Solving Medium Level Questions - LIVE

Special class

Love Babbar • Sept 11, 2022

Recursion

- array
- string
- LL
- Tree
- Subsequences

what is Recursion

Stack → Rec call

Recursion tree

Dry Run

Elimination game

i/p → 7

$\cancel{1}$, 2 , $\cancel{3}$, 4 , $\cancel{5}$, 6 , $\cancel{7}$

$\cancel{2}$, 4 , $\cancel{6}$

$\boxed{4}$ → ans

$n = 14$

~~1~~, 2, ~~3~~, 4, ~~5~~, 6, ~~7~~, 8, ~~9~~, 10, ~~11~~, 12, ~~13~~, 14

~~2~~ 4 ~~6~~ 8 ~~10~~ 12 ~~14~~

~~4~~ 8 ~~12~~

2 min

$\boxed{8} \rightarrow$ ans

$$f(n) = f(n-1) + f(n-2)$$

$n = 8$

$$\begin{array}{cccccccc} 1, & 2, & 3, & 4, & 5, & 6, & 7, & 8 \\ 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 \end{array}$$

$n = 8$

$$f_{L \to R}(n) = [\cancel{1}, 2, \cancel{3}, 4, \cancel{5}, 6, \cancel{7}, 8] \quad n$$

$n = 4$

$L \to R$

$\Downarrow$

$\to [2, 4, 6, 8]$

$2 * [1, 2, 3, 4] \quad n/2$

$R \to L$

$$\boxed{f_{L \to R}(n)} = 2 * [1, 2, 3, 4]_{R \to L} = \boxed{2 * f_{R \to L}(n/2)}$$

$$f(n) = 2 * \boxed{f(n/2)}$$
$\underline{L \to R}$ $\qquad R \to L$

$\frac{n}{2} \to 1$

$3 \to 1$

$$= 2 * [1, 2, 3, \dots \frac{n}{2}]$$
$R \to L$

$\frac{n}{2} - \frac{n}{2} + 1 \to 1$

$$= 2 * \boxed{[\boxed{\frac{n}{2}}, \dots 3, 2, \boxed{1}]}$$
$L \to R$

$(1 + \frac{n}{2}) -$

$$= 2 * [1, 2, 3 \dots \frac{n}{2}]$$
$L \to R$

$1 + \cancel{\frac{n}{2}} - (\cancel{\frac{n}{2}})$

1

$\cancel{1} + \frac{n}{2} - (\cancel{1})_2 \ \frac{n}{2}$

$$\boxed{f(n)_{L\to R} = 2 * \left(1 + \frac{n}{2} \cdot f\left(n/2\right)_{L\to R}\right)}$$

$$f_{L\to R}(n) = [\cancel{1}, 2, \cancel{3}, 4 - \quad - \quad - \cancel{n}]$$

$$f_{L\to R}\left(\frac{n}{2}\right) = [\cancel{1}, 2, \cancel{3} - \quad - \quad - \cancel{\tfrac{n}{2}}]$$

$$f_{R\to L}(n) = [1, \cancel{2},] \quad - \quad - \cancel{n}]$$

$$\frac{n}{2}$$

solve() → sol

i/p → $\underline{n}$

$f(n)_{L \to R} \longrightarrow [1, 2, 3, \ldots, n]$

$n = 8$

$f(n)_{L \to R} = [\cancel{1}, 2, \cancel{3}, 4, \cancel{5}, 6, \cancel{7}, 8] \to f(8)$

$f(n)_{L \to R} = [2, 4, 6, 8]$

$f(n)_{L \to R} = \boxed{2} * [1, 2, 3, 4] \to f(4)$

$$f_{L \to R}(n) = 2 * [1, 2, 3, 4]$$

$$f_{L \to R}(n) = 2 * f_{R \to L}(n/2)$$

$$f_{L \to R}(n) = 2 * [1, 2, 3 - - - \tfrac{n}{2}]$$

$$= 2 * [\tfrac{n}{2}, - - - - 3, 2, 1]$$

$$\underset{L \to R}{f(n)} = 2 * [\tfrac{n}{2}, \; \text{---} \; 3, 2, 1]$$

$$1 \quad 2 \quad 3 \quad \cdots \quad n/2$$

$$\left(1+\tfrac{n}{2}\right) - \cancel{\tfrac{n}{2}} = 1$$

$$\cancel{1} + \tfrac{n}{2} - \cancel{1} = \tfrac{n}{2}$$

after substracting from $\left(1+\frac{n}{2}\right)$ exp becomes

$$\underset{L \to R}{f(n)} = 2 * [1, 2, 3 \; \text{---} \; \tfrac{n}{2}]$$

$1 + \frac{n}{2} -$

$$f(n)_{L \to R} = 2 * \left[1 + \frac{n}{2} - f(n/2)_{L \to R}\right]$$

$\boxed{1}$

Code

```
int solu (int n)
{
    // B.C
    if (n == 1)
        return n;   -> F

    return 2 * [1 + n/2 - solu(n/2)];
}
```

$n = 6$

$4 \quad [1, 2, 3, 4, 5, 6]$

2

$2 * \left[1 + \frac{6}{2} - \text{solve}(6/2)\right]$

$[1, 2, 3]$

1

$2 * \left[1 + \frac{3}{2} - \text{solve}(3/2)\right]$

$[1]$

$\text{soln}(7) = [\cancel{1}, \cancel{2}, \cancel{3}, 4, \cancel{5}, \cancel{6}, \cancel{7}]$

