Session 10 – The number φ

European section – Season 2

People you will hear in the recording

- Simon Singh, author who has specialised in writing about mathematical and scientific topics in an accessible manner,
- Ian Stewart, professor of mathematics at the University of Warwick, England, and a widely known popular-science writer.
- Robin Wilson, Math historian at the Open University.
- Adam Spencer, Australian radio DJ with a penchant for pure mathematics
- Ron Knott, University of Surey, specialist about the Fibonacci numbers

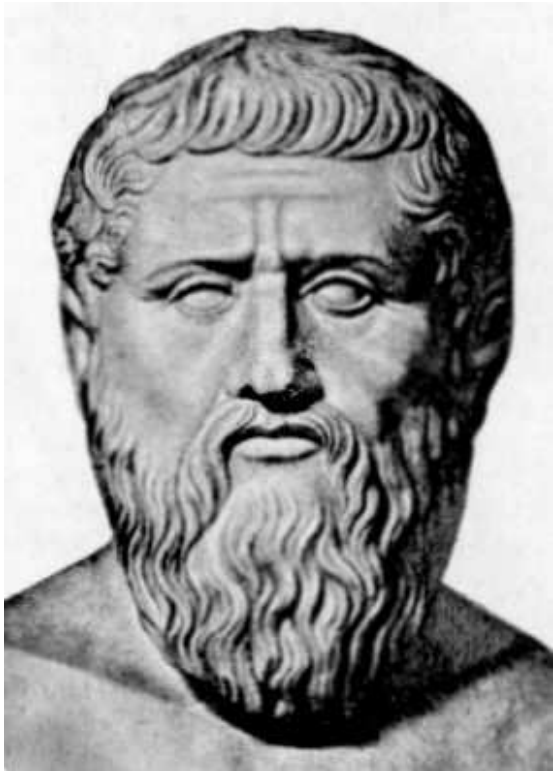
The seven parts of the recording

Part I – The Golden Ratio (Simon Singh, Ian Stewart, Robin Wilson).
Part II – Places where the Golden Ratio can be found (Simon Singh, Ian Stewart, Adam Spencer).
Part III – Properties of the number (Simon Singh, Robin Wilson, Ron Knott).
Part IV – The Fibonacci numbers (Adam Spencer)
Part V – Fibonacci numbers in parking meters (Simon Singh and Ron Knott)
Fibonacci numbers in sunflowers (Ian Stewart)
Fibonacci numbers in pineaples (Simon Singh)
Part VI – Fibonacci numbers and the Golden Ratio (Simon Singh)

What does Ian Stewart call the Platonist concept of the ideal world ?

What does Ian Stewart call the Platonist concept of the ideal world ?

They sought the perfect circle, the perfect line, and saw the Golden Ratio as a kind of perfect ratio.



Plato

How did the Ancient Greek define the number π ?

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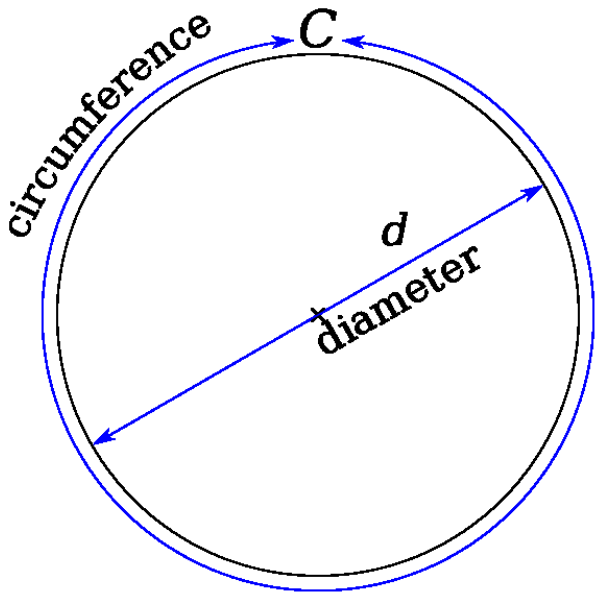
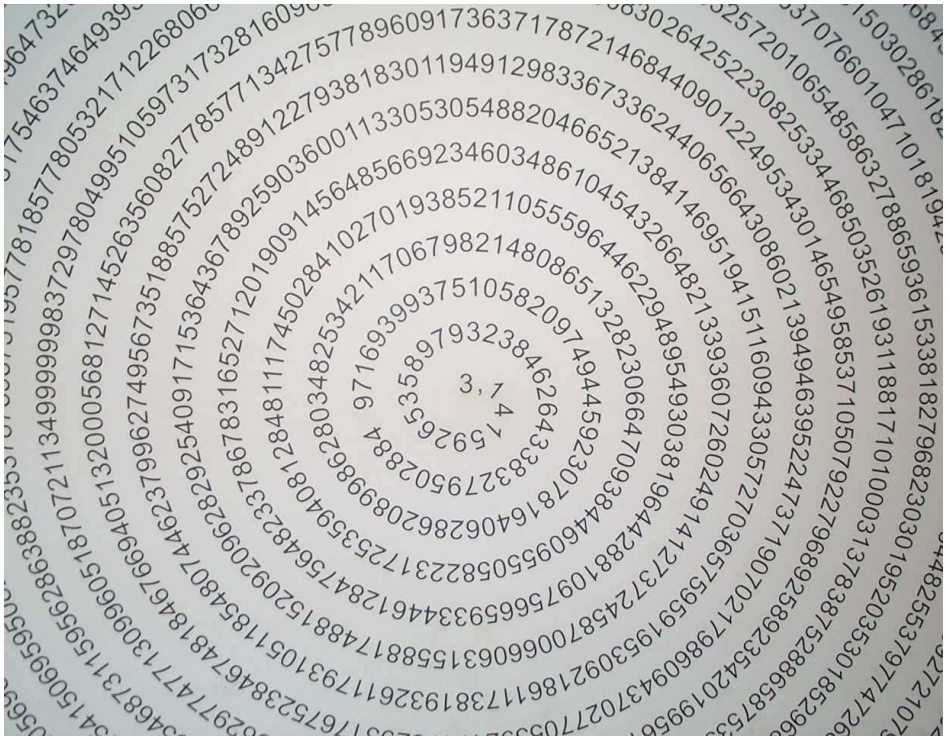
The Ancient Greek defined the number the number π as the ratio between the circumference of a circle and its diameter.





