

MECE E4606 Digital Manufacturing

Generative Embroidery

Hod.Lipson@columbia.edu





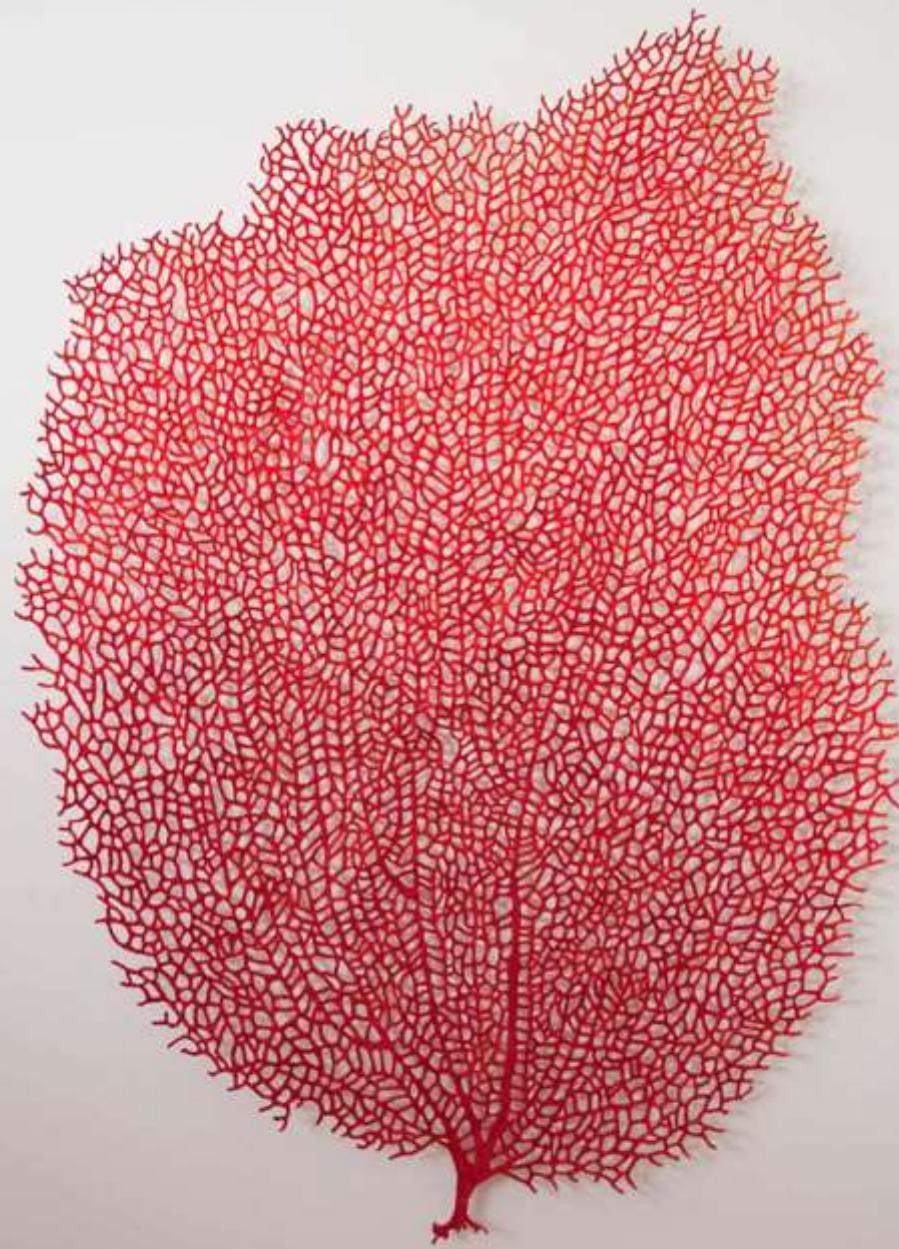


FRACTAL EMBROIDERY

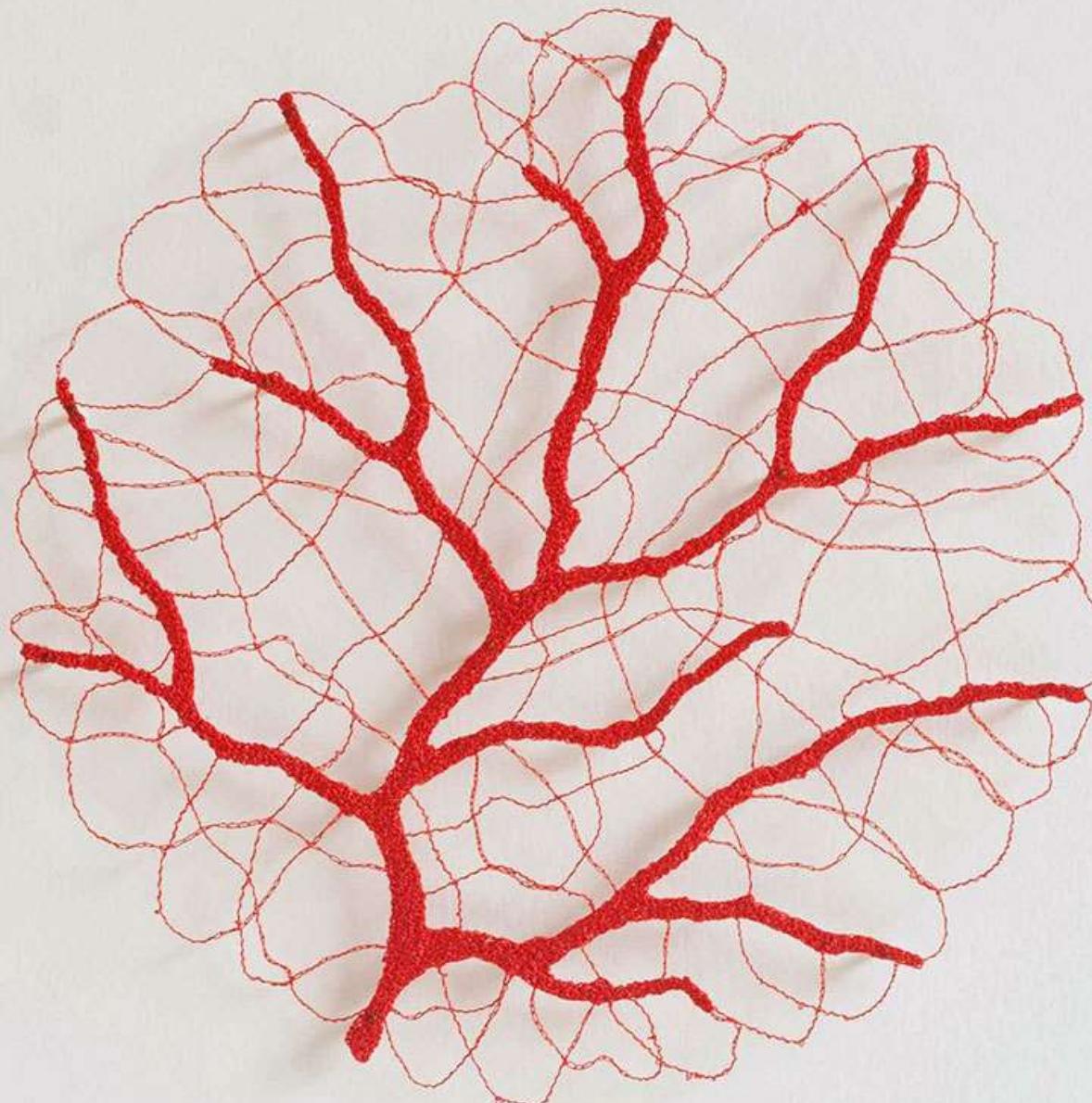


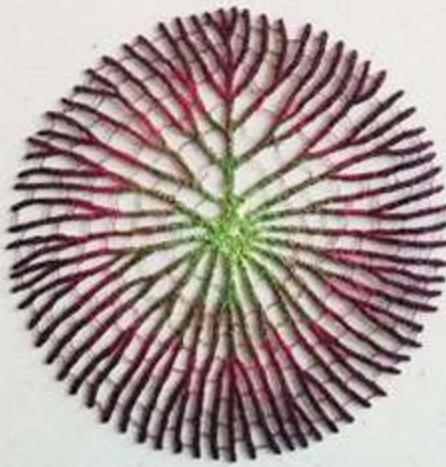
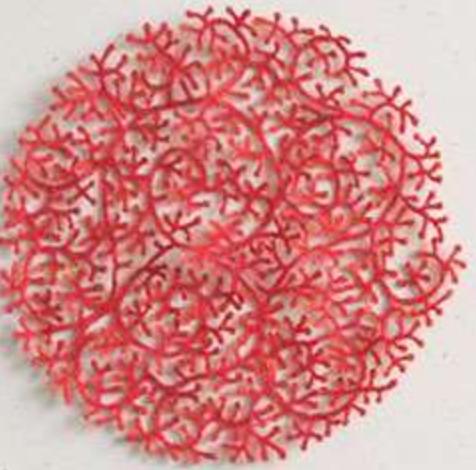


