MiNI BLUEBIRD MATH CIRCLE

Issue 12 Fractal Dimension of Pomo Baskets

Share your problems, solutions, models, stories, and art:
https://akademia.mini.pw.edu.pl/pl/ukraina

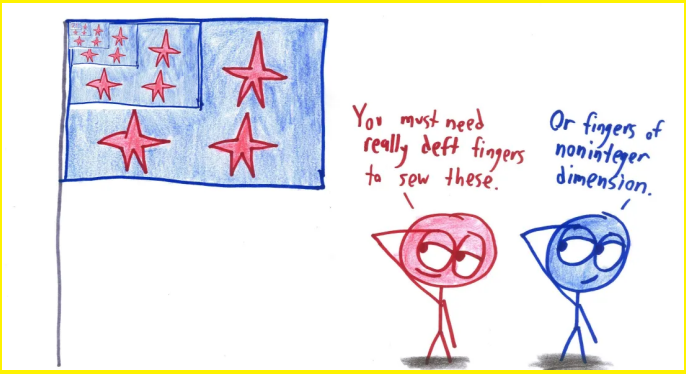
First I taught Natives from all over the country and Canada and taught basketry, and I've been to Europe and taught basketry, and what I realized is that it doesn't matter what tribe on the planet you are from, you all still made baskets. Everyone already has a basket in them and I'm just helping them to bring it out.

—Pomo basket weaver Corine Pearce

NEWSFLASH Join LIVE MiNI Bluebird Math Circle to work on these activities together with friends and family. Monday April 3, 18:30-20:00 Warsaw, Poland time, online.

Sign up at https://akademia.mini.pw.edu.pl/pl/ukraina

MATH COYOTE CORNER
"Fractalstan"
by Math with Bad Drawings

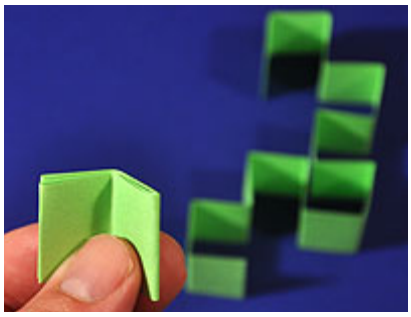


Family Circle: Baskets and Fractals

Pomo baskets come in many beautiful styles and variations. They are complex, artistically and mathematically. In each activity below, you will make a math model called *fractal*. These mathematical creations also come in many styles. As you learn to make different fractals, you will notice more and more different features of Pomo art.

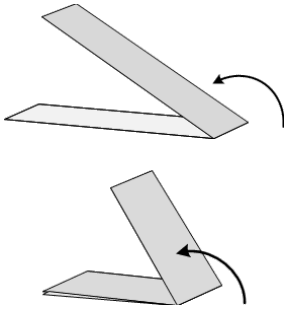
Photo: Donna Fernandez, beginning of a basket


Courtesy of California Academy of Sciences

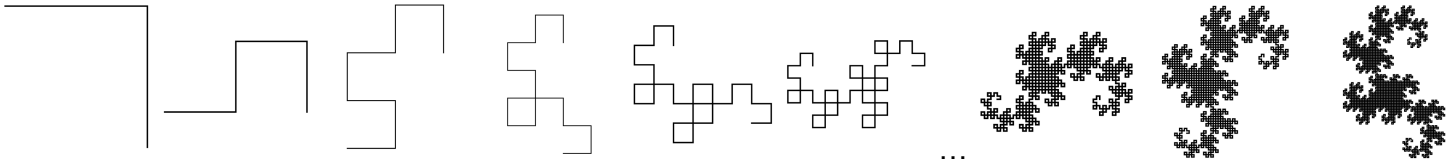


Fold a Dragon Curve Fractal Cut a strip of paper about an inch wide. Fold the strip in half. Fold it in half again in the same direction—that is, *iterate*. Then iterate again, and again: 4 times total. Unfold and crease every angle to be 90° (right angle). Combine several folded pieces with your math friends to make a big model! Imagine: could you decorate a basket with a curve like this? Sketch your ideas.