What was the preferred way of the Ancient Greek to talk about “strange” numbers such as π or φ ?

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The Ancient Greek defined these numbers as ratios of two lengths.

Euclid’s Elements

What is an irrational number ?

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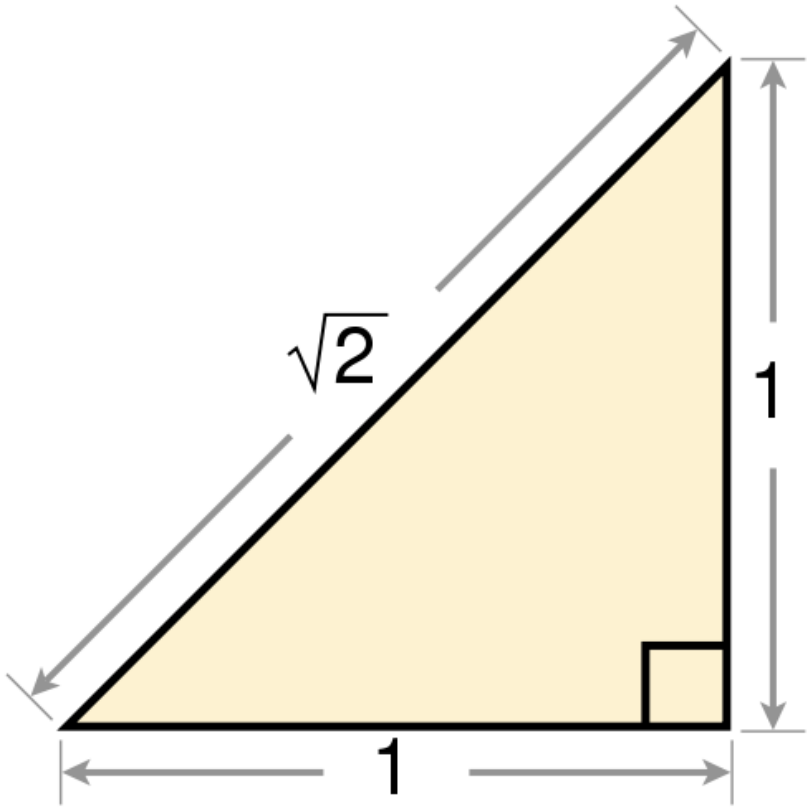
An irrational number is a real number that is not an exact fraction, such as $\sqrt{2}$, π or φ.



$\sqrt{2}$ is irrational.

What approximate value to 6DP of φ is given by Ian Stewart ?

What approximate value to 6DP of φ is given by Ian Stewart ?

$$\varphi \simeq 1.618034$$

What are the other names of the Golden Ratio ?

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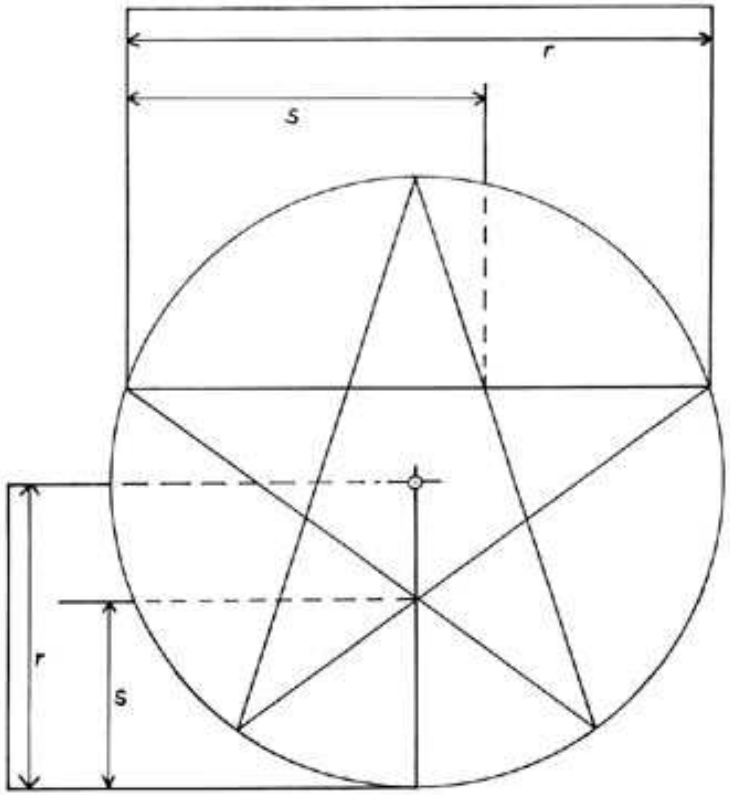
The Golden Ratio is also called the Golden Mean or the Divine Ratio.



