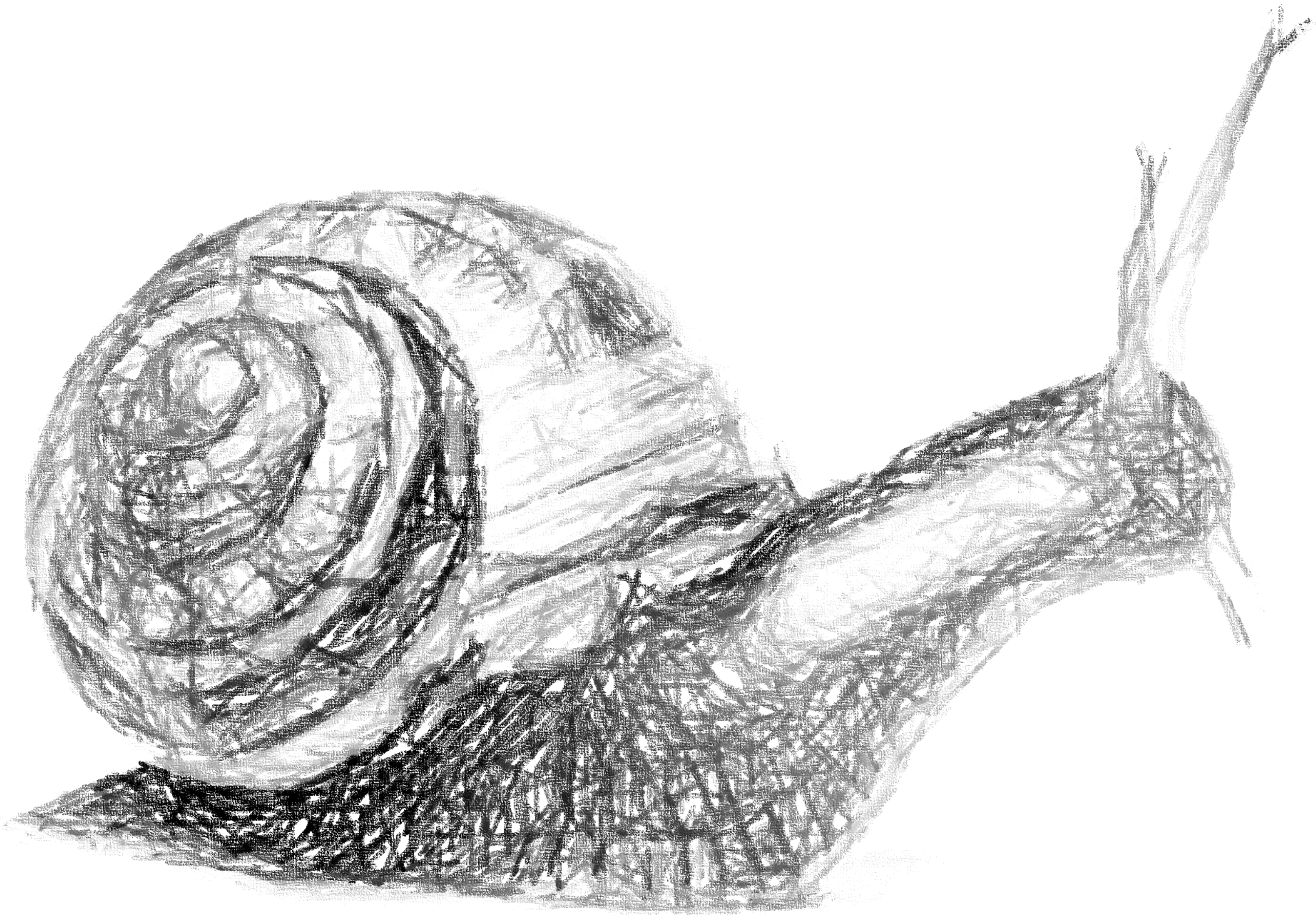
PORTFOLIO | SPRING 2016

Krupa Patel

Ecologics: Computational Techniques For Shaping the Built Environment

ADAPTIVE LOGIC : SNAILS AND SHELLS



Snails and Shells

Krupa Patel , MSSD

Snails:

Kingdom:	Animalia
Phylum:	Mollusca
Class:	Gastropoda

“The term snail is a common name applied to any gastropod mollusk who can retract into his shell. Thousands of species of snails live on land, in freshwater streams and ponds, and in saltwater bodies. They inhabit a range of regions including arid deserts and frigid sea depths.”

