Topics to discuss

Solve $T(n) = \begin{cases} 1 & , \text{if } n = 1 \\ T(n-1) + n(n-1) & , \text{if } n \geq 2 \end{cases}$

by substitution Method

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Problem 3:

$$T(n) = \begin{cases} 1 & , \text{if } n = 1 \\ T(n-1) + n(n-1) & , \text{if } n \geq 2 \end{cases}$$

$T(n) = 1 \quad , n = 1$

$T(1) = 1.$

Solution :- $T(n) = T(n-1) + n(n-1)$ —(1)

Assume , $n - K = 1$

$K = n - 1$

Put, $n \rightarrow n-1$

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

Put, $n \rightarrow n-2$

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

Substitute in eqn. —(1)

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

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

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

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

$\vdots$

$$= T(n-K) + (n-K)(n-K+1) + (n-K+1)(n-K+2) + \cdots\cdots + (n-1)n$$

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$$T(n) = T(n-K) + (n-K)(n-K+1) + (n-K+1)(n-K+2) + \cdots + (n-1)n$$

$$= T(1) + 1\cdot 2 + 2\cdot 3 + \cdots + (n-1)n.$$

$$= 1 + \sum_{i=1}^{n} i(i-1)$$

$$= 1 + \sum_{i=1}^{n} i^2 - \sum_{i=1}^{n} i$$

$$= 1 + \frac{n(n+1)(2n+1)}{6} - \frac{n(n+1)}{2}$$

$$T(n) \approx O(n^3)$$

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