The pentagram.

What did the Ancient Greek regard as the perfect rectangle ?

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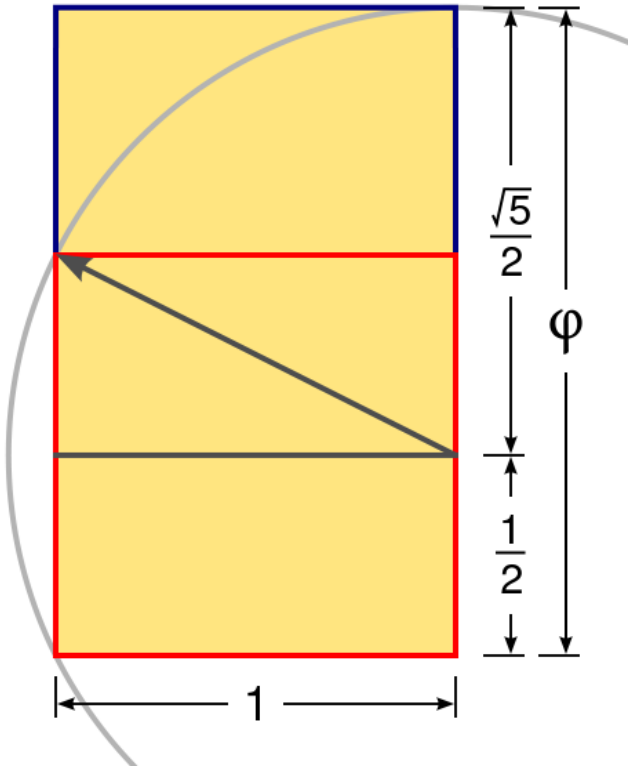
The perfect rectangle was the Golden Rectangle, with one side φ times longer then the other side.

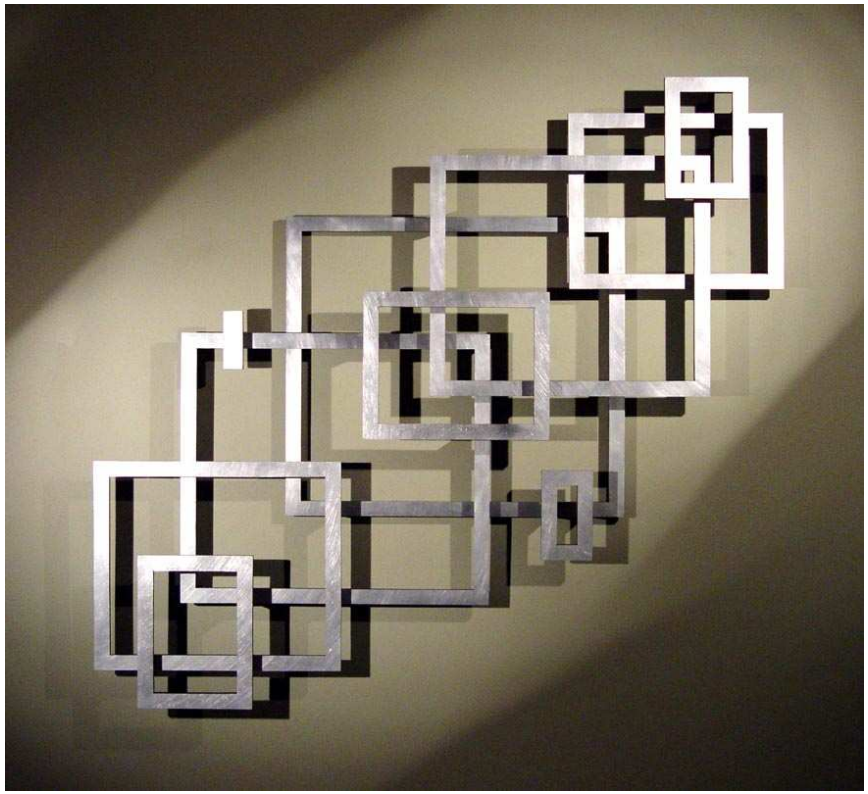


The golden rectangle.

Why was the rectangle built using the Golden Ratio considered perfect ?

Why was the rectangle built using the Golden Ratio considered perfect ?

The Golden Rectangle was considered perfect because it was not too squarish, and not too long and thin.



John Searles, *Nine rectangles*

Where did Leonardo Da Vinci see the Golden Ratio ?

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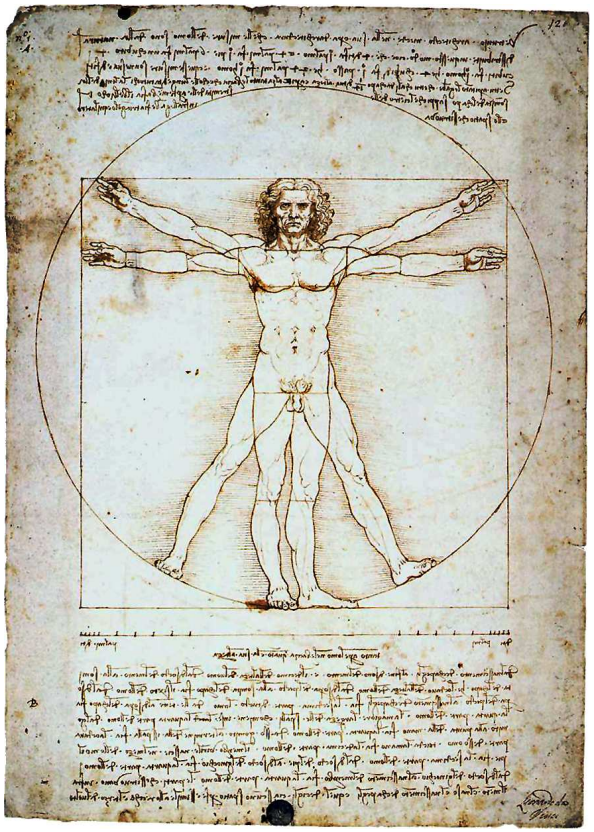
Leonardo Da Vinci thought that the Golden Ratio defined perfect proportion in the human body.

