PARAM SCIENCE MAGAZINE

"The patterns in nature are the keys to understanding the universe." - Galileo Galilei

FEB 2023 SCIENCE DAYS

World Cancer Day: 4th Feb
International Day of Women and Girls in Science: 11th Feb
National Science Day: 28th Feb

Birthdays!

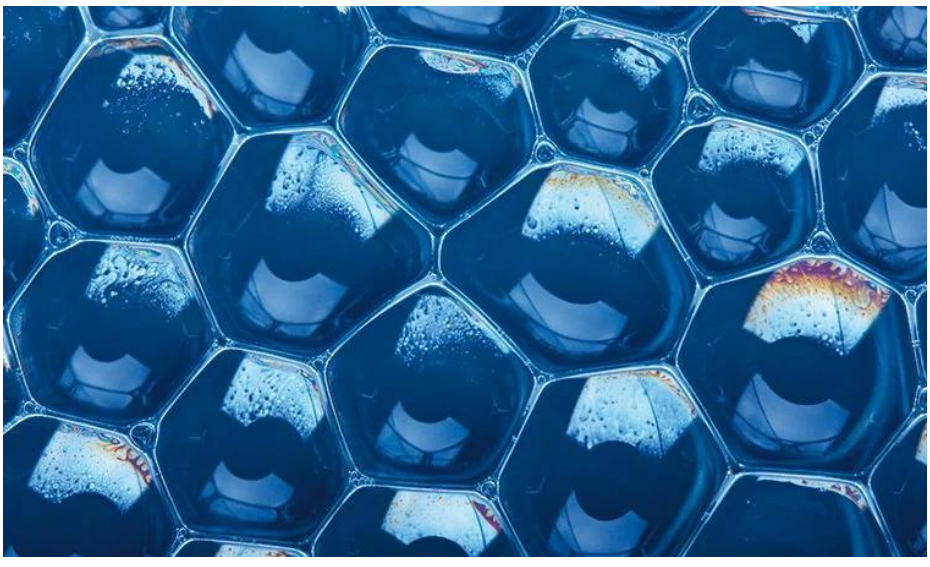
Emilio Segrè : 1st Feb 1905
Dmitri Mendeleev: 8th Feb 1834
Beulah Louise Henry: 11th Feb 1887
Galileo Galilei: 15th Feb 1564.
Mary Anderson: 19th Feb in 1866
Dr. Shanti Swarup Bhatnagar: 21st Feb 1894

Sequences and patterns, so clear and bright,
Heartbeats of the universe, a stunning sight.
Revealing secrets with every beat,
From DNA to plant growth, a grand feat.
Fractals and geometry, a wondrous show,
A deeper order, for us to know.
Let us take a moment, to see the art,
The essence of life and universe, a brilliant part.

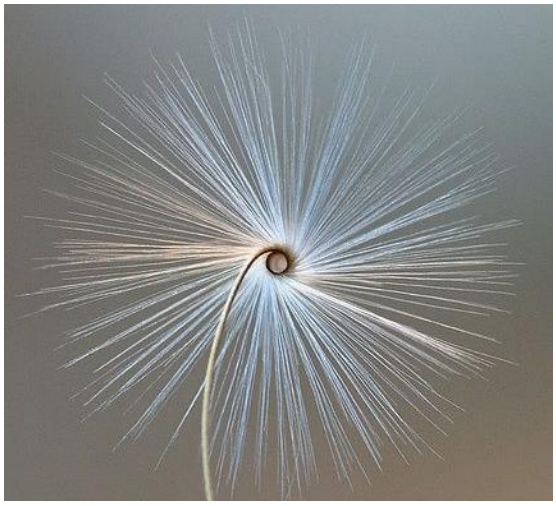
The golden spiral, symbolized by φ, embodies the divine proportionality of the golden ratio, where the ratio of the more significant part to the minor part is equal to the ratio of the whole to the more significant part, yielding a quotient of approximately 1.618.

This issue is we talk about the mesmerising magic of sequences and patterns!

https://en.wikipedia.org/wiki/Portal:Physics/Anniversaries



Source: Postdif/Wikipedia (CC BY-SA 3.0)



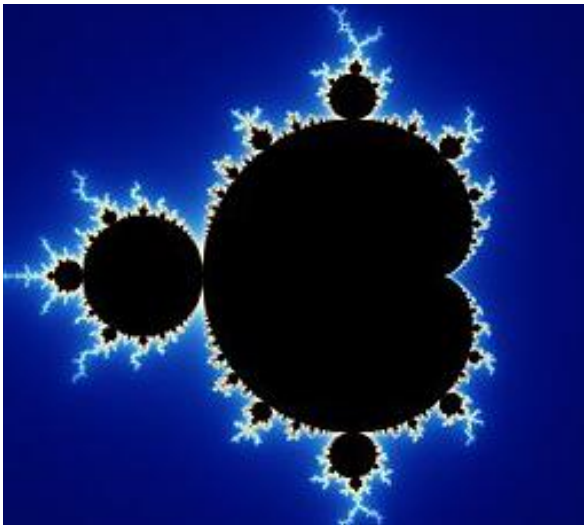
Mathematics is the science of patterns, and nature exploits just about every pattern that there is.

-Ian Stewart

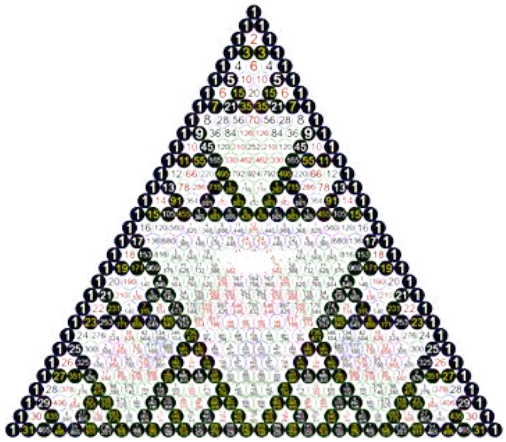
Source: https://images.app.goo.gl/cMQG6RiWiWNMGA7YA

SEQUENCES

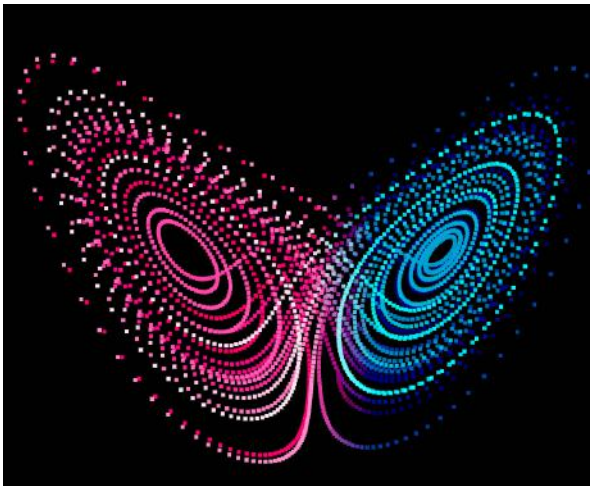
Exploring Gems of Unique Sequences



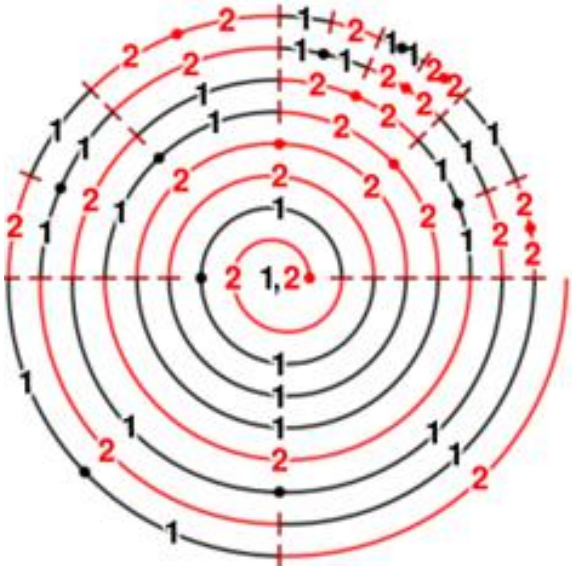
Mandelbrot set
Fractal Geometry's Crown Jewel



Sierpiński triangle or Fractal Triangles
Infinite Dimensionality in Triangles



The Lorenz Attractor's
Beauty in Chaos



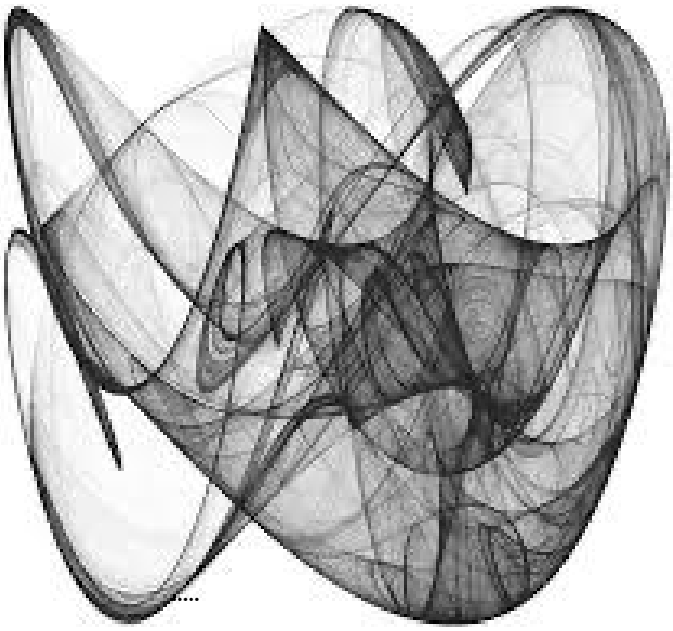
The Kolakoski sequence's Symphony

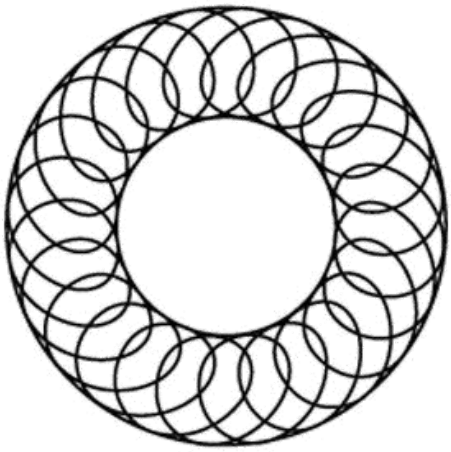
Source: Phttps://en.wikipedia.org/wiki/Mandelbrot_set

ATTRACTORS

Attractor is a set of states toward which a system tends to evolve, for a wide variety of starting conditions of the system.

Strange Attractors
The state of a mathematicaly chaotic system toward which the system trends. Unlike the randomness generated by a system with many variables, chaos has its own pattern, a peculiar kind of order.

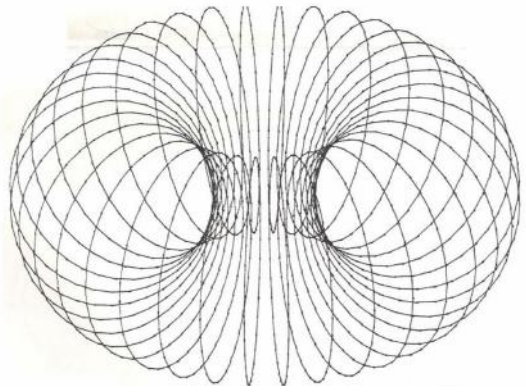




Limit cycle attractor
A limit cycle is an isolated closed orbit.

https://plato.stanford.edu/entries/turing-machine/#TuriDefi

Torus attractor
Torus attractor is a system which change in detailed characteristics with time but does not change its form. It has a trajectory which will reduce a path looking like a doughnut shape of a torus.