4

$2 * [1 + \frac{7}{2} - \text{soln}(\frac{7}{2})]$

2

$[1, 2, 3]$

$2 * [1 + \frac{3}{2} - \text{soln}[\frac{3}{2}]]$

1

$[1]$

$\cancel{1} + \frac{7}{2} - \cancel{1}$

$\frac{7}{2} \rightarrow 1$

$n = 6$

jabardast

→ Elim. hone

$f_{L \to R}(n) = [\cancel{1}, 2, \cancel{3}, 4, \cancel{5}, 6]$

L → R

R → L

$\boxed{f_{L \to R}(n) = [2, 4, 6]}$

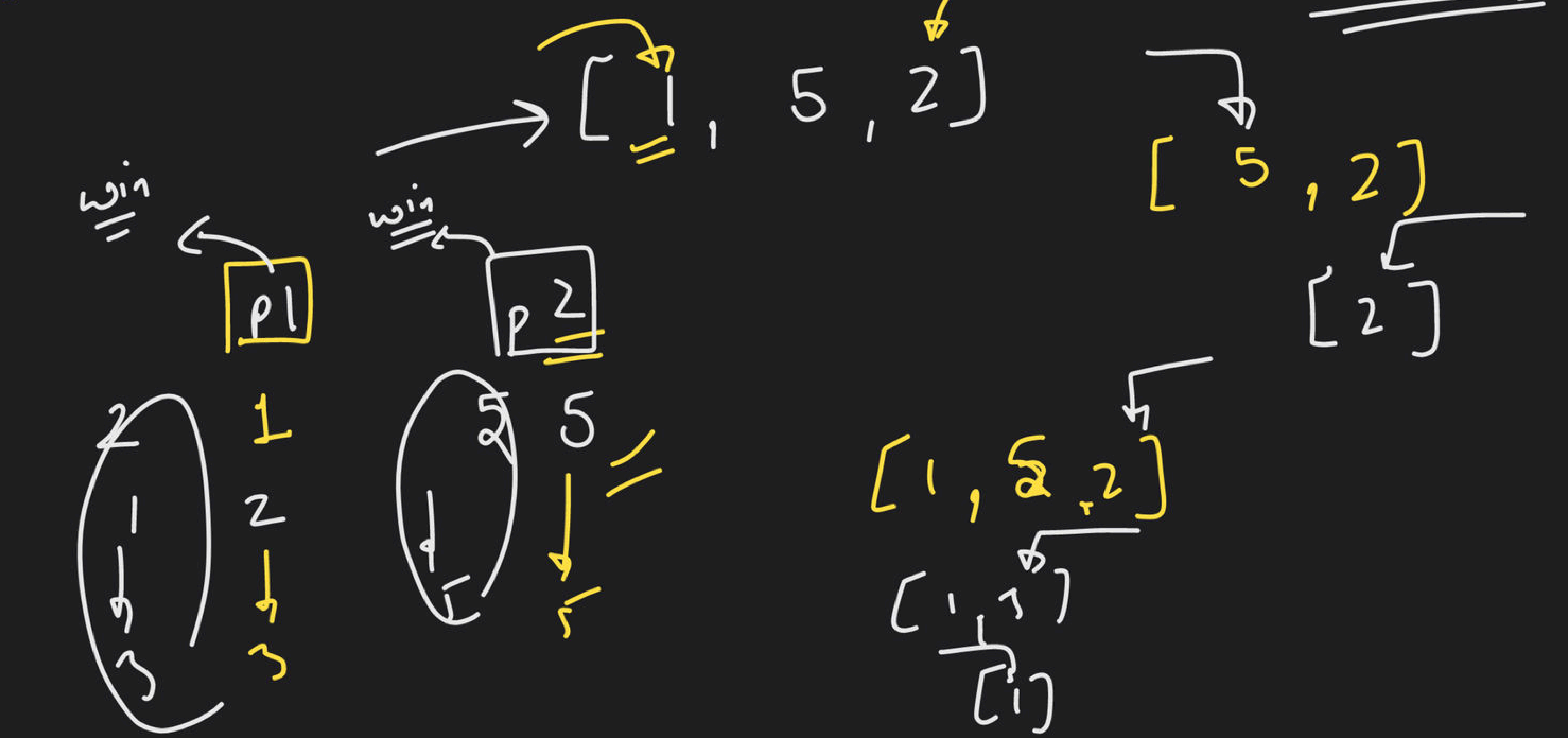
$f_{L \to R}(n) = 2 * [1, 2, 3]$

crux recursion

$f_{L \to R}(n) = 2 * f_{R \to L}(n/2)$

Predict the Winner

[1, 5, 2]



P1

P2

num

[1, 2, 4, 7, 5, 3]

i j

```
int op1 = num[i] + min( soln(i+2, j),
                        soln(i+1, j-1) );

int op2 = num(j) + min( soln(i, j-2),
                        soln(i+1, j-1) )

int p1score = max(op1, op2);
```

i+1 j-1 j

2, 4, 7, 5, 3

P2

(i+2, j)

(i+1, j-1)

[1, 2, , 4, 5, 7, 2]

Added k

p1 = 12

p2 = totalSum - p1Scan

$p1$

[5, 2, 4, 7, 6]

i j

score of p1

int option1 = $\underset{num(i)}{5} + \min\left((i+2, j), (i+1, j-1) \right)$

int option2 = $num(j) + \min\left((i+1, j-1), (i, j-2) \right)$

$i+1$ $i+2$ $j-1$ j

[2, 4, 7, 6]

$p2$ $p2$

$i+1$ $j-2$ $j-1$

[5, 2, 4, 7]

i $p2$

B:(

$[1, 2, \boxed{3}, 4, 5]$

i i j j

$i == j$

$i > j$

no element present

return 0;

$\boxed{3}$

i j

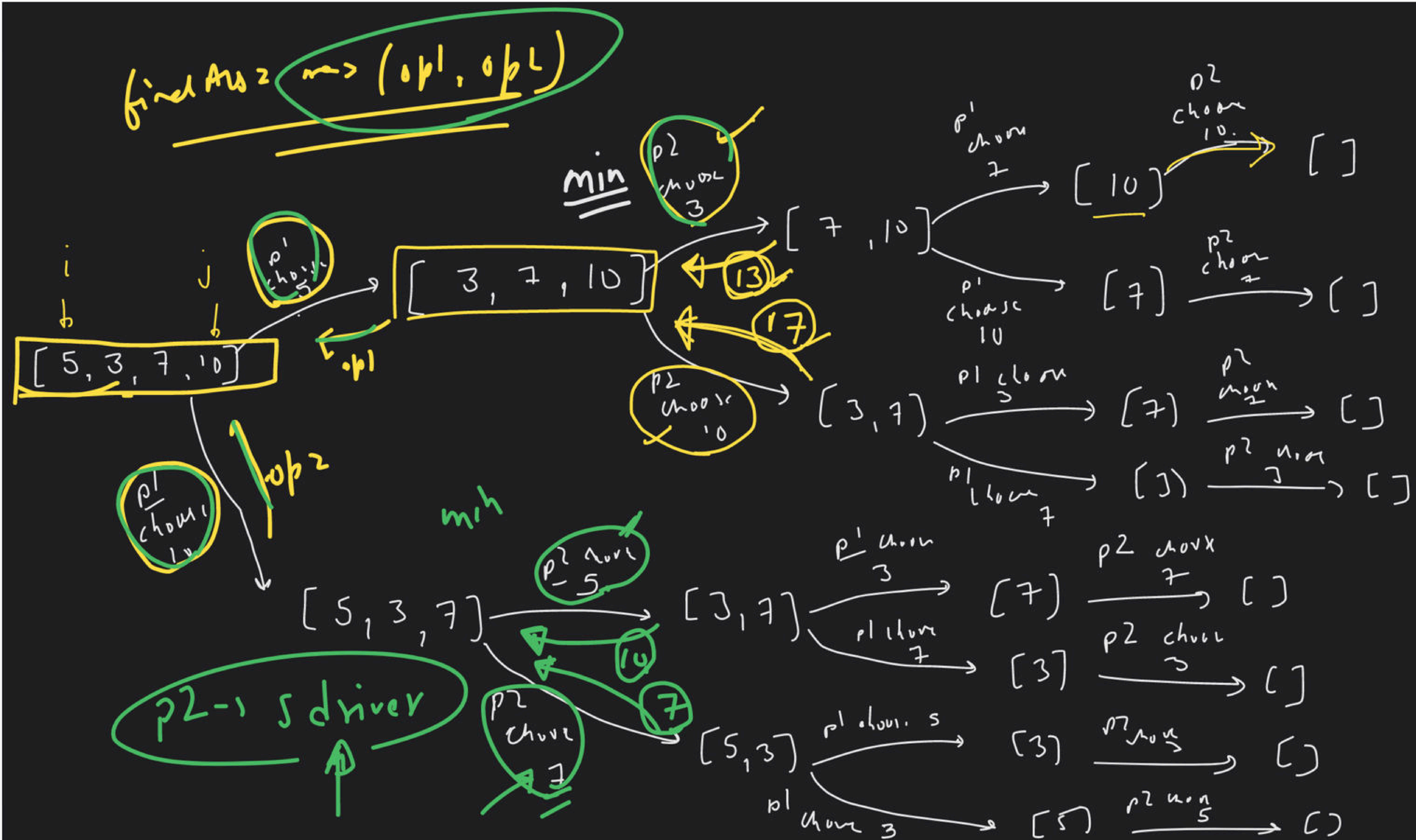
return nums[i]

B.C

no element present → if (i > j)
return 0;

single element present = if (i == j)
return num[i];

arr -> [5 , 3 , 7 , 10]


finalAns = max(op1, op2)
min
p2 choose 3
p1 choose 5
[5, 3, 7, 10]
[3, 7, 10]
op1
[7, 10]
13
17
p2 choose 10
[3, 7]
p1 choose 7
[10]
p2 choose 10
[ ]
p1 choose 10
[7]
p2 choose 7
p1 choose 3
p1 choose 7
[3]
p2 choose 3
op2
p1 choose 10
min
[5, 3, 7]
p2 choose 5
14
7
p2 choose 7
[5, 3]
p1 choose 5
p1 choose 3
[5]
p2 choose 5
p2 -> driver

$[x \quad y]$

$x < y$

$i \quad k \quad j$

$i == j$

$j \quad i$

Invalid Range

$i > j$

no

( )

[ ]

[2, 3]

[2, 7

[2, 2]

