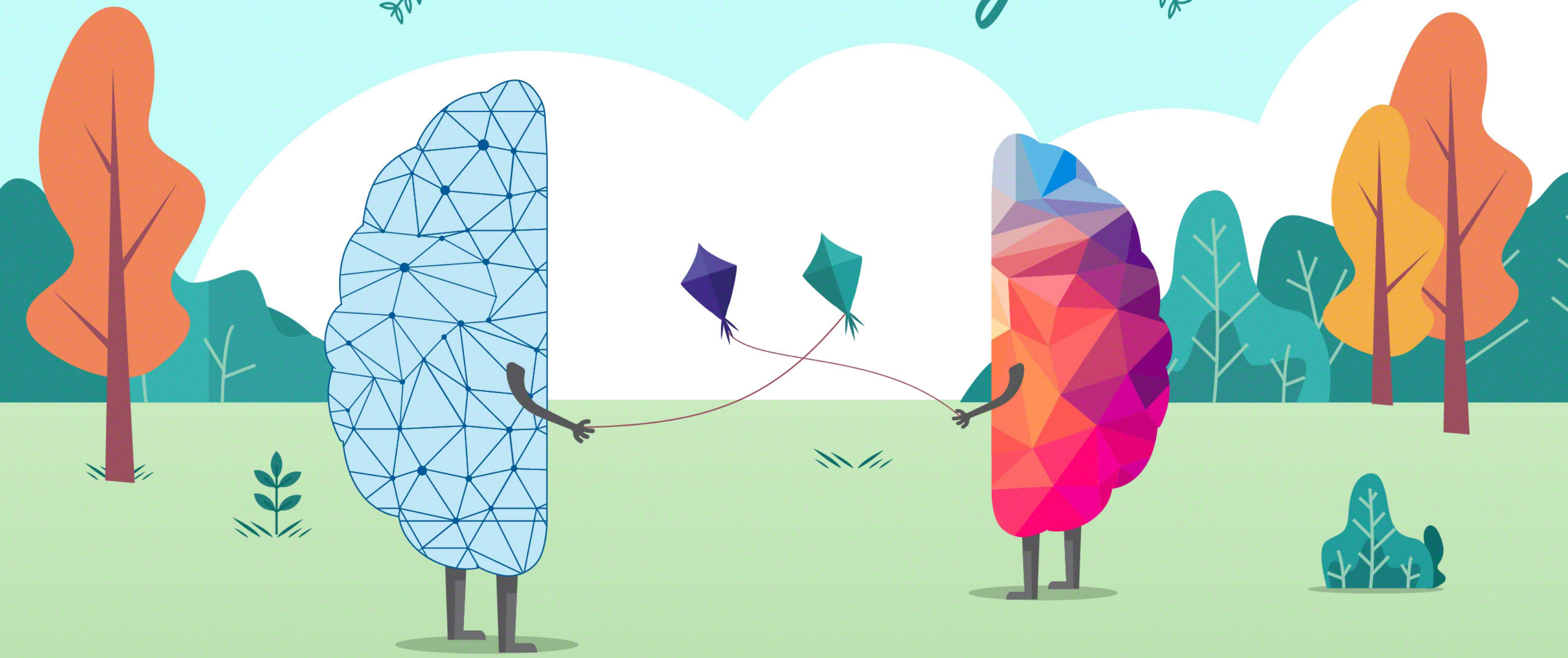
Math & Art

a love story



ARTISTS AND DESIGNERS HAVE BEEN USING MATH PRINCIPLES FOR CENTURIES

Find out why this matters to contemporary designers and artists and how this legacy—in the form of new technology—will shape the future of product packaging design, print advertising and all forms of digitally-interactive art.

