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Fibonacci Number: Its influence in Visual Design and the Plant Kingdom

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1. Abstract:

The Fibonacci sequence is an amazing sequence followed by the nature itself. The **Fibonacci** sequence is a set of numbers that starts with one or a zero, followed by a one, and proceeds based on the rule that each number (called a **Fibonacci** number) is equal to the sum of the preceding two numbers. The sequence is actually very close ratio to the Golden Ratio. The Golden Ratio is a design concept that is to create visually appealing proportions in art, architecture, design and even the human body all throughout history. It's believed that the Golden Ratio has been in use for at least 4,000 years in human art and design. However, it may be even longer than that – some people argue that the Ancient Egyptians used the principle to build the pyramids. Visual design gives an application its distinctive style, its thematic look and innate identity. Here we will try to establish the influence of Fibonacci sequence, Golden Ratio and their contribution in the field of Visual design and will try to show how the Golden Ratio is applicable to the pattern of tree leaves and relation of Fibonacci sequence with the design of flower petals, exist in nature.

2. Keywords:

Fibonacci number, Golden Ratio, Golden Rectangle, Golden Spiral.

3. Introduction:[1, 2, 3]

According to the famous mathematician Euclid, “The laws of nature are but the mathematical thoughts of God”. Mathematics is all around of us. But most of us are not interested in going deep about what mathematical explanations are in nature. Mathematical formulations and justifications are inherent in nature; in the case of plants, animals, geographical observations, fractals, Chaos, shapes and patterns and many more. Mathematical symmetry is inherent everywhere in nature. The human body would be an excellent example of a living being that has symmetry.

The Fibonacci sequence is a unique mathematical sequence followed by nature itself. Fibonacci sequence was proposed by the famous mathematician Fibonacci Leonardo Pisano who hailed from Republic of Pisa, is popularly known as Fibonacci. This sequence is a series of numbers from classical mathematics that has found applications in advanced mathematics, statistics, computer science etc.

The Fibonacci sequence is a series of numbers starting with 0 and 1 and the sum of the two preceding numbers form the next number. The mathematical rule to find any Fibonacci number (F) of the sequence is $F_n = F_{n-1}+F_{n-2}$, where$F_1=0$, $F_2=1, n\geq3$. The sequence is then given by 0, 1, 1, 2, 3,5 ,8, 13,….. and so on. The sequence is commonly seen in nature. This pattern and sequence is

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found in branching of trees, flowering artichokes and arrangement of leaves on a stem to name a few. These seemingly random patterns in nature also are considered to have a strong aesthetic value to humans. Fibonacci spiral is derived by human to apply it to create visually stunning architectures. The Pyramids of Giza, the Parthenon and Da Vinci's painting of The Last Supper are all said to be designed and composed within the parameters of this ubiquitous and ancient equation.

Golden Section, the Golden Mean or the Divine Proportion, the Golden Ratio is basically understood as 1:1.618, and is derived from the famous mathematical Fibonacci Sequence in which each number is the sum of the two numbers before it. The difference between any two numbers in this sequence isn't always exactly equal to 1:1.618 but it's approximately equal.

4. Objectives:

This study focuses on the following objectives :

(i) To explore the relationship between Mathematics and visual design and to popularize the study of Fibonacci number in visual design.

(ii) To popularize the teaching of Mathematics concept with the help of quotidian design with special reference to Fibonacci number.

(iii) To popularize core ideas of Mathematics with the help of visual presentation in an interesting way.

5. Discussion : [1,3,4]

The idea here is to use those Fibonacci numbers in a visual way for easier understanding. The "golden rectangle" is one that fits the parameters of the golden ratio. Here we will see that the more times you divide a golden rectangle according to the golden ratio, the more useful and accurate it becomes.

At first, lets divide a rectangle with the golden proportions. To make things easier, the rectangle starts with a width of 1,000 pixels with a height of 618 pixels (1:1.618).

