Mathematics in nature

"The laws of nature are but the mathematical thoughts of God"

- Euclid

Introduction

Mathematics is all around us. As we discover more and more about our environment and our surroundings we see that nature can be described mathematically. The beauty of a flower, the majesty of a tree, even the rocks upon which we walk can exhibit natures sense of symmetry. Although there are other examples to be found in crystallography or even at a microscopic level of nature.

Mathematics in nature

- Geometrical Shapes
- Symmetry
- Fibonacci spiral
- The golden ratio
- Fractals

geometrical shapes

- **Shapes - Perfect**

  Earth is the perfect shape for minimising the pull of gravity on its outer edges - a sphere (although centrifugal force from its spin actually makes it an oblate spheroid, flattened at top and bottom). Geometry is the branch of maths that describes such shapes.

- **Shapes - Polyhedra**

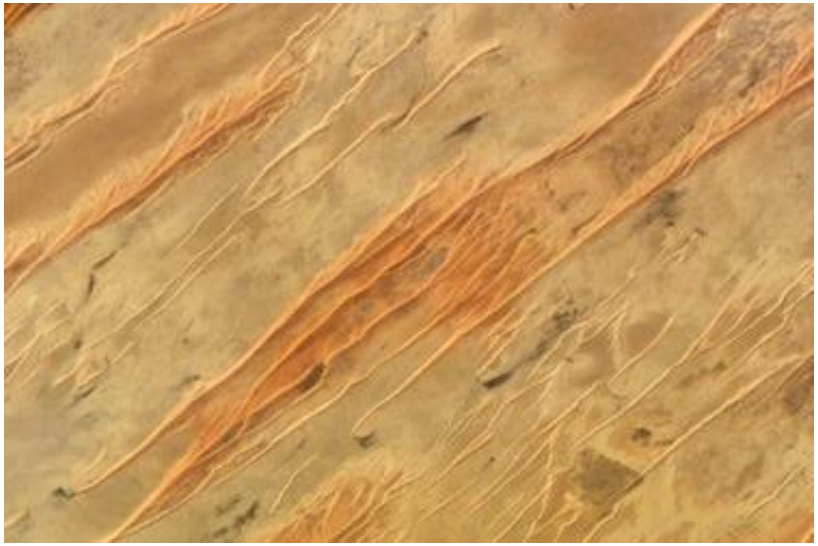
  For a beehive, close packing is important to maximise the use of space. Hexagons fit most closely together without any gaps; so hexagonal wax cells are what bees create to store their eggs and larvae. Hexagons are six-sided polygons, closed, 2-dimensional, many-sided figures with straight edges.

- **Shapes - Cones**

  Volcanoes form cones, the steepness and height of which depends on the runniness (viscosity) of the lava. Fast, runny lava forms flatter cones; thick, viscous lava forms steep-sided cones. Cones are 3-dimensional solids whose volume can be calculated by 1/3 x area of base x height.

- **Parallel lines**

  In mathematics, parallel lines stretch to infinity, neither converging nor diverging. These parallel dunes in the Australian desert aren't perfect - the physical world rarely is.



Fibonacci spiral

- **If you construct a series of squares with lengths equal to the**

Fibonacci numbers (1,1,2,3,5, etc) and trace a line through the diagonals of each square, it forms a Fibonacci spiral.

