Using the golden ratio in multimedia installations – Seeking for beauty

Ana Isabel Portugal and Pedro Campos
Center for Mathematical Sciences
University of Madeira
Campus Universitário da Penteada
9000-390 Funchal, Portugal
E-mail: {aic, pcampos}@uma.pt

Abstract

The *Golden Ratio* allows the creation of the *Golden Rectangle*, which is considered as the most aesthetic and pleasant of all possible rectangles. The Fibonacci sequence is intimately related to that ratio. That is the reason why they have been extensively used to bring Harmony to Art and Architecture. In this paper, we explain how the usage of these proportions leads to the creation of works of art that are pleasant to the spectator. We argue that the usage of these mathematical constructs represents an opportunity for multimedia artists who are interested in novel, better ways to display artistic content to museum audiences.

Introduction

In many of the nature living beings and the world's most beautiful objects one can observe mathematical properties. Aristotle once said [2]:

> *"The chief forms of beauty are order and symmetry and definiteness, which the mathematical sciences demonstrate in a special degree."*

The Artist and mathematician Luca Pacioli [1] explored this link between Mathematics and Art defining the "Golden Ratio", explaining how its application in the composition of art objects leads to the feeling of beauty and harmony. In his Work, Leonardo Da Vinci, as an illustrator working around his works, showed the truth of this assertion.

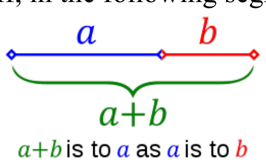
The Golden Ratio (1:1.618), which is also inherent to the Fibonacci sequence [3] is in fact consistently found in nature and was the basis for the construction of the golden rectangle, the golden triangle and the golden pyramid, which appear as baselines for several artistic composition of great beauty. Figure 1 shows a well-known example that is particularly well related to our experiment, since it uses the golden rectangle to frame "Le Corbusier".

Figure 1: *Modulor. Le Corbusier,1943.*

We found also uses of the Golden Ratio in current work regarding Web Design [4, 5, 6, 7].
We believe therefore that this type of provision in the composition of a work of art enhances its balance and as such its beauty.
In this short paper, we discuss how the domain of multimedia might offer new challenges and opportunities in the use of the golden ratio. In particular, people with no formal artistic education or training are able to create more harmonious multimedia contents and installations. If they are motivated towards the use of layouts that have been projected according to the golden ratio. This case is fairly easy to implement, since it is grounded on the attractiveness of the multimedia content that is made available and doesn't need to be justified with deep theoretical arguments, since it justifies by itself with the beauty it conveys. There are already many examples and descriptions of this type of usage, e.g. [6, 7].
In this sense, the golden ratio and other mathematical constructs can be regarded as "enablers" of artistic expression, particularly suited to less-trained people, and therefore this is a unique opportunity that both mathematicians and artists should exploit.

Material and Methods

The Golden Ratio, also known as the Divine Proportion, is an irrational mathematical ocnstant, with the approximate value of 1,618033987 (...), designated by φ.
If, in the following segment:



then

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

Starting from φ we can build the golden rectangle, which has a ratio between its two sides of 1: φ. We can also build the golden triangle, which can be characterized as an isosceles triangle with the property that the bisector of one of equal angles produces a new triangle similar to the original reason for the original area of the triangle and the triangle is equal to φ.
Other sayings and solid polygons can be generated obeying this reason [8].

The Fibonacci sequence [9] and the golden ratio are intimately bound:
0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, 377, 610, 987, …
The limit of the ratio of two consecutive members when n tends to ∞ is equal to φ:

$$\lim_{n\to\infty} \frac{F(n+1)}{F(n)} = \varphi.$$

A Fibonacci Spiral approximates the Golden Spiral if we use the squares of the Fibonacci's sequence above 34:

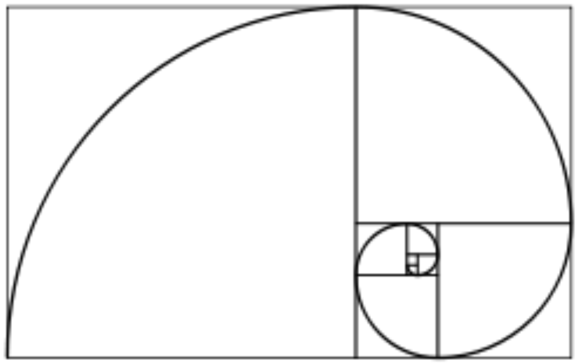


Figure 2: *The Fibonacci spiral, including the squares we used to project works of art.*

We have used these forms in order to obtain harmony and beauty in the composition of the multimedia presentation we built, aimed at displaying the works of "Machado de Castro" Museum. Thus, we defined the projection screen as a golden rectangle, and used the spiral of Fibonacci as well as the square inscribed in it, to define the movement of the succession of images.