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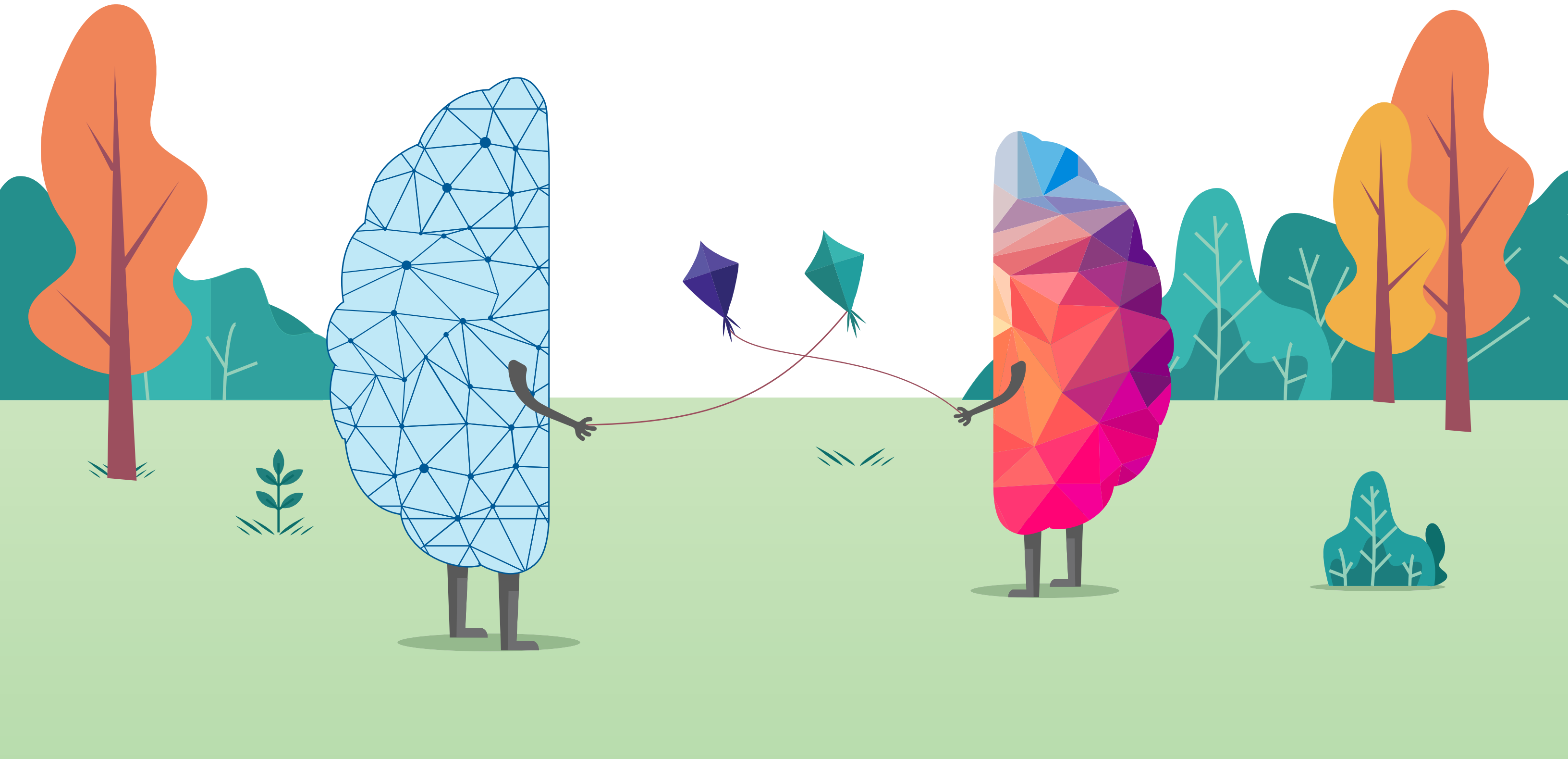


Paintbrush Plus π

The popular left brain/right brain theory holds that "math people" process information on the left side of the brain, while artists think and imagine on the opposite. But the human brain is complex and not easily pigeonholed, and throughout history artists have repeatedly incorporated mathematic principles into their work.

Many of the world's greatest artists, including Leonardo Da Vinci, Salvador Dali and Jackson Pollack, produced work that might get you thinking they were closet "math nerds."