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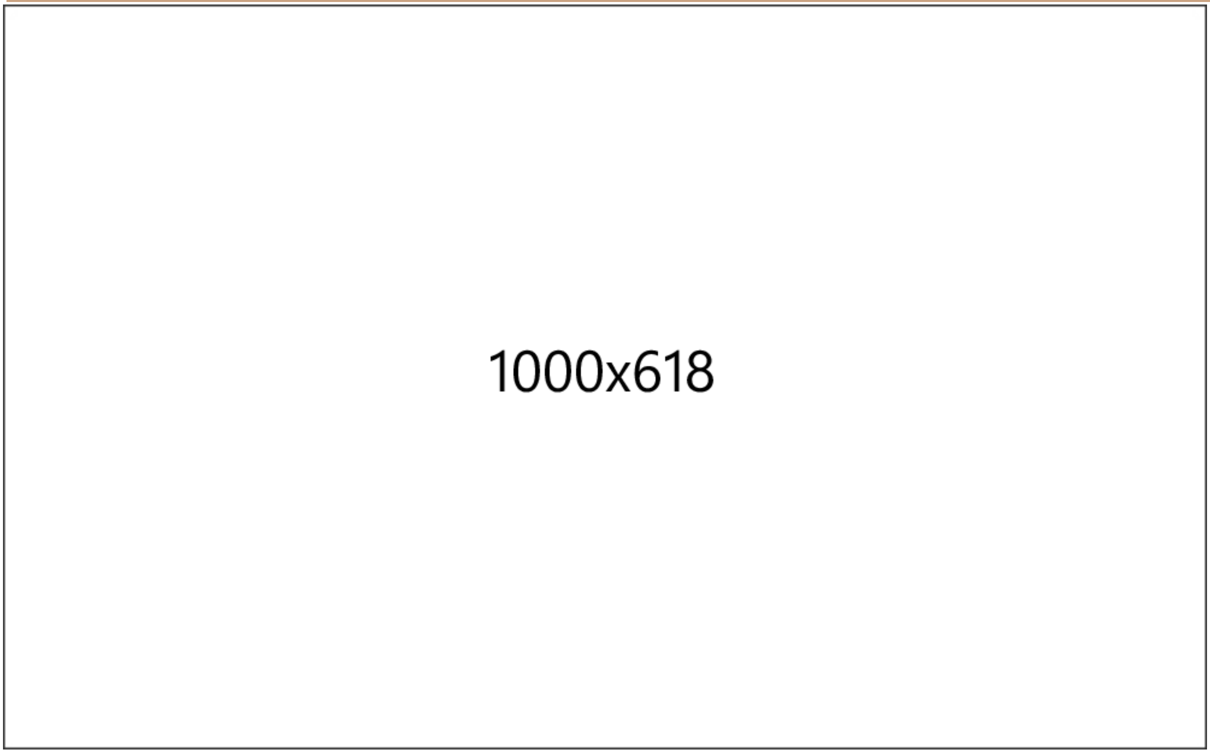

Then lets create a 618 x 618 square on the right side of the canvas, leaving the left side with a 382 x 618 rectangle.