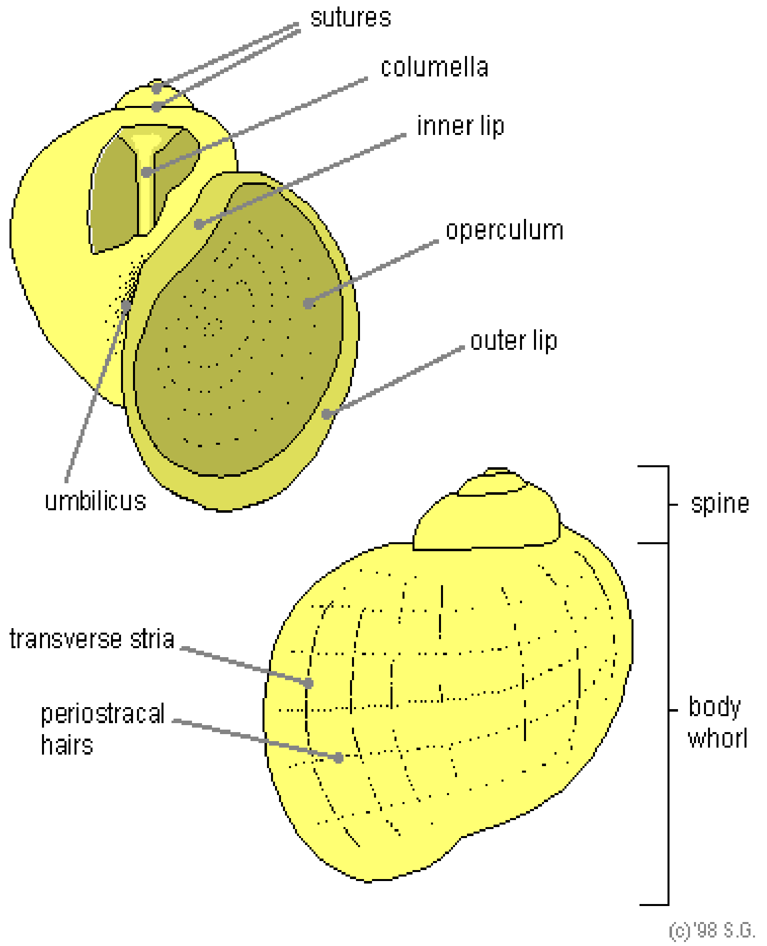
Snails have shells that are present since their early development..It is forever attached to its body. It begins its life from the exact centre of the shell.As the snail grows, simultaneously, the shell grows around the centre in a spiral form.

“offers some protection from predators and from drying out, but no, the shell isn’t really the snail’s house. The snail seeks places to live that are moist and have food, often under old rotting logs, under stonThe snail’s shell es, in the rotting leaves of the forest floor, and other secretive places.”
Shell is formed by process of mineralization of calcium carbonate and other trace minerals that are found in the local environment.
“Shell material is layered by a series of strips with cells that run along the outer fold and the extended mantel of the epithelium. This process starts at the mantel and on the lip and coils forward form there. Most of the coiling is right handed although there are examples of left handed coiling in some cases. In most cases we can observe growth rings (transverse stria) that translate to an approximate year of growth, however climate and other issues can impact this process.

http://www.ancient-wisdom.com/spirals.htm
https://en.wikipedia.org/wiki/Snail
h“ttp://en.wikipedia.org/wiki/Min...
http://animals.mom.me/survival-adaptations-snails-5298.html

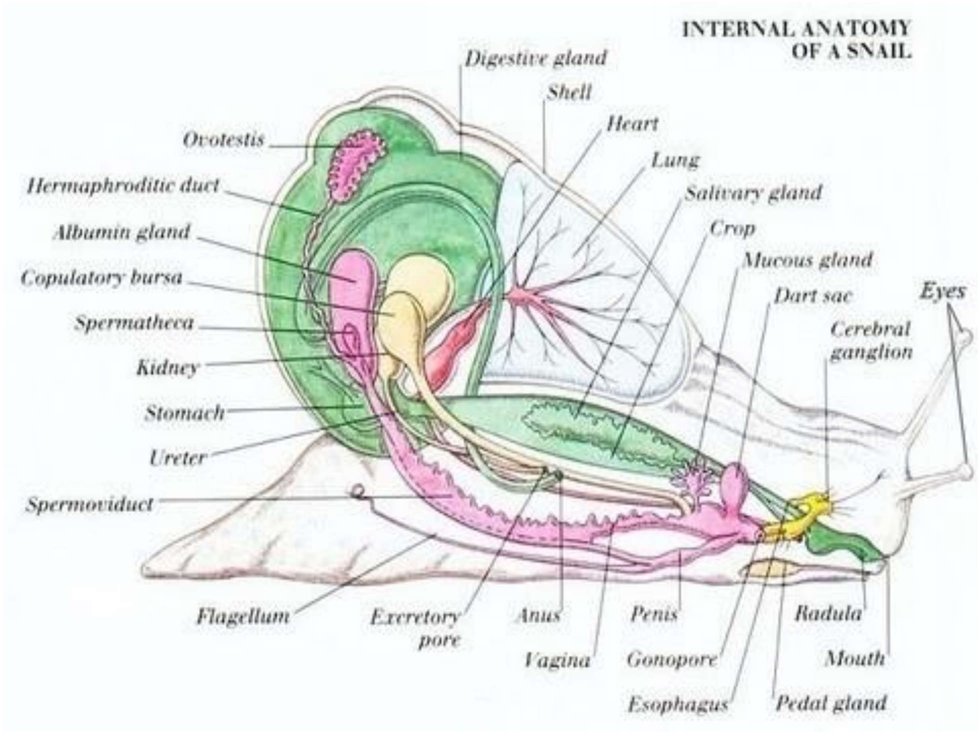
ADAPTATIONS:

- Shell adaptations depend upon the region they inhabit.
- For instance, the cone snails have evolved with a large cone shaped shell that helps them to dig the ocean sand.This adaptation helps them to protect themselves from crabs.
- Some other adaptations include the patterns that help them camouflage.
- Also, the shell thicknesses evolve in order to preserve moisture.
- The eyes of water-dwelling and land snails have adapted to perch on two eye stalks that can retract and extend from the snails' bodies.
- These eye stalks slip inside-out when retracting, protecting the snails' eyesight from predators, turf wars and the elements.
- Snail bodies have adapted for reproduction; snails are hermaphroditic -- they can change sex if necessary to procreate.
- In addition to their ability to change sex, some snails can self-fertilize and reproduce asexually.



