

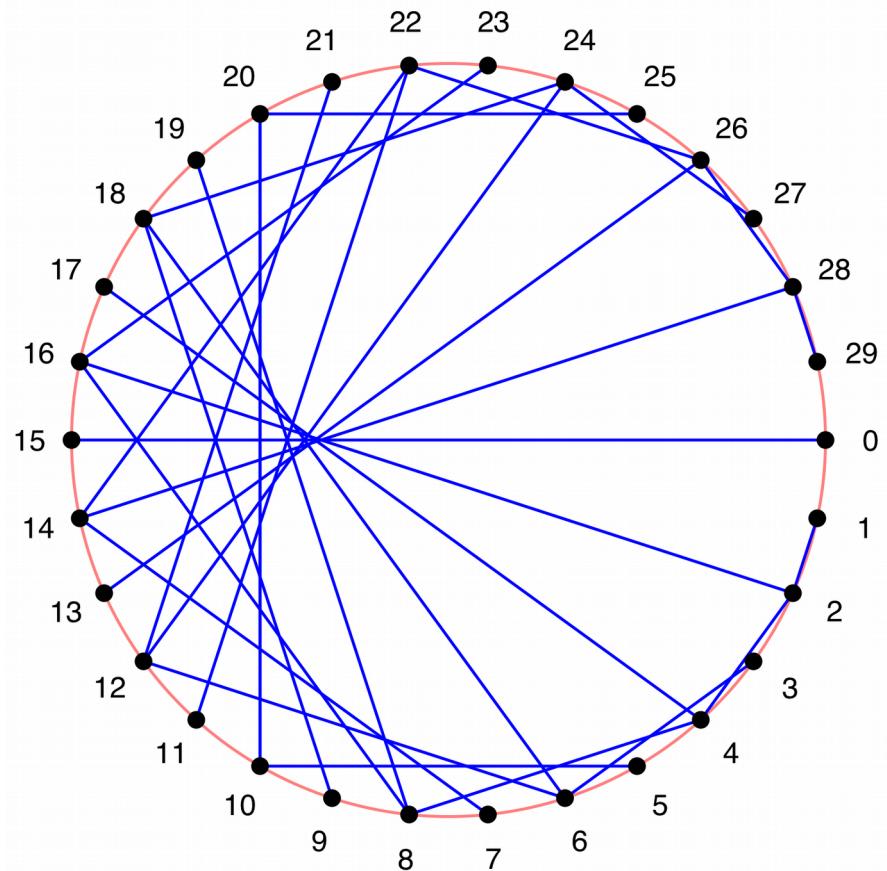


Curve stitching density plots

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1/19

Basic curve stitching

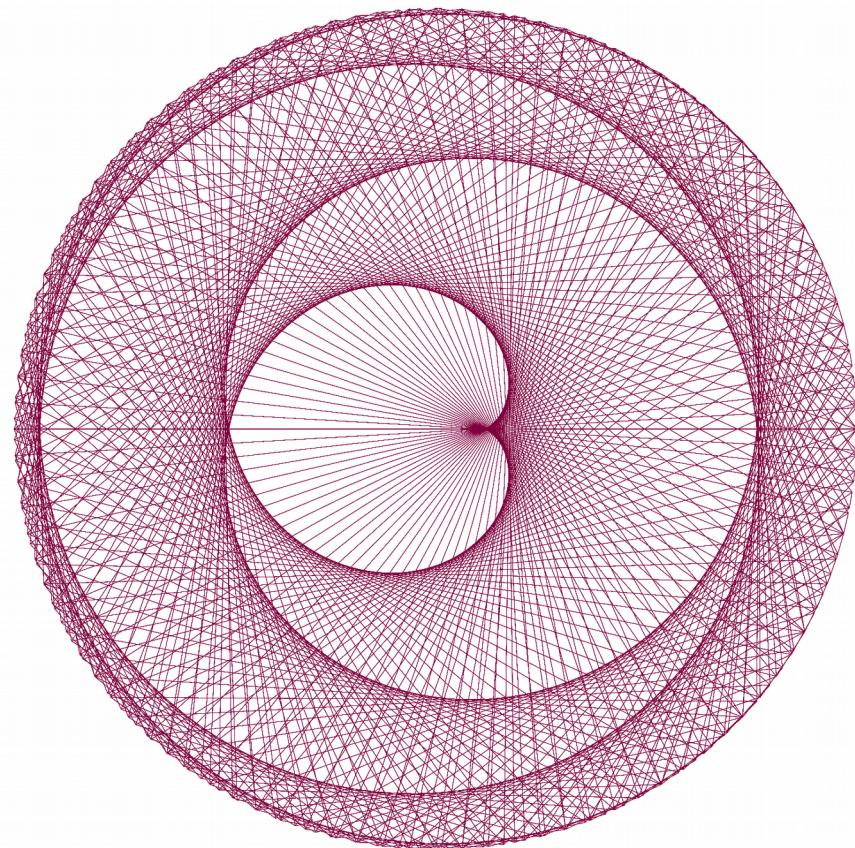
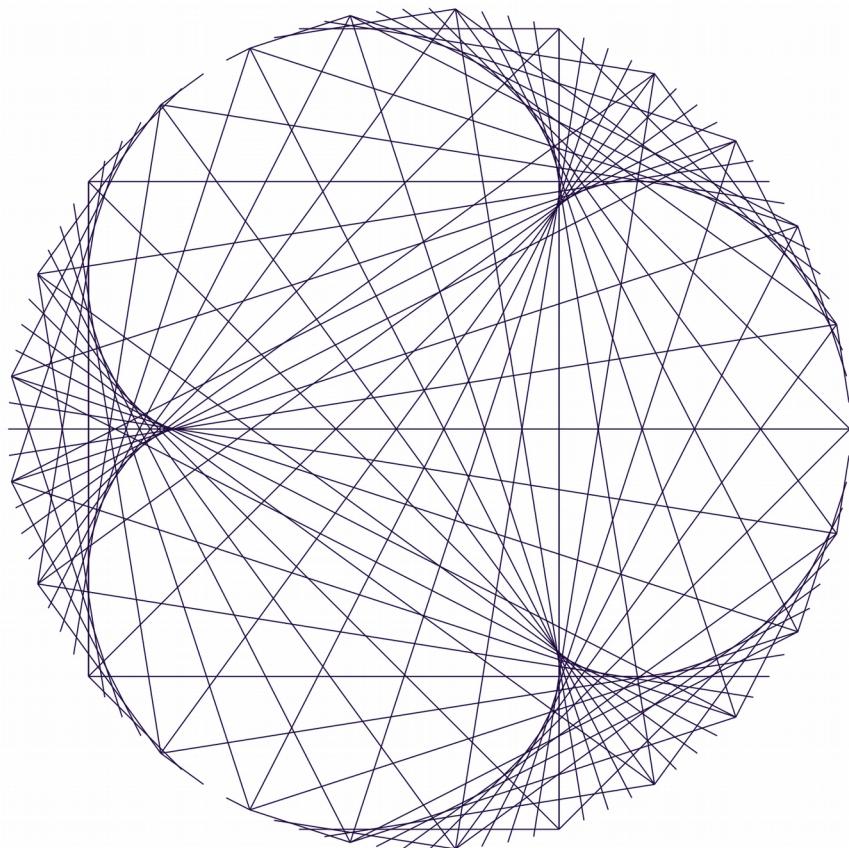
- Traditional method
 - Place N points along curve
 - Connect pairs of points: $(point_i, point_{f(i)})$
- Example
$$f(i) = (k * i) \bmod N$$
where $k=2$ and $N=30$



Simple modification

- Change
 - Connect ($point_i, point_{f(i)}$)
 - $f(i) = (k * i) \bmod N$
- To
 - Connect ($point_\theta, point_{f(\theta)}$)
 - $f(i) = k * \theta$
- Results in same image
 - Easier to code and works with parametric equations