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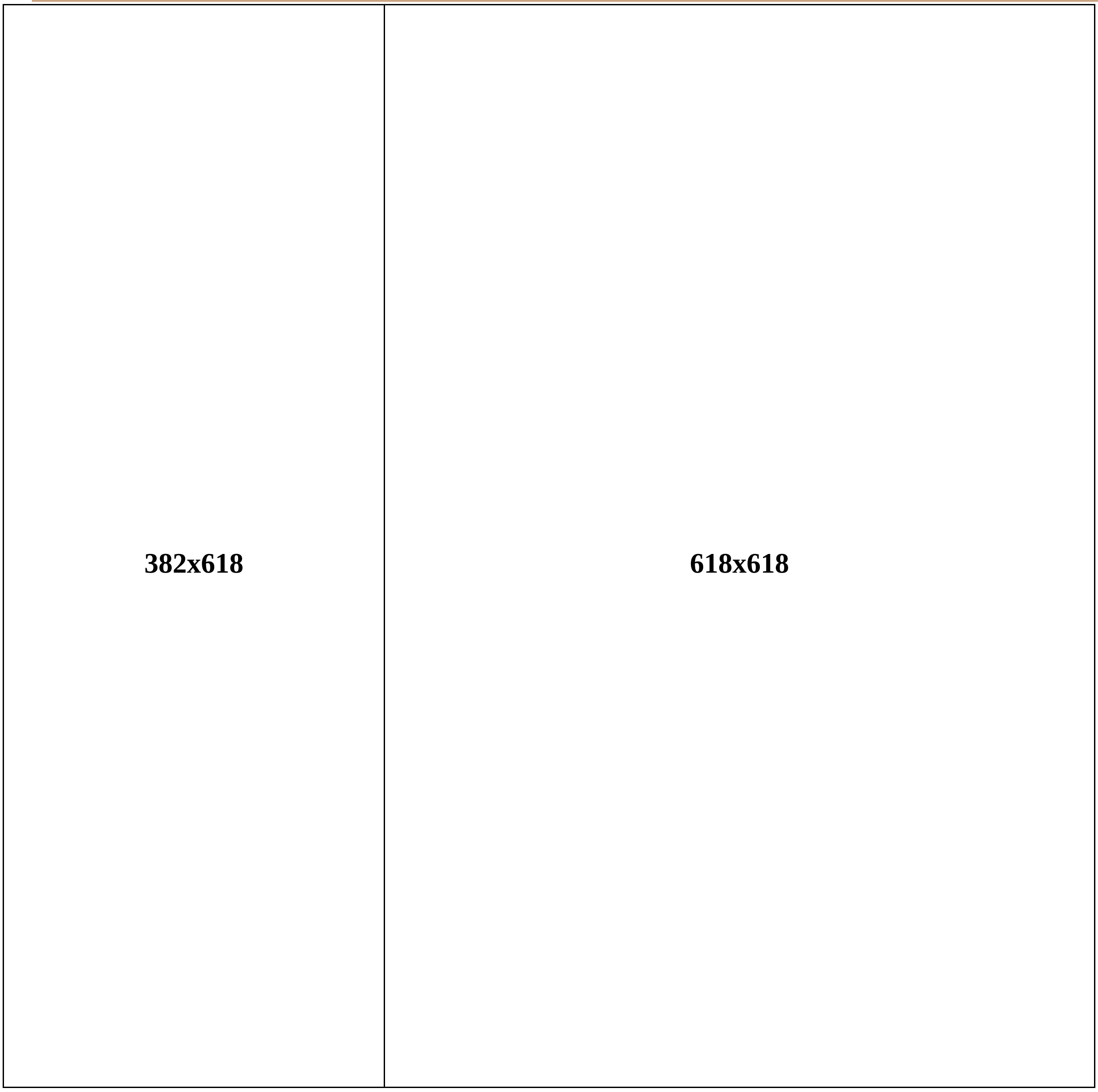

Let’s continue the sequence to create another square within it. We'll end up with another and another golden rectangle in the leftover space. We can divide that again and again, and so forth.

