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Correlation of Fibonacci Sequence and Golden Ratio With its Applications in Engineering and Science

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ABSTRACT

We have discussed in this elucidation paper about correlation of Fibonacci sequence and golden ratio with its applications in engineering and science. One of the most recurring sequences in nature is the Fibonacci sequence. As the sequence was explored, it was found out that this sequence led to the golden ratio. This study tried to apply the concept of Fibonacci and golden ratio to maximize efficiency of our live life. We consider self-similar curve like golden spiral in whose nature their beauty is much admired. The explanations show that source of Fibonacci numbers and how to exist Fibonacci numbers in the world we live. The mathematical theories of Fibonacci numbers and golden ratio gives the source of many new ideas in Mathematics, Chemistry, Civil engineering, Architecture, Automobile engineering, Philosophy, Botanic and biology, Electrical engineering, Computer science and engineering, Mechanical engineering, Communication systems, Mathematical education as well as theoretical physics and physics of high energy particles [1].

Keywords-- Fibonacci Sequence, Golden Ratio, Geometry

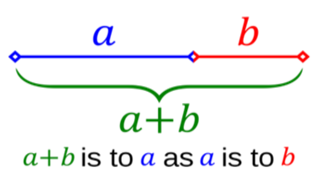
I. INTRODUCTION

Let's begin with a brief history of the excellent and the most glorious mathematician of the European Middle Ages, Leonardo Fibonacci. He is also known as Leonard of Pisa or Leonardo Pisano [2]. He was the most notable mathematician of the European Middle Ages. Fibonacci was born in the mid- 1170s into the Bonacci family of Pisa, a Prosperous mercantile Centre. His father Guglielmo was a successful vendor.Guglielmo wanted his son to follow his business. In 1190, when Guglielmo was appointed collector of customs in the Algerian city of Bugia (now Bougie). Guglielmo brought Leonardo in Bougie to learn the art of calculation. In Bougie, Fibonacci got his education from a Muslim schoolmaster, who introduced him to the Indo-Arabic numeration system and Indo-Arabic computational techniques. He also introduced Fibonacci to a book on algebra, Hisâb al-jabrw'almuqabâlah, written by the Persian mathematician, Al-Khowarizmi. When Fibonacci was an adult, he made persistent business trips to Syria, Egypt, France, Greece and Constantinople, where he studied the various systems of arithmetic. He was also living for a time at the court of the Roman Emperor, Frederick II (1194-1250), and he was busy in scientific debates with the Emperor and his philosophers. In 1200, at the age of about 30, Fibonacci returned home to Pisa. He was assured of the elegance and practical superiority of the Indo-Arabic system over the Roman numeration system then in use in Italy. In 1202, Fibonacci published his initiate work, Liber Abaci [1]. The Fibonacci sequence is splendid number sequences, and it continues to provide ample opportunities for professional and amateur mathematicians to make conjectures and to expand the mathematical horizon [3].Fibonacci Series begins with 0 and 1.Next number is found by adding the last two numbers together. Number obtained is the next number in the series.

i.e. 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, 377, 610, 987 …

In mathematics, there are two standards in the golden ratio if their ratio is the same as the ratio of their sum to the larger of the two quantities. The figure on the right represents the geometric relationship.

Expressed algebraically, for quantities a and b with a > b > 0,



$$\frac{a+b}{a} = \frac{a}{b} = \varphi$$

The golden ratio is represented by the Greek letter phi (φ) .It is an irrational number. The golden ratio is equal to 1.6180339887. This is an approximate value. It is a mathematical constant. Using quadratic formula, we get two solutions.

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$$x^2 - x - 1 = 0$$
$$x = \frac{-(-1) \pm \sqrt{(-1)^2 - 4(1)(-1)}}{2(1)}$$
$$x = \frac{1 \pm \sqrt{5}}{2}$$
$$x = \frac{1 + \sqrt{5}}{2}, \frac{1 - \sqrt{5}}{2}$$

