Prime No : Any positive no. that has exactly 2 factors.

Q Given a prime no. $\boxed{p > 3}$ (in a string)

find $(p^2 - 1) \% 24$

$1 \le P.\text{length} \le 10^5$

① $(13 \times 14) \% 2 = 0$

② $(19 \times 20) \% 2 = 0$

③ $(85 \times 86) \% 2 = 0$

Product of 2 consecutive no. → always divisible by 2

④ $(4 \times 6) \% 8 = 0$

⑤ $(126 \times 128) \% 8 = 0$

⑥ $(10 \times 12) \% 8 = 0$

Product of any 2 consecutive even no. → always divisible by 8.

2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22 ...

4, 4×2, 4×3, 4×4, 4×5

$2i, \ 2i + 2$

$(2i) \times (2i + 2)$

$2i \times 2(i + 1)$

$4(\underline{i \times (i+1)}) \Rightarrow 4 \times (2x) \Rightarrow 8x$

Product of any three consecutive no.

$$\boxed{\left(n \times (n+1) \times (n+2)\right) \% 3 = 0}$$

1 2 3 4 5 6 7 8 9 10 11

$$(P^2 - 1) \% 24 =$$

$\Downarrow$

$P^2 - 1^2$

$\Downarrow$

$(P-1)\ (P+1)$

P is Prime no > 3

$\Rightarrow$ P is odd

$\Rightarrow$ $(P-1)$ & $(P+1)$ are even

$\hookrightarrow$ consecutive

$$\Rightarrow \boxed{\left((P-1) \times (P+1)\right) \% 8 = 0}$$

$(P-1)$, $\cancel{P}$, $(P+1)$

$\because$ $P \% 3 \mathrel{!}= 0$ ($P \to$ prime no.)

$$\therefore \boxed{\left((P-1) \times (P+1)\right) \% 3 = 0}$$

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Majority element

Q Given an array of size N. Return, if there exists, a no. with $\boxed{\text{frequency} > N/2}$

1 6, 1, 1, 2, 1 $N = 6$

ME : 1 (4)

Without using any extra space.

Brute force :
- 2 loops
- Count freq of all elements
- $O(N^2)$

Sorting : $O(n \log n)$

3, 4, 3, 6, 1, 3, 2, 5, 3, 3, 3

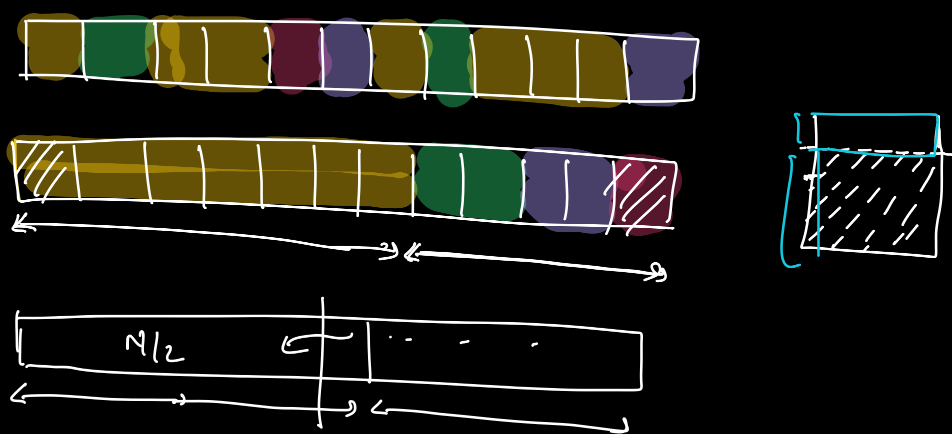
$N = 11$ $11/2$ $= 11/2 + 1$

$|ME| \geq 6$

4 6 5 3 4 5 6 4 4 4

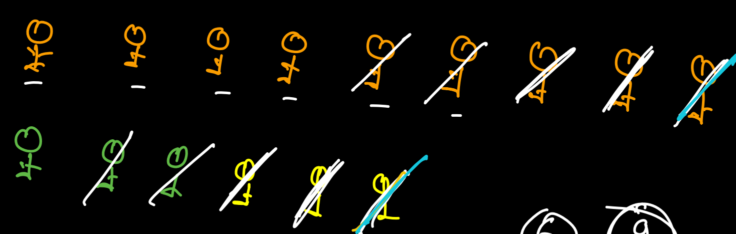
$N = 10$

$|ME| \geq 6$



Obs 1   Count of ME > count of all the others elements combined.