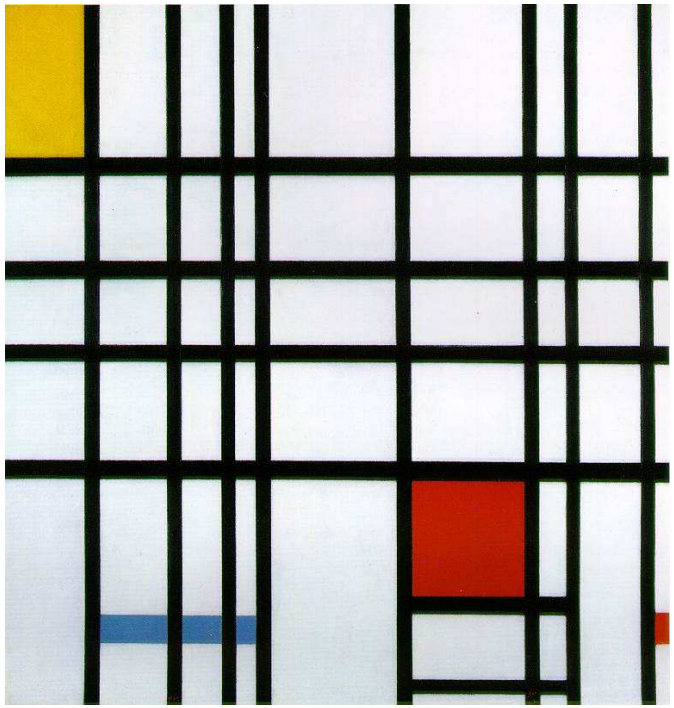


Leonardo Da Vinci, *Vitruvian Man* sketch.

Which modern painter used repeatedly the Golden Ratio ?

Which modern painter used repeatedly the Golden Ratio ?

Piet Mondrian repeatedly used the Golden Ratio in his geometrical art.



Piet Mondrian, *Composition with Yellow, Blue, and Red*

What famous Greek building is referred to in this program ? Why ?

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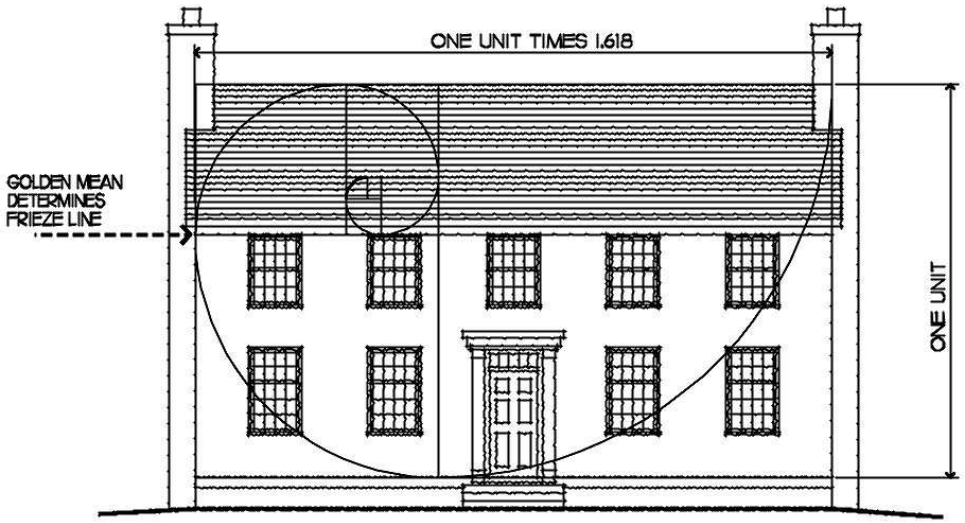
The Parthenon, in Athens, is referred to in this program because it has golden rectangles within it.

The Parthenon, in Athens.

What is the danger of looking for the Golden Ratio everywhere ?

What is the danger of looking for the Golden Ratio everywhere ?

In any building, there are thousands and thousands of measurements. If you start comparing them, you will always find something close to the Golden Ratio.



GEORGIAN STYLE HOUSE WITH FRONT ELEVATION BASED ON PROPORTIONS OF THE GOLDEN MEAN

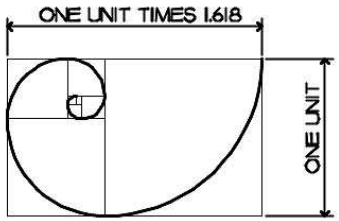


DIAGRAM OF THE

Which famous modern architect used the Golden Ratio extensively ?

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Le Corbusier deleberately used the Golden Ratio a lot, as he thought it was the perfect proportion for desigining human-size buildings.

La Cité Radieuse, Marseille

Why can we hear a heartbeat in the program ?