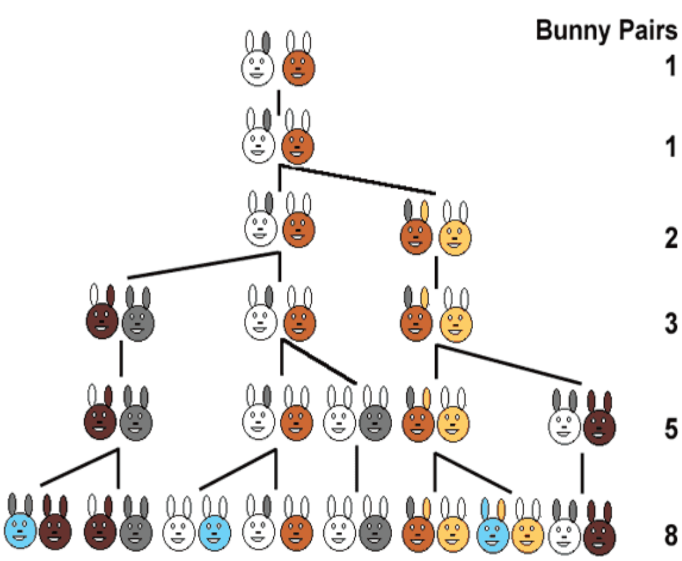
II. METHODOLOGY

Fibonacci Sequence

Fibonacci published his famous rabbit puzzle in 1202:

A man put a pair of bunny's or rabbits (a male and a female) in a garden that was enclosed. How many pairs of bunny's (rabbits) can be produced from the original pair within 12 months, if it is speculated that every months each pair of rabbits produce another pair (a male and a female) in which they become generative in the second month and no death, no escape of the rabbits and all female rabbits must reproduced during this period (year)?

The solution for this problem has a particular sequence of numbers, which is known as Fibonacci numbers or Fibonacci sequence. The below figure demonstrate that the representation of how the rabbits reproduced



Let speculate that a pair of rabbits (a male and a female) was born first in January. It will take a month before they can produce another pair of rabbits (a male and a female) which means that no other pair except one in the first of February. Then, in first of March we have 2 pairs of rabbits. This will continue by having 3 pairs in April 1, 5 pairs in May 1, 8 pairs in June 1 and so on. The table below shows the total number of pairs in a year. [4]

Table -1 - Shows the total number of pairs in one year

Month	Baby Rabbit	Mature Rabbit	Total
January 1	1	0	1
February 1	0	1	1
March 1	1	1	2
April 1	1	2	3
May 1	2	3	5
June 1	3	5	8
July 1	5	8	13
August 1	8	13	21
September 1	13	21	34
October 1	21	34	55
November 1	34	55	89
December 1	55	89	144

From above Table-1, the last column gives 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89,144,233 . . .

We know that Fibonacci numbers and we have 144 pairs of rabbits in one year. Fibonacci numbers has been one of the very interesting number sequences in mathematics. In Fibonacci sequences after every two odd numbers gets next number is an even. It is a unique. Also, the contemporary physicists and scientists commonly apply the recursive series of Fibonacci sequence. This sequence has gone away from a simple arithmetic in the branches of mathematics due to that fact it was surprisingly regained in variety of forms. Fibonacci numbers has a unique and fascinating property that, for all Fibonacci numbers is the sum of the two immediately preceding Fibonacci numbers except the first two numbers. Base on its methodological development has attended to a great application in mathematics and computer science. [4]

Pascal Triangle and Fibonacci Numbers–

A great French mathematician, Blaise Pascal he was focused in mathematics and technology. Blaise Pascal developed a triangular array known as Pascal's triangle. In which the puzzling sequence, Fibonacci numbers pop up. These Fibonacci numbers was found by adding the diagonals numbers in Pascal's triangle. The Pascal's triangle has some properties and uses. One of the properties is the addition of any two consecutive numbers into the diagonal (1, 3, 6, 10,15,21, 28, 36 …) gives the perfect square results (1, 4, 9, 16, 25, 36, 49, 64…). It is being used for finding the probability combination

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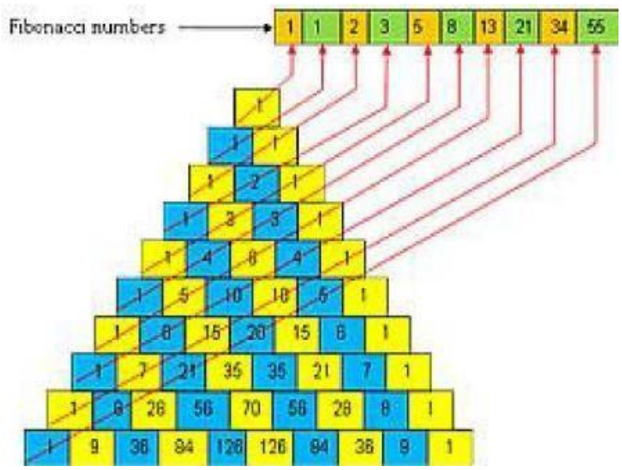
problem. The major number theorist, Fibonacci is unknowing of the connectivity between his rabbit's problem and theory of probability. But this was discovered 400 years later [4].



