

SEARCHING FOR SIMILARITY IN ELECTRONIC STRING ART IMAGES AS A MATH CIRCLE ACTIVITY

Steve Erfle, Dickinson College
with Dee Montealvo, Culver City MS

ELECTRONIC STRING ART (ESA)

Electronic String Art, ESA, extends traditional string art and allows instantaneous exploration of hypotheses by manipulating 4 parameters controlled by up and down arrows so that even very young users can create their own images and watch them change as they change parameters.

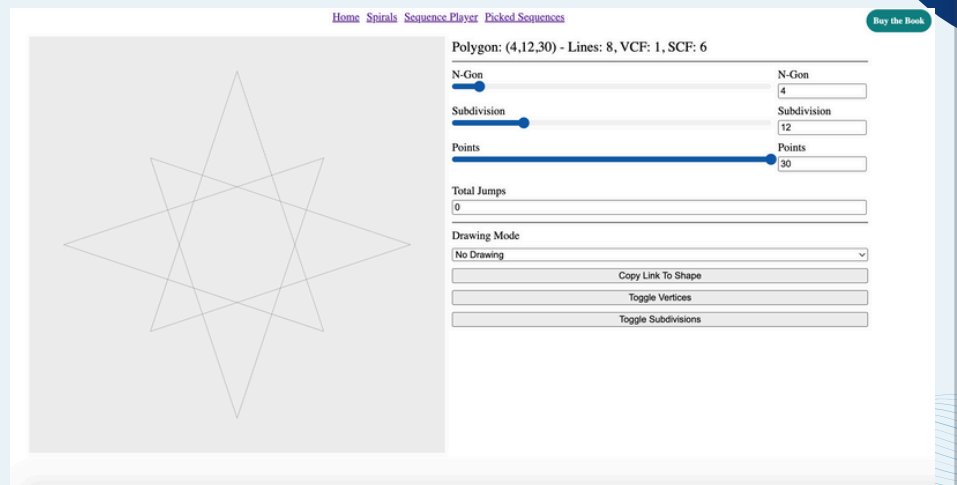
ESA is part of **Playing with Polygons**, a free web resource that explores the interplay between math and art based on regular polygons.

n, S, P, J

- ESA basics take only a few minutes to master.
- Subdivide each line of the n, J -star into S equal subdivisions.
- Connect every P th subdivision endpoint starting at the top.
- Stop when the top is the end after $n \cdot S$ or fewer lines.

PLAYING WITH POLYGONS

WEBSITE LINK



SEARCHING FOR SIMILARITY

WEBSITE



Home Spirals Sequence Player Picked Sequences [Buy the Book](#)

Polygon: (11,3,4,J(6)) - Lines: 33, VCF: 1, SCF: 1

N-Gon N-Gon

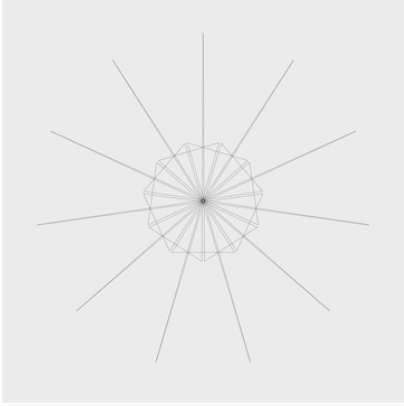
Subdivision Subdivision

Points Points

Total Jumps

Jump 1

Drawing Mode



SEARCHING FOR SIMILARITY

WEBSITE



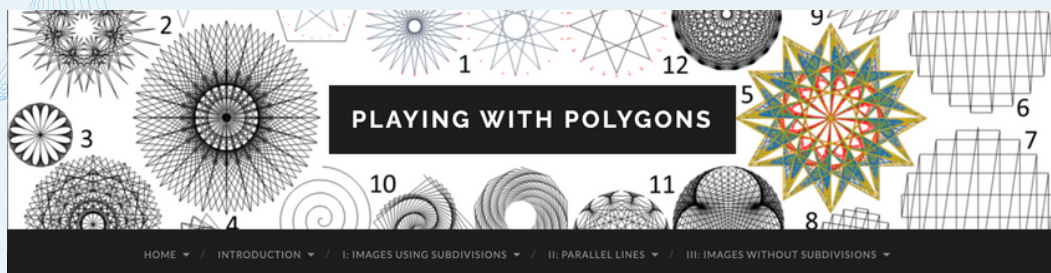
A screenshot of the 'Electronic String Art' website. The top section features a collage of various string art patterns. Below this, a video player is embedded, showing a video titled 'Video 2 CREATING SIMILAR IMAGES'. The video content includes the text: 'Once you have an image you like, the natural question is: Can I find similar images? This video provides a bit of help, based on the 11-needles image to the left. In ESA, such searches fun and lead to interesting new images.' To the right of the video player is a book cover for 'Electronic String Art Rhythmic Mathematics' by Stephen Erle, published by CRC Press. The book cover also displays several string art patterns.