SURVIVAL STATEGIES:

- **In winter**, in order to survive in the extremely cold temperatures, snails go into special hibernation.During their hibernation, their hemolymph and other organic chemicals must be regulated so that their cells do not freeze.
- When winter is close, snails lower the levels of water within their body so that the water does not easily freeze. The snails then supercool their bodies and cover themselves with a thick epiphragm. Some snails burrow into the ground for hibernation but some hibernate on the surface and even on trees.Once spring arrives, the snails quickly increase metabolic rate, rehydrate themselves, remove their epiphragm, and start looking for food



http://animals.mom.me/survival-adaptations-snails-5298.htm
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https://bioweb.uwlax.edu/bio210/2011/appel_doug/adaptation.htm

Logarithmic Spirals in Nature

Several natural phenomena showcase close to being logarithmic spiral.

CACTUS

SEA SHELLS

SATELLITE VIEW OF HURRICANE

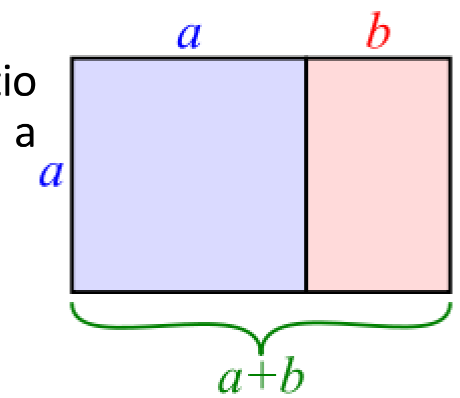
NAUTILIUS SHELL

SPIRAL GALAXY

GIANT'S CAUSEWAY,IRELAND

SPIRAL STRUCTURES AND THE GOLDEN RATIO

“Spirals are a common natural form, appearing at all levels of nature. They are the natural product of Phi (Φ), which is also called the 'Golden Section' or the Golden Mean”.



“In mathematics, two quantities are in the **golden ratio** if their ratio is the same as the ratio of their sum to the larger of the two quantities.” In geometry, a **golden rectangle** is a rectangle whose side lengths are in the golden ratio :

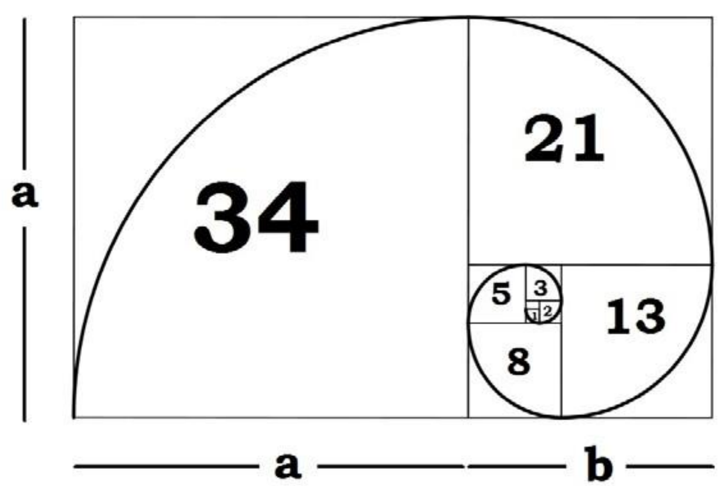
$$\frac{(1+\sqrt{5})}{2} = 1.61803$$

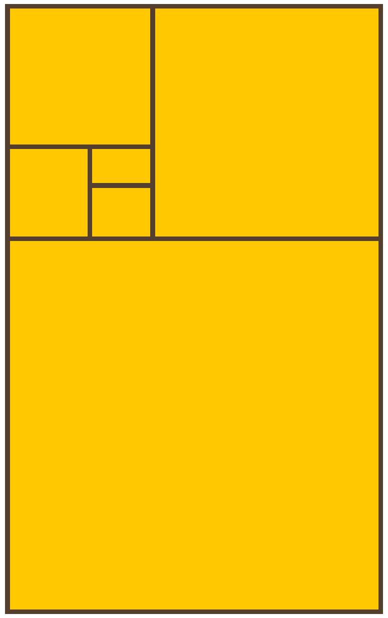
$$\frac{a+b}{a} = \frac{a}{b} \equiv \varphi .$$

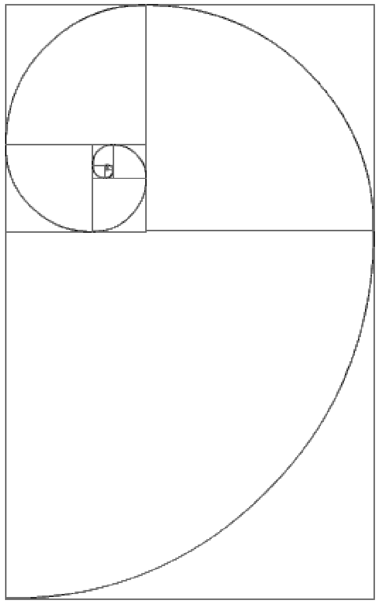
which is $1 : \varphi$ where φ is approximately 1.618.

“A traditional Golden Spiral is formed by the nesting of Golden Rectangles with a Golden Rectangle. A Golden Spiral created from a Golden Rectangle expands in dimension by the Golden Ratio with every quarter, or 90 degree, turn of the spiral.

This can be constructed by starting with a golden rectangle with a height to width ratio of 1.618. The rectangle is then divided to create a square and a smaller golden rectangle. This process is repeated to arrive at a center point, as shown in figures:”The golden spiral then is constructed by creating an arc that touches the points at which each of these golden rectangles are divided into a square and a smaller golden rectangle.