III. PRIOR APPROACH

Golden Ratio

In mathematics, there are two quantities in the golden ratio. If the ratio between the sum of two quantities and the larger one is the same as the ratio between the larger one and the smaller one. The golden ratio is also known as the most aesthetic ratio between the two sides of a rectangle [3].The golden ratio is a mathematical constant, which is 1.6180339887 approximately.

Golden ratio has singular mathematical principles in all his Shapes and models [5]. Golden ratio has unparalleled mathematical properties [6]. The golden ratio is equal to its own reciprocal plus 1[7].One of the best property is that the concept was originated in plane geometry, division of a line segment into two segments. The golden ratio is indicated by the Greek letter(phi)[4].

Relation Between Fibonacci Sequence and Golden ratio-

Fibonacci Numbers:

0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, 377, 610, 987,1597 …

Fibonacci numbers have an interesting characteristic. If we divide one number of the Fibonacci sequence to the previous one then we will get results that are so close to each other [7]. Furthermore, after the 13^{th}number in the sequence, the division will be unchangeable at 1.618, namely the golden number. [8]

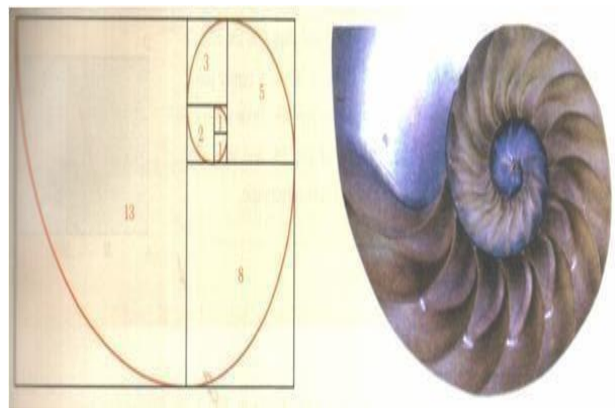
Golden ratio=1.618
233 / 144 =1.618
377 / 233 =1.618
610 / 377 =1.618
987 / 610 =1.618
1597 / 987 = 1.618
2584 / 1597 = 1.618[9]

IV. OUR APPROACH

Applications of Golden Ratio in Engineering and Science-

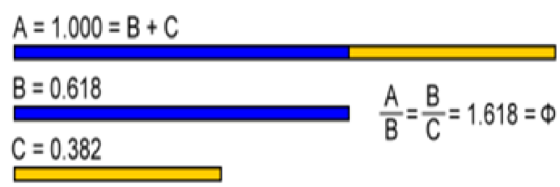
1) Golden Ratio and Mathematics

In mathematical properties of golden ratio is truly



unique and prevalent in its actualization throughout nature. The "mathematically challenged" may be more fascinated in the actualization of Phi in nature, its utilization to art, architecture and design, and its potential for understanding into the more transcendent aspects of life. Here, Pi or p (3.14…) is the ratio of the circumference of a circle to its diameter.

If we divide a line in one very special and unique way then we get golden ratio Phi or Φ (1.618 …)



What makes this so much more than an interesting exercise in mathematics is that this proportion appears throughout creation and expansive in the human face and body. It's found in the distribution of many other animals, in plants, in the solar system and even in the cost and timing movements of inventory markets and foreign currency exchange. Its demand thus ranges from mathematicians to doctors to naturalists to artists to investors to extraordinary [1].

2) Geometry of the Golden Ratio

The great scientist Johannes Kepler (1571-1630), pioneer of the true elliptical nature of the orbits of the planets in the solar system described it as such: "Geometry has two great importance: one is the Theorem of

