# Maths Concepts & Qns

video - 1


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Motivation :-

Believe in your preparation, and the right opportunity will find you.

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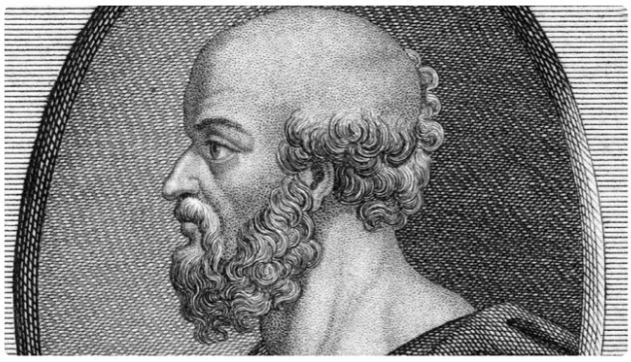
# Sieve Of Eratosthenes



1. Greek mathematician.
2. Famous for
   - Earth's circumference - Accuracy
   - Efficiently finding prime nos: "Sieve of Eratosthenes"

## What is 'sieve Of Eratosthenes'??

An ancient algorithm for finding all

prime numbers upto a given limit.

# Why is it called a "Sieve"?

(•) Sieve "filters out" non-prime numbers by marking their multiples.

(•) What remains in the sieve are Prime numbers.

. . X X X X . .

# How to check if a number is prime or not???

Prime no → Only 1 and the number itself are the factors.

Ex:- 2, 7, 11, 13 etc... ~~28~~

(1,2) (1,7) (1,11) (1,13)

n = 24 ⟶ (1, 24)

```
for ( num = 2 ; num <= n-1 ; num++) {
    if (n % num == 0) {
        return False;
    }
}
```

T.C ≈ O(n) ← $10^6$

S.C = O(1)

$n = 10^6$

# Can we do better ??

* n = 24

(2,12), (3,8), (4,6), (6,4), (8,3), (12,2)

{2, 3, 4, 6, 8, 12}  n/2 = 24/2 = 12

* n = 18 ⟶ (1,18)

{2, 3, 6, 9}

n/2

= 18/2 = 9

=

```
for (factor = 2 ; factor <= n/2 ; factor ++) {
    if (n % factor == 0)
        return false;
}
```

T.C = O(n/2) ≈ O(n)

S.C = O(1)

