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

$n = \underline{\underline{14}}$

$\cancel{1}, 2, \cancel{3}, 4, \cancel{5}, 6, \cancel{7}, 8, \cancel{9}, 10, \cancel{11}, 12, \cancel{13}, 14$

$\cancel{2} \quad 4 \quad \cancel{6} \quad 8 \quad \cancel{10} \quad 12 \quad \cancel{14}$

$\cancel{4} \quad 8 \quad \cancel{12}$

2 min

$\boxed{8} \rightarrow \underline{\text{ans}}$

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

$\underline{n = 8}$

1, 2, 3, 4, 5, 6, 7, 8

0 1 2 3 4 5 6 7

n = 8

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

L → R

n = 4

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

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

R → L

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

$$f(n) = 2 * \boxed{f\left(\tfrac{n}{2}\right)_{R \to L}}$$
$\underline{L \to R}$

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

$3 \to 1$

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

$$= 2 * [1, 2, 3, \ldots \tfrac{n}{2}]_{R \to L}$$

$$= 2 * \boxed{[\boxed{\tfrac{n}{2}}, \ldots 3, 2, \boxed{1}]}_{L \to R}$$

$$= 2 * [1, 2, 3 \ldots \tfrac{n}{2}]_{L \to R}$$

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

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

1

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

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

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

$$f\left(\tfrac{n}{2}\right)_{L\to R} = [\cancel{1}, 2, \cancel{3} - \quad \times \; \times \cdot \tfrac{n}{2}]$$

$$f(n)_{R\to L} = [1, \cancel{2},] \times - \times - \times - \cancel{n}]$$

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

i/p → $\underline{n}$

solve() → sol

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

$\underline{n = 8}$

$f(6)$

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

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

$f(4)$

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

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

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

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

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

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

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

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

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

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

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

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

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

Code

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

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

$\boxed{L}$

$n = 6$

④ $[1, 2, 3, 4, 5, 6]$

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

$[1, 2, 3]$

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

$[1]$

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

$$\downarrow$$

$$2 * \left(\frac{1 + 7}{2} - \text{soln}\left(\frac{7}{2}\right)\right) \qquad 2$$

$$\downarrow$$

$$[1, 2, 3]$$

$$\downarrow$$

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

$$\downarrow$$

$$[1]$$

$$\cancel{1} + \frac{3}{2} - \cancel{1}$$

$$\frac{3}{2} \rightarrow 1$$

$n = 6$

jabardast
→ Elim. game

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

L → R
R → L

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

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

cross recursion

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

Predict the Winner

[1, 5, 2]

[1, 5, 2]

[5, 2]

[2]

win

win

P1

P2

2 1
1 2
3 3

5 5
2 5
1

[1, 5, 2]

[1, 5]

[1]

p1

p2

(i) [1], 2, 4, 7, [5] (j-1)

num

[$\boxed{1}$, 2, 4, 7, 5, $\boxed{3}$]

i j

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

$\boxed{2}$, 4, 7, 5, $\boxed{3}$

P2

(i+2, j)

(i+1, j-1)

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

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

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

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

Avoid 1

$p1 = 12$

$p2 = totalsum - p1Scan$

$p1$

$[\boxed{5},\ 2,\ 4,\ 7,\ \boxed{6}]$

$i \qquad\qquad j$

player1

int option1 = $5 + \min\big((i+2,\ j),\ (i+1,\ j-1)\big)$

num[i]

int option2 = $num[j] + \min\big((i+1,\ j-1),\ (i,\ j-2)\big)$

$i+1 \quad i+2 \quad j-1 \quad j$

$[\boxed{2},\ 4,\ 7,\ \boxed{6}]$

$p2 \qquad p2$

$i+1 \quad j-2 \quad j-1$

$[\boxed{5},\ 2,\ 4,\ \boxed{7}]$

$i \qquad p2$

B:(

$i == j$

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

i i j j

$\boxed{3}$

i j

return nums[i]