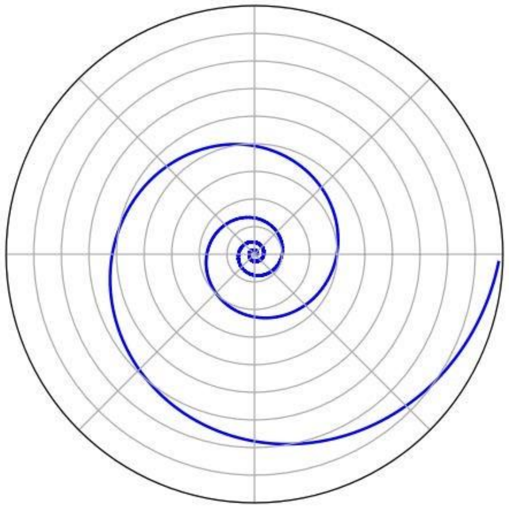






http://www.goldennumber.net/nautilus-spiral-gold
https://en.wikipedia.org/wiki/Golden_ratio
http://www.goldennumber.net/nautilus-spiral-golden-ratio/
http://www.livescience.com/37704-phi-golden-ratio.html

SPIRAL GROWTH ALGORITHM



“A **logarithmic spiral**, **equiangular spiral** or **growth spiral** is a self-similar spiral curve which often appears in nature. The logarithmic spiral was first described by Descartes and later extensively investigated by Jacob Bernoulli. called it *Spira mirabilis* meaning the marvelous spiral.”

Spiral

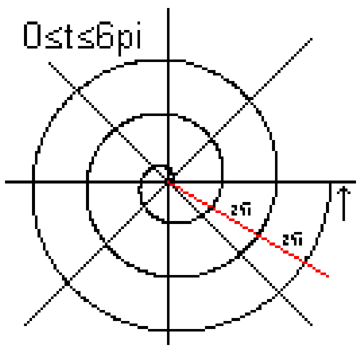
The radius r(t) and the angle t are proportional for the simpliest spiral, the spiral of Archimedes. Therefore the equation is:

(3) Polar equation: r(t) = at [a is constant].

From this follows

(2) Parameter form: x(t) = at cos(t), y(t) = at sin(t),

(1) Central equation: $x^2+y^2 = a^2[\arctan(y/x)]^2$.



$r(t) = t$

The Archimedean spiral starts in the origin and makes a curve with three rounds. The distances between the spiral branches are the same.

More exact: The distances of intersection points along a line through the origin are the same.

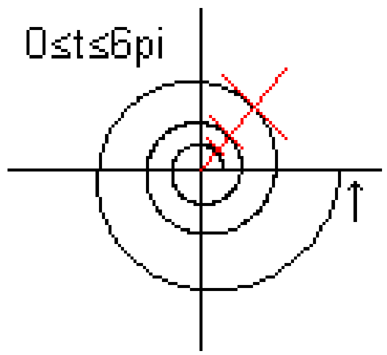
Equiangular Spiral

1) Polar equation: r(t) = exp(t).

(2)Parameter form: x(t) = exp(t) cos(t), y(t) = exp(t) sin(t).

(3)Central equation: $y = x \tan[\ln(\mathrm{sqr}(x^2+y^2))]$. The logarithmic spiral also goes outwards.

The spiral has a characteristic feature: Each line starting in the origin (red) cuts the spiral with the same angle.



$r(t) = e^{0.1t}$

https://en.wikipedia.org/wiki/Logarithmic_spiral
http://www.mathematische-basteleien.de/spiral.htm

In polar coordinates, (r, θ) the logarithmic curve can be written as $r = ae^{b\theta}$ or $\theta = \frac{1}{b}\ln(r/a)$, with e being the base of natural algorithms, and *a* and *b* being arbitrary positive real constants.

In parametric form, the curve is

$$x(t) = r(t)\cos(t) = ae^{bt}\cos(t)$$

$$y(t) = r(t)\sin(t) = ae^{bt}\sin(t)$$

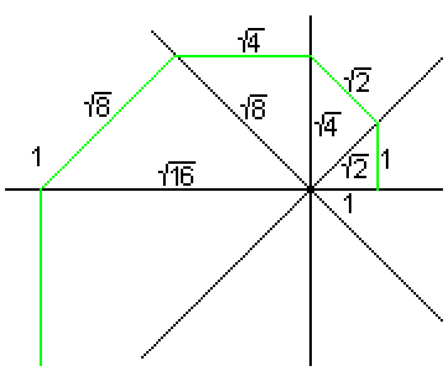
with real numbers *a* and *b.*

The spiral has the property that the angle *φ* between the tangent and radial line at the point (r, θ) is constant. This property can be expressed in differential geometric terms as :

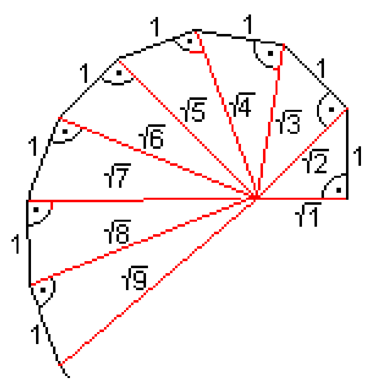
$$\arccos\frac{\langle \mathbf{r}(\theta), \mathbf{r}'(\theta)\rangle}{\|\mathbf{r}(\theta)\|\|\mathbf{r}'(\theta)\|} = \arctan\frac{1}{b} = \phi.$$

The derivative of $\mathbf{r}(\theta)$ is proportional to the parameter *b*. In other words, it controls how tightly and in which direction the spiral spirals. In the extreme case that $b = 0$ ($\phi = \frac{\pi}{2}$) the spiral becomes a circle of radius *a.*
Conversely ,in the limit that *b* approaches infinity (*φ* → 0), the spiral tends towards a straight half line. The complement of *φ* is called the pitch.

