Ayush Sharma → Module Owner for DSA

2019 ⇒ CSE, IIT Patna

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Strand Life Sciences

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Scaler Academy

1) PSP ⇒ Problem Solving Percentage

$$= \frac{\text{Total no. of problems solved}}{\text{Total no. of unlocked problems in assignment.}}$$

85 %.

2) Attendance

75% ⇒ live sessions.

(85 - 90 %.)

⇒ Post on whatsapp.

Intermediate (4 Week)

Intro. to Problem Solving
Time Complexity
Arrays — Intro.
Prefix Sum
Carry forward & Subarray
Sliding Window & Contri.
2D Matrix
Sorting Basics
Hashing Basics
String Basics
Bit Manipulation
Interview Problems

Contest → 1.5 hrs → 3 ques.
60 %.

FAQs:

1) Notes will be uploaded after class

2) Sit with a paper & pen.

3) Assignments will be unlocked after the session. (No deadline)

4) Question ⇒ Everyone ✓
Answer ⇒ Ayush Sharma

Agenda

1) Count of factors
2) Optimise
3) Check prime
4) Sum of first N natural no.s
5) AP & GP
6) Iterations
7) How to compare 2 Algorithms

Live lecture (3-5 Quest.) → Assignment (3-5)
→ Additional Problems (3-5)

What is a factor ??

i is a factor of N.

⇒ If we divide N by i ⇒ Remainder = 0

3 is a factor of 12

(N % i) == 0 ⇒ Code

(% ↓ Mod)

Q. Given an integer N.
Find the count of factors of N.

24 ⇒ 1, 2, 3, 4, 6, 8, 12, 24

8

10 ⇒ 1, 2, 5, 10

4

Soln 1) Brute force ⇒ All possibilities.

Smallest factor = 1
Largest factor = N

∴ All factors of N will be b/w 1 & N.

Code

```
int countFactors (N) {
    int count = 0;
```

```
for (i = 1; i <= N; i++) {
    if (N % i == 0)
        count = count + 1;
}
return count;
}
```

N

⇒ The code that we submit runs on servers.

How long do we wait ?? ⇒ 1 sec.

⇓

1 GHz

1 GHz ⇒ ~ 10^8 iterations in 1 sec

N	Iterations	Execution time
10^8	10^8	1 sec
10^9	$10^9 = 10 \times 10^8$	10 sec
10^{18}	$10^{18} = (10^{10}) \times 10^8$	$= 10^{10}$ sec
		$\simeq$ 317 years.

(Too long to wait)

2) Optimise

$i \times j = N$

$j = N/i$ (i & N/i both are factors)

$i \overline{)N}^{j}$

$4 \overline{)24}^{6}$

24

0

$4 \times 6 = 24$

Eg = $N = 24$

i		N/i
1	<	24
2	<	12
3	<	8
4	<	6
6	>	4
8	>	3
12	>	2
24	>	1

Goal → Reduce iterations

↓ factors are repeating

$N = 100$ ⇒ Perfect Square

i		N/i	
1	<	100	+2
2	<	50	+2
4	<	25	+2
5	<	20	+2
10	⟷	10	$i = N/i$ (+1)
20	>	5	

25	>	4
50	>	2
100	>	1

$(i \leq N/i) \Rightarrow$ Iterate

$i^2 \leq N$

$i \leq \text{sqrt}(N) \quad (\sqrt{N})$

$\Downarrow$

$[1, \sqrt{N}]$

Code

```
int countFactors (N) {
    int count = 0;          // i x i <= N
    for (i = 1; i <= sqrt(N); i++) {

        if (N % i == 0) {
            // i & N/i are both factors of N
            count = count + 1;
            if (i != N/i) {
                count = count + 1;
            }
        }
    }
```

```
    }
    return count;
}
```

N	# Iterations	Exec. time.
10^{18}	$\sqrt{10^{18}} = 10^9$	10 sec.

$i^2 \leq N \Rightarrow$

Q Given N ⇒ Check if it is a prime no. or not.

Eg ⇒ [10, 11, 23, 2, 27, 31] ⇒ 4

Q What is Prime just No. divisible by 1 & itself

Soln Prime no ⇒ Count of factors = 2.

(N = 1) ⇒ 1 ⇒ Neither prime nor composite.

$1 + 2 + 3 + 4 + 5 + 6 \ldots\ldots + 100$??

4th Class. // Gauss.

$$S = 1 + 2 + 3 + 4 \ldots\ldots + 99 + 100$$
$$+ \quad S = 100 + 99 + 98 + 97 \ldots\ldots + 2 + 1$$

$$2S = \underbrace{101 + 101 + 101 + 101 \ldots\ldots 101 + 101}_{100 \text{ times}}$$

$$2S = 100 \times (101)$$
$$S = \frac{(100)(101)}{2} = 5050$$

Generalise this N

$$S = 1 + 2 + 3 \ldots\ldots\ldots\ldots N$$
$$S = N + (N-1) + (N-2) \ldots\ldots\ldots\ldots 1$$

$$2S = \underbrace{(N+1) + (N+1) \ldots\ldots\ldots\ldots (N+1)}_{N \text{ times}}$$

