Class 35

18 March 2023 11:07

CLASS 35

String
- LPS
- KMP
- Rabinkarp
- StringStream

] Questions

Number Theory (Maths)

Basic Maths using Coding

- DA
- CP
- DSA

Number Theory
- Modular Arithmatic
- Modular exponentiation
- Prime Nos, factors / divisors, Seive
- GCD, LCM,
- Modular Multiplicative Inverse
- Fermat's little theorm

Division

- Euclid's Algorithm
- Logarithms [4-5]
- Pigeonhole Principle
- Pnc [factorial, combinatorial, Permutations]

Medium

Easy / Medium

Modular Arithmatic

Modular Arithmatic

int a; overflow

Modvalue

Prime no

$(a_n x^{n-1} + b_n x^{n-2} + \cdots + s[i])$ %0 M;

Prime no better Algo

int a → Range ≈ 10^9

overflow

Mod!

10^9+7 → Modvalue

1) Int range

→ Prime no

10^{11}

-ve no

Random no

a %0 M = [0 --- M-1]

INT_MAX INT_MAX

22

INT_MAX+5

-5

=> 22 = 3*7 + 1

22 %0 3 = 1

Remainder

(0 - M-1)

a %0 3 => (0, 1, 2)

int → 10^9

$0 - 2*10^9 - 1$

10^{11} %0 M

10^{11} %0 10^9

10^9

INT_Range

$0 \to 10^9 - 1$

we can store in int

Mod ~ 10^9+7

int %0 M

(Prime No)

10^9+6

a %0 M => (0 --- M-1)

log log

Hash function

2 Reason

int value

Result int Range

long long

① int → 10^9 (+10)

Mod = 10^9+7

$5 \% 4 = 1$

$25 \% 4 = 1$

② Rabin karp main function main value mod

prime No

Prime value

Generic Mod value

Overflow → negative

divide Mod

$22 = 3 \times 7 + 1$

$\frac{22}{3} = 7$

$22 \% 3 = 1$

22 / 3

1, %0

3 3 3 3 3 3 3

3 24

22

$3 \times 7 = 21$

21 Remainder

$3 - 22 \% 3 \Rightarrow 3 - 1 = 2$

2

1 unit → add 5

1 unit → 10 (Remove)

2 unit → add 10

1 unit → Remove 11

Modular Aritmatic

① Addition $(a+b)\%M$

a , b

$(a+b)\%M \Rightarrow (a\%M + b\%M)\%M$

$(a-b)\%M \Rightarrow (a\%M - b\%M + M)\%M$

$(17+18)\%6 \Rightarrow 5$

$(17\%6 + 18\%6)\%6 =$

$5 + 0$

$(5+0)\%6 \Rightarrow 5$

$(18-13)\%4 = 1$

$(18\%4 - 13\%4 + 4)\%4$

$(2 - 1 + 4)\%4 = 1$ (0)

$(1+4)\%4 \Rightarrow (1\%4) + (4\%4)$

$= 1$

~~13 18~~ $(13-15)\%4$

-2

$(-2)\%4$

$(-2+4)\%4$

≥ 0 $2\%4 = 2$

Hash value [if ($t<0$) .

Hash value

```
if (t<0)
    t += M;
```

$(a+b) * m \Rightarrow a*m + b*m$

(3) Multiplication

$(a * b) \% M \Rightarrow (a \% M * b \% M) \% M$

Addition
Subtraction
Multiplication

Total range > int → overflow → Int range

(M) → 0 - M-1 ; $M = 10^9 + 7$

10^{11}

int → $10^5 * 10^{14} \% M$

$= (10^5 \% M * 10^{14} \% M) \% M$

$= (10^5 * 10^{14}) \% M$

$= (10^{19}) \% M$

overflow

overflow → -ve % M ⇒ galat wrong

Modular arithmatic

To prevent overflow in intermediate steps

Final ans return → int

long long → intermediate steps ans > 10^9

Tight constraints (Memory)