How did we use this ratio in order to display better artistic content targeted at museum audiences? Firstly, anything that provides the easy and pleasant reading of a work of art leads the spectator into spending his or her time in observing and admiring the artistic content. The golden ration can work as a marketing attitude that can achieve an exhibition that is more attractive than other exhibition not presented in that way.

By running an experiment to evaluate this approach, we created a succession of images that did not follow this ratio and the multimedia composition was evaluated being perceived as less beautiful for about 89% of the 300 people who were shown the two presentations. In this quite large experiment, we were interested in assessing the actual value that can be brought to multimedia presentations, by the usage of mathematical components like the Golden Ratio and the others we described previously.
The projector's standard ratio is not a golden ratio. But we overcome that situation quite easily since we used solid color black areas (in width and height) in order to frame the work of art into the golden ratio. This is extremely simple and turns the projected work of art into a more balanced and more aesthetically pleasing projection.

Exactly how did we use the spiral of Fibonacci to define the movement of the images? One of the uses was based on inscribing the works of art in the spiral, according to Figure 2, making the image begin to appear on the larger square and then moving to the smaller squares, performing a rotation of successive images that persist for a while, even when the first image is replaced by another in the main square. This situation also allows comparing works of art seen simultaneously but at different sizes.
If the image doesn't have the exact size of the golden proportion in the rectangle, its transcription into the subsequent rectangles can be made by using some of the details of that same image (the details that are not highlighted in the first or second rectangles.
In a second situation, we used the spiral inscribed in the harmonic trajectory of the movement of several animal and human figures who carry the works of art with themselves. We believe it will be particularly interesting to evaluate the audience's reaction in this situation.

Finally, we address the reliability of our experiment. The images conveyed (projected) using the golden proportions were evaluated by a set of persons that represent an unbiased sample, since they were all active adults with ages between 18 and 60 years old, studying at an institution that promotes technological training. This excludes, however, children teenagers and the elderly over 60. However, since the variety in education levels they had, we had a stratified population according to the whole city.
Also, and bearing in mind not to bias the experiment, we chose Claude Monet's painting "L'impression soleil levant" as the basis for the experiment. We displayed it randomly with and without the golden proportion framing, more concretely using a direct passepartout and a passepartout mounted with the image framed in the golden proportion. Even taking into account that the framed image diminuishes the artistic value of the work of art, most people chose the golden proportion as seeming more aesthetically pleasant.
Of course that when preparing the "non-golden" presentations, we had to make sure that we did not deliberately or subconsciously make the other presentations look much worse. However, we need also to point out that the advocates of golden ratios seeking beauty are people that deliberately try to make their works the most beautiful of all.

Conclusion

The golden rectangle is considered to be the most aesthetic and enjoyable for all possible rectangles – this was why it was extensively used to give harmony in art and architecture. When designing a sequence of squares within the golden rectangle we create the Fibonacci spiral, which is also extensively used in art, to insert in a composition the elements that we want to highlight.
Using this strategy we obtain compositions composition aesthetically very pleasing, and as Leonardo mentioned, "in the Golden Section *is contained the fundamental principle of all formation striving to beauty"*.

References

[1] Pacioli, Luca, *De Divina Proportione*, Part 1, 1509 Milan.
[2] Aristotle, *Metaphyisics* Book, 13 Part 3, 300bc.
[3] Pisa, Leonardo, *De Liber Abacci*, 2º edição, 1228, Pisa.
[4] Remick, Jarel, *The Golden Ratio in Web Design*, 29 Dec. 2008, available online at: http://net.tutsplus.com/tutorials/other/the-golden-ratio-in-web-design/#comments
[5] Friedman, Vitaly, *Applying divine proportion to your web designs*, May 29th, 2008: http://www.smashingmagazine.com/2008/05/29/applying-divine-proportion-to-web-design/
[6] bestcodingpractices, Using Fibonacci and golden ratio principles to help design web pages, 18 March 2010, http://www.bestcodingpractices.com/fibonacci_and_golden_ratio_in_web_design-39.html
[7] Gupta, Adit, *Applying mathematics to web design*, February 9th, 2010, http://www.smashingmagazine.com/2010/02/09/applying-mathematics-to-web-design/
[8] Wikipédia, Golden Ratio, http://en.wikipedia.org/wiki/Golden_ratio.
[9] Math Academy Online™, The Fibonacci sequence, available online at: http://www.mathacademy.com/pr/prime/articles/fibonac/index.asp