Recursion - 4

Lecture-30

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Finding subarrays → vo subsequence jo ki continuous fashion me ho

Find out all the subarrays of an array.

arr = {1, 2, 3, 4}

→ {}, {1}, {2}, {3}, {4}, {1,2}, {1,3}, {1,4}, {2,3}, {2,4}, {3,4},
{1,2,3}, {1,2,4}, {1,3,4}, {2,3,4}, {1,2,3,4}

1
1 2
1 2 3
1 2 3 4

2
2 3
2 3 4

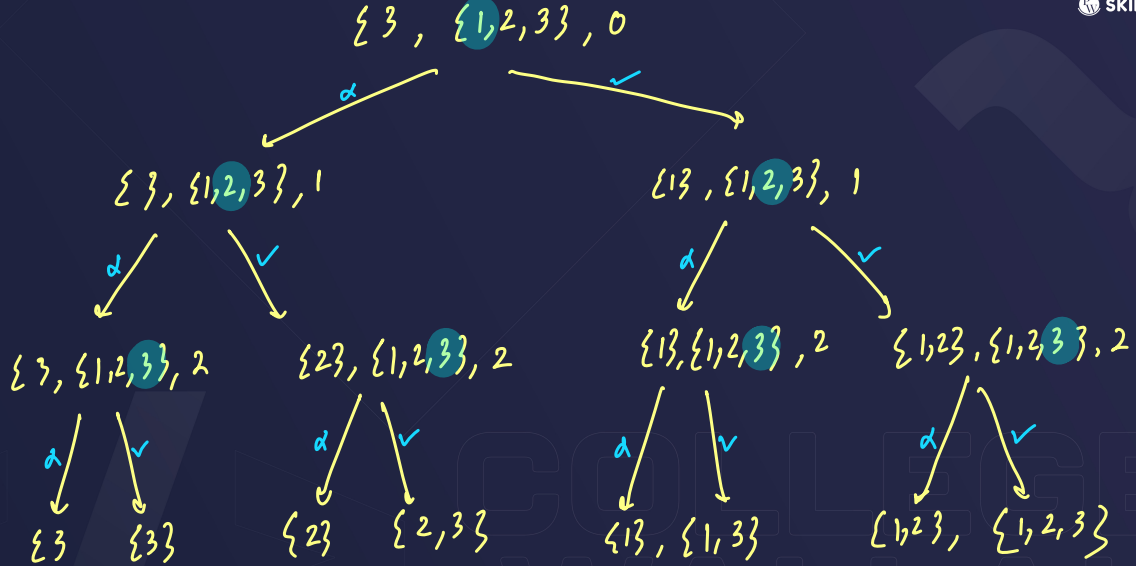
3
3 4

4

```
for(int i=0;i<n;i++){ // start
    for(int k=i;k<n;k++){
        for(int j=i;j<=k;j++){
            cout<<arr[j];
        }
        cout<<endl;
    }
}
```

k only denotes no. of rounds in loop

{1,2,3,4}



Will work in unique elements only.

Palindrome using recursion

Find out whether a given string is palindrome or not using recursion

dad

mom

aba

abcdcba

racecar

Greatest Common Divisor

Calculate Greatest Common Divisor of two numbers.

hcf (24, 60) = 12

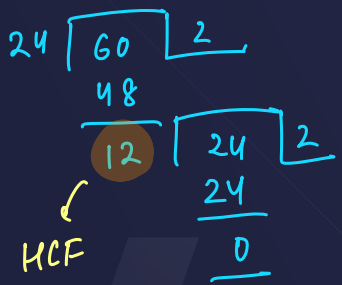
```
for(int i = 24 ; i >= 2 ; i--){
    if( 24 % i == 0 && 60 % i == 0) return i;
}
return 1;
```

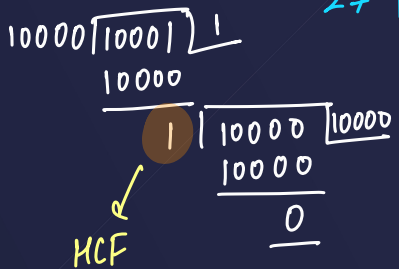
→ T.C. = O(min(a, b))

hcf (a, b) <= min(a, b)

lcm (a, b) >= max(a, b)