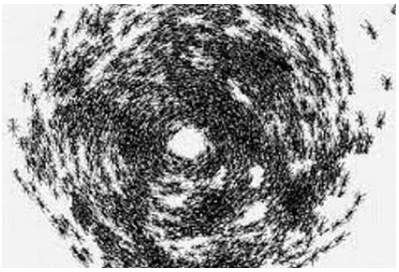
Source: https://crystal.uta.edu/~burns/project_nixieclock.html

PATTERNS

Nature

Starlings Murmuration

Fish Murmuration



Death spiral of ants

Nature's masterpiece is the synchronization of mathematical patterns found in the natural world, showing the unity and order in the universe.

Great Migrations: Sequenced Migratory Symphony

Unveiling the Genetic Blueprint of Animal Behavioral Patterns: From courtship displays to nest building".

The animal kingdom is a tapestry of genetic intricacies, woven with threads of behavioural patterns.

Source: https://images.app.goo.gl/5f6wmiRx88iKoMky8

PATTERNS

Nature Loves Science



From being just a pretty pattern, this formations follows a scientific formula based on a special sequence of numbers known as Fibonacci numbers.

The Fibonacci sequence is a symphony of numbers that can be found in the most unexpected places, a wonder of mathematics and nature, a bridge between the abstract and the concrete, the ideal and the real, the beauty and the science.

Echinoderms like this starfish have fivefold symmetry

Snowflakes have sixfold symmetry

Volvox has spherical symmetry

Anemones have rotational symmetry

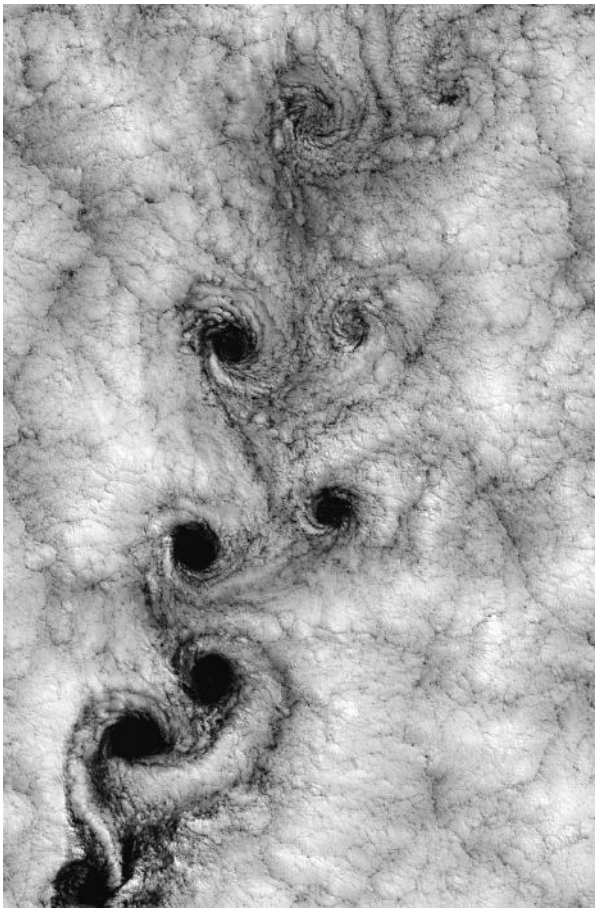
When admiring a bouquet of flowers next time, take a closer look and you will discover the beauty of nature as well as the science behind it.

Source: https://images.app.goo.gl/cFqtsue799EQSGBB6

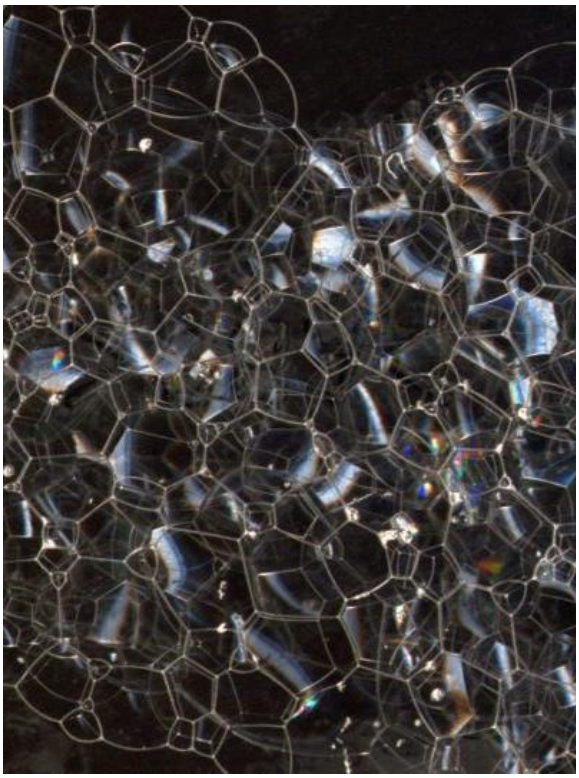
PATTERNS

Forces in Nature

Mystic beauty of the Namibia Sand Sea: a desert in motion



Wherever you see its chaos



Bubbles too have patterns

Do you relieve stress like this?

Source: https://images.app.goo.gl/dTErqrDV7u8hu3pc8

PATTERNS

Nature

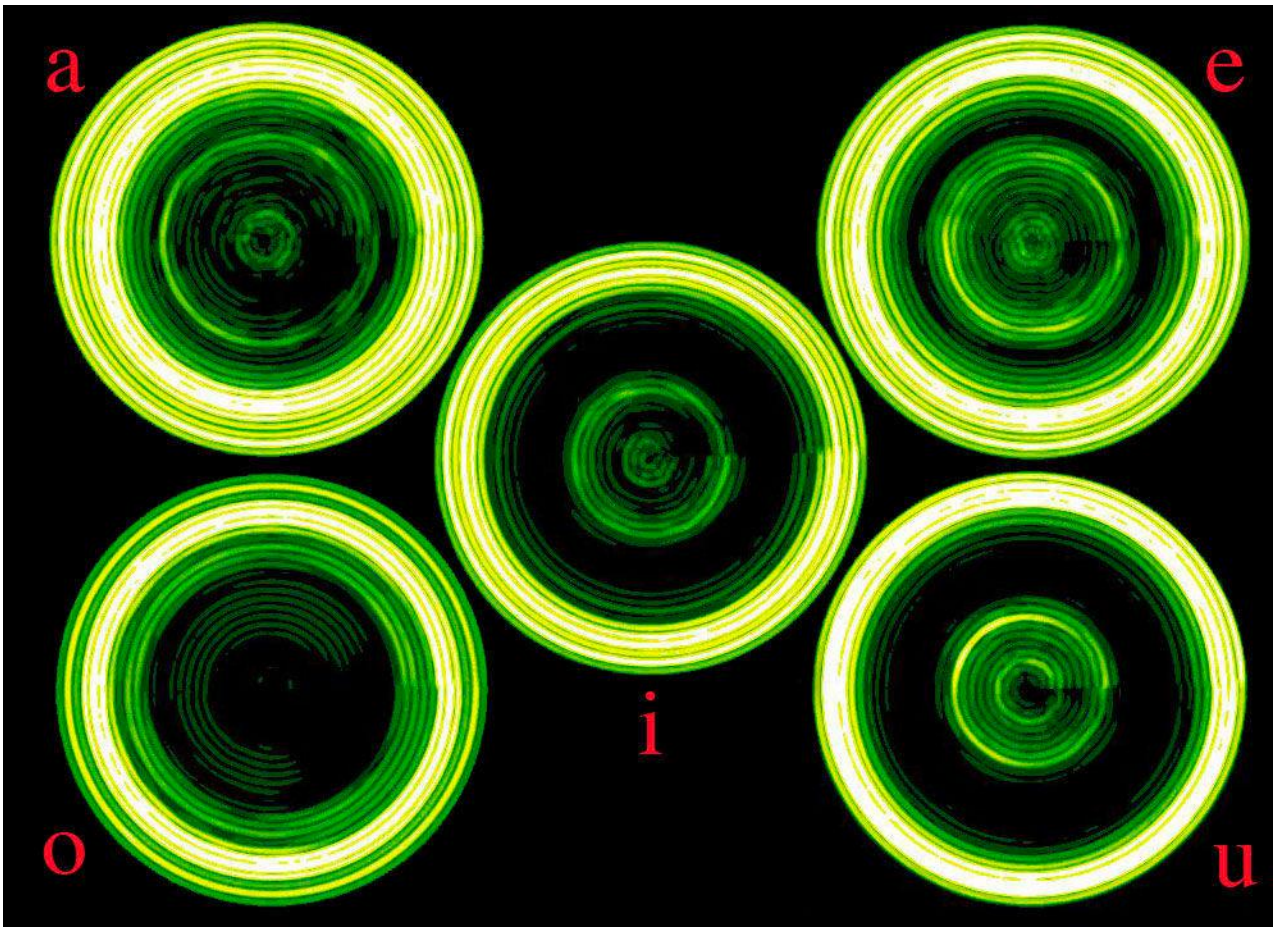
Nature photographer Kjell Bloch Sandved amassed a collection of butterfly and moth images with interesting patterns on their wings. He formed the Butterfly Alphabet, featuring all 26 letters in the English alphabet, as well as the 10 single-digit numbers.

Stripes, Spots and mazes on animals were explained by Turing in the ground breaking paper in 1952 which explained 'Turing Patterns' to the world.

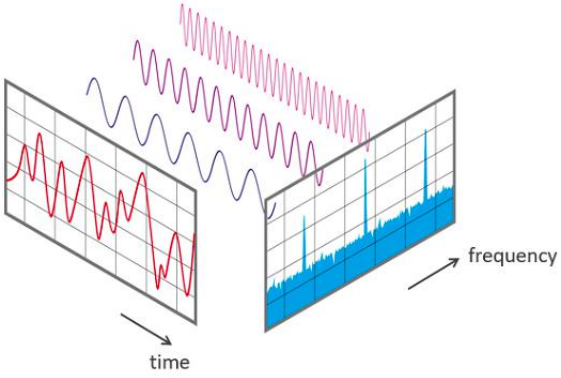
Source: https://images.app.goo.gl/rwsUixgTZXCveztm9

COMPUTERS

Understanding Sound



The distinct forms of five vowel sounds are a, e, i o and u. The bright bands in the visualisations show which frequencies are active in the voice-the further from the centre, the higher the pitch. Time is wrapped around anti-clockwise to create a loop. Computers convert speech into patterns like this so that speech recognition can become pattern matching.



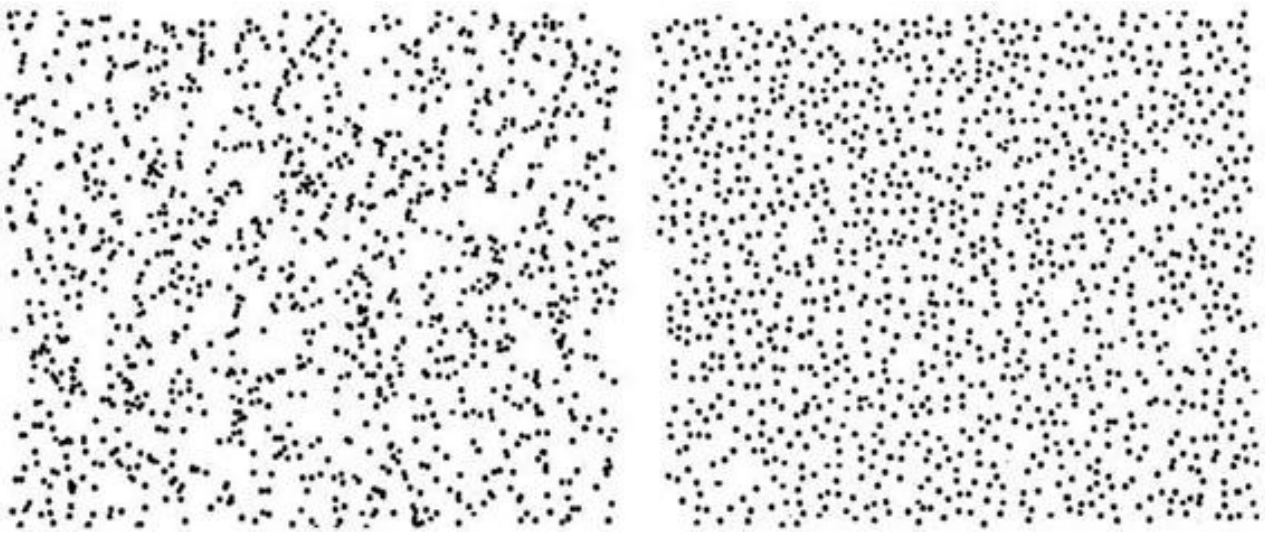
Every signal/curve can be broken up into a sum of sine and cosine waves through a method called Fourier Transformation. This is massively used in modern communication technology.