$i > j$

no element present

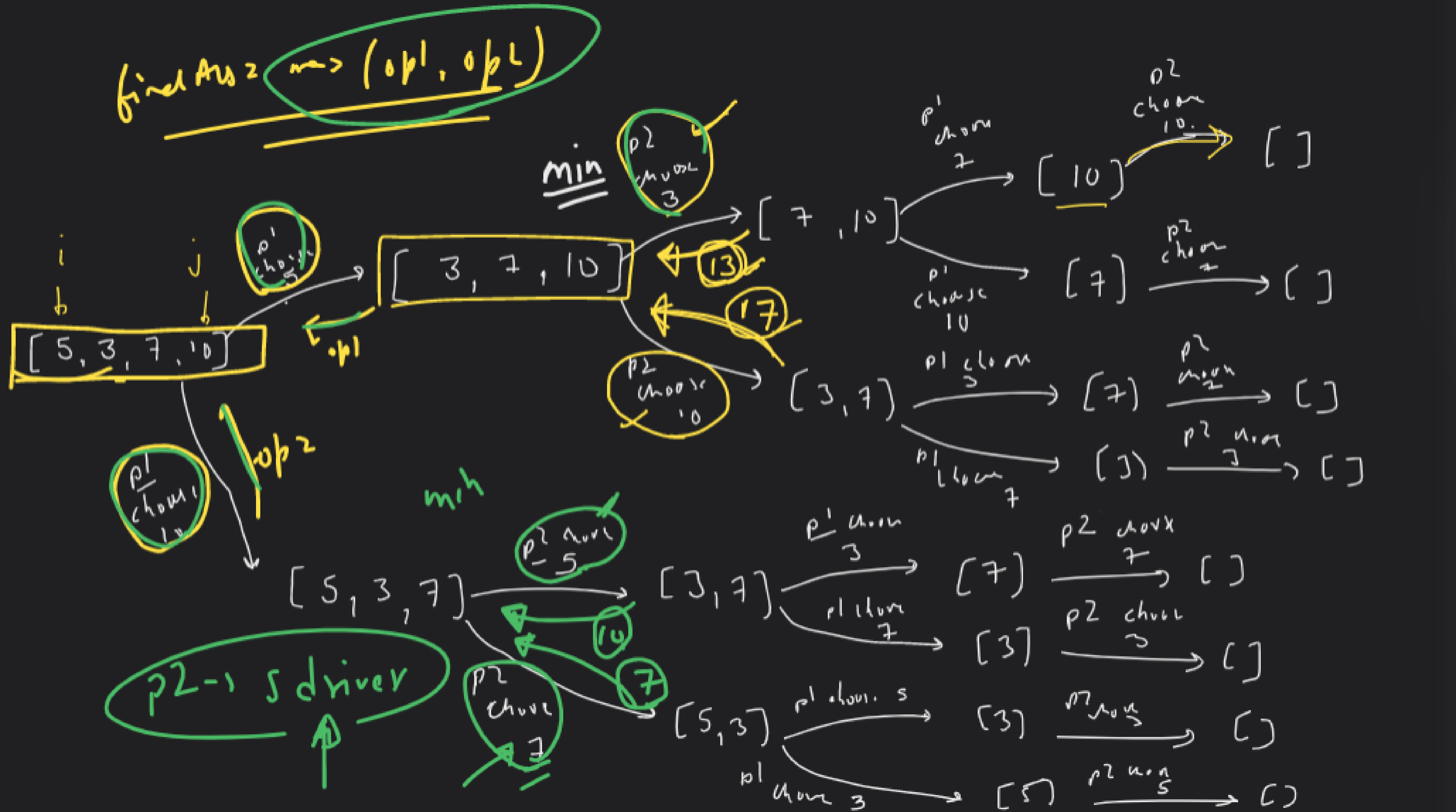
return 0;

B.C

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

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

arr $\rightarrow$ [5 , 3 , 7 , 10]



findAns2 => max(op1, op2)
min
p2 choose 3
p1 choose 5
i
j
[5, 3, 7, 10]
[3, 7, 10]
op1
op2
[7, 10]
[10]
[ ]
[7]
[3, 7]
[3]
13
17
p2 choose 10
p1 choose 10
min
p2 choose 5
[5, 3, 7]
[5, 3]
[5]
14
7
p2 choose 7
p2 -> 5 driver

