# BLUEBIRD MATH CIRCLE
# Alliance of Indigenous Math Circles

## Issue 48 Fractal Dimension of Pomo Baskets

Share your problems, solutions, models, stories, and art:
**https://aimathcircles.org/Bluebird**

*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 Bluebird Math Circle to work on these activities together with friends and family.

Wednesday April 5th, 12:30-1:30 PM MDT online.

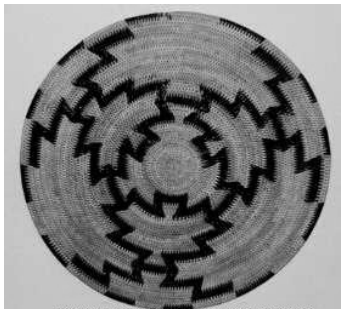
Sign up at
**https://aimathcircles.org/Bluebird**

**MATH COYOTE CORNER**
*"Fractalstan"*
*by Math with Bad Drawings*

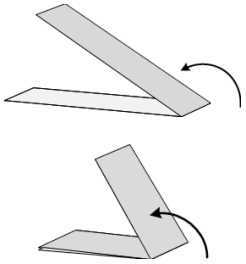

## Family Circle: Baskets and Fractals

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

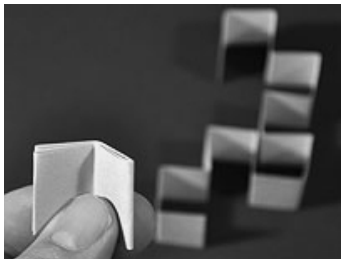
*Photo: Donna Fernandez, beginning of a basket*



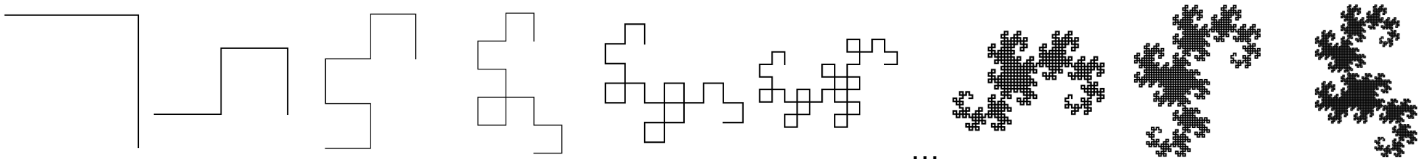
**Fold a Dragon Curve Fractal** Cut a strip of paper about an inch wide. Fold the strip in half. Fold it in half again in the same direction—that is, *iterate*. Then iterate again, and again: 4 times total. Unfold and crease every angle to be 90° (a right angle). Combine several folded pieces with your 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*

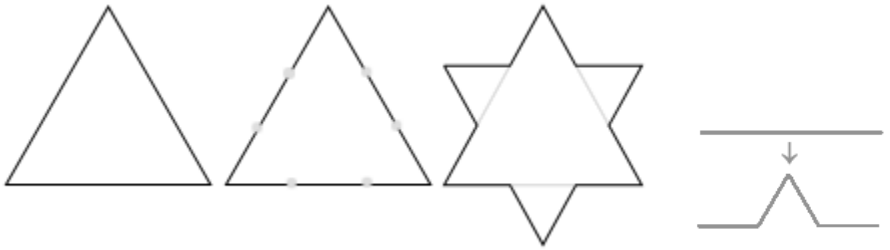


**Curve to Shape** Basket-weavers work with reeds and roots that are like *one-dimensional curves*. They bend and twist and weave until these curves *fill the space*. A thin, *two-dimensional shape* is born. (A basket is a *physical model*; like many mathematical objects, truly 2D shapes only exist in our imagination.) Some Pomo baskets have such a 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**

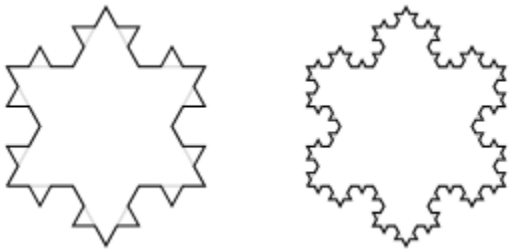


## Draw a Koch Snowflake Fractal

Here is a different fractal curve you can draw: the Koch Snowflake. (The Swedish name sounds like "kawkh," but it's okay to read it using 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 drawing puzzle 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 a 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 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 a higher fractal dimension of their feather patterns. Less healthy or underfed birds grew simpler patterns with lower fractal dimension.

*Images and article: Pierre Dalou;*
*"Fractal geometry of a complex plumage trait reveals bird's quality" by Pérez-Rodríguez et al.*

Teacher guide: https://aimathcircles.org/wp-content/uploads/2023/04/Bluebird-MC-Issue-48-Teacher-Guide.pdf