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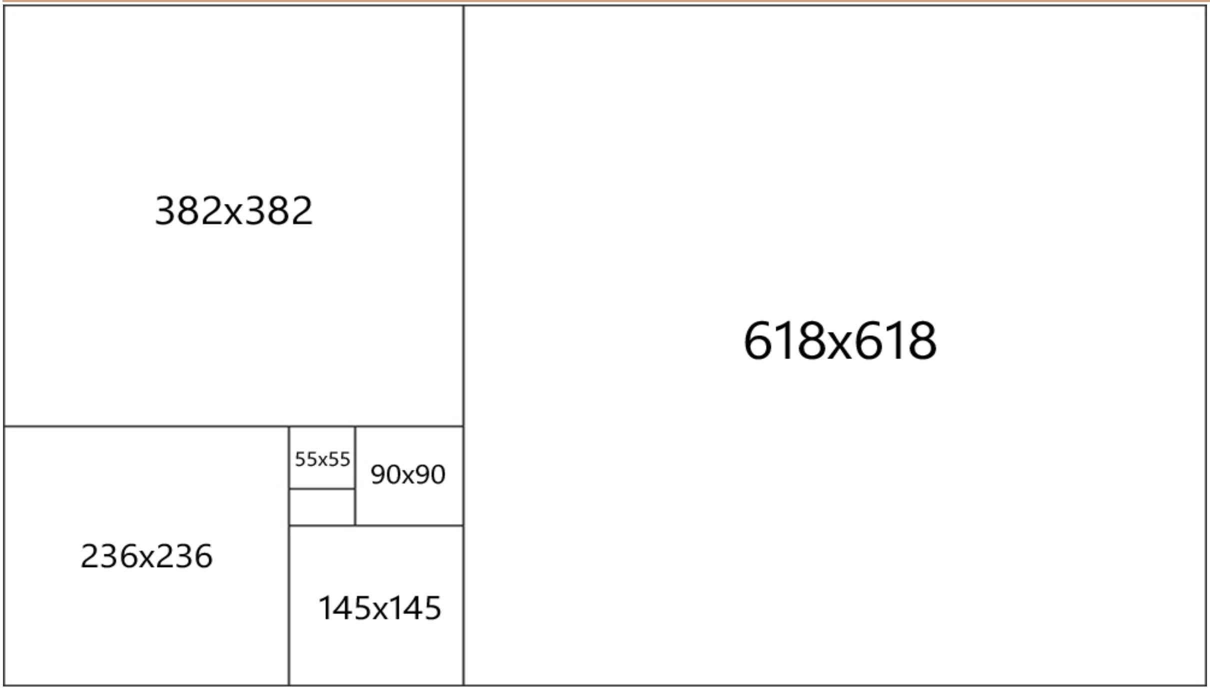
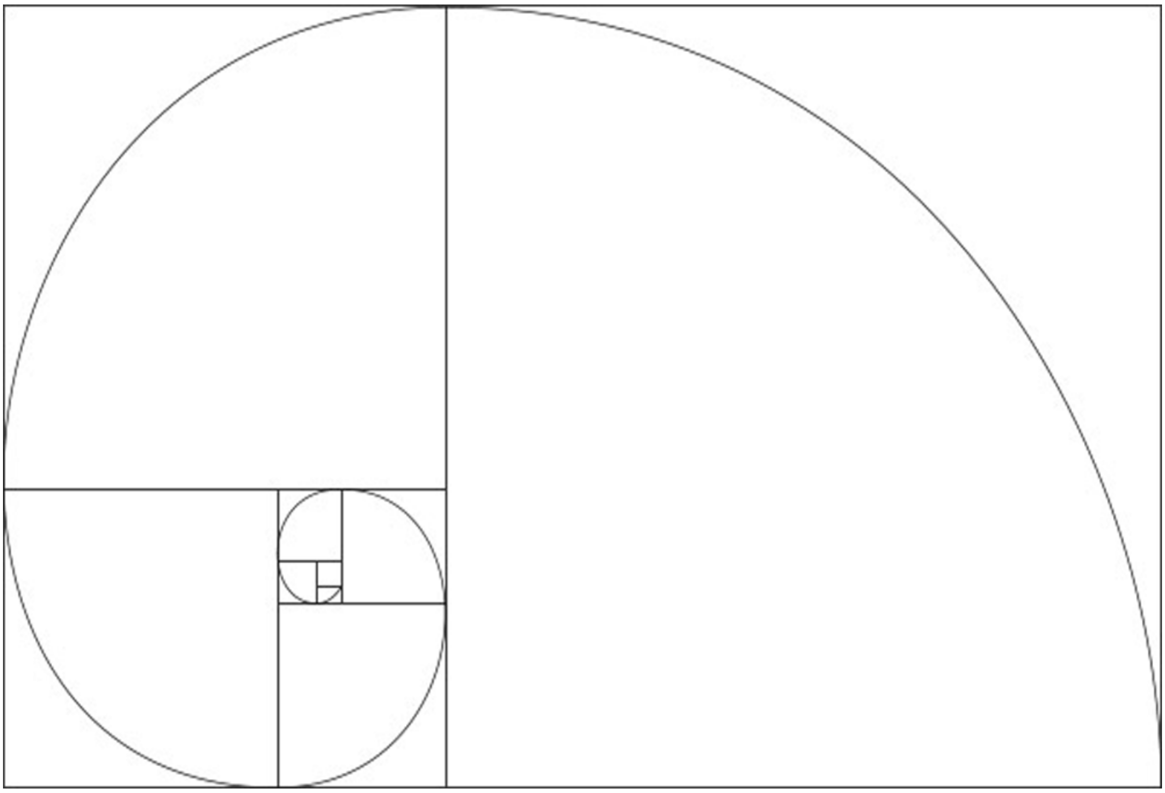


