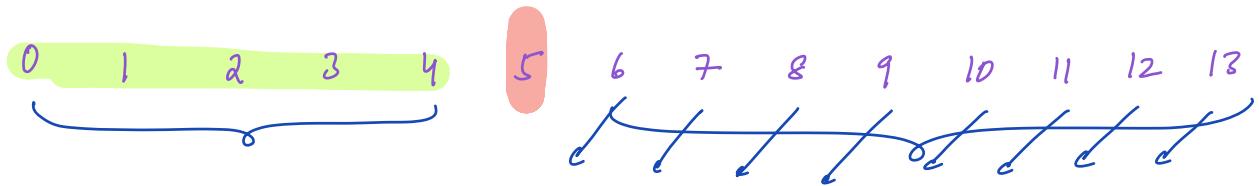
| | | |
|-------------|-------------|---|
| <u>Ex1:</u> | 0 1 2 3 4 5 | $\rightarrow \text{sumeven} = 12$ |
| | 6 - 2 | $\rightarrow \text{sumodd} = 8$ |
| | | $\rightarrow \text{sumodd} = 8 - 7 = 1$ |

Delete index 3

| | | | | | |
|---|---|---|---|-----|----------------------------------|
| 0 | 1 | 2 | 3 | 4 | $\rightarrow \text{sumeven} = 4$ |
| 6 | 3 | 2 | 6 | - 2 | $\rightarrow \text{sumodd} = 7$ |
| - | - | - | = | - | |

Ση =

ary[1..4] :



sum even [0 4]

sum odd [0 4]

sum even [6 13] = sum odd

sum odd [6 13] = sum even



sum even [0 7]

sum odd [0 7]



sum even [9 13] = sum odd

sum odd [9 13] = sum even

Even Sum :

sum even [0 7] + sum odd [9 13]

Odd Sum

sum odd [0 7] + sum even [9 13]

if (EvenSum == OddSum)

// Generalize even

// 0^{th} index special or Not?

0 1 2 3 .. $i-1$ i $i+1$.. $N-1$

Sum even $[0, i-1]$

Sum even $[i+1, N-1]$ = oddsum

Sum odd $[0, i-1]$

Sum odd $[i+1, N-1]$ = evensum

// → Constant pf even [] $\Rightarrow O(N)$

// → Constant pf odd [] $\Rightarrow O(N)$

$i = 1; i \leq N-1; i++$

Evensum = sumeven $[0, i-1]$

if $i = 0$ edges case
ps if $i = 0$

sumodd $[i+1, N-1]$

Oddsum = sumodd $[0, i-1]$ + sumeven $[i+1, N-1]$

if (Evensum == Oddsum) {

if $i \geq N-1$

cout <<

// Check if 0^{th} index special a Not

// Check if $N-1^{\text{th}}$ index special a Not

10:45 break

TC: $O(N+N+N)$

SC: $O(N+N)$

Q2) Given a String, calculate Number of pairs i, j , such that $s[i] = 'a'$ & $s[j] = 'g'$ // All characters are lower case English Alphabets

Σημ: 0 1 2 3 4 5 6 7
 b a a g d c a g

Pairs: $\{\underline{1}, 3\}$, $\{\underline{2}, 3\}$
 $\{\underline{1}, \underline{2}\}$, $\{\underline{3}, \underline{2}\}$

| <u>$\Sigma x_1 z_i$</u> | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|------------------------------------|---|-----------------|---|-----------------|---|---|---|
| $a < \underline{g}$ | d | \underline{g} | a | \underline{g} | | | |

$$\text{Pairs} = \{0, 3\}, \{0, 4\}, \{0, 6\}, \\ \{5, 6\}$$

Solution

D) Check all pairs $\ni \text{DF}_1$

$$q = 0; q \in N; q + r) \{$$

$q = q + 1; q \in N; q + r) \{$

if $[S[i] == 'a' \& q]$

$S[j] == 'g') \{$

cut_{ip}

}

}

}

return cut;