MLE, TLE

Modular Arithmatic

Sanajh

1) Addition

$a \% M + b \% M = ?$

Addition

Subtraction

Multiplication

$(5 * 9) \% 4 = 1$

$(5 \% 4 * 9 \% 4) \% 4$

$(1 * 1) \% 4 = 1$

Modular arithmetic on Division

$$\left(\frac{a}{b}\right) \% M = \left(\frac{a \% M}{b \% M}\right) \% M$$

if $(b \% M == 0)$

↓ Possibly

$b^{-1} \pm \frac{1}{b}$

$$\left(\frac{a}{b}\right) \% M \Rightarrow \left[a * (b^{-1})\right] \% M$$

$$\Rightarrow (a \% M * (b^{-1}) \% M) \% M$$

Congruency rule

$a \equiv 1 \% M \Rightarrow a \% M == 1 \% M$

$a \equiv b \% M \Rightarrow a \% M == b \% M$

GCD and LCM

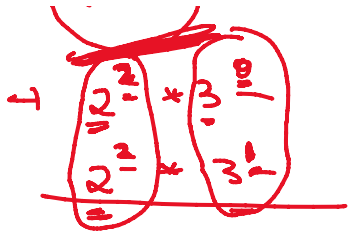
GCD (Greatest common Divisor) or HCF

$4 \rightarrow 2 * 2$

$12 \rightarrow 2 * 2 * 3$

$\Rightarrow 4$

$\rightarrow 2^2 * 3^0 \Rightarrow (4)$



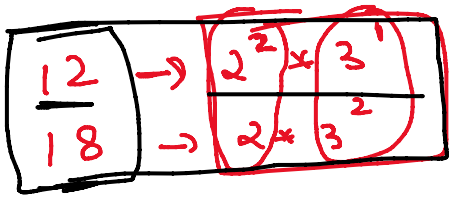
$2^2 \times 3^0 \Rightarrow 4$

LCM

4 → 2 * 2 or $2^2 \times 3^0$

12 → 2 * 2 * 3 $2^2 \times 3^1$

$2^2 \times 3^1 \Rightarrow 12$



GCD → $2^1 \times 3^1 \Rightarrow 6$

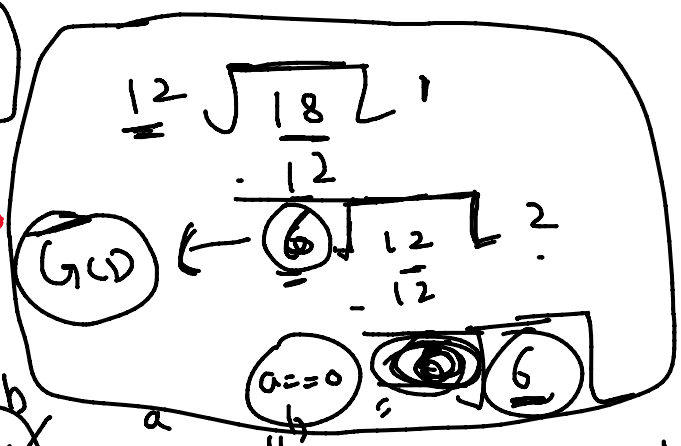
LCM ⇒ $2^2 \times 3^2 = 36$

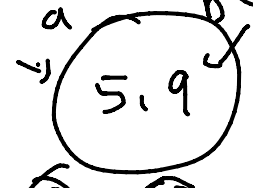
2×3 ⇒ $a \times b \Rightarrow 2^2 \times 3^1 \times 3^2$

