Computer Science & IT

ALGORITHMS

Algorithm

Lecture No. 03

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Recap of Previous Lecture

Topic

TC

Topic

Topic

Topics to be Covered

- Topic
- Topic
- Topic

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Join

@RBRSIRPW

Inspiring Stories : Girish Badragond

Background: A farmer from rural Karnataka. Wanted to help visually impaired people work the land.

Education: B. Tech. from a local college.

Achievements: Created the Blind Farming Technology, a tool with sensors that tells you soil moisture, nutrition, and temperature via audio.

Impact: Lets blind farmers grow crops confidently, bringing dignity and independence back to their fields.

Inspiring Stories : Ashok Gorre

Background: From a poor farming family in Telangana, saw how hard planting and weeding was.

Achievements: Built simple, low-cost tools for sowing, reaping, and weeding. Co-founded Rural Rise Agrinery to scale his tools.

Impact: Helped small farmers save labor and time, making farming easier and cheaper.

Inspiring Stories : Pradeep Kumar

Background: A farmer in Haryana worried about his solar panels being stolen.

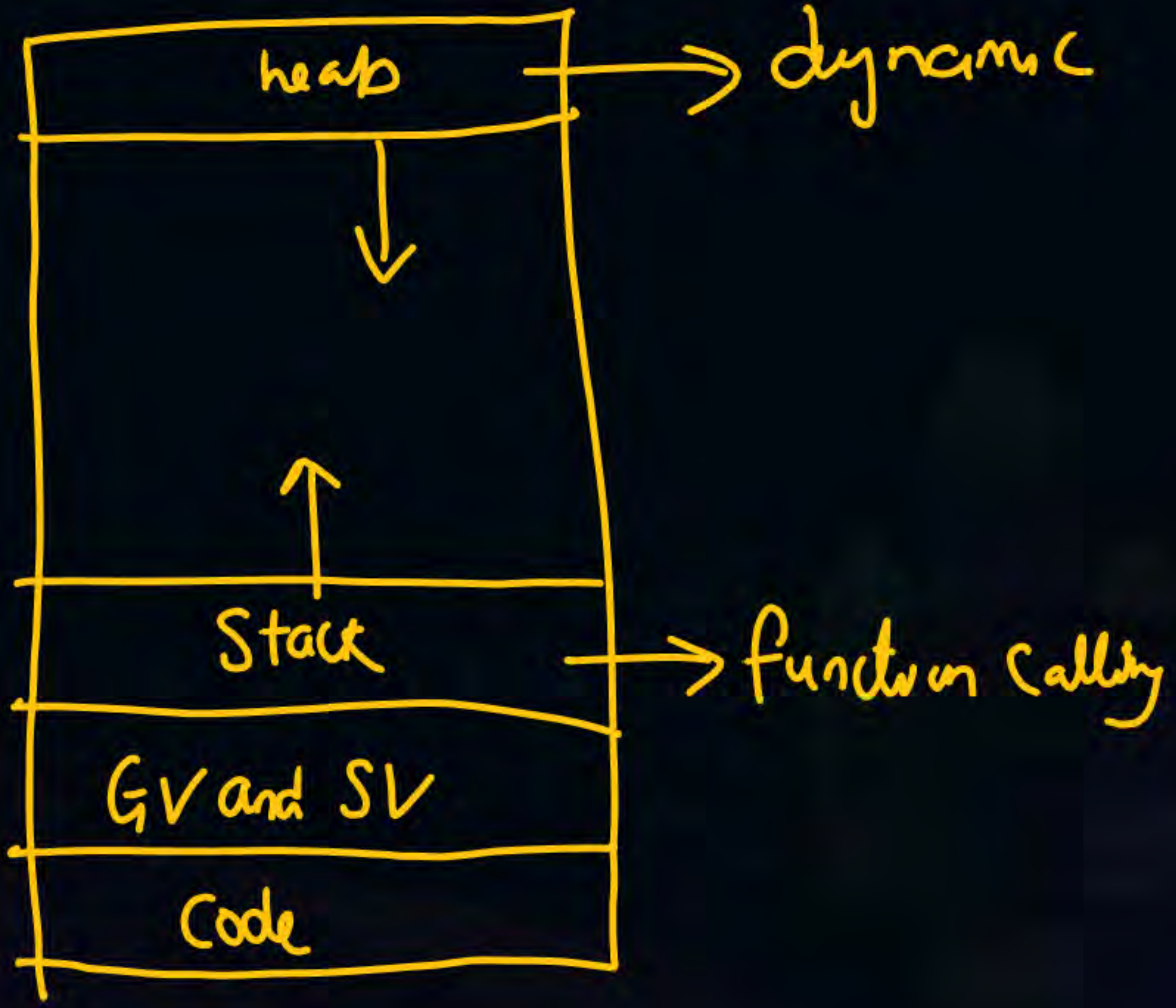
Education: Local farmer, hands-on inventor.