$[3, 2] \rightarrow \times$

K^{th} symbol in Grammar

$0 \rightarrow 01$

$1 \rightarrow 10$

observation

i/p $\rightarrow$ n^{th} row , K digit

table

1^{st} row $\rightarrow$ 0

2^{nd} $\rightarrow$ 01

III $\rightarrow$ 0110

IV $\rightarrow$ 01101001

V $\rightarrow$ 011010011001 0110

0

01

01 10

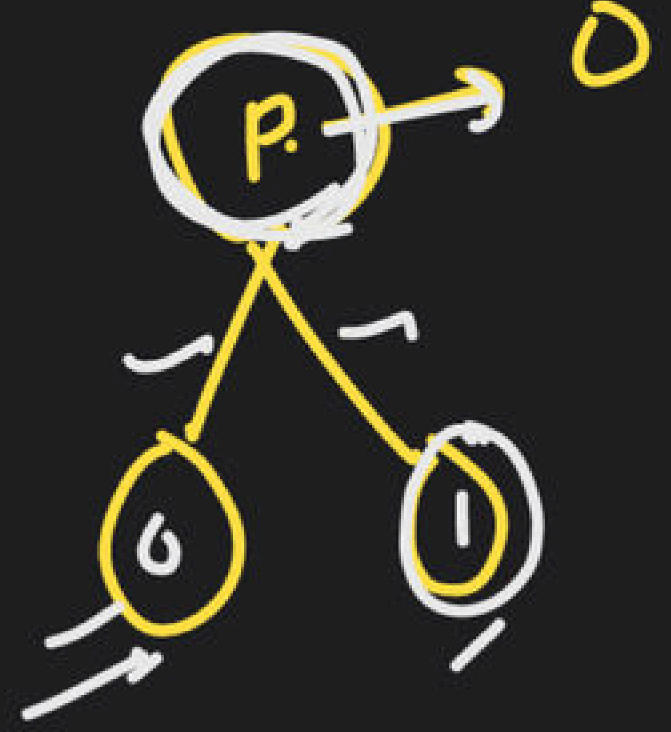
0110 1001

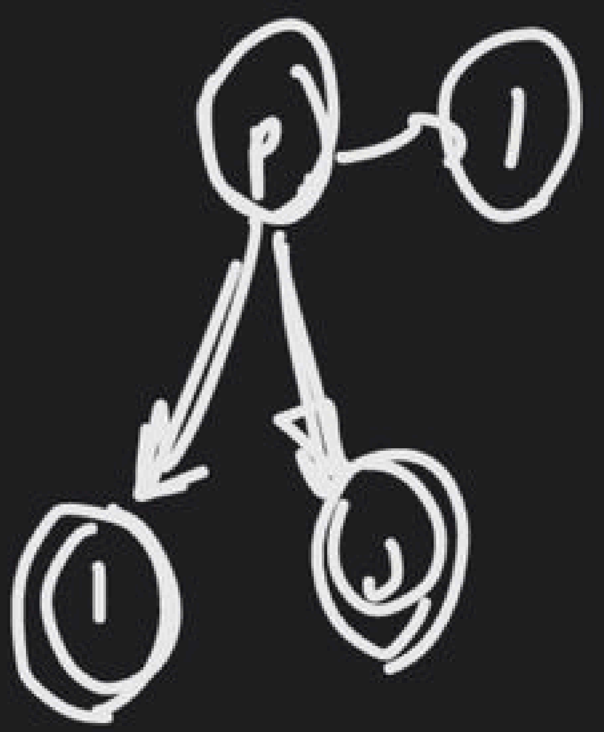
01101001 10010110

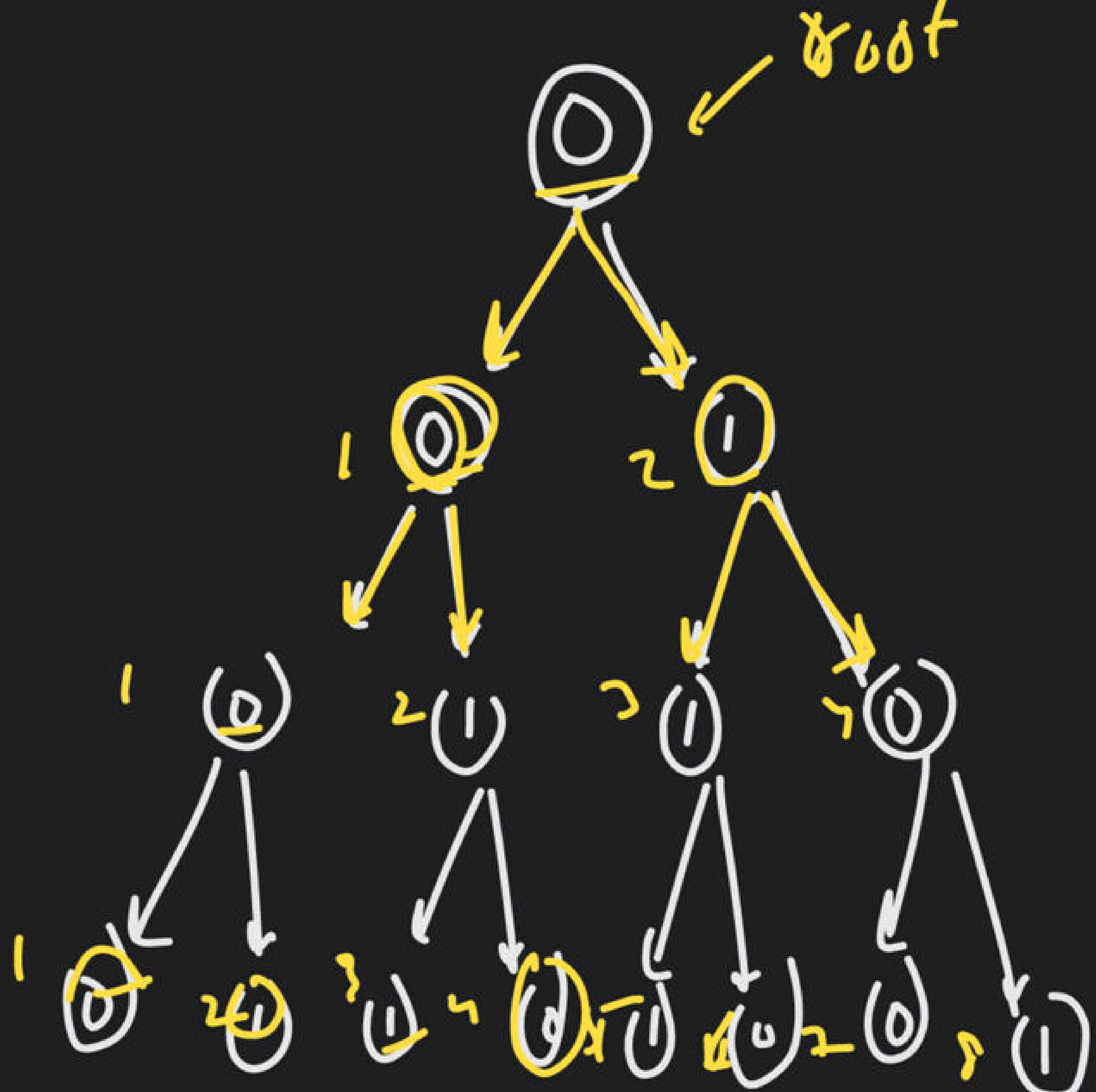
$n = 3$

$K = 3$ $\rightarrow$ ans = 1

1min







Left node → odd

right node → even

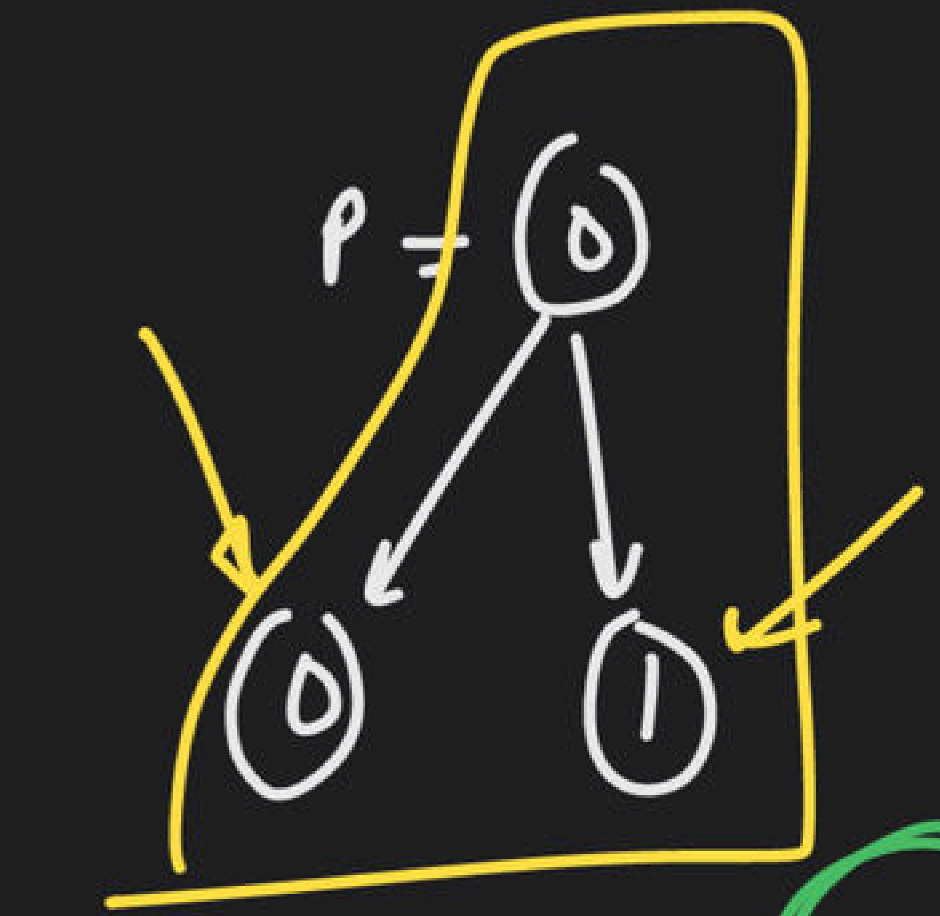