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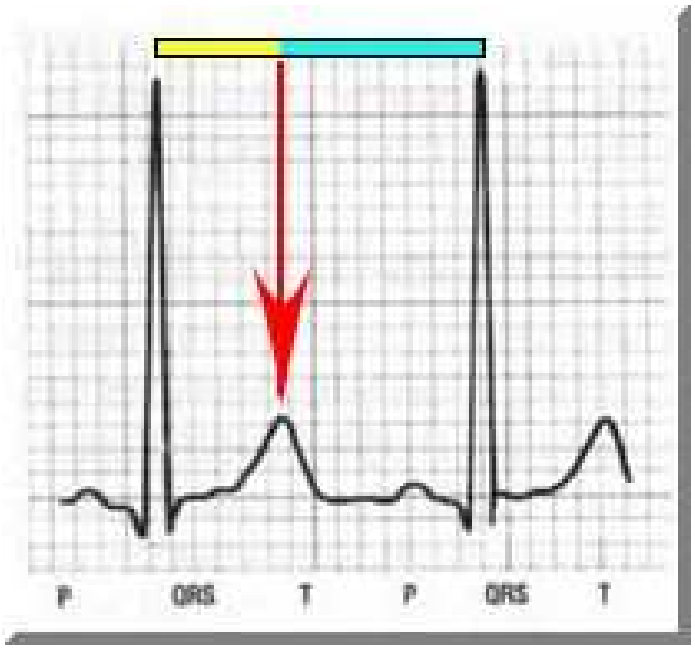
Because it seems that the ventricles in the heart reset themselves at the golden ratio point in the heart's rythmic cycle.



How is the DNA spiral involving the Golden Ratio ?

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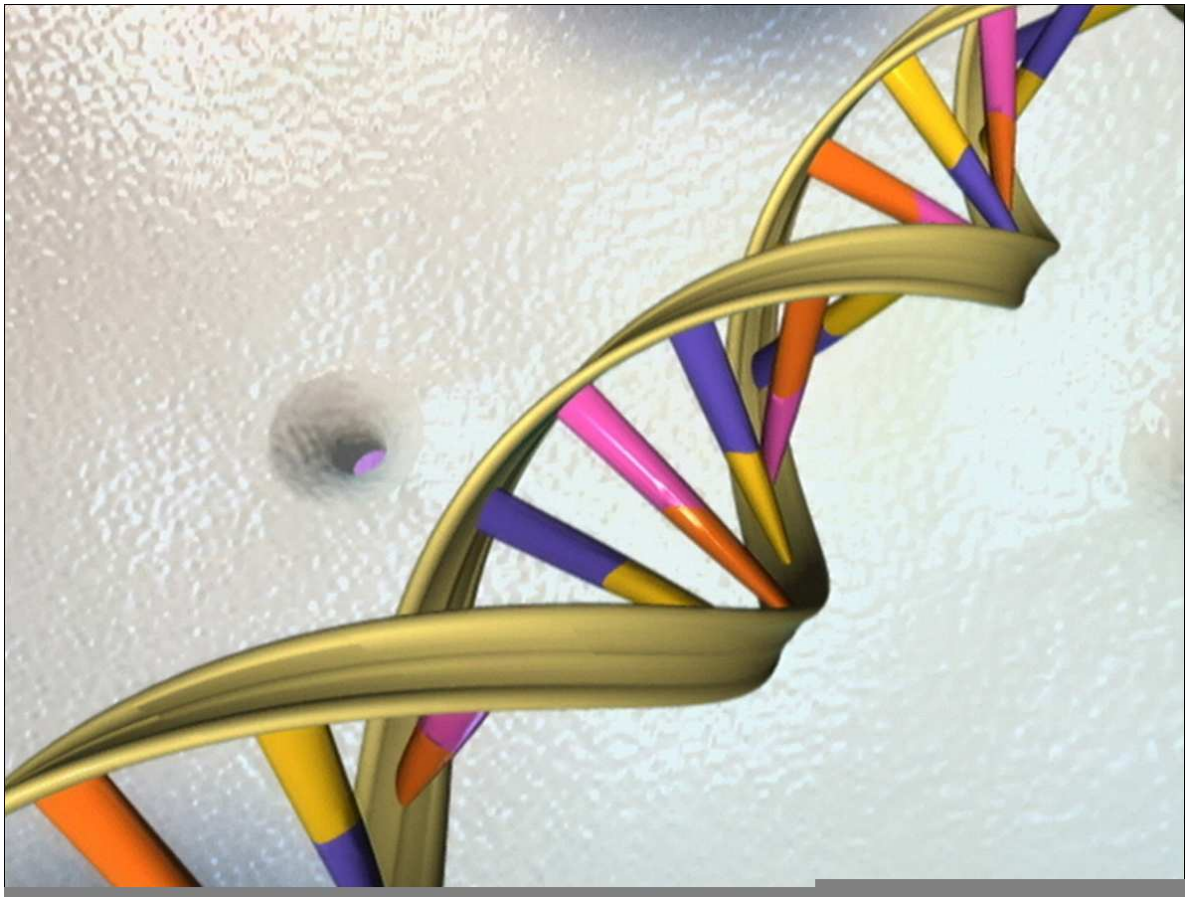
Divide the pitch of the DNA spiral by its diameter, and you get roughly the Golden Ratio.



What figure is created by the rectangles introduced by Adam Spencer ?