$[\, x \quad y \,]$

$x < y$

$i \quad k \quad j$

$i == j$

$[\, j \quad i \,]$

Invalid Range

$i > j$

no

$(\quad)$

$[\quad]$

$[2, 3]$

$[2, 7$

$[2, 2)$

$[3, 2] \to \times$

K^{th} symbol in Grammar

$0 \rightarrow 01$

$1 \rightarrow 10$

observation

i/p → $\underset{\text{row}}{n}$, $\underset{\text{digit}}{K}$

0

0 1

01 10

0110 1001

01101001 10010110

n = 3

K = 3 → ans = 1

1min

table

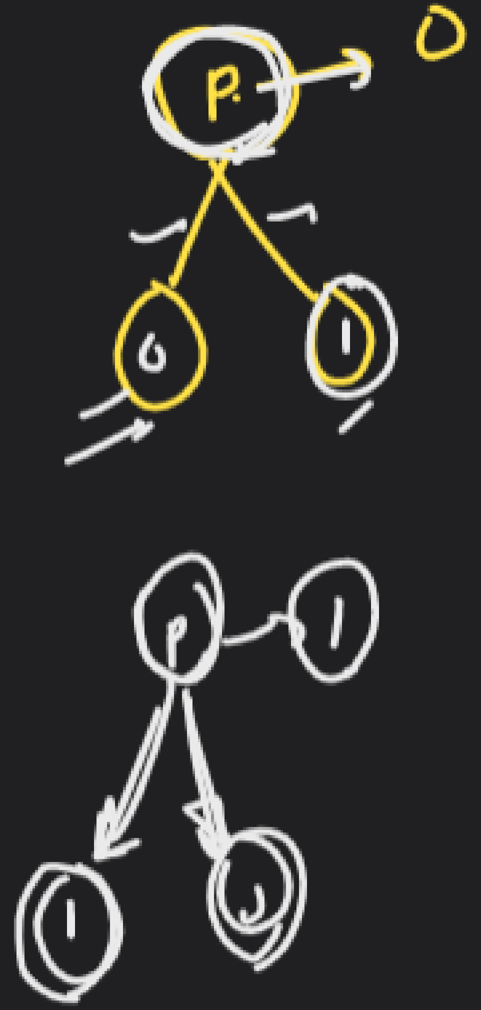
1st row → 0

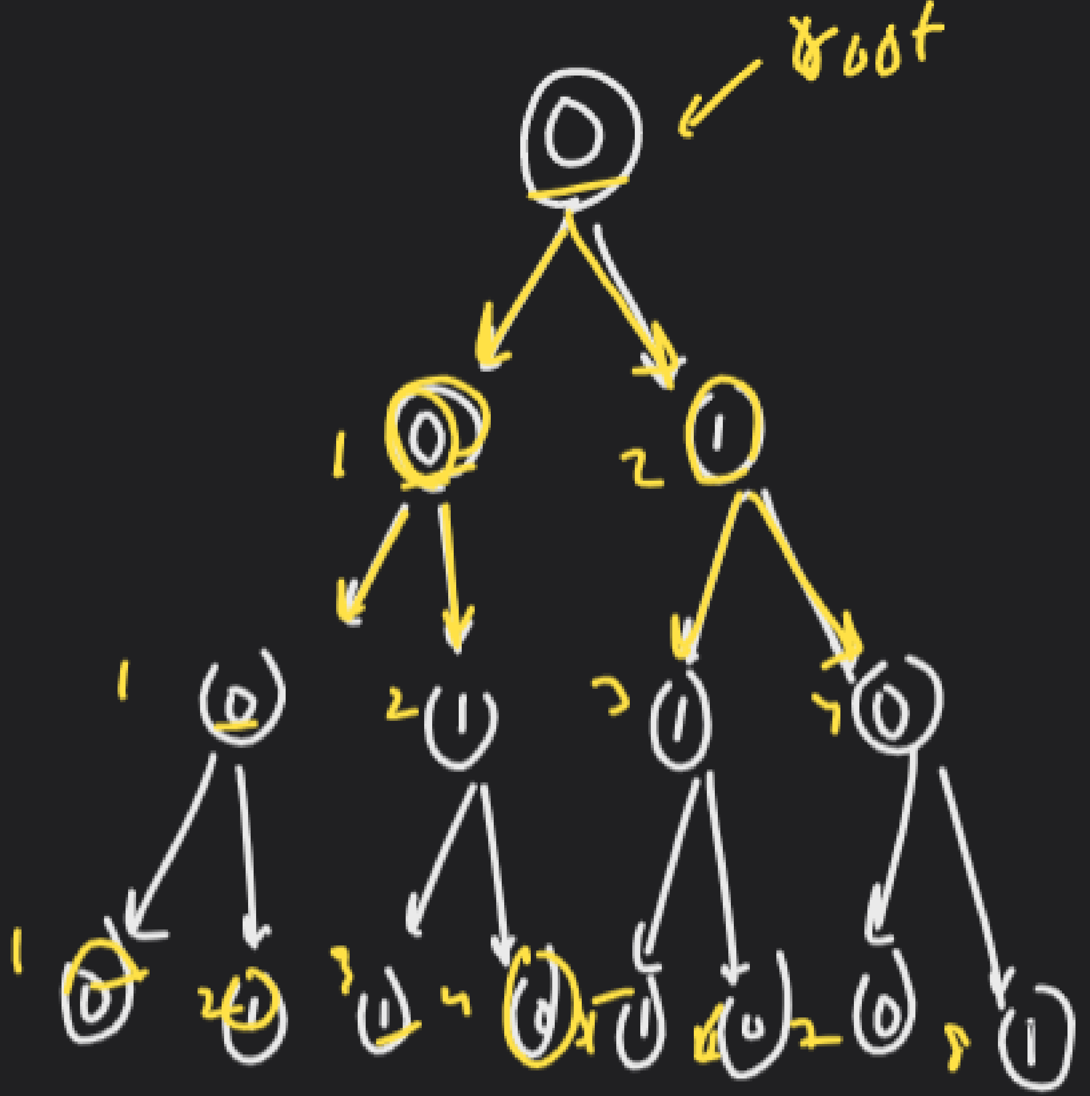
2nd → 01

III → 0110

IV → 01101001

