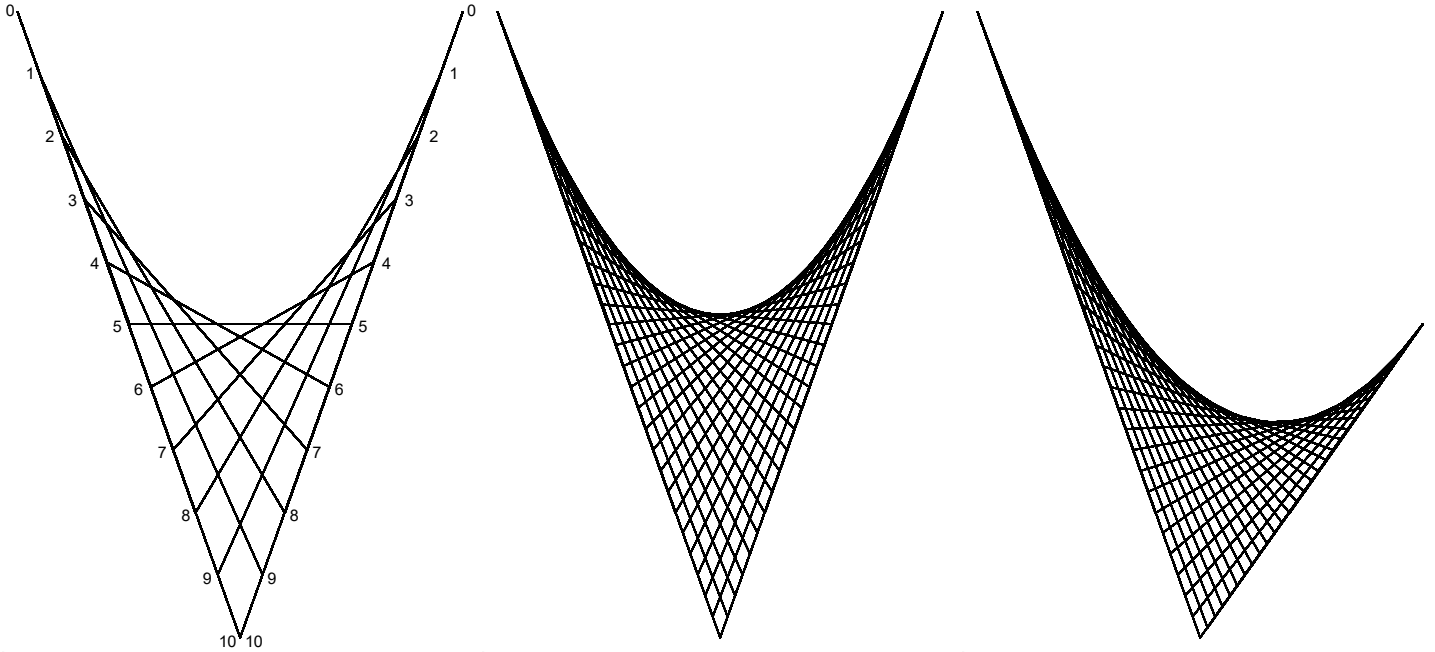


Creating Curves from Straight Lines (with an assist from *Single-Step* Triangles)

One of the most interesting properties of string art is that you can create curves from straight lines by moving in opposite directions on two non-parallel lines equal increments each time. This is simplest to see by filling in angles like the ones below. The 11-line left image connects left to right subdivision endpoints using the following rule: left + right = 10. The 32-line middle image shows that the curve becomes smoother as the number of subdivisions increases. The subdivision lengths on each line need not be the same size as the 32-line right image shows. Both legs have the same number of subdivisions but the right leg is smaller, and hence has smaller-sized equally spaced subdivisions than the larger-sized equally spaced subdivisions on the left leg.