Euclid's Division Algo (long division method)





Time Complexity of $gcd(a, b)$ is $O(\log(a+b))$

HCF → 27 & 45

$gcd(27, 45)$

$\downarrow$

$gcd(45\%27, 27) = gcd(18, 27)$

$\downarrow$

$gcd(27\%18, 18) = gcd(9, 18)$

$\downarrow$

$gcd(18\%9, 9) = gcd(0, 9)$ ← HCF

$27 \% 45$

$a \% b = a$ if $a < b$

$gcd(45, 27) = gcd(27, 45)$

a b

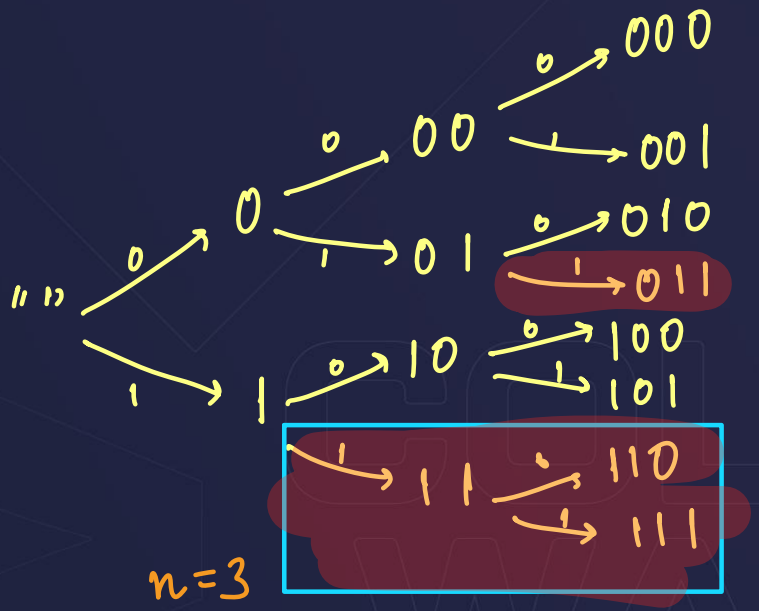
Practice

