Problem-5: Dry Run & Analyse: Time and Space Complexity.

1. Dry run the code for n=4. How many times is * printed? What is the time complexity.?

```
void printTriangle(int n){
  for(int i=0 ; i<n; i++)
     for (int j=0; j<=i ; j++).
      System.out.print ("*");

}
```

Dry Run:-

```
i = 0; j=0
*
i=0, j-1 // false
*
i=1, j-0
*
*
i-1, j-1
*
**
i=1, j=2 // false.
*
**
i-2, j-0
*
**
*
i=2, j-1
*
**
**
```

```
i=2, j=2
*
**
***
i=2, j=3 //false
*
**
***
*
i-3, j-1
*
**
***
**
i-3, j-2
*
**
***
***
i-3, j-3
*
**
***
****
```

```
i-3, j-4 //false
*
**
** *
** **
```

star printed :- 10 star's are printed as inner loop runs (n(n+1))/2 times across all iterations.

Time complexity :- outer loops runs n times and inner loop runs (n(n+1))/2 across all iterations times which lead to time complexity of $O(n^2)$.

Q.2. Dry run for n=8. Whats the number of iterations? Time complexity?

```
void printPattern (int n){
    for (int i=1, i<=n; i*=2)
        for (int j=0; j<n; j++)
            System.out.println (i+","+j);
}
```

Dry run :-

outer loop iterations.	Inner loop iterations.
1, i=1 →	j=0, j=1, j=2, j=3, j=4, j=5, j=6, j=7.
2, i=2 →	j=0, j=1, j=2, j=3, j=4, j=5, j=6, j=7.
3, i=4 →	j=0, j=1, j=2, j=3, j=4, j=5, j=6, j=7.
4, i=8 →	j=0, j=1, j=2, j=3, j=4, j=5, j=6, j=7.
5, i=16 →	// False.

Number of iterations = 32.

Time complexity :- The number of iterations of the outer loop is approximately $\log_2 n+1$ times. For each iteration of the outer loop, the inner loop runs exactly n times. Therefore, time complexity of this program: $O(n \log n)$.

Q.3. Dry run for n=20. How many recursive calls? what values are printed.?

```
void recHalf (int n){
    if (n<=0) return;
    System.out.println (n+" ");
    recHalf (n/2);
}
```

Dry Run :

```
n = 20 ....  20
n = 10 ....  20 .10
n = 2  ....  20  10  5
n = 1  ....  20  10  5  2
n = 0  ..... //false.
```

Final output :

20 .10., 5 2 1

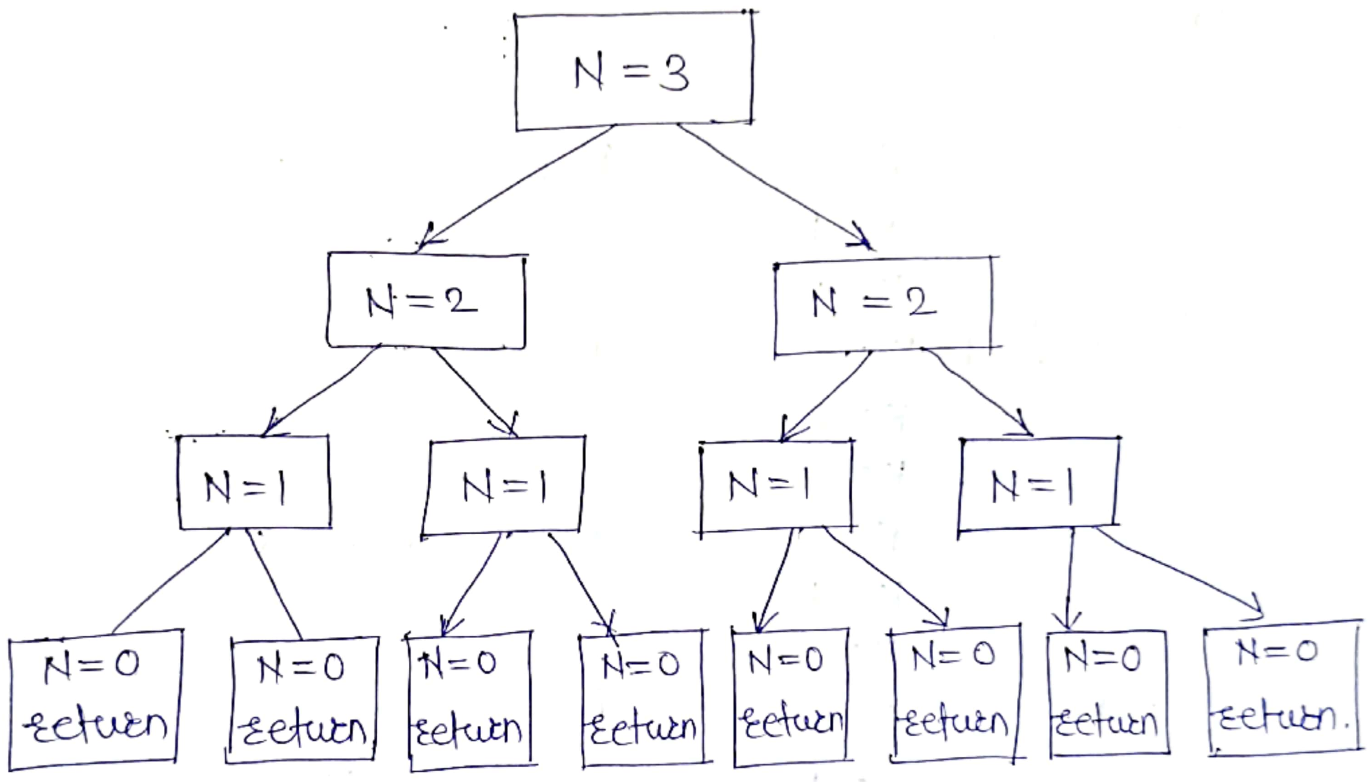
Number of recursive calls : 6

Time complexity: $O(\log_2 n)$.

Q.4. Dry run for n = 3. How many total calls are made ? what's the time complexity. ?

```
Void fun (int n) {
    if (n == 0) return;
    fun (n-1);
    fun (n-1);
}
```

Dry Run :



Number of recursion call made : 8

Time Complexity :- This recursive function makes two recursive calls at each step, resulting in ~~is~~ exponential growth. The time complexity is $O(2^n)$ because at each level, the number of calls doubles.

Q.5 Dry run for n=3. How many total iterations? Time complexity?

```
void tripleNested (int n) {
    for (int i=0; i<n; i++)
        for(int j=0; j<n; j++)
            for(int k=0; k<n; k++);
              System.out.println (i+j+k);
}
```

Dry run;

```
i=0  j=0  k=0          i=1  j=2  k=0
          k=1                    k=1
          k=2                    k=2
i=0  j=1  k=0          i=2  j=0  k=0
          k=1                    k=1
          k=2                    k=2
i=0  j=2  k=0          i=2  j=1  k=0
          k=1                    k=1
          k=2                    k=2
i=1  j=0  k=0          i=2  j=2  k=0
          k=1                    k=1
          k=2                    k=2
i=1  j=1  k=0
          k=1
          k=2
```

Number of total iterations = 27

Time complexity : Outer loop executes n times, 1st inner loop runs n*n i.e. n^2 times and 2nd inner loop executes n*n*n i.e. $O(n^3)$