Hello Everyone :)

→ Welcome to intermediate module of DSA

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→ BTech - 2019, MTech - 2021 (IIT Bombay)

→ ~1 year of part-time teaching experience

FAQ's

→ Notes will be uploaded after the class

→ Assignments will be unlocked after the class ends.

→ No deadline for assignments.

→ Classes will be recorded.

→ During doubt session, attendence not counted.

→ Language Independent {only Pseudo code}

Agenda

→ factors Count

→ Prime number

→ Sum of N natural numbers

→ log basics

→ Sqrt() of a number

Number of factors

if N = 24 is 4 a factor of 24? → YES

24 % 4 = 0

find the factor count of 12?

12 → {1, 2, 3, 4, 6, 12} ⇒ count = 6

```
countFactors(N):
    c = 0
    for(i=1; i<=N; ++i) {
        if (N%i == 0)
            // i is factor of N
            ++c
    return c
```

Assumption: 10^8 iterations per sec

10^8 iterations → 1 sec

1 iteration → $1/10^8$

N iterations → $N/10^8$

this code will take **N iterations**

say $N = 10^9$ ⇒ $N/10^8$ sec = $10^9/10^8$ = **10 sec**

say $N = 10^{18}$ ⇒ $10^{18}/10^8$ = 10^{10} sec ~ **316 years**

you → children → ~~gf~~ → ~~3/4/5~~ → **617**

even if we iterate to N/2 only,

316 years will only become 158 years which is also not good.

if $i \times j = N \Rightarrow$ i & j are factors of N

$j = N/i \Rightarrow \{i, N/i\}$ are factors of N

> if i is a factor of N then
> N/i is also a factor of N

$N = 24$

i		N/i		C = 0
1	<	24	24/1	C = C+2
2	<	12	24/2	C = C+2
3	<	8	24/3	C = C+2
4	<	6	24/4	C = C+2
				C = 8
6	4	4	24/6	
8	4	3	24/8	
12	4	2	24/12	
24	4	1	24/24	

$N = 100$

i		N/i	C = 0
1	<=	100	C = C+2
2	<=	50	C = C+2
4	<=	25	C = C+2
5	<=	20	C = C+2
10	<=	10	~~C = C+2~~ C = C+1
			C = 9
20		5	
25		4	
50		2	
100		1	

if $a <= x$ max value of a ?

$a = x$

iterate till :

$i <= N/i$ $\quad\quad$ $i_{max} = N/i$

$\Rightarrow \quad i \times i \geq N$

$$\boxed{i_{max} = \sqrt{N}}$$

$i = [1, 2, \ldots, \sqrt{N}] \Rightarrow \sqrt{N}$ iterations

for $N = 10^8 \rightarrow \sqrt{10^8}$ iterations

$= 10^9$ iterations

10^8 iterations $\rightarrow$ 1 sec

10^9 iterations $\rightarrow$ 10 sec

Count factors (N) :

```
c=0                    i*i<=N
for( i=1; i<=√N ; ++i)
    if (N%i ==0) :
        // i is a factor of N & N/i is also factor
        if (i == N/i) :
            ++c
        else
            c=c+2
return c
```

Prime Numbers

1. Number divisible by 1 & itself only ✗
2. Has exactly 2 factors ✓

N = 1 [Not Prime]

Check whether a number is prime or not ?

```
isPrime(N):
    if( countfactors(N) == 2):
        return True
    else
        return false
```

⇒ $\sqrt{N}$ iterations

Story of a 4th class boy

find the value of

$$1+2+3+\ldots\ldots+100$$

$$S = 1 + 2 + 3 + \ldots\ldots + 99 + 100$$

$$S = 100 + 99 + 98 + \ldots\ldots + 2 + 1$$

$$= 101 + 101 + 101 + \ldots\ldots + 101 + 101$$

$$2S = 101 \times 100$$

$$S = \frac{101 \times 100}{2} = 101 \times 50$$

Find the sum of first N natural no. ?

$$S = 1 + 2 + \ldots + N$$

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

sum Of N Natural NO (N) :

```
ans = (N * (N+1)) / 2
return ans
```

Break : 8:11 - 8:21

Find a sqrt() of a number ?

1. Given a perfect square N, find sqrt(N) ?

N = 16 (4^2)
25 (5^2)
100 (10^2)
↳ perfect sq. no.
11, 12, 13, 14, 15 ✗

sqrt(N) :

```
for (i = 1; i<=N; ++i)
    if (i*i == N)
        return i
```

N = 16 : i = 1, 2, 3, 4 → 4 iterations

N = 25 : i = 1, 2, 3, 4, 5 → 5 iterations

N : i = 1, 2, ... , $\sqrt{N}$ → $\sqrt{N}$ iterations

2. If a number is not perfect square ? N >= 1

$\sqrt{17}$ = 4.xxxx = 4

$\sqrt{20}$ = $4^2 = 16$ = 4.xxxx = 4

$5^2 = 25$

i = 1	1 x 1 <= 17	ans = 1
i = 2	2 x 2 <= 17	ans = 2
i = 3	3 x 3 <= 17	ans = 3
i = 4	4 x 4 <= 17	ans = 4
i = 5	5 x 5 <= 17	

```
sqrt(N) :
    ans = 1
    for ( i=1; i*i <= N; ++i)
        ans = i
    return ans
```

$\sqrt{N}$ iterations

Log basics

$$\log_a b = c \quad \Leftrightarrow \quad a^c = b$$

for what power should we raise a s.t. it becomes equal to b.

$\log_2 64 = ?$

$\log_2 64 = c \Rightarrow 2^c = 64 \Rightarrow c = 6$

$\log_3 27 = 3$

$\log_2 10 = 3.\text{xxx}$

$2^c = 10$

$2^3 = 8 \qquad 2^4 = 16$

$\text{floor}(\log_2 10) = 3$

$\log_2 2^6 = 6$

$$\log_a a^c = c$$

$\log_3 9^2 = 4$

$3^c = 9^2 = (3^2)^2$

$3^c = 3^4 \Rightarrow c = 4$

Homework:

How many times we need to divide N by 2 till it reaches 1 ?

$N=9 \xrightarrow{/2} 4 \xrightarrow{/2} 2 \xrightarrow{/2} 1 \Rightarrow 3$ times

Expectations

1. Attend classes regularly
2. Revise Notes
3. Solve Assignments
   - Classwork
   - Homework
4. Doubts
   - Content
     - ask in class
     - stay back for doubt session after class
   - Assignments
     - debug on your own
     - raise a TA request
     - once in 2-3 weeks
     - Problem Solving Session
       - ↳ recorded
       - ↳ attendence optional
5. Join on time
6. If you miss the class
   - ↳ must watch recording
   - ↳ must revise notes

Doubt

10^{10} sec $\rightarrow \frac{10^{10}}{60 \times 60 \times 24 \times 365}$ years