

The Golden Code of Life: A Wondrous Journey from Mathematical Proportions to Painting Composition

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Abstract: *From the perspective of a high school student, this paper explores the intrinsic connection between the golden ratio in mathematics and the composition of paintings. By analyzing famous artwork cases, campus practice records, and artistic creation experiments, the paper transforms the abstract mathematical formula $\varphi=1.618$ into an intuitive visual composition tool, elucidating the application methods and aesthetic value of the golden ratio in artistic creation. The study demonstrates that understanding the golden ratio not only enhances the sense of harmony in painting composition but also fosters interdisciplinary thinking skills in students, enabling mutual inspiration and reinforcement between mathematical learning and artistic creation.*

Keywords: Golden Ratio, Painting Composition, Mathematical Application.

1. Introduction

I remember in the math class of my first year of high school, the teacher wrote on the blackboard “ $\varphi=1.618$ ” and said it was the “most beautiful proportion”. I stared at this number and muttered to myself: Can beauty still be measured by numbers? A few weeks later in art class, the teacher showed Leonardo da Vinci’s “Mona Lisa” and pointed to the painting, saying, “Look, her facial position and background segmentation all imply a magical proportion.” I suddenly realized - isn’t this the “phi” in math class? At that moment, I had a strong curiosity: how does a mathematical proportion affect artistic creation? This question opened up my six-month exploration. This article is a record of this exploration, and I want to prove that mathematical formulas can not only solve equations, but also help us draw more beautiful pictures.

2. The Golden Ratio: It's Actually Quite Simple

The golden ratio, also known as the golden ratio, refers to dividing a whole into two parts, with the ratio of the larger part to the larger part being equal to the ratio of the smaller part to the larger part, with a value of approximately 1:1.618. This proportion is not artificially created, but originates from the natural growth laws of all things, from the arrangement of petals and conch spirals to the distribution of galaxies, its traces can be found. In the field of art, the golden ratio is regarded as an important principle for building harmonious beauty. Artists use this ratio to plan compositions and divide spaces, making their works visually more in line with human aesthetic intuition, achieving a perfect unity of balance and tension, and becoming a classic aesthetic code that transcends time, space, and culture.

The origin of mathematics and aesthetics is quite deep. Ancient Greek scholars believed that mathematics was the starting point of philosophy, and it was precisely because of the innovation and creation of philosophy that aesthetics stood out. Beauty is nurtured in mathematics, and aesthetics cannot be separated from mathematics. Every mathematical formula is composed of a series of symbols, which are interrelated and

influence each other. Even if we break away from the logical validity of mathematical formulas and simply look at the arrangement and combination of symbols, it is a beautiful experience. In recent years, advertisements and paintings have also seen works composed of numbers and letters, which are new attempts at symbolic aesthetics and provide more possibilities for the combination of mathematics and beauty [1].

2.1 An Ancient Proportion Game

If you want to draw a line on paper and divide it into two sections to achieve the most comfortable visual effect, how should you divide it? This seemingly simple question had a clever answer as early as ancient Greece. The ancient Greeks discovered through long-term observation and exploration of nature and art that when the ratio of longer segments to the total length of a line segment is exactly equal to the ratio of shorter segments to longer segments, the overall visual harmony is optimal. This is the classic golden ratio, with a core ratio of about 0.618:1. This proportion is not simply a mathematical concept, but rather an aesthetic law that conforms to human aesthetic intuition, and is widely used in many fields such as painting and architecture.

The golden ratio was known as the “Middle to Late Ratio” in ancient Greece and was recorded in the Elements. During the Renaissance, Leonardo da Vinci’s friend, mathematician Luca Pacioli, was deeply attracted by the geometric structure with the golden ratio while organizing “Elements” and praised it as the “sacred proportion”. Between 1496 and 1498, Luca Pacioli wrote the book “Sacred Proportion” on this topic, discussing the importance of the golden ratio in mathematics and art. Leonardo da Vinci created many illustrations for ‘The Sacred Proportion’. Luca Pacioli himself also designed an elegant serif font using the tangent relationship between circles and rectangles [2].

We can clearly derive this ratio using the equation we have learned: assuming the total length of the line segment is 1 and the length of the longer segment is x, according to the definition of the golden ratio, the equation can be given:

$x/1=(1-x)/x$. After sorting, we obtain $x^2=1-x$, which means $x^2+x-1=0$. Solving this quadratic equation (excluding negative roots), we can ultimately obtain $x \approx 0.618$. This concise and precise numerical value has become an aesthetic code that spans thousands of years and connects the East and the West, providing important visual balance guidance for various creations.

2.2 Fibonacci Sequence: the “design map” of Nature

0, 1, 1, 2, 3, 5, 8, 13, 21... This seemingly ordinary sequence contains infinite fun, and it is the famous Fibonacci sequence. The rule is simple and straightforward: starting from the third term, every number is the sum of the first two numbers, so the recursion can be infinitely extended. What's even more amazing is its hidden password - the ratio of adjacent items changes: $3/2=1.5$, $5/3 \approx 1.667$, $8/5=1.6$, $13/8=1.625$, $21/13 \approx 1.615$. As the number of items increases, this ratio will continue to approach 1.618, which is the perfect value known as the “golden ratio”.