V → 0110100110010110





Left node → odd

right node → even

~~n~~, K

K^th symbol

2 factors

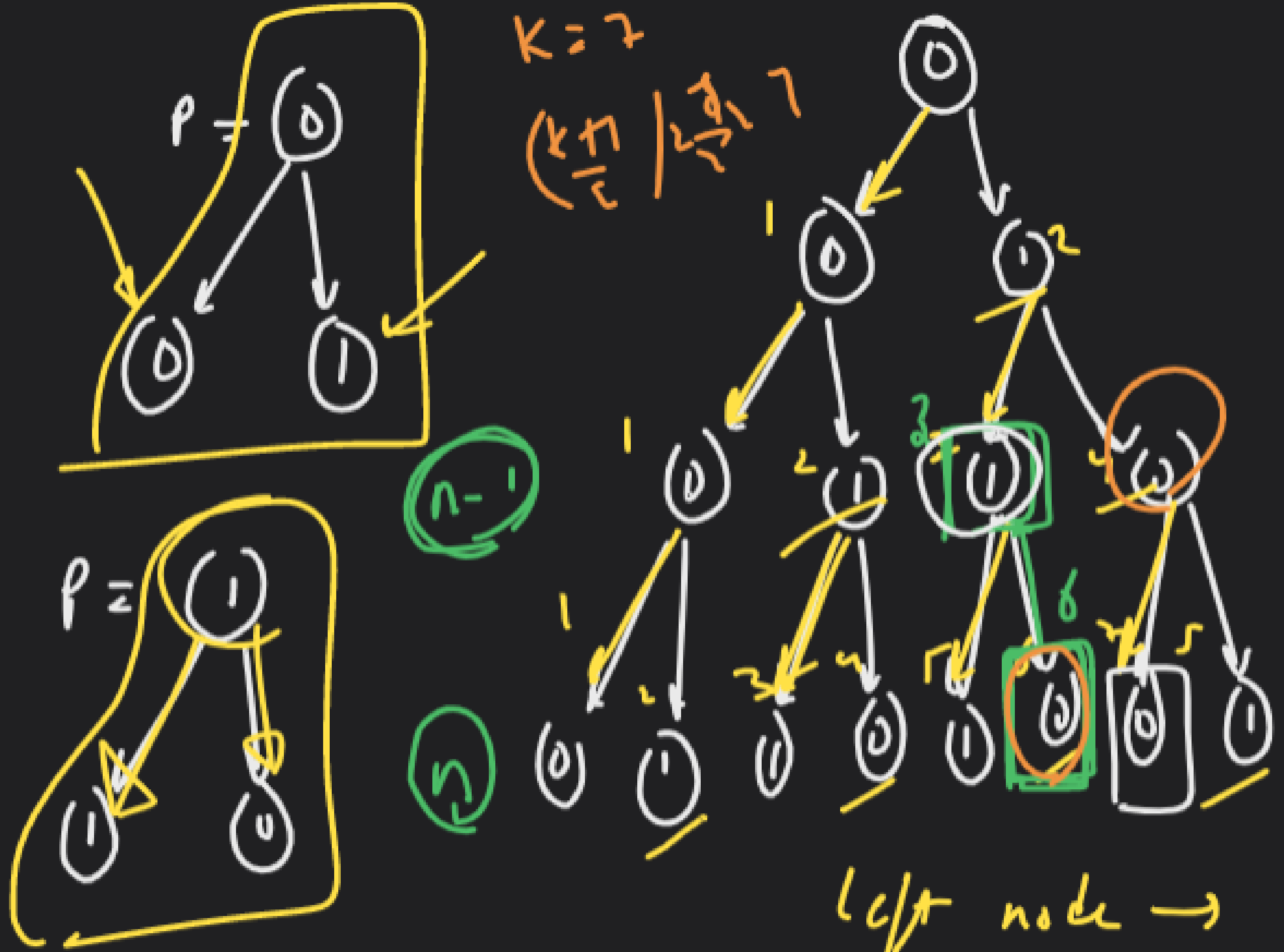
↳ parent of K

↳ K → even / odd

K^{th} - Symbol

→ K parent

→ K → even/odd



$K = 2$

$\frac{K}{2} = 1$

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

left node → odd no.

right node → even no.

$n = 4$
$K = 6$

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

$f(n, K)$

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

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)