Achievements: Invented a mobile solar panel trolley, so panels can be moved and stored safely. Offers free servicing for a year through his startup TG Solar Pumps.

Impact: Makes solar energy safer and easier for poor farmers, lowering their risk and maintenance burden.

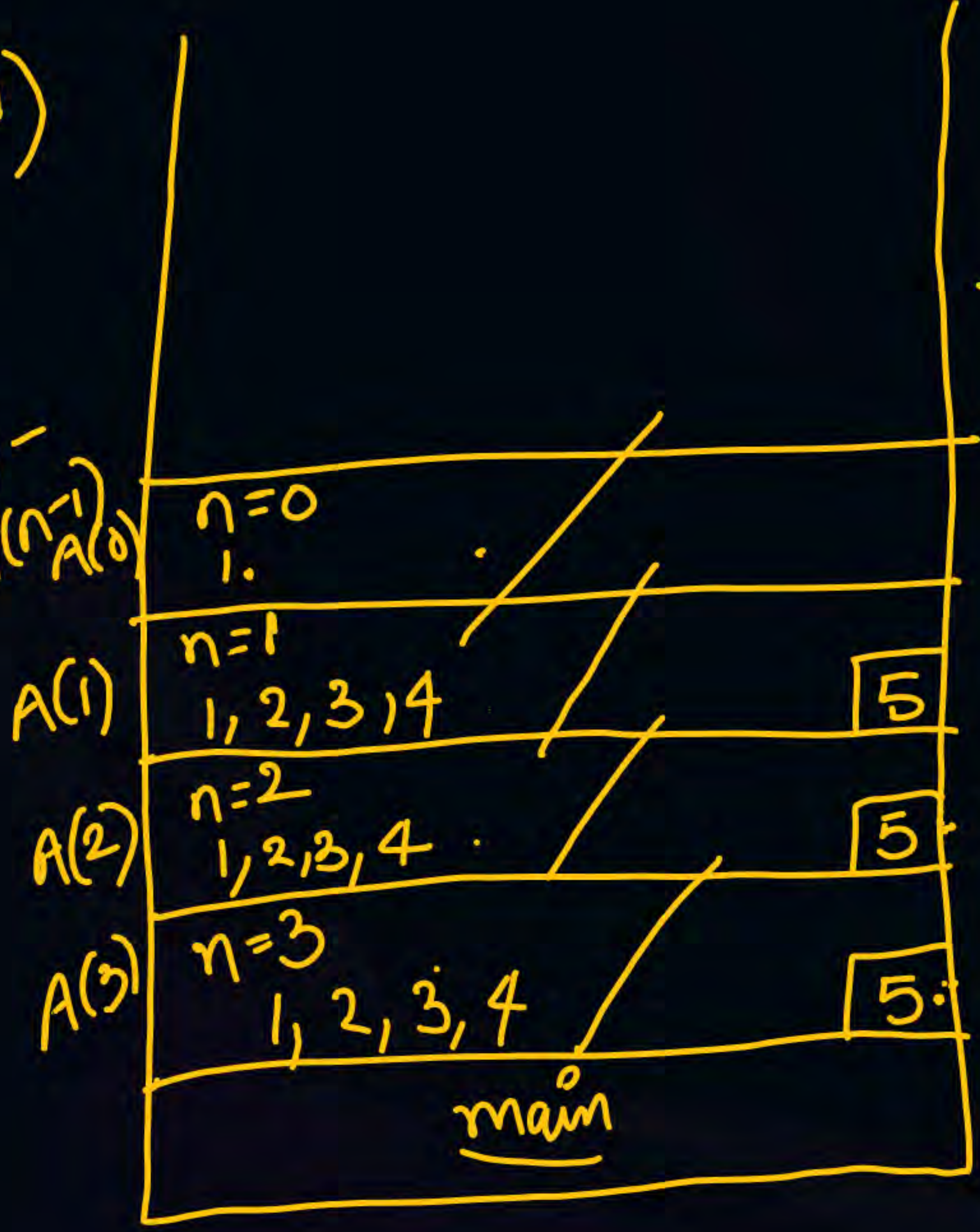
