



MiNI BLUEBIRD MATH CIRCLE

Issue 10: Kolam and Circuits

Share your problems, solutions, models, stories, and art:

<https://akademia.mini.pw.edu.pl/pl/ukraina>

Every child deserves the opportunity to learn, to create, and to change the world.

—Danielle Boyer, Ojibwe Founder & CEO, The STEAM Connection

NEWSFLASH Join LIVE MiNI Bluebird Math Circle to work on these activities together with friends and family. Monday February 6, 18:30-20:00 Warsaw, Poland time, online. Sign up at <https://akademia.mini.pw.edu.pl/pl/ukraina>

MATH JOKE

Not all math puns are terrible.

Just sum.

Warm Up: Invisible Grids and Cozy Circuits

Today, we are visiting math friends from India. In southern Indian villages, people sweep flat spots by their front doors at dawn. Then, they draw designs called *kolam* with rice flour. They always start with *pulli*: tiny piles of flour that are dots for our math purposes. We will follow their long tradition and use only our hands as our measuring tools. That's because touching geometry helps our minds to imagine mathematical structures. We'll replace the flat ground and flour with plain paper and pencils.



Painting by Vishalandra Dakur.

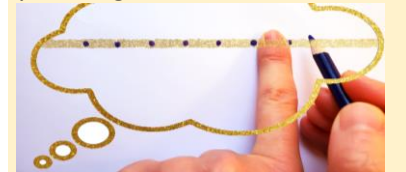
Draw a dot. Use your finger to measure out a distance and draw another dot.



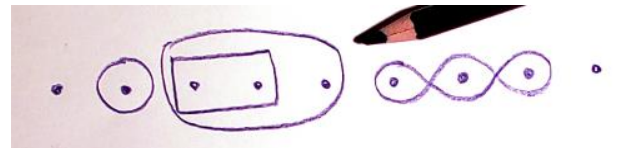
Imagine the straight line going through your two dots. Measure out the same distance along that line, and draw dot number three.



Keep going till you make many dots on the invisible line that you imagined.



Kolam makers not only imagine lines. They also spread flour to draw visible, beautiful straight lines and curves. In folk stories, kolams welcome friends and good spirits to prosperous homes—safe from any dangers outside. So, draw cozy little "homes" for your dots. Enclose dots inside curves that end where they start, called *circuits* in graph theory. There are infinitely many ways to enclose dots in circuits. Make up your own ways to create first kolams of your own!

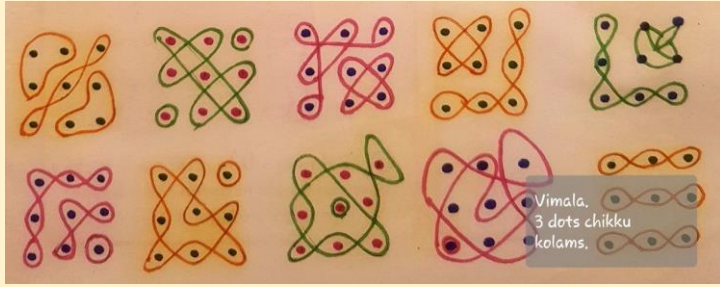


During holidays, people make more elaborate kolams. Take a short break to watch: <https://youtu.be/jznGGQA5bA4> Then, let's follow their lead, and make a grid for our kolam patterns. Your grids will look more precise once you draw a few.

| | | | | |
|---|--|--|---|--|
| | | | | |
| <p>Start with a line of three dots.</p> | <p>Imagine a square with two of your dots for corners.</p> | <p>Draw dots on the other two corners. Keep going...</p> | <p>...Until you draw a 3x3 dot pattern like this...</p> | <p>...On the invisible square grid you see in your mind.</p> |

With a grid, there are even more ways to house dots inside circuits. Make up your own 3x3 kolams.

Here are a few examples of 3x3 kolams. Art by Vimala Ramakrishnan.



Family Circle: Kolam Prompts

Prompts 1-4 work well with 3x3 grids of dots. You are welcome to try different grids. The prompts invite you to make more art.