Now we can see that each time we divide a golden rectangle, the largest dividing line creates a spiral into itself. This is called the golden spiral, the ubiquitous shape that works with the golden ratio. This golden spiral is a logarithmic spiral whose growth factor is φ, which is the golden ratio.



The golden rectangle is one of the simplest way to visualize the golden ratio. Other shapes can create their own golden ratio based on the said sequence.

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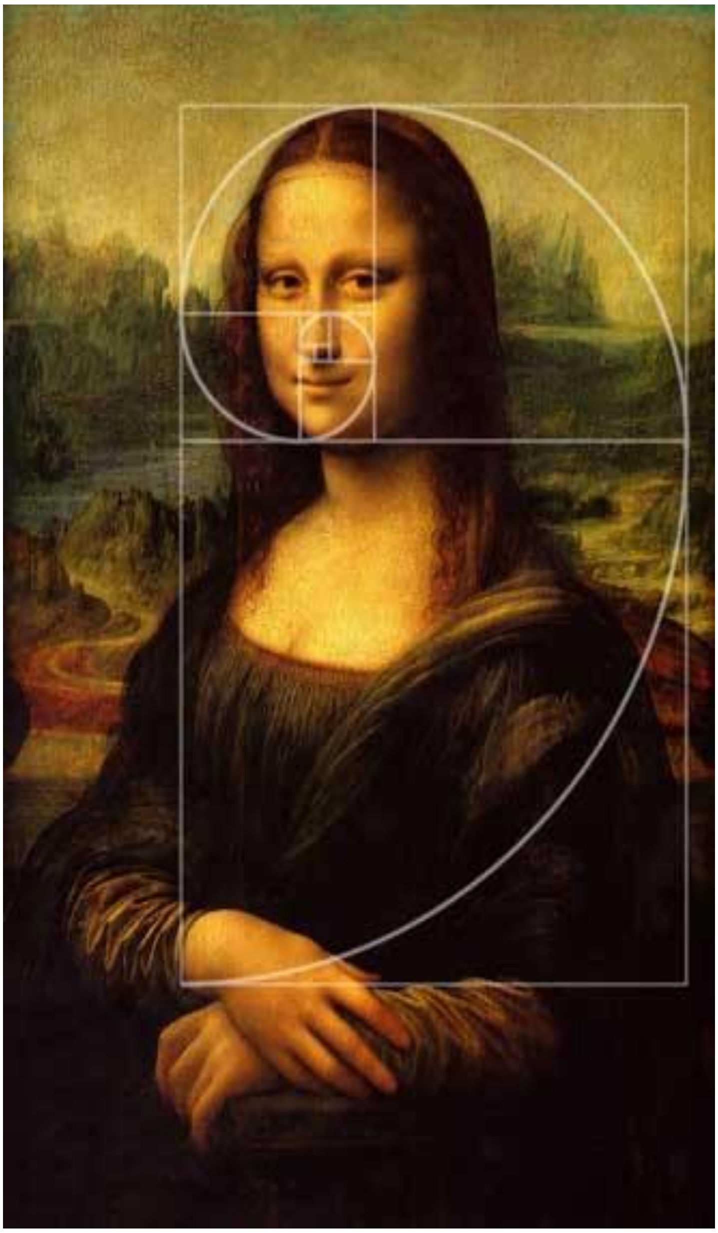
6. Methodology:

