Triangle Task

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BRUTEFORCE PSEUDOCODE

```
Algoritm isTriangular(A[], N) {
    if (N < 3)
        return 0;

    for i = 0 to N - 2 step 1 do   ---> N-1
    {
        for  j = i + 1 to N - 1 step 1 do ---> N-i-1
        {
            for k = j + 1 to N step 1 do   ---> N-j
             {
                if (A[i] + A[j] > A[k] && A[j] + A[k] >
A[i] && A[k] + A[i] > A[j]) then ---> 1
                {
                    return 1;
                }
             }
        }
    }
    return 0; ---> 1
}


The WorstCase TimeComplexity = O (n³)
The BestCase  TimeComplexity = O (1)
The AverageCase TimeComplexity = O (n³)
```
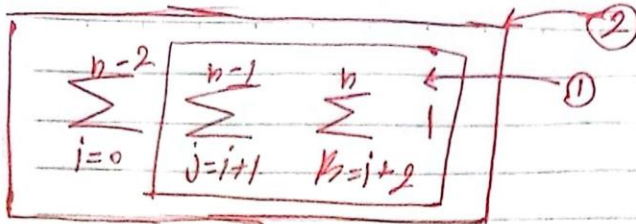
BRUTEFORCE ANALYSIS

$$\boxed{\sum_{i=0}^{n-2} \boxed{\sum_{j=i+1}^{n-1} \sum_{k=j+2}^{n} i \quad \textcircled{1}}} \quad \textcircled{2}$$

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

$$= (n-1)(n-1-i) - \frac{(n-1)(n-1+i+1)}{2}$$

$$= \frac{2(n-1)(n-1-i) - (n-1)(n-1+i+1)}{2}$$

$$= \frac{2[n^2-n-(n-1)-(ni-i)] - n^2-n+in-i}{2}$$

$$= \frac{2n^2-2n-2n+2-ni+i-n^2-n+in-i}{2}$$

$$= \frac{n^2-5n+2}{2} \qquad = n^2-n \text{ (by ignoring constants)}$$

$$\textcircled{2} \rightarrow \sum_{i=0}^{n-2} n^2 - \sum_{i=0}^{n-2} n = (n^2)(n-1) - (n)(n-1)$$

$$= n^3-n^2-n^2+n = n^3-2n^2+n$$

$$\boxed{= O(n^3)}$$

MERGESORT RECURRENCE METHOD

```
int isTriangular(int *A, int N) {

    if (N < 3) then ---> n-1
        return 0;

    mergeSort(A, 0, N - 1); ---> n log n

    for i = 0 to N - 2 step 1 do ---> n-1
    {
        if ((long long)A[i] + A[i + 1] > A[i + 2])
            return 1;
    }

    return 0;
}

The T(n) Recurrence Raltion Will be = T(n) = T(n log n) + O(n)

The WorstCase TimeComplexity = O (n log n)
The BestCase  TimeComplexity = O (1)
The AverageCase TimeComplexity = O (n log n)
```

MERGESORT RECURRENCE METHOD ANALYSIS
ITERATIVE METHOD

$$T(n) = 2\,T(n/2) + 2 \cdot \theta(n), \quad T(1) = 1$$

$$T(n) = 2\,T(n/2) + 2 \cdot C \cdot n$$

$$T(n/2) = 2\,T(n/4) + 2 \cdot C \cdot (n/2)$$

$$T(n) = 2\left(2\,T(n/4) + 2 \cdot C \cdot (n/2)\right) + 2 \cdot C \cdot n$$

$$T(n) = 4\,T(n/4) + 2 \cdot C \cdot n + 2 \cdot C \cdot n = 4\,T(n/4) + 4 \cdot C \cdot n$$

$$T(n/4) = 2\,T(n/8) + 2 \cdot C \cdot (n/4)$$

$$T(n) = 4\left(2\,T(n/8) + C \cdot (n/2)\right) + 4 \cdot C \cdot n$$

$$= 8\,T(n/8) + 2 \cdot C \cdot n + 4 \cdot C \cdot n = 8\,T(n/8) + 6 \cdot C \cdot n$$