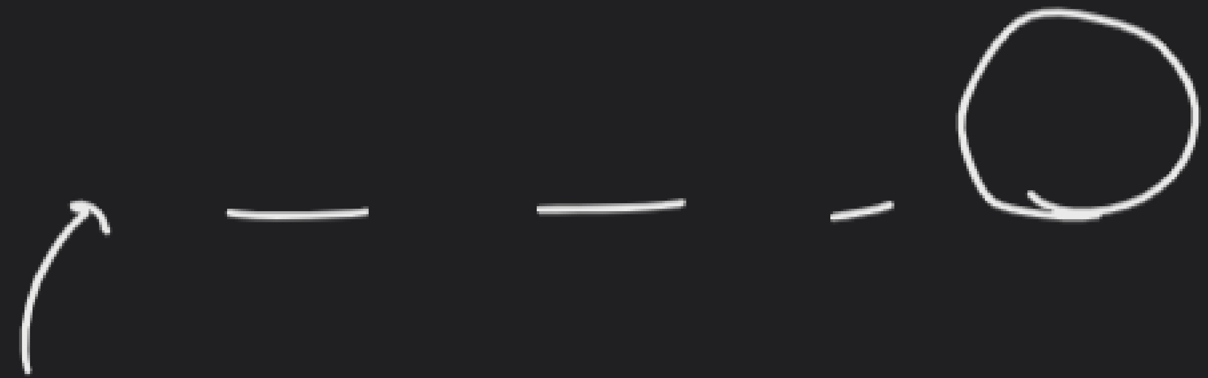
ans = 0

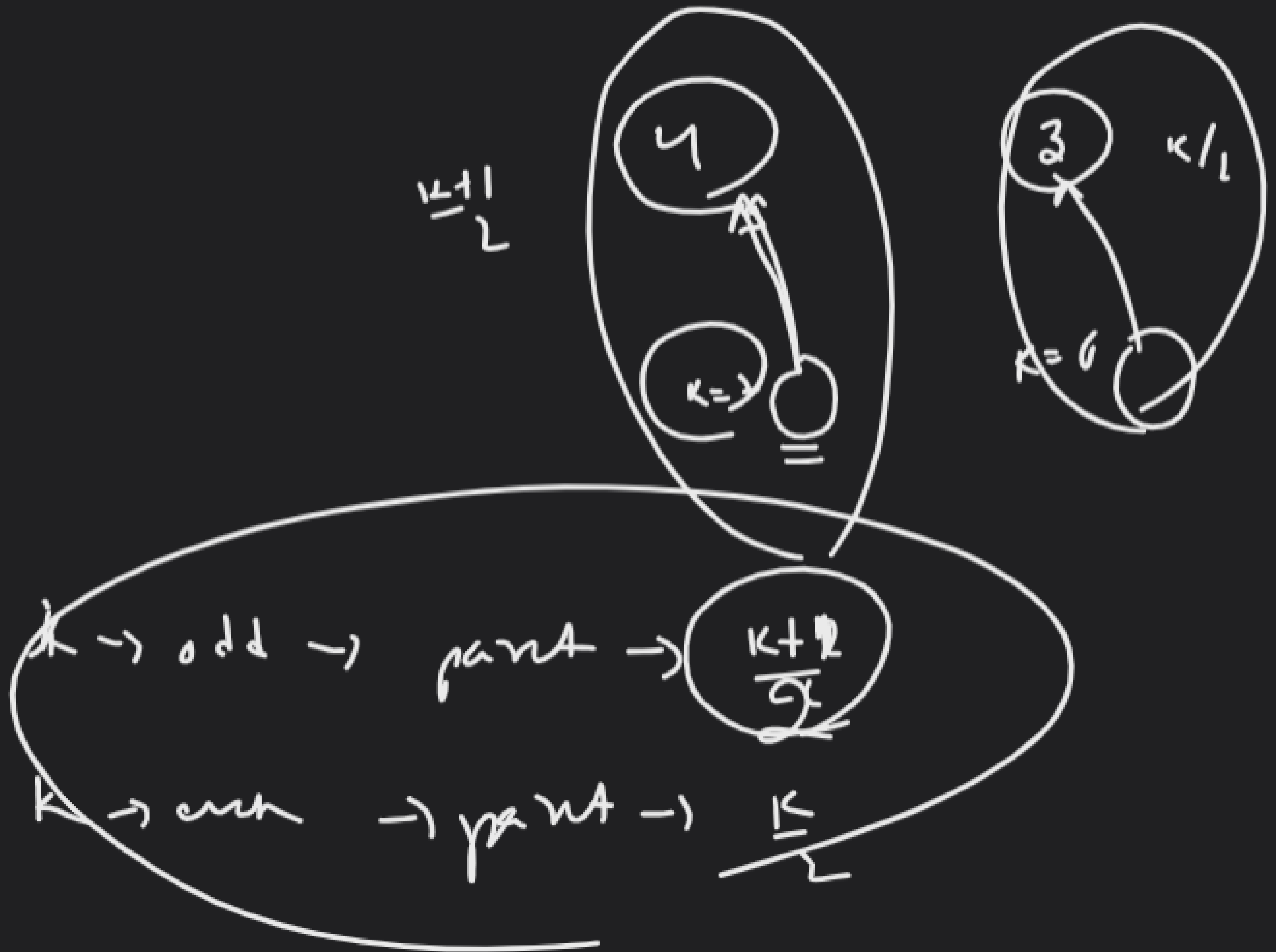
if (K_par = 1 & K is odd)