The research paper is mainly based on observational type of field work and Analytical method. For this we have used a combination of some of the classical social sciences research tools- questions and interviews, archives and quotidian visual references.

Implementation of Golden Ratio in Graphic Design



The golden ratio is a mathematical theory, but it somehow shows up in the real world. But it should be kept in mind that the golden ratio is based on irrational numbers, so many of these examples don't exactly conform to the golden ratio.

So even when the golden ratio can be found in the work of art, that doesn't necessarily mean that the artist intentionally included it as part of his/her design. It's presence, whether intended or not, is a demonstration of their natural balance. It's a rule of geometry that can be as pleasing as a classical composition. The Golden Ratio is a mathematical ratio. It is commonly found in nature, and when used in design, it fosters organic and natural looking compositions that are aesthetically pleasing to the eye. It's 99.99% accurate.

The logo of famous computer company apple is based on Fibonacci Spiral as evident from the following Picture.

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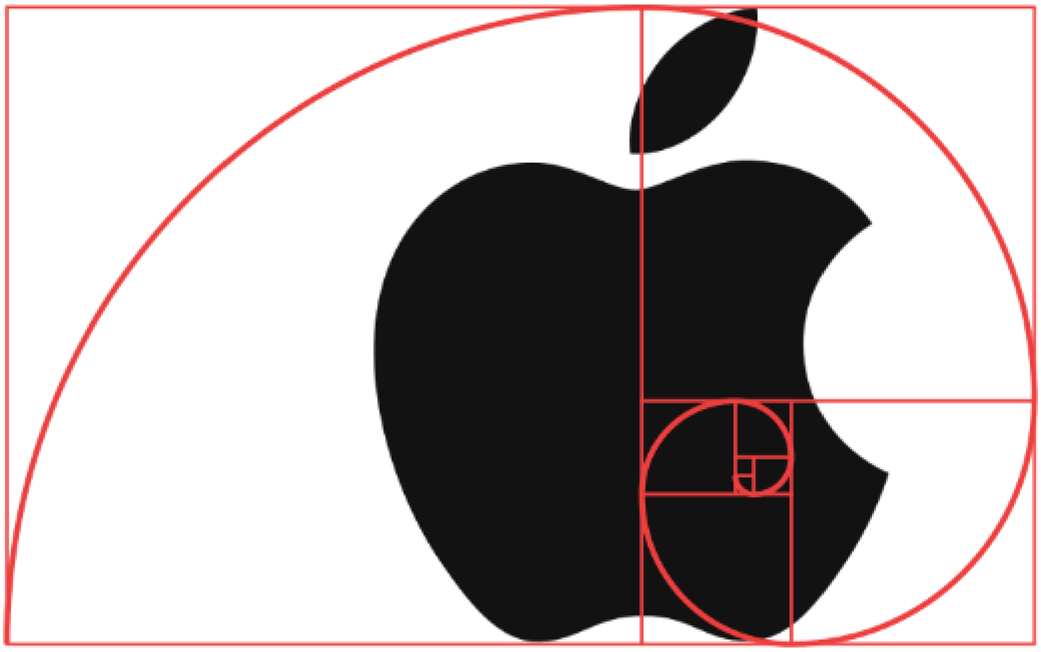
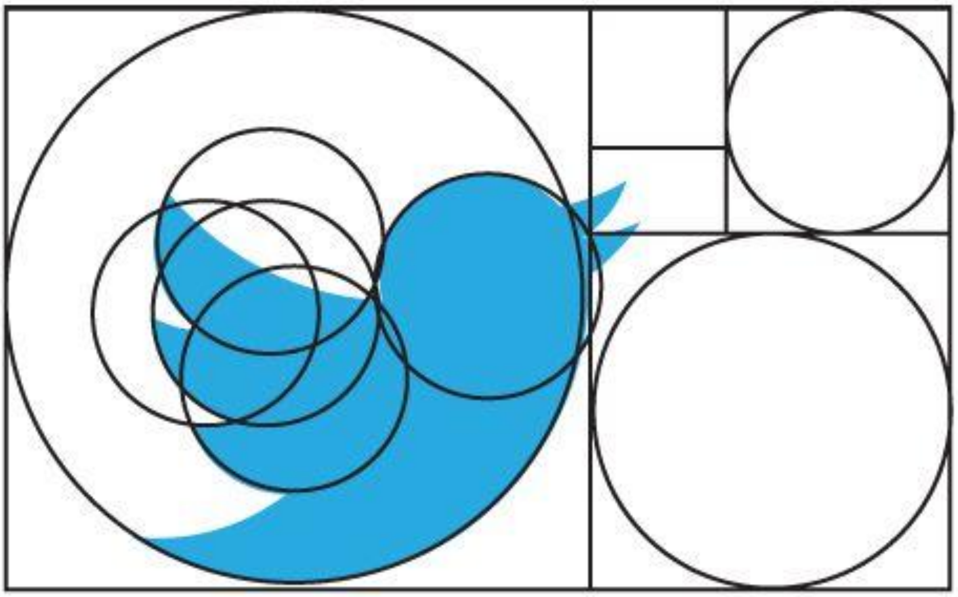