Recursion:-

Process



$A(n) \Rightarrow T(n)$

```
{ 1 if(n>0)
  2 {
  3     Pf(n-1)
  4     A(n-1)      = T(n-1)
  5 }
}
```



$$T(n) = T(n-1) + c, \quad n>0$$
$$= 1, \quad n<=0$$

$SC = 4 * \text{Stack frame}$

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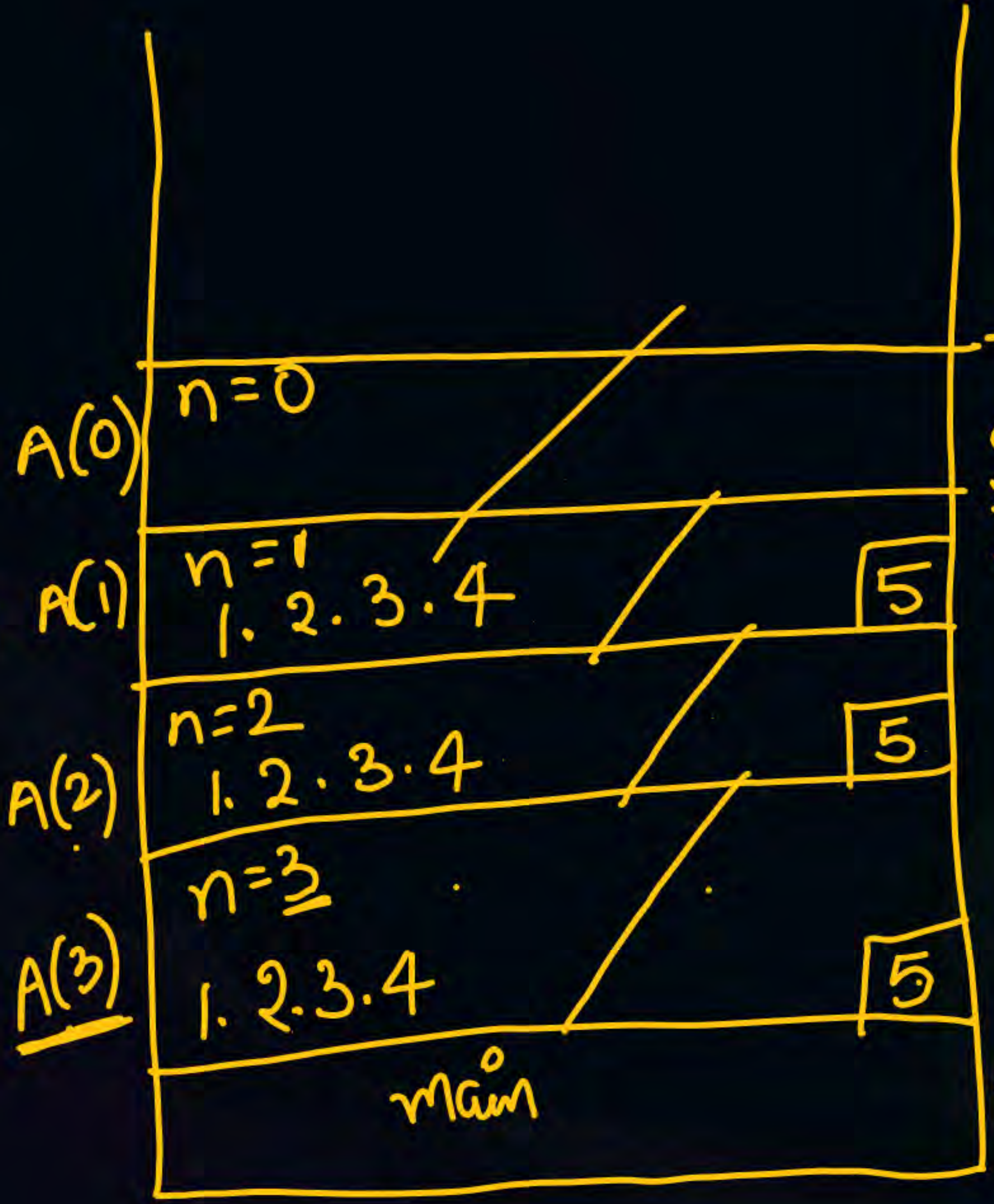
a) Repeat