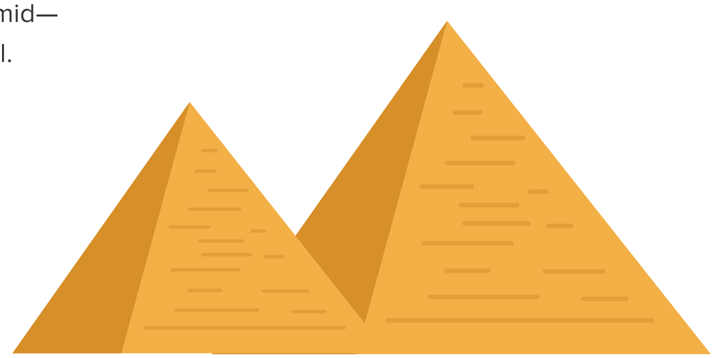
The journey of art and math begins in Egypt, with stops in Renaissance Italy and Hollywood, before arriving in our time with the promise of Signal Rich™ art.

A Tomb Made of Trapezoids

As with many key developments, the ancient Egyptians did it first. Around 3000 B.C., Egyptian scribes began making numerical marks for the purpose of counting. The early Egyptians used whole numbers, fractions, additions, subtraction and multiplications—the basis of mathematics.

Architecture offers us some of the oldest surviving examples of art. *The Step Pyramid* of Saqqara in Egypt utilized truncated pyramids (trapezoid shape) of decreasing sizes placed on top of one another. Builders knew how to calculate the area of a trapezoid and likely used this knowledge to find the volume of a truncated pyramid—useful for estimating the required building material.

Centuries later, between the years 600 and 400 B.C., the ancient Greeks took this knowledge and formalized it into proofs and solutions.



Hate Geometry Class? Blame the Greeks

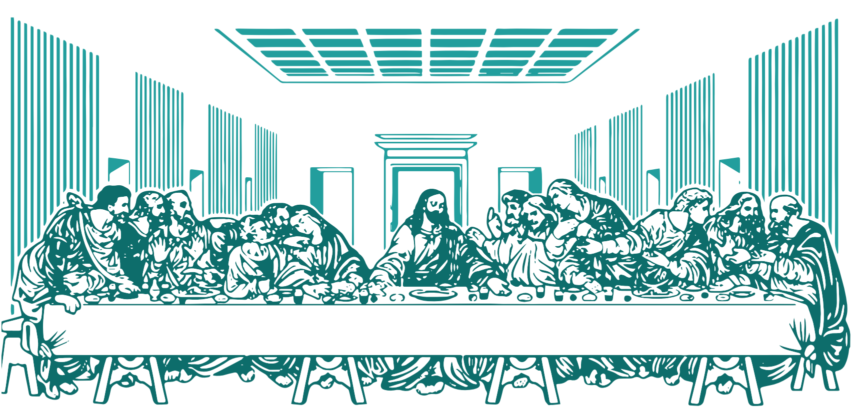
Plato and Aristotle believed nature had an underlying logic and universal form. Aristotle took it one step further, asserting that triangles and circles weren't just concepts in the mind, but actually existed in objects. This led Euclid (365–300 B.C.) to develop principles and methods now known as Euclidian geometry, which is largely the foundation of modern geometry.

Many iconic, surviving architectural structures from ancient Greece—including the *Parthenon*—relied on geometric principles like the so-called *"golden ratio"* for the beauty of its triangular façade. But it didn't end with the Greeks. Artists have remained fascinated with geometry throughout the centuries. This continued into the 20th century, for example, with the famous painting *"Composition 8"* by Russian artist Wassily Kandinsky.

Nobody Ever Remembers the Rectangles

The Renaissance period in Italy was a time of many new artistic developments. The architect Filippo Brunelleschi discovered linear perspective, a method to help draw 3-D buildings on a 2-D, flat surface. The artist Leon Battista Alberti took the idea one step further and claimed a viewer's eyes form a visual triangle as they look at a painting. Alberti wrote a treatise on how the rules of perspective work.