All possible due to the simplicity of repeating patterns.

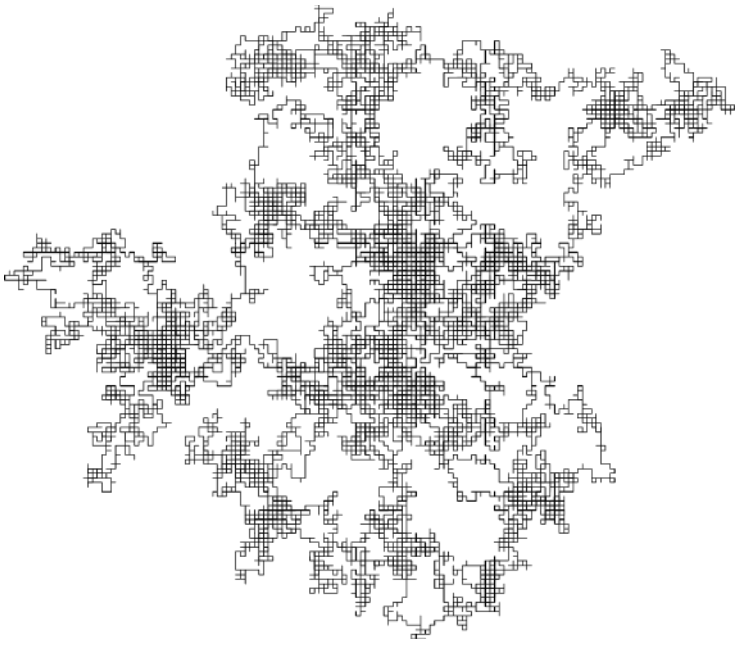
Source: https://blog.matthen.com/post/38716705517/the-distinct-forms-of-five-vowel-sounds-a-e-i-o

RANDOMNESS

Order in Chaos



One of the patterns represents true randomness, while the other represents how humans randomly place dots on a paper. It is impossible to find true randomness anywhere, and as a result, we see a lot of constrained pseudo-random representations in nature. Whether in behaviour, skin patterns or even sounds, inherent constraints massively deviate from truly randomness.



The left represents a random walk in 2 dimensions where one randomly goes up, down, left or right randomly each step.

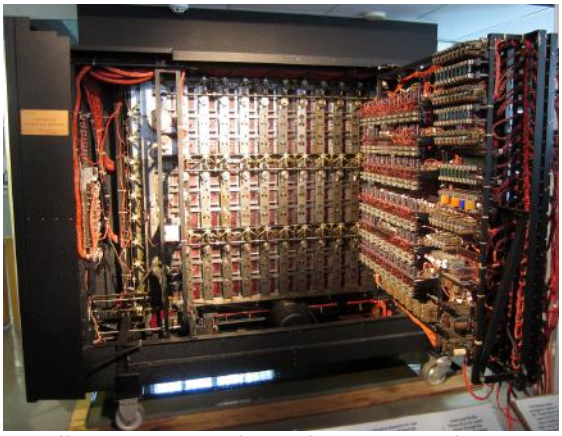
But we humans are geared towards seeing patterns, and we tend to find them where there are none. Thus patterns in stars, clouds and nature are sometimes deemed supernatural or a miracle.

Source: https://images.app.goo.gl/bLTBMkNPEtuyBBYi6

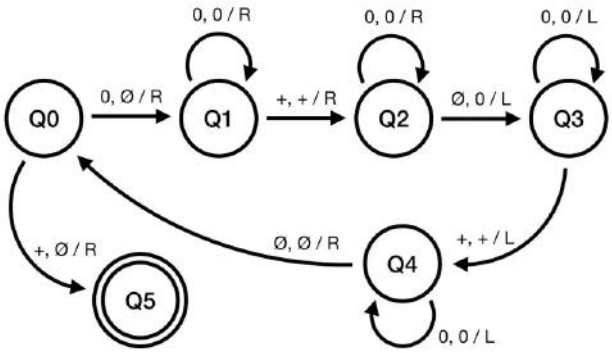
MACHINES

Turing Machine

Turing machines are simple abstract computational devices intended to help investigate the extent and limitations of what can be computed. Turing's 'automatic machines', as he termed them in 1936, were specifically devised to compute real numbers.

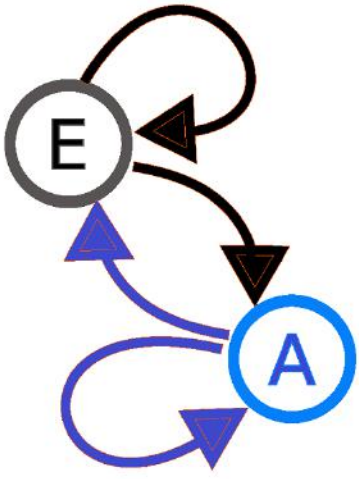


https://plato.stanford.edu/entries/turing-machine/#TuriDefi



A Turing Machine (TM) consists of two memories: an unbounded tape and a finite state control table. The tape holds data as symbols. The machine has a minimal set of proper operations, six (read, write, move left, move right, change state, halt) on the tape.

A Markov Algorithm is a method to model a sequence of events where the probability of each event depends only on the previous event -Commonly used in AI, NLP, speech recognition and other fields to model sequences of data. Named after Andrey Markov, a Russian mathematician who first described the concept in the early 20th century.

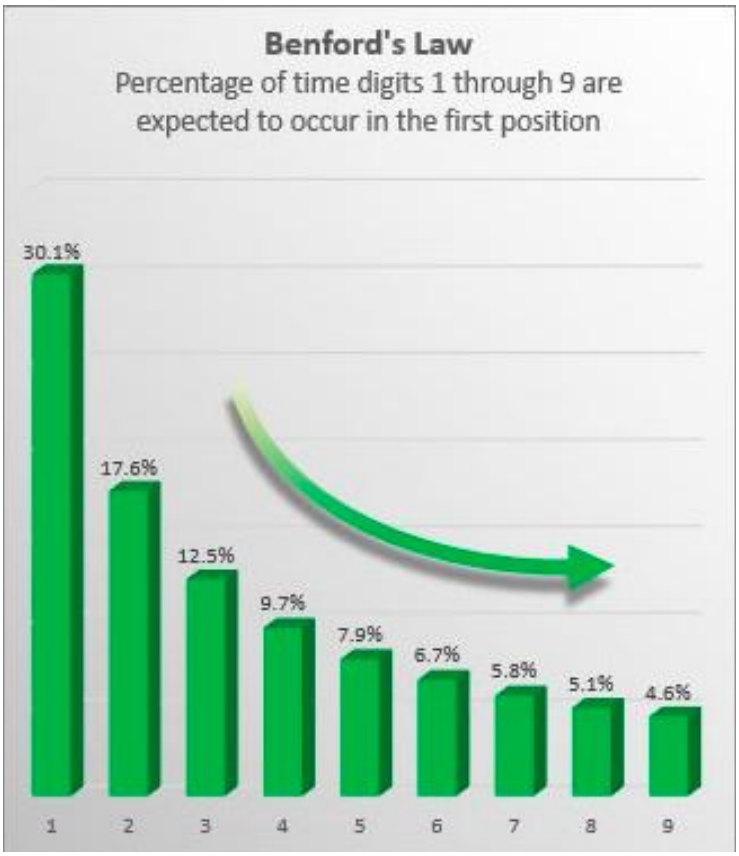


Source : https://crystal.uta.edu/~burns/project_nixieclock.html

FRAUD

Detecting Fraud using Patterns

Detecting fraud is very easy due to the inability of humans to produce truly random generations. Even if we use a simulation or roll a die, it is highly unlikely that the result will correspond to the event's true nature. These inconsistencies can be easily detected through inconsistencies in the resulting distribution. Some simplest and commonly known methods include Benford's Law, Zipf's Law and Pareto Distribution.



A simple exercise you can do at home to verify Benford's Law. Pick any newspaper or magazine. Leave out all years, phone numbers, page numbers and dates. Choose all other numbers you can find. You will see that the first digits of all those numbers will form a curve like the one on the left, with digit 1 occurring close to 30% of the time.

Such techniques have been used to detect fraud in elections, accounting, academic research and even covid data released by administrations.

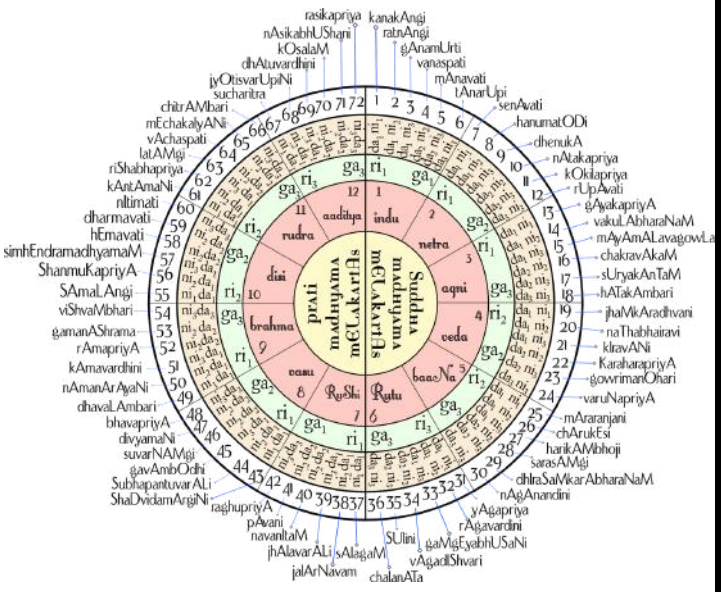
There is a famous story where an election was discovered to be rigged when they saw that most of the last digits were seven which is usually the go-to last digit of a number when humans try to generate seemingly random numbers.

Source: https://www.journalofaccountancy.com/issues/2017/apr/excel-and-benfords-law-to-detect-fraud.html

MUSIC

Rhythm & Melody

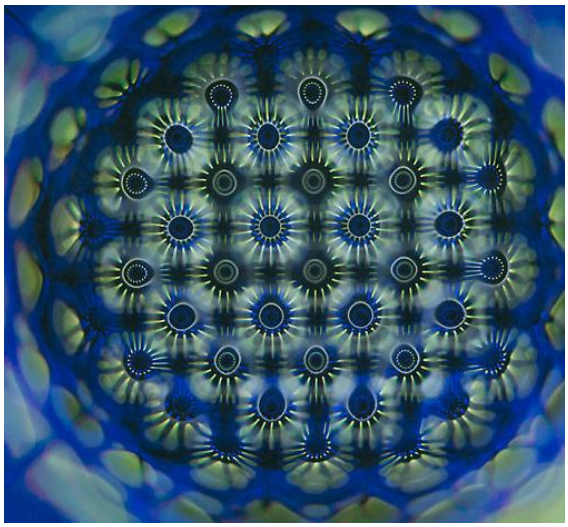
The symphony of mathematics and music is a beautiful dance of patterns, where the repetitive rhythms of music echo the elegant equations of math, both weaving a harmonious tapestry of understanding.