This mathematical law does not only exist in theory, but can also be seen everywhere in nature: the scales of pine cones are arranged in two sets of Fibonacci numbers in a spiral, which is both stable and space saving; The seeds on the sunflower disk form a spiral in both clockwise and counterclockwise directions, with a quantity exactly equal to the adjacent Fibonacci numbers; Even the number of petals is mostly Fibonacci numbers such as 3, 5, 8, and 13. It turns out that nature has long understood the mystery of this sequence, using the most efficient way to complete growth and reproduction, and integrating the beauty of mathematics into the texture of life.

3. Decryption of Two Paintings: Masters’ “Mathematical Secrets”

3.1 Mona Lisa: Exquisite Balance

The golden ratio (1:1.618), as an aesthetic code that runs through nature and art, is an important principle for artists throughout history to create balance and tension in their paintings. In many classic Eastern and Western paintings, the use of this ratio has long surpassed deliberate design and become a natural aesthetic expression. In the field of Western painting, Leonardo da Vinci's Mona Lisa can be regarded as the pinnacle of the use of the golden ratio.

The painter constructs the core of the painting with precise proportions: in the vertical division of the Mona Lisa's face, the distance from the hairline to the brow bone, from the brow bone to the bottom of the nose, and from the bottom of the nose to the chin approaches the golden ratio; In the horizontal dimension, the ratio of the line connecting the eyes to the midline of the image, as well as the ratio of the width of the head to the extent of shoulder expansion, perfectly fit the golden relationship of 1:1.618. More intricately, Leonardo da Vinci used the proportion design of the background perspective to layer the distant mountains and waters vertically in the golden ratio. The handrails in the foreground, the characters in the middle, and the hazy mountains and waters in the far form a gradual proportional transition, which not only enhances the depth of the space, but also guides the

viewer's gaze to naturally focus on the mysterious smiles of the characters, making the picture both realistic and harmonious.

3.2 Journey to the Mountains and Streams: The Charm of the East

In traditional Chinese painting, Fan Kuan's “Journey to the Mountains and Streams” deeply integrates the golden ratio with the artistic conception of mountains and waters, showcasing the unique charm of Eastern aesthetics. The overall composition of this vertical axis painting strictly follows the logic of the golden ratio: the vertical boundary of the picture is the golden ratio point, and about one-third of the area below (the lower part of the golden ratio) is arranged with caravans and giant rocks at the foot of the mountain. The thick rock mass forms a stable visual foundation with the moving people and animals; The upper two-thirds of the area is painted with the main peak towering into the clouds. The white space between the peaks and the solid proportion is just right, forming a visual balance of “top heavy and bottom light” but stable as Mount Tai.

In terms of details, the height ratio between the main peak and the secondary peaks on both sides, the layout of streams and mountain paths, and even the density distribution of trees in the mountains all conform to the golden ratio. This proportion design not only highlights the grandeur and magnificence of northern mountains and rivers, but also makes the picture clear in hierarchy and the interplay of reality and virtuality - the texture of giant stones in the foreground, the strength of trees in the middle, and the misty peaks in the distant view, forming a progressive visual guidance in proportion coordination, perfectly interpreting the aesthetic conception of “harmony between heaven and man” in traditional Chinese landscape painting, and also confirming the universal aesthetic value of the golden ratio across cultures and regions.

4. Three Campus Experiments: Our Journey of Discovery

4.1 The ‘Most Beautiful Perspective’ Sketching Experiment

To explore the relationship between the golden ratio and the “most beautiful perspective”, 10 of us conducted a fun sketching experiment. Before the experiment, we sorted out the application logic of the golden ratio in famous paintings, and then selected the ancient pavilion landscape on campus as the sketching object.

The experiment was divided into two groups: the control group freely chose to sketch from a different perspective, while the experimental group divided the images according to the golden ratio, placing the main body of the ancient pavilion at the golden ratio point and adjusting the ratio of the pavilion to the background trees and sky to about 1:1.618.

After completing the creation, we invite art teachers and classmates to anonymously rate and vote. The results showed that the average scores of “visual comfort” and “composition balance” in the experimental group were significantly higher than those in the control group. Subsequent analysis found

that sketches that conform to the golden ratio can naturally focus the viewer's attention on the subject, resulting in denser and more harmonious transitions between reality and virtuality. This experiment not only intuitively verified the aesthetic value of the golden ratio, but also experienced the integration of rational laws and emotional expression in artistic creation, providing us with a scientific and artistic perspective reference for our sketching practice.