- **Many examples of the Fibonacci spiral can be seen in**
- **nature, including in the chambers of a nautilus shell.**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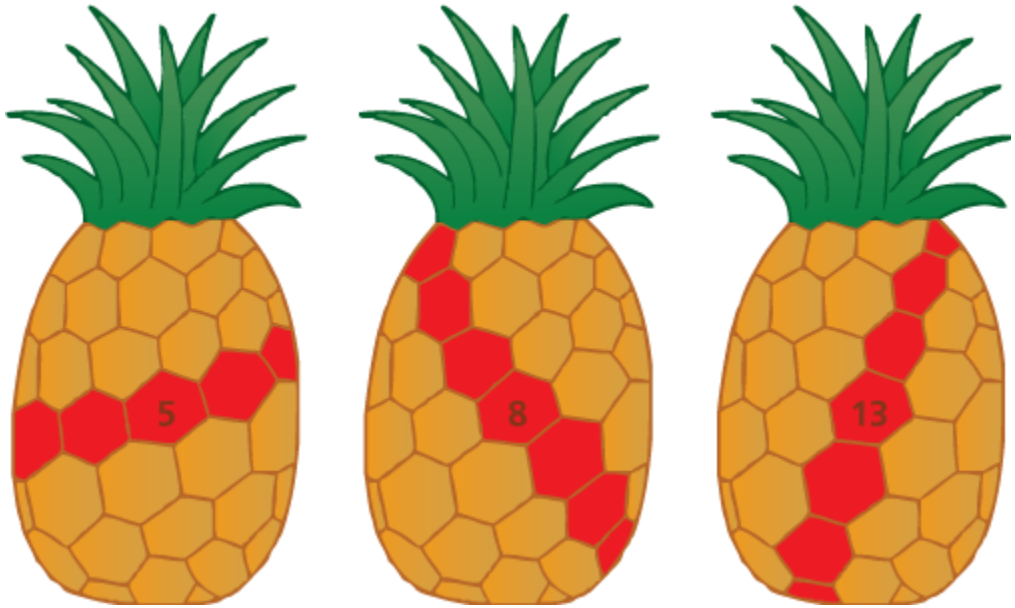
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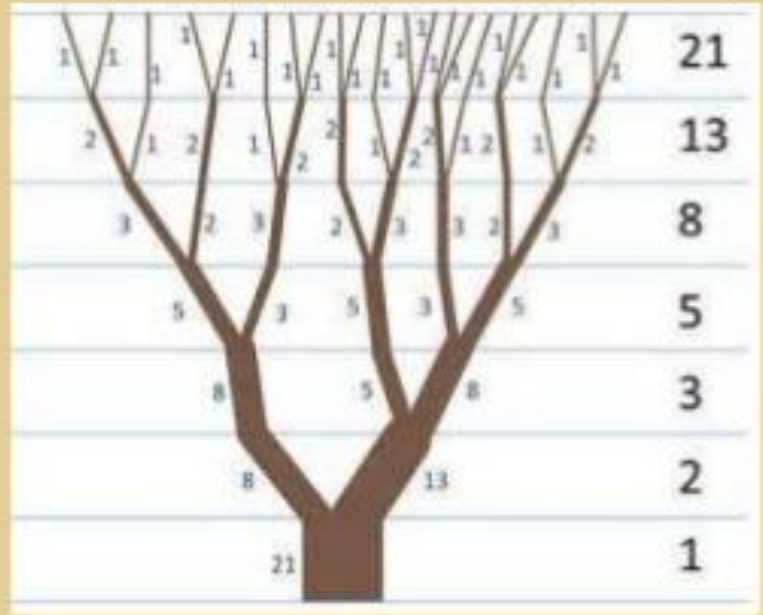
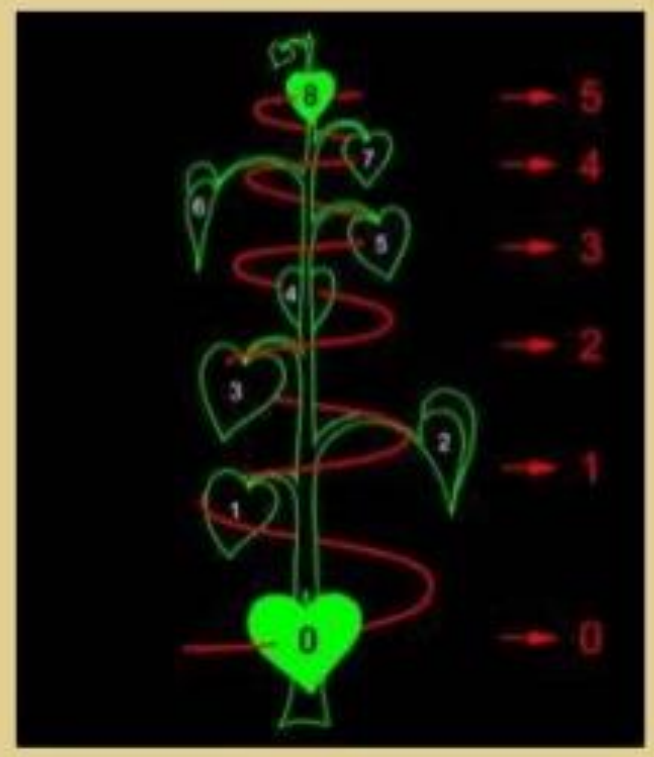
FIBONACCI IN PLANTS