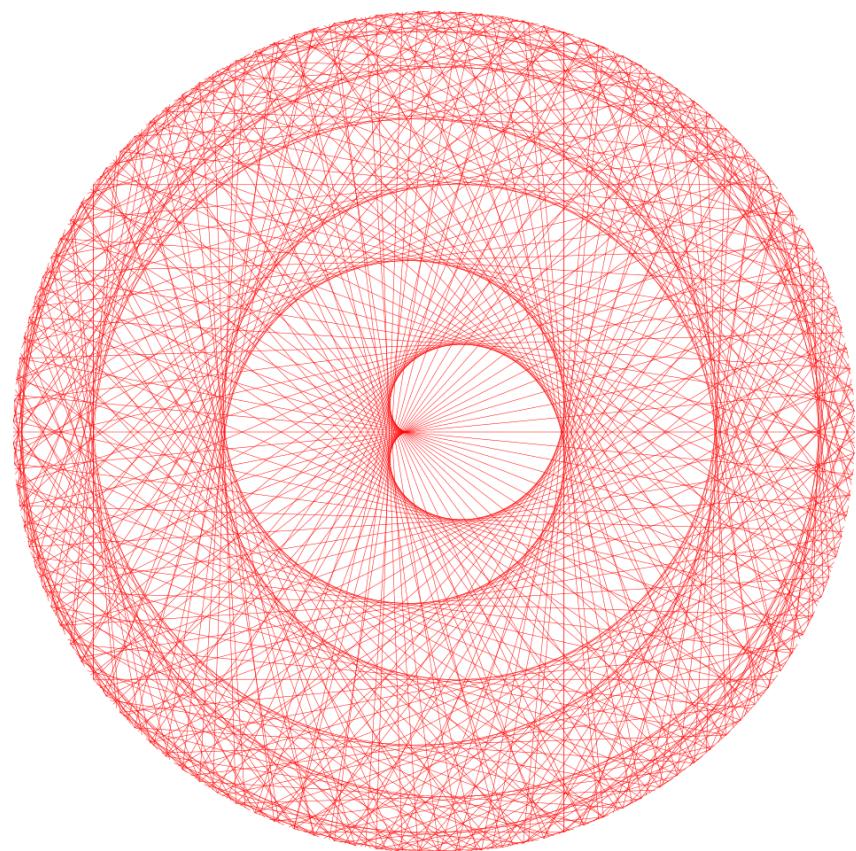
Examples



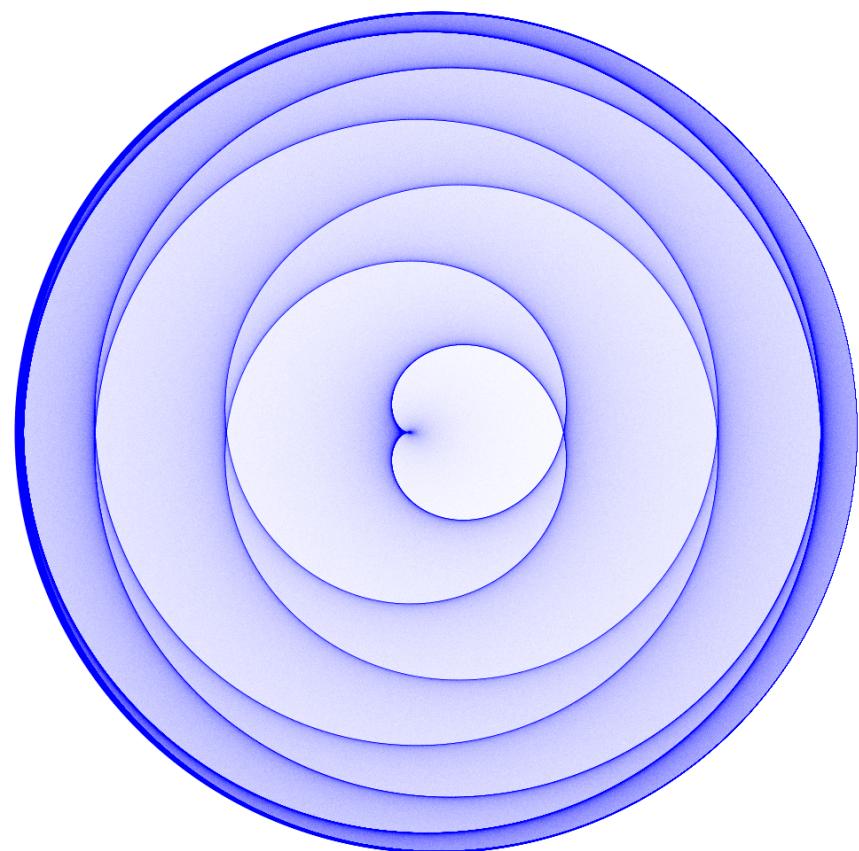
Density Plots

- Rather than drawing N lines, randomly select S lines, and then randomly select a point on each line.
- Keep track of counts
- Convert the counts to an image