The process of composing music often involves mathematical concepts such as symmetry, patterns, and probability.
Hindustani talas has tintal (4 + 4 + 4 + 4 beats), rupaktal (3 + 2 + 2 beats), and jhaptal (2 + 3 + 2 + 3 beats).

Among the most widely used Karnatak talas are adi, which is by far the most common (4 + 2+ 2); misra capu (3 + 4); and jhampa (7 + 1 + 2); among the most complex are ata (5 + 5 + 2 + 2) and druva (4 + 2 + 4 + 4).

Cymatics
Liquid vibrating in a confined space results in standing waves at specific frequencies. These are Faraday waves (nonlinear standing waves that appear on liquids enclosed by a vibrating receptacle). This is similar to how specific notes form in musical instruments.



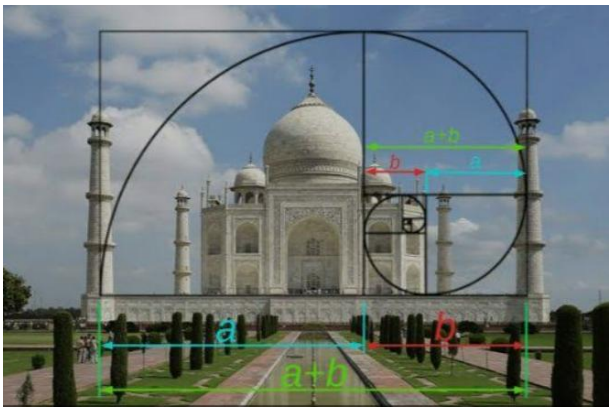
Source: https://www.boredpanda.com/water-blasted-sound-photos-linden- gledhill/tm_source=google&utm_medium=organic&utm_campaign=organic
source: https://en.wikipedia.org/wiki/Raga

ARCHITECTURE

Patterns are often the projection of standardized wholes, a certain symmetry. Their usage in the world of design and architecture induces balance and equilibrium.

Architects have long relied on the golden ratio's ability to create a sense of balance and harmony in structures. The Fibonacci sequence may have been used in the design of the Pantheon's dome, as the ratio of the diameter to the height of the dome is close to the Golden Ratio.


The Parthenon, Greece



A golden rectangle is a rectangle whose side lengths are in the golden ratio, one-to-phi, that is, approximately 1:1.618 which is the math behind the Taj Mahal

The Fibonacci sequence can be used to model the number of ways to climb a flight of stairs. Each step can be either one or two steps, and the Fibonacci sequence represents the total number of ways to climb the stairs, given the number of steps in the flight.

Pyramid of Khafre

- The golden rectangle formed by the apex points of Khafre has sides with a ratio of 1.613.
- The bases of Khafre express the concept of dividing a line at its golden ratio point.

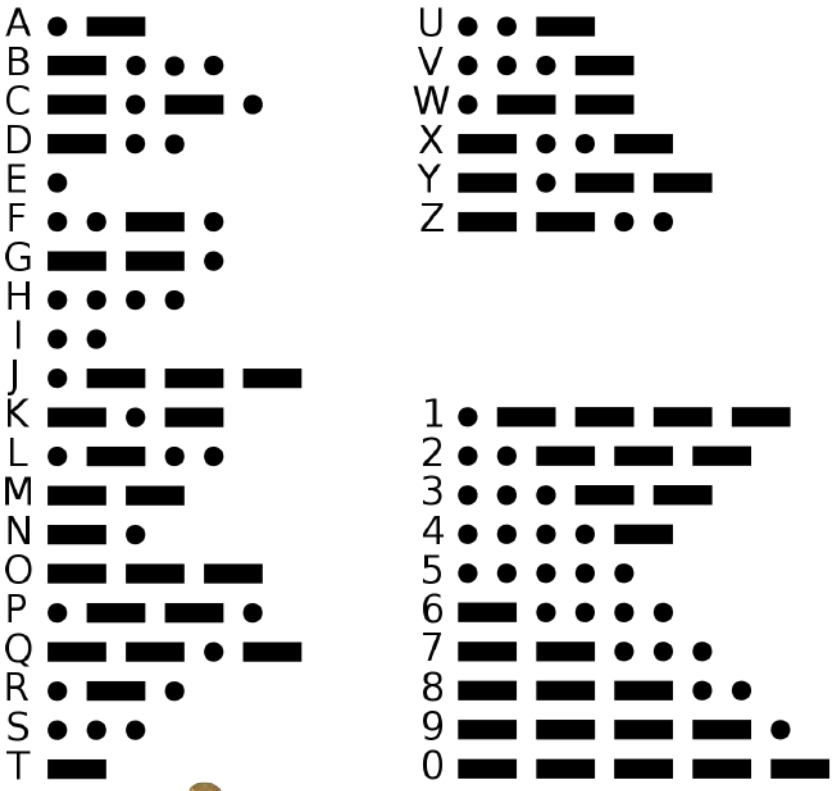
Source: https://images.app.goo.gl/Sjj5CpKbk3dVvMoM8

MORSE CODE

Morse code is a method used in telecommunication to encode text characters as standardized sequences of two different signal durations, called dots and dashes, or dits and dahs.

International Morse Code

1. The length of a dot is one unit.
2. A dash is three units.
3. The space between parts of the same letter is one unit.
4. The space between letters is three units.
5. The space between words is seven units.



The Morse code is generally taught using two methods namely the Farnsworth method and the Koch method.

When messages are sent by Morse code, dots are short beeps or clicks or flashes, and dashes are longer ones.

Source: https://en.wikipedia.org/wiki/Morse_code

DIY PATTERNS

Tie dying your shirts

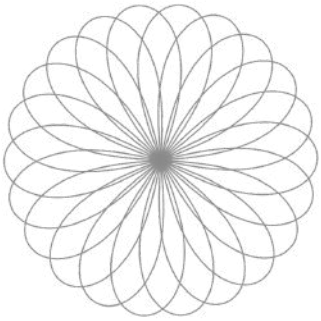
Here are the supplies you'll need for this project.

- Fiber-reactive dye in assorted colors
- Fabric items, like shirts / sweatshirts
- Laundry detergent
- Rubber bands or strong string
- Squeeze bottles, to apply dye
- Plastic tablecloths or large trash bags to protect your work surface

Source: https://sarahmaker.com/tie-dye-spiral/

ART

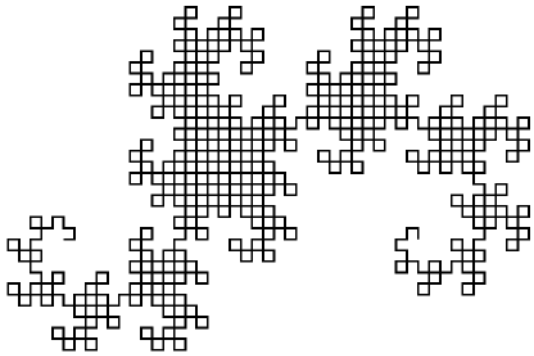
Mathematical rangolis

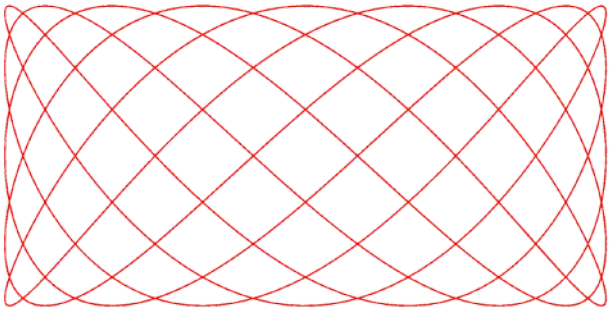


$$r = 5\sqrt{cos2\left(\frac{\theta\pi}{2}\right)}\,;\, 3\pi \le \theta \le 5\pi\pi$$

$$f_1(x,y) = \frac{1}{\sqrt{2}}\begin{pmatrix} cos45^\circ & -sin45^\circ \\ sin45^\circ & cos45^\circ \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix}$$

$$f_2(x,y) = \frac{1}{\sqrt{2}}\begin{pmatrix} cos135^\circ & -sin135^\circ \\ sin135^\circ & cos135^\circ \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix} + \begin{pmatrix} 1 \\ 0 \end{pmatrix}$$