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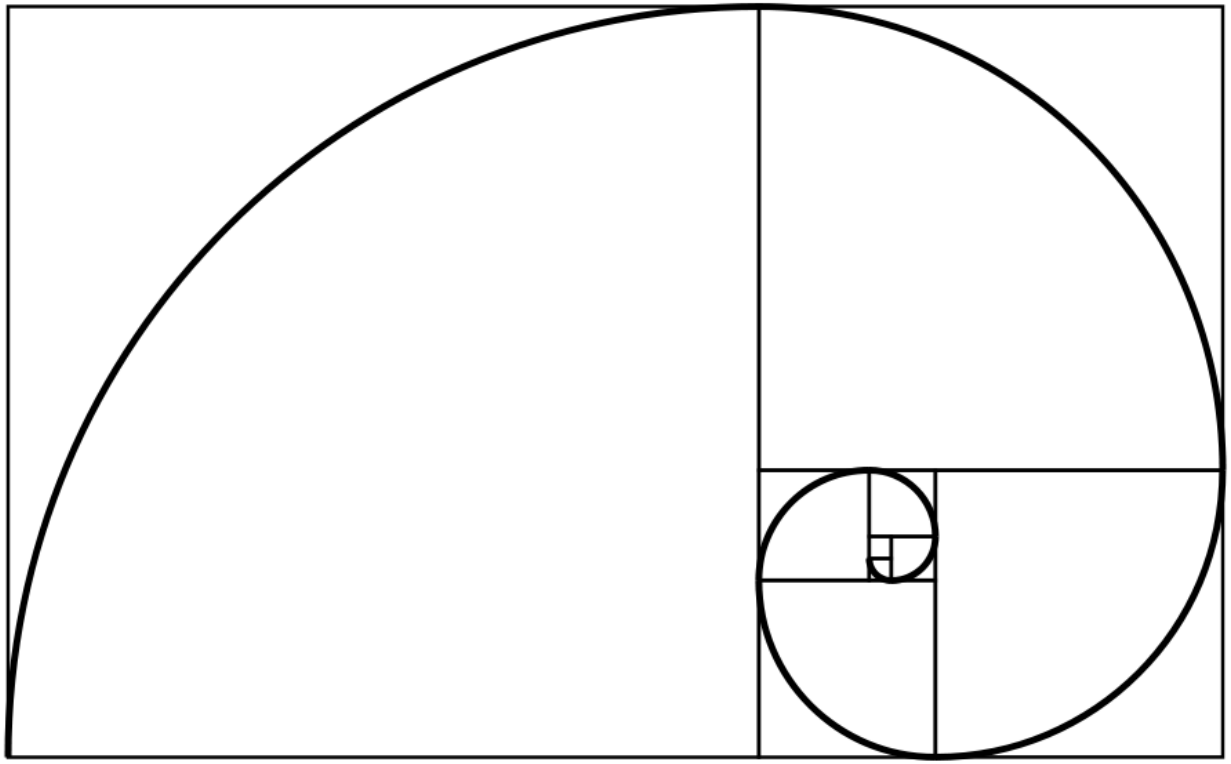
The figure is created by this series of golden rectangles is called the Fibonacci spiral or Golden spiral. It's mistakenly called spiral of Archimedes in the program.



Where is this figure appearing in nature ?

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The spiral of Archimedes can be found in and snailshells and crustaceans.

Cutaway of a nautilus shell

What do you get if you square the Golden Ratio ? What if you take its reciprocal ?

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$$\varphi^2 = \varphi + 1 \simeq 2.618$$

$$\frac{1}{\varphi} = \varphi - 1 \simeq 0.618$$

Why does the Golden Ratio have this property ?

Why does the Golden Ratio have this property ?

The Golden Ratio has this property because it satisfies the quadratic equation

$$x^2 = x + 1$$

What process described by Ron Knott ends up with the Golden Ratio ?

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The process described by Ron Knott is : Take any number, add one to it, compute its reciprocal, add one to the result, compute its reciprocal, and so on.

An example : $5 \mapsto 6 \mapsto 0.167 \mapsto 1.167 \mapsto 0.857 \mapsto 1.857 \mapsto 0.538 \mapsto 1.538 \mapsto 0.65 \mapsto 1.65 \mapsto 0.606 \mapsto 1.606 \mapsto 0.623 \mapsto 1.623 \mapsto 0.616 \mapsto 1.616 \mapsto 0.618 \mapsto \mathbf{1.618}$

Who was Fibonacci ?

Who was Fibonacci ?

Fibonacci was a mathematician around 1180, called Leonardo da Pisa.