4.2 Research on Facial Portrait Painting

To further explore the practical value of the golden ratio in artistic creation, we conducted an experiment on facial proportion measurement and portrait painting. In the experiment, we accurately measured and plotted the facial proportions of 20 students, and the results were surprising: the average eye position (measured by the distance from the hairline to the chin as 1) fell at 0.618, and the length ratio from the nose tip to the chin to the mouth to the chin was close to 1:1.618. When smiling, the corner of the mouth corresponded exactly to the facial width at 0.382 and 0.618, which confirms the universal existence of the golden ratio in human aesthetics.

Subsequently, based on the measurement data, we conducted portrait drawing and discovered a key phenomenon during the process: strictly copying the 1:1.618 mathematical scale to draw the face appeared rigid and lacked vitality; However, portraits with slight fluctuations around the golden ratio of 0.618 appear more natural, vivid, and full of charm.

This experiment has made us deeply understand that artistic creation is not a mechanical copy of mathematical formulas. The golden ratio is an aesthetic reference worth learning from, rather than a shackle that restricts creation. The true charm of art lies precisely in the balance between following laws and moderate changes. This realization also coincides with the application logic of the golden ratio in famous paintings, which is "naturally formed rather than deliberately carved", giving us a more vivid understanding of the integration of art and rational laws.

Many people may wonder why the golden ratio is 0.618? A clear answer can be found from the perspective of visual psychology. When the human eye scans the image, it does not move at a constant speed, but rather captures information through a jumping gaze, and the golden ratio point happens to be the most natural and easiest position for the line of sight to stay. Related scientific research has confirmed that when the subject of the image is in the golden ratio area, the neural transmission efficiency of the brain in processing image information is the highest, and there is no need to consume additional cognitive resources for adjustment. This' low load 'information processing process directly translates into the' comfort 'and' harmony 'we perceive, which is also the core reason why the golden ratio is widely used in fields such as painting, photography, and design. From the perspective of self similarity in mathematical geometry, the golden ratio possesses unique and elegant recursive properties. If we cut a square from a golden rectangle (with a length to width ratio of 1.618), the remaining small rectangles will still be a golden rectangle. This process can be infinitely repeated, continuously dividing into proportionally small golden

rectangles, ultimately fitting a smooth logarithmic spiral. This self similar structure can be seen everywhere in nature - the shell patterns of seashells, the seed arrangement of sunflower flower plates, and the leaf growth morphology of ferns all conform to this law, making the golden ratio the "universal code" connecting mathematics and nature.

From the perspective of the inheritance of aesthetic history, the charm of the golden ratio transcends the boundaries of time, space, and civilization. The ancient Greeks had already discovered the beauty of harmony in this ratio and incorporated it into the architectural design of the Parthenon. The height of the temple's columns and the aspect ratio of the facade strictly followed the 0.618 ratio; During the Renaissance, artists even regarded the golden ratio as their standard. In works such as "Mona Lisa" and "The Last Supper," Leonardo da Vinci used the golden ratio to plan the composition of characters and the layout of images, achieving the ultimate balance and layering in the works. After thousands of years, the golden ratio has evolved from a mathematical formula to an aesthetic paradigm, profoundly influencing humanity's definition and pursuit of "beauty". Because the 'golden ratio' contains rich aesthetic values, when it is integrated with art, it will constantly create works of 'rational beauty'. Today, the "golden ratio" has become an important formal beauty principle, widely applied in art creation and design, adding a lot of beauty to people's lives [3].

When the core of creation is to pursue strong visual impact or convey vivid emotions, the golden ratio is not suitable. The characteristic of the golden ratio is to make the image look balanced and comfortable, in line with our eyes' perception of "harmony". However, this "gentleness" can actually hinder creativity that requires highlighting emotions or catching the eye.

For example, when we draw the feeling of depression after failing an exam, we may draw characters in the corners of the picture and use skewed lines to express our low mood; If we force the golden ratio to place the character in a "comfortable position", that sense of frustration will fade away and cannot be immediately perceived. For example, the cheering poster for the tug of war competition held by the class must have the word "cheer" prominently and asymmetrically placed to create a lively atmosphere; If the golden ratio is used to balance the composition, the poster will appear lackluster and fail to inspire people.

When the creative object has a fixed function or regular form, the golden ratio should give way to practical needs and form logic. Although the golden ratio is a universal aesthetic rule, when it comes to things with clear purposes or fixed shapes, aesthetics cannot be prioritized. For example, when we draw our own textbooks, which are rectangular in shape and need to meet our needs for flipping through books and writing, if we draw them thin and long just to make up for the golden ratio, it is not realistic at all; Compared to the square shaped sticky notes and circular buttons, the beauty of these things lies in their regularity and symmetry. If they are cut open with a golden ratio line, it will look particularly strange.

The same is true in painting, such as the square dining table

and symmetrical double desk in the artist's work. Symmetrical composition should be used to highlight the sense of neatness. Forcing the golden ratio will only make the picture uncoordinated and go against the original appearance of these things.

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