Symmetry

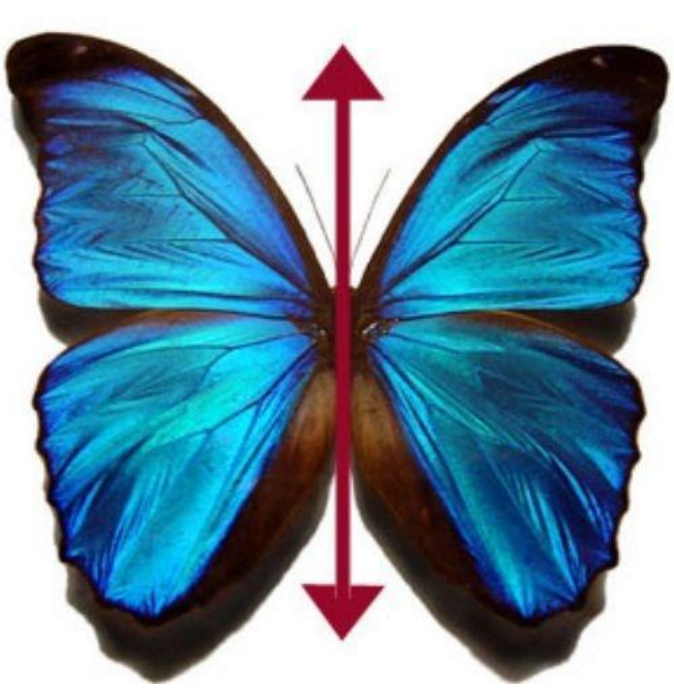
Symmetry is everywhere you look in Nature
Symmetry is when a figure has two sides that are mirror images of one another. It would then be possible to draw a line through a picture of the object and along either side the image would look exactly the same. This line would be called a line of symmetry.