Generate all binary strings of length n without consecutive 1's

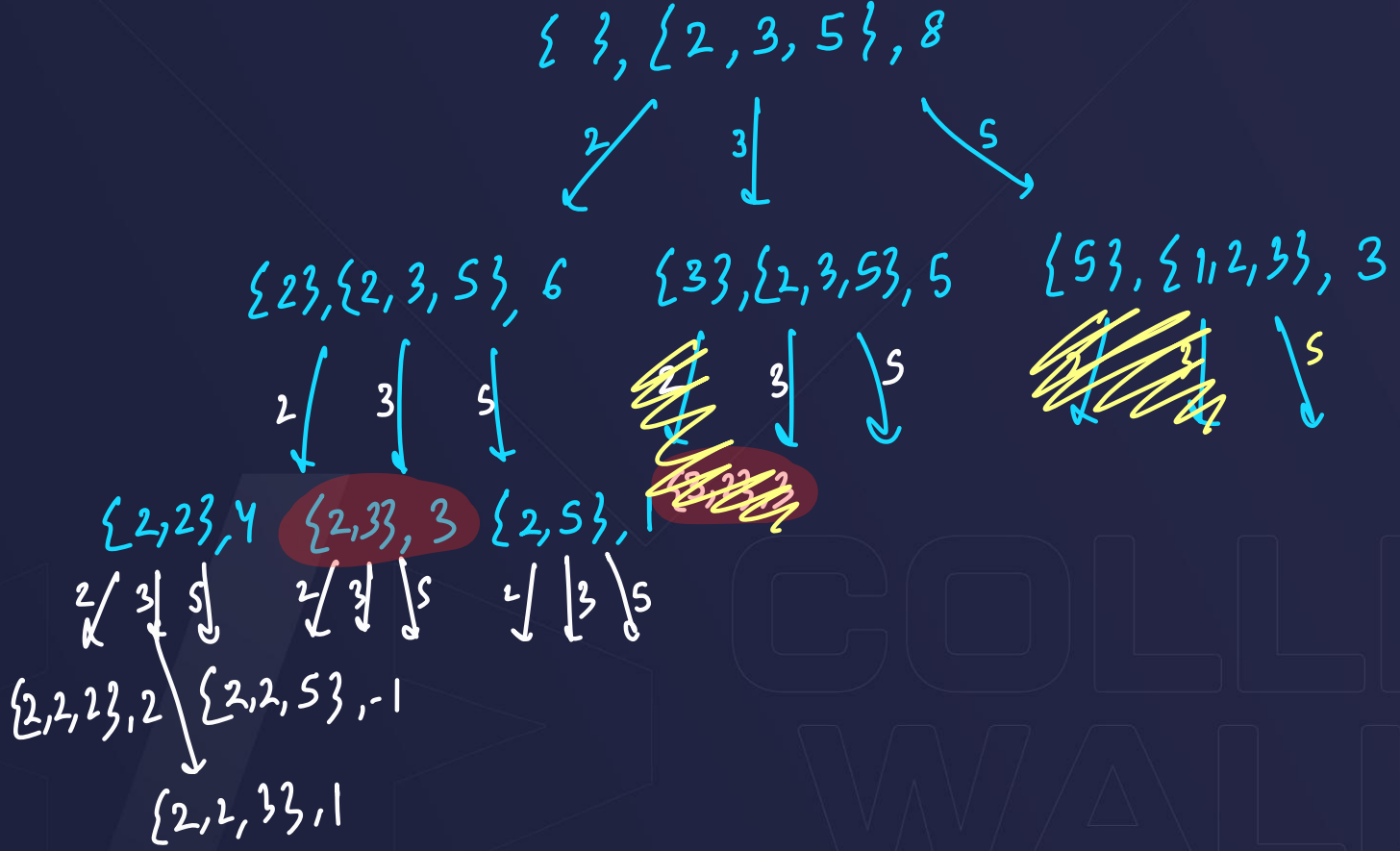
2^n

n = 2

→ "00"
"01"
"10"
"11"



Ques: Combination Sum [Leetcode - 39]



Ques: Generate Parentheses [Leetcode - 22]

```
Input: n = 3
Output: ["((()))","(()())","(())()","()(())","()()()"]
```

VVIMP Observations

at every instant,
no. of opening bkts >=
no. of closing bkts.

n = 1 → ()

n = 2 → ()() , (())