Comparison for $k = 1.125$

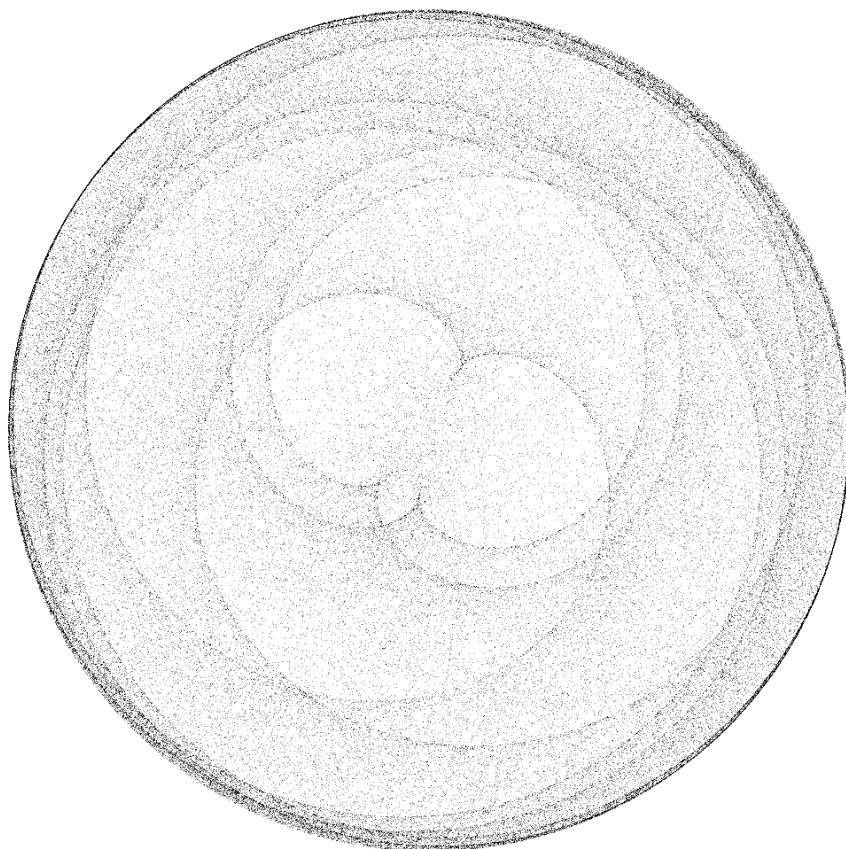


$N=500$

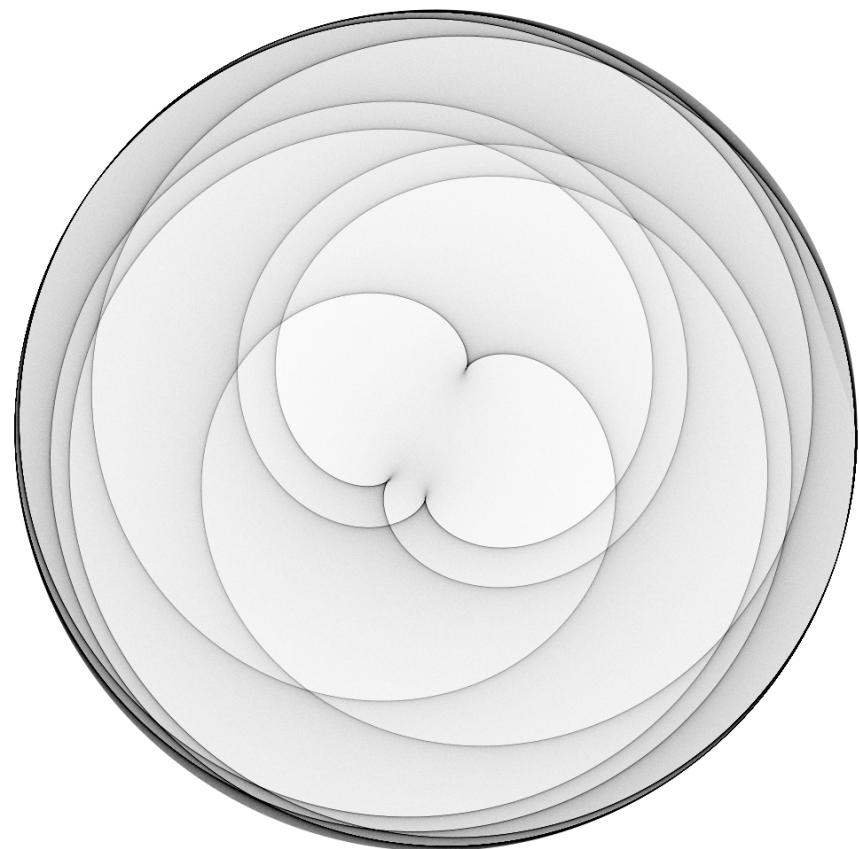


$S=100,000,000$

Effect of S value



S=100,000, time=1.9 sec



S=100,000,000, time=181.2 sec

Curve variations

- No reason to limit curves to circles
- Density plots can be created from any set of parametric equations for (x, y) for a curve,
 - Closed curves
 - Equations here based on θ , but could be time-based as well

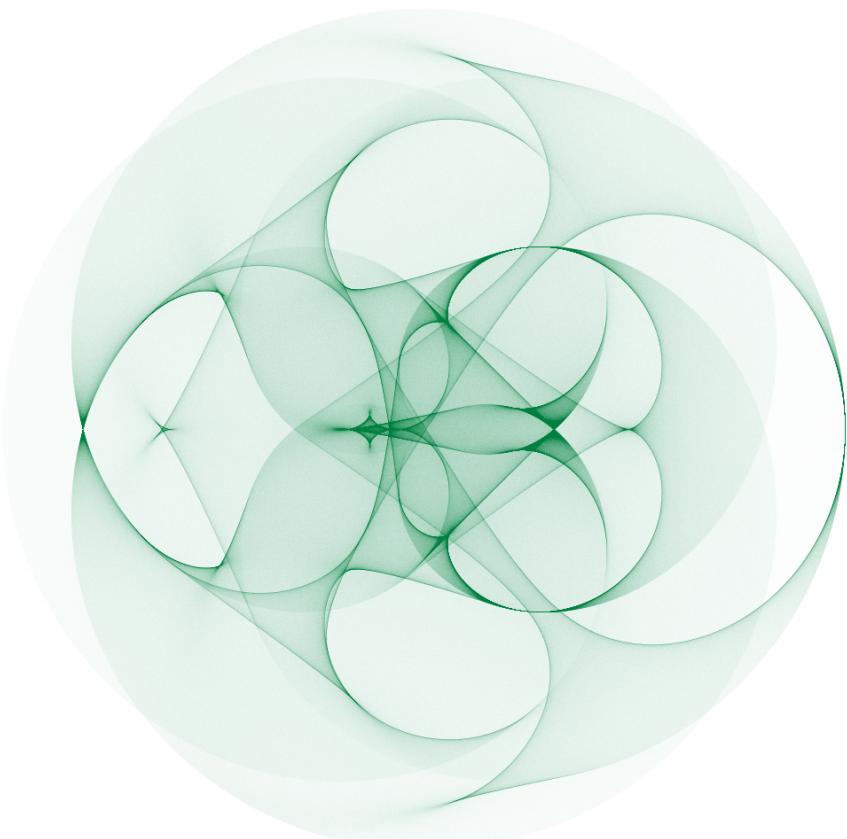
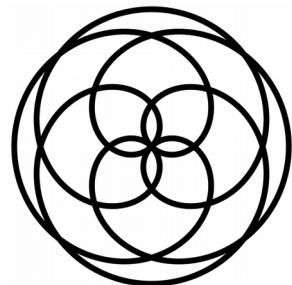
Rose curve