<https://www.boredpanda.com/embroidery-sewing-sculptures-meredith-woolnough>

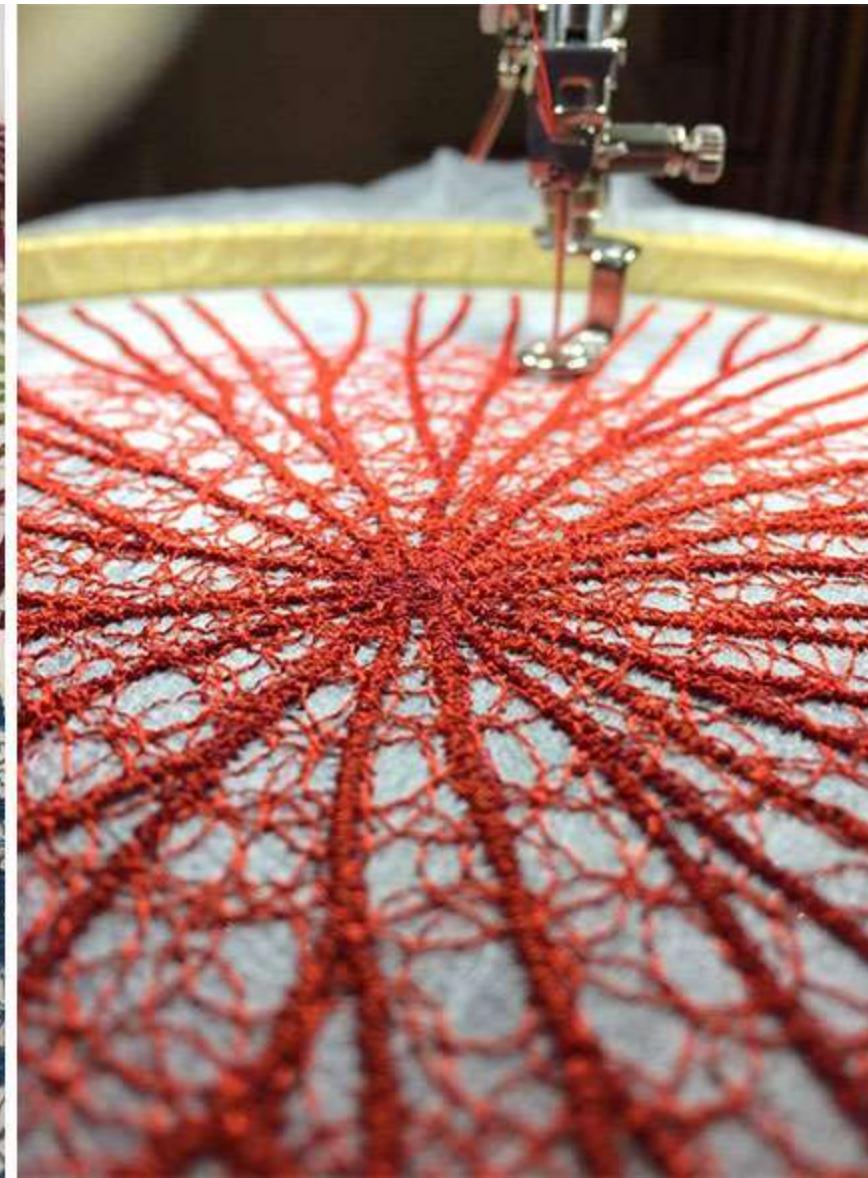




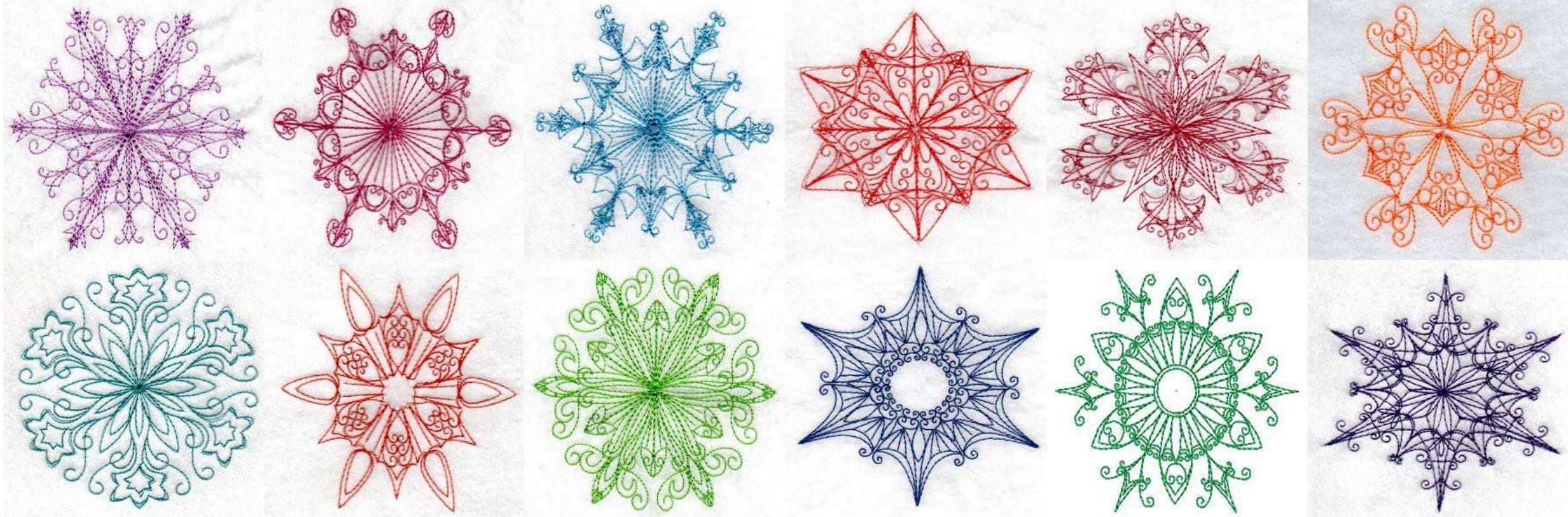




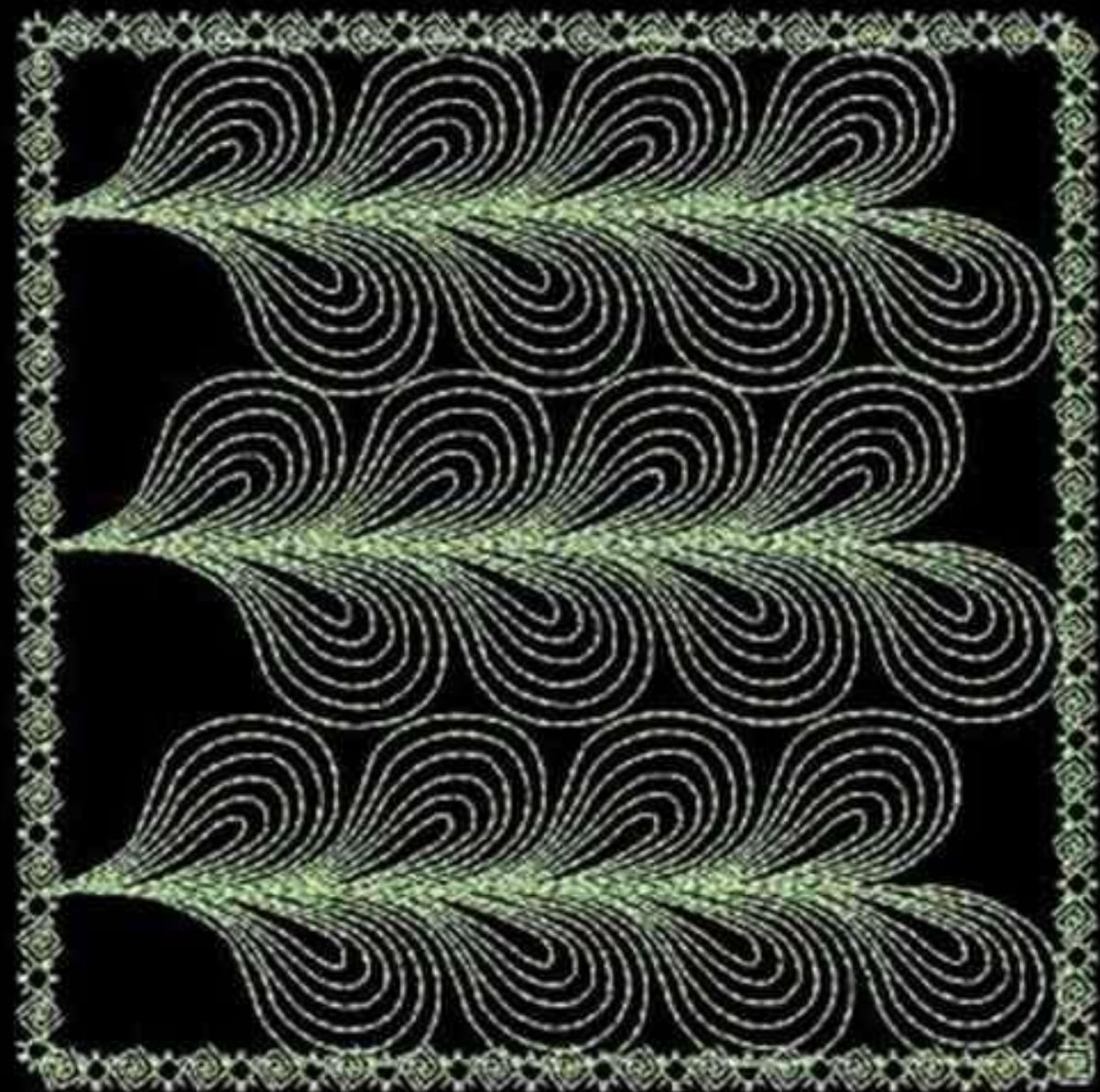
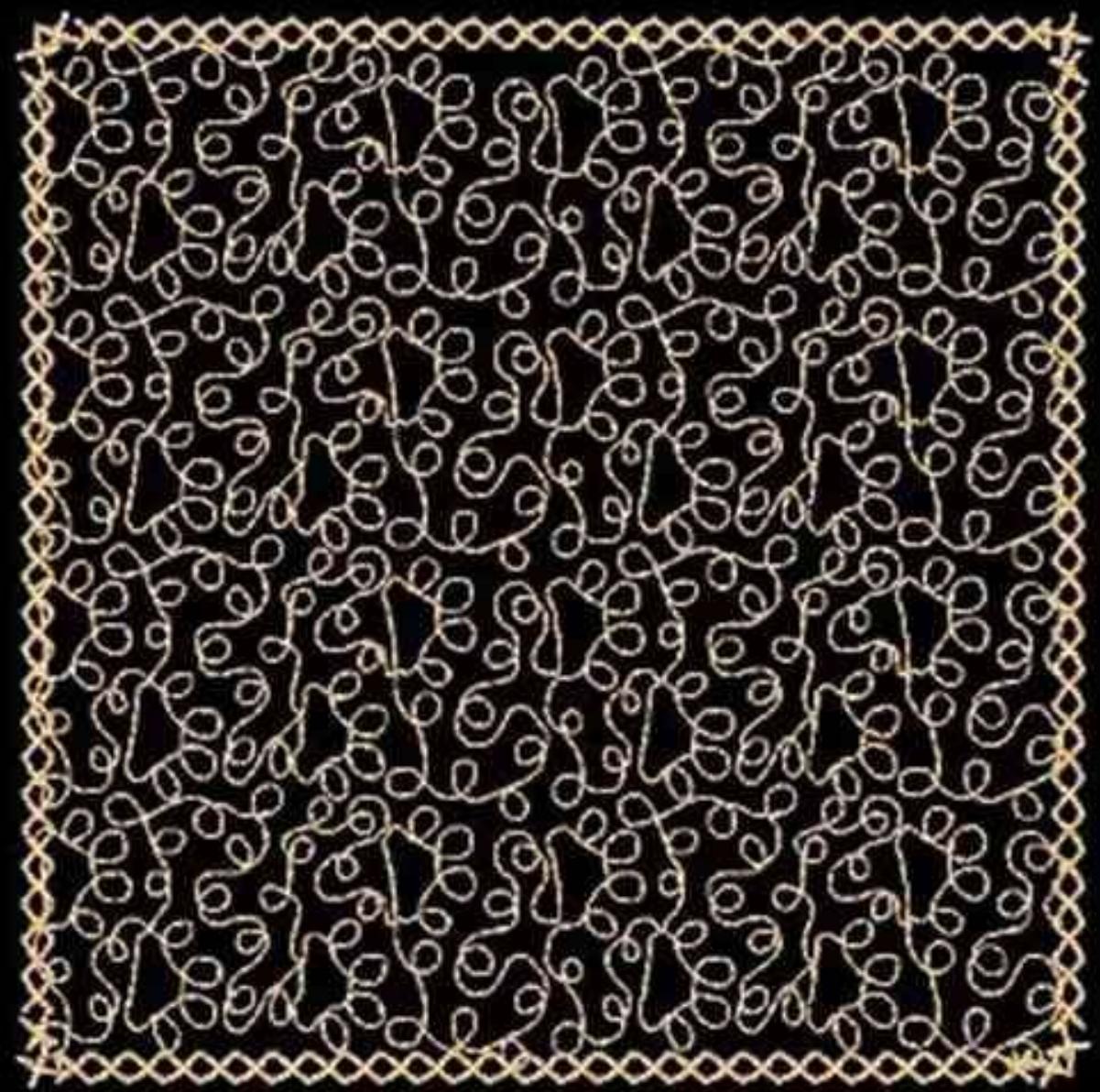




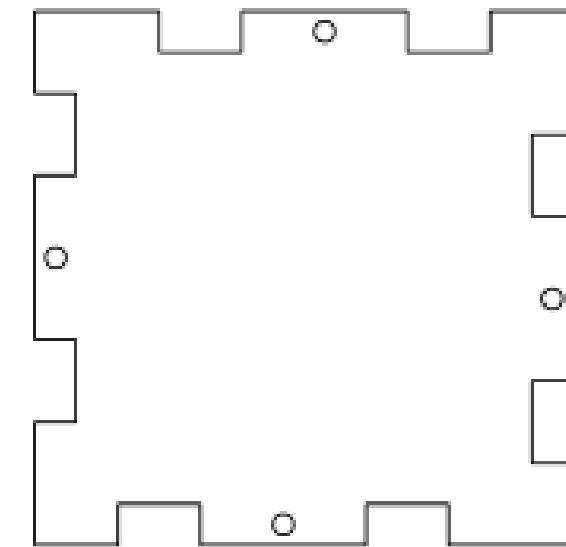
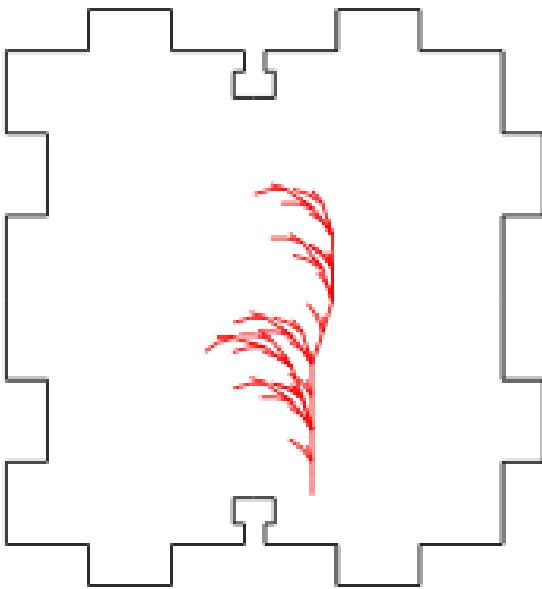
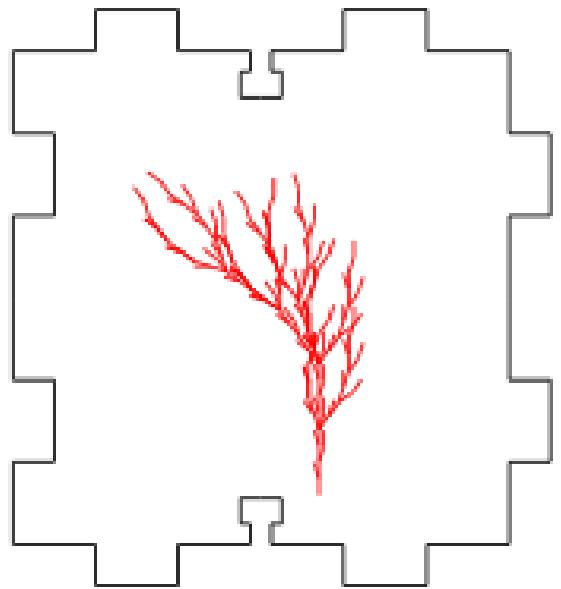
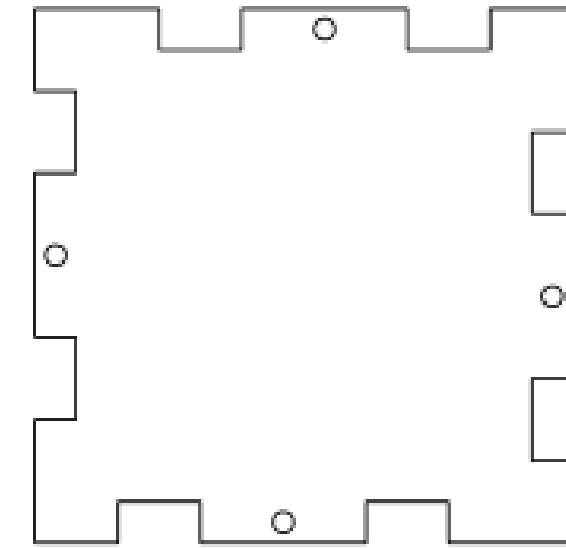
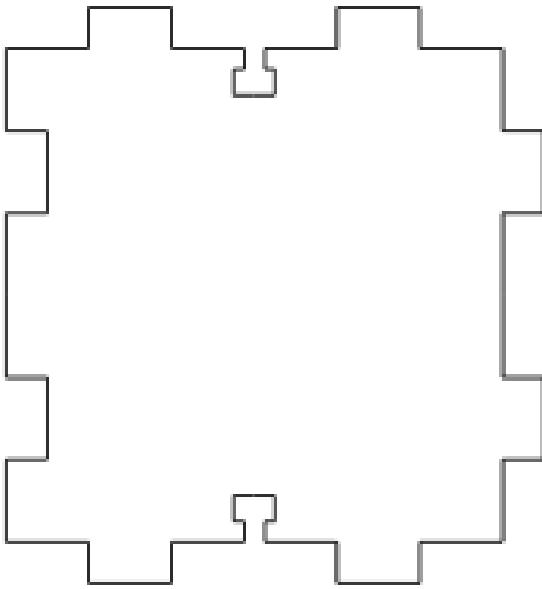
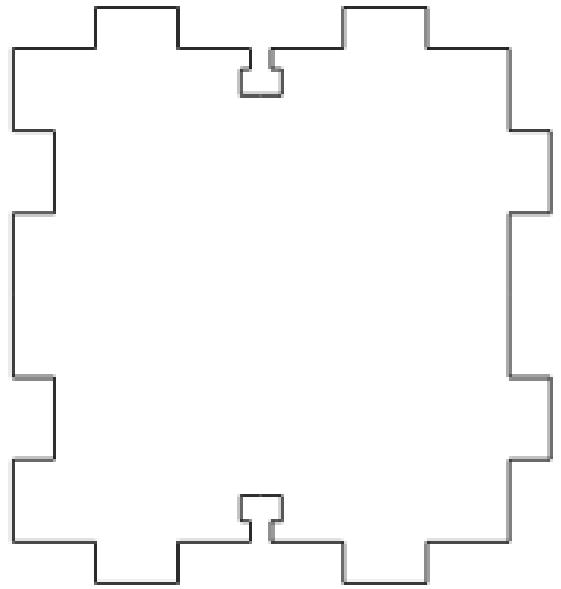


