

A Time Complexity Question

What is the time complexity of following function fun()? Assume that log(x) returns log value in base 2.

```
void fun()
{
    int i, j;
    for (i=1; i<=n; i++)
        for (j=1; j<=log(i); j++)
            printf("GeeksforGeeks");
}
```

Time Complexity of the above function can be written as $\theta(\log 1) + \theta(\log 2) + \theta(\log 3) + \dots + \theta(\log n)$ which is $\theta(\log n!)$

Order of growth of $\log n!$ and $n \log n$ is same for large values of n , i.e., $\theta(\log n!) = \theta(n \log n)$. So time complexity of fun() is $\theta(n \log n)$.

The expression $\theta(\log n!) = \theta(n \log n)$ can be easily derived from following [Stirling's approximation](#) (or [Stirling's formula](#)).

$$\log n! = n \log n - n + O(\log(n))$$

Please write comments if you find anything incorrect, or you want to share more information about the topic discussed above.

Sources:

http://en.wikipedia.org/wiki/Stirling%27s_approximation

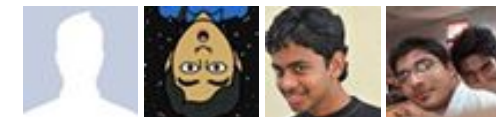
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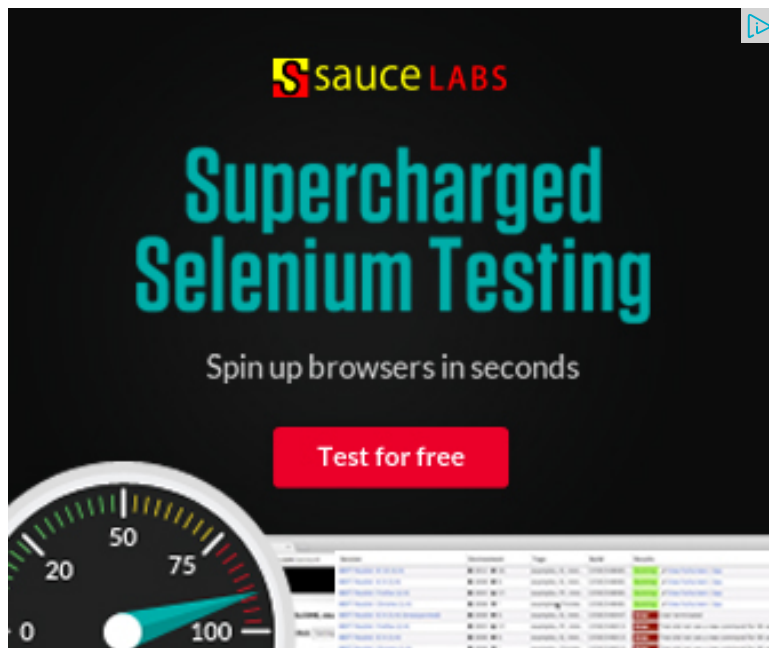
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GeeksforGeeks

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Devesh_D • 3 months ago

One more reason is there for use of quick sort more than merge sort because the cases (best , avg, worst) that means it is not depend on the input type(like quick sort if we are using randomized quick sort then we are sure that there is the time taken by the quick sort is always less than or equal to merge sort.

^ | v .



Prince • 8 months ago

Yes harsh, correct..n! 's upper bound is n^n so will beome $n \log n$.

^ | v .



Har?sh • a year ago

$n! = 1 \times 2 \times 3 \dots n$

$n! \leq n \times n \times \dots n$

$n! \leq n^n$

$\lg n! \leq \lg n^n$

$\lg n! \leq n \lg n$

$T(n) = O(n \lg n)$ (Asymptotic tight upperbound).

1 ^ | v .