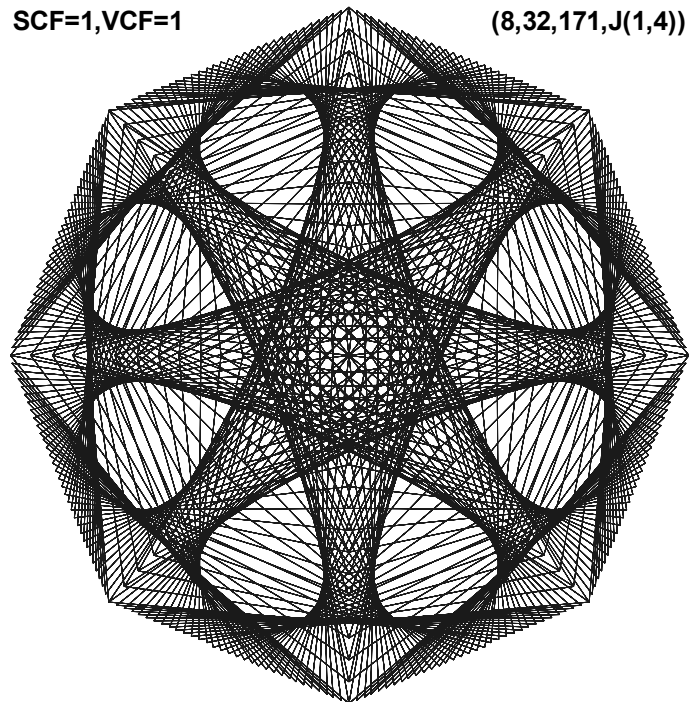
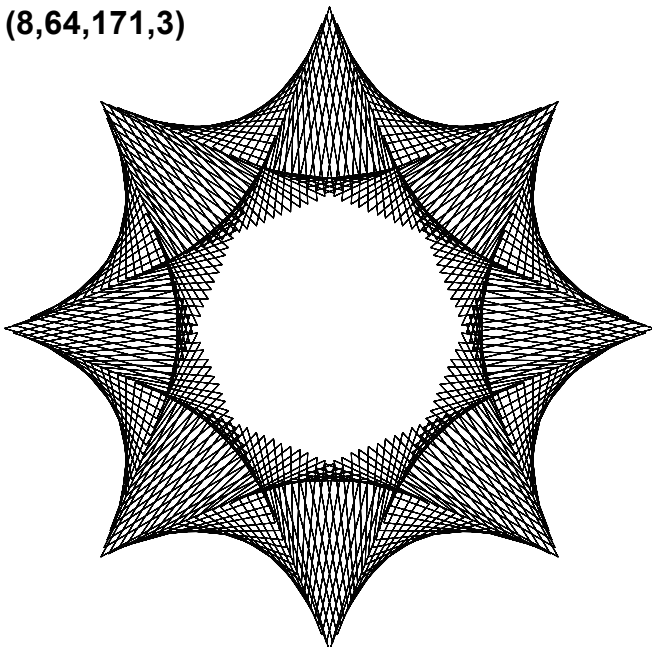
This same thing happens with ESA images on a polygonal vertex frame. Both images have 512 lines. The left is a single jump image; all subdivisions of the 8,3-star vertex frame are the same size. The double jump set image on the right follows a sequence of 1 jump (to the next vertex) with a 4 jump (across the diameter). Subdivisions on the octagon (1 jumps) are much smaller than on diameters (4 jumps) since the ratio of side length to diameter length of an octagon is 0.38:1. Jump sets are the focus of **ESA** Part III, and the Double Jump model is examined in [E16](#).

(n, S, P, J)
(8,64,171,3)