n = 100

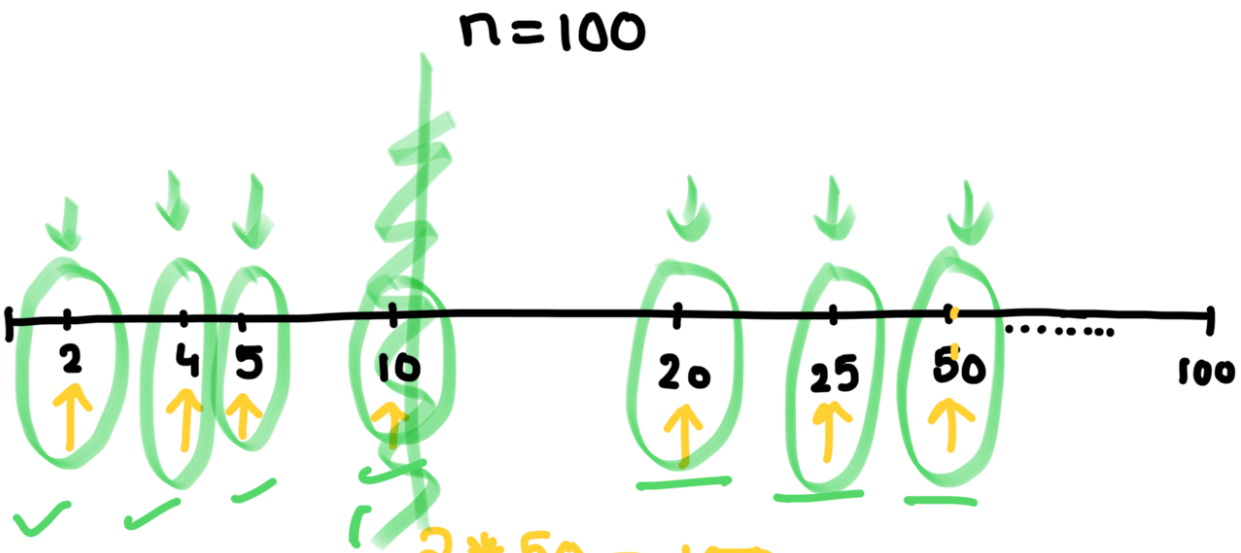
(1, n)x

n/2 = 50

{2, 4, 5, 10, 20, 25, 50}

n/2

# Can we further improve??




$2 * 50 = 100$

$4 * 25 = 100$

$5 * 20 = 100$

$10 * 10 = 100$

$20 * 5 = 100$

$25 * 4 = 100$

$50 * 2 = 100$

$a * b = 100$

$a == b$

$a * b = 100$

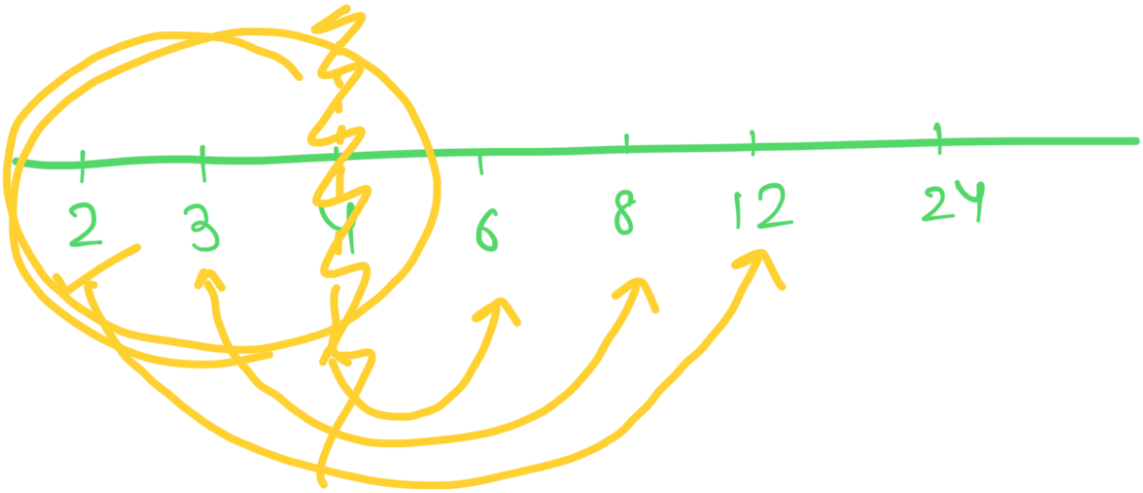
$a^2 = 100$

$a = b = \sqrt{n}$

~~n*k~~ ~~n/k~~

```
for (int factor = 2 ; factor <= sqrt(n) ; factor++)
    if (n % factor == 0)
        return false;   // n is not prime
}
```

$\sqrt{24} = 4.89 \simeq 4$ $\quad n = 24$




$n = 29 \rightarrow 1, 29$

2 $\quad \sqrt{29} \simeq 5$

2 to $\sqrt{n}$

2, 3, 4, 5

$X_{29}$ X X X

```
for ( j = 2 ; j <= √n ; j++) {
    if ( n % j == 0)
        Not prime
}
```

Prime.

# Sieve Of Eratosthenes

Find all primes upto a given number n.

## Naive Approach :-

n = 30

output: 2, 3, 5, 7, 11, 13, 17, 23, 29

⇒ `for ( int num = 2; num <= n ; num++) {` → O(n)

if (isPrime(num) == True) { → O(√n)

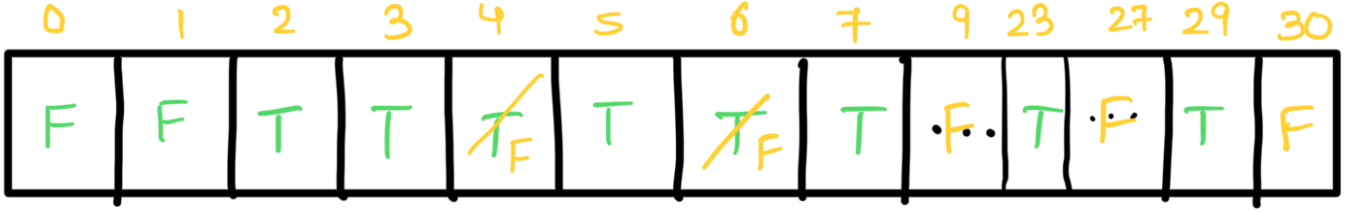
result.push_back(num);

