

# Introduction to Problem Solving

Nov 22, 2023



## AGENDA:

A.

- Need for Problem Solving
- 1. Some simple and fun problems  
Quizzes
- 2. Real World Examples

B.

Next 2 months topic and schedule

C.

Doubts

## About Me :

- Graduated from IIT Kharagpur  
Studied Mathematics and Computing
- Software Developer @ Indihood (a startup :)
- Instructor @ Scaler (last ~ 1.5 years)
- Plays Badminton, Basketball. Loves reading books, watching TV series (Loves The Office :)

## Few terms that you shall see throughout the course:

1. PSP : Problem solving percentage =  $\frac{\text{Solved Assignment problems}}{\text{Total Assignment problems}}$

\* 2 sections of problems

- ↳ Assignments → PSP is calculated on this.
- ↳ Additional

\* Try to keep PSP 85% no matter what.

2. Attendance : live / Recorded

\* Try to maintain at least 80-90% attendance either through live classes or watch recording.

\* Live attendance → Highly recommended!

## Intermediate Module Description

1. Intro to problem solving  [we are here 😊]
2. Time complexity
3. Intro to arrays
4. Prefix sum
5. Carry forward
6. Subarrays
7. 2D Matrices
8. Sorting Basics
9. Hashing Basics
10. String Basics
11. Bit Manipulation Basics
12. Interview problems
13. Contest [covers full Intermediate DSA]

- \* Designed to make you comfortable with programming
- \* Exploring and getting the basics of all data structures
- \* Contest will be organised at the end.
  - 1.5 hours
  - Conducted within class hours followed by a discussion
  - 3 questions : Solve  $\geq 2$  to pass 😊
  - Reattempts of the contest also available in case you don't pass 😒

## FAQs

- \* Notes will be uploaded after class.
- \* Assignments will be unlocked just after class ends.
- \* No deadline for assignments
  - (But solve it within the same week if you don't want backlogs ;)

N.B. :-

- Answers in Private chats.
- Questions in Question Tab.; Discussion in public chat.
- Acknowledge with Yes/No
- Have a pen and paper handy, to answer quizzes.
- Quizzes are faster-finger-first of KBC 😊  
(only one attempt to get it correct, be careful!)
- We will use Pseudo-code only, throughout the lecture.  
Implementing actual C++/Java code will be your H-W ;)

Let's Begin !!

Q. Prime no. ?

↳ A. no. which has 2 factors - 1 and itself.

Q. Given a no., count the no. of factors.

24 → 1, 2, 3, 4, 6, 8, 12, 24 : 8 factors.

10 → 1, 2, 5, 10

\* i is a factor of N if  $N \% i == 0$

cnt = 0

for (int i = 1; i <= N; i++)

{

    if ( $N \% i == 0$ )

        cnt++

}

return cnt.

Assumed that  $10^8$  iterations can run in 1 second  
on the machine. ↗ (Depends on machine)

<u>Input</u>	<u>Iterations</u>
$N$	$10^8$
$10^9$	$10^9$
$10^{18}$	$10^{18}$

Time taken

$$\frac{10^8}{10^8} = 1 \text{ second}$$

$$\frac{10^9}{10^8} = 10 \text{ seconds}$$

$$\frac{10^{18}}{10^8} = 10^{10} \text{ seconds}$$

$$\left[ \frac{a^m}{a^n} = a^{m-n} \right]$$

$10^{10}$  seconds  $\rightarrow \sim 317$  years ☺

$$\frac{10^3}{10^2} = 10$$

$$\frac{10^4}{10} = 10^3$$

## Optimisation ?

(24)

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, ..., 24

(12) ————— 24

Go till  $N/2$

$N/2, \dots, N$

24

$$a * b = 24$$

✓ 1 \* 24 = 24

✓ 2 \* 12 = 24

—

✓ 3 \* 8 = 24

\* Every factor occur in pairs.

36

1 ? ✓

$$36/1 \checkmark$$

2 ? ✓

$$36/2 = 18 \checkmark$$

3 ✓

$$36/3 = 12$$

4 —

$$36/4 = 9$$

5 ✗

6 ✓

$$36/6 = 6$$

$$a * b = N$$

32

a    b

$$1 * 32 = 32$$

$$2 * 16 = 32$$

$$4 * 8 = 32$$

$$8 * 4 = 32$$

$$16 * 2 = 32$$

$$32 * 1 = 32$$

} Part 1

} Part 2

$$\underline{a \leq b}$$

$$a > b$$

Max value of A  
possible in Part I  
 $= \underline{b}$

Max value of  $a$  in Part I  $= b$

$$b * b = N$$

$$\Rightarrow b = \sqrt{N}$$

$$= a$$

} For the max factor.

48

a \* b

$$1 * 48$$

$$2 * 24$$

$$3 * 16$$

$$4 * 12$$

$$6 * 8$$

$$8 * 6$$

$$12 * 4$$

:

:

$$\underline{\underline{a \leq b}}$$

6....

$$\sqrt{48}$$

$$a * b = N$$

Code.

cnt = 0

for (int i = 1; i <= sqrt(N); i++)

{

if (N % i == 0) {

if (N / i == i)

cnt += 1

else

cnt += 2

}

}

return cnt

math.sqrt(N)

pow(N, 0.5)