Leonardo Da Vinci was the true *"Renaissance Man,"* a genius in both the arts and sciences. In *"The Last Supper,"* he used linear perspective to place subjects in a large building without having them "overshadowed" by the building's depth. To accomplish this, Da Vinci inserted a series of rectangles (hung tapestries in the painting) on the side walls, with the vanishing point behind the central subject, to keep the viewers fixed on this figure in the foreground. Geometry is critical to this painting's beauty and purpose.



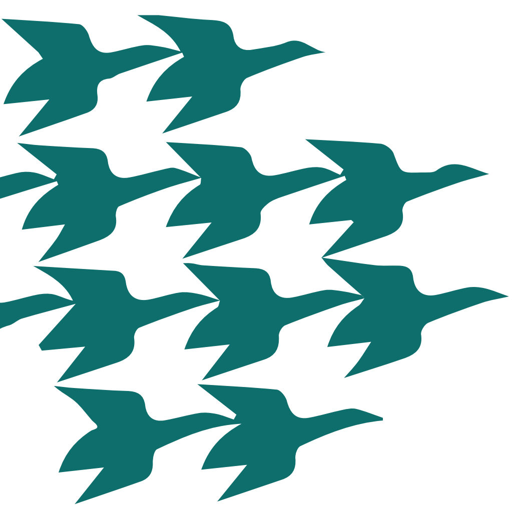
Origami: Art for Math Geniuses

We think of origami as the cute art activity our children do in school, but it is an art form of great interest to mathematicians. Origami means "folding paper" in Japanese and the earliest written reference to the activity is in Japan in the 1680s. In creating an origami object, the "push fold" action is common and this is—mathematically speaking—equal to bisecting an angle.

Mathematicians have long found that origami provides a medium for investigating mathematical problems. Peel open an origami object, and you'll find squares and triangles. This also allows for particular geometric patterns to be created, ones that are not possible with a ruler and compass construction.

M.C. Escher: Math Nerd

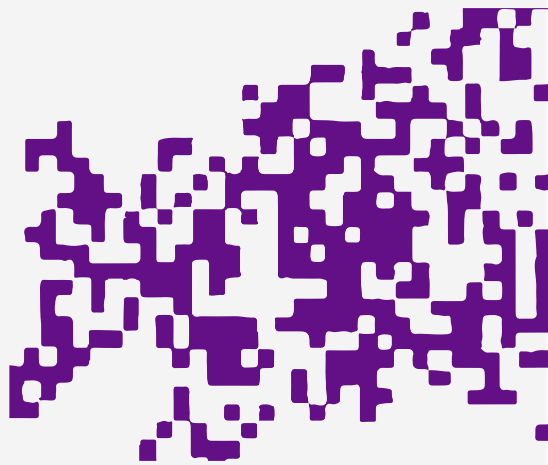
Even people who don't like art know M.C. Escher. His work appears on refrigerator magnets and coffee mugs, and it stimulates curiosity. In the 1930s, Escher was inspired by the geometric patterns of tiles at the Alhambra in Spain and began to study mathematics. He started working as an illustrator of mathematical principles, before eventually creating the work he is famous for.



One of his most famous lithograph prints, *"Ascending and Descending,"* has an "impossible staircase," which was inspired by a British mathematician's discovery of so-called "impossible objects," such as a staircase that can be climbed without going up any further. Impossible objects are 2-D figures that our eyes interpret as representing a projection of something in 3-D.

Numbers + Phone Book = Art

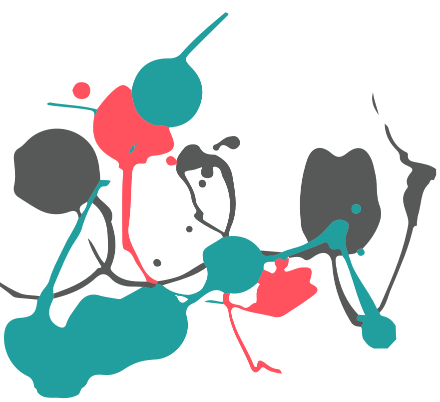
In Europe after World War II, the concrete art movement sprung up as Europeans looked for new forms of expression. The concrete art artists used abstract-like geometric patterns in their work, and Swiss artist Max Bill believed concrete art "expressed the understanding of nature as embodying mathematical patterns."