$i = 0$; $s \in N$; $p \rightarrow$ $\in BF2$

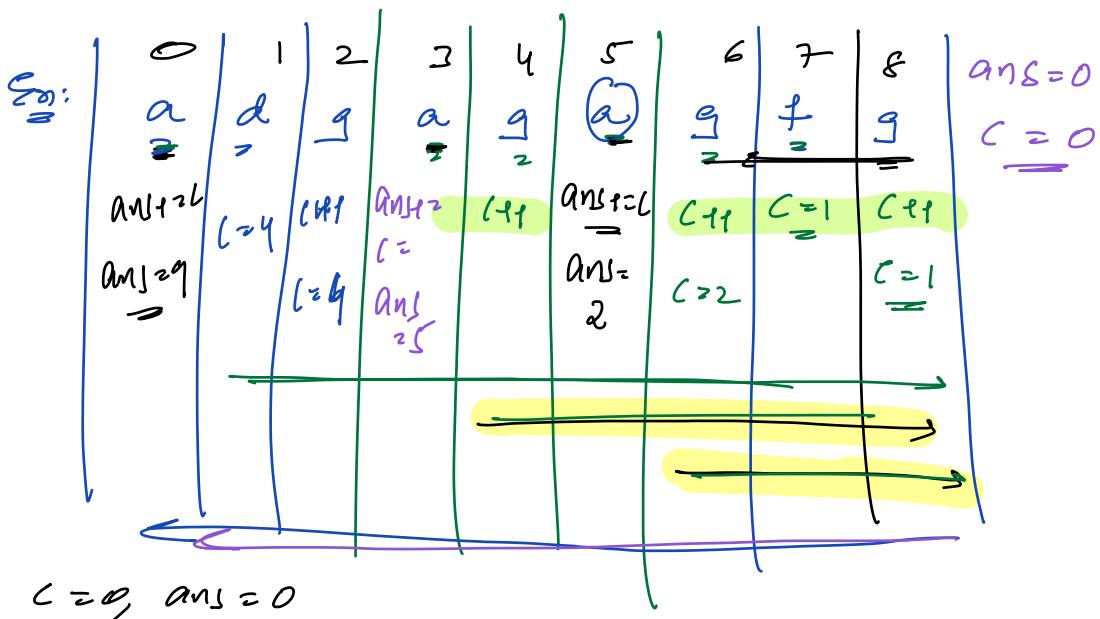
if ($s[i] == 'a'$) { } if $s[i] == 'a'$

$i = i + 1$; $s \in N$; $p \rightarrow$ { } \Rightarrow Number of g's in input

if ($s[j] == 'g'$) { } SPde }

} Cnt++ }

TC: $O(N^2)$ SC: $O(1)$



$p = N - 1$; $q >= 0$; $q--$ { }

if ($car[p] == 'g'$) { } if { }

an if ($car[p] == 'a'$) { } if $ans - 1 == 1$ }

return ans;

TC: $O(N)$

SC: $O(1)$

// For every ' g' we need no: f a's in left side

$$\text{ans} = 0, c = 0$$

$$q = 0; q < N; q++ \}$$

$$\left. \begin{array}{l} \text{if } C[s[i]] == c_a \} \\ \quad | \\ \quad \quad c++ \end{array} \right\}$$

$$\left. \begin{array}{l} \text{else if } C[s[i]] == c_g \} \\ \quad | \\ \quad \quad // Number of a's to the left of g \end{array} \right\}$$

$$\left. \begin{array}{l} \\ \quad | \\ \quad \quad \text{ans} + c \end{array} \right\}$$

}

return ans;

