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

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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.

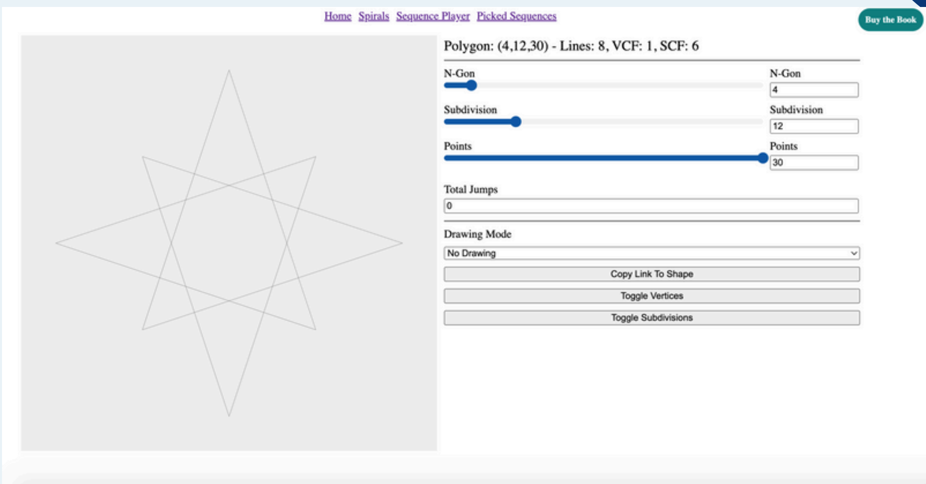
ESA is part of **Playing with Polygons**, a free web resource that explores the interplay between math and art based on regular polygons.

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 Pth subdivision endpoint starting at the top.
- Stop when the top is the end after $n \cdot S$ or fewer lines.