>50% ⇒ Party 1 :



=

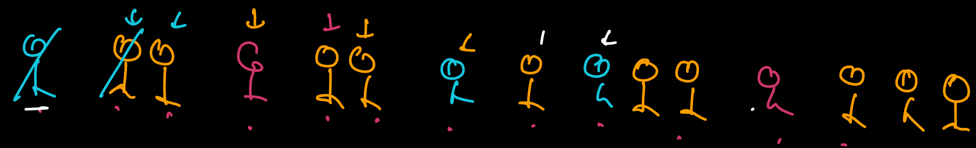
Party 2-3 :

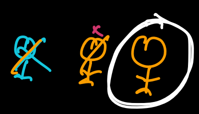
6	9 → -2
5	7
4	5

Size	|ME|	
N	$\frac{N+1}{2}$	
$\boxed{N-2}$	$\frac{N}{2}$	$= \frac{N-2}{2} + 1 = \frac{N-2+2}{2} = \frac{N}{2}$
$N-4$	$\frac{N}{2} - 1$	

If we remove 2 distinct elements from the array ⇒ ME will remain the same

Moore's Voting Algo



Winner : 

Count : ~~1~~ ~~0~~ ~~1~~ ~~0~~ ~~1~~ ~~2~~ ~~1~~ ~~2~~ ~~1~~ ~~2~~ ~~3~~ ~~2~~ ~~3~~ ~~4~~ 5

3, 4, 3, 6, 1, 3, 2, 5, 3, 3, 3

ME : 3 ~~4~~

Count : ~~1~~ ~~0~~ ~~1~~ 0, ~~1~~ ~~0~~ ~~1~~ ~~0~~ ~~1~~ ~~2~~ 3

3 4 3 6 1

ME ~~3~~ ~~3~~ 1

Cont ~~1~~ ~~0~~ ~~1~~ ~~0~~ 1

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$$|ME| > \frac{N}{3}$$

$$|ME| > N/K \qquad (K-1)$$

2, 3, 2, 3, 2, 3, 1, 2, 3

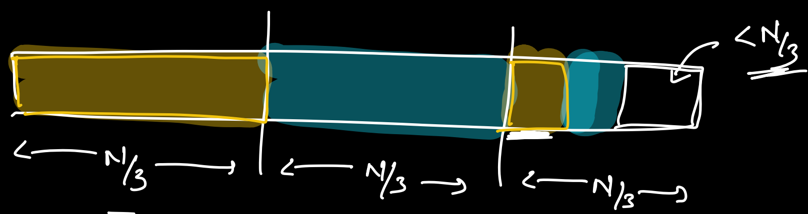
$N = 9$

$|ME| \geq 4$

$-2 \to 4 \to 3$

$-3 \to 4 \to 3$

$1 \to 1 \to 1$



Size	$|ME|$
N	$\frac{N}{3} + 1$
$N-3$	$\frac{N}{3}$

$$\frac{(N-3)}{3} + 1 = \frac{N-3+3}{3} = \frac{N}{3}$$

If we remove 3 distinct elements then the ME remains the same.