n, K

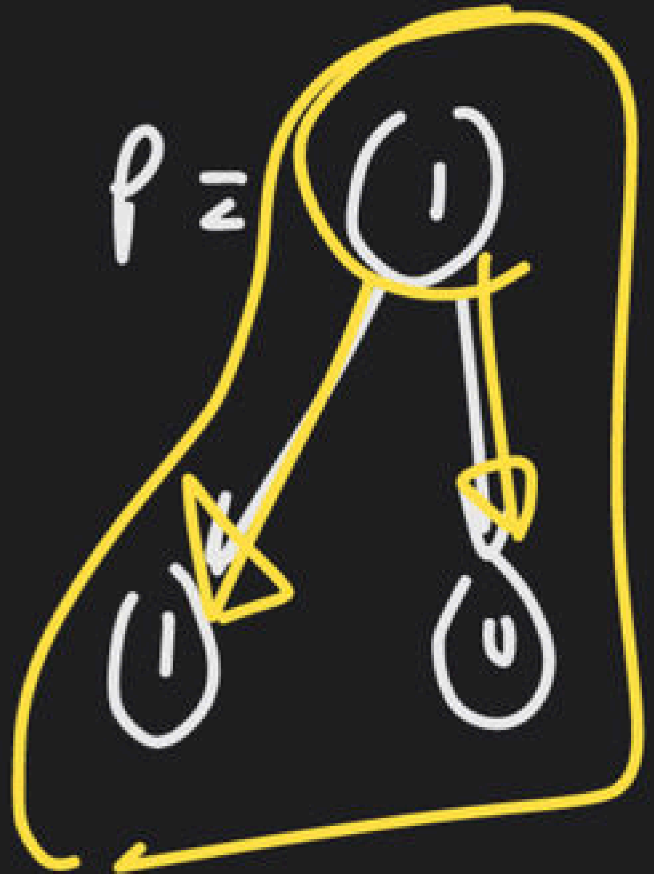
K^{th} symbol

2 factors

↳ parent of K

↳ K → even / odd





$K = 7$

K^{th} - Symbol

- K parent
- $K \rightarrow$ even/odd

$n = 4$

$K = 6$

$\frac{K}{2} = 3$

left node $\rightarrow$ odd no.

right node $\rightarrow$ even no.

$f(n, K)$

$\rightarrow f\left(n-1, \frac{K}{2} + K\%2\right)$

$K = 3$

$\frac{K}{2} = 2$

$\frac{K}{2} + K\%2$

if (K parent = 0 & K is even)

ans is 1

if (K parent = 0 & K is odd)

ans is 0

if (K par = 1 & K is even)

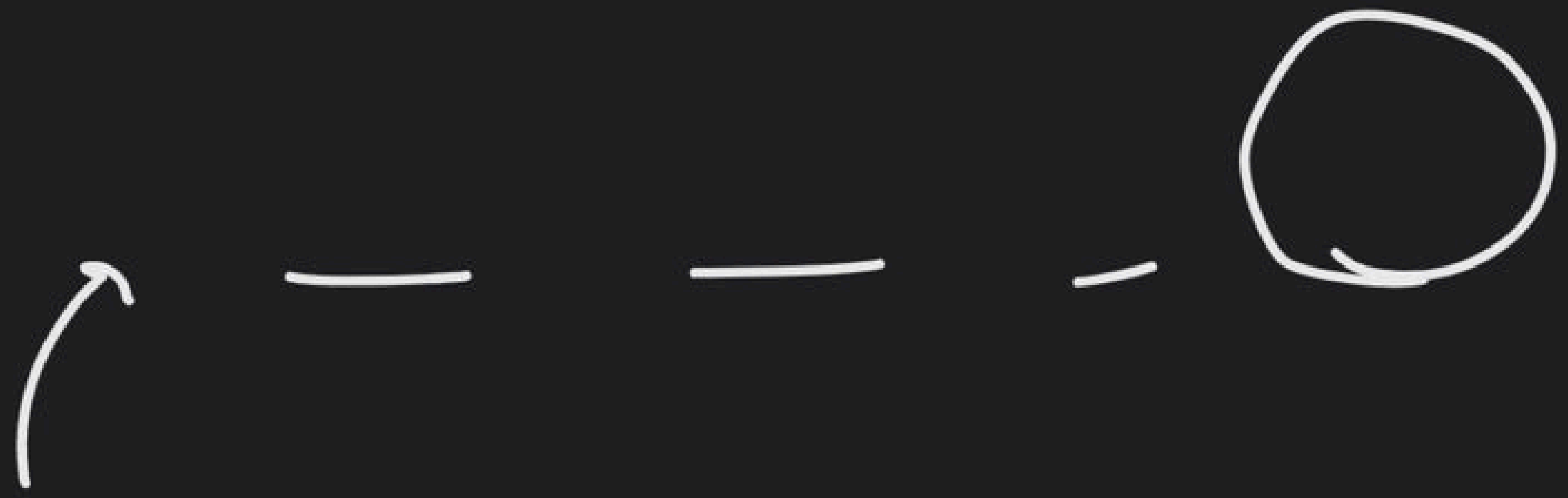
ans = 0

if (K_par = 1 & K is odd)