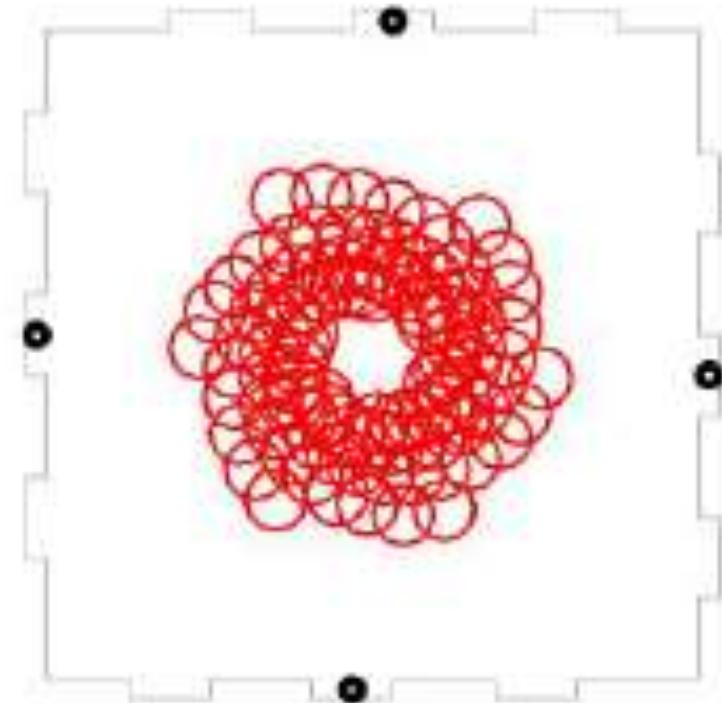
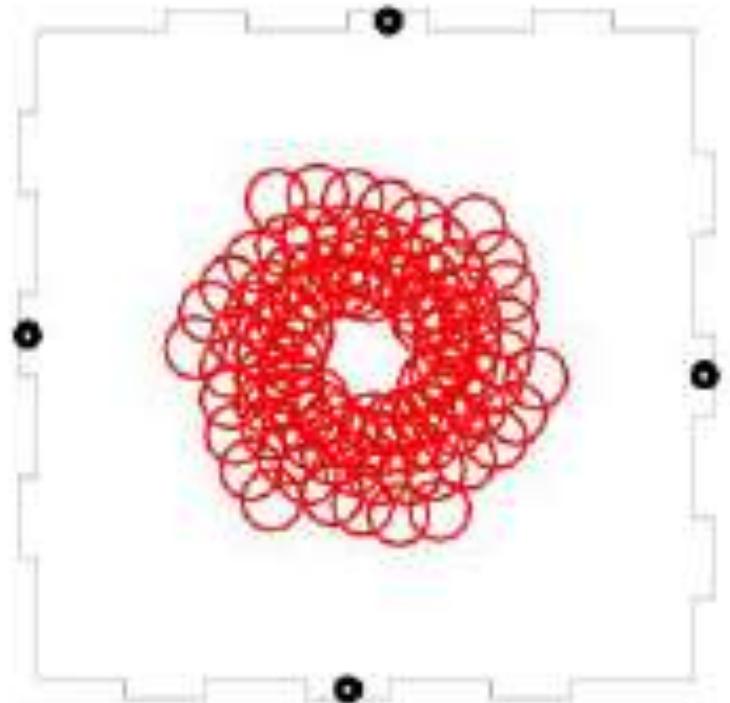














WEARABLE









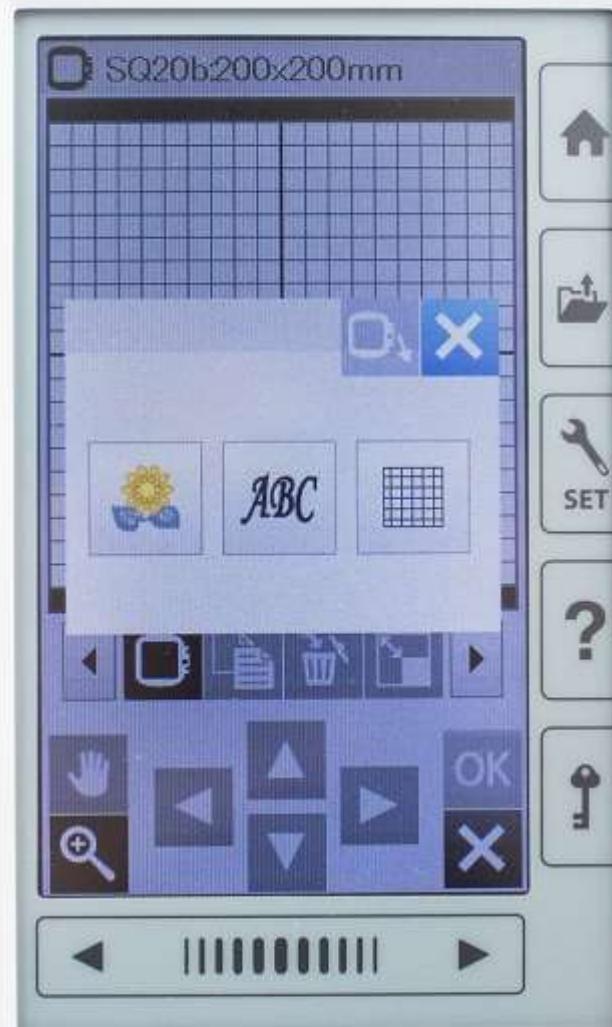
Janome Memory Craft 400E Embroidery Machine

MACHINE



<https://www.amazon.com/gp/product/B01CKCMPDA>





Memory Craft 400E





<https://www.youtube.com/watch?v=LqwnYs3UEOs&t=806s>

	Memory Craft 500E	Memory Craft 400E
Hook Type	Top loading full rotary hook bobbin	Top loading full rotary hook bobbin
Number of Built-in Designs	160	160
Fonts for Monogramming	6 fonts with a 2 and 3 letter monogramming function	6 fonts with a 2 and 3 letter monogramming function
Maximum Embroidery Size	7.9" x 11"	7.9" x 7.9"
Design Transfer Option	Via USB	Via USB
Embroidery Sewing Speed	400-860 SPM	400-860 SPM
Embroidery Format	.jef	.jef
On-screen Editing Functions	Include enlarge/reduce, rotate, flip, drag and drop, arc, combine, copy and paste, grouping, corner layout, single color sewing, zoom	Include enlarge/reduce, rotate, flip, drag and drop, arc, combine, copy and paste, grouping, corner layout, single color sewing, zoom
Programmable Jump Thread Trimming	X	X
Adjustable Speed While Embroidering	X	X
Flexible Stitch Traveling	By units of 1, 10, 100	By units of 1, 10, 100
Direct Jump to Desired Stitch Point	X	X
Auto Return Post Thread Break	X	X
Adjustable Hoop Positioning	X	X
Built-in Advanced Needle Threader	X	X
Automatic Thread Cutter	X	X
Easy Set Bobbin	X	X
Bobbin Winding Plate with Cutter	X	X
Bobbin Thread Sensor	X	X

Programmable Jump Thread Trimming	X	X
Adjustable Speed While Embroidering	X	X
Flexible Stitch Traveling	By units of 1, 10, 100	By units of 1, 10, 100
Direct Jump to Desired Stitch Point	X	X
Auto Return Post Thread Break	X	X
Adjustable Hoop Positioning	X	X
Built-in Advanced Needle Threader	X	X
Automatic Thread Cutter	X	X
Easy Set Bobbin	X	X
Bobbin Winding Plate with Cutter	X	X
Bobbin Thread Sensor	X	X
Full Color LCD Touchscreen	X	X
Thread Brands	Janome, Robison-Anton, Madeira, Mettler	Janome, Robison-Anton, Madeira, Mettler
Extra Wide Table Included	X	
Cover	Dust cover	Dust cover
Included Hoops	RE28b: 7.9" x 11" SQ20b: 7.9" x 7.9" RE20b: 5.5" x 7.9" SQ14b: 5.5" x 5.5"	SQ20b Hoop (7.9" x 7.9")



