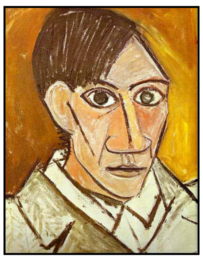

Math and Art of the Face: From Da Vinci to Picasso

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Thermalito Union School District

CMC - Asilomar - December 2009

The frequent appearance of the Golden Ratio in the arts over thousands of years presents us with an interesting question:

Do we surround ourselves with the Golden Ratio because we find it aesthetically pleasing, or do we find it aesthetically pleasing because we are surrounded by it?

In the 1930's, New York's Pratt Institute laid out rectangular frames of different proportions, and asked several hundred art students to choose which they found most pleasing. The winner? The one with Golden Ratio proportions.

source:
The Golden Ratio
http://library.thinkquest.org/C005449/aesthetics.html

Golden Definitions

Golden Sequence / Fibonacci Sequence

1, 1, 2, 3, 5, 8, 13, 21, 34, 55......

Generated by adding the previous two numbers in the list together to form the next and so on and so on...

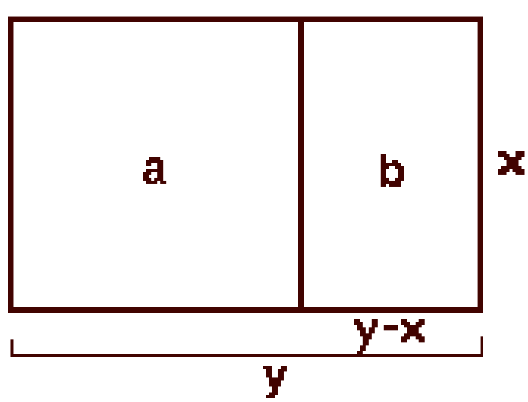
Golden Ratio

1.6180339887498948482 (approximate)

Divide any number in the Fibonacci sequence by the one before it, for example 55/34, or 21/13, and the answer is always close to 1.61803.

Golden Rectangle

A rectangle in which the ratio of the length to the width is the Golden Ratio.



$$\frac{y}{x} = 1.61803\ldots$$

The Fibonacci Sequence and the Golden Ratio

The Golden Ratio (or "Golden Section") is based on **Fibonacci Numbers**, where every number in the sequence (after the second) is the sum of the previous 2 numbers:

1, 1, 2, 3, 5, 8, 13, 21, 34, 55......

Divide any number in the Fibonacci sequence by the one before it, for example 55/34, or 21/13, and the answer is always close to 1.61803.

This is known as the Golden Ratio, and hence Fibonacci's Sequence is also called the Golden Sequence.

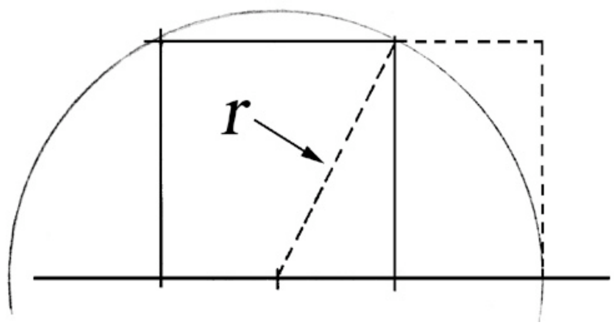
The ratio of each number in the Fibonacci sequence to the one before it:

1/1 = 1	13/8 = 1.625
2/1 = 2	21/13 = 1.61538...
3/2 = 1.5	34/21 = 1.61905...
5/3 = 1.666...	55/34 = 1.61764...
8/5 = 1.6	89/55 = 1.61861...