French artists remained interested in the principles of the concrete art movement well into the 1950s, and Francois Morellet began using algorithms to create his own art. He initially made art in regular, formalized patterns, but eventually moved to random patterns. Art historian Lynn Gamwell writes that in Morellet's work, "*Random Distributions of 40,000 Squares Following the Even and Odd Numbers in a Telephone Book,*" he "arranged red and blue squares in a grid according to the pattern of odd and even number in a telephone book."

A Turkey Baster with a Ph.D.

When we think of "classical" geometry, we think about perfect squares and circles. But objects in nature are usually rougher, messier. This is where fractal geometry can help. It uses the same rules in classical geometry, but then the rules are applied over and over again – iteratively – until the shapes become more "chaotic," more like objects in nature. A simple example of a fractal-like structure in nature is how branches continue to "repeat" in odd new ways off the trunk of a tree.



American artist Jackson Pollock became famous (or infamous) for his drip paintings in the 1950s. He used a turkey baster and would stand over a canvas creating splatters in multiple colors. Physicist Richard Taylor studied Pollock's paintings using magnification and he claims that the drip splatters appear to be random, but like fractals, are actually repeated identifiable patterns, recurring at different scales. He claims this underlying math structure explains the continued popularity of Pollock's work.

Pixar Studios: Hollywood's Math Club

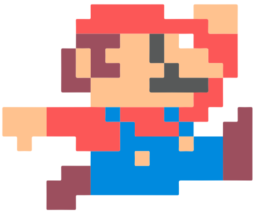
Cinema is arguably the most popular modern art form after music. Everybody loves going to the movies, and ever since Pixar Animation Studios began hitting it big with movies like "*Toy Story*" in 1995, we've begun loving movie effects derived from math.

The software that powers the computer animation in these films is math driven and requires "turning complicated shapes into some form that computers will deal with," said Pixar's senior scientist Tony DeRose in an article in "*The Verge*." Making these movies requires that Pixar's scientists find better algorithms to intelligently approximate scale in the movies, all without losing the details that make Pixar's characters and settings so visually appealing.

Math Made the Mario Brothers

If you or your children play video games, you should know that your favorite characters or villains would be inactive blobs without math. If you want them to jump, shoot or swim, you need math. While there is simple math used in gameplay scripting (the predefined series of events in a game), it can get quite complicated when building the game's architecture.

The next time you hear someone say studying math in school is impractical or (even worse) boring, remind them that algebra, trigonometry and calculus are responsible for cool things in game design like rocket blasts and racing cars. And don't forget, when Mario jumps up and down it's a parabola (a curve where any point is equal distance from a fixed point or fixed straight line) that makes that possible.

