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HANDS ON - 6

Q3 Mathematically derive the average runtime complexity of the non-random pivot version of quicksort.

Ans Recurrence relations is used in order to derive the average runtime complexity of the non-random pivot version of quicksort.

The recurrence relation is

$$T(n) = T(p-1) + T(n-p) + \Theta(n)$$

Where,

$T(n)$ = time complexity of quicksort for an array of size $n$.

$p$ = position of the pivot element after partitioning the array.

$T(p-1)$ = time to sort left subarray (elements smaller than pivot)

$T(n-p)$ = time to sort the right subarray (elements greater than the pivot).

$\Theta(n)$ = represents the time to partition the array.

Let's consider the average case, where we assume that each element is equally likely to the pivot. In this case, $p$ is on average $n/2$

The recurrence relation becomes:

$$T(n) = 2T(n/2) + \Theta(n)$$

By applying Master Theorem, we can determine the average runtime complexity:

$$\boxed{T(n) = \Theta(n \log n)}$$