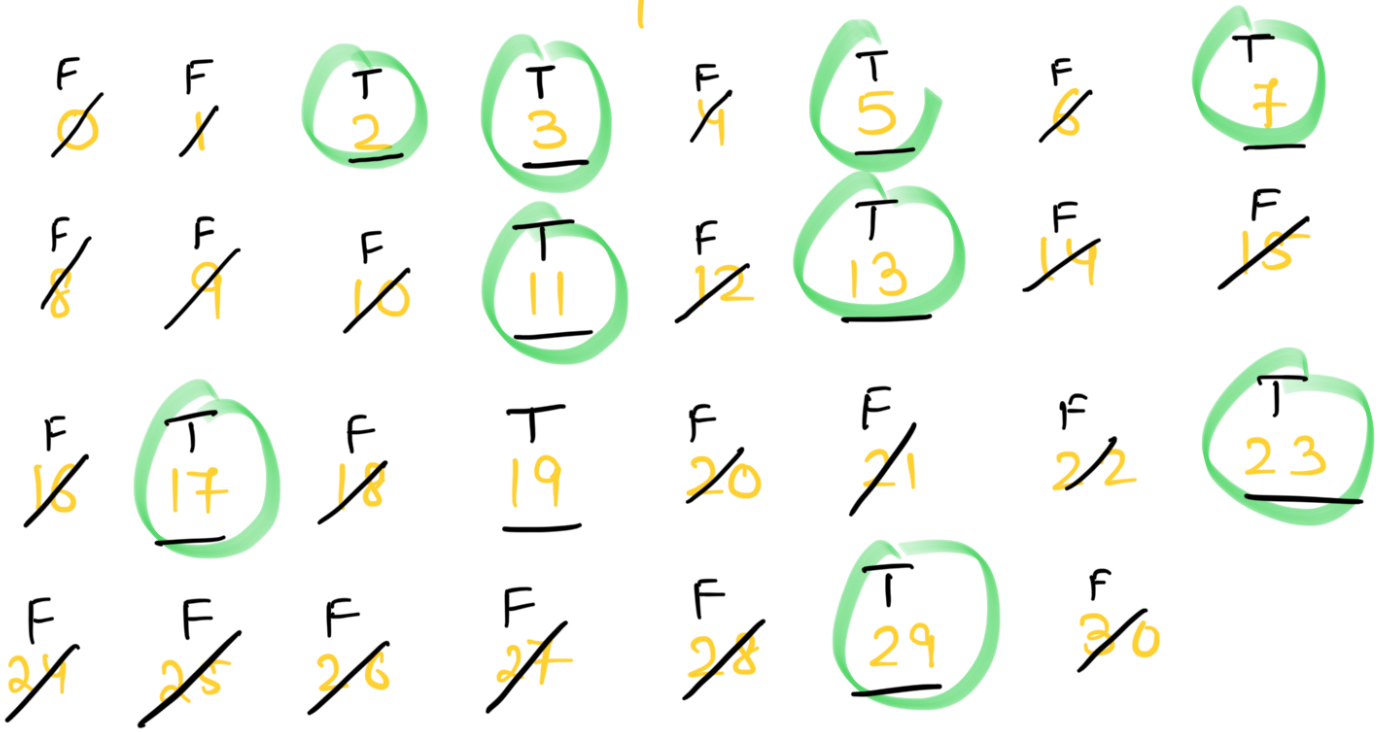
}

}

T.C = O(n * √n).