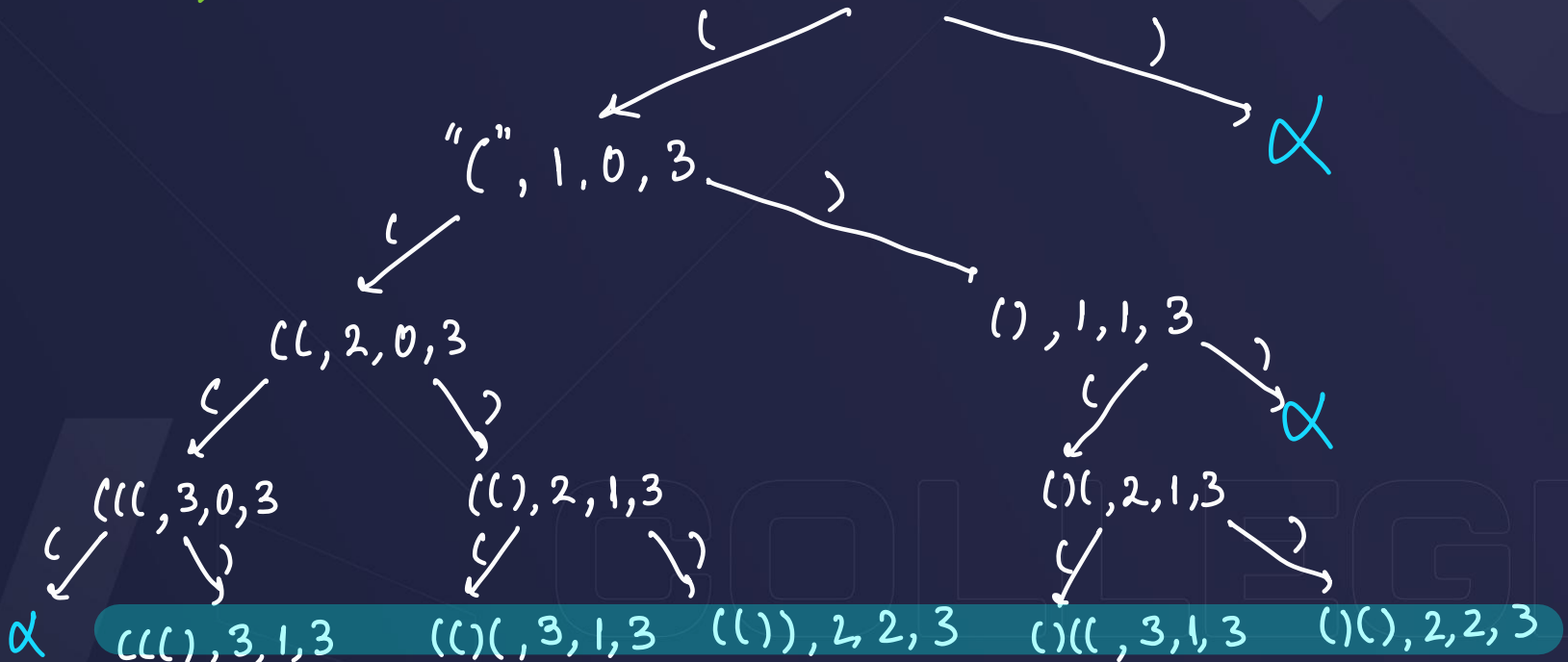
n = 3 → ()()() , (()()) , (())() , ((())) , ()(())

Ques: Generate Parentheses [Leetcode - 22]

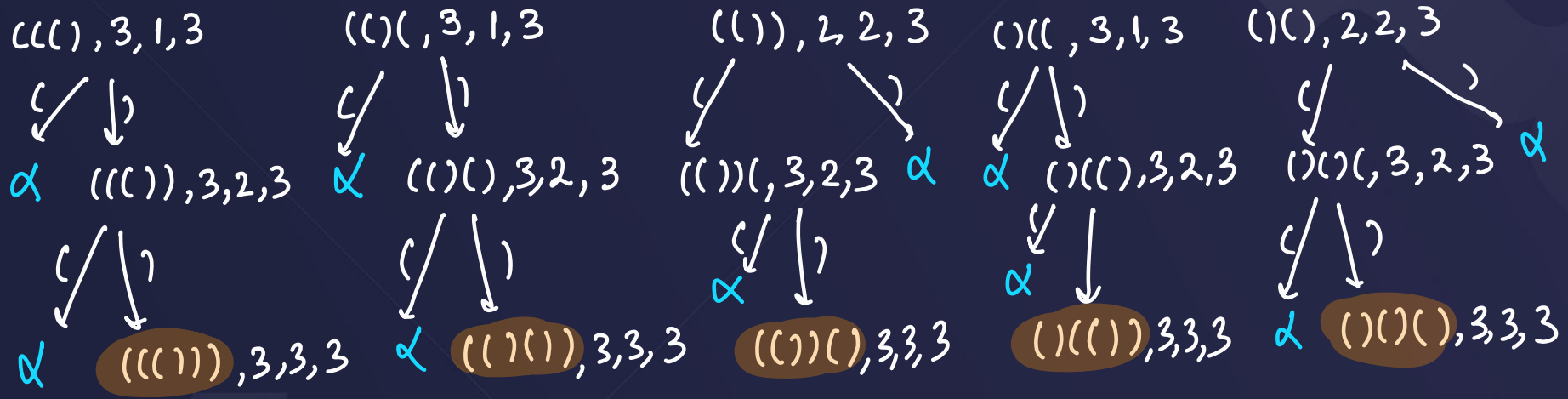
$n = 3 \rightarrow$ (((,) ,) ,)

str op cl n

"" , 0 , 0 , 3



Ques: Generate Parentheses [Leetcode - 22]




```
Input: n = 3
Output: ["((()))","(()())","(())()","()(())","()()()"]
```