$Tc: O(N)$
 $Sc: \underline{\underline{O(1)}}$

Closer Min Max

→ Continue part of array
→

Given an array find the length of smaller subarray

which contains both Min Max of array

$\frac{O(N+1)}{2}$

Ex: $\{1, 2, 3, \underline{1, 3, 4, 6}, 4, \underline{6, 3}\}$

Min: 1
Max: 6

$[3 \underline{6}] = 4$

Ex: $\{2, 2, 6, 4, 5, 1, 5, 2, \underline{6, 4, 1}\}$

Min: 1

$[2 \underline{10}] : \text{len} = 8$

Max: 6

$[2 \underline{5}] : \text{len} = 4$

$[4 \underline{10}] : \text{len} = 3$

Ex: $\{1, 6, 4, 2, 7, \underline{7, 5, 1}, 3, 1, 1, 5\}$

Max: 7
Min: 1

$[5 \underline{7}] \text{ len} = 3$

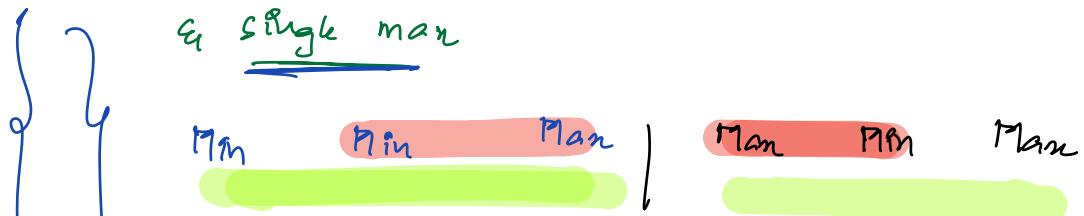
Ex: $\{e, f, f, f, f\}$

Max: f
Min: f

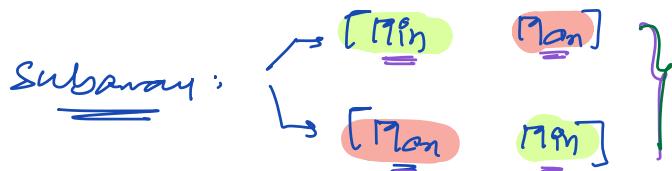
$\text{len} = 1$

Final Subarray

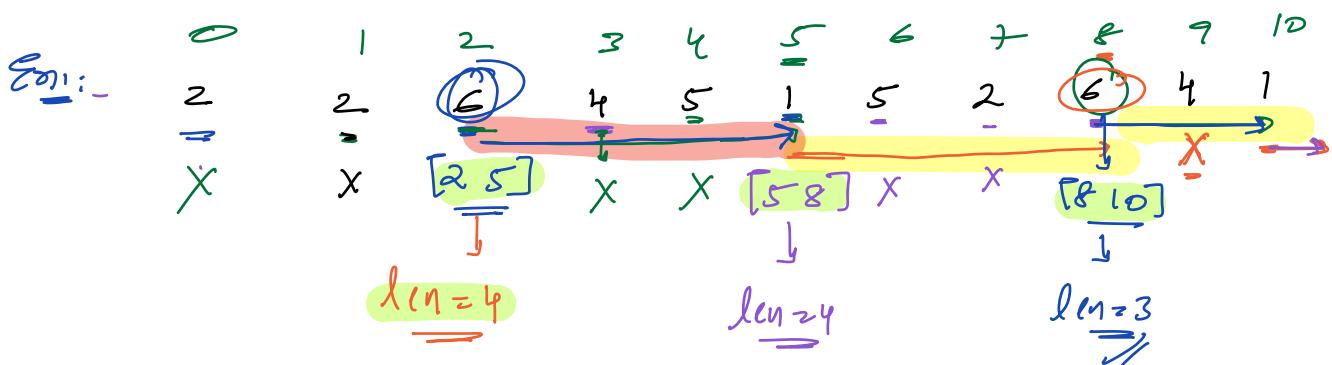
obs1: Our Subarray Should only contain single man