2, 5, 2, 3, 2, 5, 2, 1, 3, 6

ME1 : $\boxed{2}$

Cont 1 : ~~1~~ → 2 → 1
1
2
~~1~~
3 → 2 → 1

ME2 : ~~3~~ Null

Cont 2 : ~~1~~ 0

2 ~~2~~
~~3~~
~~6~~

Code ⇒ Tricky

−2 4 3 6 3 4 7 3 10 3

ME1 10

Cont1 1

ME2 3

Cnt 2 1

−~~2~~ ~~6~~ ~~4~~
~~4~~ ~~3~~ ~~7~~
~~3~~ ~~4~~ ~~3~~

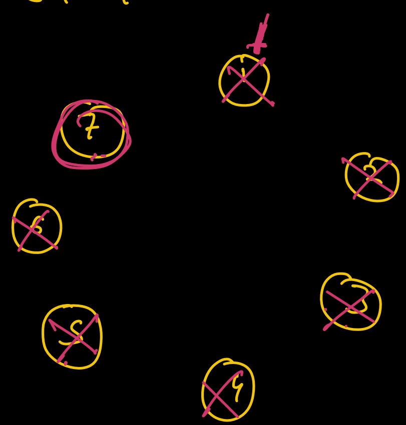
Break till 11.00p

Q

DeeShow

Josephus

N = 7



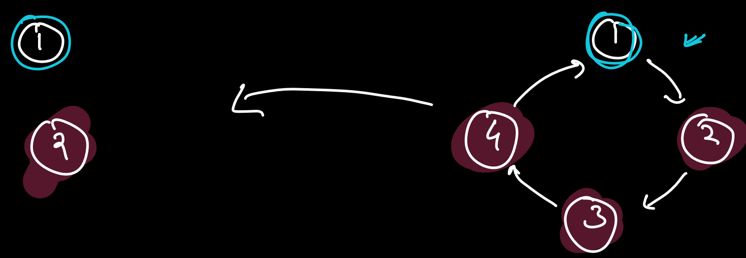
N = 6

→ Last odd no.

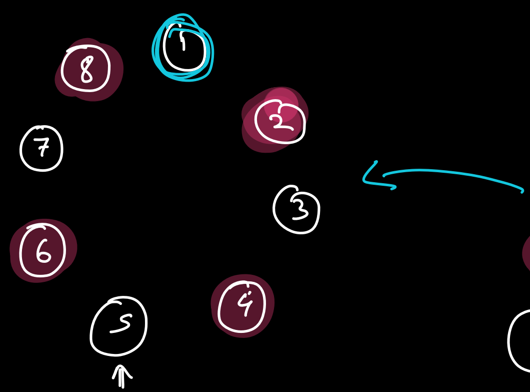
→ N —odd→ N

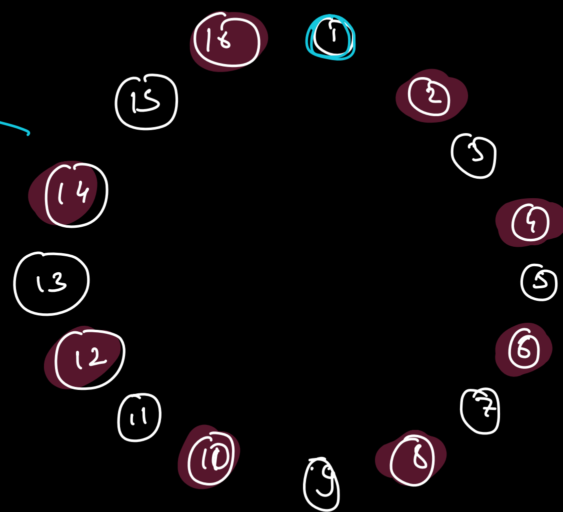
  └—even→ N-1

→ Last prime no.



