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("*");
}
```

Ans: -

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=0
*
**
***
*
i=3, j=1
*
**
***
**
i=3, j=2
*
**
***
***
i=3, j=3
*
**
***
****
i=3, j=4  //false
*
**
***
****
```

Stars Printed: 10 stars are printed as inner loop runs (n(n+1))/2 times across all iterations.

Time Complexity:

Outer loop runs n times and inner loop runs (n(n+1))/2 across all iterations times which lead to time complexity of **$O(n^2)$**.

2. Dry run for n = 8. What's 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);
}
```

Ans: -

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)**.

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

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

Ans: -

Dry Run:

```
n=20 20
n=10 20 10
n=5  20 10 5
n=2  20 10 5 2
n=1  20 10 5 2 1
n=0  //False

Final Output:
20 10 5 2 1
```

Number of recursive calls: 6

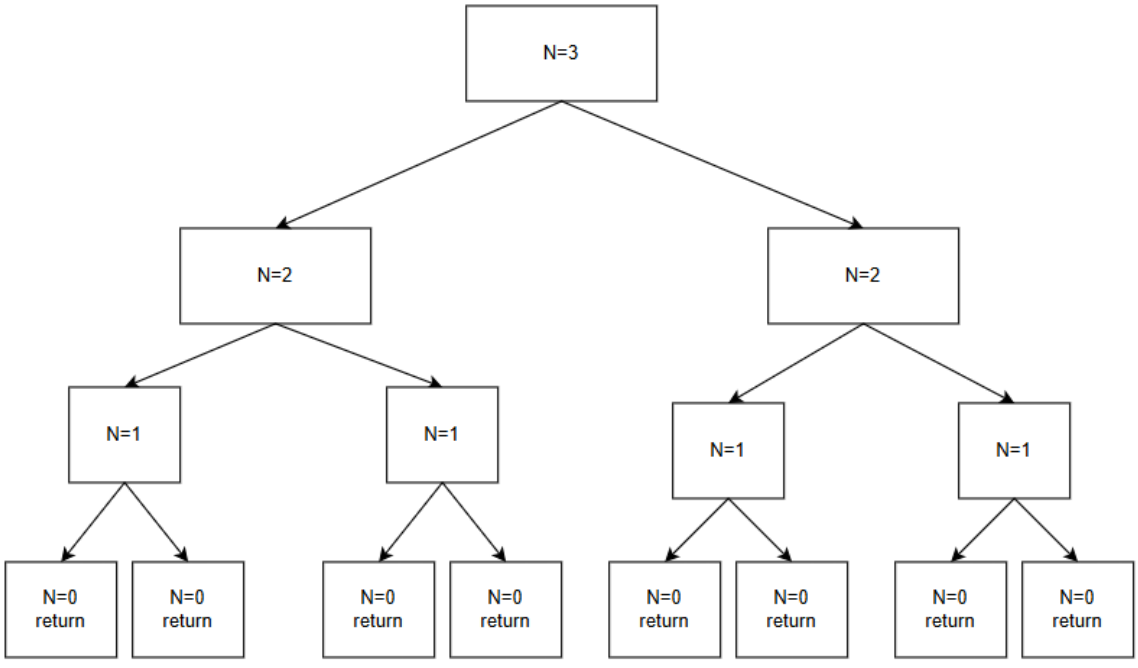
Time Complexity: $O(\log_2 n)$

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);
}
```

Ans: -

Dry Run:



Number of recursion calls made: 8

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

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);
}
```

Ans: -

Dry Run:

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

```
i=1 j=2 k=0
        k=1
        k=2
i=2 j=0 k=0
        k=1
        k=2
i=2 j=1 k=0
        k=1
        k=2
i=2 j=2 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. **$O(n^3)$**.