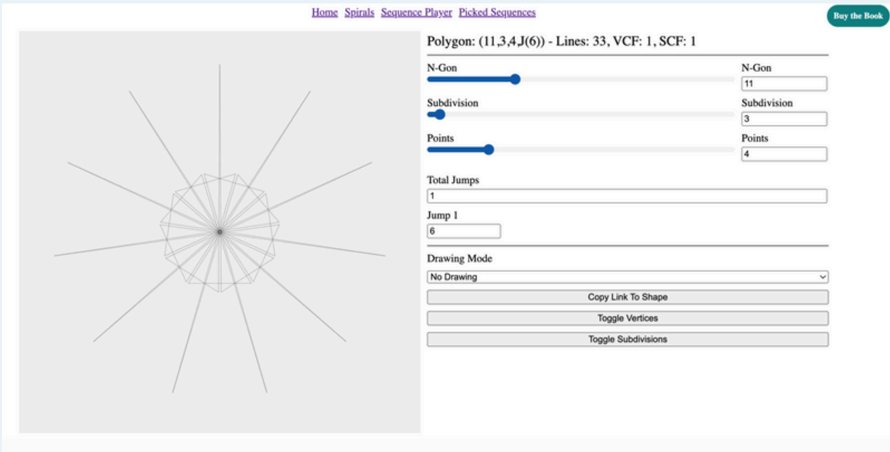
PLAYING WITH POLYGONS

WEBSITE LINK



SEARCHING FOR SIMILARITY

WEBSITE



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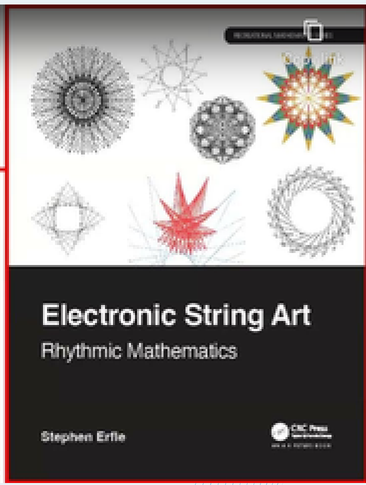
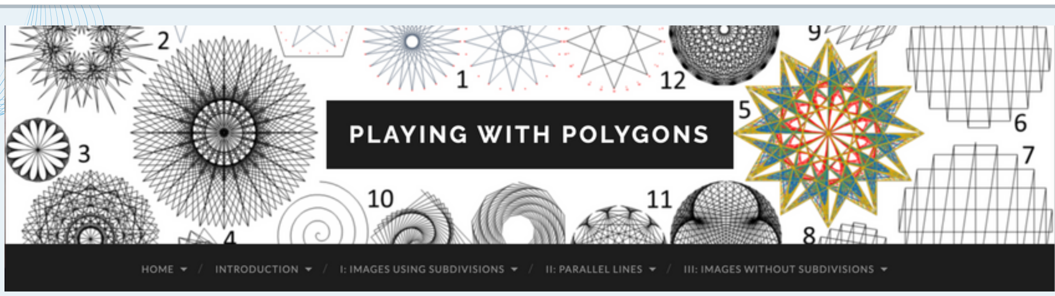
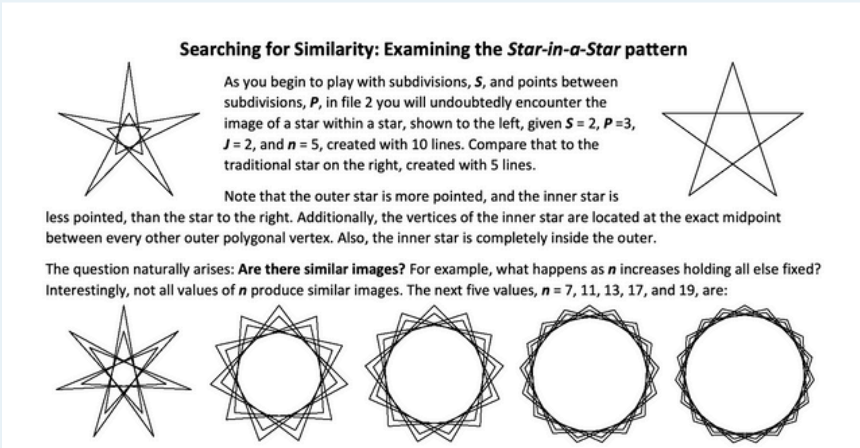


WHY DOES THIS WORK?

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).





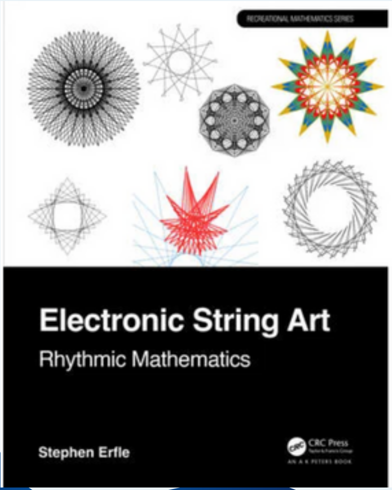
Searching for Similarity: Examining the *Star-in-a-Star* pattern

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:

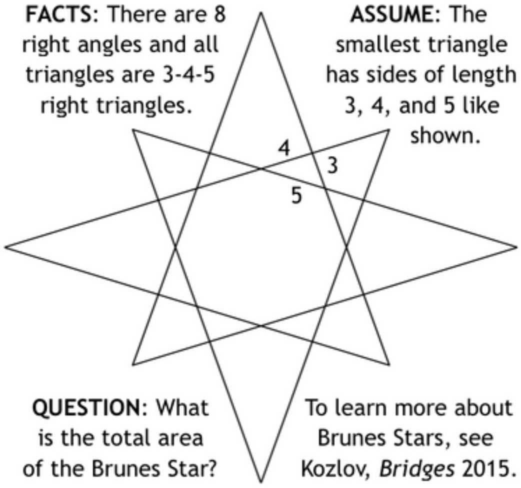
WIN THE ESA BOOK!



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!

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