The famous microblogging company twitter's logo was designed with the help of Fibonacci spiral.



We can find examples of golden ratio everywhere in nature. As a part our study two case examples regarding Fibonacci sequence and golden ratio with the pattern of flower petals and leaf structure of some commonly available plants in different areas of Assam , India are reflected below

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7. Empirical Studies [5,6,7]

7.1 Case 1: Fibonacci sequence and the pattern of flower petals

In nature, the flowers of different species have some definite patterns and number of petals. An exciting relation is observed between the Fibonacci sequence and the structure of petals of some common flowers. The number of petals is equal to a term of the Fibonacci sequence: 0, 1, 1, 3, 5, 8, 13, ... For the present study, several common flowers and their photograph have been collected locally. The photographs of 16 arbitrarily chosen flowers are presented below.

Table 1 (below): Represents the common names, scientific names and the number of petals of the 16 flowers. The observations are presented in the last column.

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Sl No.	Local Names	Scientific Names	Number of petals	Observation
1.	Kori flower	*Tabernaemontana*	5	Fibonacci Number
2.	Zinnia	*Zinnia elegans*	13	Fibonacci Number
3.	Jaba	*Hibiscus rosa-sinensis*	5	Fibonacci Number
4.	Tara gandha	*Tagetes erecta Linn*	8	Fibonacci Number
5.	Aparajita/Asian pigeonwings	*Clitoria terntea*	2	Fibonacci Number
6.	Korobi/Oleander	*Nerium oleander*	5	Fibonacci Number
7.	Halud flower	*Unknown*	5	Fibonacci Number
8.	Wild flower	*Unknown*	5	Fibonacci Number
9.	Kachu /Arum flower	*Colocasia esculenta*	1	Fibonacci Number
10.	Bokful /Heron flower	*Sesbania grandiflora*	5	Fibonacci Number
11.	Bougainvillea	*Bougainvillea glabra*	3	Fibonacci Number
12.	Kanchan	*Bauninia acuminata*	5	Fibonacci Number
13.	Rose	*Rosa*	5	Fibonacci Number
14.	Sapla	*Nymphaeaceae*	8	Fibonacci Number
15.	Nayantara	*Catharanthus roseus*	5	Fibonacci Number
16.	White water lily	*Nymphaea alba*	8	Fibonacci Number

