The Normal Distribution Theorem of Prime Numbers

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Introduction

Let \( \pi(N) \) be the number of primes less than or equal to \( N \), \( \pi(2 \leq p \leq \sqrt{N}) \) be taken over the primes less than or equal to \( \sqrt{N} \), then exists the formula as follows:

\[
\pi(N) = \int \pi(N) \left[ N \times \prod_{2 \leq p \leq \sqrt{N}} \left( 1 - \frac{1}{p} \right) \right] + m - 1 = Li(N) - \frac{1}{2} \times Li \left( \sqrt{N} \right) = R(N)
\]

Where the \( \int \{ \} \) expresses the taking integer operation of formula spread out type in \{ \}.

One: The Prime Numbers

Let \( n_i \) is a natural integer less than or equal to \( N \), then exists the formula as follows: \( n_i \leq N \) (1)

In terms of the above formula we can obtain the array as follows:

\( (1), (2), (3), (4), (5), \ldots, (N) \).

From the above arrangement we can obtain the formula as follows:

\[ N_i(N) = N = \text{Total of integers } n_i \text{ less than or equal to } N \quad (2) \]

If \( n_i \) can be divided by the prime anyone less than or equal to \( \sqrt{N} \), then sieves out the positive integer \( n_i \); If \( N_p \) can not be divided by all primes less than or equal to \( N \), then the number \( N_p \) is a prime (Figure 1).

Two: The Sieve Method

Let \( p_i \) be a prime less than or equal to \( \sqrt{N} \), the number of integers \( n_i \) can be divided by the prime \( p_i \) is \( \int n_i \div p_i \), the number of integers \( n_i \) can not be divided by the prime \( p_i \) is:

\[
\pi(p_i) = \int (1-\frac{1}{p_i}) \int \left( \int 1 \right) = \int \left( \int \frac{1}{p_i} \right) - 1 \quad (3)
\]

Where the \( \int \) expresses the taking integer operation of formula spread out type in \{ \}.

Figure 1.
Three: The Prime Number Theorem

Let $P_i(N)$ be the number of primes less than or equal to $N$, $P_i (2 \leq P_i \leq P_m)$ be taken over the primes less than or equal to $\sqrt{N}$, then exists the formulas as follows:

$$N_\pi(N) = \text{INT} \left[ N \times \left( 1 - \frac{1}{P_1} \right) \times \cdots \times \left( 1 - \frac{1}{P_m} \right) \right] = \text{INT} \left[ N \times \prod \left( 1 - \frac{1}{P_i} \right) \right]$$

$$P_i(N) = N \pi(N) + m - 1 = \text{INT} \left[ N \times \prod \left( 1 - \frac{1}{P_i} \right) \right] + m - 1$$

Where the $\text{INT} \{ \}$ expresses the taking integer operation of formula spread out type in $\{ \}$.

Four: The Normal Distribution Theorem of the Prime Numbers

From above we can obtain that:

Let $P_i(N)$ be the number of primes less than or equal to $N$, for any real number $N$, the New Prime Number Theorem can be expressed by the formulas as follows:

$$P_i(N) = \text{Li}(N) + \frac{N}{2} - \text{Li}(\sqrt{N}) + \frac{1}{2 \pi} \text{exp}(\log N)^2 + \cdots + \frac{1}{2 \pi} \text{exp}(\log N)^{2k} \cdots$$

$$= \frac{N}{2} + \frac{1}{2 \pi} \text{exp}(\log N)^2 + \cdots + \frac{1}{2 \pi} \text{exp}(\log N)^{2k} \cdots$$

Where the $\text{Li}(N)$ is the logarithmic integral function, the $\text{Li}(N)$ denotes the natural logarithm of $N$.

$$P_i(N) = r(N) + K \times \left( \text{Li}(N) - \text{R}(N) \right), 1 > K > -1.$$  \hspace{1cm} (7)

$$P_i(N) = 1.994714 \times 0.02 \times \text{exp}(-12.5 \times K \times K) \cdots$$  \hspace{1cm} (8)

Where the $r(N)$ is the Riemann Prime Counting Function, the $r(N)$ is the logarithmic integral function, the $P(K)$ is the Normal Distribution $N \mu = 0, \sigma = 0.2$.

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