1. A Room of My Own. Make a kolam where each dot has an enclosure ("room") to itself.

2. An Euler's Circuit. Draw a kolam by these rules:

1. Draw one continuous curve without lifting your pen.
2. End your curve at the same point where you started.
3. Never re-trace any parts of your curve (crossing is okay).

3. Mirror, Mirror. Make a kolam with mirror symmetry: one half reflects the other half.

4. No Mirrors, Only Turns. Draw a kolam that looks the same if you rotate it 90 degrees, but has no mirror symmetry. Try 180° too!

5. Frieze: A Repeating Border. Here are a few kolams that can keep going and going along a long, narrow grid. They make great borders for other art, pages, rooms, etc. In algebraic geometry, we call these patterns *frieze*. Figure out how to draw these lovely examples, and design frieze kolams of your own! Can you imagine your frieze kolam growing to infinity? Art by KamalasCorner.com



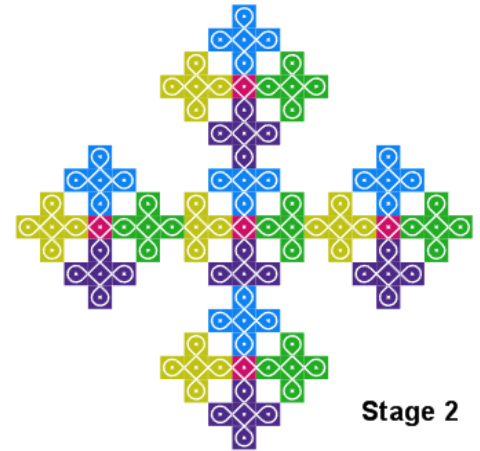
6. Fractal: A Growing Pattern. Here is a family of kolam patterns called Anklets of Krishna. They grow from stage to stage. To start, draw Stage 0. To make the next stage, replace four loops sticking out at the top, bottom, left, and right of your current stage with the entire current stage. Can you imagine this fractal kolam growing to infinity? Design a growing kolam of your own! (We used <https://mathigon.org/polypad>.)



Stage 0



Stage 1



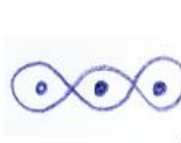
Stage 2

7. Let's count! So far, we only counted the number of pulli (dots) in our kolams. Math people often look for several different things to count. Why? Because counting might reveal hidden relationships! Find or draw several kolams that look like they might be related—"a family". What else can you count in your kolams, besides the dots? Write down the results for each kolam, and for a while, admire the numbers you collected. Do you notice any patterns or relationships among these numbers?

Ask Bluebird QUESTION—*What is a recursive formula?* From Donna Fernandez. **BLUEBIRD SAYS**—*Recursion is a very doable way to keep a pattern. That's because we only need the last step (or last few steps) in the pattern to figure out the next step! For example, to queue up at a store, find the last person in the queue so far, and stand behind them. If you are working on a list of odd numbers, 1, 3, 5, 7, just add 2 to your last number to make more: 9, 11, 13... Our Anklets of Krishna kolam family is recursive: we only use the latest stage to make the next stage. Another famous example: add the last two numbers to continue the Fibonacci sequence 1, 1, 2, 3, 5, 8, 13, 21, 34...*



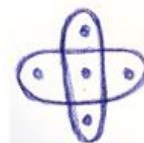
FUN FACT OF THE FORTNIGHT One of the kolam traditions goes by strict rules: our prompt #1 (no more than one dot per enclosure), #2 (one closed circuit without retracing), and also, no empty enclosures, and no more than 2 curves crossing per intersection. Find or draw some kolams like that; here are a few examples. Count the *intersections* of curves for each kolam; you'll find that **Dots=Intersections+1**



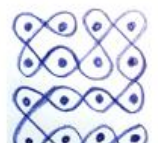
3 dots
2 intersections



6 dots
5 intersections



5 dots
4 intersections



16 dots
15 intersections