SOFTWARE



by **wilcom**®

<https://www.wilcom.com/hatch>



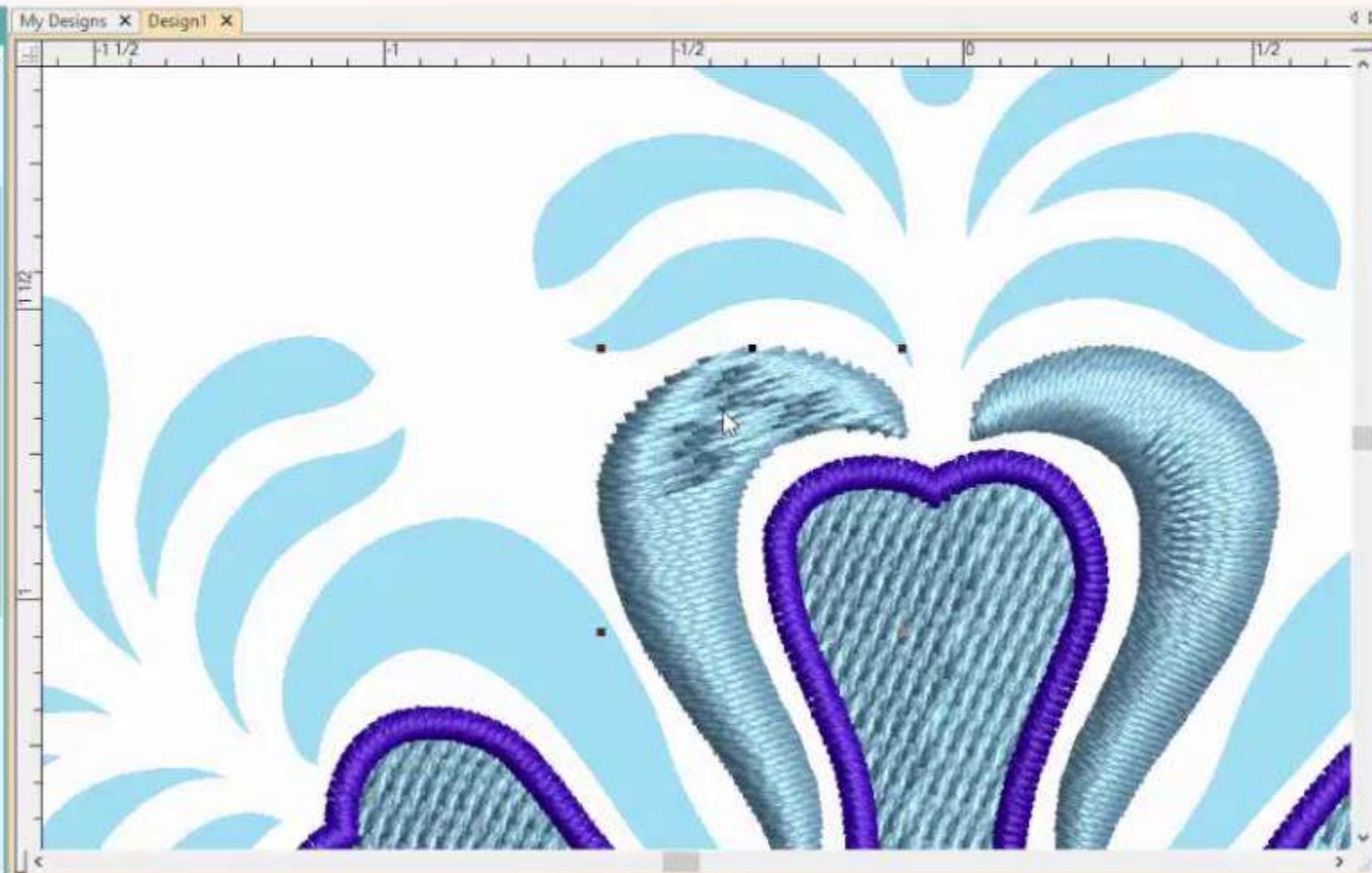
Position X: -0.364 in Position Y: 0.943 in Width: 0.518 in Height: 0.972 in 100.00 % 100.00 % Size +10% Size -10% Mirror X Mirror Y Left 15° Right 15° 15° 15°

Corners Trim Underlay Create Motif... Create Border...



Toolboxes

- ▲ Edit Objects
 - Object Properties >>
 - Copy Object Properties
 - Apply Object Properties
 - Reshape
 - Adjust Stitch Spacing...
 - Remove Overlays
 - Create Color Blend...
 - Add Stitch Angles
 - Remove Stitch Angles
 - Smooth Shapes...
 - Optimize Color Changes...
 - Apply Closest Join
 - Resequence Manually >>
 - 1 2 3 Resequence by Selected Order
 - Ambience Quilting...
 - Create Outlines and Offsets...
 - Create Trapunto Outlines...



Object Properties

Fill Effects Stitching

▲ Feather Edge

Feather side: Remove Effect

Side 1 Both sides Side 2

Max. width: 0.118 in

Raggedness: Low Medium High

▲ Radial / Curve Fill

Radial fill

Hole width: 0.10 in

Hole height: 0.10 in

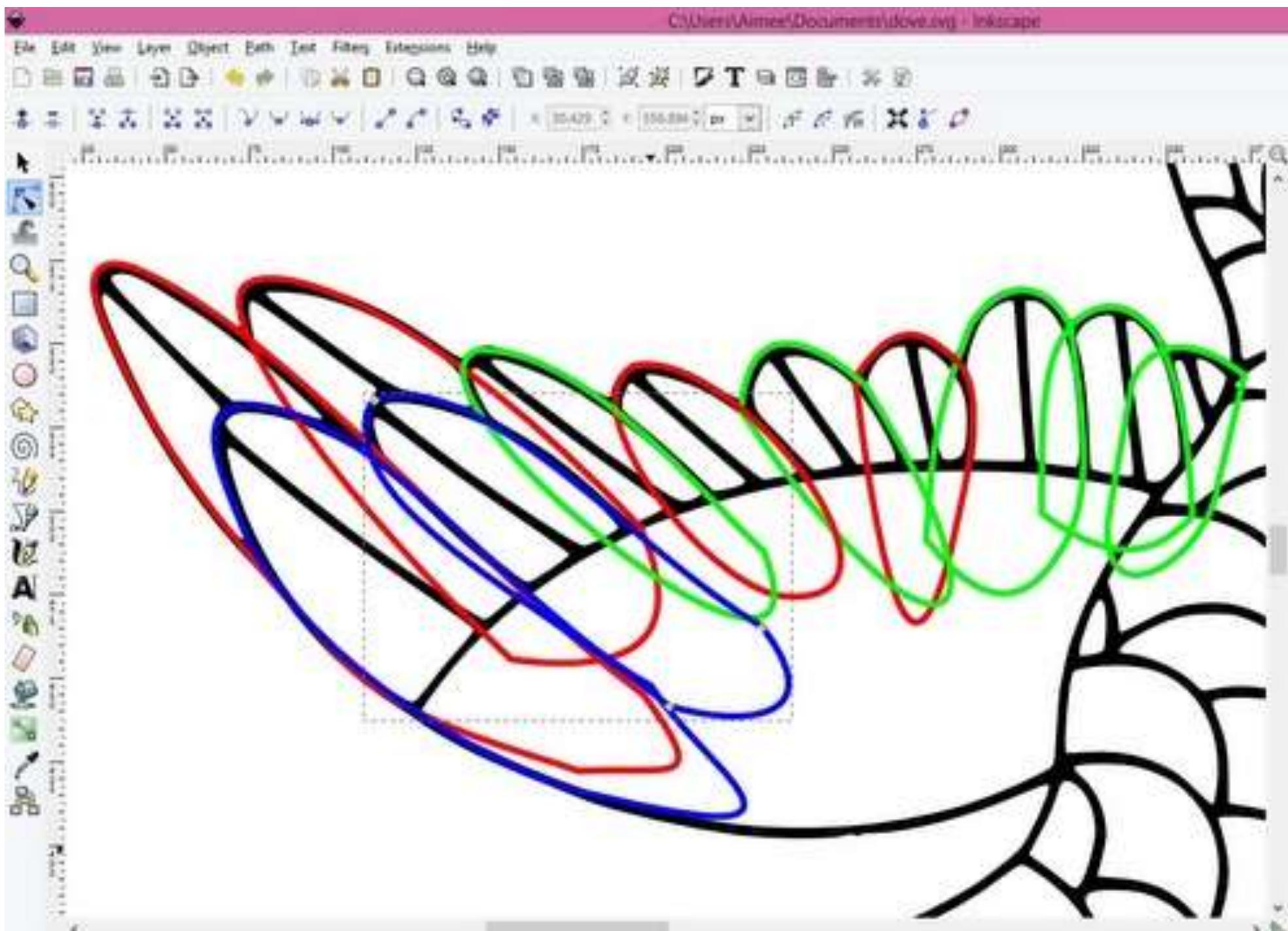
Florentine effect

3D Warp



INKSCAPE

<https://inkscape.org/>





<https://inkstitch.org/docs/install/#>

Error?

Try opening
and re-saving
in Hatch



Requirements

- Create and sew a simple pattern (First Sunday)
 - e.g. circle
- Create and sew a fractal pattern (Second Sunday)
 - E.g. tree

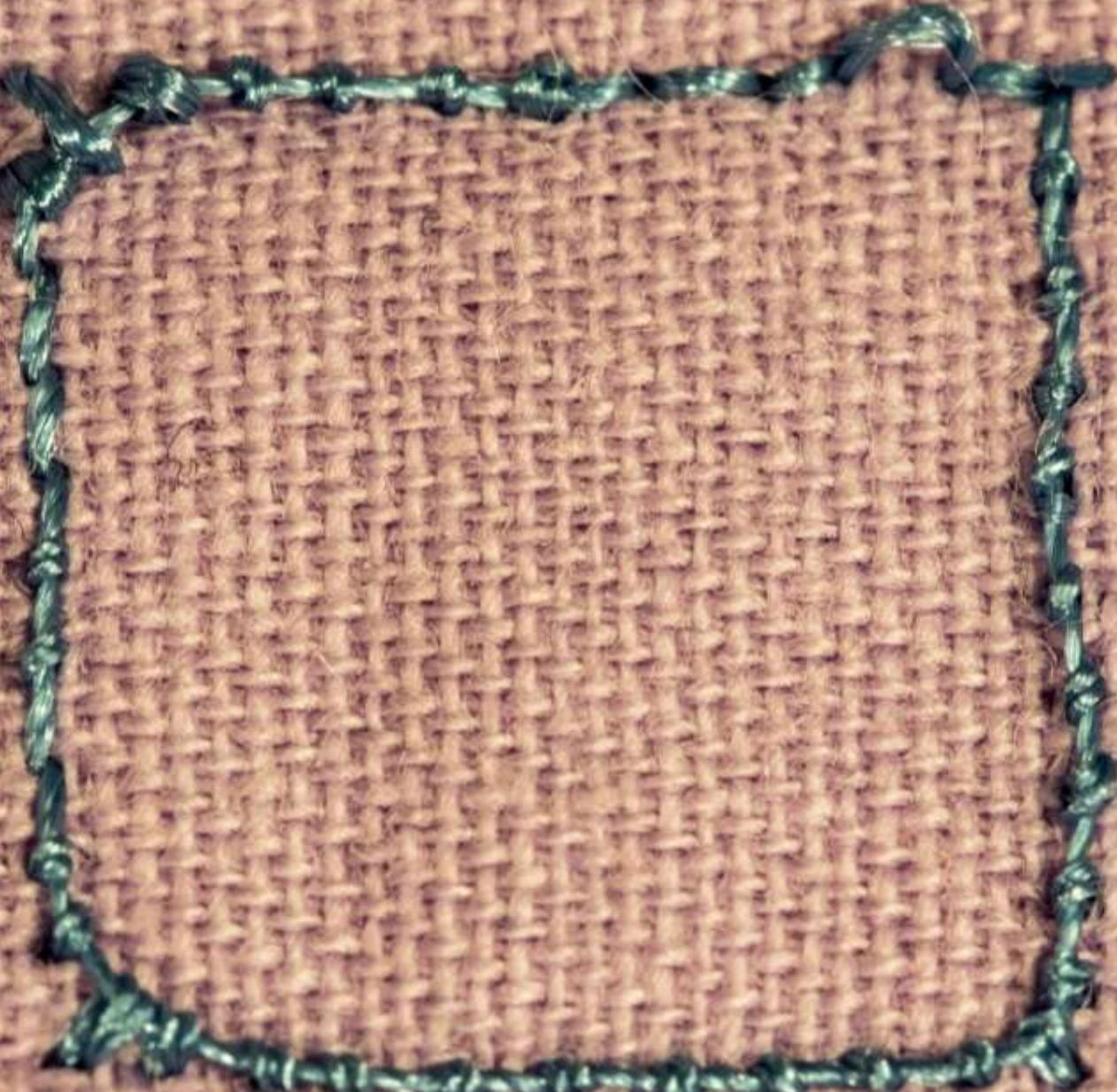
Specifications

- Fit in a 10x10cm hoop
- JEF file generated directly from code
- Fractal pattern is parametric
 - depends on some parameters

Baby Steps

- Start by embroidering square5.jef
 - Compare to image:
- Re-generate square5.jef by running square5.py
 - Test it in Hatch, embroider
- Modify square5.py a bit and repeat
 - E.g. Change size of square,
- Make more changes
 - Change square to circle, test it in Hatch, embroider





Grading

- Complexity and aesthetics of pattern
- Quality of sewing
- Number of parameters
- Use of multiple threads
- Documentation