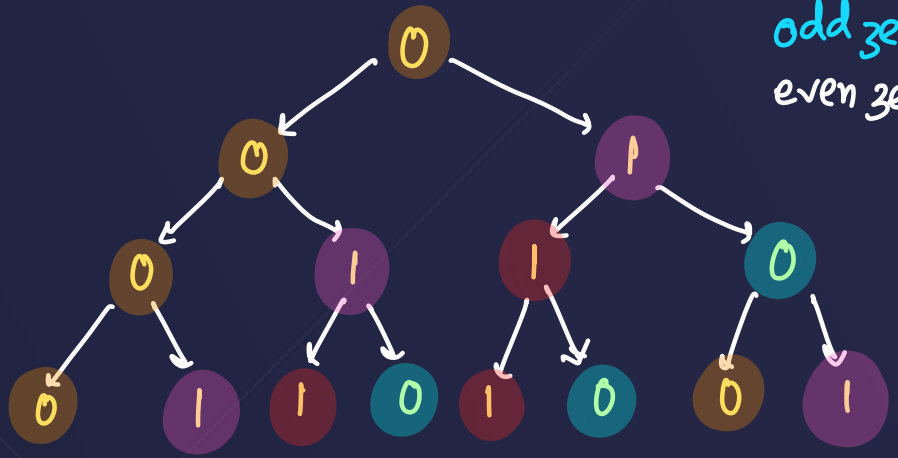
Ques: Kth Symbol in Grammar [Leetcode - 779]

1 →

2 →

3 →

4 →



odd zeroes → 0 se gen

even zeroes → 1 se gen

T.C. = O(n)

n = 4, K = 5

0 → 01

1 → 10

Odd ones → 1 se

even eves → 0 se

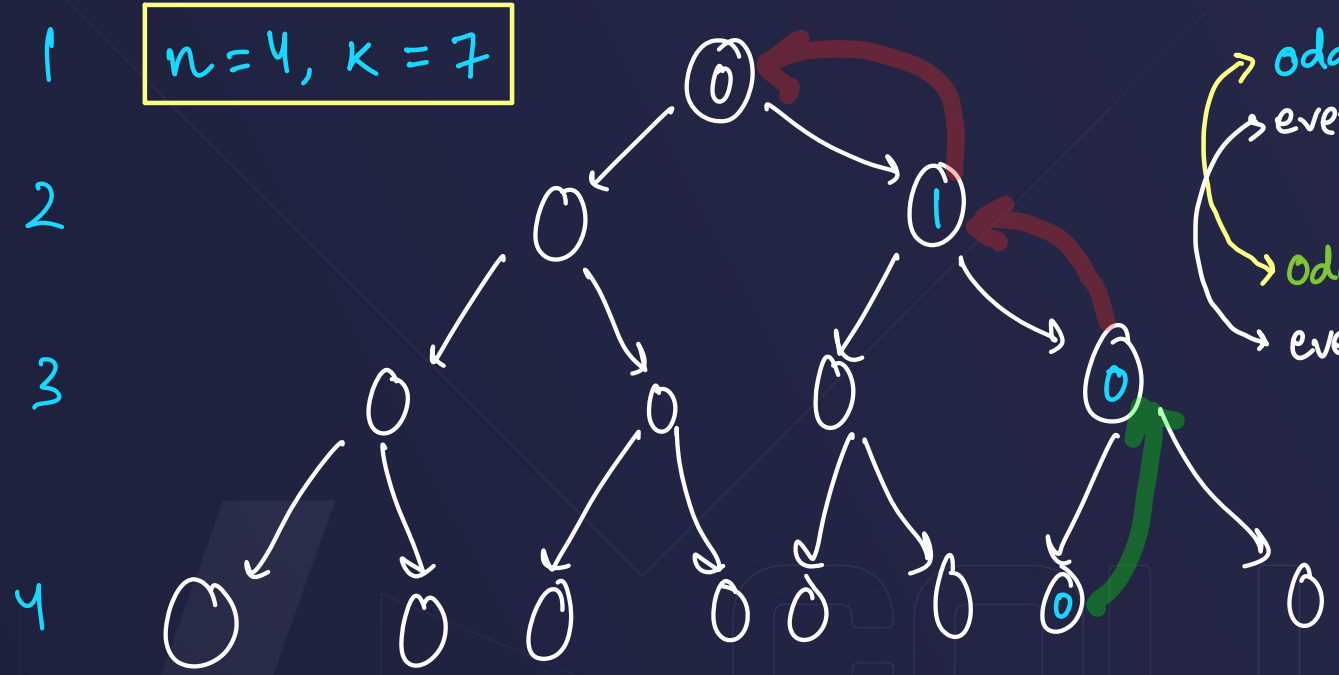
Kth(n,K) → if(K%2==0) → Kth(n-1, K/2)