ans = 1

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

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





(k+1)/2
4
k=3
3
k/2
k=6
k → odd → parent → (k+1)/2
k → even → parent → k/2

odd → $K \% 2 == 0$ → even

even $K \% 2 == 1$ → odd

K&1

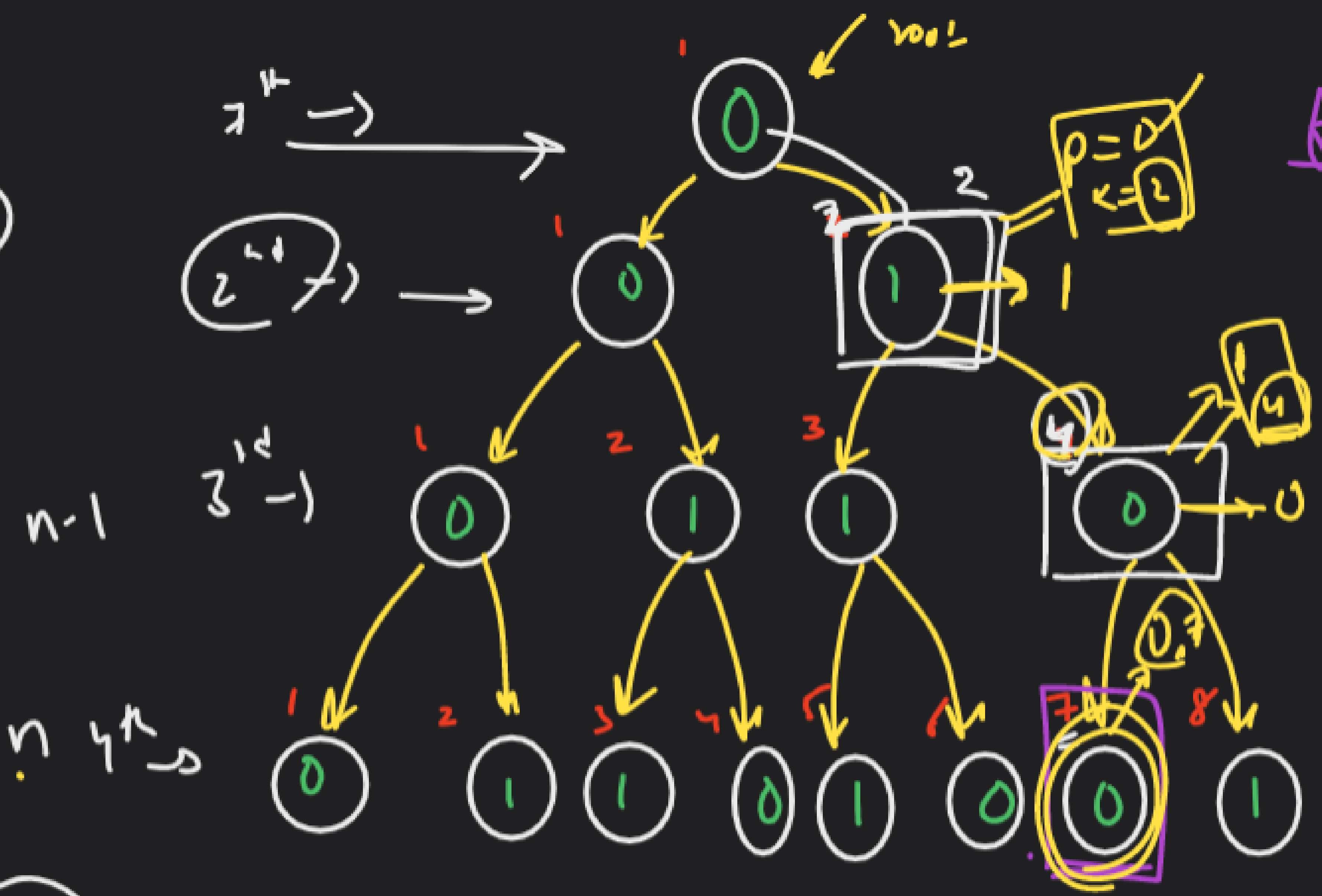
% → heavy op — ∠

good practice ← $K \& 1$ → true → odd   why

→ false → even

$n = 4$

$K = 7$



$f(n, K)$

$\downarrow$

$f(4, 7)$

$\downarrow$

$f(3, 4)$

$\downarrow$

$f(2, 2)$

$\downarrow$

$f(1, 1)$

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

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

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

H/W → K^{th} symbol in Grammar → other approach → H/W

→ Decode String → H/W

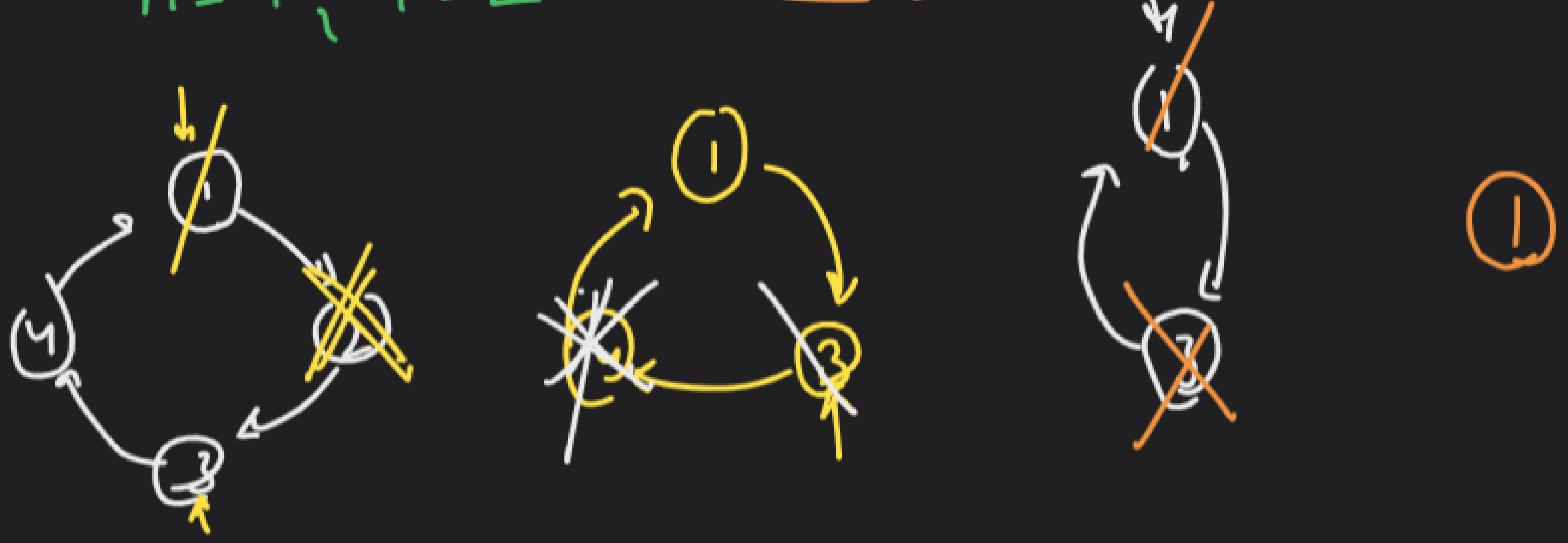
→ Maximum points in an Archery competition → H/W