FABRIC



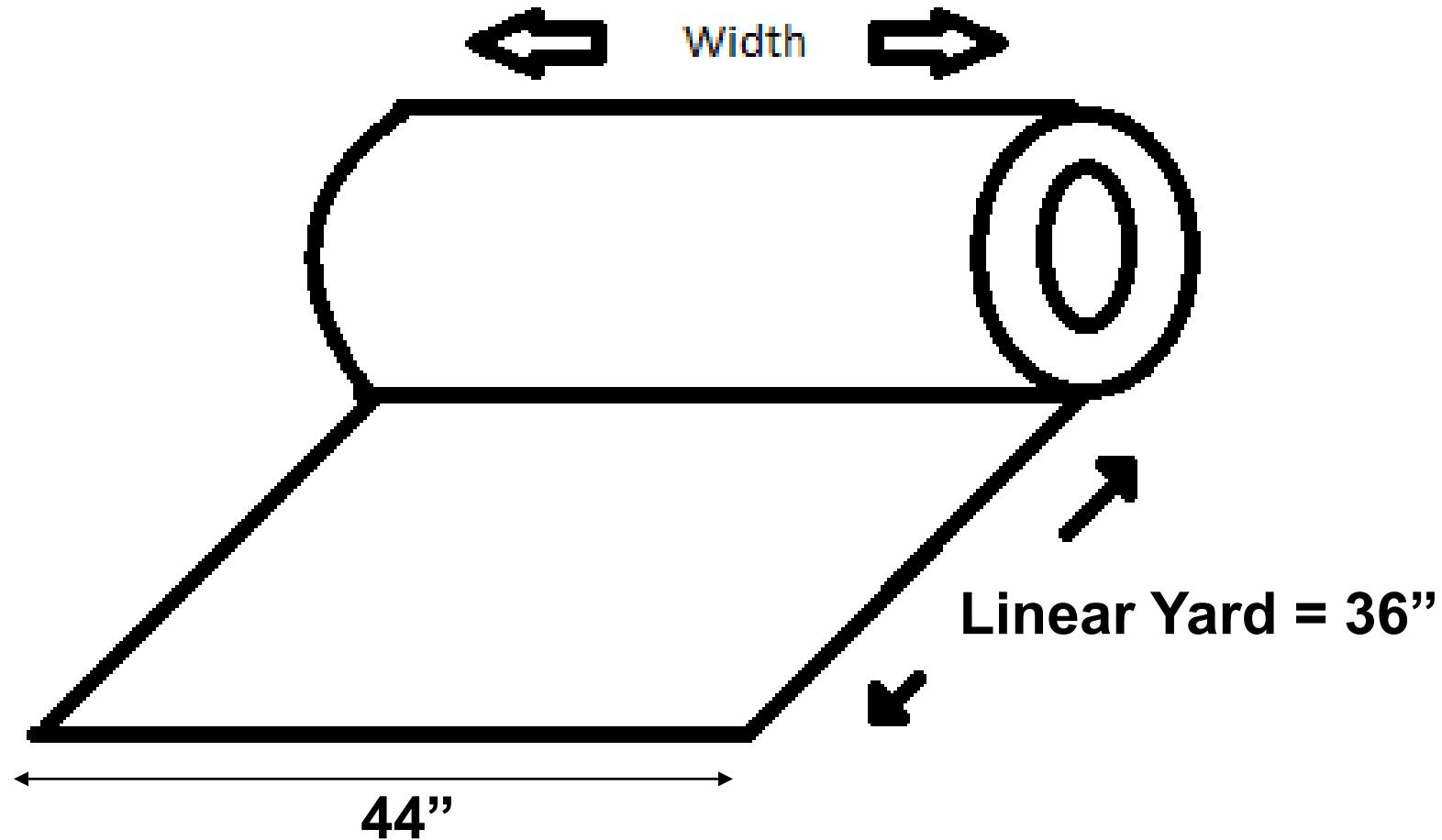






Quilting: “Fat Quarter”





Crosswise Grain, Typically 42"-44"

1 Yard
= 36" Along the Selvage (Lengthwise Grain)

Fat Quarter
18"x22"

Fat Eighth
11"x18"

Regular Quarter Yard, 9"x44"

Selvage Edge

Kona Cotton Solids



Linen Cotton Blend (55%
Linen/45% Cotton)



Nonwovens
Felt 100%
Virgin Wool
Homespun



Silk



THREADS



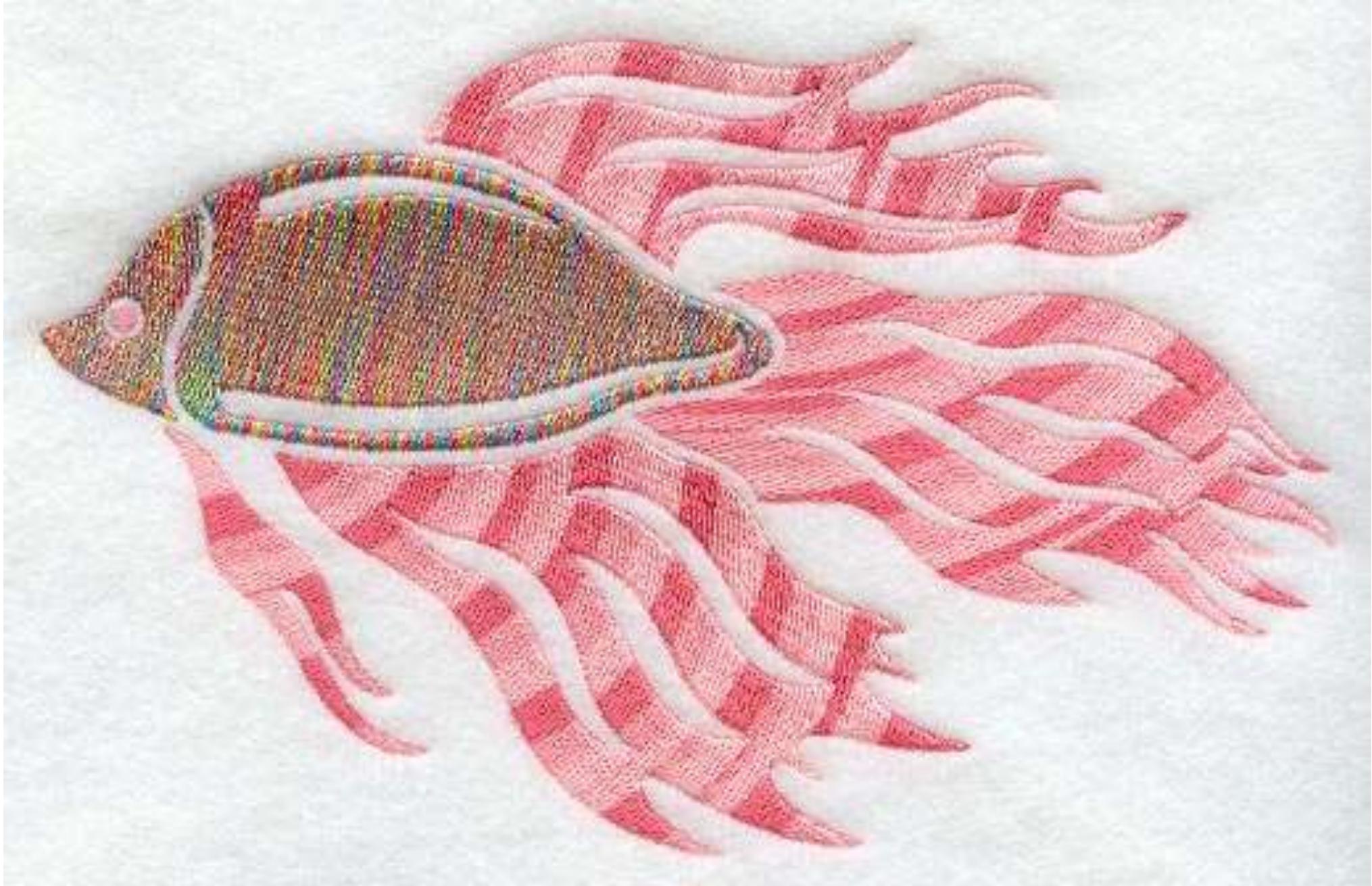
Thread Brands
Janome, Robison-
Anton, Madeira,
Mettler



Metallic

Variegated





<https://www.absolutedigitizing.com/machine-embroidery-specialty-threads-101/>



Sara Gallegos





<https://www.youtube.com/watch?v=J4zuALq-aJo>

STABILIZERS

Stabilizers

- ~ Choosing a Stabilizer
- ~ Cut-Away Stabilizers
- ~ Tear-Away Stabilizers
- ~ Wash-Away Stabilizers
- ~ Specialty Stabilizers
- ~ Toppings



[https://media.rainpos.com/6245/
bernina_justembroiderit_ebook
stabilizers.pdf](https://media.rainpos.com/6245/bernina_justembroiderit_ebook_stabilizers.pdf)



Cut-Away



Tear-Away

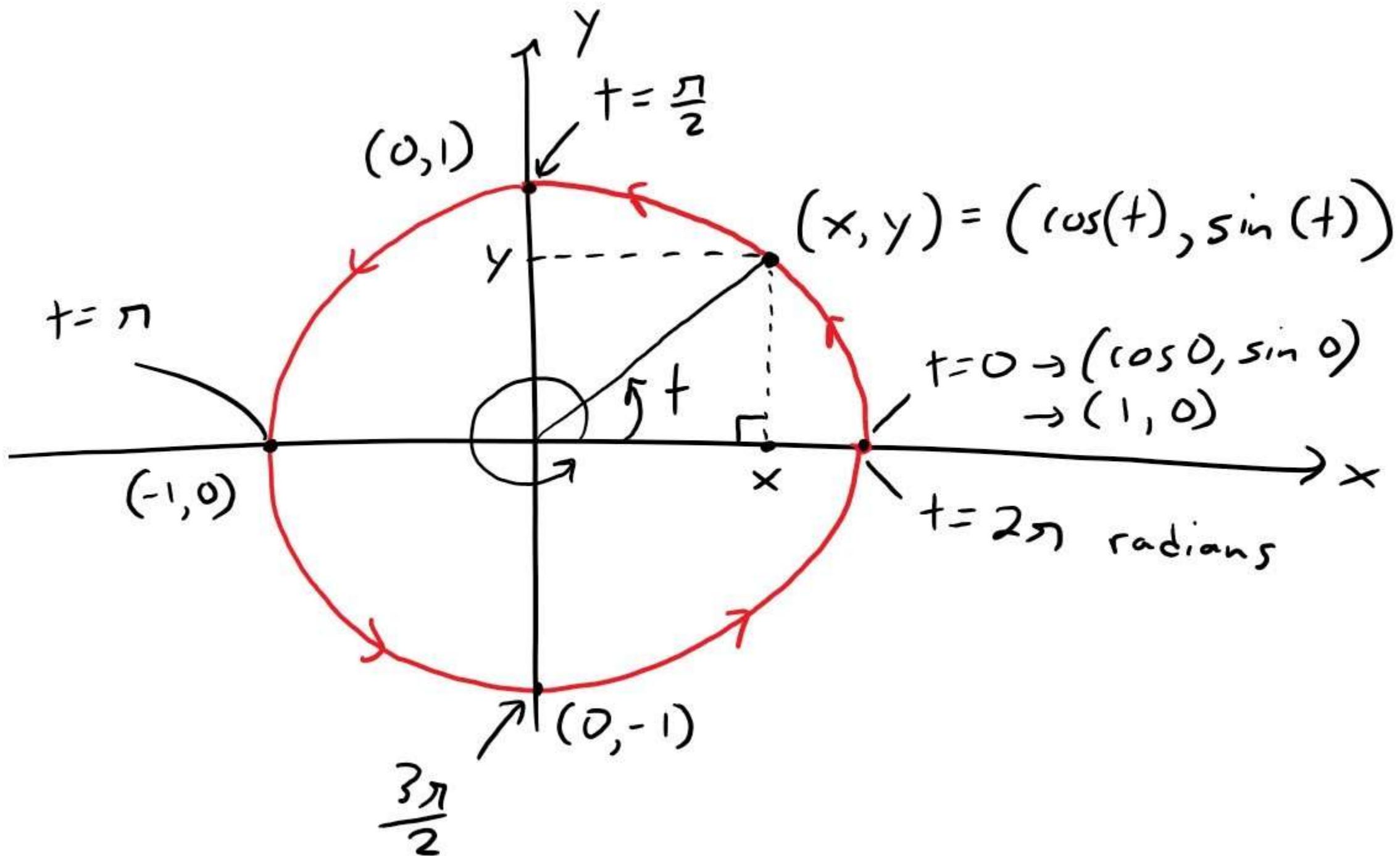


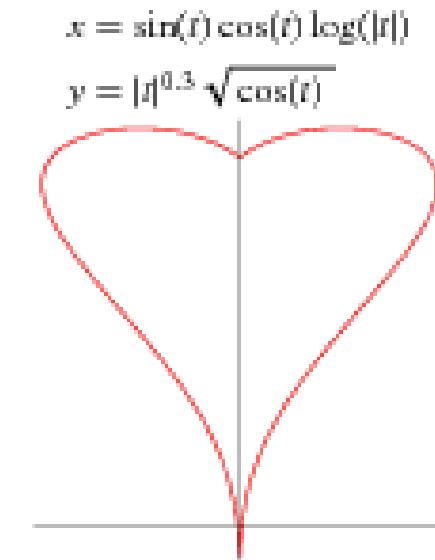
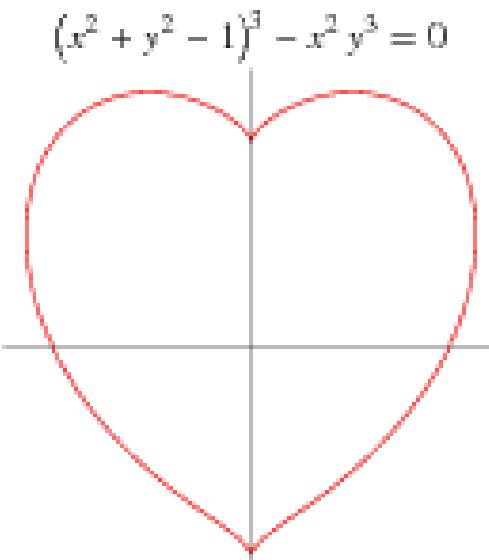
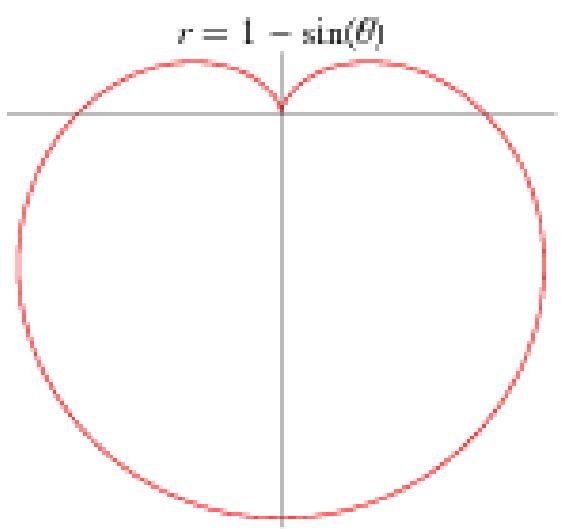
Wash-Away



