

A Study on the Pattern in the Prime Numbers and Primality Test

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Abstract

The purpose of this paper is to introduce patterns in prime numbers and then primality test from those patterns. Those patterns are the regularity among odd numbers for eliminating the composite number such as Sieve of Eratosthenes. Those patterns shows the regularity among the odd numbers except 2. Those patterns may be used to determine which odd numbers are prime numbers. This pattern may reduce the computation time to find prime numbers in some number range.

1. Pattern in the prime Numbers

All odd numbers could be expressed as a list of numbers having the regular pattern, as shown in Figure 1.

- A prime number is the number except numbers in square boxes. In other words, if it is not the representative number or the extension number or the square number, it becomes a prime number.
- These numbers could be divided into the left number and the right number around the square number.
- The odd number in a square box is equal to the number of multiplying the left number and right number.
- Therefore, it is possible to check whether it is a prime number or not by dividing the right number only.

$$a^2 = M$$

Where a is the square root number closest N

- 2) Let's divide odd number which is nearest N by the odd numbers (or prime numbers) less than a.
- 3) If it is not divided by odd numbers (or prime numbers) smaller than a, it is a prime number.

For example,

Find the biggest prime number under 3579

- 1) Let's find the closest square root number under 3579.

$$59^2 = 3481$$

Let's review only the prime numbers which are smaller than 59.

3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59

It could be determined the prime number by checked only these numbers.

- 2) Let's verify that 3579 is divided by 3.

$$3579 \div 3 = 1193$$

It's not a prime number.

It also means that 3577, 3575 is not multiples of 3.

On the other hand, 3573 is multiples of 3.

- 3) Let's verify that 3577 is divided by 7.

$$3577 \div 7 = 511$$

It's not a prime number.

4) The prime number ends with 5 in its one's place is the composite number. So it's not necessary to verify the 3575.

It's not a prime number.

5) It is not necessary to verify the 3573 because this number is divided by 3.

It's not a prime number.

6) Let's verify the 3571.

It is not divided by the prime numbers which are smaller than 59.

It's a prime number.

Thus the biggest prime number under 3579 is 3571.

3. Reference

Horsley, Rev. Samuel, F. R. S., "Κόσκινον Ερατοσθένους or, The Sieve of Eratosthenes. Being an account of his method of finding all the Prime Numbers," *Philosophical Transactions* (1683–1775), Vol. 62. (1772), pp. 327–347.