


Practice

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Question 1 [5 Marks]

What is the value of following recurrence.

$$T(n) = T(n/4) + T(n/2) + cn^2$$

$$T(1) = c$$

$$T(0) = 0$$

Where c is a positive constant

 $O(n^3)$  $O(n^2)$

C

 $O(n^2 \text{ Log} n)$

D

 $O(n \text{ Log} n)$

Explanation

Following is the initial recursion tree for the given recurrence relation.

$$\begin{array}{ccc} & cn^2 & \\ & / \quad \backslash & \\ T(n/4) & & T(n/2) \end{array}$$

If we further break down the expression $T(n/4)$ and $T(n/2)$, we get following recursion tree.

$$\begin{array}{cccc}
 & & cn^2 & \\
 & / & & \backslash \\
 c(n^2)/16 & & & c(n^2)/4 \\
 / & \backslash & / & \backslash \\
 T(n/16) & T(n/8) & T(n/8) & T(n/4)
 \end{array}$$

Breaking down further gives us following

$$\begin{array}{ccccccc}
 & & & & cn^2 & & \\
 & & & & / & & \backslash \\
 & & & & c(n^2)/16 & & c(n^2)/4 \\
 & & & & / & \backslash & / & \backslash \\
 c(n^2)/256 & c(n^2)/64 & c(n^2)/64 & c(n^2)/16 & & & & \\
 / & \backslash & / & \backslash & / & \backslash & / & \backslash
 \end{array}$$

To know the value of $T(n)$, we need to calculate sum of tree nodes level by level. If we sum the above tree level by level, we get the following series

$$T(n) = cn^2 + 5(n^2)/16 + 25(n^2)/256 + \dots$$

The above series is geometrical progression with ratio $5/16$

To get an upper bound, we can sum the above series for infinite terms. We get the sum as $(n^2) / (1 - 5/16)$ which is $O(n^2)$

Refer following video lecture for more details.

http://www.youtube.com/watch?v=whjt_N9uYFI (http://www.youtube.com/watch?v=whjt_N9uYFI)

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