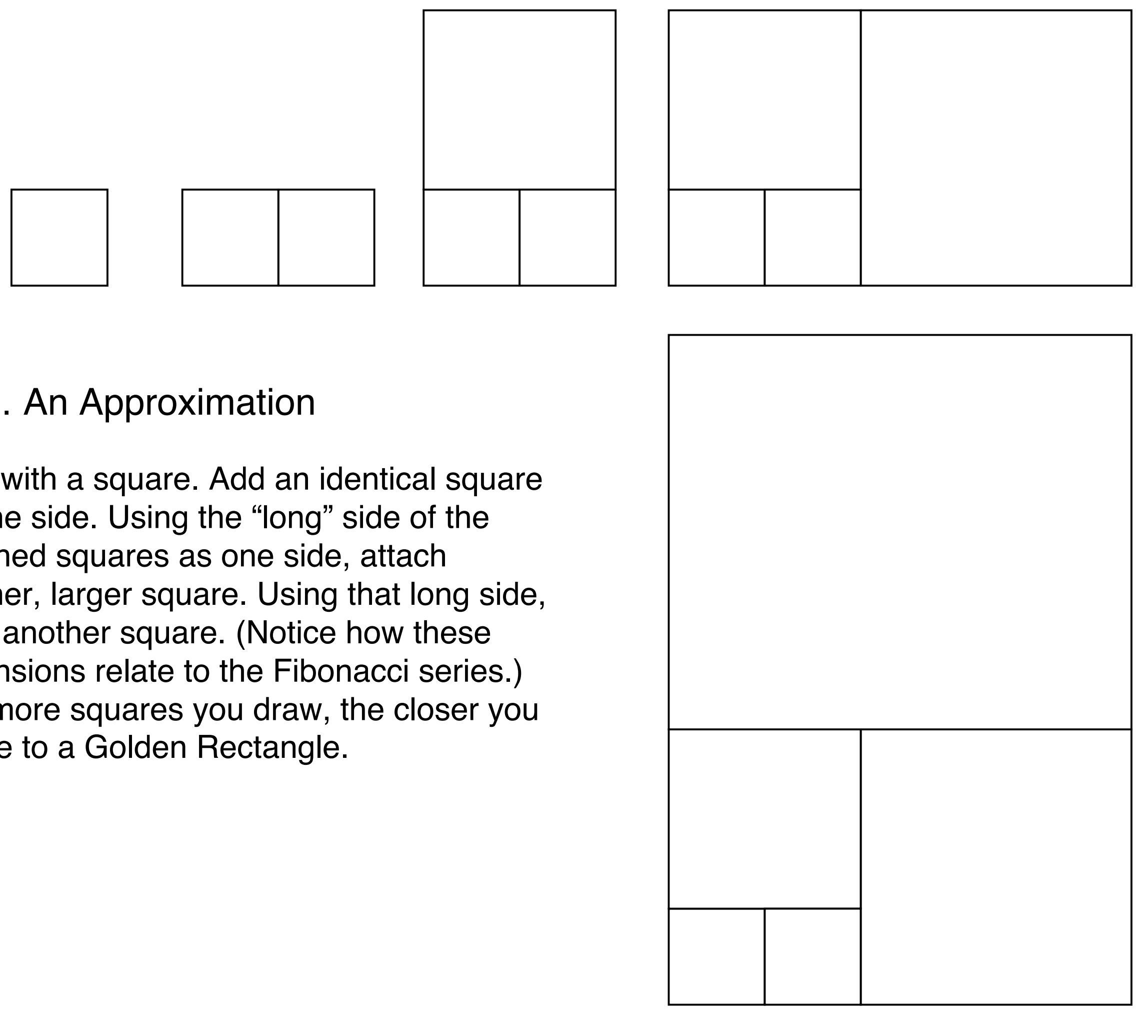
If we keep going, we produce "phi" (**Golden Ratio** or **Golden Section**):

1.618 033 988 7...