obs2: Min & Plan should be on corners



$$\text{Plan} = 6, \quad \text{Min} = 1$$



// Calculate min-val & max-val, ans = N

i = 0; i < N; i++) {

if (arr[i] == min-val) {

// Iterate in right to get ith min index

j = i + 1; j < N; j++) {

if (arr[j] == min-val) { break; }

// Subarray [i - j]

ans = min (ans, j - i + 1)

else if (arr[i] == max-val) {

// Iterate in right to get ith max index

j = i + 1; j < N; j++) {

if (arr[j] == max-val) { break; }

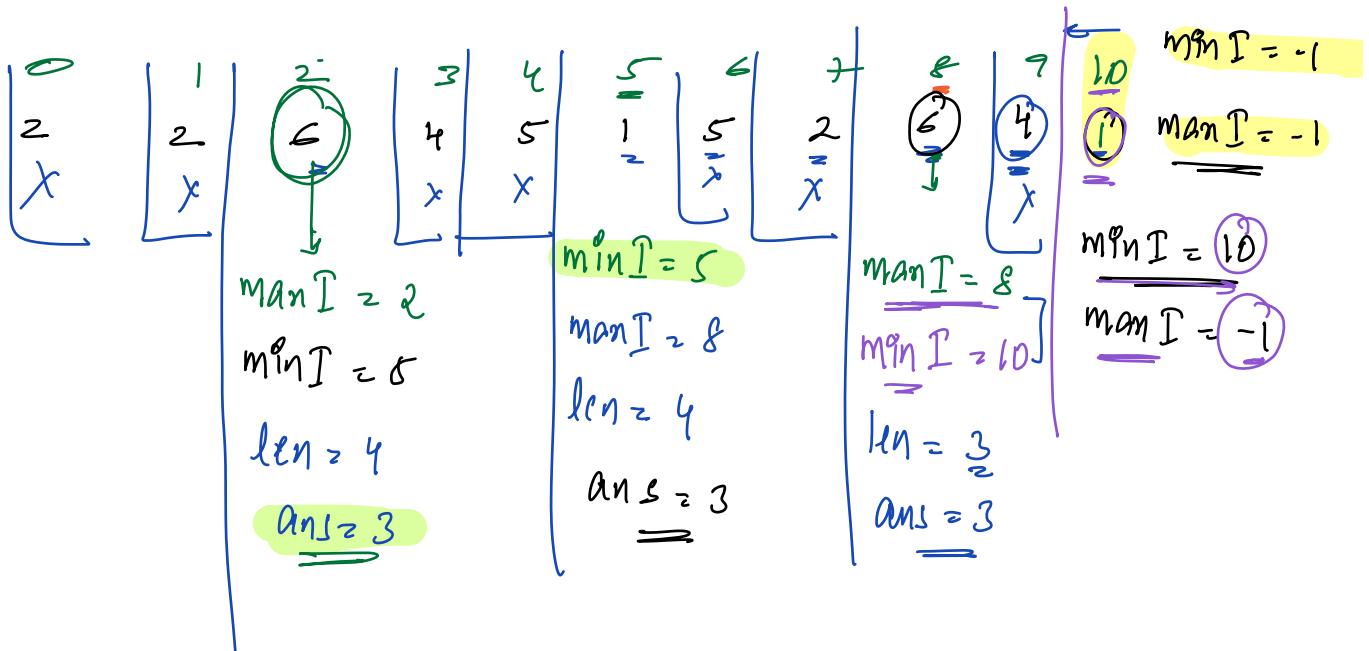
// Subarray [i - j]

ans = min (ans, j - i + 1)

TC: O(N²) SC: O(1)

// Iterate \leftarrow from R-L & get Min & Max Index

ans = N



HandCode

Step 1: calculate Min Value & Max value

Step 2: $\underline{\text{ans}} = N$, $\underline{\text{Min I}} = -1$, & $\underline{\text{Max I}} = -1$