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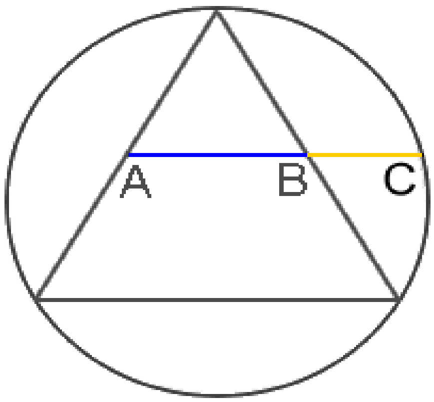
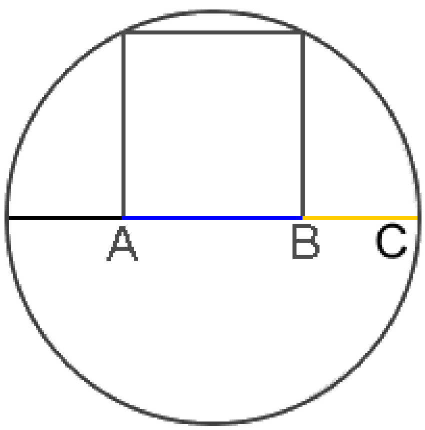
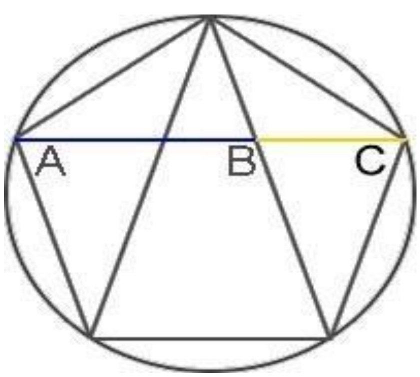
Pythagoras and another is the division of a line into extreme and mean ratio. The first we may compare to a measure of gold.

The Golden Ratio is also found in basic constructions of an equilateral triangle, square and pentagon placed inside a circle, as well as in more complex three-dimensional solids such as dodecahedrons, icosahedrons and "Bucky balls," in geometry. Which were titled for Buckminster Fuller and are the basis for the shapes of both Carbon 60 and soccer balls[1].

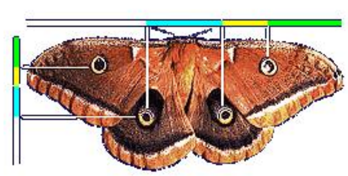






3) Phi Matrix and Golden Ratio-

While the Golden Section has been used for centuries, the concept for PhiMatrix is based on a model insight to fits developer in 1997 that the Golden Section could be enforced in repetition to a line to create a "Golden Ruler™." PhiMatrix is a graphic analysis and design device that lets you see and apply phi ratio to any image. Application of Phimatrix is picture of a variety of life forms revealed that their physical dimensions were all based upon the same distribution of design using the number phi. Some examples are shown below.



4) Perceptions of Beauty

Some would dispute that beauty is in the eye of the beholder, but there is witness to support that what we perceive as beauty in women and men is based on how

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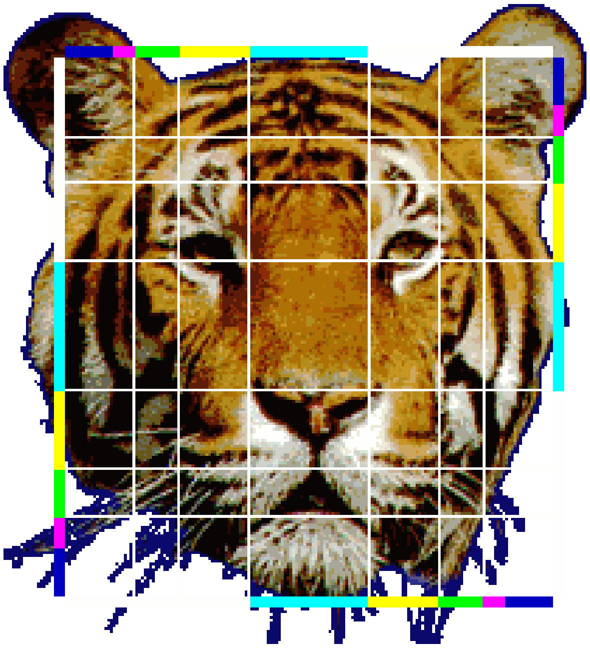
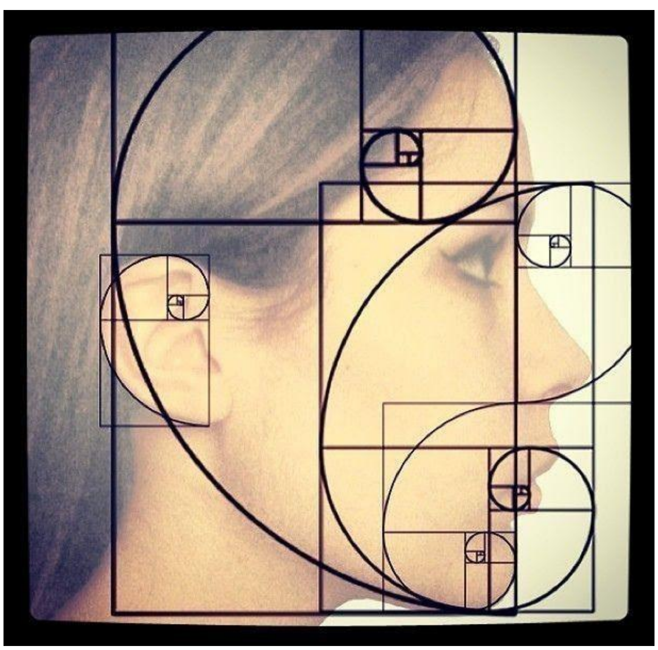
closely the proportions of facial and body dimensions come to Phi. It shows that Phi is hard-wired into our awareness as a guide to beauty. For this reason, Phi is applied in both cosmetic dentistry and facial plastic surgery as a guide to achieving the most natural and beautiful results in facial features and appearance.