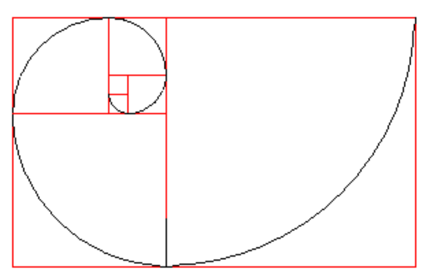
Some other derived spirals are as follows :



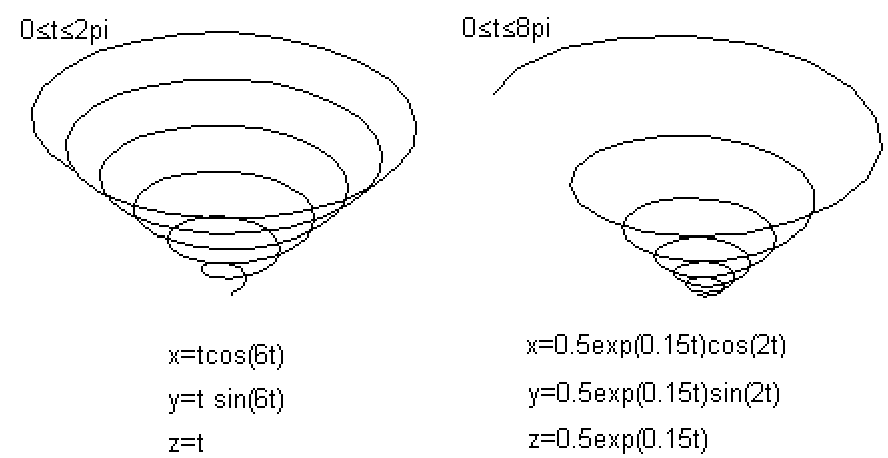
Spiral formed by straight lines that form 45° angles



Spiral formed by chain of right angled triangles



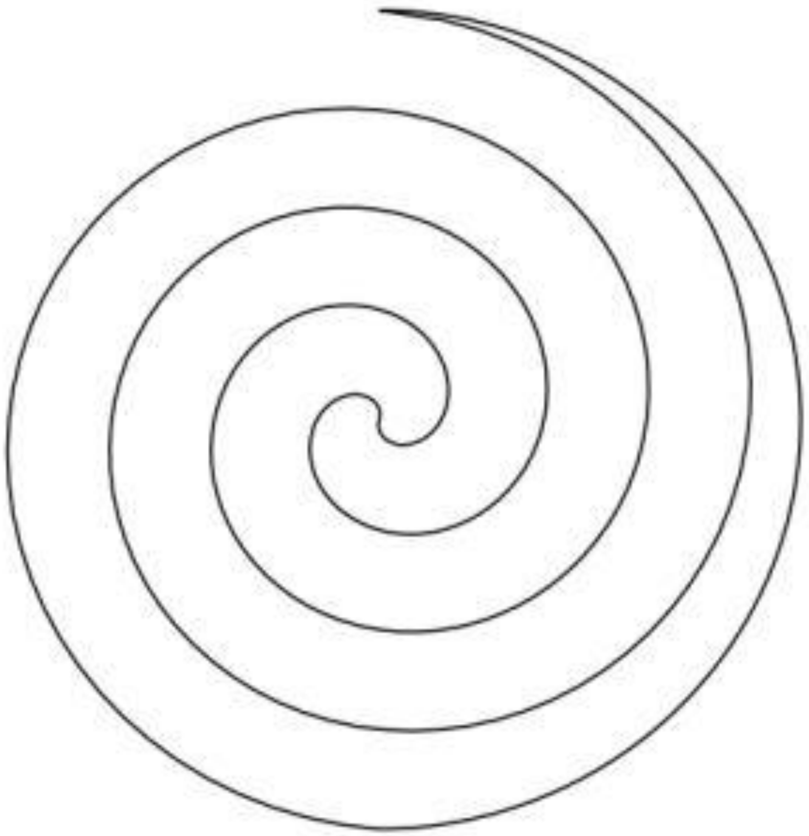
Fibonacci Spiral



Conical helix with Archimedean spiral and equiangular spiral

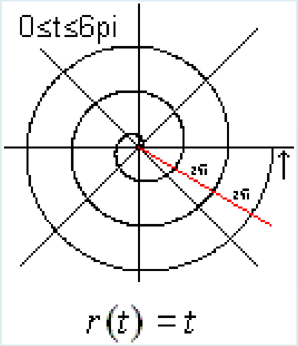
http://www.mathematische-basteleien.de/spiral.ht

DYNAMIC SCRIPT: SPIRALS



KRUPA PATEL | 02/03/2016

SPIRALS



Spirals are based on basically two parameters

- **Radius**
- **Angle of rotation (Vector with x-axis)**

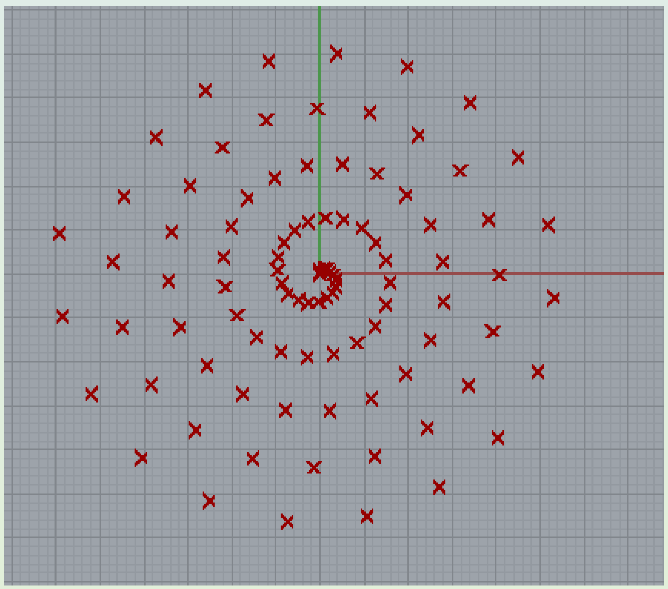
As radius (r) is proportional to angle of rotation (t),
(1) Polar equation: r(t) = at [a is constant].
From this follows
(2) Parameter form: x(t) = at cos(t)
y(t) = at sin(t)