Making a Golden Rectangle



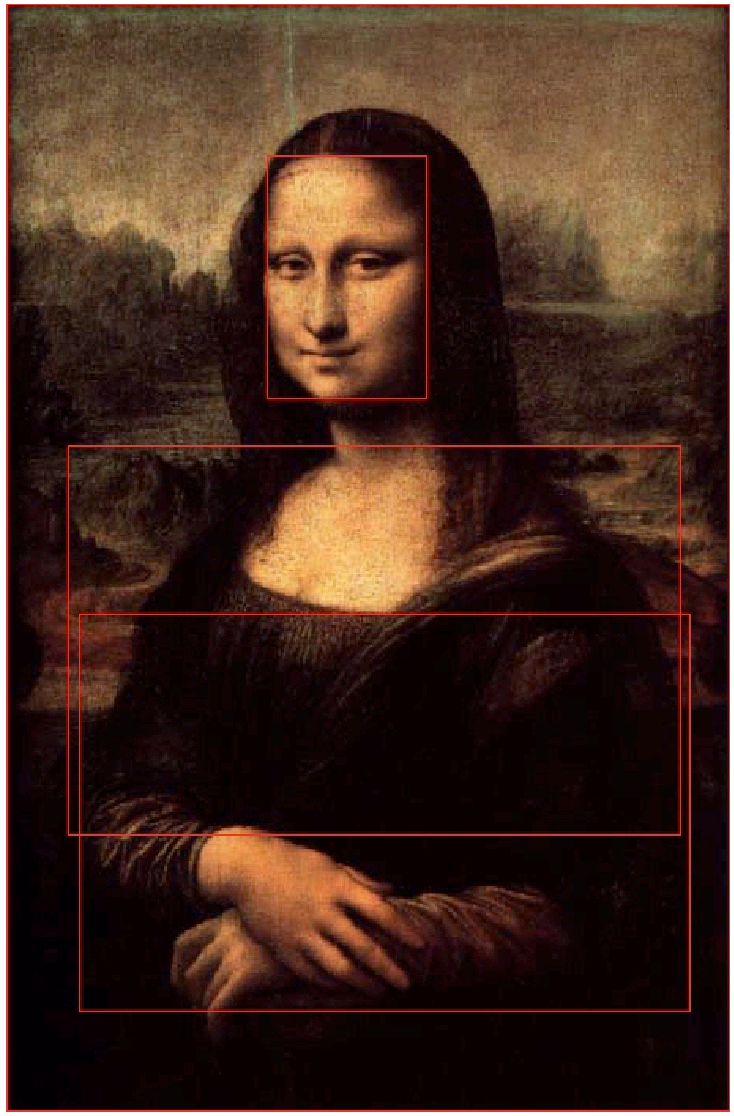
Start with a square. Find the midpoint on the base line; draw a line from that point to the opposite corner. Using that line as a radius, draw an arc. From the point where the arc intersects the baseline, draw a perpendicular line and extend the top line to create the golden rectangle.



Or … An Approximation

Start with a square. Add an identical square on one side. Using the “long” side of the attached squares as one side, attach another, larger square. Using that long side, draw another square. (Notice how these dimensions relate to the Fibonacci series.) The more squares you draw, the closer you will be to a Golden Rectangle.

Golden Rectangles in The Mona Lisa



- the length and the width of the painting itself

- the rectangle around Mona's face (from the top of the forehead to the base of the chin, and from left cheek to right cheek).

  Subdivide this rectangle using the line formed by using her eyes as a horizontal divider to divide the Golden Rectangle.

- the three main areas of the Mona Lisa, the neck to just above the hands, and the neckline on the dress to just below the hands

Sources:
The Golden Ratio in Art -- http://cuip.uchicago.edu/~dlnarain/golden/activity3.htm
and
Leonardo da Vinci and the Golden Ratio -- http://us.geocities.com/jyce3/leo.htm

Search for the Golden Ratio in Your Face

Take the following measurements:

a = top of head to chin = _______ cm

b = top of head to pupil = _______ cm

c = pupil to nosetip = _______ cm

d = pupil to lip = _______ cm

e = width of nose = _______ cm

f = outside distance between eyes = _______ cm

g = width of head = _______ cm

h = hairline to pupil = _______ cm

i = nosetip to chin = _______ cm

j = lips to chin = _______ cm

k = length of lips = _______ cm

l = nosetip to lips = _______ cm

Now, find the following ratios:

a/g = _______ cm

b/d = _______ cm

i/j = _______ cm

i/c = _______ cm

e/l = _______ cm

f/h = _______ cm

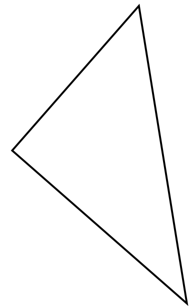
k/e = _______ cm

What did you find?

