The riemann hypothesis essay sample

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The Problem

One of the most influential mathematicians who lived during the 19 th and 20 th century composed a list of the unsolved problems mostly is of mathematics. This famous mathematician is David Hilbert. He is known for his famous contribution in the field of mathematics through his own discoveries. In 1900, he made a list of 23 unsolved problems at the International Congress of Mathematicians in Paris. This list of unsolved mathematical problems became the most influential, successful, and extremely well thought-out collection of open problems.

The list of these 23 unsolved problems, are included in the Hilbert's program which David Hilbert had proposed in 1920, as to be an explicit research project. This is done together with his personal objective; he wanted a solid and logical foundation to formulate mathematics. And that this formulation of mathematics to be on solid and logical foundation could be done upon showing two conditions. The first one is that there must be a correctly-chosen limited classification of self-evident truth from which other knowledge and truth will be formulated, and that mathematics should follow on this self-evident truth or also known as axioms. The second states that these collections of self-evident truth or axiom system are consistent on their proofs.

One of the famous 23 unsolved problems is the Riemann hypothesis. It is on the 8 th position on the list. This hypothesis was formulated by Bernhard Riemann during the year 1859. This is said to be the most famous among the 23 unsolved problems and had been though out for over centuries but

still the proof is not concrete or there is no one who had made and find the proof for it. Over this period of time, it has been attracting the minds of many outstanding mathematicians to put efforts upon solving this open mathematical problem. And who would not be stunned finding its solution which amounts to a million dollar of worth.

The Riemann Hypothesis

History

In 1859, Bernhard Riemann wrote a paper entitled ‘ On the Number of Primes Less Than a Given Magnitude’. In this paper, he mentioned a certain concept that was now a part of history. This concept is about conjecture which was now known as the Riemann hypothesis. It made a big impact among the mathematicians and to anyone that are concerned. He did not really intend to put this concept on top of the whole book, putting a concept without even attempting to prove it but it became one.

In contrast with the range of the non-trivial zeros of the zeta function, Hadamard and de la Vallee-Poussin made a proof that on the line $Re(z) = 1$, there could be no zeros that could lie on it. And thus, they made a conclusion that the only place these non-trivial zeros could lie is on between $0 < Re(z) < 1$, which is the interior of the critical strip. This proof of these two mathematicians was used in proving the prime number theorem.

There are 23 unsolved problems David Hilbert included in his program in the year 1900. In this well-known list of the 23 unsolved problems, the Riemann hypothesis made its way to be on the list. It is the number 8 unsolved

problem of Hilbert's list. Hilbert made a personal comment on the problem. He had said there that if anyone had tried to wake him after his long time sleep of about a millennium, there is one question that he would ask first. And that question is: " Has the Riemann hypothesis been proven?".

The Conjecture

A mathematical statement which has not been formally proven but seems to be true through the concept of mathematical logic is called a conjecture. The Riemann hypothesis is an example of what is called a conjecture. As mentioned earlier, one mathematical statement that was used by Riemann in his paper entitled ' On the Number of Primes Less Than a Given Magnitude' is an example of a conjecture. That mathematical statement has been also called as the Riemann hypothesis. It was a hypothesis because there was no formal proof based on a mathematical logic of that statement.

The Hypothesis Background

There is a deep connection involved concerning the Riemann zeta-function and the distribution of prime numbers. There is a property in mathematics which was satisfied by the Riemann zeta-function and the prime numbers. The property is known as the explicit formulae, a duality property in the distribution of numbers. It shows that there is a harmonic frequencies occurring in the distribution of prime numbers using the zeros of the Riemann hypothesis.

Who cares about the hypothesis?

The overall distribution of primes can be really explained by the Riemann hypothesis being a self-evident truth. But it cannot be accepted as a theorem as long as it has been formally proven. As mentioned earlier in this paper, David Hilbert made the Riemann hypothesis became famous where he put this hypothesis as an unsolved problem in his famous list of 23 unsolved problems. Through putting a bound on the real part of the zeros in the critical strip to be away from 0 and 1, Hadamard and de la Vallee Poussin had proven the prime number theorem. Thinking critically, the Riemann hypothesis was used to prove the prime number theorem, but the Riemann hypothesis itself has not yet been proven. Ironic isn't it.

The Hypothesis

The simplest way to state the Riemann hypothesis is that the zeros of the zeta function exists and are defined in the form (1/2 + it). Wherein, this function exists for all complex numbers which is not equal to 1. Examples are at s = -2, s = -4, s = -6 and so on…). The zeros that can be found on this region s < 0, are called the trivial zeros. However, it was not the concern of the Riemann hypothesis. The Riemann hypothesis' main spotlight is about the non-trivial zeros. And that there exists a critical line which is the real part s = 1/2. This critical line is where the non-trivial zeros of the zeta function should lie. This was the critical line which is equal to ½ + *it* , where t is a real number and i is an imaginary unit. In 2004, there is a report on a study about this hypothesis that on the critical line between 0 and 1, which is 1/2, there exist the first ten billion non-trivial zeros of the Riemann zeta function.

The Riemann zeta-function and the critical line Re(s) = ½ and the real part (represented by the red line) and the imaginary part (represented by the blue line).

A polar graph of the Riemann zeta-function along the critical line

There are five zeros visible on the polar graph on the critical strip. These are the places on the polar graph where the spirals pass through the origin.

Conclusion

There are several reasons why the Riemann hypothesis is so famous that it is now worth a million dollars. The Riemann hypothesis has been an open unsolved problem meaning that it is open to anyone to solved the problem and that there is a prize placed by the Clay Mathematics Institute to anyone who can provide the first correct proof. Also, it is open for almost a century, just like an antique item in an antique shop, the prize includes many zeros. In addition, if anyone had made a correct proof, then he can wake David Hilbert after his thousand years sleep, with his first question: “ Has the Riemann hypothesis been proven?”, and then he can answer proudly and loudly: “ YES!”.

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