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Applications of Number Theory in Engineering

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Abstract: Number theory is a discipline of mathematics devoted mostly to the study of integers. In contrast to calculus, geometry, etc., number theory as such finds little use in engineering. Its inability to be used directly in any application was the difficulty. But the number theory offers intriguing answers to practical issues when paired with the computing capacity of current computers. It is useful in many different areas, including computing, numerical analysis, and cryptography. Here, we emphasize using number theory to solve engineering problems

Key words: Number theory, engineering applications.

Introduction

Number theory is the branch of mathematics that concerns about only positive integers 1, 2, 3, 4, 5 which called natural numbers. These natural numbers have been categorized as odd, even, square, and prime, Fibonacci, triangular, and other terms since ancient times. Number theory is important in mathematics because there are so many unanswered problems. The most recent classification of number theory based on the methods employed to solve related issues Figure 1 displays the most current division of number theory according to the methods employed to solve related issues.

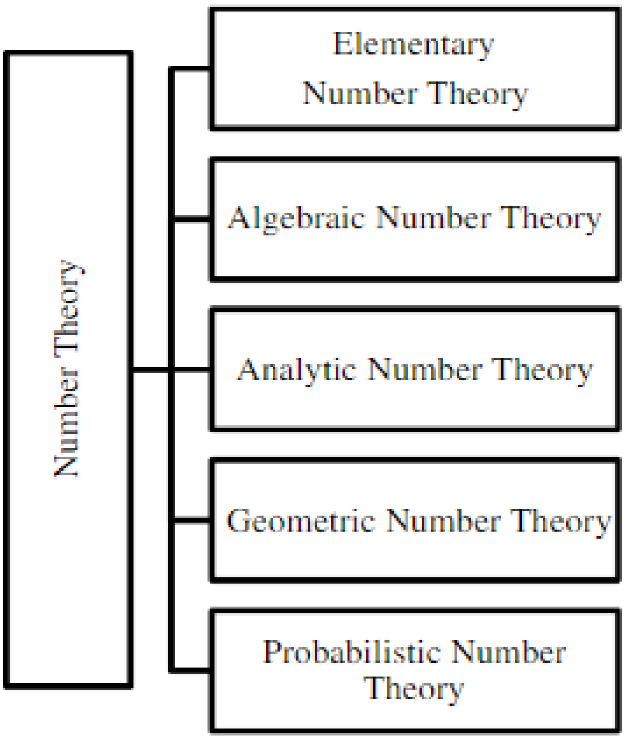

Figure 1. Modern classification on Number Theory

Greeks deserve all the credit for conducting scientific studies on integers. Later, a significant shift in this idea occurred as a result of the publication of Euclid's famous book "Elements," in which the mathematics itself is illustrated with explicit justification. There exist o few kinds of literature discussing about the applications of number theory in engineering. So, the purpose of present work is to perform a censorious review on the existing enactment related to the number theory applications in engineering

Applications of number theory

Number theory, a field of pure mathematics, saw less practical application in the early years. But when paired with existing processing technology, it offers answers to a number of pressing issues. The authors covered some of the theory's applications to engineering-related topics in this section.

In the current digital era, where online security is a major concern, cryptography is one of the most important subjects. Without adequate security, a message sent from a sender to a recipient online runs the danger of being observed by an unauthorized person. The idea of encryption and decryption is used to tackle this issue. The sender's message is said to be "encrypted" or "encoded" with the aid of a large number, typically a prime number, known as a "key," and the recipient needs the same key in order to "decrypt" or "decode" the message. In this case, the production of such big prime numbers is an application of number theory. With the use of number theory, Maurer [1] created an effective algorithm to produce such numbers. Modular arithmetic, a cornerstone of number theory, includes the congruence modulo relation. In addition to linear transformations, congruence modulo relations are crucial in cryptography [2]. The product of two prime numbers, say and, where and, need not be different, yields a natural number, A semi prime is a prime that need not be distinct. In the field of cryptography, semi primes are incredibly useful, particularly in public key cryptography. The idea of "elliptic curves" is crucial to number theory. In the past, research on number theoretic issues related to elliptic curves was done mostly for creative purposes. These questions have recently become crucial in several applicable fields, including coding theory, creating pseudorandom numbers, and most importantly, cryptography [4]. The topic "elliptic curve" is especially unique. Number Theory of Elementary Numbers Number theory in algebra Analysis of Numbers Theory of Geometric Numbers Cryptography using probabilistic number theory in the study of encryption. The present cryptic system is further protected by coding theory, which is based on number theory. The production of pseudorandom numbers is ideal for creating "keys." The super elliptic Diophantine equation, which is a crucial component of the study of number theory and is used for numerous applications based on computer coding, was described by Srikanth [5]. There are a lot of fascinating number sequences that are crucial for addressing problems. Fibonacci series is one of them (0, 1, 1, 2, 3, 5, 8). Engineering can use it in a variety of ways. The "Fibonacci search strategy," as discussed by Ferguson [6], is a method of searching a sorted array in computer science engineering. It employs a divide and conquers strategy. With the use of Fibonacci numbers, this approach helps to reduce the range of potential placements for the required element. The array is divided into two segments with sizes that are consecutive Fibonacci numbers using the Fibonacci search algorithm. It has the advantage that only addition and subtraction are required to calculate the indices of the accessible array members, eliminating the need for extra time-consuming operations. the reliance on time The Fibonacci series are used in the simulation to account for the time dependence of moments and size distributions during consolidation. The golden ratio is a crucial idea connected to the Fibonacci series (phi). If the ratio of any two quantities is the same as the ratio of their sum to the larger of the two quantities, then the ratio is said to be in the golden ratio. For two numbers x and y, represented algebraically, $x > y > 0$, $(x + y)/x = x/y = \varphi$.. The golden ratio is observed to be obeyed by the shapes of many natural and man-made things [7]. Some of the classic examples include the spirals found in plant blooms and the Parthenon, a well-known structure. The Fibonacci series is frequently seen in nature and has been used extensively in engineering and construction. The behavior of structural components utilized in engineering is explained by the phi code. It is seen as a defining parameters in the stress analysis of beams. Collins and Brebbia [8] pointed out the existence of phi code in the relation between shear stresses and normal. The normal stress σ (x) and the maximum shear stress τ max, for the condition $\sigma x = \tau x y$ and $\sigma y = 0$, is related as $\tau \max = \sigma x [\sqrt{5} / 2]$, where $\sqrt{5} = (1 + \Phi^2)/\Phi$. It is a useful tool for structural analysis

