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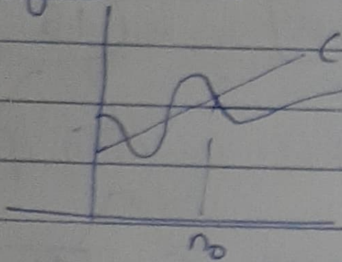
Tutorial-1

Q1 **Asymptotic notations**

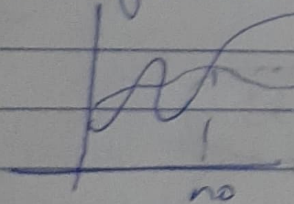
They are mathematical ~~of~~ notations used to describe the running time of an algo when input tends towards a particular value or limiting value.
There are mainly 3 types:

- **Big O** - It represents upper bound



$f(n) = O(g(n))$
There exist +ve const. c & n_0
such that $0 \le f(n) \le cg(n)$
for all $n \ge n_0$

Omega - It represents lower bound
$\Omega\, g(n) = f(n)$ there exist +ve const c & n_0 such that $0 \le cg(n) \le f(n)$
for all $n \ge n_0$



Theta notation - It represent lower & upper bound of running time of algo
$f(n) = \Theta g(n)$ there exist +ve const c_1, c_2 & n_0 such that $0 \le c_1 g(n) \le f(n) \le c_2 g(n)$
for all $n \ge n_0$

Q2 for (i=1 to n) { i = i * 2 }

i	1	2	4	8 --	2^k
val	2^0	2^1	2^2	2^3	n

$2^k = n$

$k \log_2 2 = \log_2 n$

$k = \log n$

$T.C = O(\log n)$

Q3 $T(n) = \begin{cases} 3T(n-1, & n > 0 \\ 1 \end{cases}$

By forward

$T(n) = 3T(n-1)$, $T(0) = 1$

$T(1) = 3T(1-1)$

$= 3T(0)$

$= 3$

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

$= 3T(1) = 3 \times 3 = 3^2$

$T(3) = 3T(3-1)$

$= 3T(2) = 3 \times 3^2 = 3^3$

$\vdots$

$T(n) = 3^n$

$T.C = O(3^n)$

Q4 $T(n) = \begin{cases} 2T(n-1) - 1, & n > 0 \\ 1, & n = 0 \end{cases}$

$T(0) = 1$

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

$= 2T(0) - 1$

$= 2 - 1 = 1$

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

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

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

$T(n) = 1$
$T.C = O(1)$

Q5
```
int i = 1, s = 1
while (s <= n)
{ i++;
  s = s + i;
  print ("#");
}
```
let for k iteration
$s(k) = 1 + 2 + 3 + \dots + k = \frac{(k+1)^* k}{2}$
$\frac{(k+1)k}{2} > n$
$k = O(\sqrt{n})$
$TC = O(\sqrt{n})$

Q6
```
fun (int n)
{ int i, count = 0;
  for (i = 1; i * i <= n; i++)
  { c++; }
}
```
for $S(k) = 1^2 + 2^2 + 3^2 + \dots + k^2 <= n$
$= \frac{k(k+1)(2k+1)}{6} \leq n$
$= 2k^3 + 3k^2 + k \leq n$
$TC = \sqrt[3]{n}$

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Q7 fun(int n)
{ int i, j, k, z=0
for (i = n/2 ; i<=n; i++)
for (j= 1; j <= n; j = j*2)
for (k=1; k<=n; k=k*2)
count ++;

Outer loop run n/2 times
Second loop runs log n times
Third loop runs log n times

$T.C = \frac{n}{2} * \log n * \log n$

$T.C = O(n(\log(n)^2)$

Q8 fun(int n)
{ if (n==1) return;
for (i=1 to n)
for (j=1 to n)
print ("*")
fun(n-3)
}

for 1st loop n times
for 2nd loop n times

$TC = n * n = O(n^2)$

Q9 fun (int n)
for (i=1 to n)
for (j=1; j<=n; j=j+i)
print ("*");

outer loop n times
inner loop log n times

$TC = n * \log n$
$= O(n \log n)$

Q10 n^k & c^n
$n^k = O(c^n)$