N=18

$\sqrt{18}$

i = 1

cnt = 2

i = 2

cnt = 4

i = 3

cnt = 6

i = 4 X

N=25

1, 5, 25

5 is counted twice

100

1, 2, 4, 10

i	N/i
1 * 36	
2 * 18	
3 * 12	
4 * 9	
6 * 6	

N

Iterations

$10^8$

$$\sqrt{10^8} = 10^4$$

Time taken

$$\frac{10^4}{10^8} = 10^{-4} \text{ sec}$$
$$= 0.1 \text{ ms}$$

Going from 1 to  $\sqrt{N}$  only

$10^{18}$

$$\sqrt{10^{18}} = 10^9$$

$$\frac{10^9}{10^8} = 10 \text{ secs} \therefore$$

317 years

$\longrightarrow$  10 sec  $\therefore$

(Use the inbuilt function for sq root)

Q. 10, 11, 23, 2, 25, 27, 31

Q. For a no. N, check whether it is prime.

Approach →

Using above code, count the no. of factors.

if (cnt == 2) : Should be exactly = 2.  
"prime"

Break till 8:17 AM

## Gauss

$$S = 1 + 2 + 3 + 4 + 5 + \dots \dots \dots 99 + 100$$

$$(+) \quad S = 100 + 99 + 98 + 97 + 96 + \dots \dots \dots 2 + 1$$

$$2S = 101 + 101 + 101 + \dots \dots \dots 101 + 101$$

$$2S = 101 \times 100$$

$$S = \frac{101 \times 100}{2}$$

$$S = \frac{N(N+1)}{2}$$

[Sum of nos. from 1 to N]



## Intervals

$[a, b]$  → Set of nos. from a to b, including a and b.

[closed interval]

$(a, b)$  → Set of nos. from a to b, excluding a and b.

(open interval)

$[a, b)$  → a is included, b is excluding.

e.g.

$$[3, 8] = \{ 3, 4, 5, 6, 7, 8 \}$$

$$[2, 5) = \{ 2, 3, 4 \}$$

$$(3, 6] = \{ 4, 5, 6 \}$$

\* No. of nos. in

(square) brackets  $\rightarrow$

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

$$[a, b) = b - a$$

parenthesis  $\rightarrow$   $(a, b) = b - a - 1$

$$[\underline{3}, \underline{8}] = 8 - 3 + 1 = 6$$

$$3, 4, 5, 6, 7, 8$$

$$[\underline{2}, \underline{4}] = 4 - 2 + 1 = 3$$

$$\underline{\underline{2, 3, 4}}$$

\* Iteration  $\rightarrow$  No. of times the loop runs.

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

i = 1  
i = 2  
i = 3  
i = 4  
...  
i = N ✓

i = N+1 XX

$$\begin{aligned} & \text{No. of iterations} \\ & [1, N] = N - 1 + 1 \\ & = \underline{\underline{N}} \end{aligned}$$

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

i = 0  
i = 1  
i = 2  
i = 3  
...  
i = 100  
i = 101 XX

$$\begin{aligned} [0, 100] &= 100 - 0 + 1 \\ &= 101 \end{aligned}$$

101 iterations

```

for( i=1 ; i<=N ; i++ )
{
    if( i%2 == 0 )
         $\text{not } i$ 
}
for( j=1 ; j<=M ; j++ )
{
}

```

≡

[1, N]  
→ N iterations  
→ M iterations  
N+M iterations

\*\*

### Arithmetic progression

$+3 \nearrow +3 \nearrow +3 \nearrow +3$   
 $2, 5, 8, 11, 14, 17, 20, \dots$

$a =$  first term

$d =$  Common difference

Sum of first  $n$  terms of AP

$$= \frac{n}{2} [2a + (n-1)d]$$

1, 3, 5, 7, 9, 11

$$S = \frac{6}{2} [2*1 + (6-1)*2]$$

$$a=1$$

$$d=2$$

$$n=6$$

$$= 3 [2 + 5*2]$$

$$= 3 [2 + 10]$$

$$= \underline{\underline{36}}$$

1, 2, 3, 4, 5, 6 ... 100

$$a=1$$

$$d=1$$

$$n=100$$

$$S = \frac{n}{2} [2*1 + (n-1)*1]$$

$$= \frac{n}{2} [2 + n - 1]$$

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

## Geometric progression

$$1, 2, 4, 8, 16, 32,$$

2, 6, 18, 54, 162

$a$  = first term

$n$  = no. of terms

$r$  = common ratio

$$\text{Sum of first } n \text{ terms of G.P.} = \frac{a(r^n - 1)}{r - 1}$$

2, 6, 18, 54, 162

$$\frac{2(3^5 - 1)}{3 - 1}$$

$$a = 2$$

$$r = 3$$

$$n = 5$$

$$= 242$$

2, 4, 8, 16, 32

$$a = 2$$

$$r = 2 \quad [\text{common ratio}]$$

$$n = 5$$

$$S = \frac{2(2^5 - 1)}{2 - 1}$$

$$= 2 * 31$$

$$= 62$$

## Contest :-

Problem: Sort an array.

[ 10, 3, 7, 8, 2, 4 ]

Sriram

[ Ram X ]

15 s

[ Windows XP ]



[ Macbook Pro ]

7 sec

C++ developer



12 sec.

Mount Everest :-



India

9 sec.



Madhuri

[ Mad X ]

10 s

[ Macbook Pro ]

10 s

Python

On top of a  
volcano :-



India

7 sec.



## Conclusion :-

Time taken by the code to run is not a valid criteria.

∴

Check the no. of iterations ☺



is independent of language

OS

processor

external environmental  
conditions.

## Next class

→ Time complexity / Big O

→ logarithm (Maths)

→ Space complexity

→ Time limit Exceeded ... ?

Importance of constraints.

Some maths :)

A.P

G.P

Logarithms

Power operations

Modulus

Prime nos.

GCD / HCF

Permutation & Combinations

Khan Academy, You tube,

Brilliant

Assignments → P0

Additional problems → P1

Leetcode → P2