There are two kinds of Symmetries

- Bilateral symmetry
- Radial symmetry

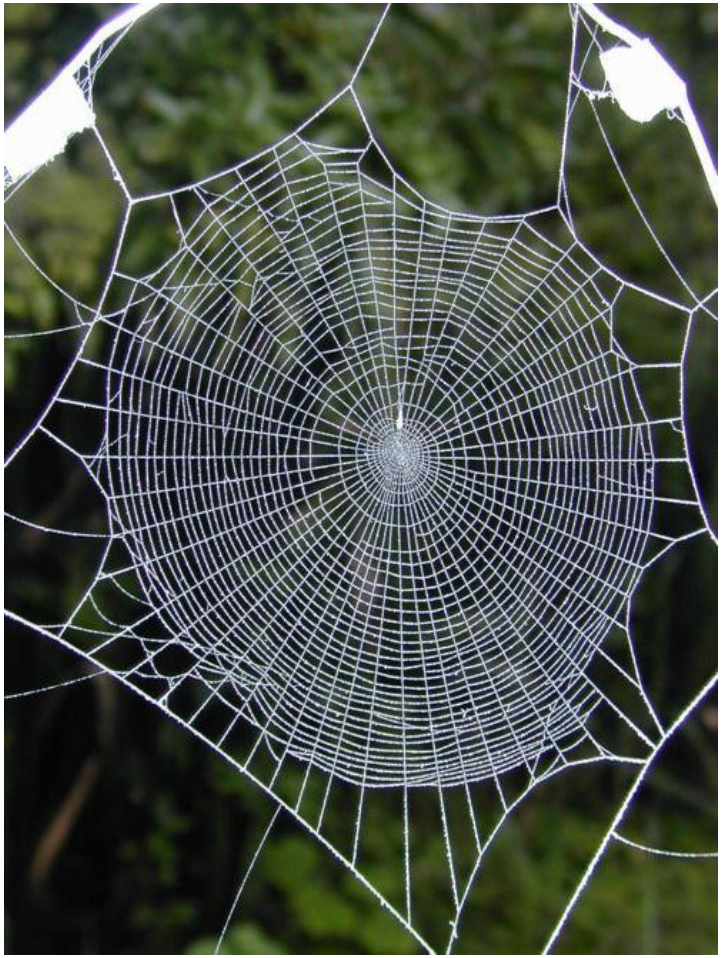
Bilateral symmetry

- One is **Bilateral Symmetry** in which an object has two sides that are mirror images of each other.
- **The human body would be an excellent example of a living being that has Bilateral Symmetry.**



Radial symmetry

- The other kind of symmetry is **Radial Symmetry.** This is where there is a center point and numerous lines of symmetry could be drawn.
- Radial symmetryRadial symmetry is rotational symmetry around a fixed point known as thecenter. Radial symmetry can be classified as either cyclic or dihedral.Cyclic symmetries are represented with the notation Cn, where n is the numberof rotations. Each rotation will have an angle of 360/n. For example, an objecthaving C3 symmetry would have three rotations of 120 degrees.Dihedral symmetries differ from cyclic ones in that they have reflectionsymmetries in addition to rotational symmetry. Dihedral symmetries arerepresented with the notation Dn where n represents the number of rotations,as well as the number of reflection mirrors present. Each rotation angle will beequal to 360/n degrees and the angle between each mirror will be 180/ndegrees. An object with D4 symmetry would have four rotations, each of 90degrees, and four reflection mirrors, with each angle