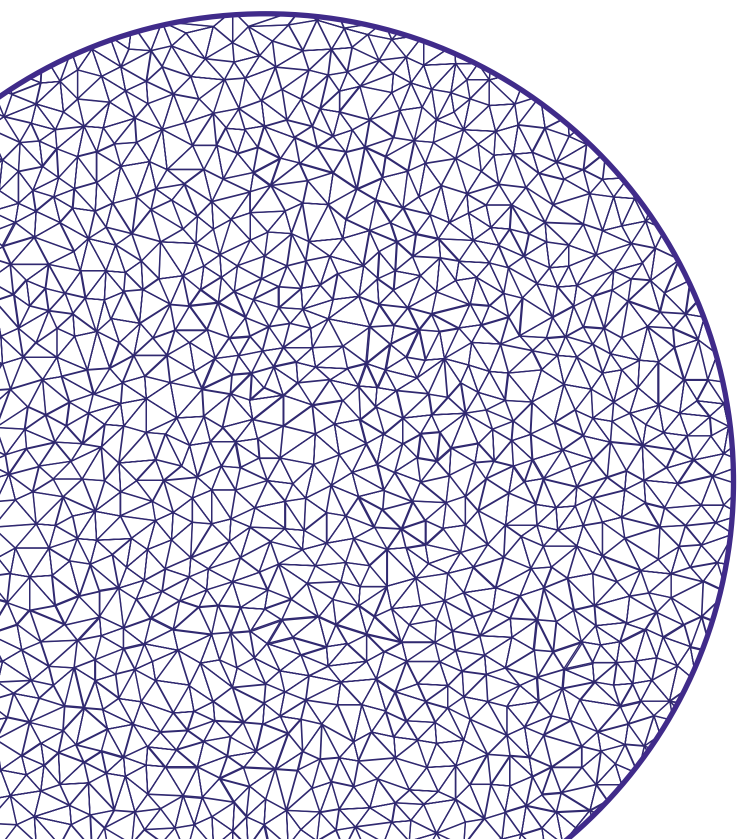


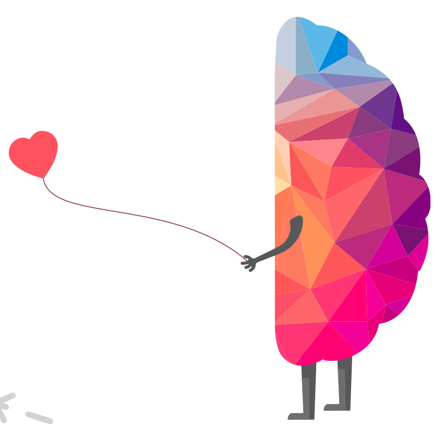
Signaling the Future of Math-Created Art

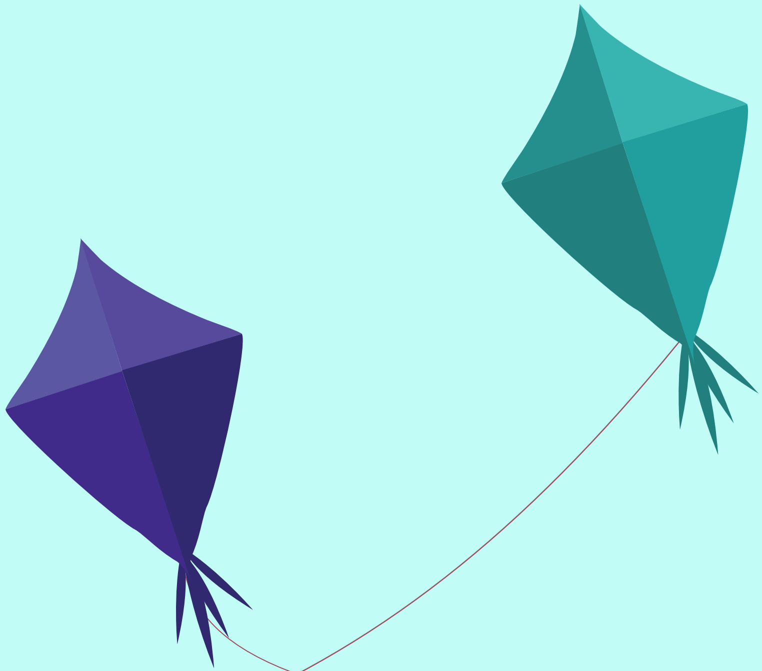
Today we are increasingly familiar with objects, like product packaging, that have codes and can be read by consumer phones and barcode scanners. But what if the code was the art? This is the promise of Digimarc's Signal Rich™ art, which is based on mathematical concepts and algorithms that literally offer an infinite number of new design approaches for artists and designers.

With Signal Rich art, the code is inherent in the design. The artwork contains a number of codes repeated throughout the product package, commercial print piece or work of art. The Signal Rich art tools under development employ breakthrough advances in imaging science, machine vision and artificial intelligence, trigggering a number of valuable applications for both consumers and many industries, including retail operations. It is not commercially available, but Digimarc previewed a few examples at Adobe MAX 2018 to inspire the design community.

Just as has been for centuries, so it will be in the future: Math & Art together, forever.







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Digimarc Corporation

9405 SW Gemini Drive

Beaverton, OR 97008

T: +1 800 DIGIMARC (344 4627)

F: +1 503 469 4777

info@digimarc.com
www.digimarc.com

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