The "Pythagoras theorem" is one of the most well-known mathematical hypotheses. Giving the relationship between the sides, it deals with right-angled triangles. It comes as no surprise that it has uses in any subject that involves triangles. Following are a few well-known examples. The "Delta wing" is the wing configuration found on contemporary jet aircraft. This configuration's effective and efficient design is aided by the theorem. Rocket tips, which appear to be an isosceles triangle in section, have similar uses. Another illustration is the sectional

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study of a multi-stage rocket's frustum of cones, which acts as fairing in between the stages. The theorem is used to calculate the angles of engine and propeller blades. Using a range and sound source, meteorologists and space scientists hypotheses. This theorem is used by meteorologists and aerospace experts to determine range and sound source for right-angled triangles. The Pythagoras theorem and non-arithmetic sequence make for an intriguing combination in number theory. The legs of the right triangles in the numbers 3, 5, 9, 11, 15, 19, 21, 25, 29, and 35 are all odd numbers, while the lengths of the sides are all integers. The length of the hypotenuse is a prime number. [9] As Manfred [10] has discussed, number theory can be used to enhance the acoustics of performance halls. The acoustic quality is significantly improved by building new musical scales that maximize sound dispersal in the halls. The work of Manfred illustrates methods for enhanced sound dissipation via reflection phase-gratings based on three different number theory notions. The restricted partition function was described by Boris and Leonid [11] as a method for obtaining all algebraically independent invariants of the degrees arising from the finite group's action on the vector space over the complex field. The application of limited partition functions to the job of computing "emergent algebraically independent invariants" The task of determining "algebraically independent invariants" of the degrees that appear as a result of an action of "the finite group on the vector space over the field of complex numbers" is accomplished through the use of restricted partition functions. Generalization of the complete elliptic integral to two parameters Victor Barsan talked about the second kind, which is given in relation to the Appell function [12]. In this paper, this function is further reduced to a much more convenient bilinear form in the entire elliptic integrals, and a few practical applications in solid-state physics are briefly explained.

Alexander Berkovich and Krishnaswami Alladi provided new polynomial counterparts of Jacobi's triple product [13]. Weights nof the codewords, a straightforward introduction to both the mathematical and technical aspects of coding theory, was covered by Robert and Howard [14]. From a utilization-oriented approach, Roger [15] demonstrated the actual properties of regular point lattices increasing. He briefly discussed the traits of plant biology's Farey sequences. Armen et al. [16] studied "Newton-Girard power-sum" formulas equivalents for entire and meromorphic functions with applications to the Riemann zeta function.

The discussion concludes with a Ramanujan sum application in engineering. Over the past few decades, signal processing has become aware of the shape of this sum. The Ramanujan sum can be used to extract periodic components from discrete time signals, as demonstrated by Vaidyanathan [17]. Once more, Vaidyanathan [18] introduced the Ramanujan subspace and investigated its characteristics in order to demonstrate how finite duration signals can be broken down into the finite sum of orthogonal subspaces.

Thus, numerous areas of number theory's vast applicability are mentioned. Given the current situation, number theory plays a larger part in solving cyber security issues. Due to advancements in high-speed computing, there will be a wide range of potential applications in the future, and number theory applications have room to expand.

Conclusion

The number theory's many engineering applications were all covered in depth. It was initially recognized that number theory had made a considerable contribution to computer science engineering in the domain of cryptography in recent years. In practically every area of engineering, the significance of well-known series and sequences was discovered. It is clear that while certain applications of number theory did not directly include them, in others, their fundamental nature served as a catalyst for how to approach a solution. Also acknowledged was the applications' adaptability. More applications of number theory to both pure mathematics and applied/engineering mathematics will be made possible by further study and development of the subject.

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