n = 30




vector<bool> isPrime (n+1, True);

isprime[0] = False;

isprime[1] = False;

for (int i = 2; i*i<=n; i++) {

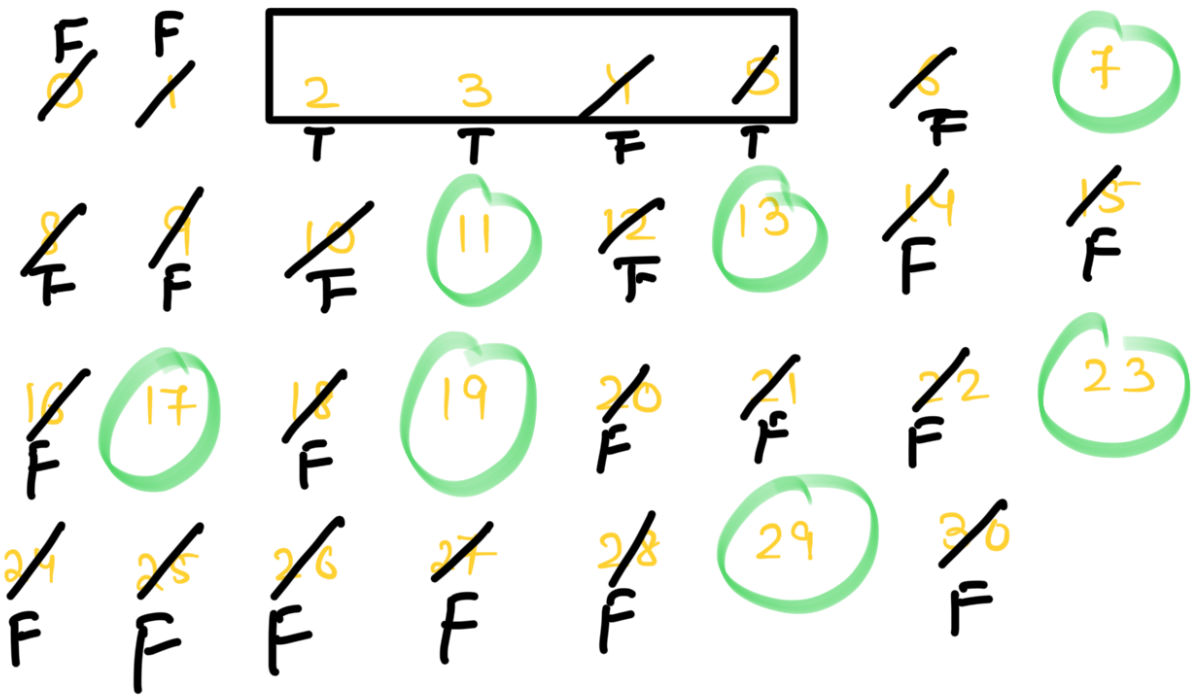
$i <= \sqrt{n}$

$i <= sqrt(n)$

$i*i <= n$

```
if (isprime[i] == True) {
    for(int j=2; i*j<=n ; j++) {
        isPrime[i*j]= False;
    }
}
```

$n = 30$ $\sqrt{n} = 5$




## T.C ...

```
for (int i=2; i*i<=n ; i++) {
    if (isprime[i] == True) {
        for(int j=2; i*j<=n ; j++) {
            isPrime[i*j]= False;   ← n/3
        }
    }
}
```