$$2S = (N)(N+1)$$

Sum of 1st N natural no = $\frac{(N)(N+1)}{2}$

Range

1) $[a, b]$ ⇒ All no. from a to b including a & b

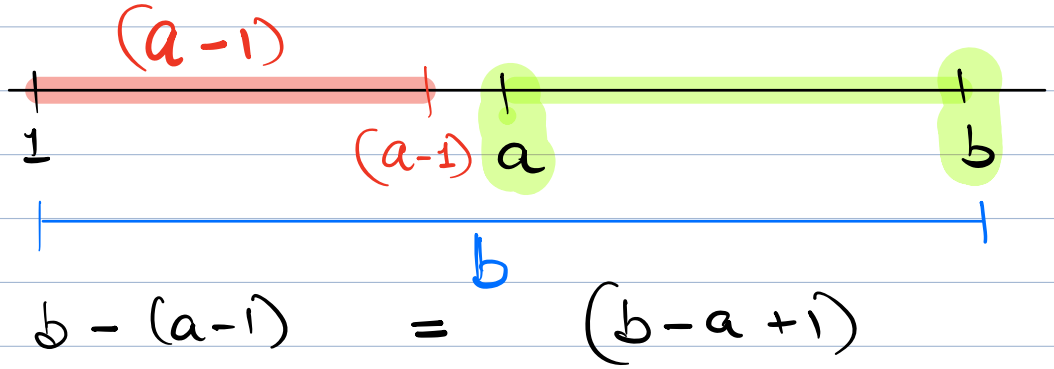
2) (a, b) ⇒ " " " " excluding a & b.

How many no's in $[3, 10]$.

3, 4, 5, 6, 7, 8, 9, 10

8

How many no's in range $[a, b]$



$b - (a-1) = (b-a+1)$

Imp

Elements in $[a, b]$ = $b - a + 1$

Iterations

⇒ No. of times a loop runs.

Q1

```
for (i = 1; i <= N; i++) {
    if (i == N) { break; }
}
```

$i : [1, N] = N$

(1 = a, N = b)

Q2

```
for (i = 0; i <= 100; i++) {
    s = s + i + i^2;
}
```

$i : [0, 100] = 100 - 0 + 1 = 101$

(0 = a, 100 = b)

Q3

```
for (i = 1; i <= N; i++) {
    .....
}

for (j = 1; j <= M; j++) {
    .....
}
```

N

M

Iterations = (N + M)

Geometric Progression (G.P.)

a → first term
r → common ratio

a = 5, r = 2

5, 10, 20, 40, 80, 160 .....

10/5 = 2
20/10 = 2
40/20 = 2

$5 \times (2^6 - 1)$
$5 \times (64 - 1)$
5×63
$= 315$

$a, ar, ar^2, ar^3 \ldots\ldots\ldots$

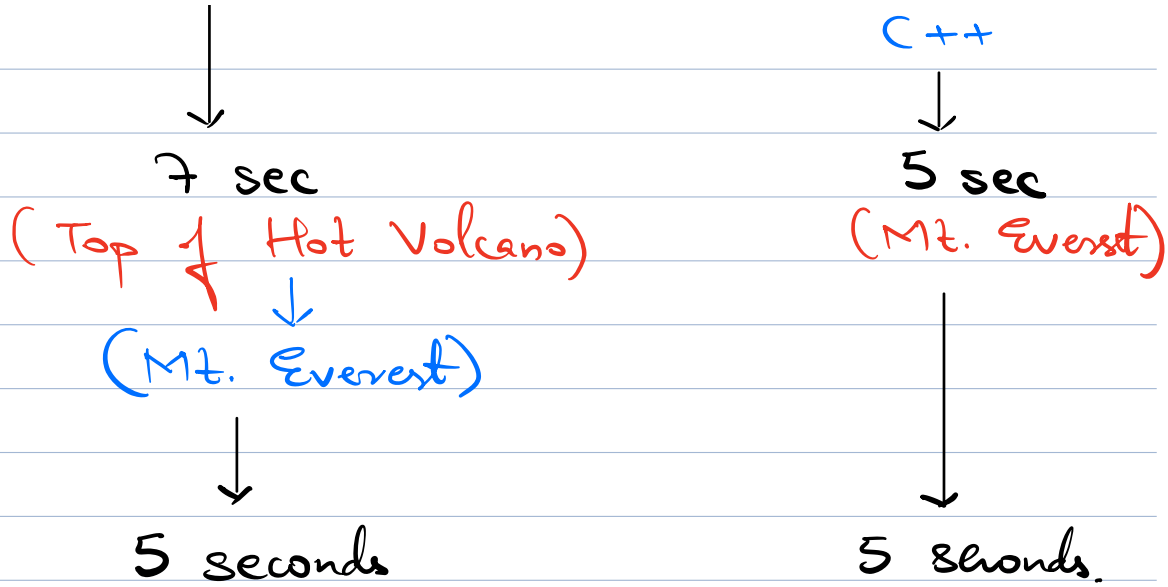
Sum of a GP.

$$\text{Sum} = \frac{a \times (r^N - 1)}{(r - 1)} \qquad (r != 1)$$

How to compare 2 Algo

Implement a sorting algo. (Input same)

Roshan (Super Sort)	Pooja (Awesome-sort)
15 sec	10 sec
(Window XP)	(Macbook M2)
↓	↓
(Macbook M2)	10 sec
↓	(Python)
7 sec	↓
(C++)	
↓	



Conclude

Execution time is dependent on factors beyond control.

⇓ Parameter independent of any factor.

⇒ Iterations.

Next class

⇒ Time complexity.
⇒ Big O, Drawbacks, Asymptotic
⇒ Space complexity.
⇒ TLE, importants of constraints
(Time Limit Exceed)

Doubt

Task ⇒ Before friday

Habbit → 9:00PM

Weekends ⇒