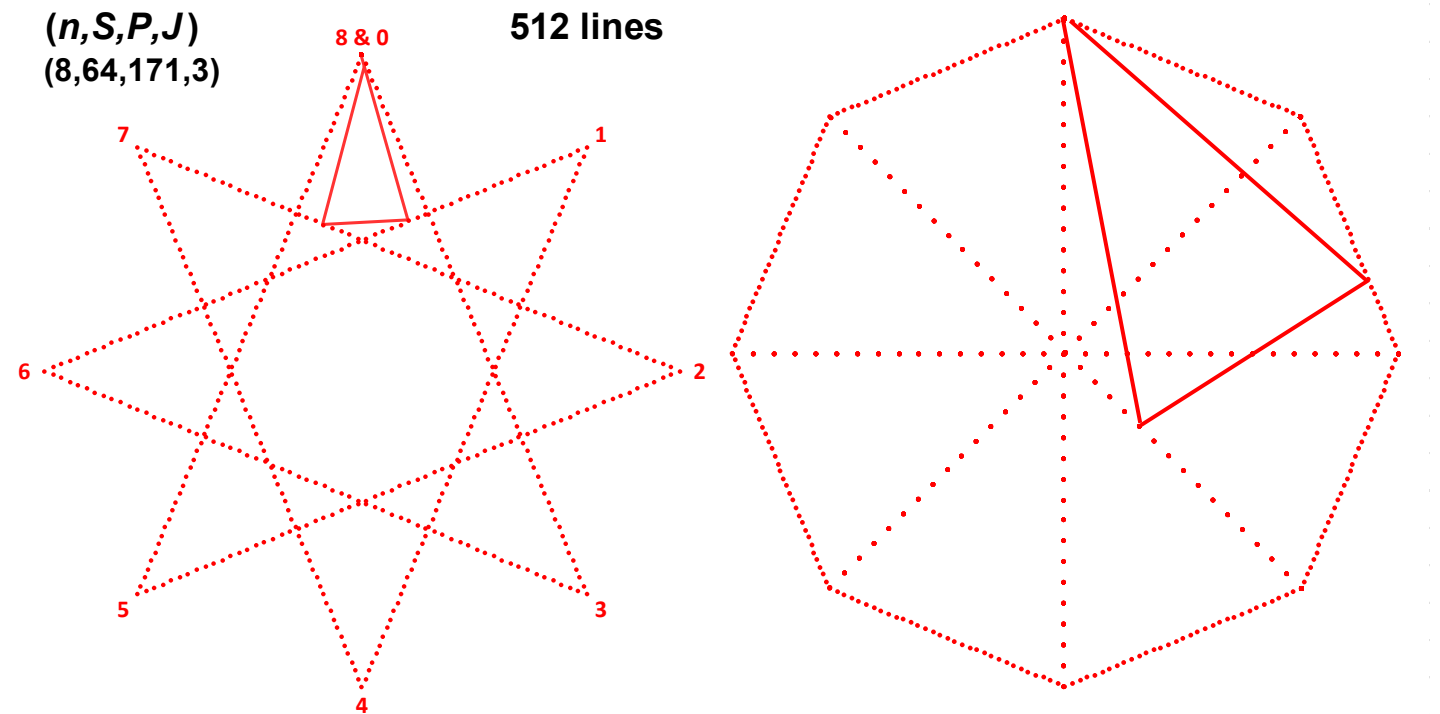
512 lines

SCF=1, VCF=1

(8,32,171, J(1,4))



Single-step images. Both images were chosen because they have a very pretty way in which they are drawn. If you watch each get drawn three lines at a time, you will find the experience mesmerizing; if you watch often enough, you will come to understand why the curves are where they are. Both images are *single-step* of length 3 because the end of the third segment is 1 subdivision from the top as shown in both images, because $3 \cdot 171 = 513 = 512 + 1$.



Full density P values near 171 in both cases produce similar static images (try $P = 169$ and 173) but appear haphazardly drawn (of course, they are not). The best way to understand this is to watch each image get drawn a few times, then adjust P , and rewatch. Since both images are based on n , S , and jumps as powers of 2, all odd P are full density. To watch, click [here for left](#) and [here or right](#), then click *Drawing Mode, Fixed Count Line Drawing*, and set *Drawn Lines* to 3.

The Left Image. We focus here on the single jump image because the curves are easier to follow. This is a triangular example of *Polygons and Stars in a Cycle*, [E10.5](#). The first line of the first triangle starts at the top and ends at the 43rd subdivision endpoint on the third line of the VF (from **6** to **1** since $171 = 2 \cdot 64 + 43$). The second line ends at the 22nd subdivision endpoint on the 6th line of the VF (from **7** to **2** since $2 \cdot 171 = 5 \cdot 64 + 22$), and the third ends one past the top as noted above. The next 3 lines end 1 subdivision after the previous endpoints on each of those lines, and the same goes for the 3rd set of 3 lines, and so on. Now, focus on individual lines in sets of 3 as they move through the first cycle, [E5.1](#).

First lines. The first lines' starting points moves down the first line of the VF from **0** (**8&0**) towards **3**; the ending point moves outward along the VF line from **6** to **1**. After 21 first lines ($64 - 43$), the endpoint is vertex **1** (which ends the first cycle), and these first lines CREATE the curve from **0** to **1**. We will call this curve **0C1**. It the outer curve shown in the blow-up of the first 64 line cycle.

Second lines. Each second line starting point is the first line ending point. These endpoints move toward vertex **1**. The ending points move along the **7** to **2** VF line towards **2**. After 21 first lines ($64 - 43$), the starting point is vertex **1**, and these second lines CREATE the second half of the curve spanning vertices **7** to **1**, **7C1**.

Third lines. Each third line starting point moves down the VF line from **7** to **2**, while the ending points move from **0** towards **3**. These lines form the first half of the curve spanning the two vertices from **0** to **2**, **0C2**.

As this process continues, the second half of the **0C2** curve will be formed, as will the first half of the **1C3** curve and the entire **1C2** curve once the second cycle is completed at vertex **2**. After 8 cycles, the completed image is formed. The eighth cycle creates the last half of the curve **6C0**, all of curve **7C0**, and the first half of the curve **7C1**.