Leonardo da Pisa AKA Fibonacci

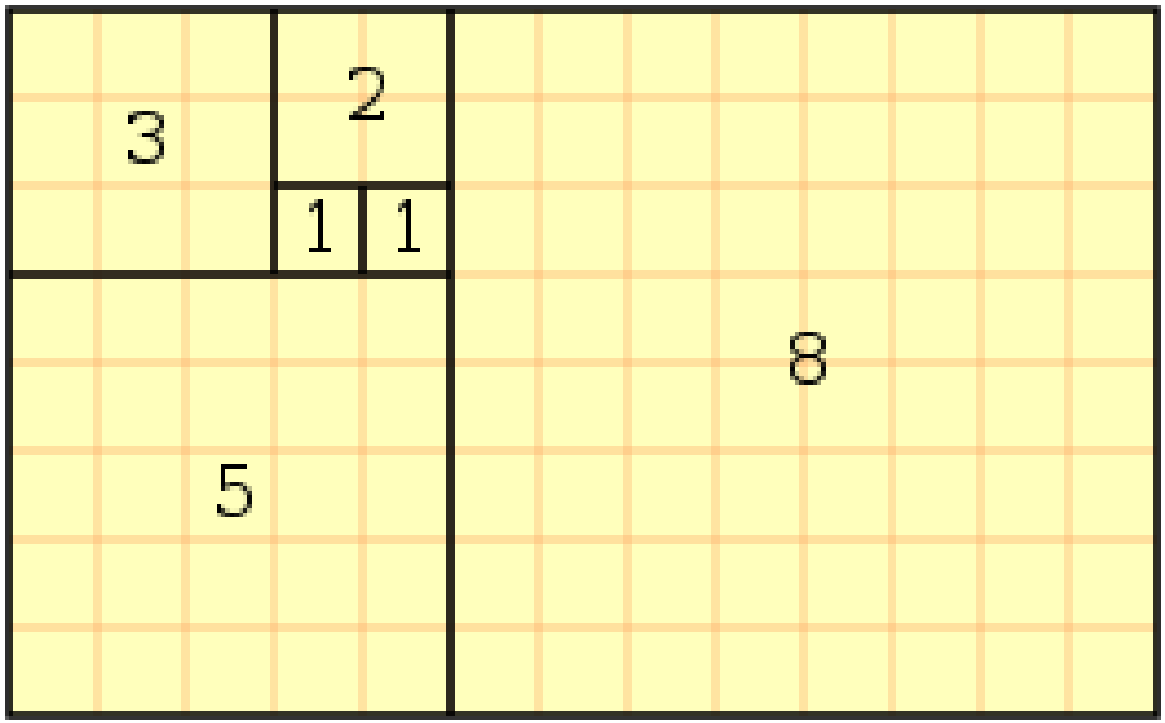
Beginning of *Liber quadratorum* by Leonardo Pisano. From "Il Libro dei Quadrati di Leonardo Pisano" in *Physis: Revista Internazionale di Storia della Scienza*, 1979, p. 197. Reprinted with permission of the author, Ettore Picutti.

Page 1 of his *Liber quadratorum*

How is the Fibonacci sequence built ?

How is the Fibonacci sequence built ?

Start with the two numbers 0 and 1. Add them together to get 1. Take the last two numbers of the list to get 2. Keep adding the last two numbers of the list to generate the next one.



A tiling with squares whose sides are successive Fibonacci numbers

Initially, what phenomenon were the Fibonacci numbers modelled on ?

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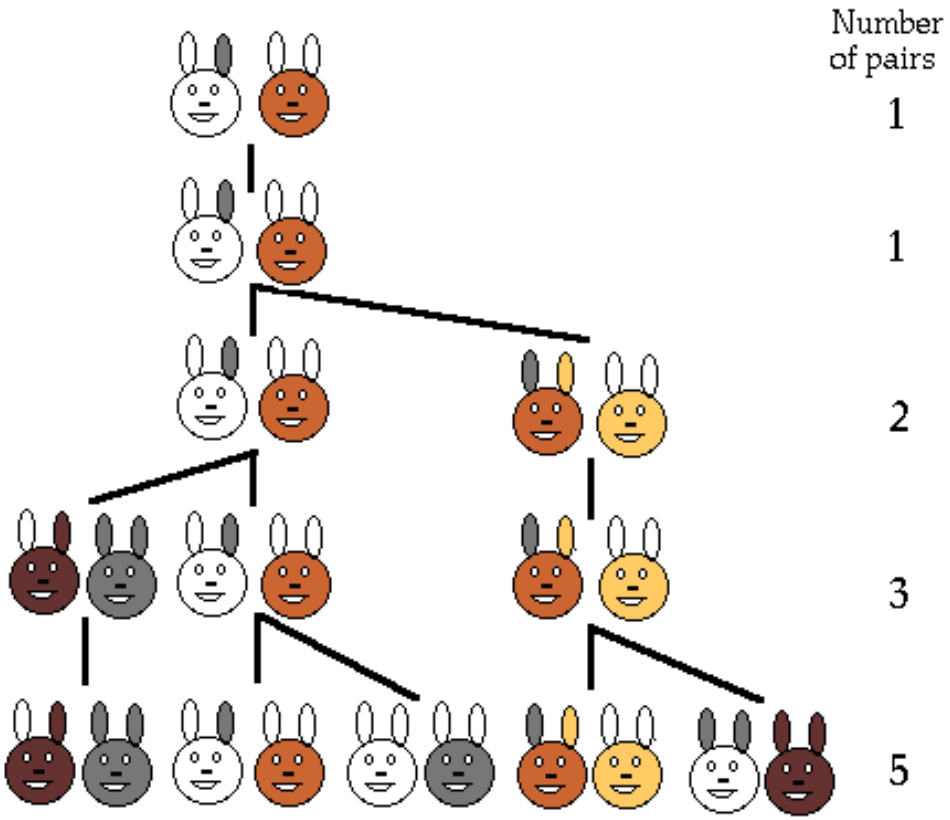
The Fibonacci numbers were originally modelled on a hypothetical population of rabbits.



The Fibonacci rabbits.

Why are the Fibonacci numbers so important in mathematics ?