$n = 30$

2, 4, 6, 8, 10, 12, 14, 16, 18, 20,
22, 24, 26, 28, 30

$n/2$

3, 6, 9, 12, 15,
18, 21, 24, 27, 30

$i = 3$

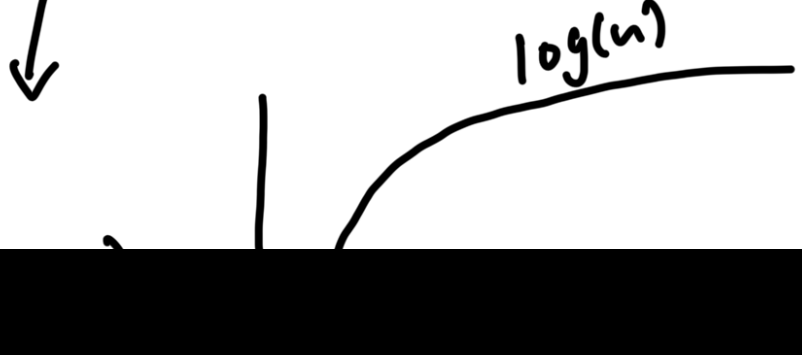
$n/3$

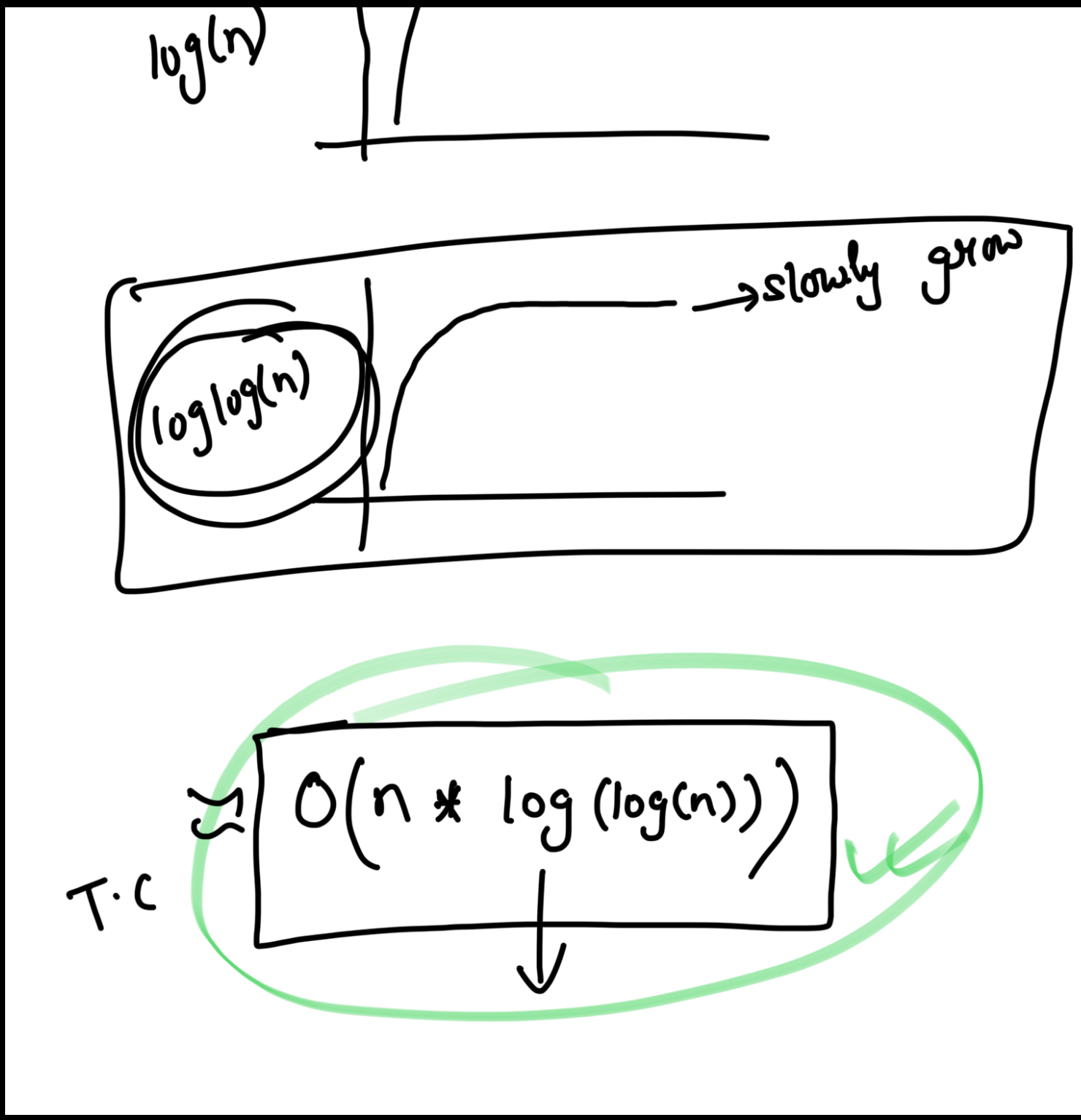
$i = 2$

$$\frac{n}{2} + \frac{n}{3} + \frac{n}{5} + \frac{n}{7} \cdots \ldots$$

$$= n\left\{\frac{1}{2} + \frac{1}{3} + \frac{1}{5} + \frac{1}{7} + \ldots\ldots\right\}$$

"Harmonic Series over Primes"






T.C ≅ $O(n * \log(\log(n)))$