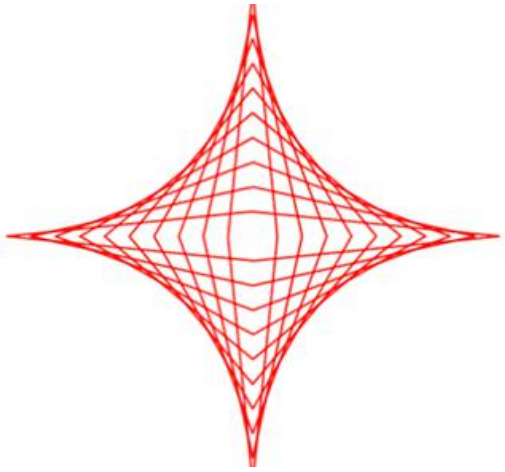


$$\left(2sin\left(5t + \frac{\pi}{2}\right), \sin(9t)\right)$$

$$0 \le t \le 10$$

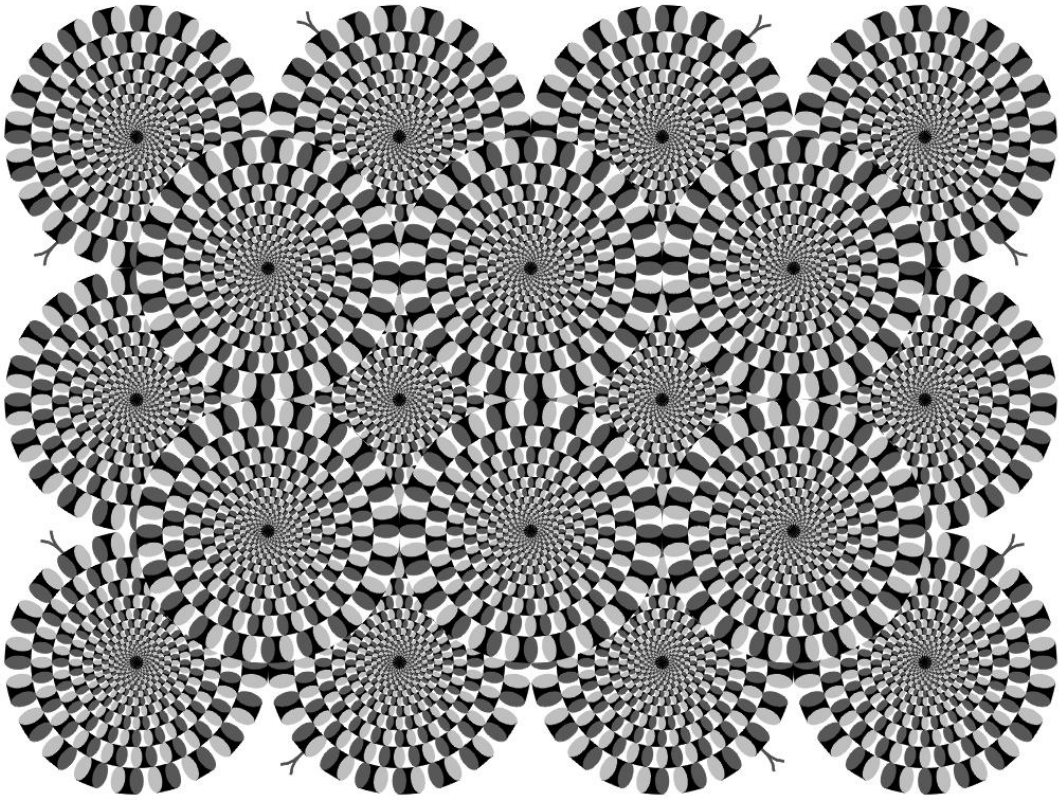
$$|y| = a + \frac{a}{a - 11}|x|$$

$$a = [1,\ldots,10]$$



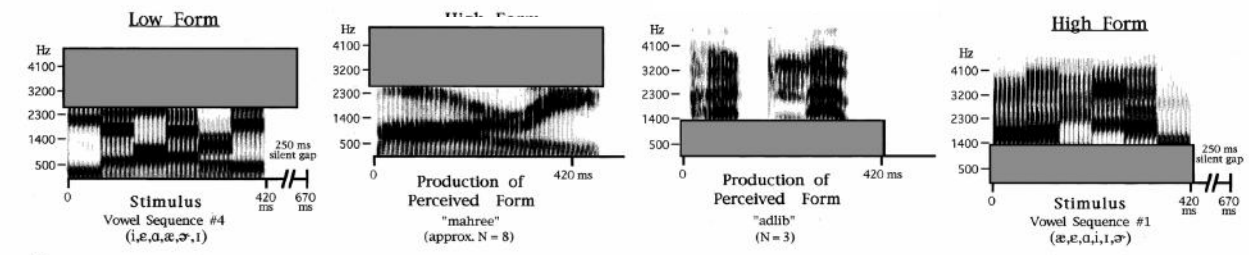
ILLUSION

The Rotating Snakes Illusion employs patterns with repetitive asymmetric luminance steps forming a “snake wheel.” In the underlying luminance sequence {black, dark grey, white, light grey}, coded as {0, g1, 100, g2}



Vowel Sequence Illusion

Repeated sequences of steady-state vowels have durations of their phonetic components below the 100-ms threshold for identification of order, the phonemes lose their identity. The sequences are heard as syllables occurring in the listener’s lexicon (the Vowel-Sequence Illusion).



https://www.researchgate.net/figure/a-The-half-greyscale-Snake-Illusion-disk-shows-the-two-grey-fields-with-luminance_fig1_313685170

ANCIENT INDIAN

Ancient Indian architecture is renowned for its elaborate temples, intricate carvings, and innovative use of space, such as the iconic stepwells and 'chhatri' pavilions.

Indian patterns are known for their vibrant colors and richly decorated elements, such as paisley, mandalas, and traditional henna designs.
These designs carry aesthetic appeal as well as symbolic meaning.

India's ancient architecture is a treasure trove of advanced scientific knowledge, from magnetic meridians to equinoxes, engineering to astronomy, that continue to amaze and inspire with their brilliance.

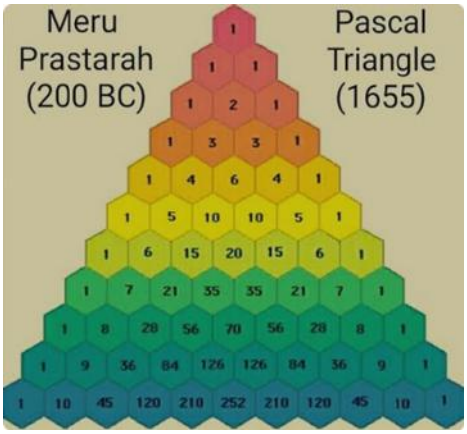
Source : https://en.wikipedia.org/wiki/Hindu_units_of_time

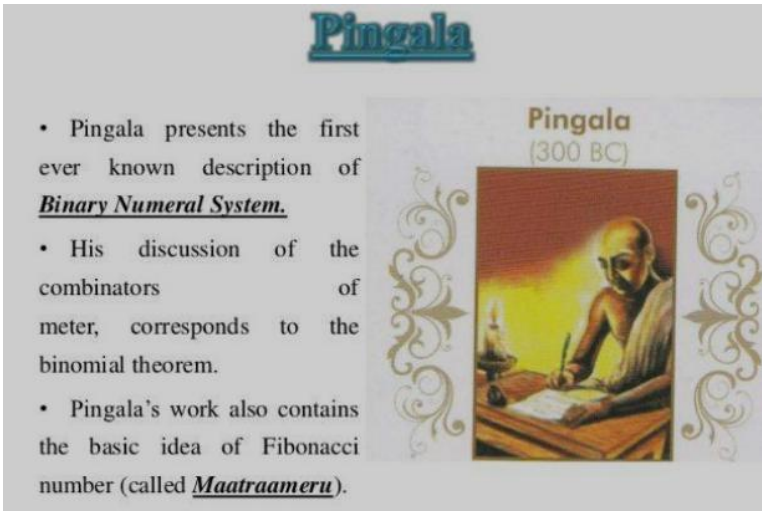
ANCIENT INDIAN

samasya dvikaraṇī. pramāṇaṃ tṛtīyena vardhayet
tac caturthenātmacatustriṃśonena saviśeṣaḥ
-Baudhāyana

$$\sqrt{2} \approx 1 + \frac{1}{3} + \frac{1}{3 \cdot 4} - \frac{1}{3 \cdot 4 \cdot 34} = 1.4142156\ldots$$

To get the value of the diagonal of a square, by adding one-third to the side, then adding one-fourth of it, then subtracting thirty-fourth of it, what is obtained is approximately the value of the diagonal.





Decimal	Binary	Octal	Hexadecimal
0	0000	000	0000
1	0001	001	0001
2	0010	002	0002
3	0011	003	0003
4	0100	004	0004
5	0101	005	0005
6	0110	006	0006
7	0111	007	0007
8	1000	010	0008
9	1001	011	0009
10	1010	012	A
11	1011	013	B
12	1100	014	C
13	1101	015	D
14	1110	016	E
15	1111	017	F

In computing systems, the binary string equivalents of large decimal numbers can become quite long. When 16- or 32-bit numbers are involved, it becomes difficult to read and write them without producing errors. These problems can be overcome by arranging the binary numbers into groups of four bits, i.e., by using the hexadecimal numbering system.

Source : https://en.wikipedia.org/wiki/Baudhayana_sutras

DATA PATTERNS

Data patterns refer to the regularities, trends, and relationships observed in data sets and are analyzed to extract valuable insights and inform decision-making processes.

Geologists use patterns in data from seismographs, atmosphere, and animal behaviour to predict earthquakes and volcano eruptions, and aftershocks following an earthquake.

Financial analysts use patterns in past data of stock prices, interest rates, and currency exchange rates to predict future market changes, with the potential for significant financial gain.

Analysts use patterns in past data of behaviour, trends and many other factors to predict changes in the future for financial and other gains.

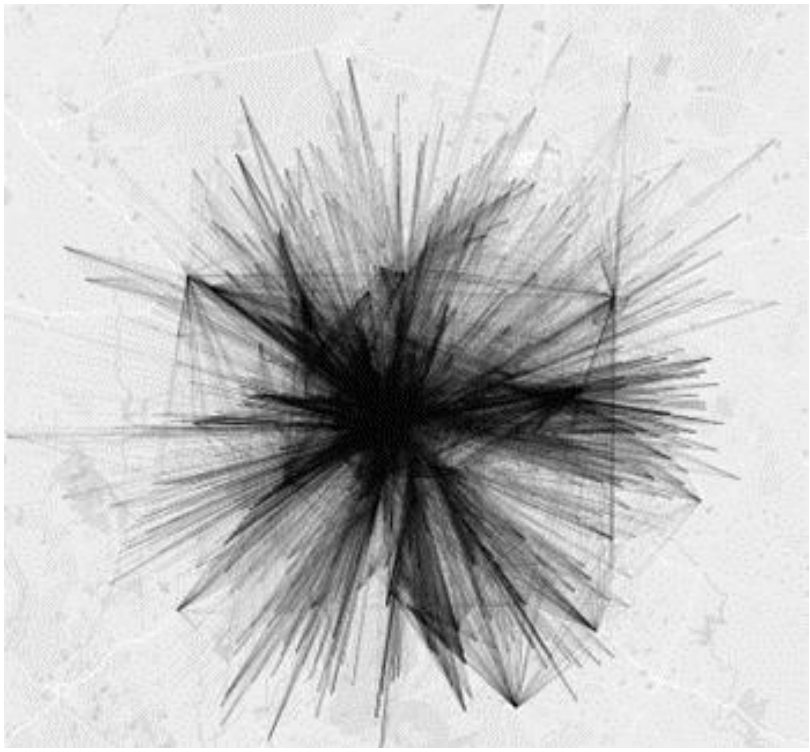
Source: https://europepmc.org/article/pmc/pmc8993841

DATA PATTERNS

Patterns and Data

Street Map of Important Cities

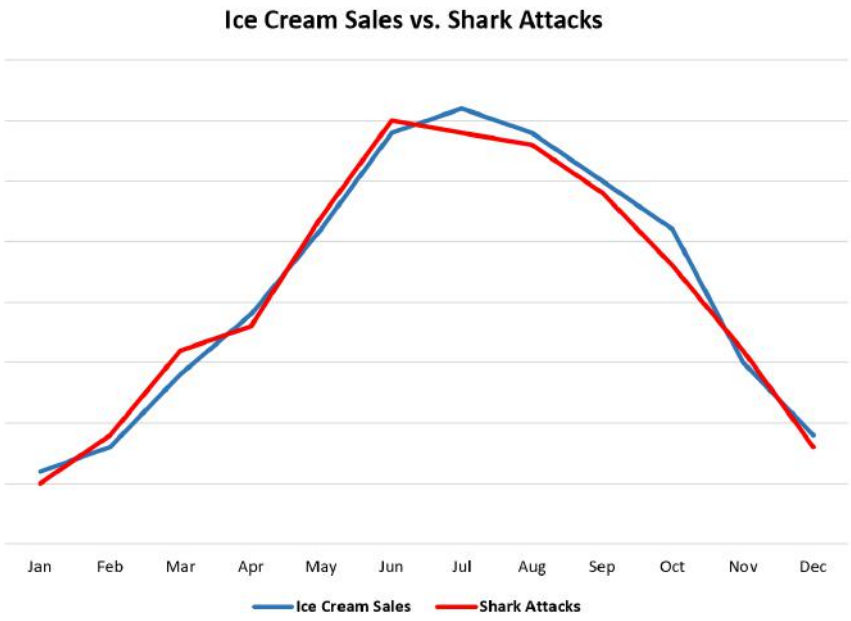
The BMTC network covering the entire city



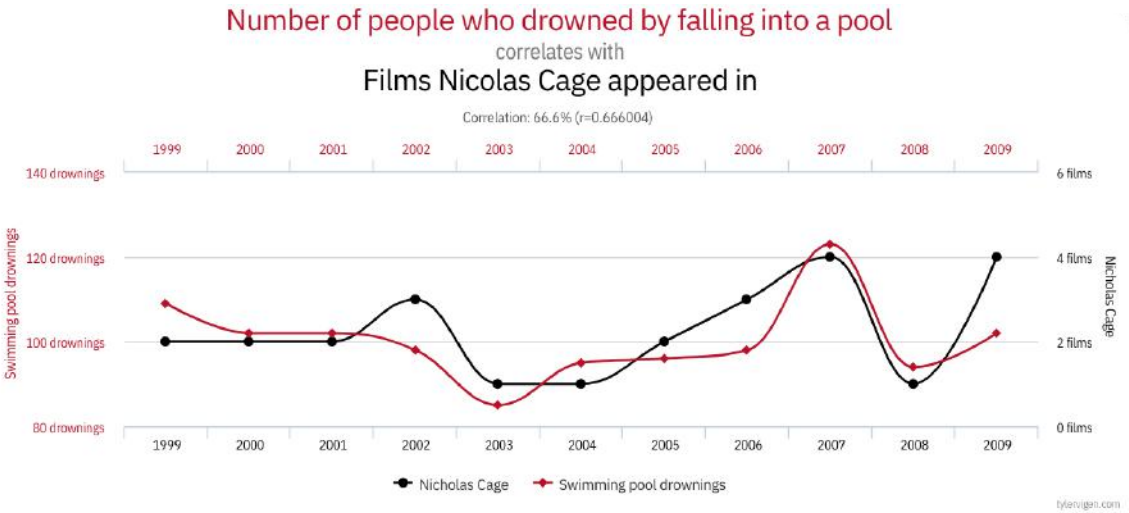
Source: https://datameet.org/2016/02/14/analysing-bangalores-bus-network/

CONNECTED OR CAUSED

Correlation ≠ Causality



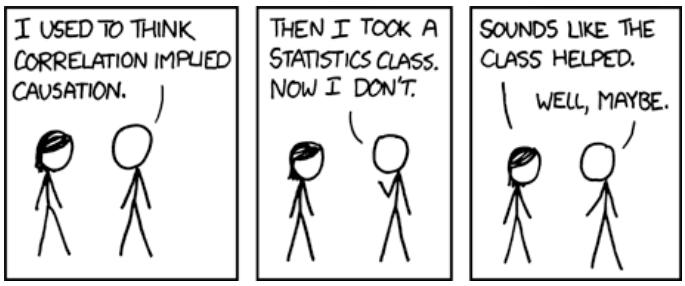
The expression 'correlation does not equal causation' is frequently used in statistics to indicate that a relationship between two variables does not automatically imply that one variable is responsible for the occurrence of the other.

