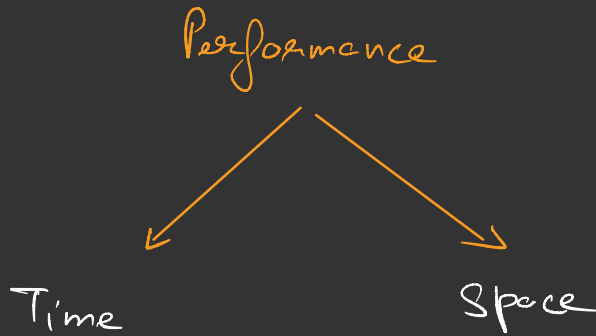


Time and Space Complexity



→ No of operations

1 operation will take 1 unit of time

`syso("Hello World")` → 1 operation
1 unit of time

`syso(1)`
`syso(2)`
`syso(3)`
`syso(4)`
`syso(5)`

} → 5 operations
↳ 5 unit time

`for(int i=1; i<=100000; i++) {`

`syso(i);` → 1 operation] 10^5 times

10^5 operations

Time Complexity

no of operations with respect to input data

Linear search

```
for(int i=0; i<arr.length; i++) {  
    if (val == arr[i]) {  
        return i;  
    }  
}
```

0	1	2	3	4
10	20	30	40	50

Best case $\Omega(1)$ no of operations $\rightarrow 1$

Average case $\Theta(n)$ $\frac{1 + 2 + 3 + 4 + \dots + n}{n} \Rightarrow \frac{n \times (n+1)}{2} \Rightarrow \frac{n+1}{2}$

$O(n)$

Worst Case

(n) comparisons

\rightarrow max time /
max no of operations my algo will take

Constant

$$g(n) = 4n + 3 \Rightarrow O(4n) \Rightarrow O(n)$$

$$f(n) = 8n^2 + 2n + 10 \Rightarrow O(8n^2) \Rightarrow O(n^2)$$

1) Remove all the non significant and constants

```
Scanner scn = new Scanner(); // '
int n = scn.nextInt(); // 1 ] p=2 2
```

for(int i=1; i<=n; i++){

 syso(i); // 1

 syso(i); // 1

}

$2 \times n$ $2n$

unit time

$\Rightarrow O(n)$

$$\text{for}(\text{int } i = 1; i \leq n; i++) \{$$

$$\quad \text{for}(\text{int } j = 1; j \leq n; j++) \{$$

$$\quad \quad \text{syso}(i, j)$$

$$\quad \}$$

$$\}$$

i	j	0
1	1-n	n
2	1-n	n
3	1-n	n
...
n	1-n	n

$$\begin{aligned}
 TC &\Rightarrow n + n + n + n \dots \dots \dots n \\
 &\Rightarrow n(1 + 1 + 1 + 1 \dots \dots \dots 1) \\
 &\hspace{15em} n \text{ times} \\
 &\Rightarrow n \times n \Rightarrow O(n^2)
 \end{aligned}$$

```

for(int i=1; i<=n; i++){
    for(int j=1; j<=i; j++){
        Syso(i, j)
    }
}

```

i	j	#Ops
1	1-1	1
2	1-2	2
3	1-3	3
⋮		
n	1-n	n

$$\Rightarrow 1 + 2 + 3 + \dots \dots \dots n$$

$$\frac{n \times (n+1)}{2} \Rightarrow \frac{n^2 + n}{2} \Rightarrow O(n^2)$$

```

for(int i=1; i<=n; i++){
    for(int j=i; j<=n; j++){
        Syso(i, j)
    }
}

```

i	j	#Op
1	1-n	n
2	2-n	n-1
3	3-n	n-2
⋮		
n	n-n	1

$$\Rightarrow n + (n-1) + (n-2) + \dots \dots \dots 1$$

$$\Rightarrow \frac{n \times (n+1)}{2} \Rightarrow O(n^2)$$

Types of TC

input

Operations

- | | | |
|--|-----------------|------------------|
| ① <u>Constant</u> $\rightarrow O(1)$
\hookrightarrow independent of input | 10^9 | 1 |
| ② Logarithmic $\rightarrow O(\log_2 n)$ | $10^9 (2^{30})$ | 30 |
| ③ Linear $\rightarrow O(n)$ | 10^9 | 10^9 |
| ④ Super Linear $\rightarrow O(n \log_2 n)$ | 10^9 | 30×10^9 |
| ⑤ Polynomial $\rightarrow O(n^2)$ | | |
| ⑥ Exponential $\rightarrow O(c^n)$ | | |
| ⑦ Factorial $\rightarrow O(n!)$ | | |

$$\log_2 10^9 \Rightarrow \log_2 2^{30} \\ \Rightarrow 30 \log_2 2 = 30$$

$$10^9 = 2^{30}$$