- Rose curve

$$x_{\theta} = \cos(n\theta)\cos(\theta)$$
$$y_{\theta} = \cos(n\theta)\sin(\theta)$$

- Example

$n=.4$ and $k=4$



Lemniscate

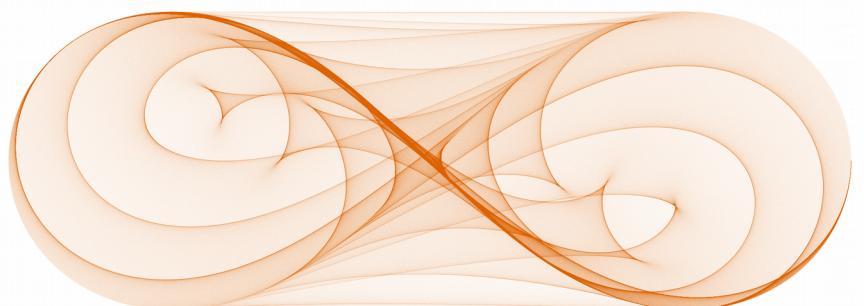
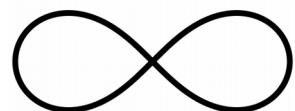
- Lemniscate

$$x_\theta = \frac{\alpha \cos(\theta)}{1 + \sin^2(\theta)}$$

$$y_\theta = \frac{\alpha \sin(\theta) \cos(\theta)}{1 + \sin^2(\theta)}$$

- Example

$$k=1.9$$



Hypotrochoid

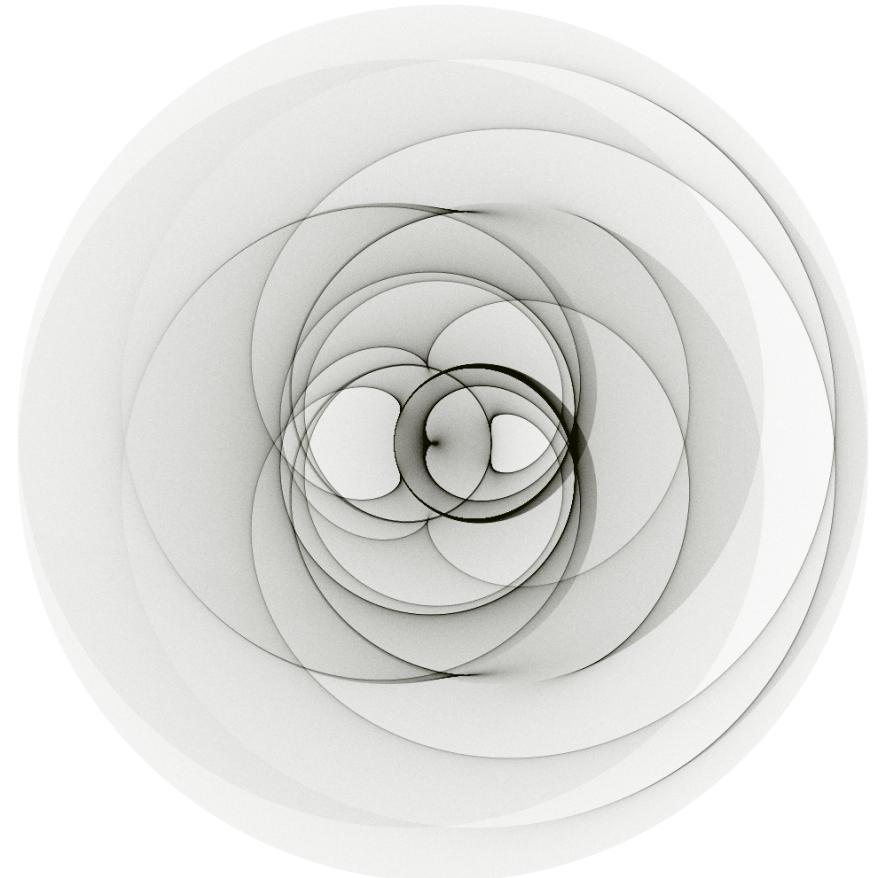
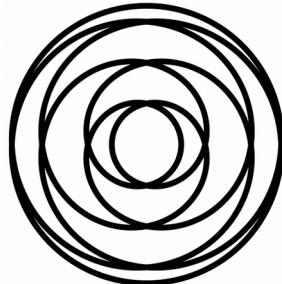
- Hypotrochoid