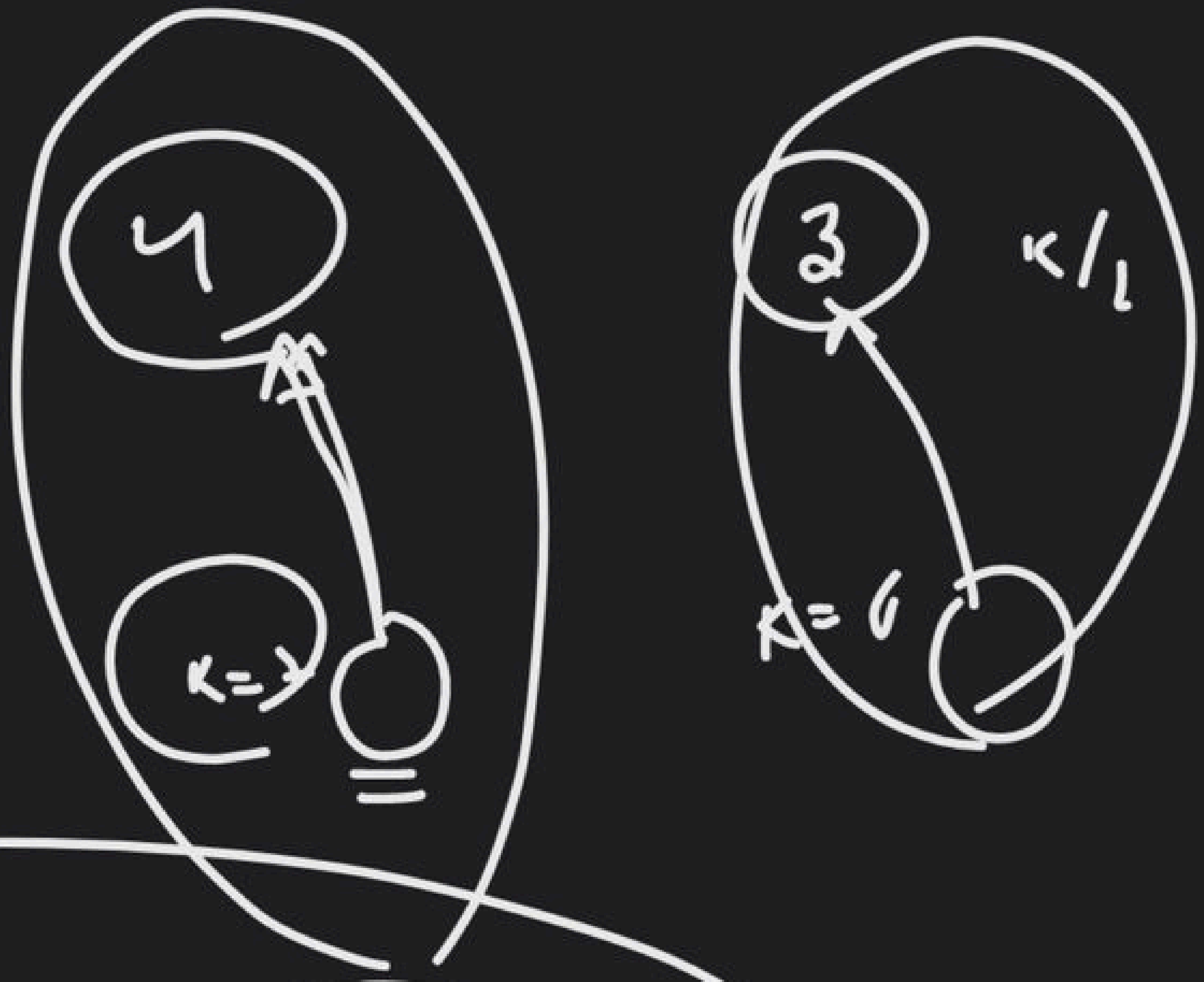
ans = 1

$$\frac{K}{2} + K \% 2$$

$$\begin{array}{r|l} 2 & 7 \quad 3 \\ & 6 \\ \hline & 1 \end{array}$$



$\frac{k+1}{2}$



$k \to odd \to parent \to \frac{k+1}{2}$

$k \to even \to parent \to \frac{k}{2}$

odd → $K \% 2 == 0$ → even

even $K \% 2 == 1$ → odd

K&1

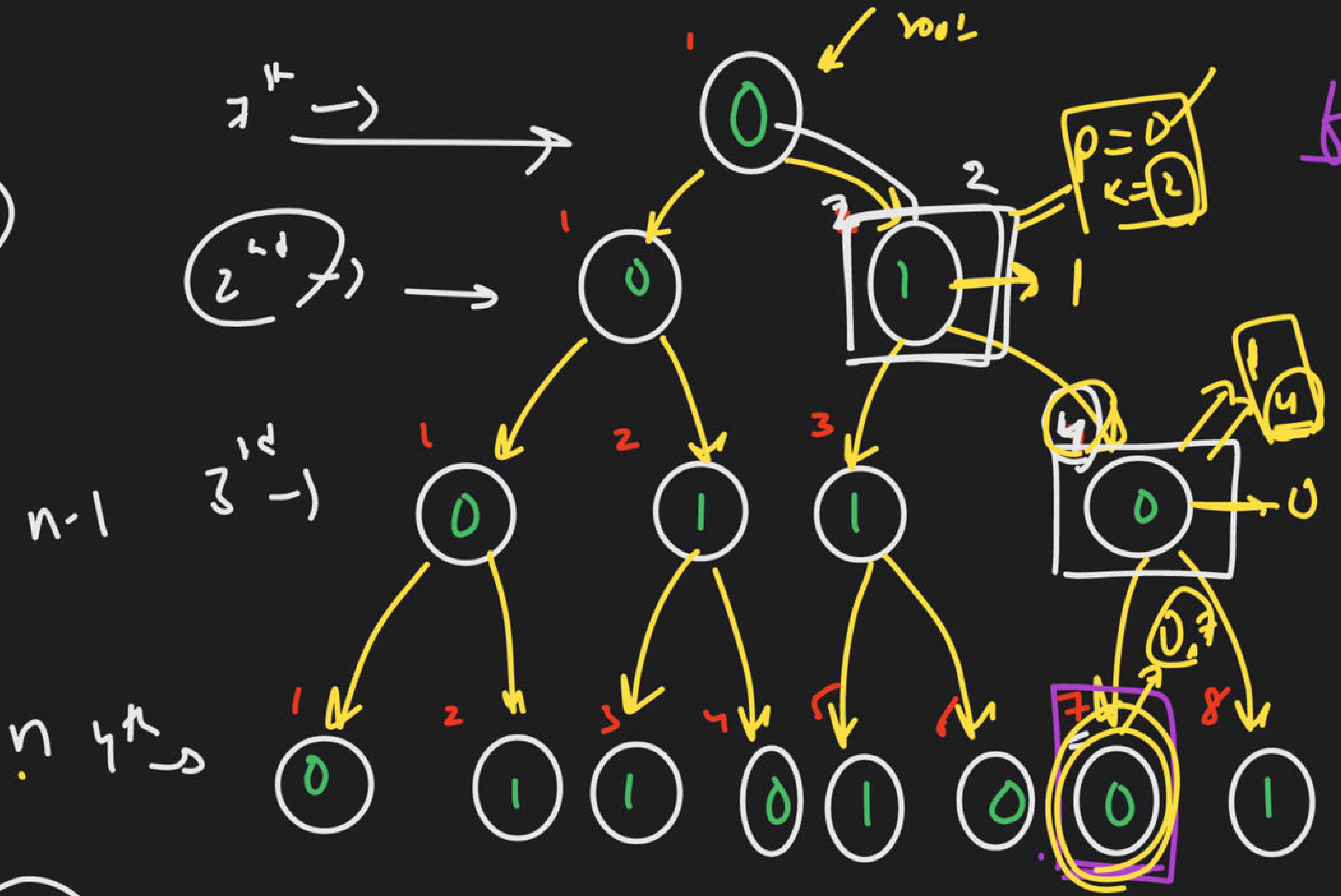
% → heavy op — &

good practice ← K & 1 → true → odd   why

→ false → even

$n = 4$

$K = 7$



$f(n, K)$