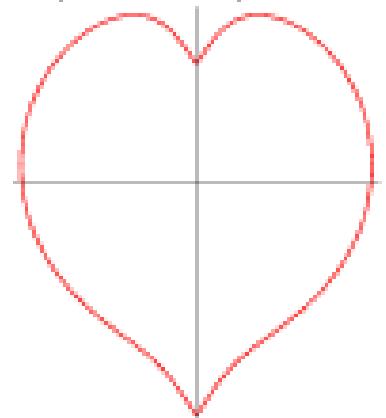


INITIAL PATTERN

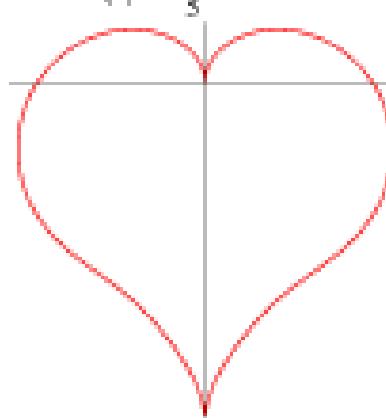




$$\left(y - \frac{2(|x| + x^2 - 6)}{3(|x| + x^2 + 2)} \right)^2 + x^2 = 36$$

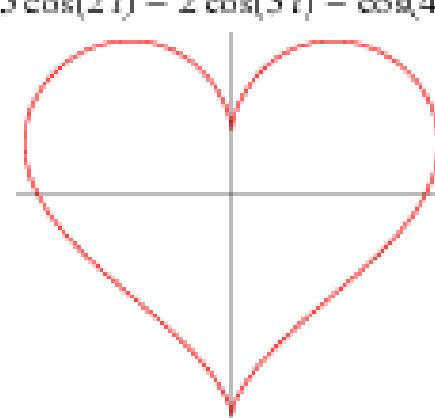


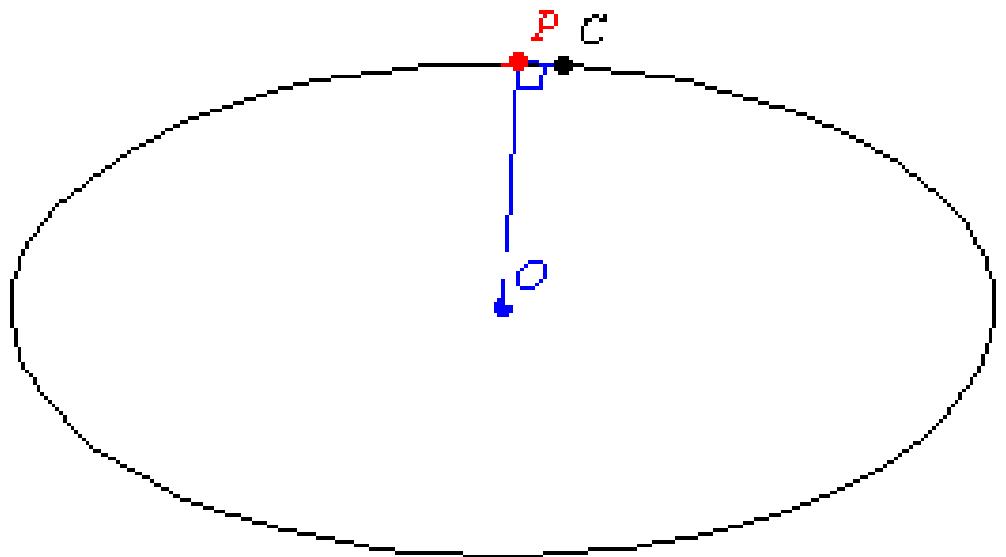
$$r = \frac{\sin(t) \sqrt{|\cos(t)|}}{\sin(t) + \frac{7}{3}} - 2 \sin(t) + 2$$



$$x = 16 \sin^3(t)$$

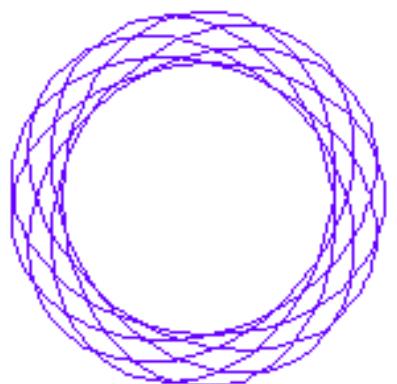
$$y = 13 \cos(t) - 5 \cos(2t) - 2 \cos(3t) - \cos(4t)$$



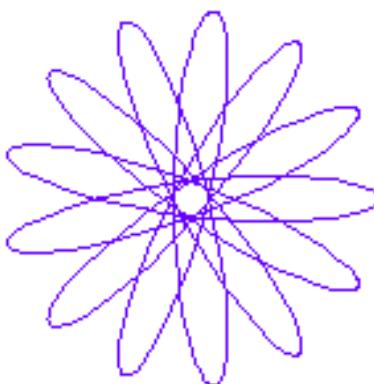


$$x_p = \frac{x_0 f'^2 + f g'^2 + (y_0 - g) f' g'}{f'^2 + g'^2}$$
$$y_p = \frac{y_0 g'^2 + g f'^2 + (x_0 - f) f' g'}{f'^2 + g'^2}.$$

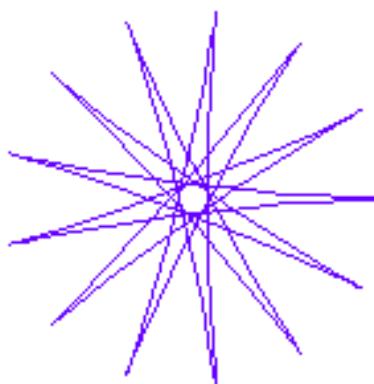
<http://mathworld.wolfram.com/PedalCurve.html>



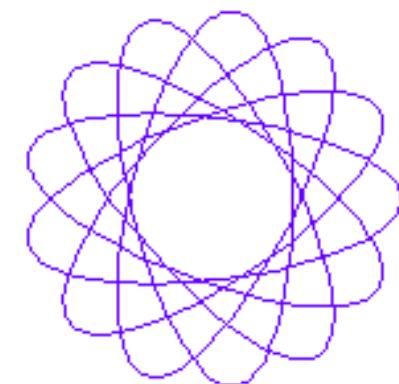
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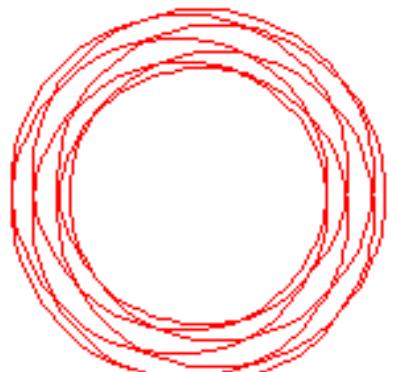
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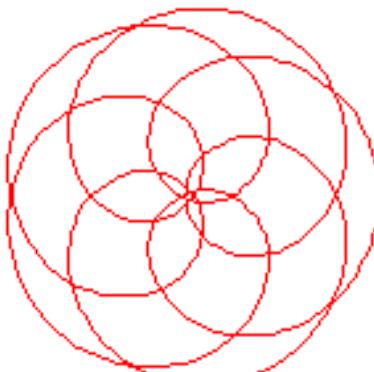
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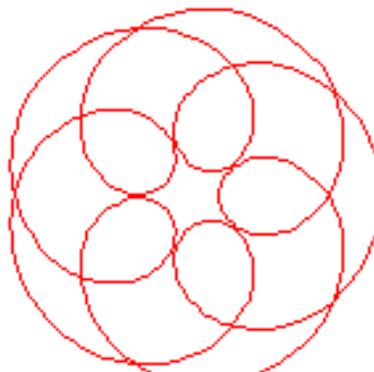
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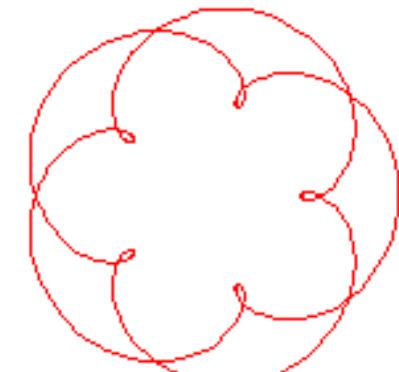
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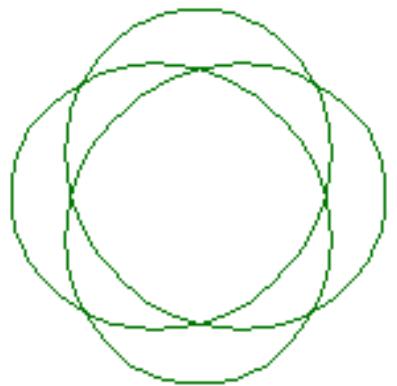
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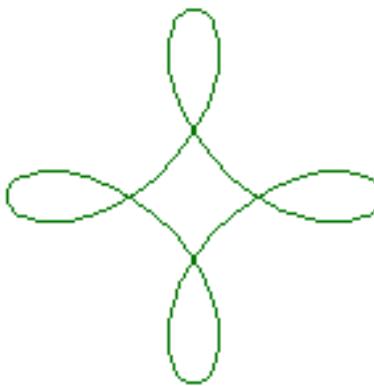
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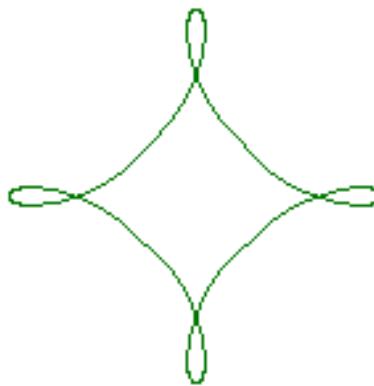
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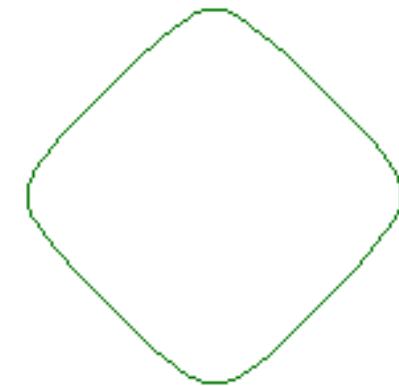
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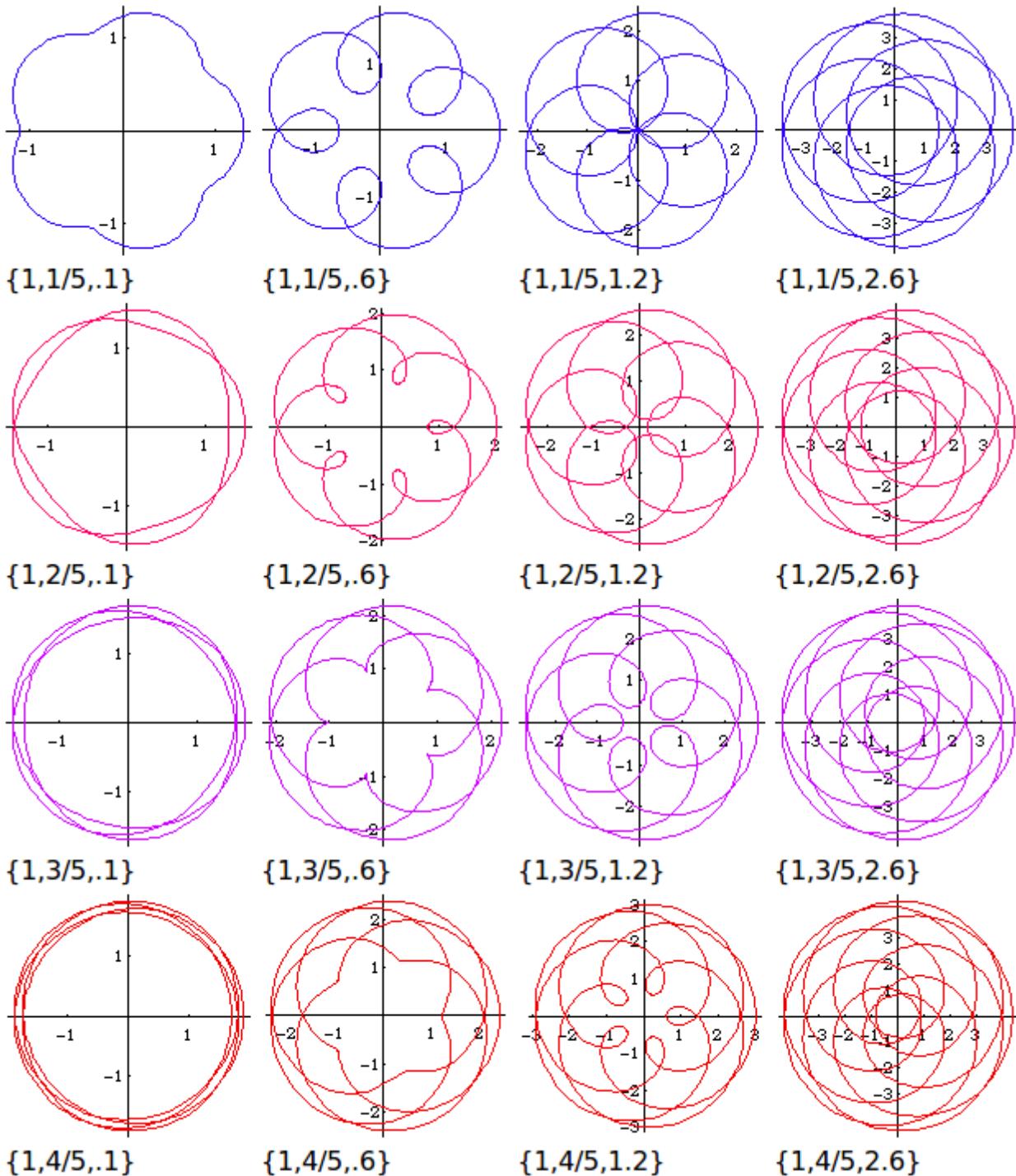
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{1,3/4,7/13}