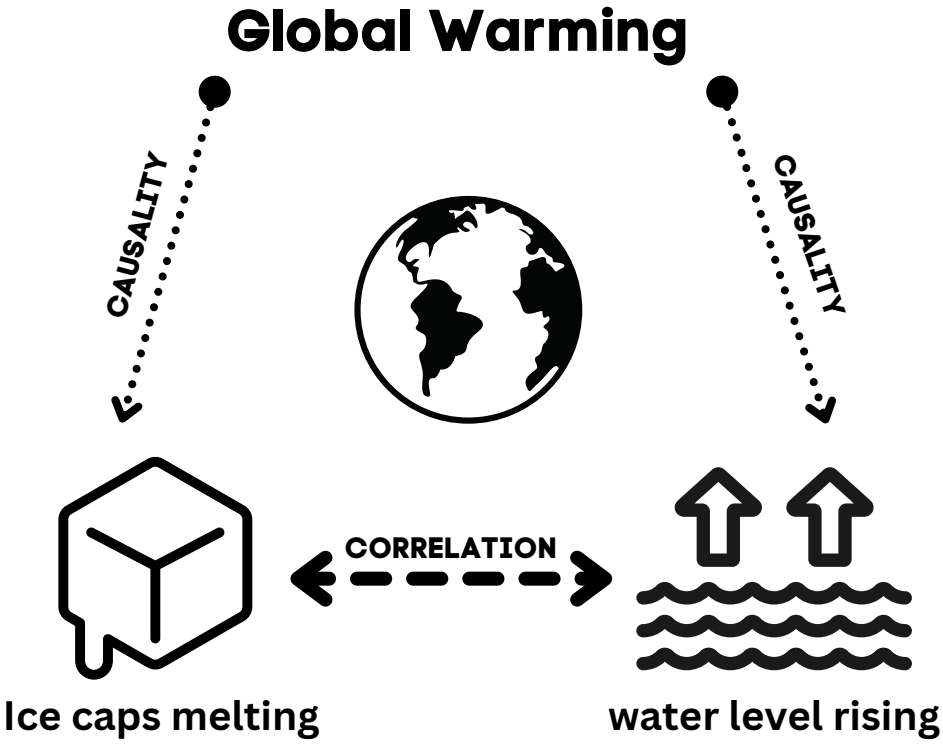


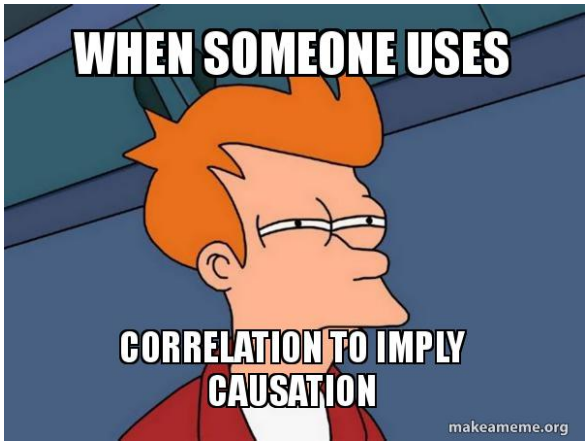
https://www.tylervigen.com/spurious-correlations
https://www.statology.org/correlation-does-not-imply-causation-examples/

CONNECTED OR CAUSED

Culprits of Confusion

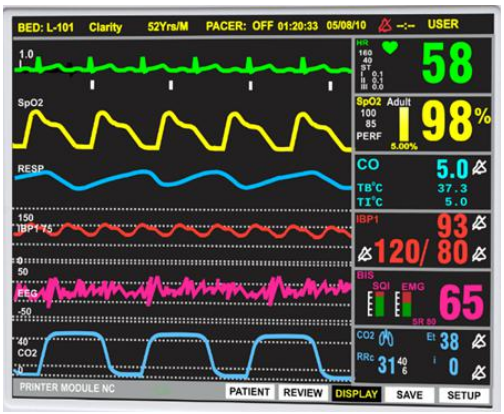




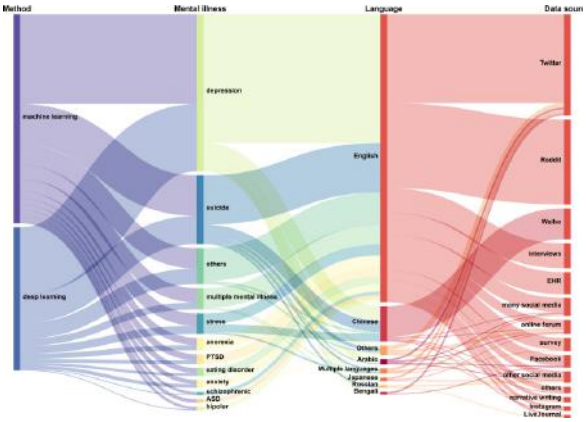


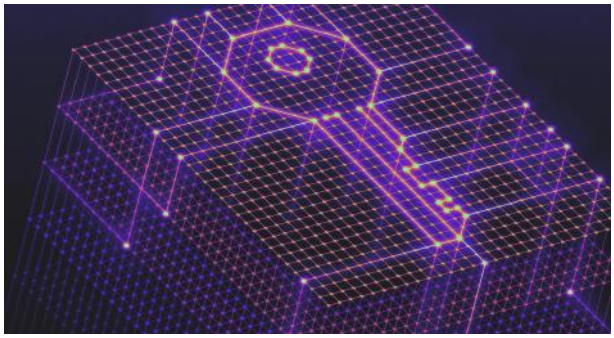
NEWS & LATEST RESEARCH

Latest news from the world of STEM



A patient monitor: the vital link between patients and healthcare professionals.
Fourier transform (FT) and Wavelet transform (WT) were extensively used for processing and analysis.

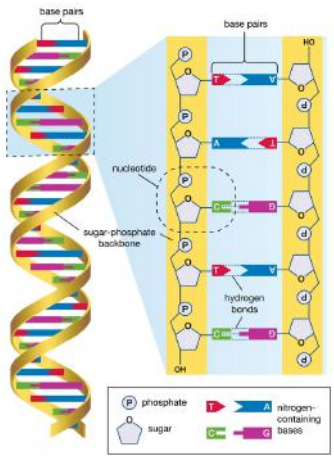




Decoding the Mind through Language: NLP bridges the gap between human communication and computer understanding

Cryptography
Lattice cryptography promises to protect secrets from the attacks of far-future quantum computers. They rely on mathematical lattices which are arrangements of dots in space.

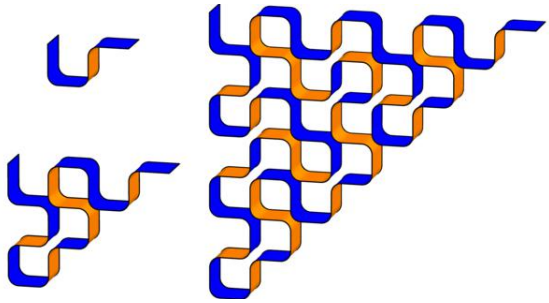
DNA Matching
DNA matching compares DNA sequences to determine relatedness or identify an individual, used in forensic science, paternity testing, and genealogy.



Source: https://europepmc.org/article/pmc/pmc8993841

FACTS & SNIPPETS

Interesting tidbits about



The Thue-Morse sequence is a binary sequence that starts with 0 and in which the next number is determined by whether the previous number has an even or odd number of 1s.

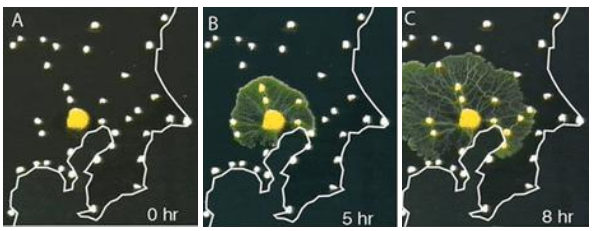
The three basic types of fingerprint patterns are arch, loop and whorl.

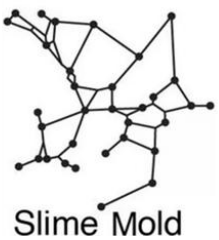
Zebra's stripes is to ward off biting flies that can carry deadly diseases.

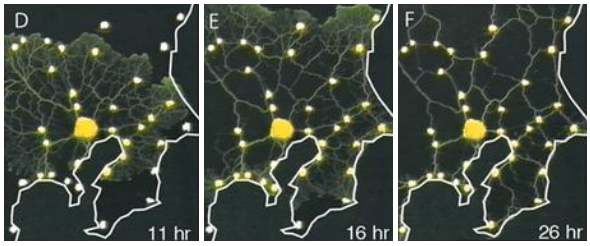
Online Encyclopedia of Integer Sequences (OEIS) contains more than a quarter of a million different sequences of numbers that arise in different mathematical contexts

Our own human eyes actually move in fractal patterns!!!
Scientists using eye-tracking machines discovered that our pupils first do a big scan of a scene, and then scan again in smaller versions of the bigger scans.

DID YOU KNOW
TRAIN SYSTEMS ARE INSPIRED BY MOULD PATTERN !







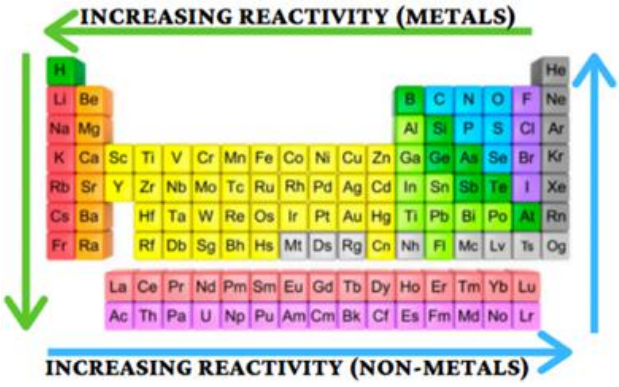
Solving Crime

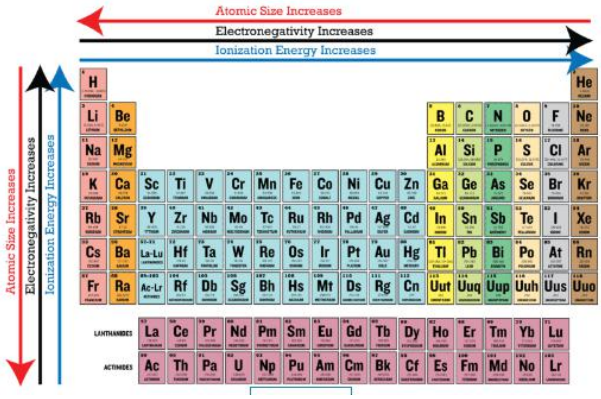
Criminal justice professor Kim Rossmo developed a mathematical algorithm called "geospatial profiling" to detect patterns in attack locations and locate the killer's residence. It has been used by the military to find insurgency bases.
It's not exactly unexplained, but still a pretty amazing real-world application of patterns in math.