$$\boxed{T(n) = 2^k\,T(n/2^k) + \sum_{j=0}^{k-1} 2 \cdot C \cdot n}$$

$$T(n/2^k) = T(1)$$

$$n = 2^k \longrightarrow k = \log_2 n$$

$$T(n) = 2^{\log_2 n} + \sum_{j=0}^{\log_2 n - 1} 2 \cdot C \cdot n = n + 2 \cdot C \cdot n \left(\frac{\log_2 n - 1 - 0 + 1}{}\right)$$

$$= n + 2 \cdot C \cdot n \cdot \log_2 n$$

$$\boxed{= O(n \log n)}$$

MERGESORT RECURRENCE METHOD ANALYSIS
MASTER METHOD

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

$\rightarrow a = 2, b = 2, K = 1, P = 0$

$\rightarrow \log_2 2 = 1 = K \longrightarrow \theta(n^K \log^{P+1} n) \longrightarrow \theta(n \log n)$

"Master method"

RECURSIVE ALGORTIHM PSEUDOCODE

```
Algorithm isTriangular(*A,  N,  i,  j, k) {
    if (i >= N - 2) then {
        return 0;
     }
    if (j >= N - 1) then
    {
        return isTriangular(A, N, i + 1, i + 2, i + 3);
    }
    if (k >= N) then
    {
        return isTriangular(A, N, i, j + 1, j + 2);
    }

    if (A[i] + A[j] > A[k] && A[j] + A[k] > A[i] && A[k]
+ A[i] > A[j]) then
    {
        return 1;
    }

    return isTriangular(A, N, i, j, k + 1);
}

The WorstCase TimeComplexity = O (3ⁿ)
The BestCase  TimeComplexity = O (1)
The AverageCase TimeComplexity = O (3ⁿ)
```

The WorstCase TimeComplexity = $O(3^n)$

The BestCase TimeComplexity = $O(1)$

The AverageCase TimeComplexity = $O(3^n)$

RECURSIVE ALGORITHM ANAYLSIS

ITERATIVE METHOD

$$T(n) = T(n-1) + T(n-2) + T(n-3) + C$$

$$T(n) = 3T(n-1) + C$$

$$T(n-1) = 3T(n-2) + C$$

$$T(n) = 3(3T(n-2) + C) + C = 9T(n-2) + 4C$$

$$T(n-2) = 3T(n-3) + C$$

$$T(n) = 9(3T(n-3) + C) + 4C$$

$$T(n) = 27T(n-3) + 13C$$

$$T(n) = 3^k T(n-k) + \sum_{i=0}^{k-1} 3^i C$$

$$n - k = 0 \longrightarrow \boxed{n = k}$$

$$T(n) = 3^n + C \sum_{i=0}^{n-1} 3^i = 3^n + C \cdot \left(\frac{3^n - 1}{3 - 1} \right)$$

$$= 3^n + C \cdot \left(\frac{3^n - 1}{4} \right)$$

$$= O(3^n)$$

RECURSIVE ALGORITHM ANAYLSIS

MASTER METHOD

$$T(n) = T(n-1) + T(n-2) + T(n-3) + C$$

$$T(n) = 3T(n-1) + C$$

$\quad\quad\quad \hookrightarrow a = 3, \; b = 1, \; k = 0$

$\quad\quad\quad \hookrightarrow a > 1 \longrightarrow O(a^n n^k) \longrightarrow O(3^n)$

"Master Method"

THE COMPARISON

TIMECOMPLEXITY	BRUTEFORCE	MERGESORT ALGORTIHM	RECURSIVE ALGORITHM
BESTCASE	$\Omega(1)$	$\Omega(1)$	$\Omega(1)$
WORSTCASE	$O(n^3)$	$O(n \log n)$	$O(3^n)$
AVERAGECASE	$\Theta(n^3)$	$\Theta(n \log n)$	$\Theta(3^n)$

The First Algorithm Take $O(n^3)$ in The Worst Case

The Second Algorithm Take $O(n \log n)$ in The Worst Case

The Third Algorithm Take $O(3^n)$ in The Worst Case

<u>Regarding To The Increaseing of Growth Functions ,</u>
<u>3^n > n^3 > n log n , n log n has the Slowest Growth and</u>
<u>the Fastest Runtime</u>

<u>So The Best Algorithm To Choose Is The ' MergeSort</u>
<u>Algorithm '</u>