

# Development of sieve of Eratosthenes and sieve of Sundaram's proof

## Sieve of Eratosthenes

The Sieve of Eratosthenes is an algorithm that creates a list of numbers from 2 to a given limit, and then marks off the multiples of each prime number, starting with 2. The unmarked numbers that remain in the list are prime. It is a simple and efficient algorithm that has been used for centuries and is still widely used today in modern cryptography and computer science.

Time Complexity of  
sieve of Sundaram

$O(n \log n)$

Time Complexity of  
sieve of Eratosthenes

$O(n \log(\log n))$

## Sieve of Sundaram

The Sieve of Sundaram is an algorithm that creates a table of odd numbers up to a given limit, and then marks out all the numbers that can be expressed in the form of  $2p + 1$ , where  $p$  is a prime number. The remaining unmarked numbers are all prime. It was developed by the Indian mathematician S. P. Sundaram in 1934 and is a very efficient algorithm for finding prime numbers, especially for larger limits.

### Algorithm of sieve of Eratosthenes

- Create a list of all numbers from 2 to the given limit.
- Set the value of the current prime number to 2.
- Mark all the multiples of the current prime number as not prime.
- Move to the next unmarked number in the list.
- If the next unmarked number is less than or equal to the square root of the limit, set it as the new current prime number and go to step 3.
- If the next unmarked number is greater than the square root of the limit, all the remaining unmarked numbers in the list are prime.

### Algorithm of sieve of Sundaram

- Create a list of all odd numbers from 3 to the given limit.  
(Note: 2 is not included in the list because it is the only even prime number.)
- Create a variable called "j" and initialize it to 1.
- For each value of "i" from 1 to "j", calculate the value of "n" using the formula:  $n = i + j + 2ij$
- Mark all the values of "n" in the list as not prime.
- If  $j < (\text{"limit"} - 2) / (2 * j + 1)$ , increment "j" by 1 and go to step 3.
- All the remaining unmarked numbers in the list are prime.

### First development of SOE (D1SOE)



- The code implements the Sieve of Sundaram algorithm to find prime numbers up to a given limit.
- An array of size  $(n_m + 1)$  is initialized with all elements set to false.
- The mean elimination theorem is used to eliminate composite numbers from the array up to a calculated limit.
- The outer loop iterates over values of  $n$  from 1 to the calculated limit.
- The inner loop iterates over multiples of  $(2 * n + 1)$  to mark corresponding array elements as true for composite numbers.
- The prime numbers are printed by iterating over the array and printing the values of  $(2 * n + 1)$  for false array elements.

### Second development of SOE (D2SOE)



- The D2SOE algorithm generates prime numbers up to a given limit.
- It is a modified version of the Sieve of Eratosthenes that uses two sieves to eliminate composite numbers.
- It initializes an array of boolean values and marks all multiples of 2 and 3 as composite.
- It uses the mean elimination theorem to determine which numbers to eliminate next.
- It eliminates all multiples of primes up to the square root of the upper limit.
- The remaining numbers in the array are all prime and are printed out by the program.

### Proof and development of sieve of Sundaram (DSOS)



- Implements Sieve of Sundaram algorithm to find prime numbers up to a limit  $n_m$ .
- Initializes an array of size  $(n_m + 1)$  with all elements set to false.
- Eliminates composite numbers from the array using the mean elimination theorem.
- Prints all prime numbers by iterating over the array and printing the values of  $(2 * n + 1)$  for all indices where the array element is false.