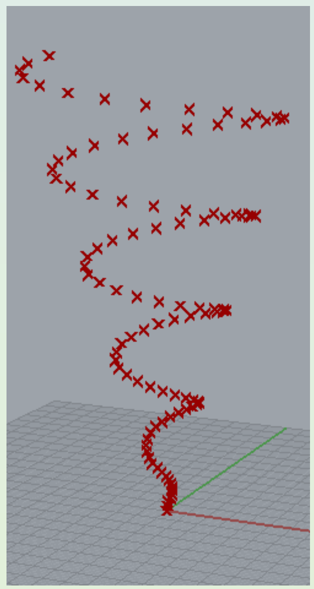
BEHAVIOR

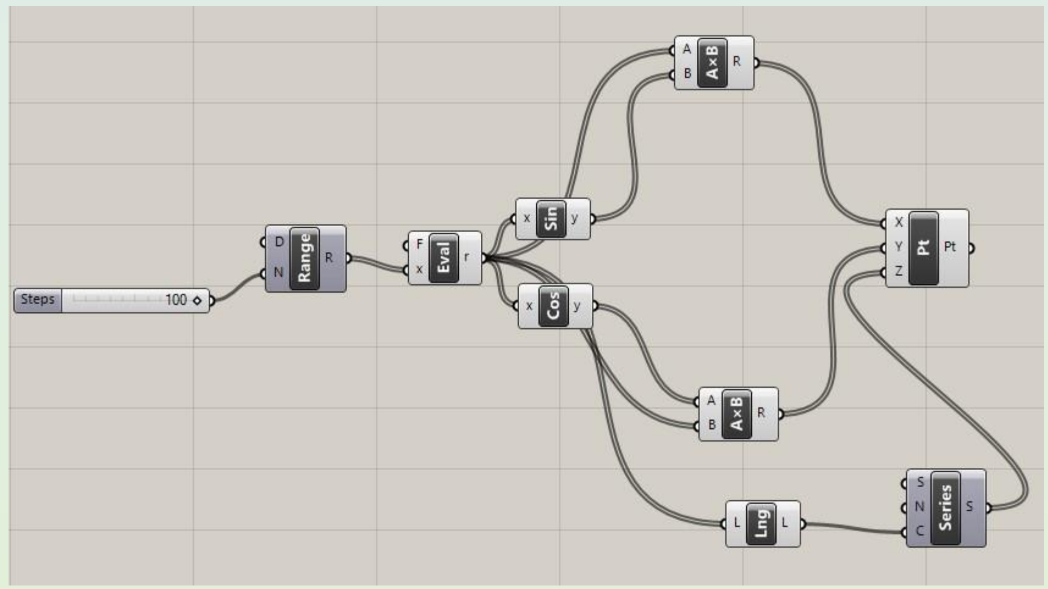
The distances of intersection points along a line through the origin are the same.

The spiral length variates based on the multiple of 2∏ assigned to t. (Number * 2∏)

The spiral can be pulled in z direction in order to form a shell structure, and the length and width of curves depend upon the variable t.







RULE SET

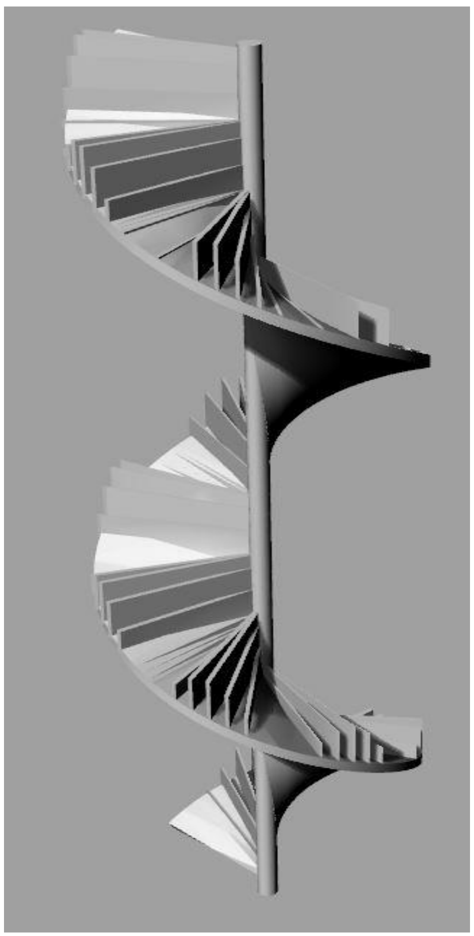
1. DEFINE A RANGE OF POINTS (In multiple of 2∏)
2. DEFINE A FUNCTION TO A VARIABLE
3. ASSIGN SINE AND COSINE FUNCTIONS TO VARIABLE
4. MULTIPLY THE SINE AND COSINE VALUES TO THE FUNCTION DEFINED, AS PER THE PARAMETRIC EQUATION
5. ASSIGN POINTS TO THESE TO CREATE A SPIRAL
6. ASSIGN ALL THE POINTS TO A SERIES AND CONNECT TO Z VECTOR FOR 3D SPIRAL