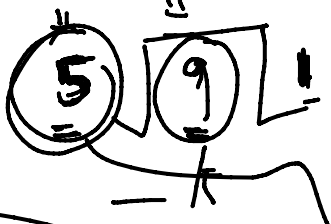
$2^1 \times 3^1$

L.C.M = $\frac{a \times b}{GCD}$ or GCD × LCM = a × b

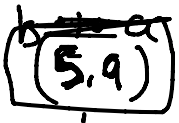
Long Division

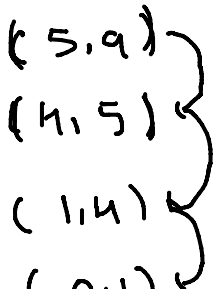


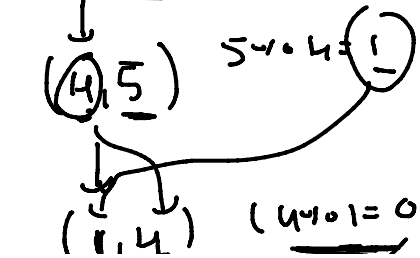


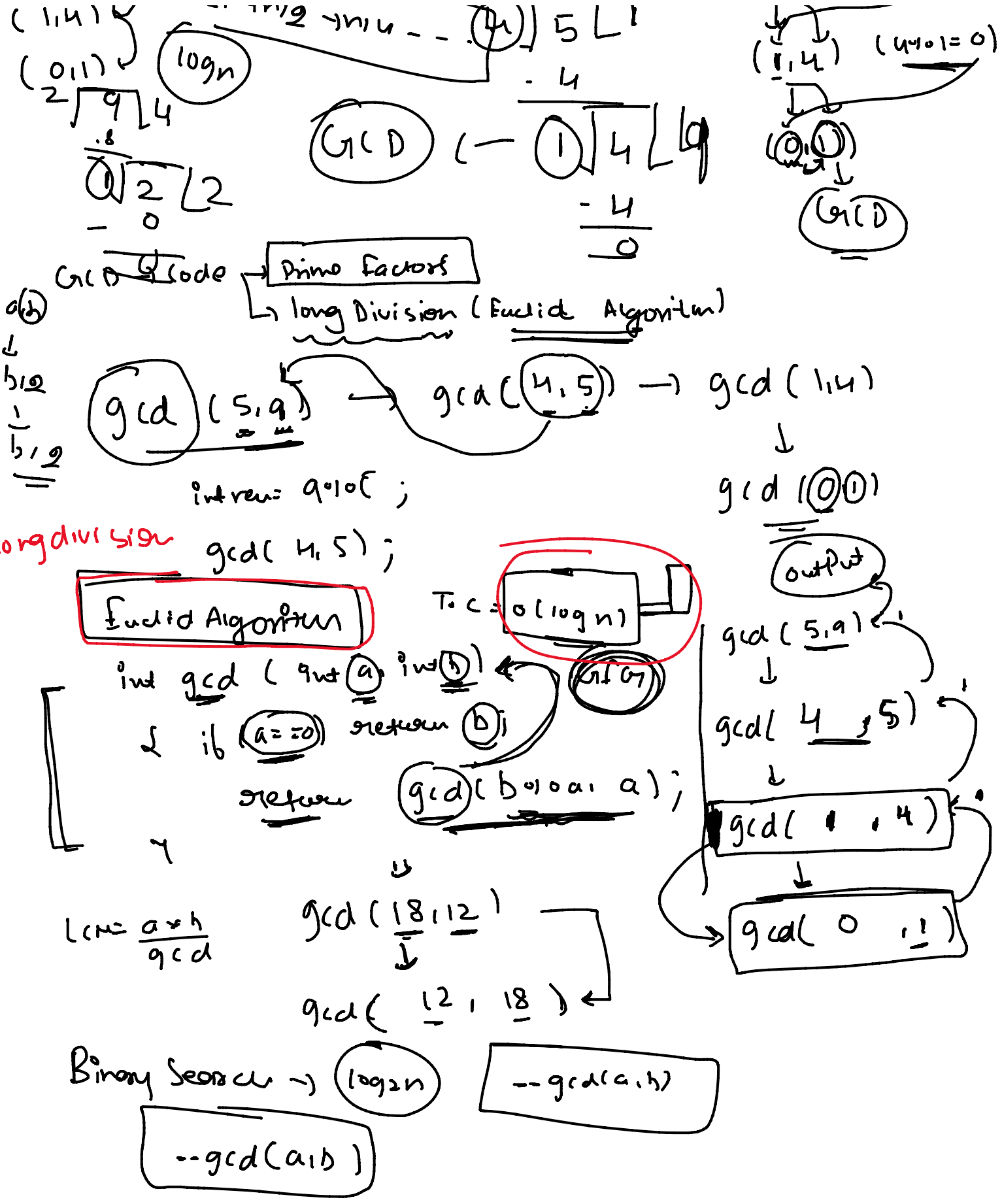