Kth(n,K) → if(K%2!=0) → Kth(n-1, K/2 + 1)

Ques: Kth Symbol in Grammar

[Leetcode - 779]

n = 4, k = 7



odd zeroes → 0 se gen

even zeroes → 1 se gen

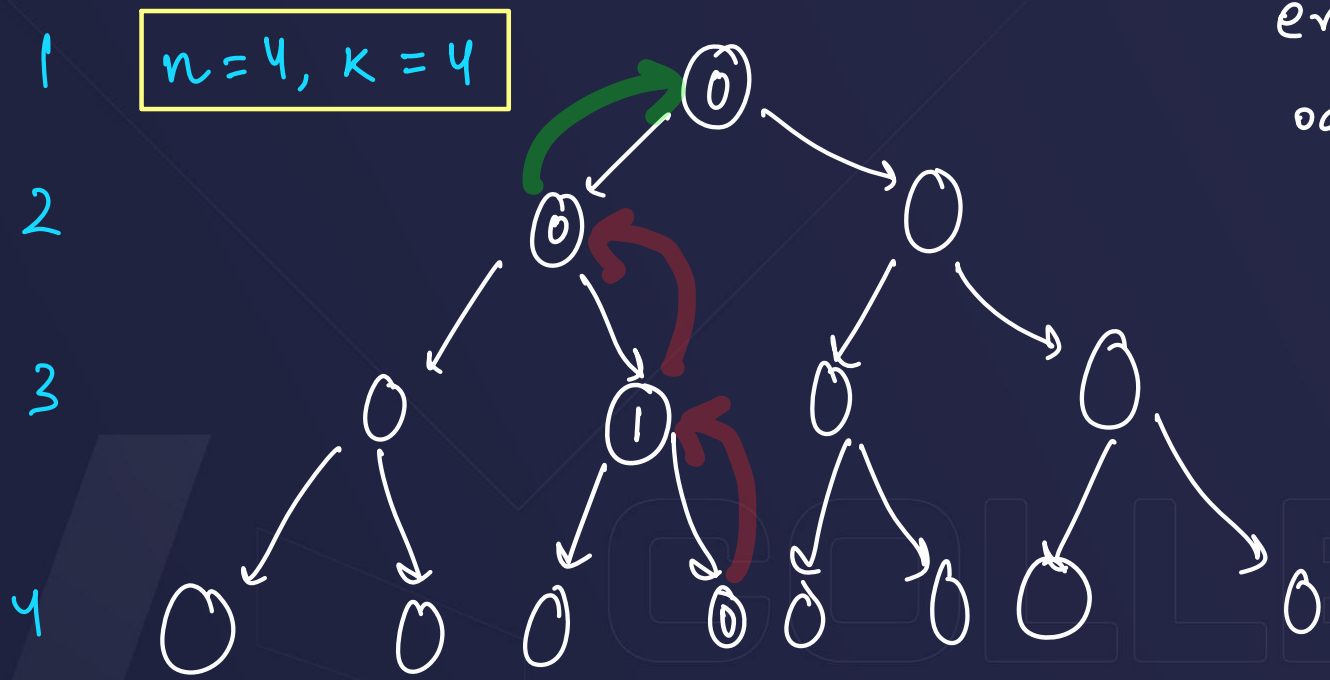
odd ones → 1 se

even one → 0 se

Kth(n,K) → if(K%2==0) → Kth(n-1, $\frac{K}{2}$)

Kth(n,K) → if(K%2!=0) → Kth(n-1, $\frac{K}{2}$+1)

Ques: Kth Symbol in Grammar [Leetcode - 779]



Ques: Count and Say [Leetcode - 38]

cas(n) = the way you would speak cas(n-1)

cas(1) = "1";

cas(2) = one 1 → "11"

cas(3) = two 1 ⇒ "21"

cas(4) = "1211"

cas(5) = "111221"

cas(6) = "312211"

cas(7) = "13112221"

cas(8) = "1113213211"

"3322251"

two 3's, three 2's, one 5, and one 1

2 3 + 3 2 + 1 5 + 1 1

"23321511"

Ques: Permutation Sequence [Leetcode - 60]

$n = 4 \rightarrow 4! = 24$ permutations

$k = 9$

ori	n	ans	idx	k
"1234"	4	""	0	9
134	3	2		3
14	2	23		

1234	3124
1243	3142
1324	3214
1342	3241
1423	3412
1432	3421
2134	4123
2143	4132
2314	4213
2341	4231
2413	4312
2431	4321

1 se start → 6

2 → 3rd string

ans

134
143
314
341
413
431

→ 14

2 _ _ _

1, 3, 4

n = 4
k = 18 → fact = (n-1)! = 3! = 6

1234	3124
1243	3142
1324	3214
1342	3241
1423	3412
1432	3421