Source: The Perfect Face - http://cuip.uchicago.edu/~dlnarain/golden/activity8.htm

Picasso-Inspired Geometric Face

Create a face collage using:



- three or more triangles
- one circle
- one rectangle or square
- any other shapes you need

OR

- any number of triangles, no two alike
- a polygon with no lines of symmetry
- two congruent figures
- any other geometric shapes you need

Extensions:

Identify the geometric figures by labeling the drawings.
Explain how you decided what to draw.

A Sprinkling of California Math Standards
Related to Activities from "Math and Art of the Face"

In Third Grade, students are asked to…
- … identify, describe, and classify polygons
- … identify attributes of triangles and quadrilaterals
- … identify right angles in geometric figures
- … determine whether other angles are greater or less than a right angle

In Fourth Grade, students are asked to…
- … measure the area of rectangular shapes.
- … recognize that rectangles that have the same area can have different perimeters, and that rectangles that have the same perimeter can have different areas.
- … understand and use formulas to solve problems involving perimeters and areas of rectangles and squares.
- … identify parallel and perpendicular lines, congruent figures, and figures that have bilateral and rotational symmetry
- … know the definitions of a right angle, acute angle, obtuse angle
- … know the definitions of different triangles and different quadrilaterals

In Fifth Grade, students are asked to…
- … compute with very large and very small numbers.
- … estimate, round, and manipulate very large numbers (i.e., millions).
- … estimate, round, and manipulate very small numbers (i.e., thousanths).
- … add, subtract, multiply and divide with decimals.
- … use the formula for the area of a triangle and of a parallelogram, and
- … compare the formula with the formula for the area of a rectangle.
- … find perimeter and area of two-dimensional objects.
- … measure, identify, and draw angles, perpendicular and parallel lines, rectangles, and triangles by using appropriate tools.
- … visualize and draw two-dimensional views of three dimensional objects made from rectangular solids.

Golden Ratio Resources

Mr. Narain's Golden Ratio Page
http://cuip.uchicago.edu/~dlnarain/golden/

The Golden Ratio
http://library.thinkquest.org/C005449/home.html

The Golden Mean in Fibonacci numbers
http://www.educ.queensu.ca/~fmc/may2002/GoldMean.htm

Math and Art: The Golden Rectangle
http://educ.queensu.ca/~fmc/october2001/GoldenArt.htm

Golden Ratio Activities
http://cuip.uchicago.edu/~dlnarain/golden/activities.htm

The Perfect Face
http://cuip.uchicago.edu/~dlnarain/golden/activity8.htm

Math and Nature: A whole month of Golden Ratio information and activities
http://www.educ.queensu.ca/~fmc/may2002/may2002.htm

Leonardo DaVinci and the Golden Ratio
http://www.geocities.com/jyce3/leo.htm

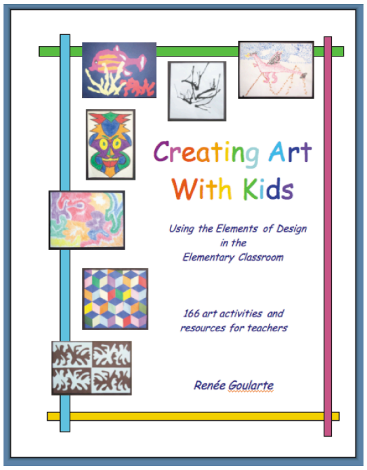
Ask Dr. Math
http://mathforum.org/dr.math/faq/faq.golden.ratio.html

Cynthia Lanus' Lesson: Make an approximation of a Golden Rectangle
http://math.rice.edu/%7Elanius/Geom/building.html

Art Resources

Pablo Picasso: Ma Jolie; Portrait of Ambroise Vollard; Self-Portrait 1907

Leonardo Da Vinci: Mona Lisa



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