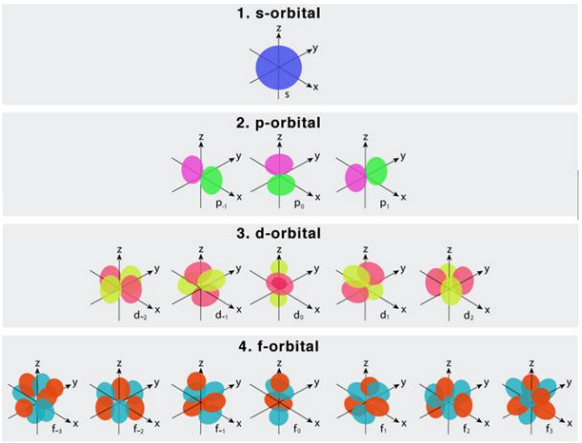
Source: http://blog.zacharyabel.com/2012/01/thue-morse-igami/

FROM MICRO

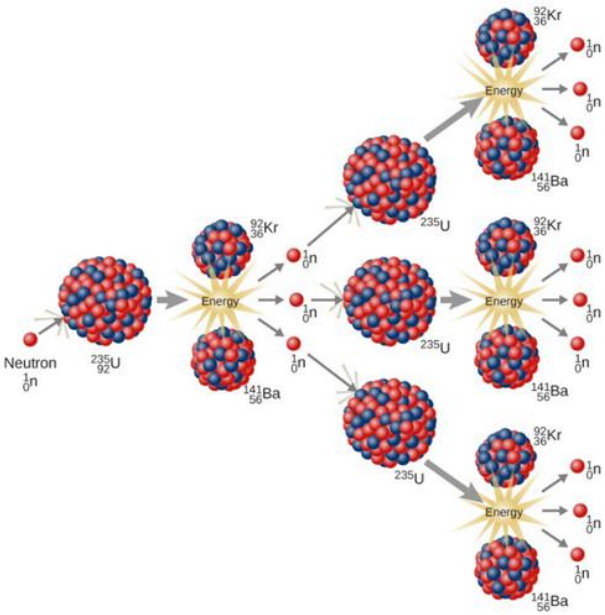
Periodic Table, a beautiful and scientifically elegant depiction of nature's building blocks.







The atomic orbitals, with their intricate patterns and sequences, reveal the symphony of quantum mechanics within the atom.

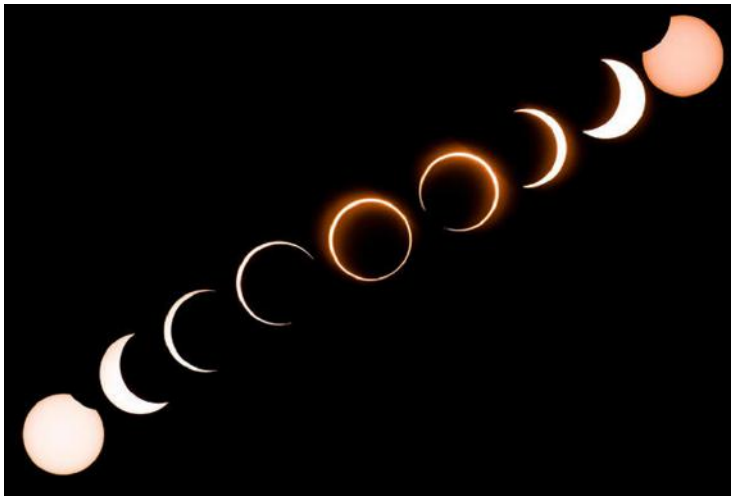


Nuclear Fission
Splitting atoms, sparking energy and new nuclei, all in a beautiful, self-sustaining chain reaction. A true scientific wonder.

Source: https://chemistrytalk.org/periodic-trends-made-easy/

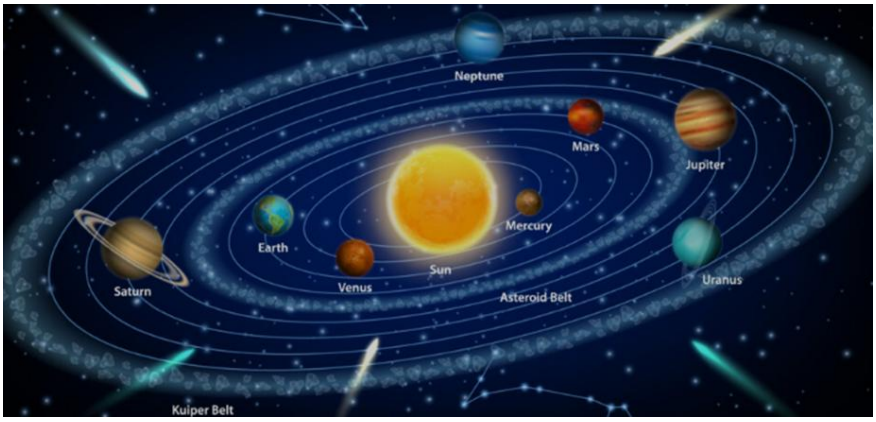
TO MACRO

The Moon's patterns, a sequence of celestial elegance



The sun's patterns, a cosmic crescendo of light and shadow during the solar eclipse, a spectacular display of the celestial symphony.

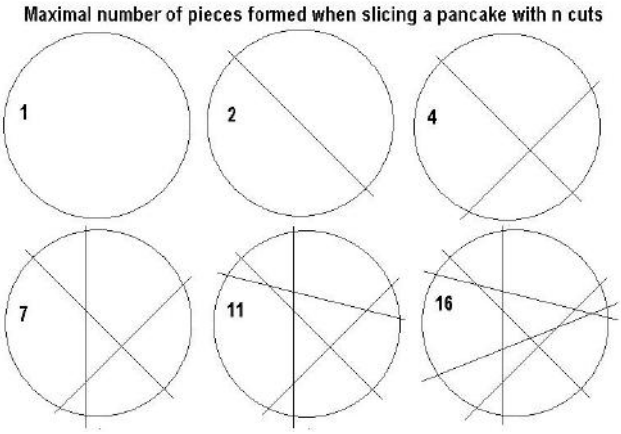
The Solar System's celestial composition is a symphony of patterns and sequences, with planets orbiting in a style of gravity and motion.



Source: https://www.istockphoto.com/search/2/image?phrase=waxing+crescent+moon

EQUATIONS

Some interesting equations that produces unique patterns.



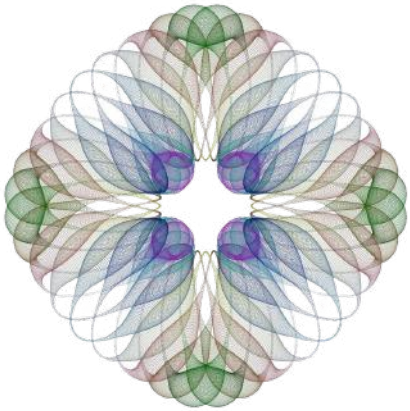
The central polygonal numbers, also referred to as the maximum number of pieces that can be created by cutting a circle using straight cuts. For instance, if three cuts are made on a circle such as a pancake, and the cuts intersect at a single point, it results in six pieces. However, if the cuts do not meet at one point, the number of pieces would be seven.

The maximum number p of pieces that can be created with a given number of cuts n, where n ≥ 0, is given by the formula

$$p = \frac{n^2 + n + 2}{2}.$$

Using binomial coefficients, the formula can be expressed as

$$p = \binom{n+1}{2} + 1 = \binom{n}{2} + \binom{n}{1} + \binom{n}{0}.$$



This image shows 9,000 circles. For $k = 1, 2, 3, ..., 9000$, the center of the k-th circle is $(X(k), Y(k))$ and the radius of the k-th circle is $R(k)$, where

$$X(k) = \cos\left(\tfrac{14\pi k}{9000}\right)\left(1 - \tfrac{3}{4}\left(\cos\left(\tfrac{36\pi k}{9000}\right)\right)^2\right),$$

$$Y(k) = \sin\left(\tfrac{14\pi k}{9000}\right)\left(1 - \tfrac{3}{4}\left(\cos\left(\tfrac{36\pi k}{9000}\right)\right)^2\right),$$

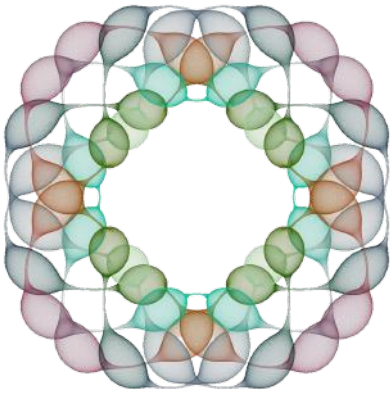
$$R(k) = \tfrac{1}{200} + \tfrac{1}{10}\left(\sin\left(\tfrac{64\pi k}{9000}\right)\right)^6.$$

This image shows 14,000 circles. For $k = 1, 2, 3, ..., 14000$, the center of the k-th circle is $(X(k), Y(k))$ and the radius of the k-th circle is $R(k)$, where

$$X(k) = \cos\left(\tfrac{10\pi k}{14000}\right)\left(1 - \tfrac{1}{2}\left(\cos\left(\tfrac{16\pi k}{14000}\right)\right)^2\right),$$

$$Y(k) = \sin\left(\tfrac{10\pi k}{14000}\right)\left(1 - \tfrac{1}{2}\left(\cos\left(\tfrac{16\pi k}{14000}\right)\right)^2\right),$$

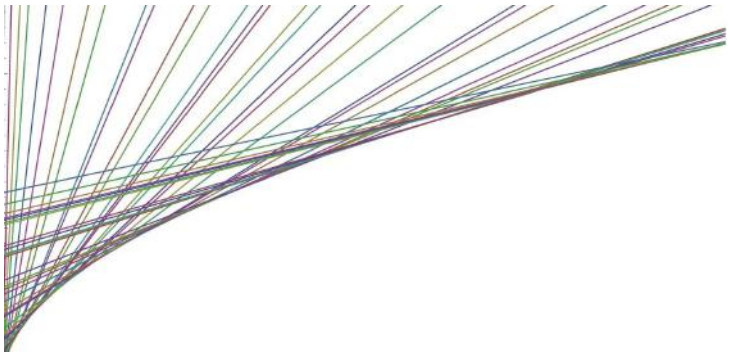
$$R(k) = \tfrac{1}{200} + \tfrac{1}{10}\left(\sin\left(\tfrac{52\pi k}{14000}\right)\right)^4.$$



https://edublognss.wordpress.com/2013/04/16/famous-mathematical-sequences-and-series/

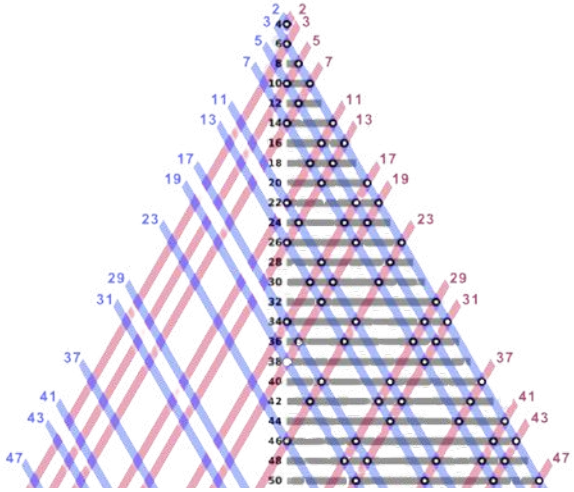
UNKNOWN MYSTERIES

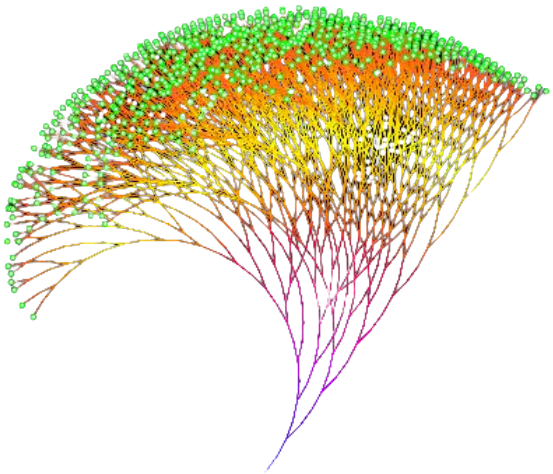
Unsolved problems are scientific or mathematical challenges that have yet to be resolved, despite ongoing efforts and research.