$$x_{\theta} = (R - r) \cos(\theta) + d \cos\left(\frac{R - r}{r} \theta\right)$$

$$y_{\theta} = (R - r) \sin(\theta) - d \sin\left(\frac{R - r}{r} \theta\right)$$

- Example

$$R=2, r=7, d=4 \text{ and } k=\frac{2}{3}$$

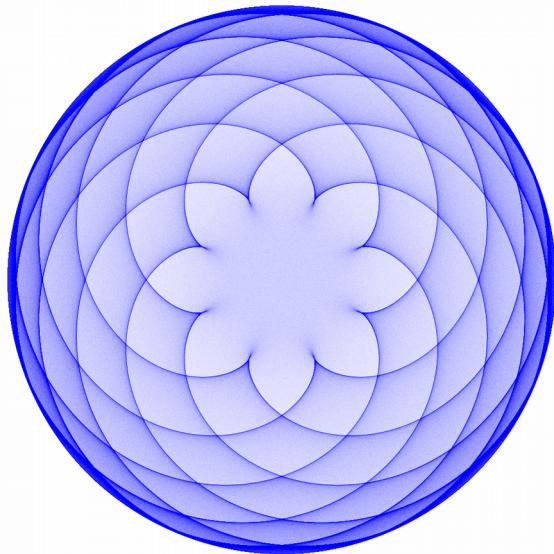


Curve displacement

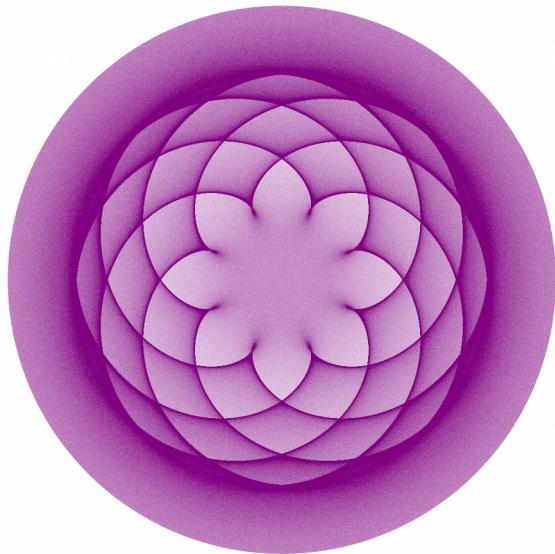
- Previous images connect two points traveling at different speeds on one curve
- Two curves can have
 - Different sizes, and/or
 - Different positions