$\downarrow$

$f(4, 7)$

$\downarrow$

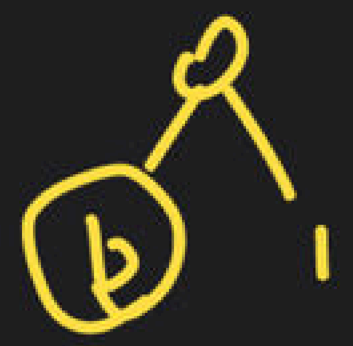
$f(3, 4)$

$\downarrow$

$f(2, 2)$

$\downarrow$

$f(1, 1)$



$$\frac{K+1}{2} = \frac{7+1}{2} = 4$$

$$4 \to \frac{K}{2} \to \frac{4}{2} = 2$$

$$2 \to \frac{2}{2} \to 1$$

H/W → K^{th} symbol in Grammar

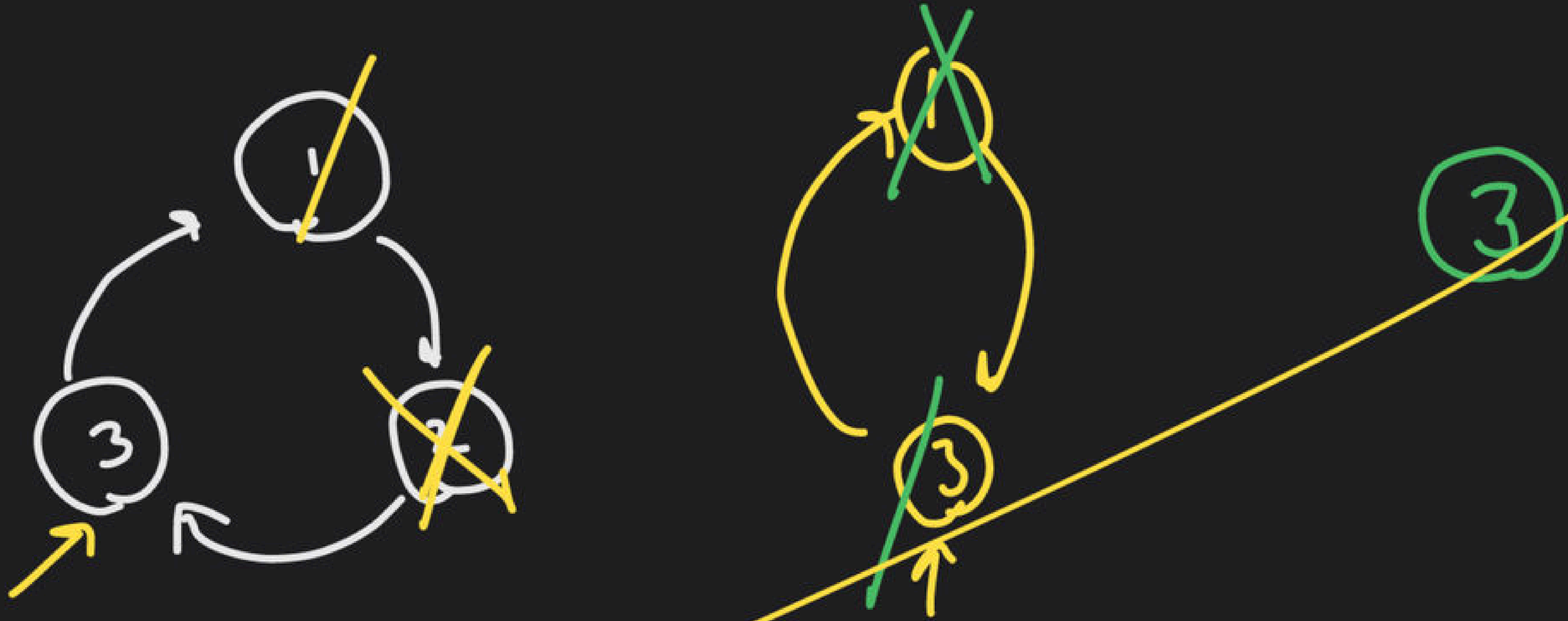
↳ Other approach → H/W

→ Decode String → H/W

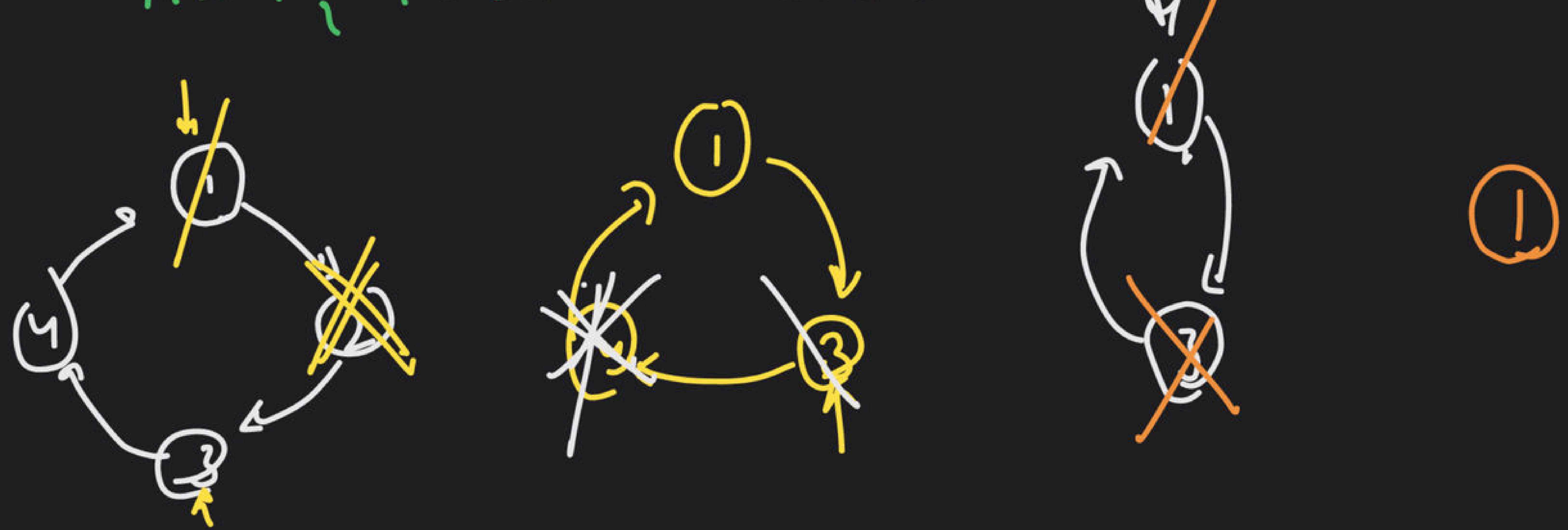
→ Maximum points in an Archery Competition → H/W

