



Example 2: Measuring Time Complexity

Compute time complexity of a given algorithm with nested loops.

We'll cover the following ^

- A Nested Loop
 - Time Complexity
- Quick Quiz

In the previous lesson we went through a simple loop example and computed its time complexity by summing up all the basic operations.

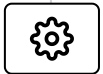
A Nested Loop

Now we will extend the previous example and make it a little harder by adding a “nested loop” in the program. We will calculate its time complexity by following the same series of steps that we did in the previous example. Let's take a look at the following example. It is a simple piece of code that prints the number of times the increment statement runs throughout the program. Let's compute its time complexity.

```
1 n = 5 # n can be anything
2 sum = 0
3 for i in range(n):
4     for j in range(n):
5         sum += 1
6
```



```
7 print(sum)
8
```



Time Complexity#

We will first break this program into individual operations like this:

Statement	Number of Executions
<code>n = 5</code>	1
<code>sum = 0</code>	1
<code>range(n)</code> line 3	1
<code>i = 0</code>	1
<code>i = 1</code>	1
<code>i = 2</code>	1
...	
<code>i = n - 1</code>	1
<code>range(n)</code> line 4	$n \times 1$
<code>j = 0</code>	$1 \times n$



Statement	Number of Ex
<code>j = 1</code>	$1 \times n$
<code>j = 2</code>	$1 \times n$
...	
<code>j = n - 1</code>	$1 \times n$
<code>sum+=1</code>	$(3n) \times n$
<code>print(sum)</code>	2
Total	$5n^2 + 2n + 4$

We're multiplying every statement of the inner loop with n because the outer loop runs it n times

Also, note that, while `range(n)` executes only once, it's execution cost is n , i.e., each call to `range(n)` results in n individual operations.

Time Complexity

$$= 1 + 1 + n + (1 + 1 + 1 + \dots + 1) + n \times n + n(1 + 1 + 1 + \dots + 1) + (3n) \times n + 2$$

$$\Rightarrow 2 + n + n + n^2 + n^2 + 3n^2 + 2$$



$$\Rightarrow 5n^2 + 2n + 4$$



Quick Quiz#



Suppose that in the above code the variable `sum` is initialized to zero in the inner `for` loop.

```
n = 5 # n can be anything
sum = 0
for i in range(n):
    sum = 0
    for j in range(n):
        sum += 1

print(sum)
```

What will be the time complexity for the code?

A) $5n^2 + 2n + 3$

B) $5n^2 + 3n + 2$

C) $5n^2 + 3n + 4$

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