Examples

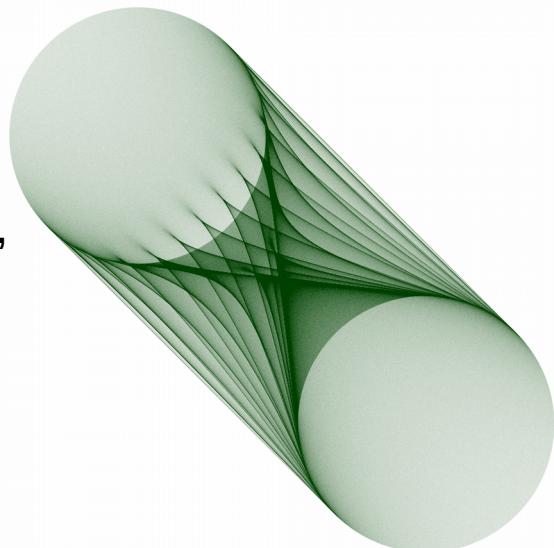
One circle



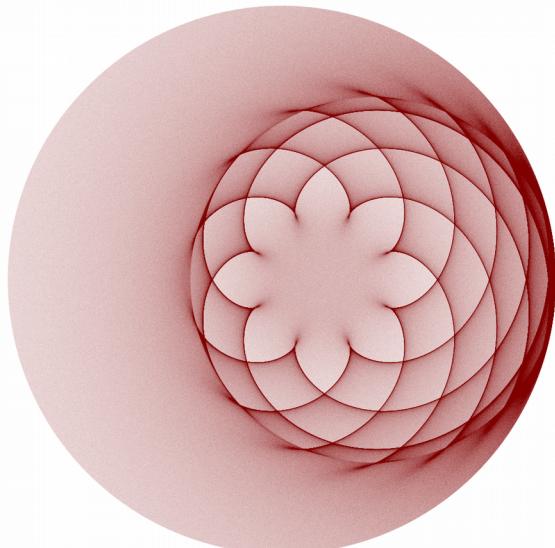
Two circles,
Different radii



Two circles,
Different
positions



Two circles,
Different sizes
And positions

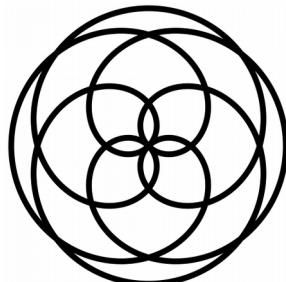


Combining curves

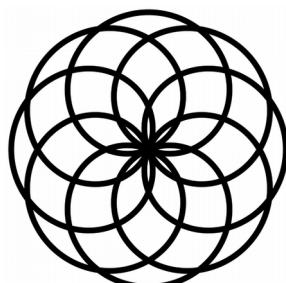
- With different versions of the same curve, additional variations become obvious
 - Same curve, different parameters
 - Two different curves
 - More than two curves