More fascinating yet is the extensive appearance of Phi throughout the human form, in the face, teeth, body, fingers, and even our DNA, and the impact that this has on our realization of human beauty.



5) Nature and Life

There are many other interesting mathematical relationships and oddities in both Phi and the Fibonacci series that can be analyze in more depth ,but now let's take a step away from the purely mathematical and journey into nature [10], where Phi and the Fibonacci series manifest themselves extensive, but not universally [11]. Fibonacci numbers generally appear in the numbers of petals in a flower and in the spirals of plants [12]. The location and portion of the key dimensions of many animals are based on Phi. Examples include the body sections of ants and other insects, the wing dimensions and location of eye- like spots on the spirals of sea shells, Ant and the position of the dorsal fins on porpoises. Even the spirals of human DNA embody phi proportions[13].

6) The Solar System and Universe

Terribly enough, we even find relationships of golden ratio, solar system and universe. The diameters of the Earth and Moon form a triangle whose dimensions are based on the mathematical characteristics of phi. The space of the planets from the sun correlate surprisingly closely to exponential powers of Phi. The beautiful rings of Saturn are very close in dimension to the golden ratio of the planet's diameter. NASA released findings that the dodecahedron based on Phi in2003.

7) Automobile Engineering

The golden ratio has been used for centuries for design and formation in the arts and architecture, and it is frequently used by professional designers in Logo design, Graphic design, Fonts and type spacing, Product design, Photo cropping and photo composition and Website design.

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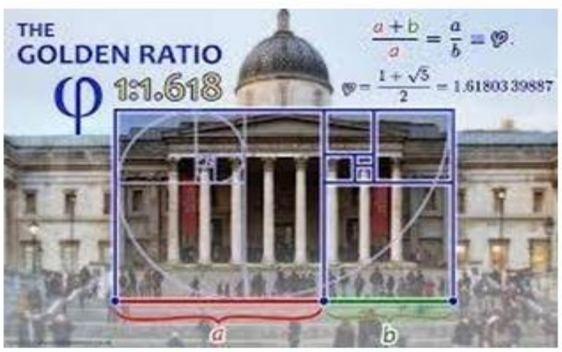
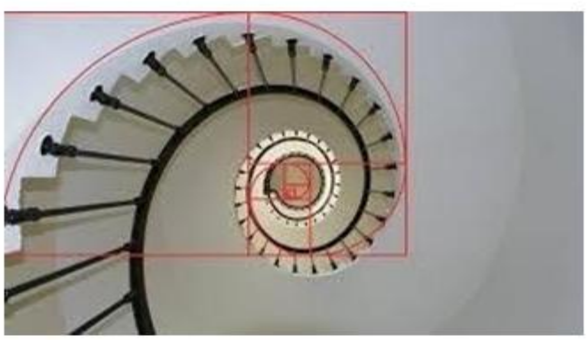
8) Architecture Engineering

Many projects of art are challenged to have been designed by using the golden ratio. [14]

E.g.: The Parthenon, according to some studies, has many proportions that approximate the golden ratio.





V. CONCLUSION

In this paper we conclude, that how to use golden ratio in day to day life. Before of that part it explained interesting relationship between Fibonacci sequence and golden ratio. Golden ratio is totally based on Fibonacci sequence. If we apply golden ratio in daily life then the work will be easier, accurate and effectively. Golden ratio is applicable to solve real life engineering and science problems.

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