2134	4123
2143	4132
2314	4213
2341	4231
2413	4312
2431	4321

	str	n	k	ans
→	1234	4	18	""
→	124	3	fact	3

fact = (4-1)! = 6

idx = 18/6 - 1 = 2

if (k % fact != 0) idx = k/fact;

if (k % fact == 0) idx = k/fact - 1

n = 4
k = 17 → fact = (n-1)! = 3! = 6

1234	3124
1243	3142
1324	3214
1342	3241
1423	3412
1432	3421
2134	4123
2143	4132
2314	4213
2341	4231
2413	4312
2431	4321

	str	n	k	ans
→	1234	4	17	""
→	124	3	5	3

fact = 6

idx = $\frac{17}{6}$ = 2

k-fact

17 % 6 = 5

if (k % fact != 0) idx = k/fact ;

if (k % fact == 0) idx = k/fact - 1

n = 4
K = 4 → fact = (n-1)! = 3! = 6

	str	n	K	ans
→	1234	4	4	""
→	234	3	4	1

fact = 6

idx = K / fact = 4 / 6 = 0

1234	3124
1243	3142
1324	3214
1342	3241
1423	3412
1432	3421
2134	4123
2143	4132
2314	4213
2341	4231
2413	4312
2431	4321

n = 3

K = 3

123

132

213

231

312

321

	str	n	K	ans
→	123	3	3	""
→	13	2	1	2
→	3	1	1	21

$fact = (2-1)! = 1! = 1$

$idx = \frac{K}{fact} - 1 = \frac{1}{1} - 1 = 0$

$n = 4$

$K = 2$

Str	n	K	ans
1234	4	2	1111
234	3		1

fact = 6

idx = $\frac{2}{6} = 0$

```
q = 1;
if (K%fact == 0) q = fact
else (K>fact) q = K%fact
```

Next Lecture

Advanced Sorting Algorithms