Example: two rose curves

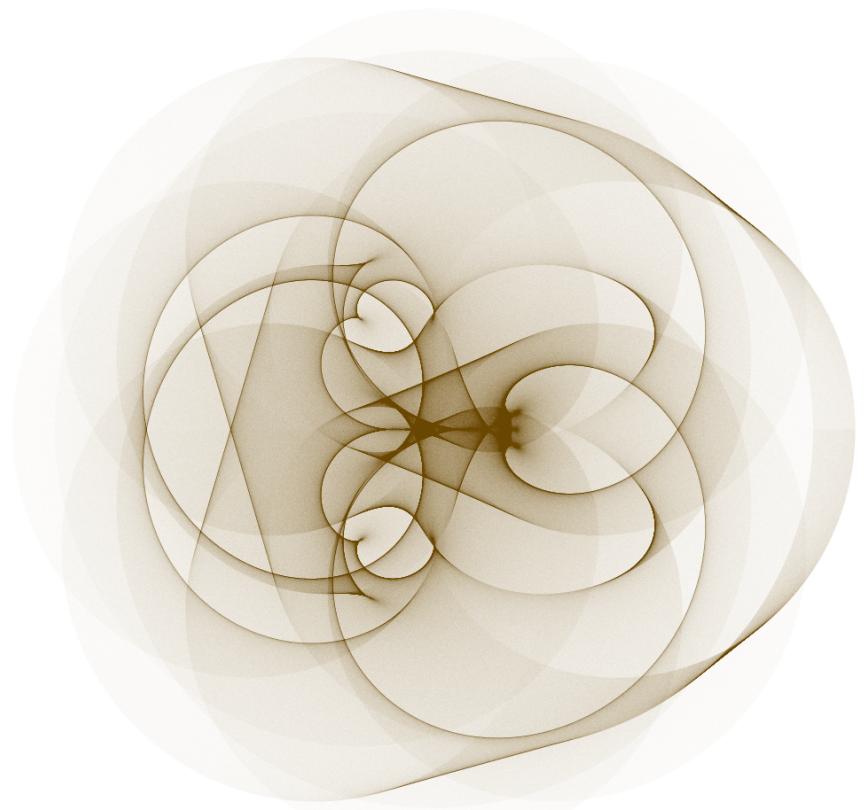
- $n=.4$



- $n=.8$

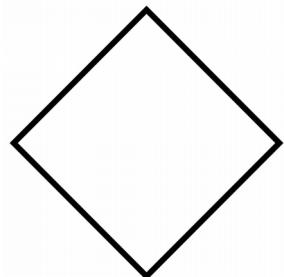


- $k=1.5$

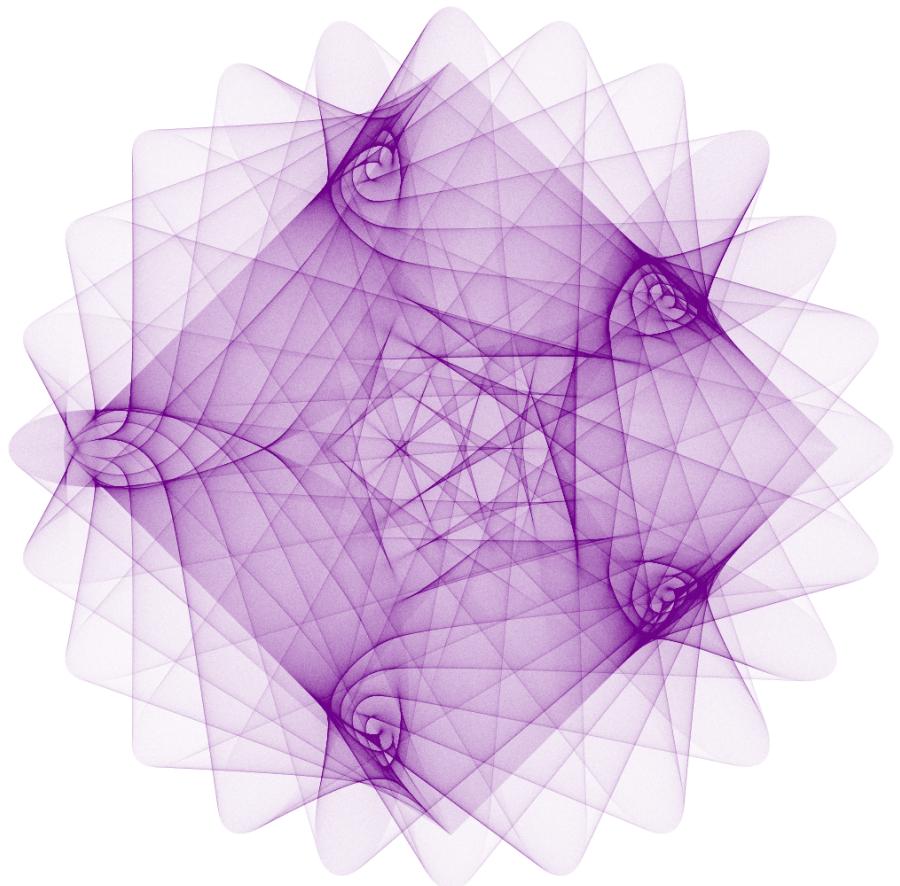
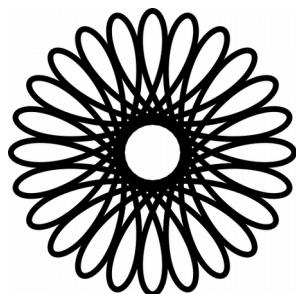


Example: square and hypotrochoid