Circular game

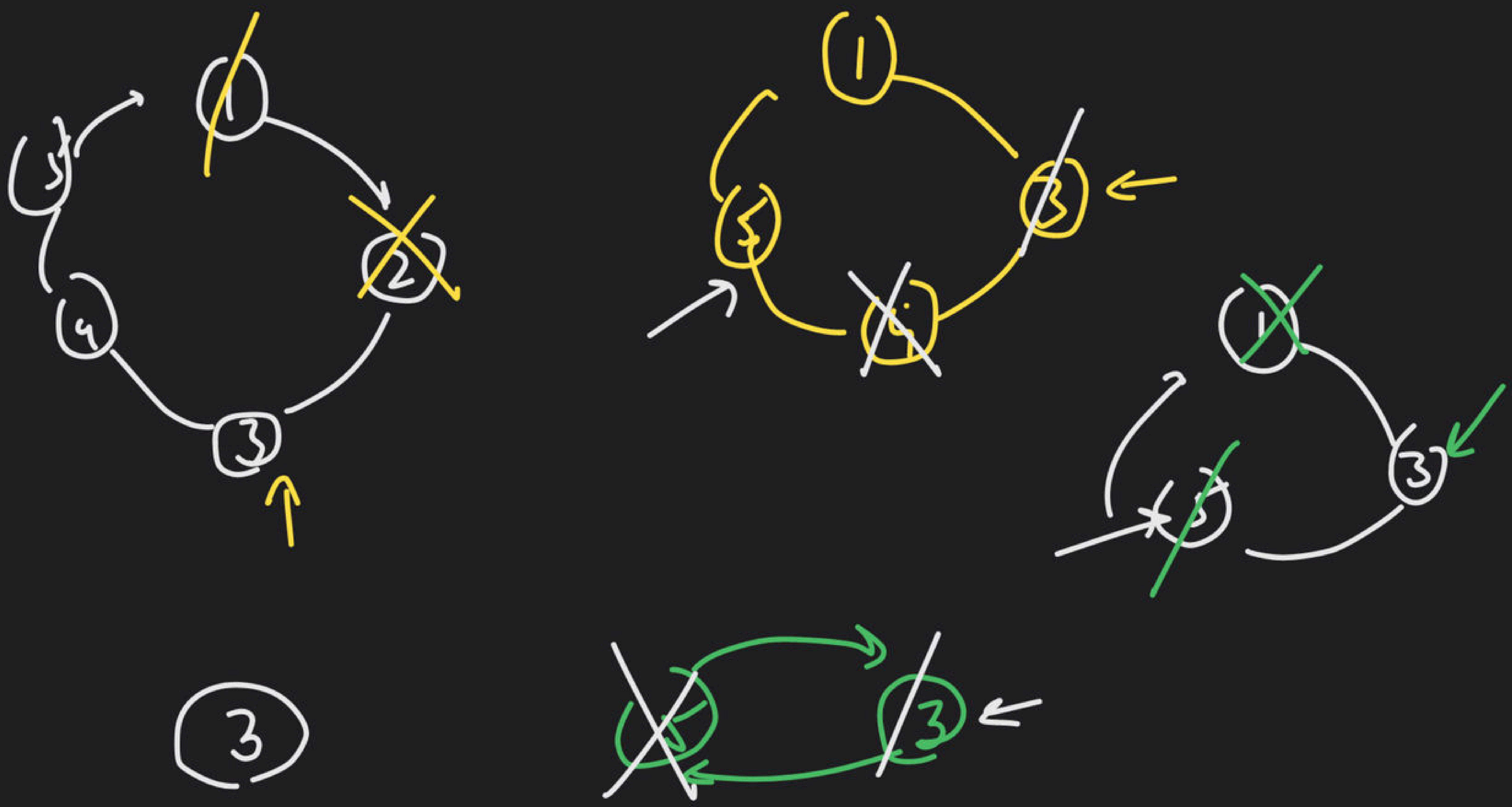
$n = 3$, $k = 2$ — $ans = 3$



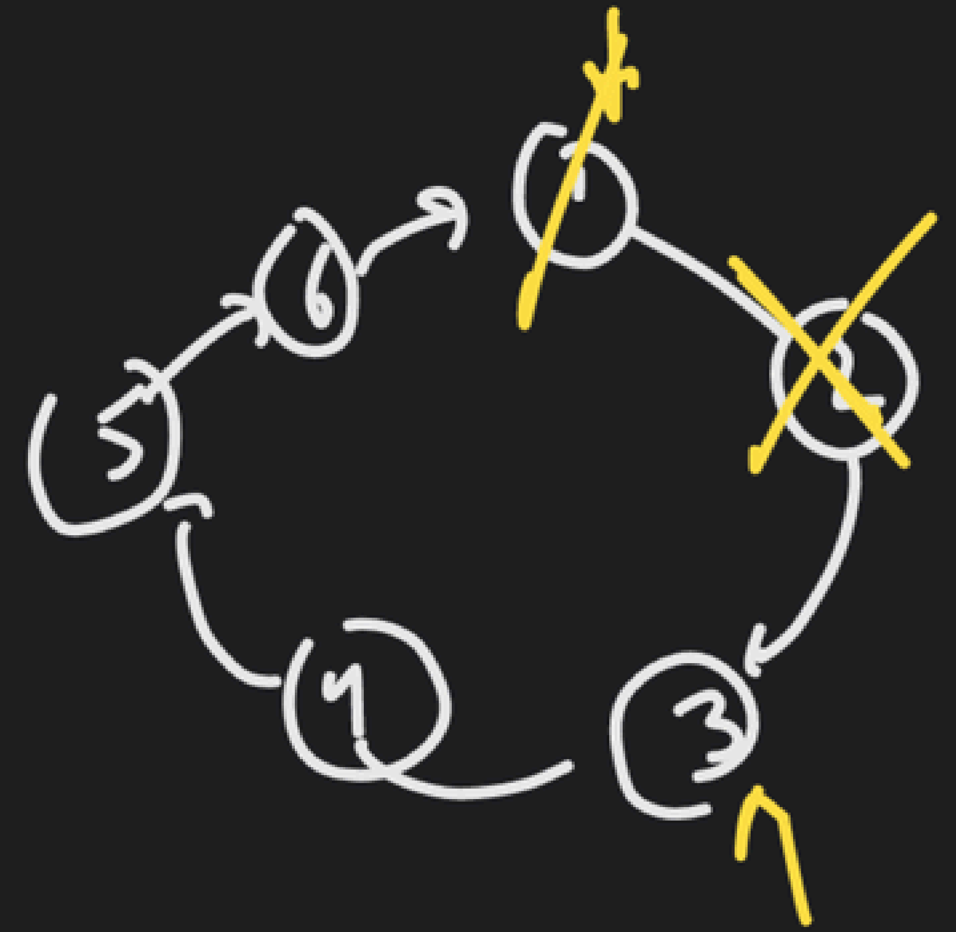
$n=4, \; k=2 \rightarrow$ ans = 1

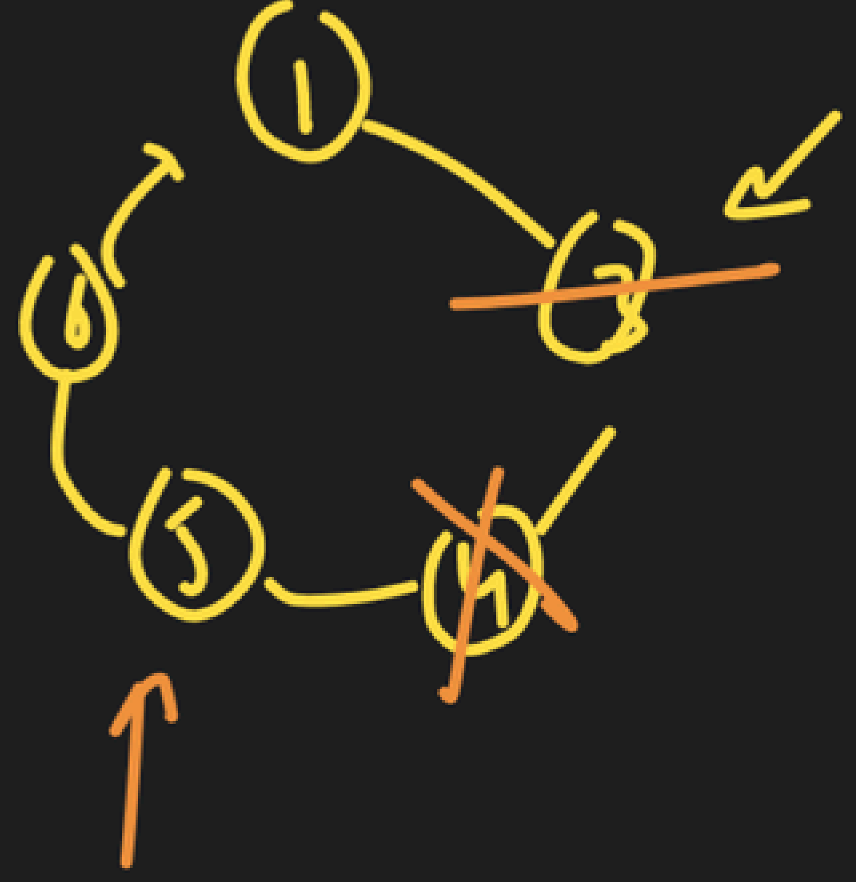


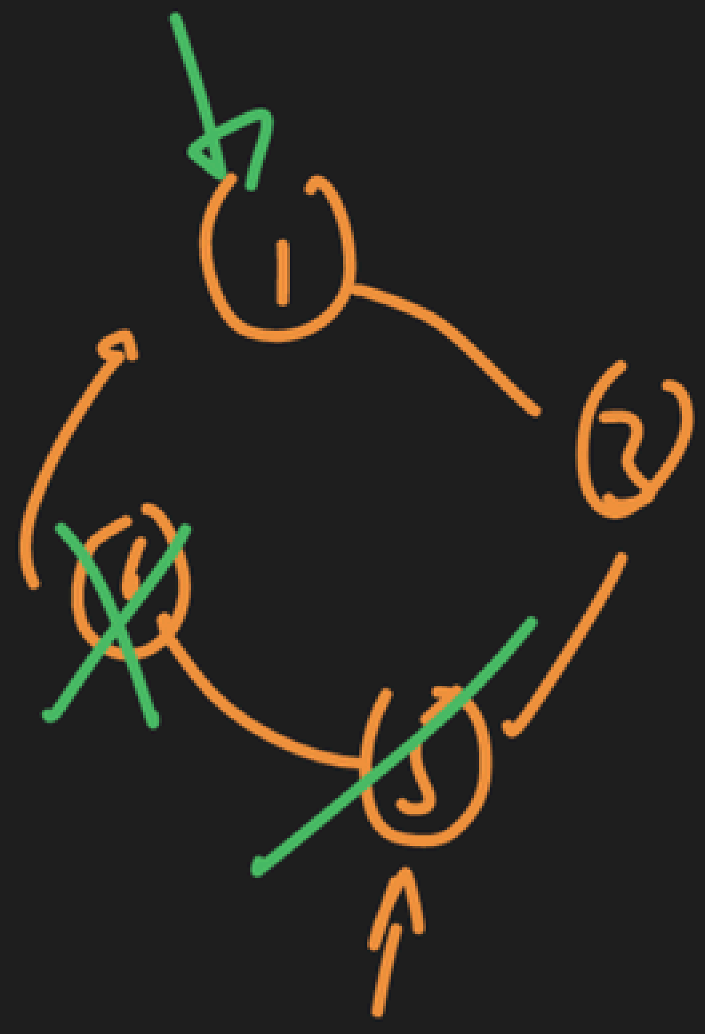
$n = 5$, $k = 2$

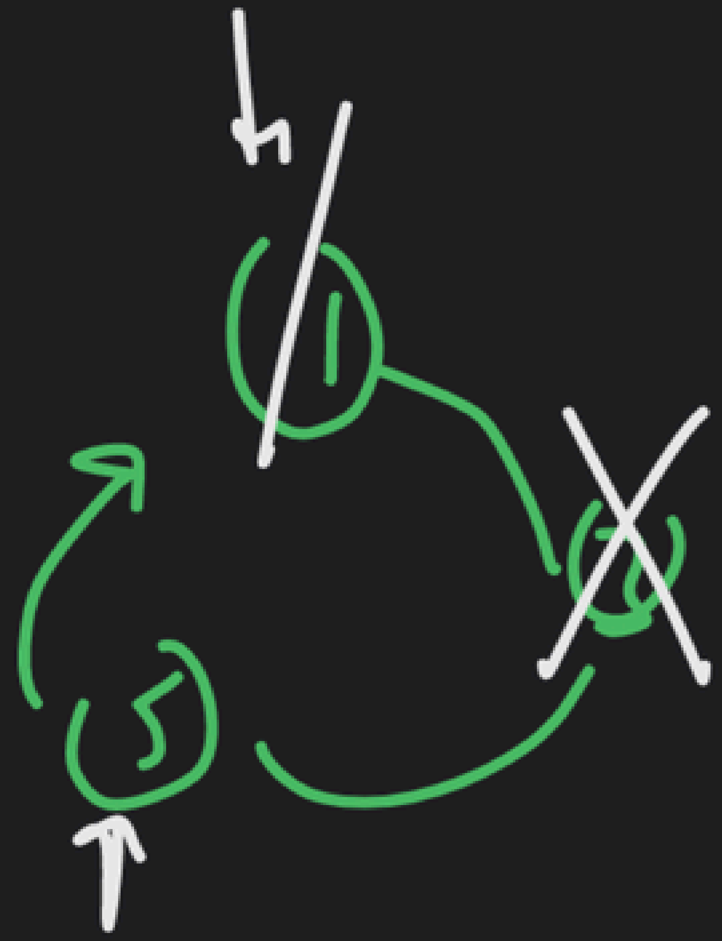


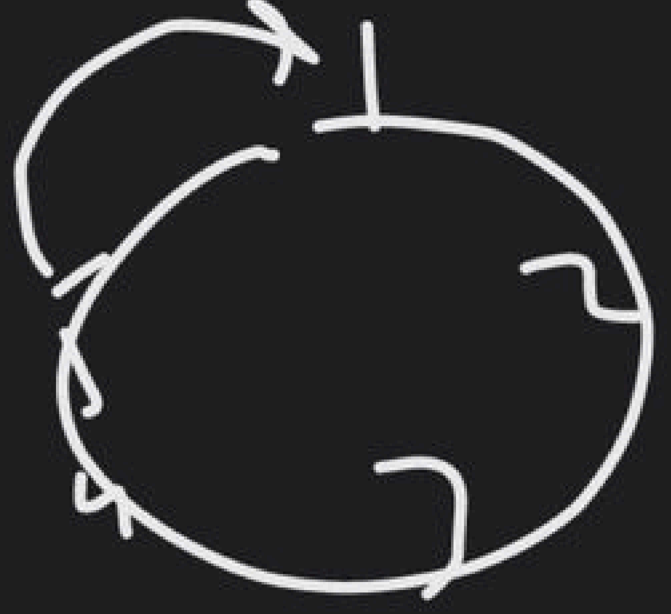
$n = 6 \quad , K = 2 \longrightarrow ans = 5$











if (n == 1)
return 0;

n = 4 , k = 2 → ans = 1

n = 5 , k = 2 → ans = 3

+2 +k

n = 6 , k = 2 → ans = 5

n = 7 , k = 2

n-1 , k = 2

$f(n, k) \rightarrow (f(n-1, k) + k) \% n$

0 1 2 3

0 1 2 3

0 1 2 3

0 1 2 3

1 2 3 4

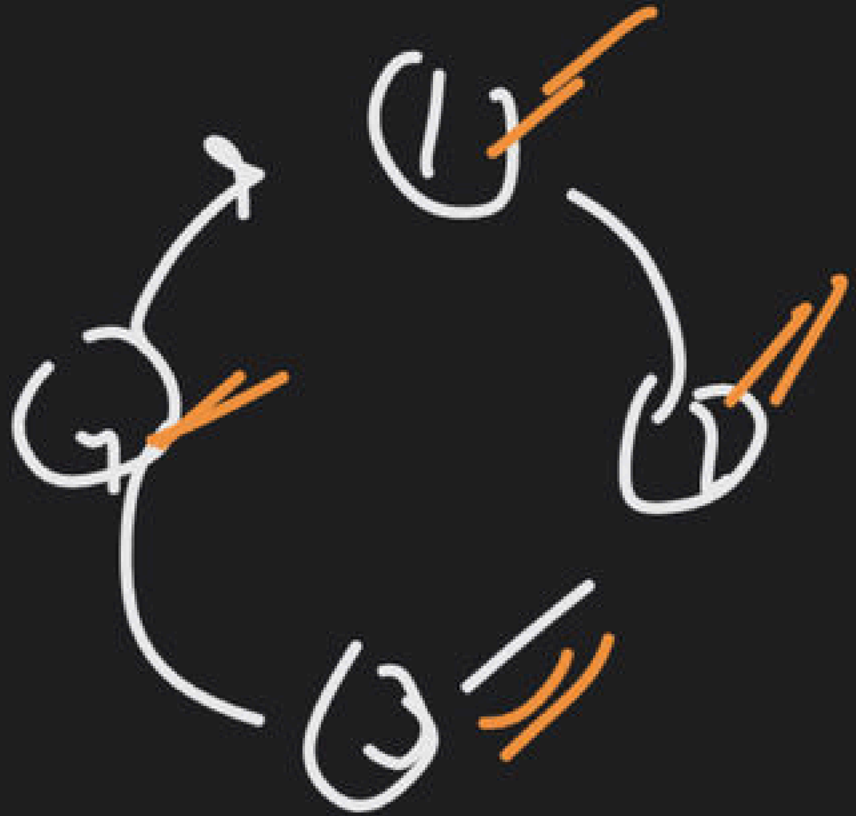
1 2 3 4

1 2 3 4

1|2

+1 0, 1, 2, 3

1, 2, 3, 4



n	%4
1	1
2	2
3	3
4	0
5	1
6	2
7	3
8	0
9	1
10	2
11	3