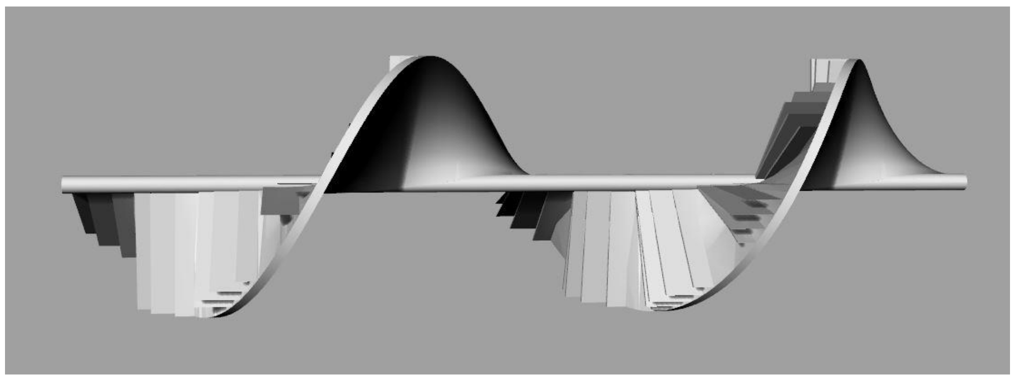
3D PRINT: SPIRALS

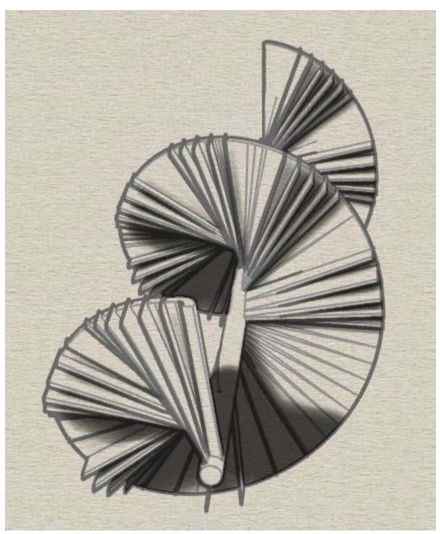
SPIRAL....

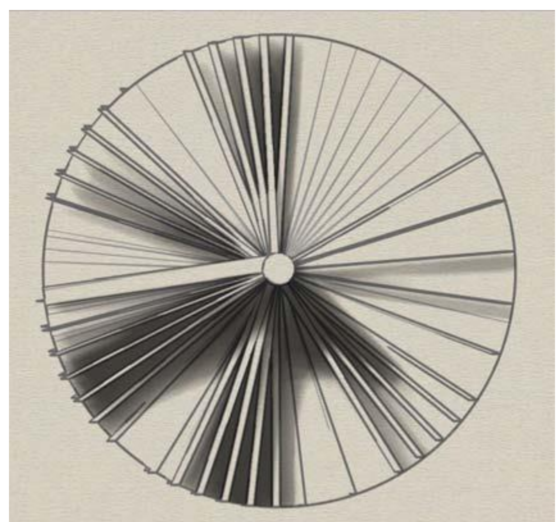
Krupa Patel

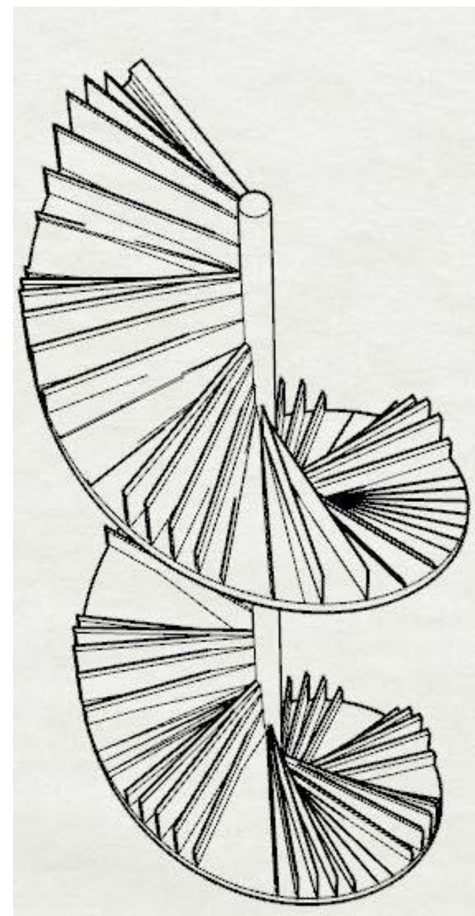
A spiral accounts for uniform growth .It is a curve that progresses continuously, from a center point.
Keeping that in mind, first an axis was created as a basic path for the curve to revolve around.
Then horizontal lines along the axis were created which were rotated in a 3 dimensional way such that they follow a specific logarithm.
Basically, through this model, I wanted to understand the uniform yet illusive progressive nature of spiral.The projections on it are a smaller version of the same principle that is applied throughout the planar surface.