- Square

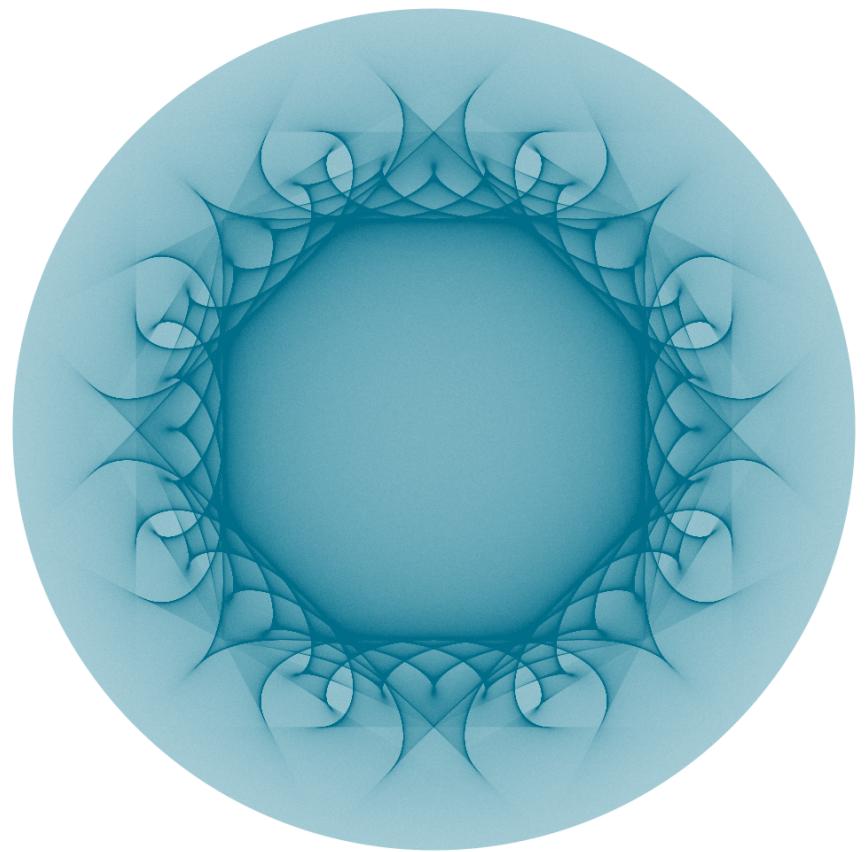
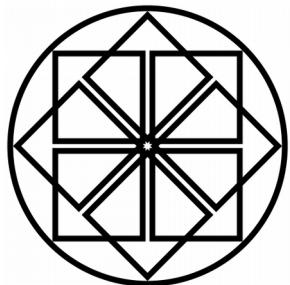


- Hypotrochoid



Example: circle with 8 squares

- Pattern



Code examples

- Sample Python code available at
<https://github.com/nicholsonja/Bridges-2019>

Questions?