12	0

11

ans

$n = 4,\ K = 2 \longrightarrow 1$

$n = 5,\ K = 2 \longrightarrow 3$

$n = 6,\ K = 2 \longrightarrow 5$

$n = 7,\ K = 2 \longrightarrow 7$

$n = 8,\ K = 2 \longrightarrow \boxed{9}$

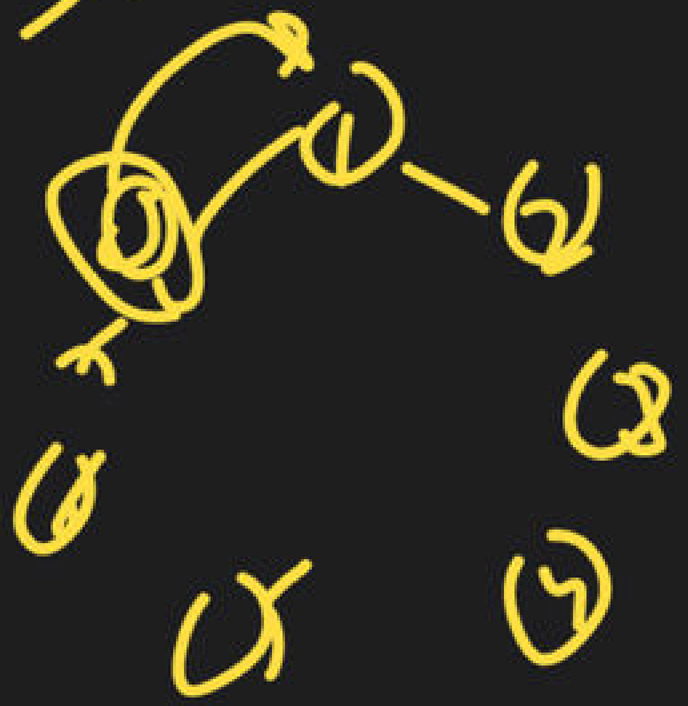
2 K K 1

2

2 2

$9 \% n = 9 \% 8 = 1$

$\% n$



$$f(n, K)$$

$$\rightarrow f(\underline{n-1}, k) + K$$

$$f(4, 2) \longrightarrow f(3, 2) + K$$

```
int solve (int n, int k)
{ if (n == 1)
      return 0;

  return (solve(n-1, k) + k) % n;
}

int main ()
{
  return solve(n, k) + 1;
}
```

→ F

2

→ 3

f(4, 2)

3

ans

5 min

1

999E

2 → solve(4, 2)

[solve(3, 2) + 2] % 3

0

[solve(2, 2) + 2] % 2

0

[solve(1, 2) + 2] % 1

n = 1

$\frac{2}{1}$ → Q $\frac{2}{1}$

$2 \% 1$ → R

D ... 10 ex

4) 8 (2
8
—
0
remainder

1) 2 (2
2
—
0