Images: CutOutFoldUp.com, California Academy of Sciences

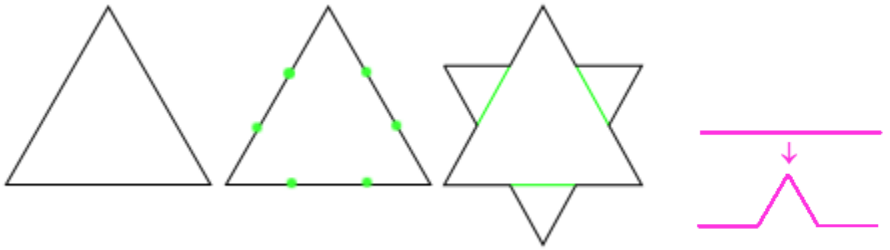


Curve to Shape Basket-weavers work with reeds and roots that are like *one-dimensional curves*. They bend and twist and weave until these curves *fill the space*. A thin, *two-dimensional shape* is born. (A basket is a *physical model*; like much of math, truly 2D shapes only exist in our imagination.) Some Pomo baskets have such dense weave that they can hold water! Likewise, the dragon curve is a *space-filling curve*. Imagine that you iterate the dragon curve process again and again and again, folding infinitely many times. Wild! The result will fill a 2D shape entirely. You can watch, or imagine using pictures. https://youtu.be/UBuPWdSbyf8

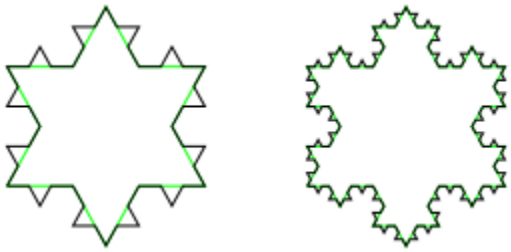


Draw a Koch Snowflake Fractal

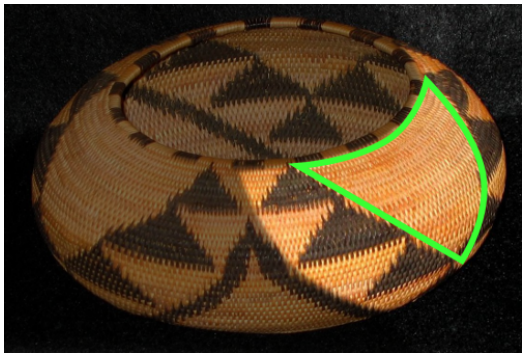
Here is a different fractal curve you can draw: Koch Snowflake. (The Swedish name sounds like "kawkh," but it's okay to read it by the English rules.) Start with a triangle. Divide each side into thirds. Draw a smaller triangle on the middle third:



Another way to see what you just did: replace every straight *line segment* with a bumpy shape. Your new snowflake is made of a lot more than 3 segments in a triangle. How many, by the way? It's longer, too. How much longer?



Next, replace every one with a bumpy segment again—iterate. That's a lot of tiny segments! Keep iterating while you can…



Basket: Annie Burke, California State Library

Now for the wild math. Can you imagine infinite iterations? Is that more like a filled shape (2D), or more like a curve (1D)? Could you decorate a basket with smaller triangles growing on big triangles? Or other shapes growing on intervals? Sketch your ideas.

Dimensions and Powers

We can split some shapes into scaled-down little copies of the same exact shape. Try that for yourself with a triangle or a square, like the shapes in the Pomo baskets here. These split shapes are called *self-similar.* If you split each filled little copy again and again (iterate), you can make a fractal. The more little copies you fill in, the higher your design's *fractal dimension*. What's that? Fractal dimension is power! Literally power: it's the exponent that describes your fractal art. Here is the equation to explore with your math circle:

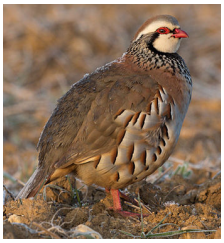
Images: So'-kah-dam, UC Davis; Oakland museum of California

$$[\text{scaling factor}]^{\{\text{fractal dimension}\}} = [\text{number of filled little copies}]$$

Ask Bluebird

QUESTION—*What's the highest number that people know?* From Aleks S.

BLUEBIRD SAYS—People make numbers like they make fractals! First we count to ten, then we go self-similar: ten of tens (100), ten of ten of tens (1000), and so on. We never run out of numbers: we can always go 10x higher. But we do run out of *names* in any human language. If we switch from multiplication to powers, 10^{100} is called *googol.* (Yes, the search engine is named after that number.) And ten to the power of googol is called *googolplex*. Googolplex is the largest number that has its own name in English. Feel free to make and name even larger numbers!



Fun Fact of the Fortnight

Red-legged partridges live in the Southern Europe. They are cute, chunky birds with striking fractal patterns on their chests. For a study, biologists measured the fractal dimension of each bird's feather pattern. Healthier, stronger, better-fed birds had higher fractal dimension of their feather patterns. Less healthy or underfed birds grew simpler patterns with lower fractal dimension.

Images: Pierre Dalou, Eric Isselee. Article: "Fractal geometry of a complex plumage trait reveals bird's quality" by Pérez-Rodríguez et al.