b) CRC

$A(n) \Rightarrow T(n)$

```
{
1  if (n>0) ①
2  {
3     Pf(n-1) ①
4     A(n-1) ⇒ T(n-1)
5  }
}
```



$T(n) = T(n-1) + c, \; n > 0$

$= O(1), \; n <= 0$

$S(n) = O(n)$

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a) one mole example

b) enough

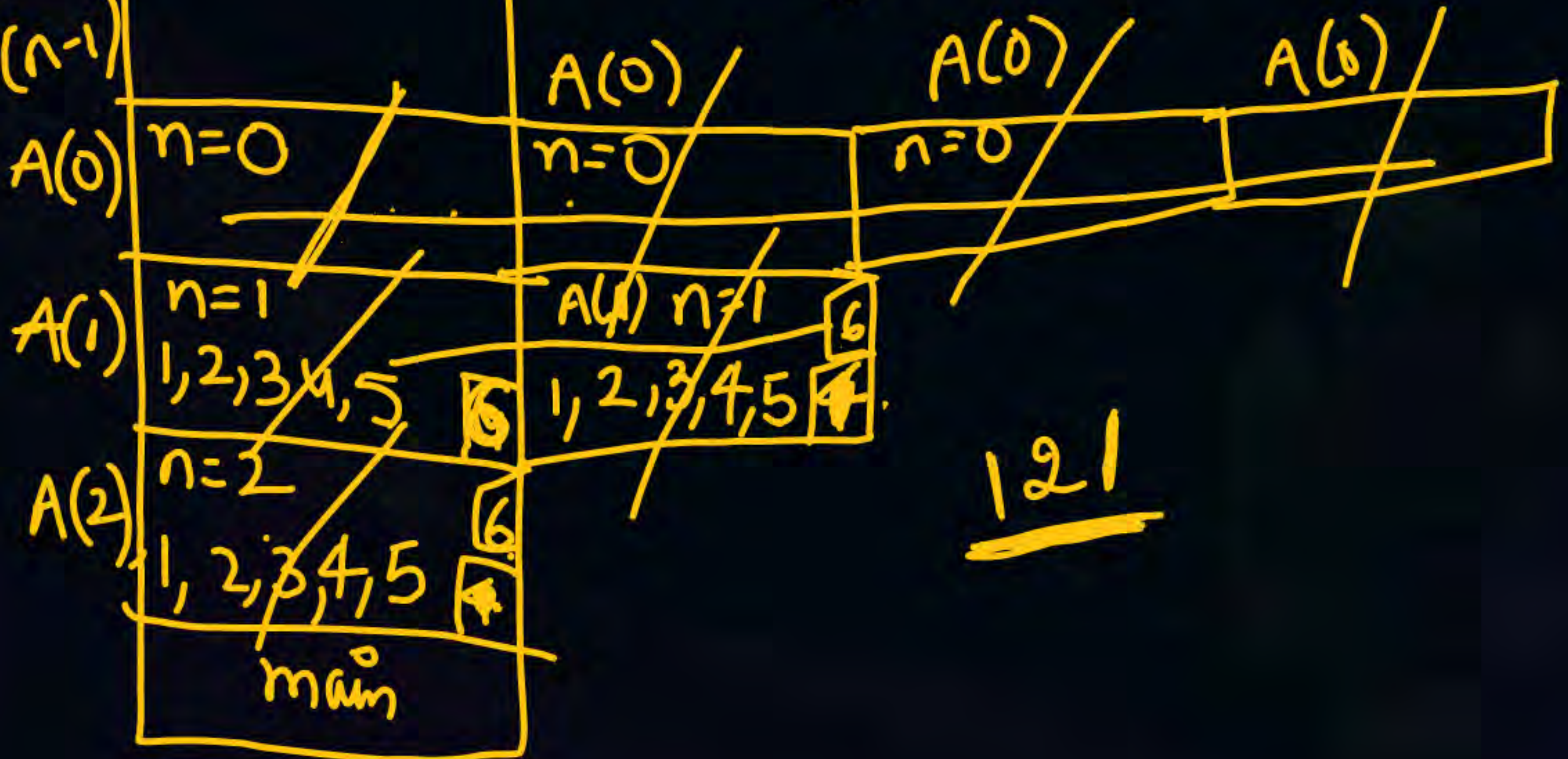
$A(n) \Rightarrow T(n)$ $\quad A(2)$

```
{
1 if(n>0) - O(1)
2 {
3   A(n-1) => T(n-1)
4   pf(n) - O(1)
5   A(n-1) => T(n-1)
6 }
7 }
```