{1,3/4,30/13}



<http://mathworld.wolfram.com/topics/PlaneCurves.html>

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Discrete Mathematics

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*Created, developed, and
nurtured by Eric Weisstein
at Wolfram Research*

Geometry > Curves >

Plane Curves

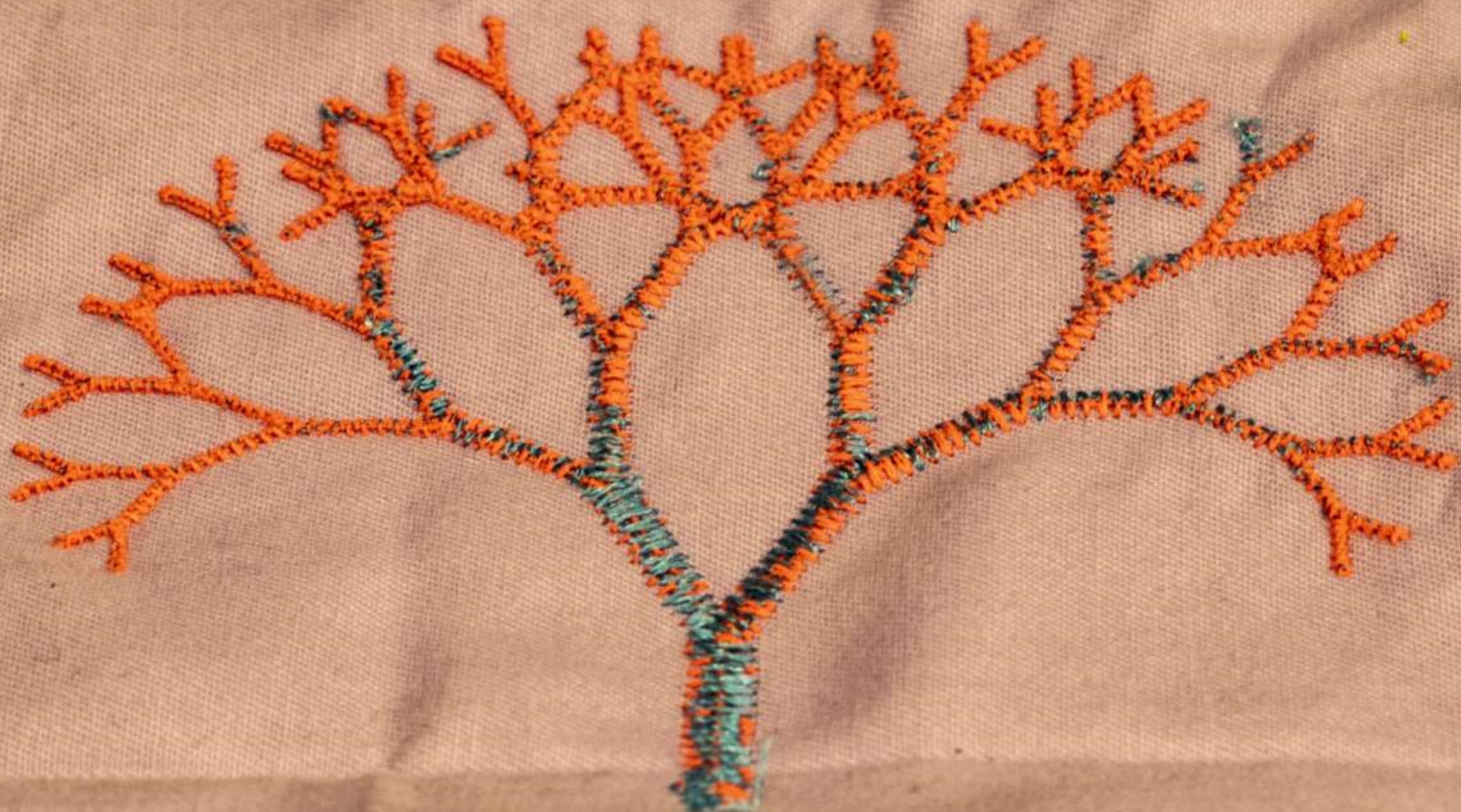
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- [Radial Curves \(10\)](#)
- [Roulettes \(62\)](#)
- [Strophoids \(3\)](#)