WHY DOES THIS WORK?

Why are Needles Created given $S = 3$, $P = 4$ for odd n and $J = (n-1)/2$?



The second ESA video provides visual “proof” that one obtains sharper and sharper needles as n increases given odd n values. Given $(n, S, P, J) = (n, 3, 4, (n-1)/2)$, the first line drawn is from the top to a point one third of the way along the second line of the vertex frame from vertex $(n-1)/2$ to vertex $n-1$. This first endpoint is just to the right of the vertical diameter of the circle containing vertices of the n -gon and it forms the right side of the vertical needle in the final image (the left side of the vertical needle is the last line of the final image).



Searching for Similarity: Examining the *Star-in-a-Star* pattern

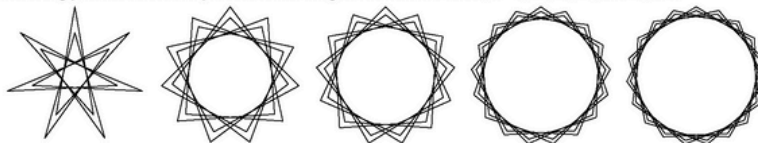


As you begin to play with subdivisions, S , and points between subdivisions, P , in file 2 you will undoubtedly encounter the image of a star within a star, shown to the left, given $S = 2$, $P = 3$, $J = 2$, and $n = 5$, created with 10 lines. Compare that to the traditional star on the right, created with 5 lines.

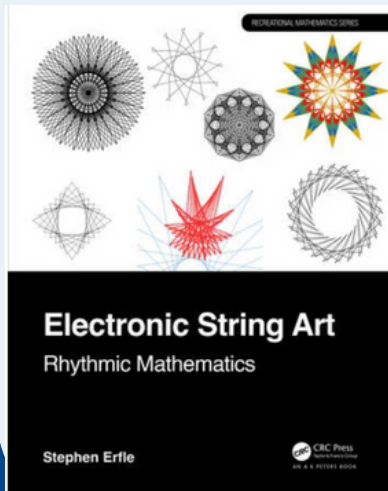


Note that the outer star is more pointed, and the inner star is less pointed, than the star to the right. Additionally, the vertices of the inner star are located at the exact midpoint between every other outer polygonal vertex. Also, the inner star is completely inside the outer.

The question naturally arises: **Are there similar images?** For example, what happens as n increases holding all else fixed? Interestingly, not all values of n produce similar images. The next five values, $n = 7, 11, 13, 17$, and 19 , are:



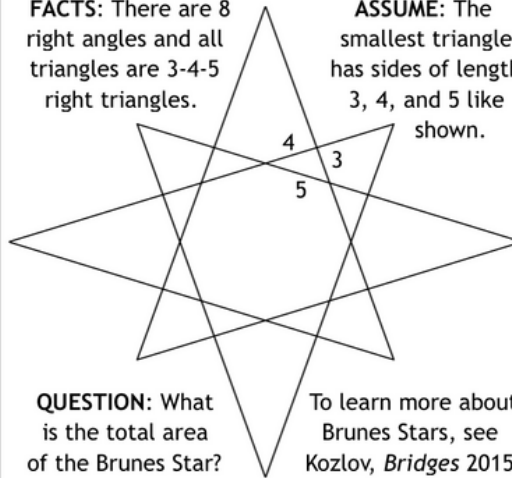
WIN THE ESA BOOK!



This Brunes Star is based on $(n, S, P, J) = (4, 2, 3, 1)$

FACTS: There are 8 right angles and all triangles are 3-4-5 right triangles.

ASSUME: The smallest triangle has sides of length 3, 4, and 5 like shown.



QUESTION: What is the total area of the Brunes Star?

To learn more about Brunes Stars, see Kozlov, *Bridges* 2015.





THANK YOU FOR LISTENING!

STEVE ERFLE

erfle@dickinson.edu

DEE MONTEALVO

deemontealvo@ccusd.org