$$T(n) = 2 * T(n-1) + C \quad \text{if } n>0$$
$$= C \quad \text{if } n \le 0$$

$$S(n) = O(n)$$

✓



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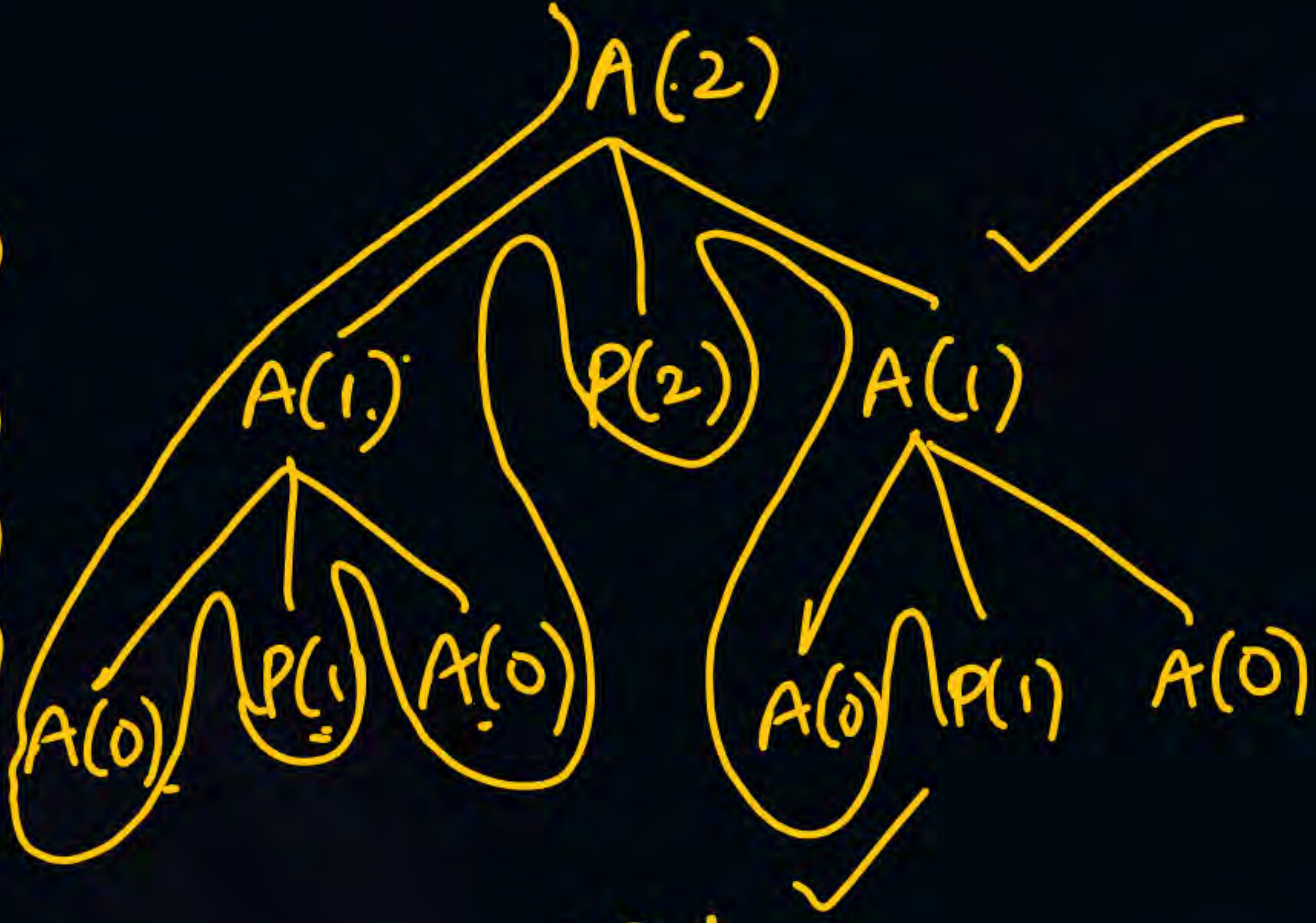
```
A(n)
{ if (n>0)
  { 1 A(n-1)
    2 Pf(n)
    3 A(n-1)
  }
}
```



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In order to find time complexity of Recursive function, we use recurrence relations

$A(n) \Rightarrow T(n)$

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

```
{ if(n>0)
  {
    A(n-1) + A(n-2)
  }
  else
    return 1
}
```

$A(n-1) \Rightarrow T(n-1)$, $A(n-2) \Rightarrow T(n-2)$

methods to solve recurrance relations:-

1) Substitution method ✓
2) Recursive tree ✓
3) master theorem ✓

$T(n) = aT(n/b) + O(n) \longrightarrow$ masters

$T(n) = T(n-1) + T(n-2) \longrightarrow$ Recursive tree

$T(n) = 2\underbrace{T(n-1)}_{\text{one term}} + K \longrightarrow$ Substitution

Substitution method :-

$$T(n) = \begin{cases} 1 & \text{if } n = 1 \\ T(n-1) + n & \text{if } n > 1 \end{cases}$$

$T(n) = T(n-1) + n \rightarrow (1)$

$T(n-1) = T(n-2) + n-1 \rightarrow (2)$

$T(n-2) = T(n-3) + n-2 \rightarrow (3)$

Substitute (2) in (1)

$T(n) = T(n-2) + (n-1) + n \rightarrow (4)$

Substitute (3) in (4)