a%b



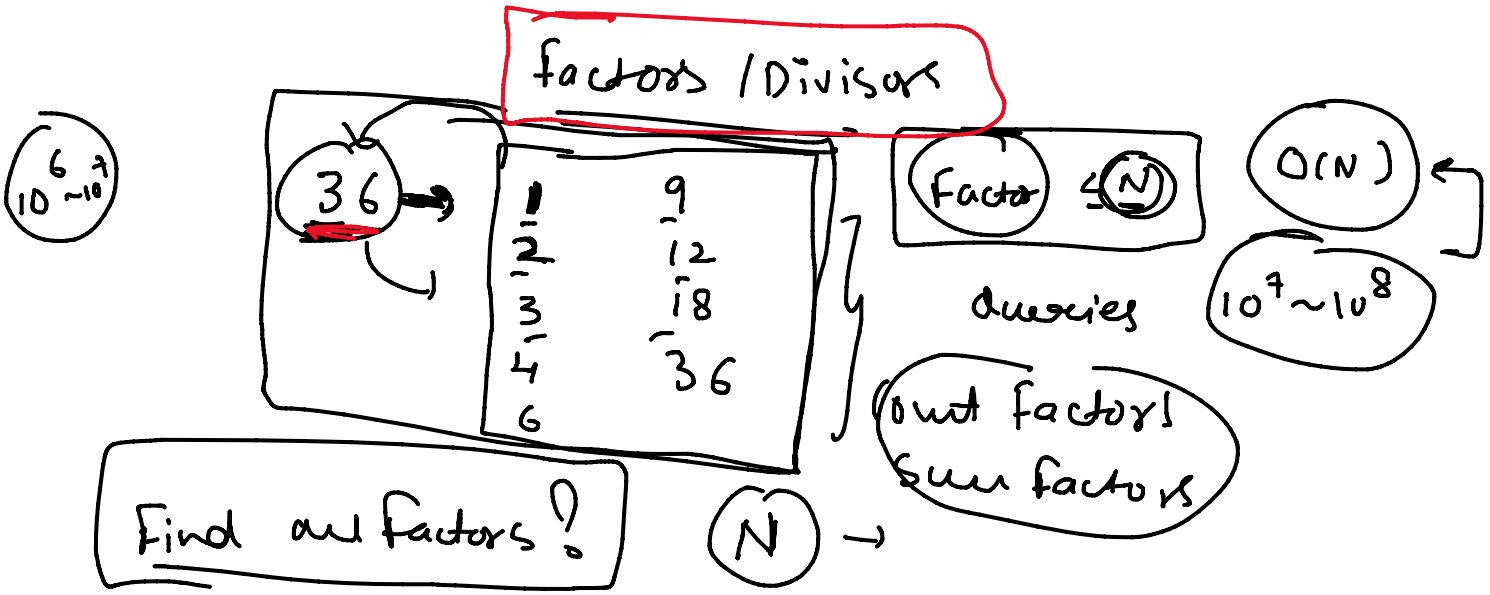






GCD, LCM, Modular Arithmatic, Euclid Algorithm

GCD, LCM, Modular Arithmetic, Euclid Algorithm




```
int count=0; int sum=0
for ( i=1; i<=n; i++ )
    { if ( n%i==0 )
        { cout << i << " "; count++; sum+=i;
        }
    }
```