$\text{if } (\text{Min_value} == \text{Max_value}) \text{ return 1}$

$P = N-1$; $q >= 0$; $P--$ {

$\text{if } (\text{ar}[i] == \text{Min_Value}) \{$

$\underline{\text{Min I}} = i$; // Get first min in right

$\text{if } (\text{Max I} != -1) \{ \quad [\underline{\text{Max}} \quad \underline{\text{Max}}]$

$\underline{\text{ans}} = \min(\underline{\text{ans}}, \underline{\text{Max I}} - \underline{\text{Min I}} + 1)$ } }

}

$\text{Un if } (\text{ar}[i] == \underline{\text{Max_Value}}) \{ \quad [\underline{\text{Max}} \quad \underline{\text{Max}}]$

$\underline{\text{Max I}} = i$; // Get last min in right

$\text{if } (\text{Min I} != -1) \{$

$\underline{\text{ans}} = \min(\underline{\text{ans}}, \underline{\text{Min I}} - \underline{\text{Max I}} + 1)$ }

}

return $\underline{\text{ans}}$;

Darbst

$$\begin{array}{r} \text{Summ:} \\ \begin{array}{r} 0 \quad 1 \quad 2 \\ 4 \quad 3 \quad 2 \\ \hline 7 \end{array} \end{array} \quad \begin{array}{r} 3 = 4 \quad 5 \\ 6 - 2 \end{array} \quad /$$

$$\text{Pferen[7]: } 4 \quad 4 \quad 6 \quad 6 \quad 12 \quad 12$$

$$\text{Pfodd[7]: } 0 \quad 3 \quad 3 \quad 10 \quad 10 \quad 8$$

3 ist special

left:

Sumeven[0 2]

Pferen[2]

odden $\Rightarrow [0 2]$

Sumodd[0 2]

Pfodd[2]

odd $\Rightarrow [0 2]$

Right

Sumeven[4 5]

Pfodd[5] - Pferen[3]

(even[0 5] = even[0 3])

\Rightarrow Sumeven $\Rightarrow [4 5]$

Sumodd[4 5]

as[12]: 0 1 2 3 4 5 6 7
 3 2 4 5 6 7 10 11

$$\text{Pf}[e] = \text{Pf}[\underline{P_{-1}}] + \text{ar}[i]$$

$$\text{Pf}[P_{el}] = \text{Pf}[P] + \text{ar}[P_{el}]$$

$$\begin{array}{ccccccc} 0 & 1 & 2 & 3 & 4 & 5 & 6 \\ \text{ar}[e]: & 3 & 4 & 2 & 1 & 6 & e & 7 \\ \text{Pf}[e]: & 2 & 7 & 9 & 10 & 16 & 24 & 33 \end{array}$$

$$\begin{array}{l} \text{Pf}[5] = 24 \\ \text{Pf}[3] = 10 \end{array}$$

$$\begin{array}{l} \text{Pf}[5] - \text{Pf}[3] = 14 \\ \text{Sum f all even } [5-4] \end{array}$$

$$\text{Pf}[e] = \text{Pf}(4) + \text{ar}[e]$$

$$\frac{\text{ar}[5] + \text{ar}[4] + \text{Pf}[3] - \text{Pf}[2]}{\text{ar}[5] \times}$$

$$\text{Pf}(4) = \text{Pf}(3) + \text{er}(4)$$

$$\text{Pf}(3) = \cancel{\text{Pf}(2)} + \text{ar}(2)$$

$$\text{Sum f } \underline{P_{el}} - N-1$$

$$\frac{\text{Pferen } [N-1]}{k} - \frac{\text{Pferen } [P]}{k}$$

$$\text{Sum f all even } \underline{O_{el}} - \text{Sum f all even } \underline{O_P}$$

$$\rightarrow \text{Sum f all even } \underline{P_{el}} - \underline{N-1} \rightarrow \textcircled{1}$$