OVERSTICHTING





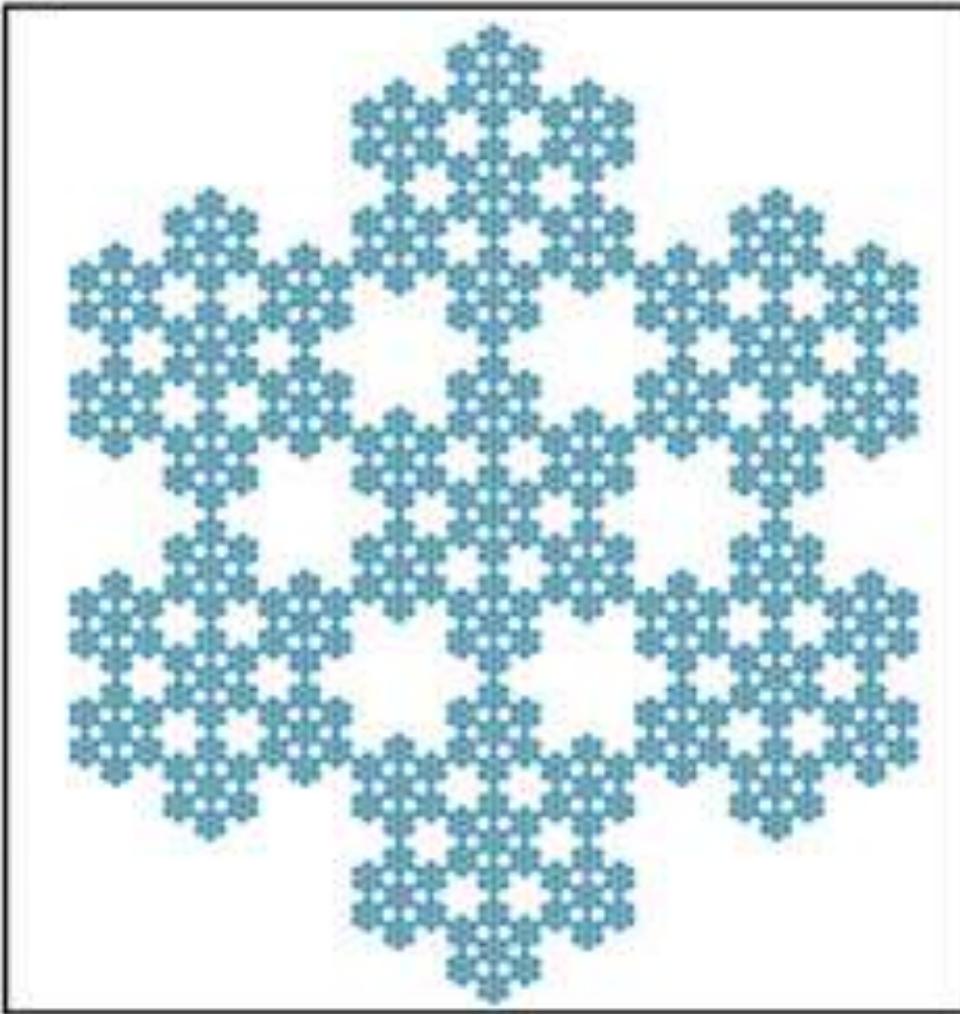




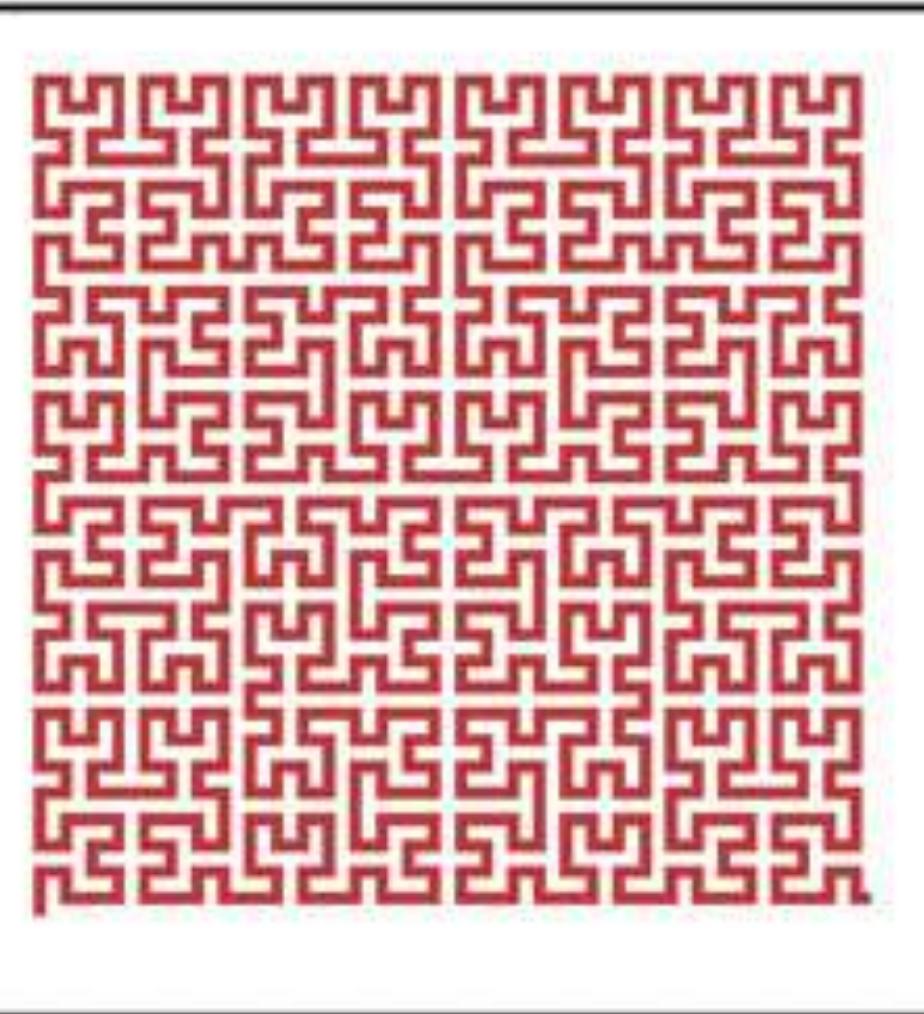
FRACTAL SHAPES

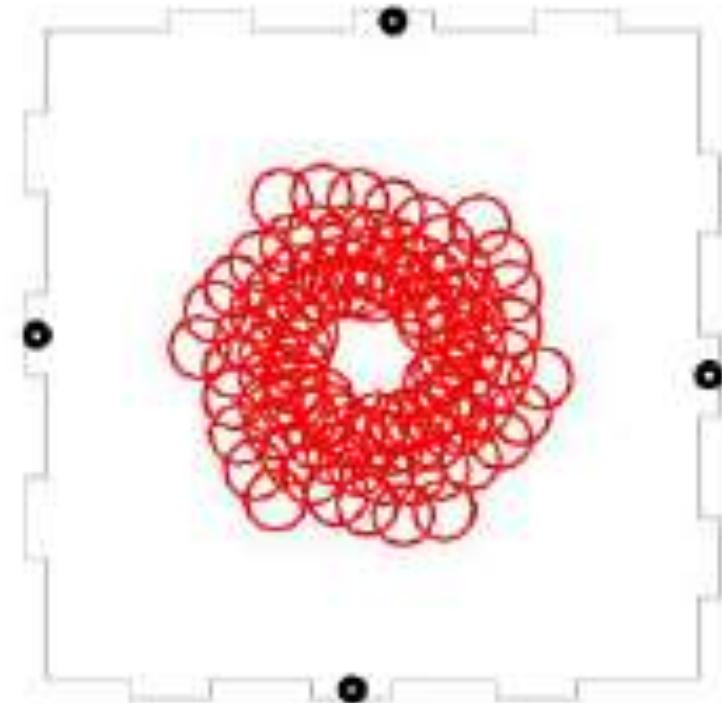
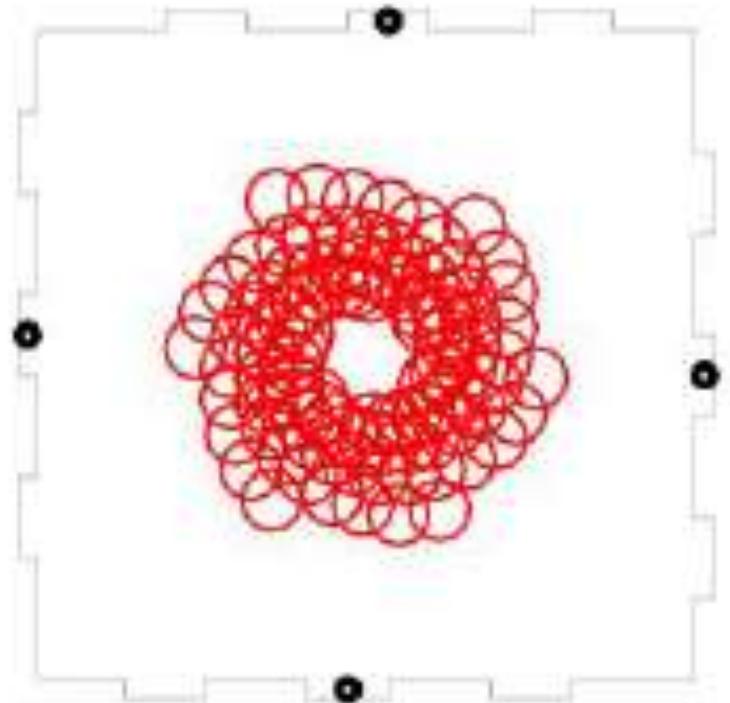
Fractal plane curves

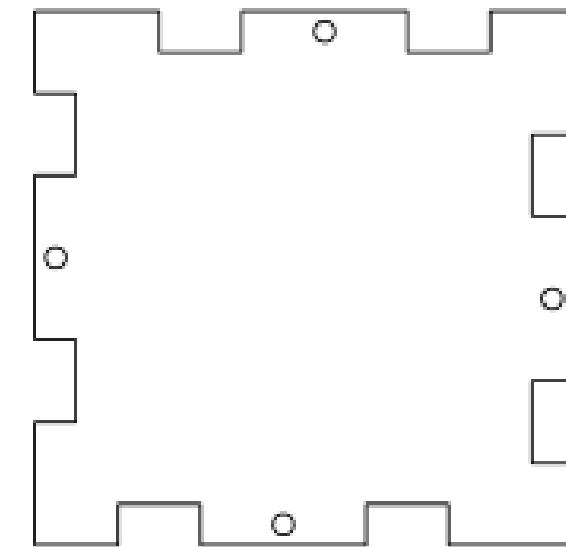
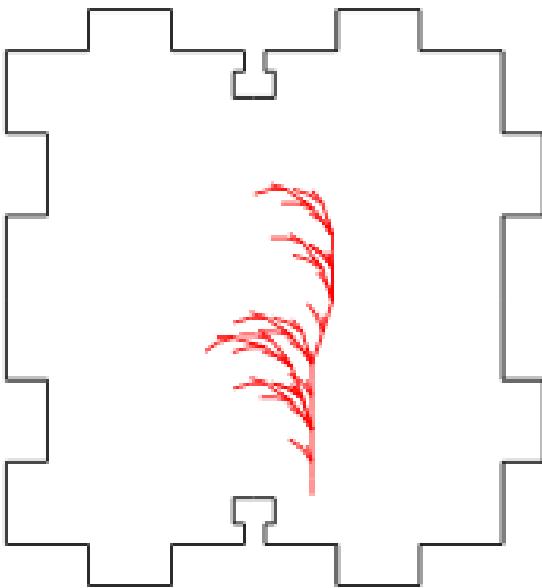
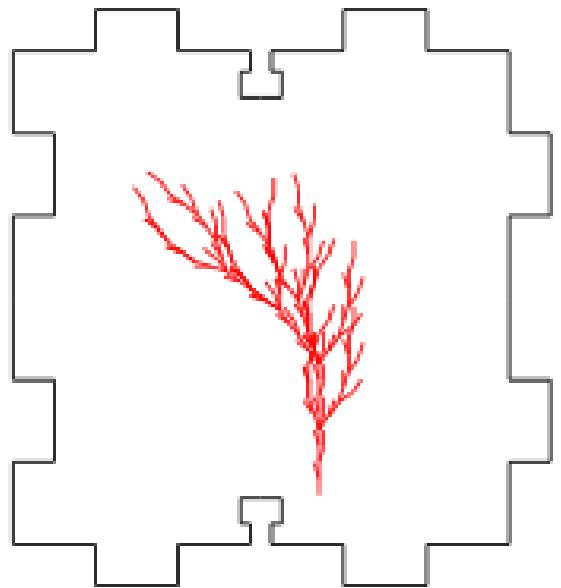
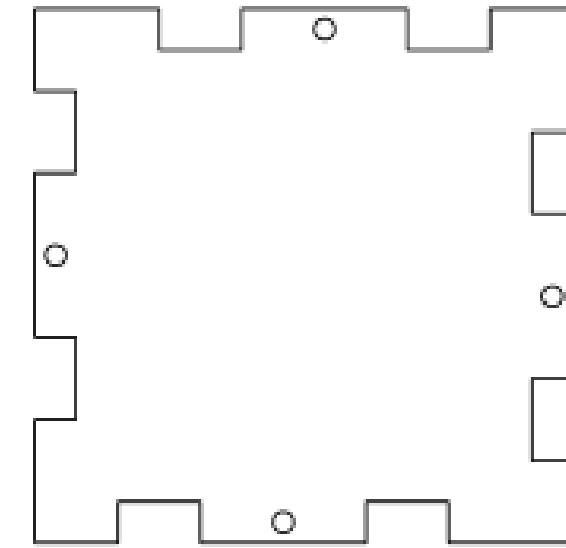
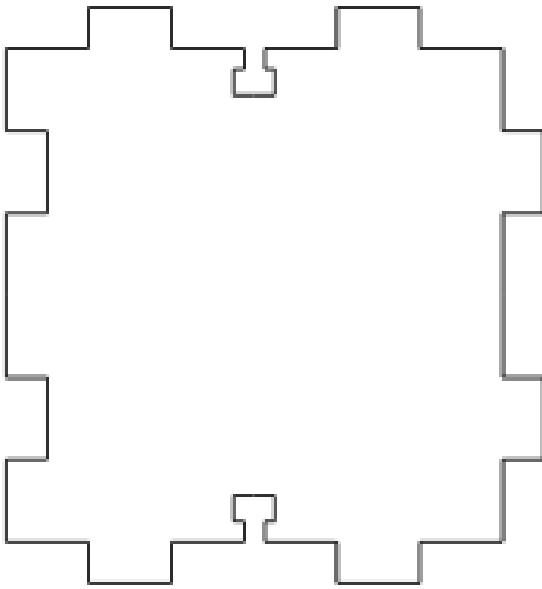
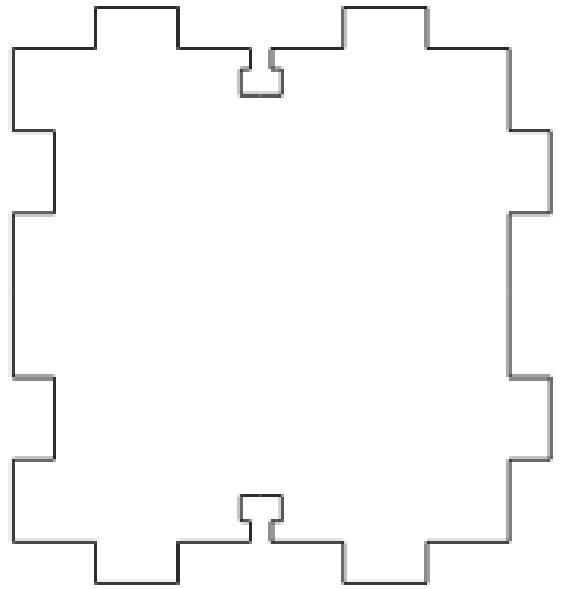
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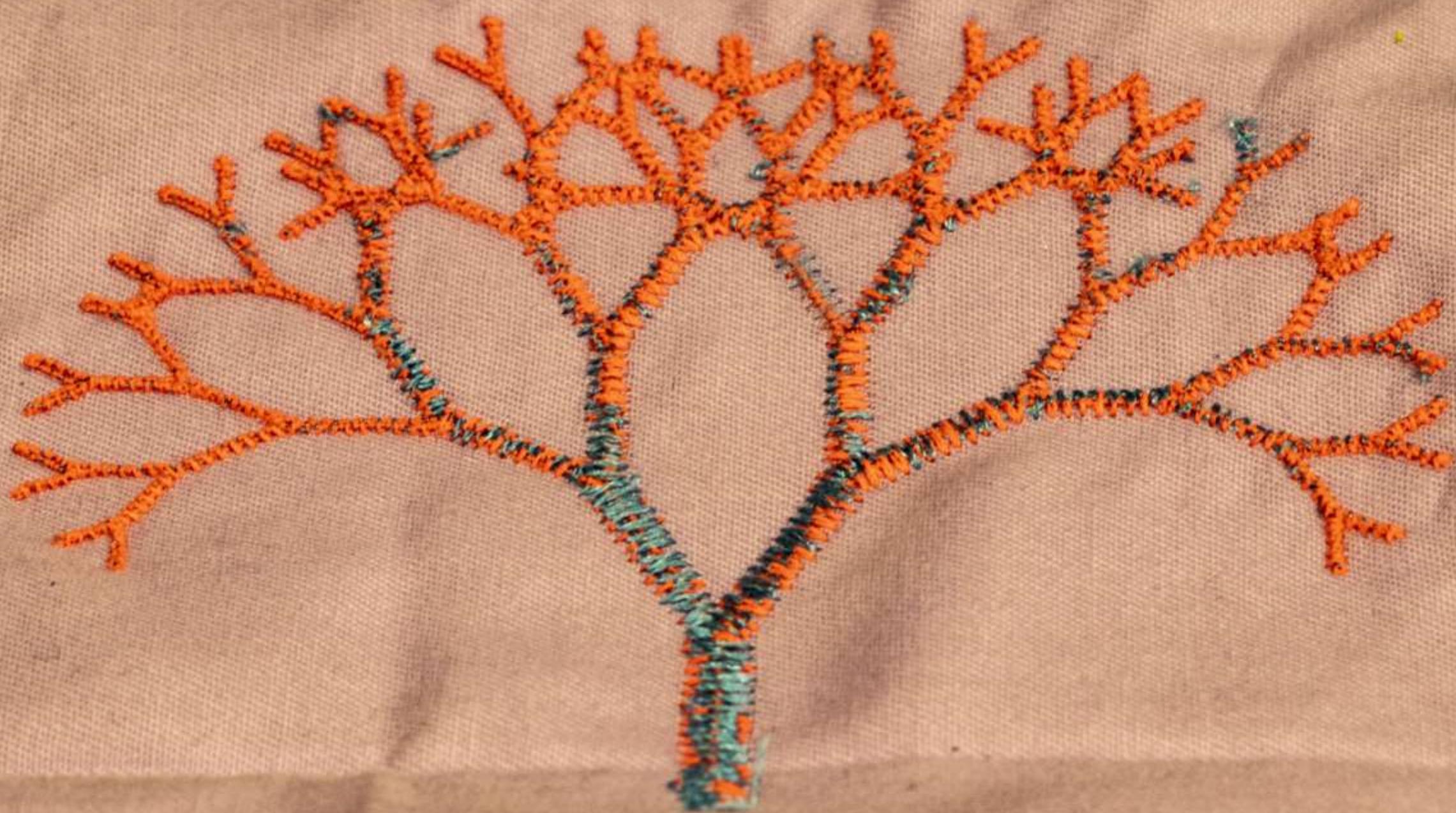
B











Demo

- Starting demo file provided in Python
 - Square5.jef



Steven Cardenas, Mark Cartolano



Kavitha Prasannan and Kassidy MacPhail