DAA

Handson-3

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1) function $x = f(n)$

$x = 1;$

for $i = 1 : n$

for $j = 1 : n$

$x = x + 1;$

1) find the runtime of the algorithm mathematically?

function $X = f(x)$

$x = 1;$

for $i = 1 : n$

for $j = 1 : n.$

$$\sum_{i=1}^{n} \sum_{j=1}^{n+1} 1$$

$x = x + 1;$

$$\sum_{i=1}^{n} \sum_{j=1}^{n+1} = 1$$

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

=> Simplify the eqn we get.

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

The dominant term here is n^2, so runtime is determined by n^2

=> Runtime is $O(n^2)$.

2)
For calculating the time taken for the function $f(n)$, we used Values of n from small to large. The Values plotted with n on x axis & time taken on y-axis.

<u>interpretation of plotting:</u>

- from the plot we can see a clear trend in quadric can as the values of n increases. showing $O(n^2)$ complexity.
- The fitted curve is polynomial which is quadratic that closely matches the timing points.

3) Upper Bound: (Big-O): The upper bound on the graph is shown by the Blue dashed line which is slightly above the fitted curve. This indicates that the time complexity is $O(n^2)$.

Lower Bound: (Big Omega): The lower bound is represented by orange dotted line which is below fitted curve, Indicating the the time complexity is $\Omega(n^2)$.

Tight bound: (Big Theta):
Since both upper & lower bound grow at the same rate
$T(n)$ is $\theta(n^2)$

4) In the code no is a vertical dashed line (yellow) at 200.
This is a value of n where the function starts to follows the quadratic trend. This can be visualized by zooming in on the plot & identifying the point where trend is minimal.

4)
```
f x = f(n)
  x=1;
  y=1;
  for i =1:n
     for j=1:n
        x=x+1;
        y=i+j;
```

in the above Psuedocode $y = i + j$ is added in inner loop. This is a constant-time operation $O(1)$. So it will increase The Overall time taken Per iteration. But the Overall time Complexity remains same which is $O(n^2)$.

5) No, adding $y = i + j$ will not affect the results from the runtime analysis. Since operation is $O(1)$. runtime will be same as its $O(n^2)$.