$T(n) = T(n-3) + (n-2) + (n-1) + n$

k times

$T(n) = T(n-k) + (n-(k-1)) + (n-(k-2)) + \dots + (n-2) + (n-1) + (n)$

$n-k = 1 \Rightarrow k = n-1$

$T(n) = T(1) + (n-(n-1-1)) + (n-(n-1-2)) + \dots + (n-2) + (n-1) + n$

$= 1 + 2 + 3 + 4 + \dots\dots (n-2) + (n-1) + n$

$= \frac{n(n+1)}{2} = O(n^2)$

$\Omega(n^2)$

$\Theta(n^2)$

$T(n)$

$T(n-1)$

$T(n-2)$

$T(n-k)$

$C = O(n)$

2 in 1

$T(n) = T(n-2) * n-1 * n \rightarrow 4$

3 in 4

$T(n) = T(n-3) * (n-2) * (n-1) * (n)$

$\Big\{$ k times

$T(n) = \underline{T(n-k)} * (n-(k-1))(n-(k-2)) \ldots \times (n-1) * n$

assume $\underline{n-k=0} \Rightarrow k = n \Rightarrow O(n)$ ✓

$= 1 * 1 * 2 * \ldots (n-1) * n$

$= n!$ $\quad \underline{O(n!)} = \underline{O(n^n)}$ ✓

$\Omega(n!)$

$\Theta(n!)$

$$T(n)=\begin{cases}0 & \text{if } n=0\\ T(n-2)+n^2 & \text{if } n>0\end{cases}$$

$T(n)=T(n-2)+n^2 \rightarrow (1)$

$T(n-2)=T(n-4)+(n-2)^2 \rightarrow (2)$

$T(n-4)=T(n-6)+(n-4)^2 \rightarrow (3)$

(2) in (1)

$T(n)=T(n-4)+(n-2)^2+n^2 \rightarrow (4)$

(3) in (4)

$T(n)=T(n-6)+(n-4)^2+(n-2)^2+n^2$

k times

$T(n)=\underline{T(n-2k)}+(n-(2k-2))^2+\cdots+(n-2)^2+n^2$

let $n-2k=0 \Rightarrow k=(n/2)$ $\quad SC=O(n)$

$T(n)=T(0)+2^2+4^2+6^2+8^2+\cdots n^2$

$=(2\times1)^2+(2\times2)^2+(2\times3)^2+\cdots(2\,n/2)^2$

$=2^2(1^2+2^2+3^2+\cdots+(n/2)^2)$

$=2^2\left(\frac{(n/2)(n/2+1)(2n/2+1)}{6}\right)$

$=O(n^3)$

$\Omega(n^3)$

$\Theta(n^3)$

Gate: 2016 :- $= \log 2*1 + \log 2*2 + \log 2*3 + \cdots + \log_2 2*n/2$

$= \log 2 + \log 1 + \log 2 + \log 2 + \log 2 + \log 3 + \cdots + \log 2 + \log n/2$

$= \frac{n}{2} \log_2 2 + (\log 1 + \log 2 + \log 3 + \cdots + \log n/2)$

$\frac{n}{2} + \log 1 \cdot 2 \cdot 3 \cdot 4 \cdots n/2$

$= \frac{n}{2} + \log \frac{n}{2}! = O(\log n!) = O(\log n^n)$

$= O(n \log n)$

$= \Omega(n \log n)$

$= \Theta(n \log n)$

$n! = 1 \cdot 2 \cdot 3 \cdots n$

$n^n = n \cdot n \cdot n \cdots n$

$$\left\{ k \text{ times} \right.$$

$$T(n) = \underline{T\left(\frac{n}{2^k}\right)} + kc$$

assume $\frac{n}{2^k} = 1 \Rightarrow k = \log n$ sc

$$T(n) = 1 + \log n \times c$$

$$T(n) = O(\log_2 n)$$

$$= \Omega(\log_2 n)$$

$$= \Theta(\log_2 n)$$

$$T(n) = \begin{cases} 1 & ; n=1 \\ T(n/2)+n & ; n>1 \end{cases}$$

THANK - YOU