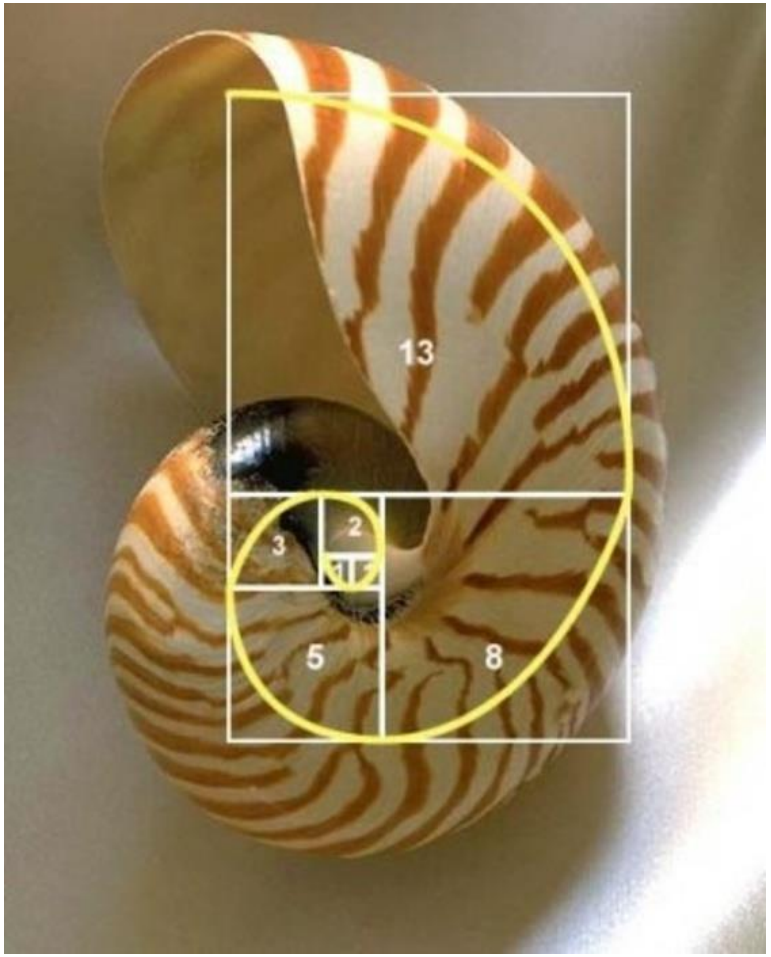


- A starfish provides us with a Dihedral 5 symmetry. Not only do wehave five rotations of 72 degrees each, but we also have five linesof reflection.

- 4.Hibiscus - C5 symmetry. The petals overlap, so the symmetry might not be readily seen. It will be upon closer examination though

The golden ratio

- The ratio of consecutive numbers in the Fibonacci sequence approaches a number known as the golden ratio, or phi (=1.618033989...). The aesthetically appealing ratio is found in much human architecture and plant life. A Golden Spiral formed in a manner similar to the Fibonacci spiral can be found by tracing the seeds of a sunflower from the center outwards.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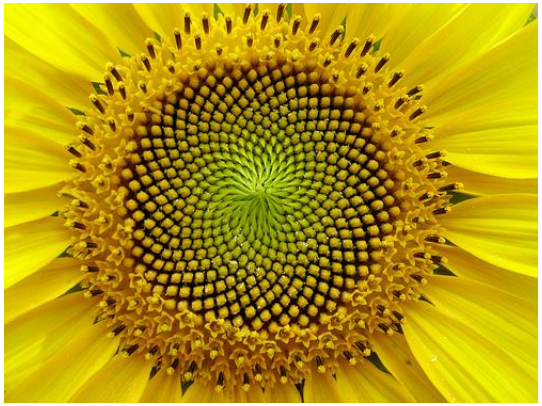
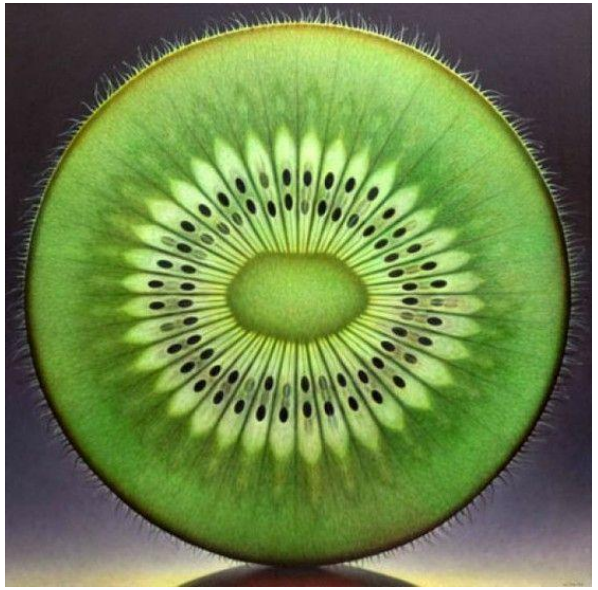


fractals

- A **fractal** is a never-ending pattern. **Fractals** are infinitely complex patterns that are self-similar across different scales. They are created by repeating a simple process over and over in an ongoing feedback loop. Driven by recursion, **fractals** are images of dynamic systems – the pictures of Chaos.



conclusion

Mathematics is everywhere in this universe. We seldom note it. We enjoy nature and are not interested in going deep about what mathematical idea is in it.

mathematics express itself everywhere, in all most every facet of life- in nature all around us.