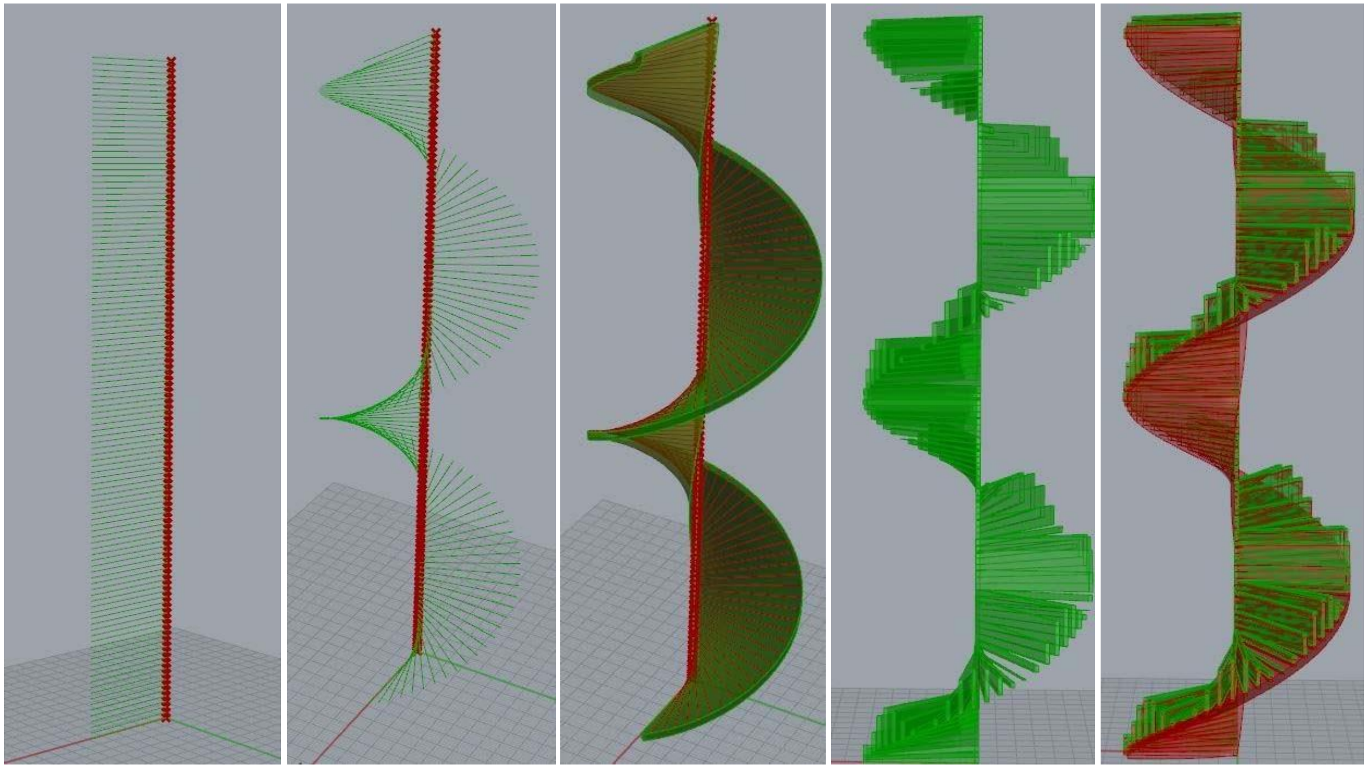


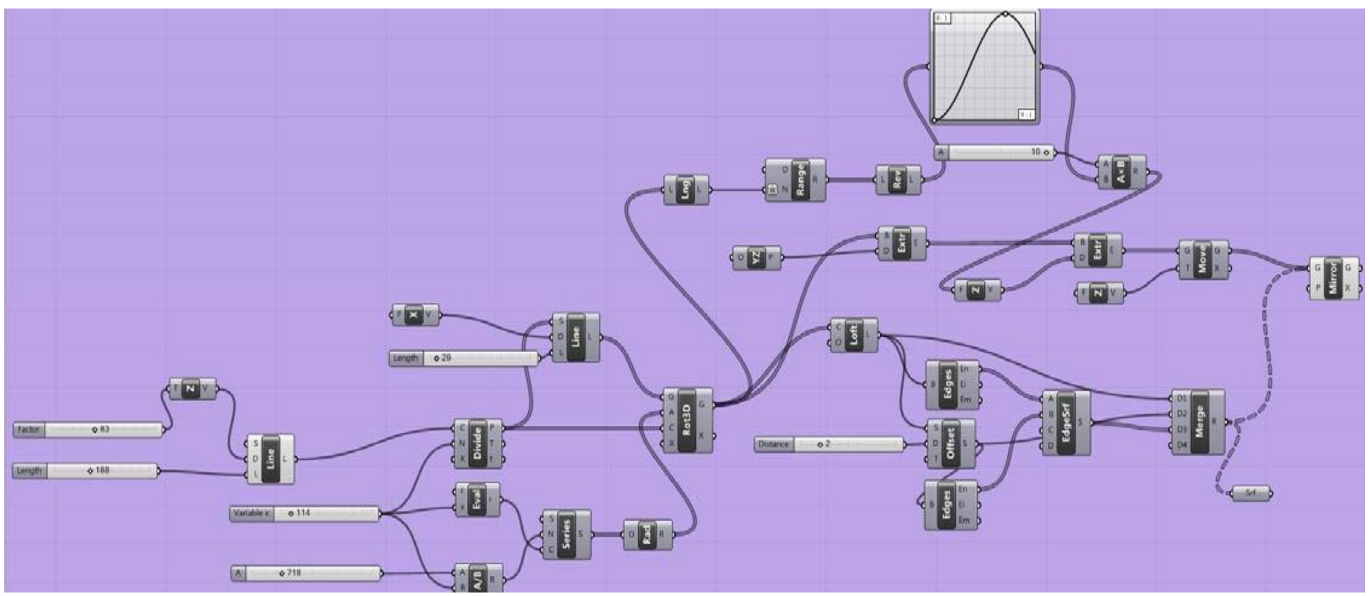








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Divide
Eval
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Loft
Edges
Offset
EdgeSrf
Merge
Extr
Move
Mirror
Range
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Srf