The Twin Prime Conjecture
There are infinitely many primes p such that p + 2 is also prime. Twin primes are two prime numbers that differ from each other by only two numbers 5 and 7, 11 and 13, 29 and 31 and so on.

The Goldbach Conjecture
It States that every even natural number greater than 2 is the sum of two prime numbers.
The conjecture has been shown to hold for all integers less than 4 × 10^18 but remains unproven despite considerable effort.





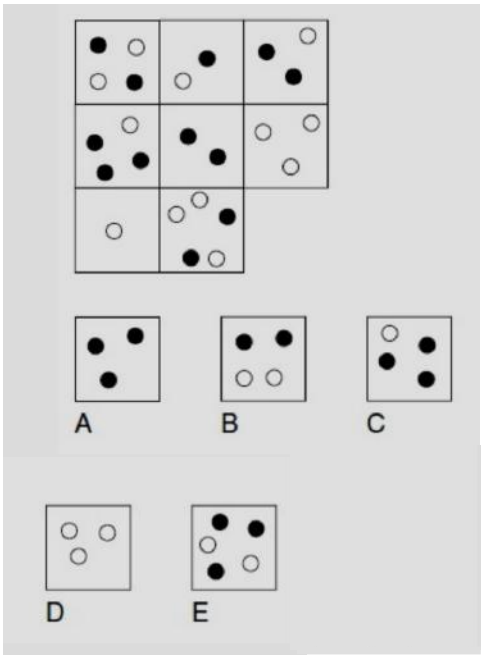
The Collatz Conjecture
It states that if you start with any positive integer, and repeatedly apply the rule "if the number is even, divide it by 2; if the number is odd, multiply it by 3 and add 1," you will eventually reach the number 1.

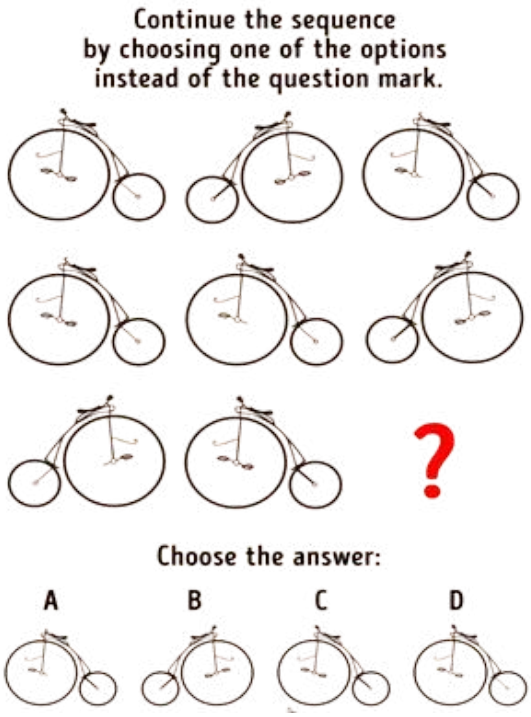
Source: https://weburbanist.com/2010/06/21/mysteries-of-math-unsolved-problems-unexplained-patterns/
https://www.cantorsparadise.com/the-twin-prime-conjecture-3671e604818e

MONTHLY CHALLENGES

Themed Puzzles

Which is the Missing Tile?





Which number comes next in the series 5, 12, 24, 36 ?

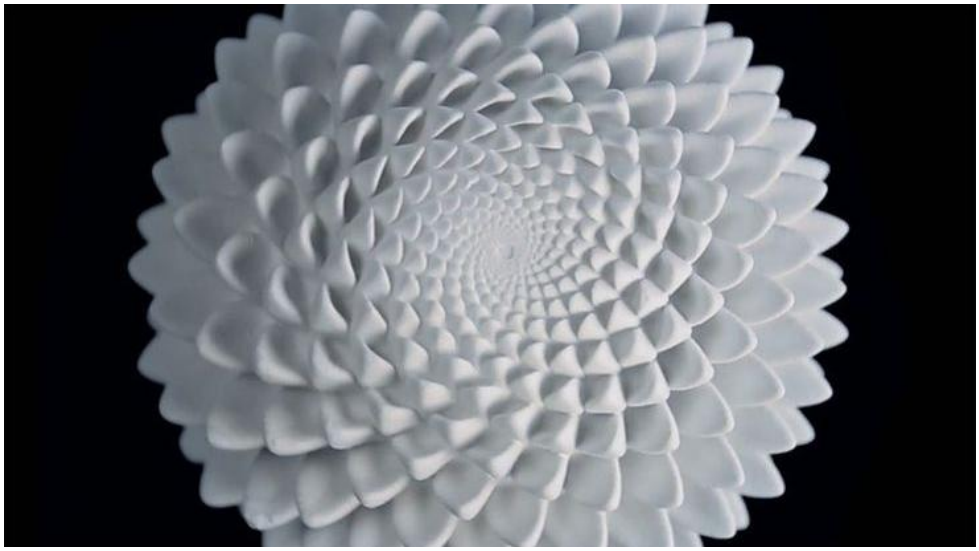
SURPRISE CHALLENGE

CAN YOU FIND THE SECRET MESSAGE HIDDEN IN MORSE CODE WITHIN THE PAGES OF THIS MAGAZINE

LOOK CAREFULLY AND DECIPHER THE DOTS AND DASHES TO REVEAL THE MESSAGE.

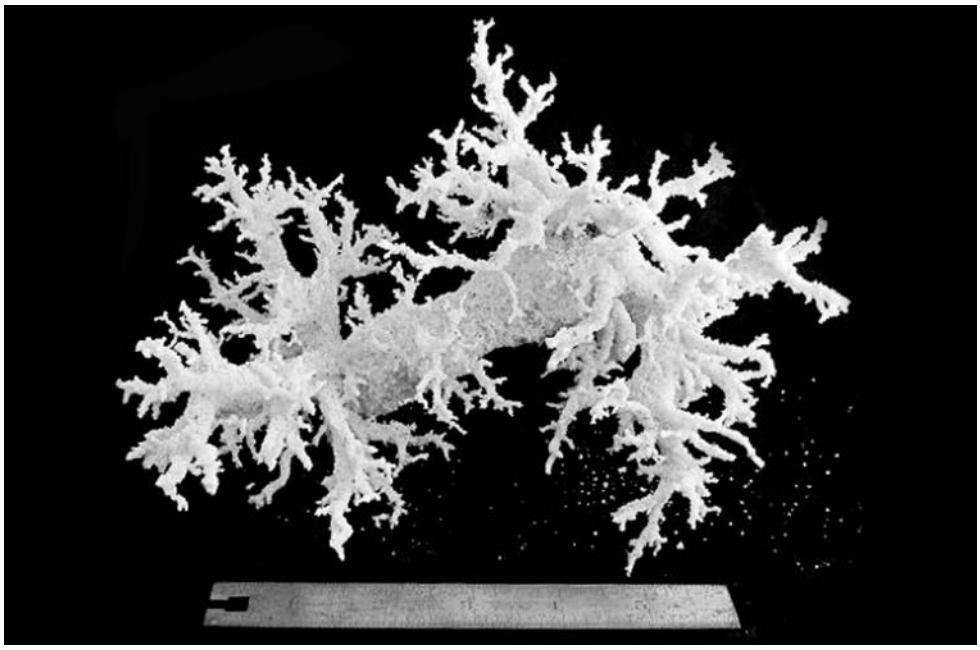
EXHIBIT OF THE MONTH

Fibonacci Zeotrope



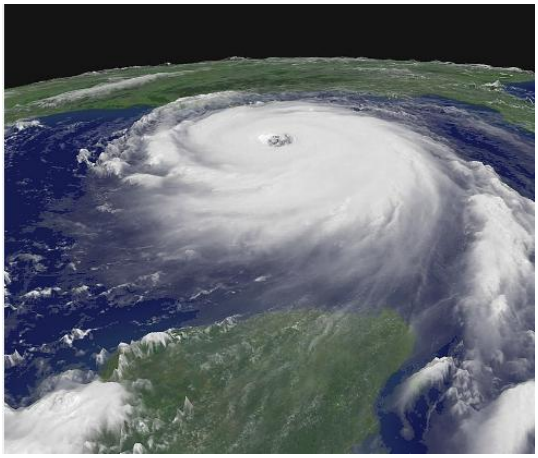
Mathematical sculptures that spin under a strobe light give off an illusion effect of growing.

Fulgurite: Lightning striking sand art



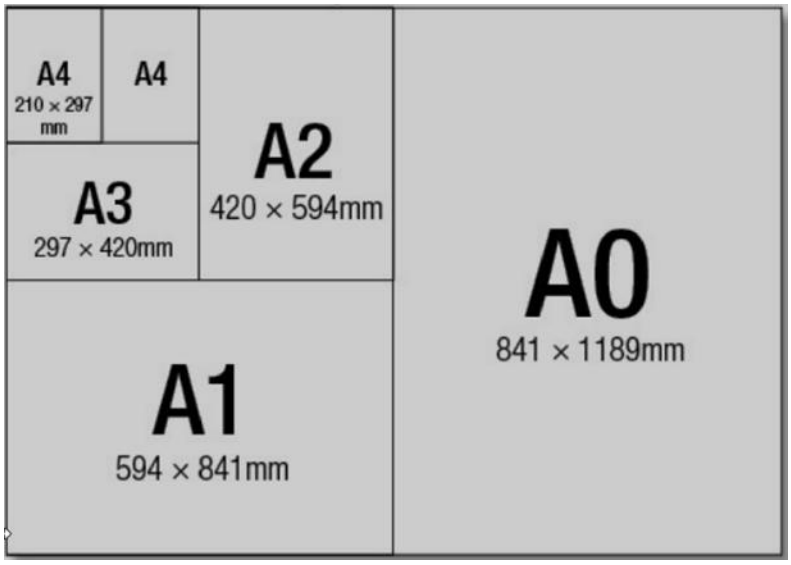
They are formed when lightning strikes the ground, fusing and vitrifying mineral grains.

DO YOU RECOGNIZE...



Source: https://images.app.goo.gl/UCnonwMXYXP849pJA

DO YOU RECOGNIZE...



Source: https://images.app.goo.gl/yKASprAsdGFTRG6p8

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