Hands on 6

2. Data, plot against best, worst and avg cases of Quick Sort

size of n	Best Case	Worst Case	avg case
10	0.000026	0.000024	0.000052
50	0.000532	0.000391	0.000058
100	0.000989	0.000797	0.000137
500	0.004608	0.006874	0.001105
1000	0.008094	0.009249	0.001589
10000	0.027368	0.027996	0.003812

3. in below page

3. mathematically derive the avg runtime complexity of the non-random pivot version of quick sort

As. Recurrence relation is

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

where

$T(n)$ - time complexity of quicksort for an array of size n
p - position of the pivot element after partitioning the array
$T(p-1)$, $T(n-p)$ - time to sort left & right subarray less & great than elements than the pivot element
$O(n)$ - represents time array

Considering avg case

$$T(n) = 2T(n/2) + O(n)$$

here $2T(n/2)$ represents avg time for recursiveeally

so $T(n) = O(n) + 2 \cdot T(n/2)$

$$T(n) = O(n) + 2\left(O\left(\tfrac{n}{2}\right) + 2 \cdot T\left(\tfrac{n}{4}\right)\right)$$

$$T(n) = O(n) + 2\left(O\left(\tfrac{n}{2}\right)\right) + 4\,T\left(\tfrac{n}{4}\right)$$

$$\therefore T(n) = k \cdot O\left(\tfrac{n}{2^k}\right) + 2^k \cdot T\left(\tfrac{n}{2^k}\right)$$

$\therefore$ Runtime complexity of quicksort for avg case is $O(n \log n)$

$$T(n) = \Theta(n \log n)$$