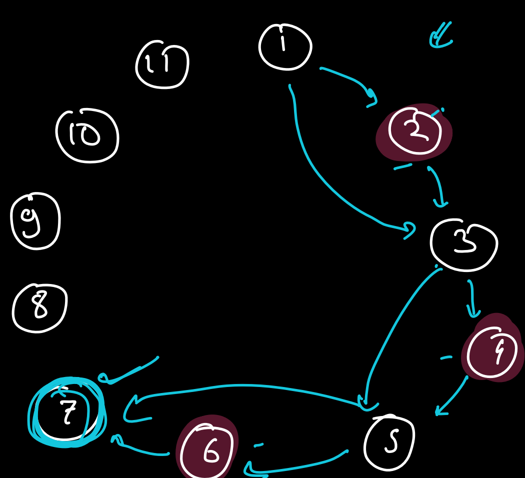
$N = 2^K$

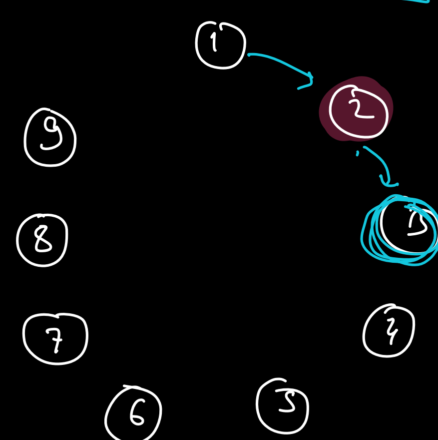




If $N = 2^K$

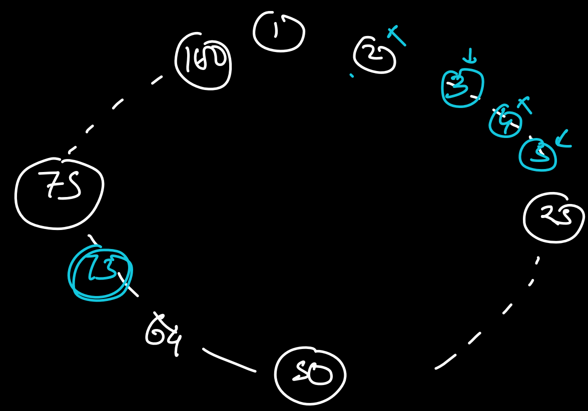
$\Rightarrow$ Person starting the killings remains alive.





$N = 100$

Closest Power of 2 $= \underline{64}$



$100 - 64 \Rightarrow \underline{36}$

$2 \times 36 + 1$

$= 73$

$N = 1000;$

$1000 = 2^K$

$\log_2 1000 = K$

$N = 10$

$\log_2 2 = 3.14 = 2^3 \Rightarrow 8$

$\log_2 100 = 6.6 = 2^6 \Rightarrow 64$

$\log_2 50 = 5.46 = 2^5 = 32$

$N = 100$

$\underbrace{2 \longrightarrow 4 \rightarrow 8 \rightarrow 16 \rightarrow 32 \rightarrow}_{O(\log N)} 64 \rightarrow 128$

$N = 50$

$\underbrace{2 \rightarrow 4 \rightarrow 8 \rightarrow 16 \rightarrow 32}_{O(\log N)} \rightarrow 64$

$$\boxed{2 * (N - 2^x) + 1}$$

Double

$$Sum_N - S_{array} = m$$

$$\cancel{1} + \cancel{2} + \cancel{3} + \ldots m + \cancel{x} \ldots \cancel{N}$$
$$- \quad \cancel{1} + \cancel{2} \ldots r + \cancel{x} \ldots \cancel{N}$$

$$\boxed{(m - r) = S_N - S_{Array}} \quad \text{— (i)}$$

$$\cancel{1^2} + \cancel{2^2} + \cancel{3^2} + \ldots m^2 + \cancel{x^2} \ldots \cancel{N^2}$$
$$- \quad \cancel{1^2} + \cancel{2^2} + \cancel{/} \ldots \cancel{x^2} + r^2 \ldots \cancel{N^2}$$

$$m^2 - r^2 = S_{sqN} - S_{sq\,Arr}$$

$$(m-r)(m+r) = S_{qsN} - S_{qs\,Arr}$$

$$\boxed{(m+r) = \frac{S_{qsN} - S_{qs\,Arr}}{S_N - S_{Arr}}} \quad \text{— (ii)}$$

All problems $\longrightarrow$ Bookmark.