Table:1

7.2 Case 2: Golden Ratio and the structure of tree leaves

The trees of different species have leaves with different shapes and texture but an interesting relationship has been observed between the Golden Ratio and the leaf structure. In the present study, two parameters, length and width of leaves of several common trees have been measured and the averages are recorded. Surprisingly, it is observed that in the majority of cases (more than 70%), the ratio of length and the width of the different tree leaves lies in between 1.5 to 1.8, which is nearly equal to Golden Ratio 1.618 A part of the results is presented in Table 2.

Table 2 (below): Represents the local names, scientific names, the length and width of the leaves of some plants.

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For better understanding, the photographs of the leaves of the above-mentioned plants are presented below.

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Serial No.	Local name	Scientific Names	Average Length of leaf (L) cm	Average width of the leaf (B) cm	Ration of L and B (L/B)	Observation
1.	Siuli	*Nyctanthes arbor-tristis*	10.3	6.3	1.6349	G. Ratio
2.	Kori flower	*Tabernaemontana*	7	4.29	1.6317	G. Ratio
3.	Jaba	*Hibiscus rosa-sinensis*	9.9	6.1	1.6229	G. Ratio
4.	Gulancha (Giloi)	*Tinospora cordifolia*	7.5	4.7	1.5957	G. Ratio
5.	Tulsi	*Ocimum sanctum Linn*	4.3	2.6	1.6538	G. Ratio
6.	Kachupata	*Colocasia esculenta*	21.5	13.5	1.5925	G. Ratio
7.	Wild pant	*Unknown*	6.4	3.7	1.7297	G.Ratio
8.	Akanda	*Calotropis giganta*	14.6	7.9	1.8481	G. Ratio
9.	Land Lotus/ Cotton Rose/ Sthal- Padma	*Hibiscus acetosella*	18.5	12.1	1.5289	G. Ratio
10.	Sim	*Phaseolus vulgaris*	11.5	7.6	1.5131	G. Ratio
11.	Boroi	*Ziziphus mauritiana*	5.3	3.2	1.6562	G. Ratio
12.	Aparajita	*Clitoria terntea*	4.4	2.9	1.5172	G. Ratio

Table:2

8. Findings :

The highlighting findings of the study are :

(i) A generic sense will develop among interested groups; common people will know how the history of visual design came into present stage.

(ii) A common man without proper education in design can hope to create interesting patterns, logos with the easier interpretation of Fibonacci numbers traditionally or manually.

9. Conclusion:

The Fibonacci sequence is a ubiquitous and intriguing mathematical number pattern. Far from being just a mathematical curiosity, however, this sequence recurs throughout nature from the breeding of rabbits to the arrangement of spirals on pinecones. In fact there is an endless array of Fibonacci sequences in art, architecture, the stock market and other areas of society and culture. Composition is important for any image or Visual Design element, whether it's to convey important information or to create an aesthetically appealing frame. The graphical implementation of mathematical idea Fibonacci number and Golden Ratio can help create a composition that will draw the eyes to the important elements of the Design. The first empirical study shows that how the Fibonacci sequence is followed by the flower petals. A fascinating observation is that maximum flowers have 5 petals. Most probably, it is due to the fact that the pentagon structure is one of the most stable structures. The second study show how the structure of most of the leaves follow the Golden Ratio. Obviously, some exceptions are present everywhere to establish the regularity.

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