Circular game

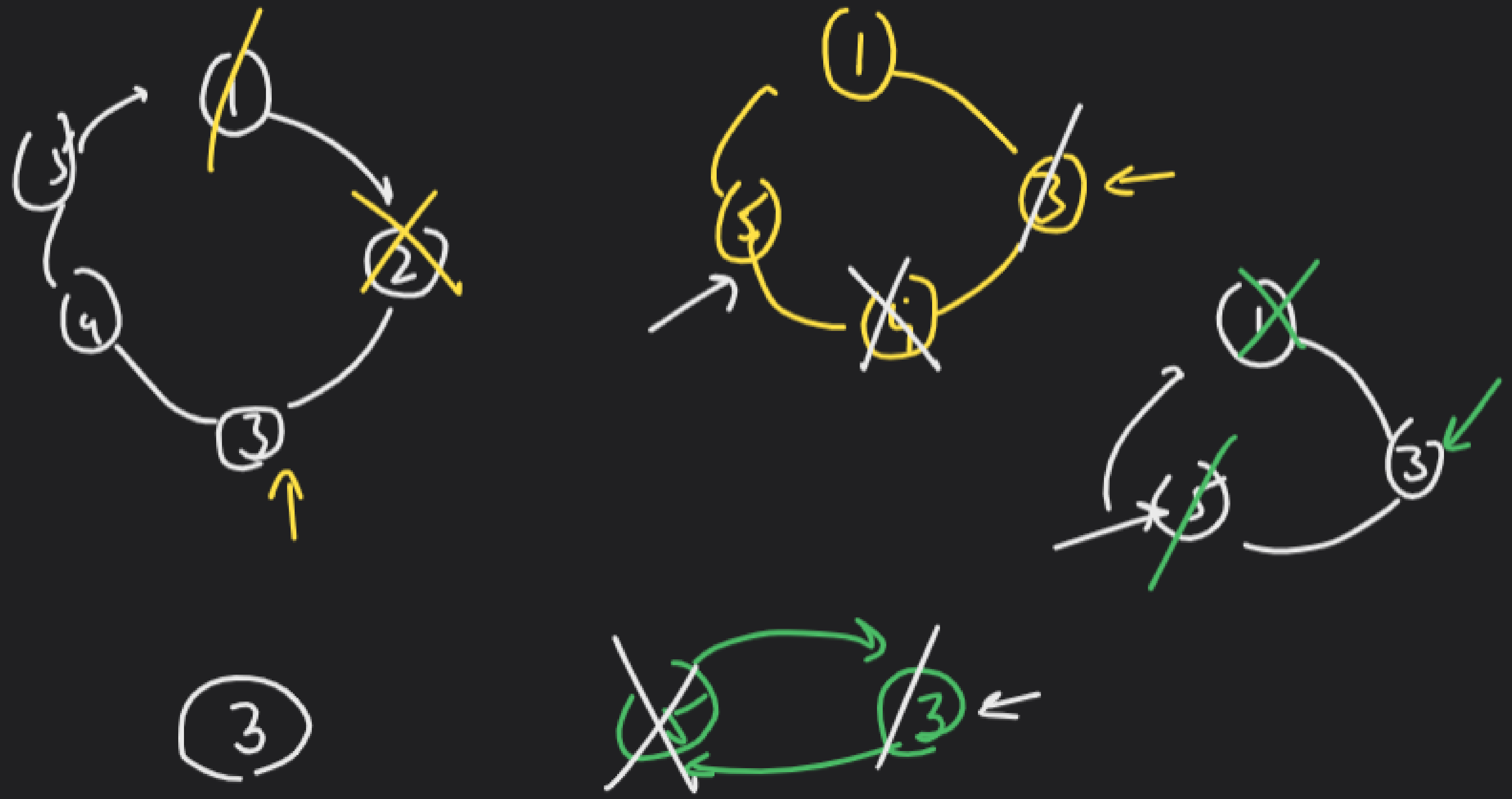
$n = 3$, $k = 2$ — ans = 3

3

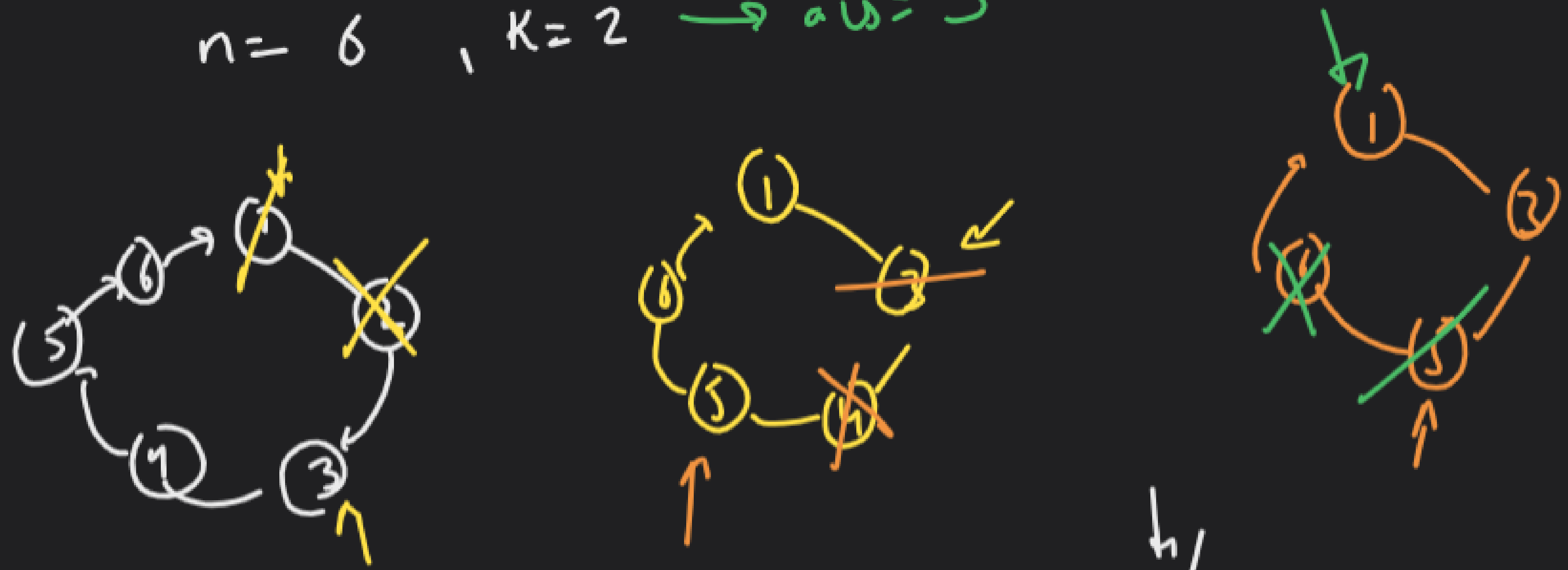
$n=4$, $k=2$ → $ans = 1$

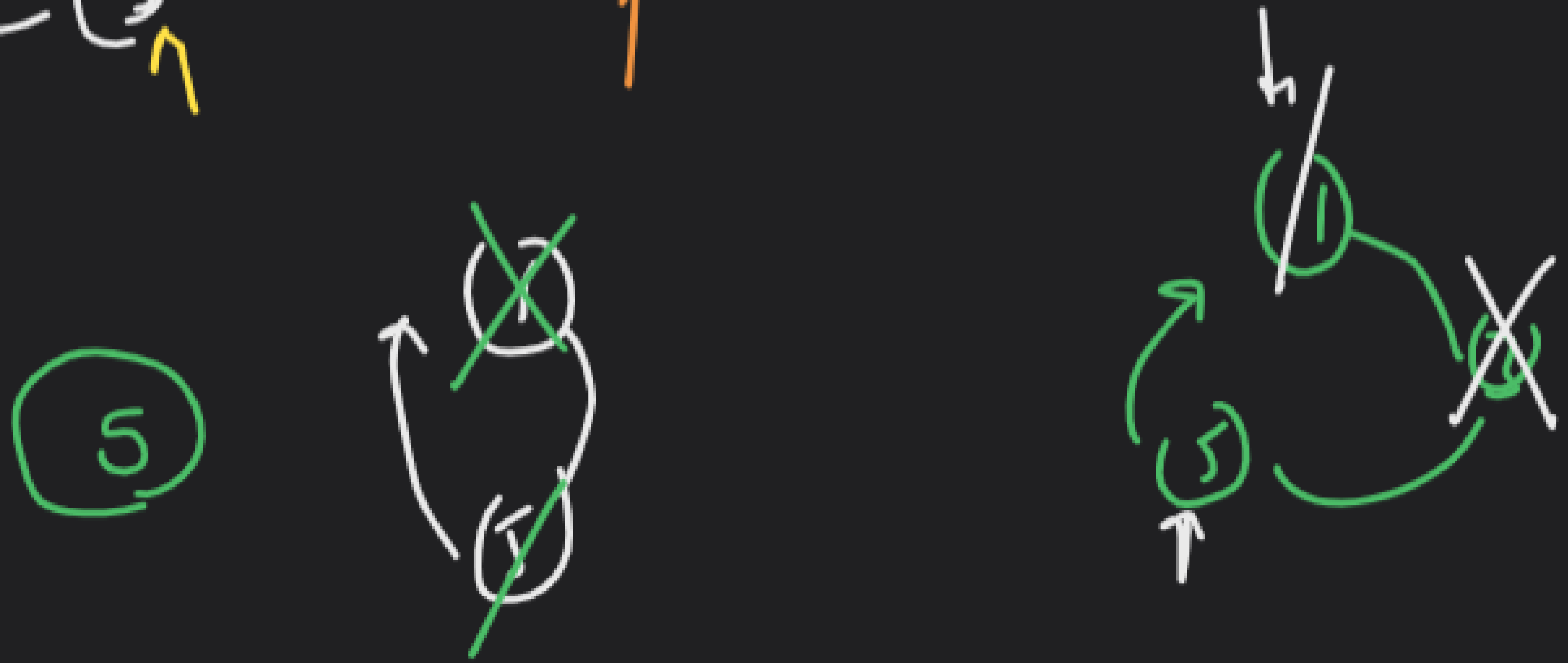


$n = 5$, $k = 2$ $\rightarrow$ 9 4 2 5

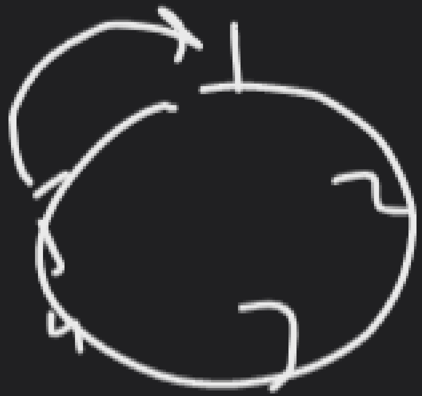


n = 6 , K = 2 → ans = 5





if (n == 1)
return 0;



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

$n = 5, \; k = 2 \rightarrow ans = 3$ $\quad +2 \quad +k$

$n = 6, \; k = 2 \rightarrow ans = 5$

$n = 7, \; k = 2$

$n = n$

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

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 → 1

n = 5, K = 2 → 3

n = 6, K = 2 → 5

n = 7, K = 2 → 7

n = 8, K = 2 → 9

2 K K
2 1
2
2 2

9 % n = 9 % 8 = 1

% n

$f(n, K)$

$f(n-1, k) + K$

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

```
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

2 solve(4, 2)

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

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

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

n = 1

5 min

999

Dynamic → 10 ex

4) 8 (2
8
0
remainder

1) 2 (2
2
0

$\frac{2}{1}$ → Q 2/1 , 2 % 1 R