Guest → **Har?sh** • 8 months ago

But here they are using Theta notation, but you have used Big-oh notation

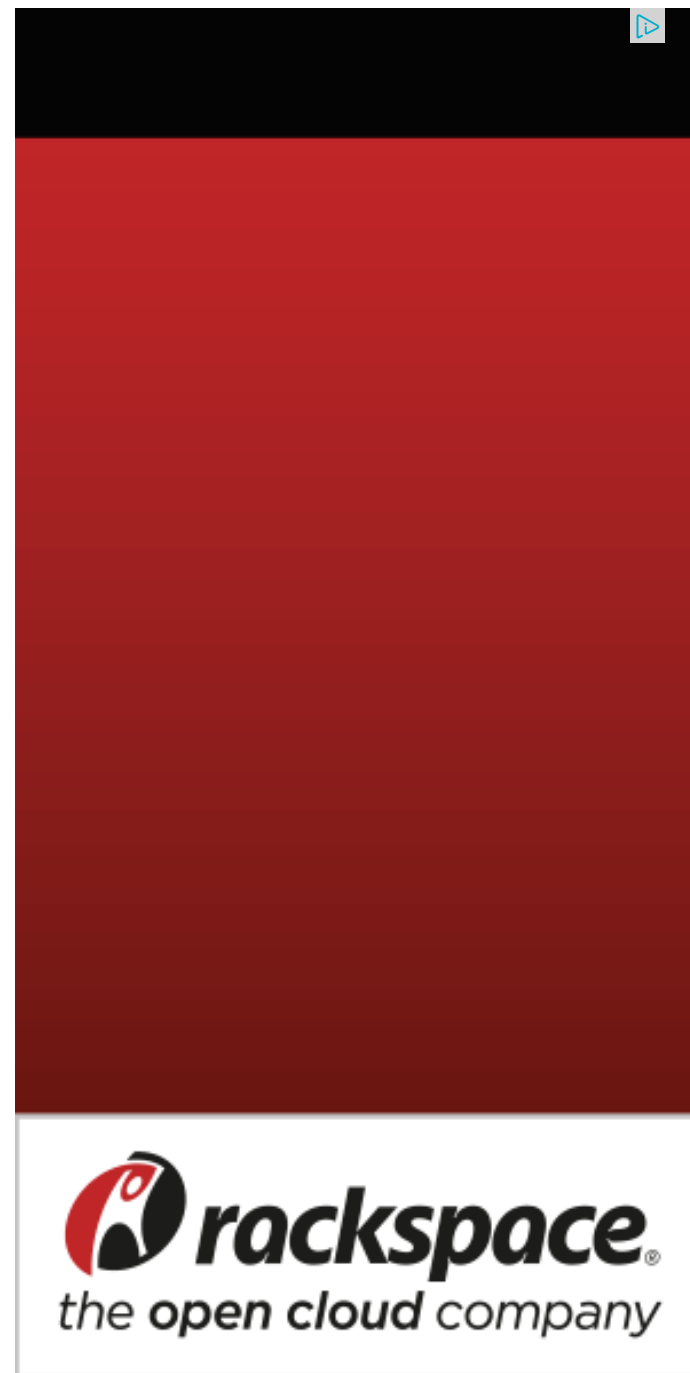
^ | v .



Mihir • a year ago

I might be wrong, but we do not know anything about the complexity of the function. How can we comment about the overall complexity without knowing this? (Unless complexity. Then it is fine.)

2 ^ | v .





Nidhi · a year ago

Shouldn't we consider the first loop "i" while calculating complexity ?

```
/* Paste your code here (You may delete these lines if not writing code)
```

^ | v ·



neha2210 → Nidhi · a year ago

We are indeed considering the first loop also that is why we are adding
As you see if both loops are repeated for n times then the complexity will be it here in a similar manner.

^ | v ·



vivek · 3 years ago

Does it mean that the given code is as efficient as following code?

```
void fun()
{
    int i, j;
    for (i=1; i<=n; i++)
        for (j=1; j<=log(n); j++)
            printf("GeeksforGeeks");
}
```

^ | v ·



Sandeep → vivek · 3 years ago

@vivek: Both codes are of same time complexity as both are asymptotic

705



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take more time in general. As an example, both $2n$ and $10000n$ are of $O(n)$ that takes $10000n$ time will definitely take more time. What we conclude is that $O(n)$ is perfect, but it is the only available way to compare algorithms irrespective of architectures.. etc. As another example, we can consider Merge Sort and Quick Sort. The worst case complexity of Quick Sort is more and average case is same as Merge Sort. The hidden greater constants in Merge Sort.

^ | v .



Doom → Sandeep · 3 years ago

@Sandeep: Could you please tell me more about the hidden greater reason why we prefer quick sort over mergesort?

^ | v .



Bhagat Vishal → Doom · 3 months ago

what i think , in case of deciding priority between the memory amount of space taken by merge sort .but this could be linked list without any extra space.

^ | v .



Amit → Doom · 3 years ago

@Doom: These constants depends upon cost of execution machine....

Like some machine incurs more cost in assignment than others.

^ | v .



viresh → Amit · 3 years ago

mergesort is not inPlace.. so each time u ask for a extra space there might be a page fault and also mergesort involves copying which makes mergesort costlier.. in contrast quicksort is in place (changing the index rather than swapping the elements in an array (swaps $2s$ in d inner loop)).

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^ | v .



Doom → Amit · 3 years ago

@Amit: yes, you are right. But discussing about the arc
am more concerned about the specific instructions whi
expensive operation than quick sort.

^ | v .



Sandeep → Doom · 3 years ago

@Doom: These constants are not fixed and vary from r
that the constants for MergeSort are greater than Quick

^ | v .



Sandeep → Sandeep · 3 years ago

@Doom: These constants are greater if number of CPL
recursion are more. The CPU cycles might be used for
data movement etc.

For example, consider the following two loops. Time co
 $O(n)$, but the constants involved in Loop 2 are more tha
vary from machine to machine.

```
// Loop 1
for(i = 0; i < n; i++)
{
}

// Loop 2
for(i = 0; i < n; i++)
{
    printf("GeeksforGeeks");
}
```

| }

Hope I made things clear this time.

^ | v •



Doom → Sandeep • 3 years ago

@Sandeep: But what are these constants related to? I r
to point out? is it like the no. of comparisons involved? c
the array? plz give some examples about the constants

^ | v •



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