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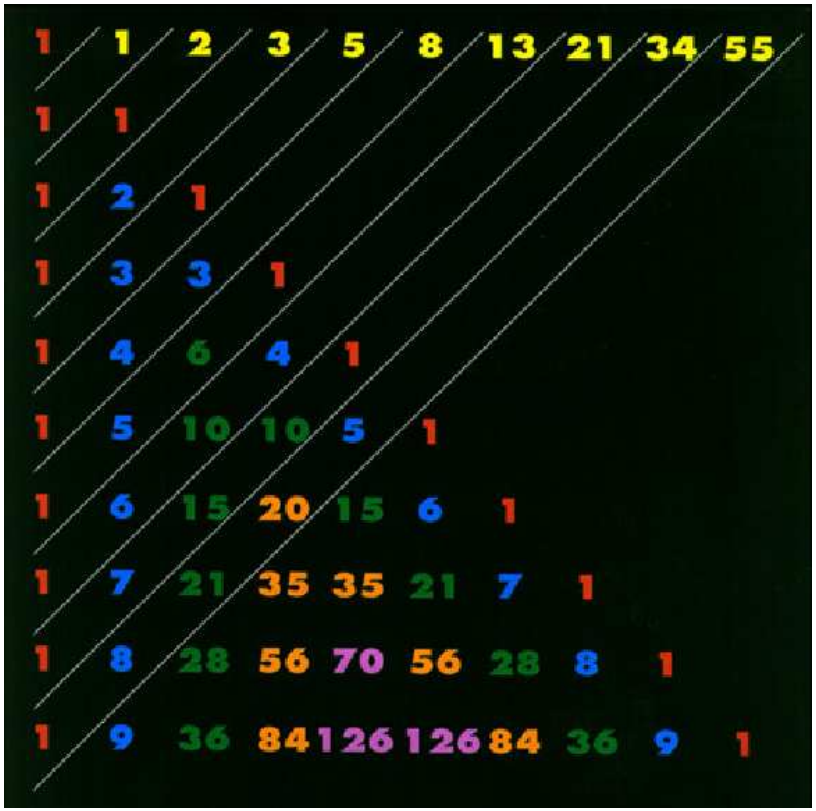
The Fibonacci numbers are so important because the crop up in many different areas of mathematics.



The Fibonacci numbers in Pascal's triangle.

What is the link between Fibonacci numbers and car-parks ?

What is the link between Fibonacci numbers and car-parks ?

If you need to pay only with 1-pound and 2-pounds coins, the number of ways to pay a certain amount is a Fibonacci number.

What is the link between Fibonacci numbers and sunflowers ?

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The numbers of clockwise and anticlockwise seeds spirals on a sunflower are Fibonacci numbers.

What is the link between Fibonacci numbers and pineapples ?

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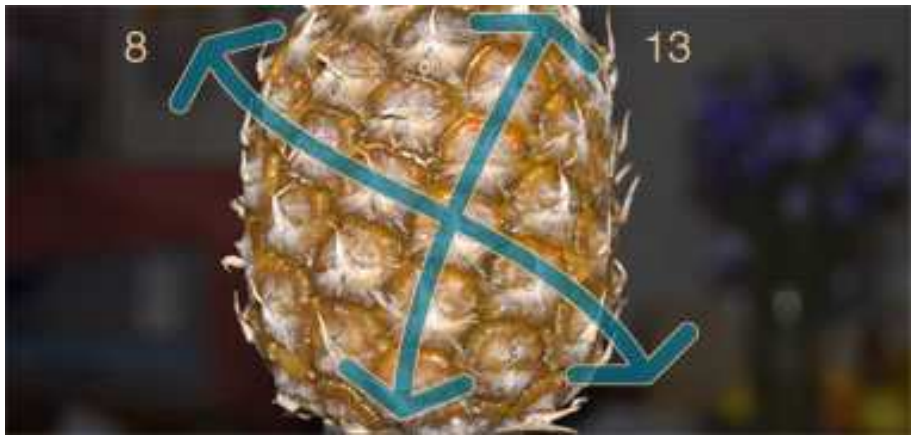
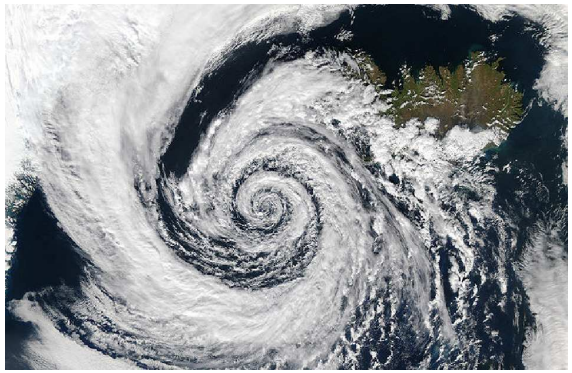
The numbers of clockwise and anticlockwise losange spirals on a pineapple are Fibonacci numbers.



What is the relation between Fibonacci numbers and the Golden Ratio ?

What is the relation between Fibonacci numbers and the Golden Ratio ?

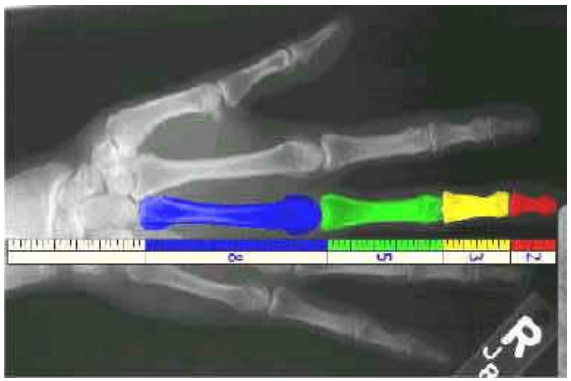
The ratio between to consecutive Fibonacci numbers approaches the Golden Ratio.



A low pressure area over Iceland

The Whirlpool Galaxy

Romanesco broccoli



Fibonacci numbers in fingers